



Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT

Title of the project activity	N2O ABATEMENT PROJECT AT NITRIC ACID PLANT NO. 11 AT AFRICAN EXPLOSIVES LTD. (AEL), SOUTH AFRICA	
UNFCCC reference number of the project activity	1364	
Version number of the monitoring report	01	
Completion date of the monitoring report	18/02/2016	
Monitoring period number and duration of this monitoring period	- Number 8 - 23/10/2014 – 05/01/2016 - 440 days	
Project participant(s)	- AEL Mining Services Limited - N.serve Environmental Services GmbH - Nordic Environment Finance Corporation	
Host Party	South Africa	
Sectoral scope(s)	Chemical industries (5)	
Selected methodology(ies)	AM0034 (Version 2)	
Selected standardized baseline(s)	N/A	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	320,007 tCO ₂ e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	0 tCO ₂ e	302,227 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 Standard EN 14181 as required by the methodology.

Relevant dates for the project activity

Registration Date: 08/02/2008

Installation of AMS: January 2006

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
9. Campaign	PC9 – 22/08/2011-17/04/2012
10. Campaign	PC10 – 25/04/2012-04/10/2012
11. Campaign	PC11 – 13/10/2012-26/11/2012
12. Campaign	PC12 – 07/12/2012-05/06/2013
13. Campaign	PC13 – 17/06/2013 – 08/03/2014
14. Campaign	PC14 – 02/04/2014 – 22/10/2014

Project Campaigns covered by current Monitoring/Verification Period:

15. Campaign	PC15 – 23/10/2014 – 25/05/2015
16. Campaign	PC16 – 28/05/2015 – 05/01/2016

Total emission reductions achieved in this monitoring period

The total amount of emission reductions achieved in this monitoring period is 302,227 t CO₂e.

A.2. Location of project activity

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Host Party: South Africa

Region/State/Province: Gauteng / Modderfontain

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 whether the Party involved wishes to be considered as project participant (yes/no)
South Africa (host)	- AEL Mining Services Limited	No
United Kingdom of Great Britain and Northern Ireland	- N.serve Environmental Services GmbH	No
Switzerland	- N.serve Environmental Services GmbH - AEL Mining Services Limited	No
Norway	- Nordic Environment Finance Corporation	No

A.4. Reference of applied methodology and standardized baseline

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- a) AM0034 "Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants"
Version 2

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 2

A.5. Crediting period of project activity

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Type: Non-renewable crediting period

Start date: 08/02/2008
 End date 07/02/2018
 Length: 10 years 0 months

A.6. Contact information of responsible persons/entities

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Organization name	N.serve Environmental Services GmbH
Street/P.O. Box	Grosse Theaterstr. 14
Building	-
City	Hamburg
State/Region	Hamburg
Postcode	20354
Country	Germany
Telephone	+494030997860
Fax	+4940309978610
E-mail	contact@nserve.net
Website	www.nserve.net
Contact person	Nikolaus Gutknecht-Stöhr
Title	Head of Portfolio Management
Salutation	Mr
Last name	Gutknecht-Stöhr
Middle name	
First name	Nikolaus
Department	Portfolio Management
Mobile	+49163 314 2825
Direct fax	+4940309978610
Direct tel.	+4940309978615
Personal e-mail	gutknecht@nserve.net

The entity is also a project participant as listed in Appendix 1 below.

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 norm EN 14181 (for a detailed description, see Section C)
- 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

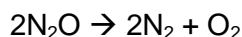
Catalyst Technology

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.

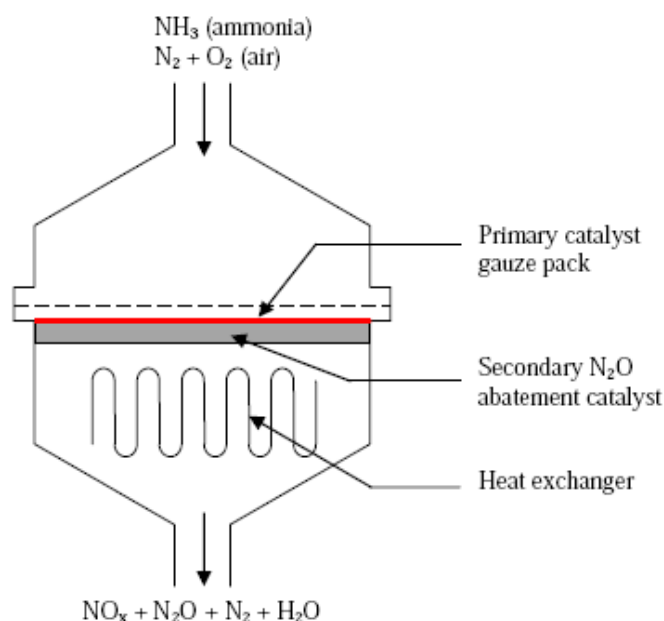
A secondary catalyst will reduce N_2O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N_2O abatement catalysts. The YARA 58 Y 1® abatement catalyst is made of cylindrical pellets 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 up to 80-90% in the following reaction:



If operated properly, the secondary catalyst system has a lifetime of several campaigns and may reduce N_2O 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 N_2O abatement catalyst.

N_2O 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 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. Please note that AMS downtime is only listed below if the plant was operating at the time of the AMS downtime.

Start date and hour	End date and hour	Campaign	Short Description
24/10/2014 16:00		PC15	Start of PC15 after gauze change.
31/10/2014 12:00	31/10/2014 23:00	PC15	No data recording, plant considered offline
13/11/2014 13:00	20/11/2014 12:00	PC15	Plant trip on faulty radio transmitter, remained offline for repair of NO compressor
29/11/2014 05:00	30/11/2014 04:00	PC15	Plant trip due to problems with steam
03/12/2014 20:00	10/12/2014 17:00	PC15	Shut down for repair of expander
17/12/2014 10:00	17/12/2015 19:00	PC15	Plant trip due to high ratio
02/01/2015 00:00	02/01/2015 23:00	PC15	No data recording, plant considered offline
16/01/2015 13:00	05/08/2015 12:00	PC15/PC16	N ₂ O Analyser failed
26/01/2015 14:00	26/01/2015 22:00	PC15	Plant shutdown due to steam problems
27/02/2015 09:00	28/02/2015 23:00	PC15	No data recording, plant considered offline
06/03/2015 13:00	09/03/2015 10:00	PC15	No data recording, plant considered offline
19/03/2015 18:00	19/03/2015 20:00	PC15	Plant trip

19/03/2015 22:00	20/03/2015 00:00	PC15	Plant trip
20/04/2015 02:00	20/04/2015 02:00	PC15	No data recording, plant considered offline
22/04/2015 10:00	22/04/2015 10:00	PC15	No data recording, plant considered offline
30/04/2015 03:00	30/04/2015 03:00	PC15	No data recording, plant considered offline
25/05/2015 05:00	29/05/2015 07:00	PC15/PC16	Plant shut down for gauze change
04/06/2015 11:00	05/06/2015 23:00	PC16	No data recording, plant considered offline
25/06/2015 13:00	25/06/2015 22:00	PC16	Plant shut down due to low steam pressure
29/06/2015 14:00	30/06/2015 05:00	PC16	Plant shut down due to low steam pressure
01/08/2015 00:00	01/08/2015 23:00	PC16	No data recording, plant considered offline
11/08/2015 11:00	14/08/2015 11:00	PC16	No data recording, plant considered offline
14/08/2015 12:00	05/01/2015 23:00	PC16	N ₂ O Analyser failed
18/08/2015 17:00	19/08/2015 14:00	PC16	No data recording, plant considered offline
31/08/2015 09:00	31/08/2015 23:00	PC16	No data recording, plant considered offline
19/09/2015 10:00	20/09/2015 01:00	PC16	Plant offline due to steam problem
03/10/2015 05:00	03/10/2015 17:00	PC16	Plant shut down on capacity control
05/10/2015 03:00	11/10/2015 16:00	PC16	Plant offline due to maintenance
12/10/2015 09:00	12/10/2015 23:00	PC16	No data recording, plant considered offline
30/10/2015 15:00	31/10/2015 23:00	PC15	No data recording, plant considered offline
08/11/2015 18:00	14/11/2015 09:00	PC16	Plant downtime
17/11/2015 19:00	18/11/2015 15:00	PC16	Plant downtime
30/11/2015 11:00	30/11/2015 23:00	PC16	No data recording, plant considered offline
17/12/2015 20:00	21/12/2015 19:00	PC16	Plant tripped due to power dip.
22/12/2015	22/12/2015	PC16	Plant tripped

11:00	14:00		
04/01/2015 20:00		PC16	Plant shut down for gauze change
05/01/2015		PC16	Gauze change and end of PC16

According to the methodology, the highest measured value in the campaign has to be applied for any downtime period of the AMS during the project campaigns. The downtime periods of the AMS during the project campaigns of this monitoring period are stated in section E2.

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

B.2. Post-registration changes

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

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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. 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.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

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The monitoring plan was already included in the registered PDD.

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

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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.2.6. 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.2.7. 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 N_2O 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 N_2O Analyser was Environnement S.A. MIR 9000. After the measurements for the baseline campaign were completed it was replaced by an 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

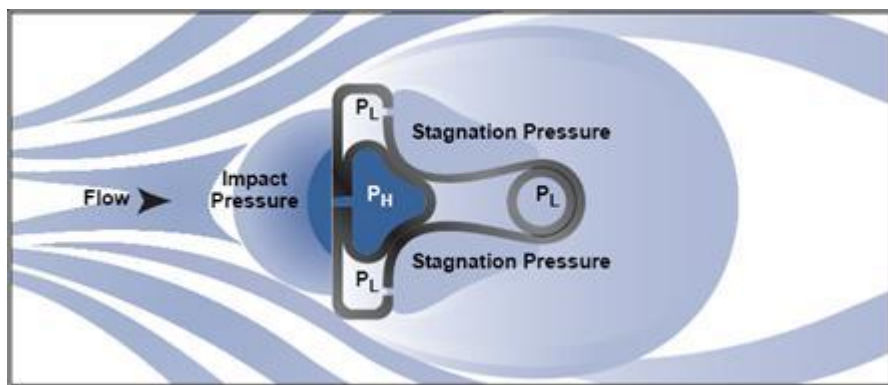
The Emerson Rosemount Flow Meter Annubar®, model no. 485, relies on the Averaging Pilot Tubes (APT's).

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 Standard 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 Technical Manager (TM) has the overall responsibility for the CDM data.

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. Nikolaus Gutknecht-Stöhr, the Project Manager for this project at 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 an 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 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

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

The N₂O analyzer is calibrated once per year by external QAL2 or AST 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 the suppliers laboratory.

Flow meter calibration procedures

The flow meter is calibrated once per year by external QAL2 or AST 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.

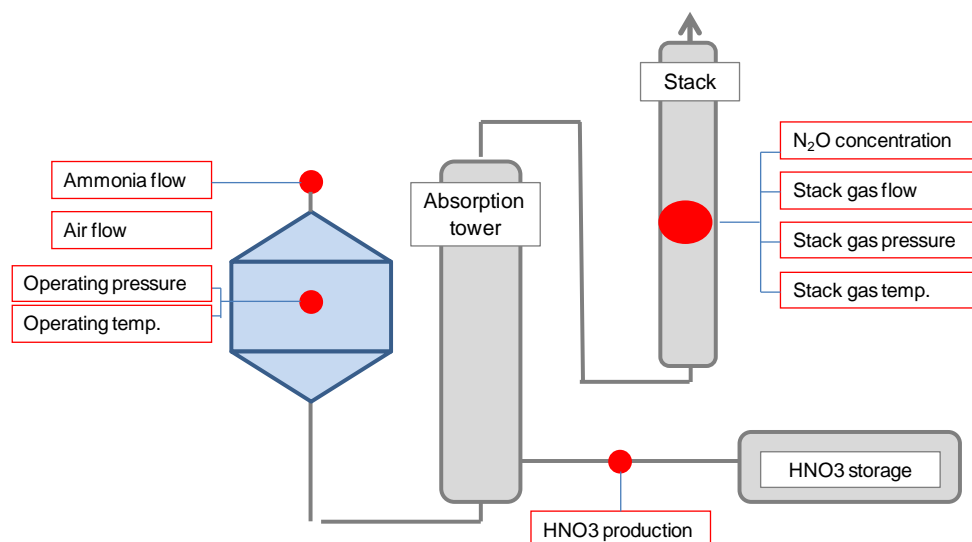


Figure: Monitoring Points for all relevant Parameters (NCSG, VSG, TSG, PSG, NAP, OTh, OPh, AFR, AIFR)

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 week's 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).

N.serve Database Management System (N.DBMS)

All data necessary for the monitoring and verification procedures related to the project activity are transferred from the nitric acid plant's data acquisition system into N.serve's dedicated relational database management system ("N.DBMS") based on Microsoft Access 2002. Database management systems are designed for a structured storage of large amounts of data providing for minimum redundancy and maximum flexibility to allow best practice data analysis.

The N.DBMS is designed to conduct all the calculation steps required by the methodology in order to derive the baseline and project emissions factors and to calculate the amount of emission reductions resulting from the project activity.

The use of the N.DBMS system is described in the PDD and therefore part of the validated monitoring plan. However for the purpose transparency and easy cross checks all calculations are provided in an EXCEL calculation sheet.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

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

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 15: 1,630.03 Value applicable for Project Campaign 16: 1,630.03

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.

Choice of data or measurement methods and procedures	<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 SCADA data acquisition system. NCSG data taken during times when the plant was operating outside the permitted operating range were eliminated. The remaining hourly average values were subjected to the following calculation steps:</p> <ol style="list-style-type: none"> Calculate the sample mean (\bar{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 NCSG values <p>The value is converted from ppmv (the mean being 828.87 ppmv) as permitted by AM0034.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>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 underestimates the N₂O 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}.</p> <p><i>Calibration information</i> <i>During Baseline period 20/07/2006 – 18/02/2007:</i> Bi-weekly Zero and span check and calibration in case of deviation >1% of range of analyzer against zero gas and certified calibration gas cylinder (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</p> <p><i>Date of last external calibration:</i> 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 order to correct the underestimation. Moreover the overall uncertainty of the AMS was applied in a conservative manner to the results of baseline emissions.</p>

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

Choice of data or measurement methods and procedures	<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 SCADA data acquisition system. VSG data taken during times when the plant was operating outside the permitted operating range were eliminated.</p> <p>The flow meter is ranged to a maximum flow of 150,000 m³/h (corresponding to normal m³ at a stack temperature of 113°C and stack pressure of 85.6 kPa (absolute) or 856 mbar) and a maximum differential pressure of 1.898 kPa (gauge). The flow meter was not re-ranged during the baseline campaign in order to avoid a confusion of the baseline date. Therefore, the measured VSG data have to be multiplied with a standard factor of 0.9594 in order to give the normal flow for the above assumed conditions.</p> <p>This factor will be readjusted in the QAL2-testing process that the AMS installed at the No. 11 plant will be subject to. This test will be conducted – in accordance with the requirements of AM0034 – for N₂O concentration and stack gas volume as specified by EN 14181.</p> <p>For the project campaigns, the flow meter will be readjusted to the appropriate range so that this factoring of the measured value is no longer necessary.</p> <p>Also, the corrected measured data need to be compensated for the actual prevailing temperature and pressure in the stack through the following calculation:</p> $\frac{P_s * V_s}{T_s} = \frac{P_a * V_a}{T_a}$ <p>Where: P refers to the Pressure (mbar) [conversion from kPa to mbar is a factor of 10] V the volumetric flow rate (m³/hr) T the temperature in Kelvin (Note 1 K = T (°C) + 273). Subscript "s" refers to the actual stack values Subscript "a" refers to the assumed stack conditions.</p> <p>This simplifies to:</p> $V_s = V_a * \frac{P_a}{T_a} * \frac{T_s}{P_s}$ <p>As an example</p> <p>The assumed stack temperature and pressure values are 113°C and 846 mbar. The measured values are: 115.16 °C and 842.59 mbar. Using a flow from the acquisition system of 73,165.32 and the conversion of 0.9594 gives a final flow of 70,873.28 Nm³/hr.</p> $73165.32 * 0.9594 * \frac{846 * (115.16 + 273)}{(273 + 113) * 842.59} = 70873.28$ <p>The resulting hourly average VSG values are now expressed in Nm³/h as required by AM0034 and where subsequently subjected to the following calculation steps:</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
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks

Additional comment:	<p>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 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><i>Calibration information</i> 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 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 15: 651.983 Value applicable for Project Campaign 16: 651.983
Choice of data or measurement methods and procedures	The total mass N ₂ O emissions during the baseline campaign are determined as a product of NCSG, VSG and the total hours of operation during that baseline campaign: $BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}$
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
Choice of data or measurement methods and procedures	Required by AM0034 to determine the total mass emissions of N ₂ O during the baseline. Since the design plant operating temperature is between 820°C and 905°C, by definition the plant is offline if the temperature recorded is at or below 800°C. For practical purposes, each hour for which the ammonia oxidation temperature (OT_h) was recorded to be below 830°C is excluded from the determination of OH_{BC} .

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
Choice of data or measurement methods and procedures	<p>Required by AM0034 to calculate the average baseline emissions factor (EF_{BL}) per tonne of 100% concentrated nitric acid produced during that baseline campaign. NAP is determined by a mass balance calculation according to the following procedures:</p> <p>The opening and closing stock are determined by tank level measurements of the plant operator for each production day and recorded in the production logs.</p> <p>Currently roughly 5% of the nitric acid production is delivered to consumers outside of AEL. A pipeline delivers nitric acid to external consumers based on the same site as the No. 11 nitric acid plant. The delivery volumes are measured by flow meters. Deliveries of nitric acid to consumers by tanker truck are checked and recorded on a weighbridge.</p> <p>The majority of nitric acid produced (approximately 95%) is supplied to AEL's own Ammonium Nitrate (AN) plants on the same site via pipeline. The transferred volumes of nitric acid are determined by tank level measurements before and after the transfer. Normally there is no nitric acid production supplied into the tanks during times of transfer to on-site consumers. Should that be the case, the tank levels at the receiving plant are checked for received nitric acid volumes instead to determine the delivered nitric acid volumes.</p> <p>The total nitric acid delivered is then calculated by a mass balance calculation.</p> <p>Using all these figures the total mass of nitric acid produced is calculated to derive the <u>Calculated Production</u>. Because both of AEL's nitric acid plants on site (No. 11 and No. 9) produce into the same storage tank, the Calculated Production is a combined result for both plants.</p> <p>There is also a coriolis flow meter installed, which continuously measures the production output of nitric acid into the storage tank. However, this flow meter is quite unreliable which is why AEL uses the calculated values for its financial planning and reporting and uses the flow meter results only for plausibility checks.</p> <p>The value of NAP has to be adjusted in accordance with the results of a comparison between CL_{BL} and CL_{normal}. In the case of AEL No. 11, the baseline campaign was longer than the normal historic campaign length. Therefore, NAP_{BC} as stated herein is not used for the calculation of EF_{BL}, but rather CL_{normal} is applied. The same adjustment will be applied to the value of operational hours (OH).</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>The nitric acid flow meter is subject of external calibration procedures every 3 years.</p> <p>Calibration information During Baseline period 20/07/2006 – 18/02/2007:</p> <p>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</p>

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
Choice of data or measurement methods and procedures	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 temperature probes inserted directly next to the flow meter inside the stack. The resulting measurements are applied to each hourly mean VSG value for calculation of normal volume flow.
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>The TSG result is automatically applied for calculating VSG at standard conditions</p> <p>Calibration information</p> <p>Calibration information</p> <p>During Baseline period 20/07/2006 – 18/02/2007</p> <p>Internal calibrations: after each campaign</p> <p>Date of internal calibration :19/07/2006</p> <p>Date of internal calibration :23/02/2007</p> <p>Date of last external calibration:</p> <p>QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012</p>

Data / Parameter:	B.7 PSG
Unit:	Pa (absolute)
Description:	Pressure in the stack
Source of data:	Stack pressure probe situated directly next to flow meter
Value(s) applied):	Not applicable
Choice of data or measurement methods and procedures	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.
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>The PSG result is automatically applied for calculating VSG at standard conditions</p> <p>Calibration information</p> <p>Calibration information</p> <p>During Baseline period 20/07/2006 – 18/02/2007</p> <p>Internal calibrations: after each campaign</p> <p>Date of internal calibration :19/07/2006</p> <p>Date of internal calibration :23/02/2007</p> <p>Date of last external calibration:</p> <p>QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012</p>

Data / Parameter:	B.8 EF_{BL}
Unit:	tN ₂ O / tHNO ₃
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 15: 0.004647 Value applicable for Project Campaign 16: 0.004647
Choice of data or measurement methods and procedures	As required by AM0034 the plant specific baseline emissions factor representing the average N ₂ O emissions per tonne of nitric acid during the baseline campaign is derived by dividing the total mass of N ₂ O emissions by the total output of 100% concentrated nitric acid during the baseline campaign. The overall uncertainty of the monitoring system shall also be determined and the measurement error will be expressed as a percentage (UNC). The N ₂ O emission factor per tonne of nitric acid produced in the baseline period (EF _{BL}) shall then be reduced by the percentage uncertainty as follows: $EF_{BL} = (BE_{BC} / NAP_{BC}) (1 - UNC/100) (tN_2O/tHNO_3)$ The given value is based on the preliminary assumption that the UNC value equals 5%. This estimate will be substituted by the accurate value based on the QAL2-test yet to be conducted.
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
Choice of data or measurement methods and procedures	In accordance with AM0034 the overall measurement uncertainty of the AMS is applied in the calculation of the baseline emissions factor (EF _{BL}). No uncertainty data was available from the analyser vendor. Therefore, Calibration data from the analyser vendor was used to calculate the expected uncertainty. The calculated values provided by the vendors of the flow meter (Rosemount engineering report), stack temperature (uncertainty according to SABS standard specifications) and pressure probes (Rosemount data sheet), the flow meter DP cell (Rosemount engineering report), the temperature transducer (calculation calibration data), the analogue input card as well as the rounding errors resulting in the data acquisition system (SCADA) were used to calculate the overall uncertainty of the AMS by taking the square root of the sum of the squares of these values.
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} .

Choice of data or measurement methods and procedures	Normally, the monitoring of AFR is required by AM0034 in order to determine AFR _{max} based on the historic campaigns. The AFR _{max} -value thus obtained is then used to determine those periods during the baseline and the subsequent project campaigns where the plant is operating outside of the permitted operating conditions.																																			
	As direct historic hourly values on gaseous ammonia flow to the plant's converter is unavailable for the No. 11 plant, AEL has determined the AFR values based on liquid ammonia consumption per day.																																			
	The daily NH ₃ consumption has been used to calculate the maximum AFR for the five historic campaigns.																																			
	Table: Maximum NH ₃ gas flow to the AOR per day																																			
	<table><tr><th>Campaign No.</th><th>Start Date</th><th>End date</th><th>Total NH₃ consumed</th><th>Maximum NH₃ consumed per day</th></tr><tr><td></td><td></td><td></td><td>tonnes</td><td>tonnes</td></tr><tr><td>C10</td><td>29/05/2003</td><td>24/11/2003</td><td>34,914</td><td>219</td></tr><tr><td>C12⁴</td><td>27/05/2004</td><td>12/12/2004</td><td>38,492</td><td>211</td></tr><tr><td>C13</td><td>15/12/2004</td><td>24/07/2005</td><td>43,187</td><td>206</td></tr><tr><td>C14</td><td>27/07/2005</td><td>28/01/2006</td><td>34,623</td><td>206</td></tr><tr><td>C15</td><td>03/02/2006</td><td>31/07/2006</td><td>28,824</td><td>198</td></tr></table>	Campaign No.	Start Date	End date	Total NH ₃ consumed	Maximum NH ₃ consumed per day				tonnes	tonnes	C10	29/05/2003	24/11/2003	34,914	219	C12 ⁴	27/05/2004	12/12/2004	38,492	211	C13	15/12/2004	24/07/2005	43,187	206	C14	27/07/2005	28/01/2006	34,623	206	C15	03/02/2006	31/07/2006	28,824	198
	Campaign No.	Start Date	End date	Total NH ₃ consumed	Maximum NH ₃ consumed per day																															
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C14	27/07/2005	28/01/2006	34,623	206																																
C15	03/02/2006	31/07/2006	28,824	198																																
The maximum daily flow rate was 218 ⁵ tNH ₃ . This corresponds to an hourly maximum flow rate of 9,094 kgNH ₃ /h.																																				
For measuring AFR values during the <u>baseline</u> campaign, the installed AMS has been used. However, when setting up the data acquisition system for the baseline campaign, it was wrongly assumed that the data control system ("DCS") indicates the ammonia flow in m ³ /h. In order to obtain the values required by AM0034, the measured results need to be converted to kgNH ₃ /h.																																				
Thus, the following formula is used for converting kg/h into m ³ /h and vice versa:																																				
$F_v = F_m * 22.41 / M_w$																																				
Where:																																				
<p>F_v – Volumetric flow rate in Nm³/hr</p> <p>F_m – Mass flow rate in kg/hr</p> <p>M_w – molar mass</p>																																				
This is based on the following assumptions:																																				
<ol style="list-style-type: none">1) The molar mass of ammonia (NH₃) is 17g/mol.2) The molar mass of air is 28.84 g/mol.3) The volume of 1 mol of ideal gas at standard temperature and pressure ("STP") is 22.41 l/mol.4) For the example calculation below, the ammonia flow to the converter is 5,774 kg/h.																																				
The illustration below on how the adjustment is applied to the data sets obtained from the DCS, is based on the following reference values:																																				
To acquire the correct volumetric flow for the ammonia flow in the example value, the following adjustment has to be made:																																				

⁴ AEL does a statutory shutdown every 3 years. These shutdowns usually take place during a time that AEL predicts low customer demand. The last statutory shutdown was done during May 2004. Because of the timing of this shutdown, the campaign before the shutdown (C11) had to be made shorter. Since this shorter campaign was not representative of normal operation, it was excluded from the analysis.

	$F_v = F_m * \left(\frac{22.41}{M_w} \right)^2$ <p>Using the sample values for ammonia:</p> $F_v = 5774 * \left(\frac{22.41}{17} \right)^2 = 10034 m^3 / hr$ <p>Along these lines, all the data obtained from the DCS is converted in order to obtain the correct units.</p>
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
Choice of data or measurement methods and procedures	AFR _{max} has been determined according to the description in table B.10 above. It is based on the maximum daily consumption of ammonia. Maximum AFR values based on daily (rather than hourly) values are more conservative in nature, because composite values are on average lower than single hourly peak values would be.
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}.

⁵ This value corresponds to the C10 value provided in the table, after the top 2.5 percentile data sets have been eliminated.

Choice of data or measurement methods and procedures	<p>The monitoring of AIFR is required by AM0034 in order to determine AIFR_{max}.</p> <p>Again, AEL applies a different approach for determining the historic AIFR values from what the procedure has been like for the baseline campaign and will be for the subsequent project campaigns.</p> <p>For the <u>historic</u> campaigns the allowable NH₃ to Air ratio is taken from the controller data sheet (No 11 Technical Manual, TM4, p250, June 1977), since no data on this value has been recorded prior to the installation of the AMS. The range as specified in the manual is 8.3% v/v - 11.5% v/v; therefore the maximum ammonia to air ratio is 11.5% v/v.</p> <p>In the <u>baseline</u> AIFR has been calculated based on AFR (as described in table B.10 above) and by relating these known ammonia flow values to air flow values. The latter are converted to the required unit according to the same procedure as the ammonia values.</p> <p>Calculations are based on the following assumptions:</p> <ol style="list-style-type: none"> 1) The molar mass of air is 28.84 g/mol. 2) The volume of 1 mol of ideal gas at standard temperature and pressure ("STP") is 22.41 l/mol. 3) For purposes of an example calculation, the air flow into the converter is 113,723 kg/h. <p>Based on these assumptions, the correct value for the example amount can be calculated as follows:</p> $F_v = F_m * \left(\frac{22.41}{M_w} \right)^2$ <p>Using the sample values above for air gives:</p> $F_v = 113723 * \left(\frac{22.41}{28.84} \right) = 88368 m^3 / hr$ <p>Along these lines, all data collected by the DCS are converted into the correct value unit.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>Calibration information</p> <p>During Baseline period 20/07/2006 – 18/02/2007</p> <p>Calibration frequency: Once every six months.</p> <p>(only during plant shutdown between campaigns)</p> <p>Date of last calibrations: 31/05/2006, 01/11/2006: 19/02/2007</p>

Data / Parameter:	B.13 CL_{BL}
Unit:	tHNO₃
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

Choice of data or measurement methods and procedures	<p>In accordance with AM0034 the baseline campaign length (CL_{BL}) has to be compared to the established average historic campaign length (CL_{normal}) measured in $tHNO_3$ which has been recorded for No. 11 in the past; and</p> <p>If $CL_{BL} \leq CL_{normal}$, then all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the “permitted range”).</p> <p>If $CL_{BL} > CL_{normal}$, then N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of EF_{BL}.</p> <p>For No. 11 the average historic campaign production was 123,290 $tHNO_3$, see table B.14 below. Thus, for the calculation of EF_{BL}, only those values below this margin are to be taken into account.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>Adjustment of Baseline Campaign Length (CL_{BL})</p> <p>As $CL_{BL} > CL_{normal}$, N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) have been eliminated from the calculation of EF_{BL}.</p>

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																																
Choice of data or measurement methods and procedures	<p>In accordance with AM0034 the average historic campaign length (CL_{normal}) is defined as the average campaign length for the historic campaigns that were used to define operating condition. CL_{normal} presents the cap on the length of the baseline campaign from which the baseline emissions factor will be derived.</p> <p>During the five historic campaigns, the following amounts of metric tonnes of 100% concentrated nitric acid have been produced:</p> <table><tr><th>Campaign No</th><th>Start Date</th><th>End Date</th><th>Total HNO₃ produced</th></tr><tr><td></td><td></td><td></td><td>tons</td></tr><tr><td>C10</td><td>29/05/2003</td><td>24/11/2003</td><td>123,730</td></tr><tr><td>C12⁶</td><td>27/05/2004</td><td>12/12/2004</td><td>133,266</td></tr><tr><td>C13</td><td>15/12/2004</td><td>24/07/2005</td><td>138,908</td></tr><tr><td>C14</td><td>27/07/2005</td><td>28/01/2006</td><td>118,659</td></tr><tr><td>C15</td><td>03/02/2006</td><td>31/07/2006</td><td>101,888</td></tr><tr><td>Average</td><td></td><td></td><td>123,290</td></tr></table> <p>Therefore, the average historic campaign length (CL_{normal}) is 123,290 tonnes of 100% concentrated nitric acid.</p>	Campaign No	Start Date	End Date	Total HNO ₃ produced				tons	C10	29/05/2003	24/11/2003	123,730	C12 ⁶	27/05/2004	12/12/2004	133,266	C13	15/12/2004	24/07/2005	138,908	C14	27/07/2005	28/01/2006	118,659	C15	03/02/2006	31/07/2006	101,888	Average			123,290
Campaign No	Start Date	End Date	Total HNO ₃ produced																														
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C14	27/07/2005	28/01/2006	118,659																														
C15	03/02/2006	31/07/2006	101,888																														
Average			123,290																														
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks																																
Additional comment:	None																																

⁶ See footnote 4 for information on why C11 was omitted.

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
Choice of data or measurement methods and procedures	<p>In accordance with AM0034 AIFR_{max} is used to determine those periods where the plant may be operating outside of the permitted operating conditions.</p> <p>The upper limits for ammonia flow and ammonia to air ratio shall be determined using one of the following three options, in preferential order:</p> <ul style="list-style-type: none"> a) Historical maximum operating data for hourly ammonia gas and ammonia to air ratio for the previous five campaigns (or fewer, if the plant has not been operating for five campaigns; excluding abnormal campaigns; or, b) If no data is available, calculation of the maximum permitted ammonia gas flow rates and ammonia to air ratio as specified by the ammonia oxidation catalyst manufacturer or for typical catalyst loadings; or c) If information for (b) above is not available, based on a relevant technical literature source. <p>Since no historical data were recorded and available, the allowable NH₃ to Air ratio is taken from the controller data sheet (No 11 Technical Manual, TM4, p250, June 1977). The range is 8.3% v/v - 11.5% v/v, therefore the maximum ammonia to air ratio is 11.5% v/v.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	None

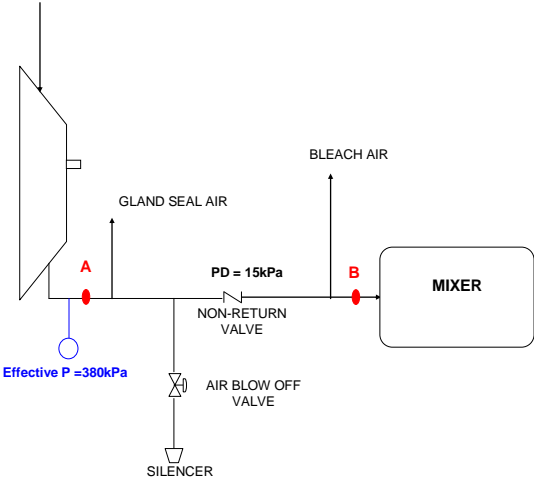
Data / Parameter:	B.16 OT_h
Unit:	°C
Description:	Oxidation temperature for each hour during the baseline campaign
Source of data:	Monitoring results of a thermocouple inside the ammonia oxidation reactor.
Value(s) applied:	Not applicable
Choice of data or measurement methods and procedures	<p>In accordance with AM0034 the oxidation temperature in the ammonia oxidation reactor (OT_h) has to be monitored and compared to the Normal range for oxidation temperature (OT_{normal}). VSG and NCSG data obtained during times when OT_h was above or below OT_{normal} has to be eliminated from the calculation of EF_{BL}.</p> <p>Oxidation temperature is set and is never actively changed during operation. The composite thermocouple is made up of six individual temperature probes and continuously measures OT_h. OT_h is dependent on AIFR which is a controlled parameter and should stay as constant as possible. OT_h is therefore a control parameter for AIFR.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>Calibration information</p> <p>During Baseline period 20/07/2006 – 18/02/2007</p> <p>Calibration frequency: Once every six months, validity 8 month (only during plant shutdown between campaigns)</p> <p>Date of last calibrations: 17/08/2006, 14/03/2007</p>

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) ⁷ .
Value(s) applied:	820 to 905
Choice of data or measurement methods and procedures	<p>AM0034 requires the establishment of the normal range of operating temperatures in the ammonia oxidation reactor. Since no historical data for the No. 11 plant are available, the range of operating temperature of between 820°C and 905°C, as stipulated in the operating manual was applied to derive OT_{normal}.</p> <p>The measuring range of the thermocouples determining the oxidation temperatures is set accordingly, i.e. when the plant is offline, the temperature reading will continue to show 820°C.</p> <p>For practical purposes, all VSG and NCSG values taken during times when the plant was operating at below 820°C will be excluded.</p>
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.

⁷ Copies of the technical plant manuals can be provided to the DOE upon request.

Choice of data or measurement methods and procedures	<p>In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (OP_h) has to be monitored and compared to the Normal range for oxidation temperature (OP_{normal}). VSG and NCSG data obtained during times when OP_h was above or below OP_{normal} has to be eliminated from the calculation of EF_{BL}.</p> <p>AM0034 prescribes the monitoring and recording of the Oxidation Pressure for each hour (OP_h) during the baseline campaign. This would imply the measurement of pressure inside the Ammonia Oxidation Reactor. AEL has no such measurement equipment installed at that point; instead the available measurements for air pressure before the ammonia-air-mixer are used to determine OP_h.</p> <p>The pressure for the oxidation reactor is taken as the pressure at point B (air to mixer pressure). The permitted range for the oxidation pressure is inferred from the values given for point A (HP compressor discharge pressure range).</p> <p>Figure: Pressure points for No. 11</p>  <p>During the baseline campaign (as well as for project campaigns) OP is monitored as air pressure to the ammonia to air mixer. Unlike during historic campaigns, these data will be archived and analysed as required by AM0034.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	<p>Calibration information</p> <p>During Baseline period 20/07/2006 – 18/02/2007</p> <p>Calibration frequency: Once every six months.</p> <p>(only during plant shutdown between campaigns)</p> <p>Date of last calibrations: 31/05/2006, 01/11/2006; 19/02/2007</p>

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 – 450

Choice of data or measurement methods and procedures	<p>AM0034 requires the establishment of the normal range of operating pressure in the ammonia oxidation reactor. Since no historical data for the No. 11 plant are available, the range of temperature stipulated in the operating manual was applied to derive OP_{normal}.</p> <p>The upper limit is 450 kPa. The lower limit is inferred from the effective discharge set point pressure, 380 kPa (Operating Instructions No. M69.0300.2008, 1978) and the pressure drop across the non-return valve (No 11 HNO_3 Plant Understanding, p. 10). The pressure recorded as the oxidation pressure is taken from Point A as contained in Figure 1 in table B. 18 above. The pressure drop given is 15 kPa. Since the NH_3-Air mixer appears down stream of the non-return valve it is assumed that the lower pressure limit in the mixer is 365 kPa. The oxidation pressure is measured in kPa.</p> <p>For dual-pressure processes, the pressure range suggested is 400 - 600 kPa (Ullmann's Encyclopedia of Industrial Chemistry, 6th Ed, Vol. 23, p3).</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	None

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
Choice of data or measurement methods and procedures	<p>AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.</p> <p>AEL has been using ammonia oxidation catalyst gauzes ("FTCplus") supplied by Heraeus for the past several years. The Heraeus FTCplus gauze contains significant levels of Palladium (approximately one third). The main motivation for this is that it leads to a weight reduction of the (more expensive) Platinum. A side effect of this gauze type is that the generation of N_2O in the ammonia oxidation process tends to be lower than with gauzes containing little or no Palladium.</p> <p>AEL has used FTCplus gauzes supplied by Heraeus during the baseline campaign and intends to continue using the same or very similar composition of gauzes for the foreseeable future.</p>
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
Choice of data or measurement methods and procedures	AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.
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%																																										
Choice of data or measurement methods and procedures	<p>In accordance with AM0034, if the composition of the ammonia oxidation catalyst used for the baseline campaign and after the implementation of the project are identical to that used in the campaign for setting the operating conditions (previous five campaigns), then there shall be no limitations on N₂O baseline emissions.</p> <p>Record of Gauze compositions installed during the historic campaigns⁸:</p> <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																																									
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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																																										

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%
Choice of data or measurement methods and procedures	<p>A change in the composition of the ammonia oxidation catalyst in the baseline campaign to a composition other than that used in the previous five campaigns, is permissible without any limitation on the N₂O baseline emissions if the following conditions are met</p> <p>(i) The baseline catalyst composition is considered as common practice in the industry, or</p> <p>(ii) The change in catalyst composition is justified by its availability, performance, relevant literature etc.</p> <p>Otherwise, the baseline emission factor shall be set to the conservative IPCC default emission factor for N₂O from nitric acid plants which have not installed N₂O destruction measures (4.5 kgN₂O/tHNO₃).</p> <p>GC_{BL} at AEL's No. 11 nitric acid plant is the same as GC_{normal}; therefore, the results of the baseline campaign are fully valid and applicable.</p>
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	None

Data / Parameter:	B.26 EF_{reg}
Unit:	tN ₂ O/tHNO ₃
Description:	Emissions cap for N ₂ O from nitric acid production set by government regulation

⁸ 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.

Source of data:	Department of Environmental Affairs and Tourism
Value(s) applied:	None
Choice of data or measurement methods and procedures	There is currently no regulation in South Africa that limits the emissions of N ₂ O from nitric acid production. However, the regulatory situation will be monitored by liaising with the responsible South African Environmental Authorities on a continuous basis. AEL has a well-established working relationship with the responsible authorities and exchanges information with their officials on a regular basis.
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	None.

D.2. Data and parameters monitored

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

Data / Parameter:	NCSG
Unit:	mg /Nm³ (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 15: 361.87 Value applicable for Project Campaign 16: 408.37
Monitoring equipment:	<p>Type: <i>ABB AO2040 URAS 14 Continuous Emissions Analyser, non-dispersive infrared analyser</i></p> <p>Overall measurement accuracy (for N₂O): 1.60% (as per QAL2 report dated 08/12/2014)</p> <p>Serial Number: <i>Instrument number 3.346854.7</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - QAL2 every 5 years - AST every year <p>Date of last external calibration:</p> <ol style="list-style-type: none"> 1. QAL2 Test (including AST) – 23/09/2014 - 25/09/2014 valid until 22/09/2019 <p>Calibration delay:</p> <p>The subsequent AST was due 23/09/2015 (1 year after the QAL2 including AST). Due to the problems with the N₂O analyser, the overdue AST has not been conducted yet. In order to adhere the guidelines for assessing compliance with the calibration frequency requirements as stipulated in paragraph 273 of VVS the maximum permissible error of the instruments for NCSG and VSG were applied. The error was applied in a conservative manner for the period between the scheduled AST and the actual date of the AST. The error was applied for the period from 23/09/2015 to 05/01/2016.</p> <p>Analyser downtime:</p> <p>The N₂O analyser failed on 16/01/2016. It was sent for repair as local engineers could not resolve the issues. The analyser was reinstalled on 04/08/2015, but failed again on 12/08/2015. It has not reported valid data until the end of this Monitoring Period. The analyser was considered non-functional and the maximum value for NCSG of each relevant campaign was used for the time period in question in accordance with the AM0034.</p>
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds)

Calculation method (if applicable):	AM0034 requires the determination of the concentration of N ₂ O 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: 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
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 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:	Nm ³ /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 15: 79,878 Value applicable for Project Campaign 16: 81,355
Monitoring equipment:	Type: Tail gas flow by differential pressure principle Overall measurement accuracy: 2.082% (as per QAL 2 report dated 08/12/2014) (Combined uncertainty for the normalized stack gas flow at standard conditions) Serial Number: <i>instrument number N/A</i> Date of last external calibration: 1. QAL2 Test (including AST) – 23/09/2014 - 25/09/2014 valid until 22/09/2019 Calibration delay: The subsequent AST was due 23/09/2015 (1 year after the QAL2 including AST). Due to the problems with the N2O analyser, the overdue AST has not been conducted yet. In order to adhere the guidelines for assessing compliance with the calibration frequency requirements as stipulated in paragraph 273 of VVS the maximum permissible error of the instruments for NCSG and VSG were applied. The error was applied in a conservative manner for the period between the scheduled AST and the actual date of the AST. The error was applied for the period from 23/09/2015 to 05/01/2016.
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
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 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 15: 131.773 Value applicable for Project Campaign 16: 152.150
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 15: 4,569 Project Campaign 16: 4,590
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 15: 138,055 Project Campaign 16: 141,281
Monitoring equipment:	Emerson coriolis mass flow meter CMF 300 Overall measurement accuracy: $\leq 0.1\%$ Serial Number: 11007573 Calibration frequency: every 3 years Date of last calibration, 19/05/2014 valid until 18/05/2017
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:	The design capacity of the plant is 775 metric tonnes per day, operating 365 days per year. This equals a total production of 390,600 tonnes for a period of 504 days. Therefore the factual production of 289,926 tonnes during this monitoring period is below the design capacity of the plant.
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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</p> <p>Overall measurement accuracy: 2.55% (as per initial QAL2 report dated 06/09/2007. Note that the overall measurement accuracy for TSG and PSG has only been established during the initial QAL2 report. The value is not relevant as the combined error for VSG includes the error for TSG and PSG)</p> <p>Serial Number: <i>instrument number N/A</i></p> <p>Calibration frequency:</p> <ul style="list-style-type: none"> - External calibration: QAL2 every 5 years; - External calibration: AST every year; <p>Date of last external calibration:</p> <ol style="list-style-type: none"> 1. QAL2 Test (including AST) – 23/09/2014 - 25/09/2014 valid until 22/09/2019 <p>Calibration delay:</p> <p>The subsequent AST was due 23/09/2015 (1 year after the QAL2 including AST). Due to the problems with the N2O analyser, the overdue AST has not been conducted yet. In order to adhere the guidelines for assessing compliance with the calibration frequency requirements as stipulated in paragraph 273 of VVS the maximum permissible error of the instruments for NCSG and VSG were applied. The error was applied in a conservative manner for the period between the scheduled AST and the actual date of the AST. The error was applied for the period from 23/09/2015 to 05/01/2016.</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 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:	Pa (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 Overall measurement accuracy: 0.7 % (as per initial QAL2 report dated 06/09/2007. Note that the overall measurement accuracy for TSG and PSG has only been established during the initial QAL2 report. The value is not relevant as the combined error for VSG includes the error for TSG and PSG) Serial Number: <i>instrument number N/A</i></p> <p>Date of last external calibration: 1. QAL2 Test (including AST) – 23/09/2014 - 25/09/2014 valid until 22/09/2019</p> <p>Calibration delay: The subsequent AST was due 23/09/2015 (1 year after the QAL2 including AST). Due to the problems with the N₂O analyser, the overdue AST has not been conducted yet. In order to adhere the guidelines for assessing compliance with the calibration frequency requirements as stipulated in paragraph 273 of VVS the maximum permissible error of the instruments for NCSG and VSG were applied. The error was applied in a conservative manner for the period between the scheduled AST and the actual date of the AST. The error was applied for the period from 23/09/2015 to 05/01/2016.</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 15: 0.000954 Project Campaign 16: 0.001077

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 <i>n</i> 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 15: 0.000952 Project Campaign 16: 0.000960
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 <i>n</i> 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 15: 0.000954 Project Campaign 16: 0.001077

Monitoring equipment:	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	To calculate the total emission reductions achieved in a campaign, the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reductions (EF_P). Thus: If $EF_{ma,n} > EF_n$ then $EF_P = EF_{ma,n}$ If $EF_{ma,n} < EF_n$ then $EF_P = EF_n$
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:	$tN_2O/tHNO_3$
Description:	EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period.
Measured/ Calculated / Default:	Calculated.
Source of data:	Calculations from EF_n
Value(s) of monitored parameter:	0.000417
Monitoring equipment:	Not applicable.
Measuring/ Reading/ Recording frequency:	Not applicable.
Calculation method (if applicable):	A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N_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 (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 .
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:	$tN_2O/tHNO_3$
Description:	Emissions cap for N_2O 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:	tHNO ₃
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 15: 138,055 Project Campaign 15: 141,281
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.

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: 07/06/2013, 02/04/2014. Validity: Each calibration is valid until the restart of the plant after the gauze change.</p> <p>Calibration frequency: Once every campaign (only during plant shutdown between campaigns)</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 internal calibrations after each campaign. 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:	<p>Type: Thermocouple products Type: K310 S/steel Thermocouple Overall measurement accuracy: +/-1% Serial Number: TP3285-3290 Installation location: reactor</p> <p>During project campaigns the calibration of operational parameters is not relevant. However the calibration dates are listed below for information only: 07/06/2013, 02/04/2014 Validity: Each calibration is valid until the restart of the plant after the gauze change.</p> <p>Calibration frequency: Once every campaign (only during plant shutdown between campaigns)</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 temperature probes are exchanged before every gauze change. They have been calibrated prior to installation by the supplier.
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: 07/06/2013, 02/04/2014 Validity: Each calibration is valid until the restart of the plant after the gauze change. Calibration frequency: After each campaign (only during plant shutdown between campaigns)
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 internal calibrations after each campaign, 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: 07/06/2013, 02/04/2014 Validity: Each calibration is valid until the restart of the plant after the gauze change. Calibration frequency: After each campaign (only during plant shutdown between campaigns)</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:	The instrument is subject to internal calibrations after each campaign, which are part of the ISO 9001 procedures.
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 15	Project campaign 16
	Platinum (Pt)	56%	56%
	Rhodium (Rh)	4%	4%
	Palladium (Pd)	40%	40%
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

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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

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The results of the N.DBMS data analysis are exported to EXCEL spreadsheets for further analysis and presentation.

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

Analysis of Historical campaign data and determination of permitted operating ranges

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 HNO₃

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		1.104
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 ₂ O	651.98
UNC	%	3.99
EF _{BL}	kgN ₂ O/tHNO ₃	4.647

Resulting EF_{BL}

The EF_{BL} derived from this analysis of historic and baseline data is 4.647 kgN₂O/tHNO₃.

Sample calculation for baseline emissions (BE) and Emission factor (EF):

BE [tN₂O] = 72,468 [Nm³/h] * 1.01 * 1,630.03 * 1.104 [mg/Nm³] * 10⁻⁹ * 4,950 [h] = 651.98 [tN₂O]

EF [kgN₂O/tHNO₃] = 651.98 [tN₂O] / 134,699.8 [tHNO₃] * 10³ * (1 – 3.99/100) = 4.647 [kgN₂O/tHNO₃]

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

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} or longer or equal than the baseline campaign length CL_{BL}, then all N₂O

values measured during the baseline campaign can be used for the calculation of EF_{BL} . If $CL_n < CL_{normal}$ or CL_{BL} , 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 15 and 16 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 ($tN_2O/tHNO_3$)

EF_{reg} Emissions level set by newly introduced policies or regulations ($tN_2O/tHNO_3$).

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

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Project emissions are calculated according to the following formula:

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

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_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 ₂ O emissions of the n th project campaign (tN ₂ O or kgN ₂ O)
NAP _n	Campaign length of the n th project campaign (tHNO ₃)

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

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

AMS Downtime

According to the methodology, the highest measured value in the campaign will be applied for any downtime period of the AMS.

The following replacement values were established:

- PC15: 406.51 mgN₂O/Nm³ (maximum NCSG value); 85,024.49 Nm³/h (maximum VSG value)
- PC16: 408.37 mgN₂O/Nm³ (maximum NCSG value); 88,245.04 Nm³/h (maximum VSG value)

The values were used during analyser downtime (when there was no plant shutdown and the AMS was down) in the following periods:

Campaign	From	To	Value	Parameter
PC15	16/01/2015 13:00	25/05/2015 23:00	406.51	NCSG
PC16	26/05/2015 00:00	05/08/2015 12:00	408.37	NCSG
PC16	14/08/2015 12:00	05/01/2016 23:00	408.37	NCSG

Analysis of Project campaign data

The following table shows the number of data sets and the respective amount of NAP during the campaigns included in this monitoring period:

Campaign	Data sets	NAP (in tHNO ₃)
PC15	5,159	138,055
PC16	5,400	141,281

Incomplete and implausible monitoring data sets have been eliminated. The following exclusion criteria according to plant operation trip values were applied; all datasets recorded during times when the plant was not in operation are excluded:

$$OT_h > 820 \text{ }^{\circ}\text{C}$$

The remaining number of datasets is the number of operating hours. The table below shows the operating hours for each campaign included in this monitoring period:

Campaign	Operating hours (OH)
PC15	4,569
PC16	4,590

By applying the 95% confidence interval on the remaining NCSG and VSG values mavericks and outliers are excluded. 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. The resulting mean values for NCSG and VSG are applied for calculation of the Project emissions (PE).

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

The resulting values for $NCSG_n$, VSG_n , OH_n , NAP_n , project emissions (PE_n) and project emission factor (EF_n) for the project campaigns covered by this monitoring report are:

Value	Unit	PC15: 23/10/2014 – 25/05/2015	PC16: 28/05/2015 – 05/01/2016
$NCSG_n$	mg/Nm ³	361.87	408.37
QAL2 $NCSG$		1.0058	1.0058
VSG_n	Nm ³ /h	79,878	81,355
QAL2 VSG		0.992	0.992
OH_n	h	4569	4590
NAP_n	t HNO ₃	138,055	141,281
PE_n	t N ₂ O	131.773	152.150
EF_n	kg N ₂ O/t HNO ₃	0.954	1.077

Please refer to the submitted excel calculation spread sheet for further detail of the calculation.

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).

Sample calculation for campaign emissions (PE) and Emission factor (EF_n) for the 15th project campaign:

$$PE [tN_2O] = 79,878 [Nm^3/h] * 0.992 * 362 [mg/Nm^3] * 1.006 * 4,569 [h] * 10^{-9} = 131.8 [tN_2O]$$

$$EF [kgN_2O/tHNO_3] = 131.8 [tN_2O] / 138,055 [tHNO_3] * 10^3 = 0.95 [kgN_2O/tHNO_3]$$

Note that small deviations occur due to rounding. The figures stated here reflect the correct values as of the excel calculation. Please refer to the calculation excel file for details.

Sample calculation for campaign emissions (PE) and Emission factor (EF_n) for the 16th project campaign:

$$PE [tN_2O] = 81,355 [Nm^3/h] * 0.992 * 408 [mg/Nm^3] * 1.006 * 4,590 [h] * 10^{-9} = 152.1 [tN_2O]$$

$$EF [kgN_2O/tHNO_3] = 152.1 [tN_2O] / 141,281 [tHNO_3] * 10^3 = 1.08 [kgN_2O/tHNO_3]$$

Note that small deviations occur due to rounding. The figures stated here reflect the correct values as of the excel calculation. Please refer to the calculation excel file for details.

E.3. Calculation of leakage

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No leakage occurs under this project type.

E.4. Summary of calculation of emission reductions or net 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:

$$\begin{aligned} \text{If } EF_{ma,n} > EF_n & \text{ then } EF_p = EF_{ma,n} \\ \text{If } EF_{ma,n} < EF_n & \text{ then } EF_p = EF_n \end{aligned}$$

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 . As the project campaigns of this current monitoring period includes only the 9th project campaign consideration of EF_{min} is not yet of relevance.

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

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

Sample calculation of emission reductions:

13 th PC: ER [tCO ₂ e] =	(4.647 - 0.954) [kg N ₂ O/t HNO ₃] * 138,055 [t HNO ₃] * 10 ⁻³ * 298 =	151,916	[tCO₂e]
14 th PC 2012: ER [tCO ₂ e] =	(4.647 - 1.077) [kg N ₂ O/t HNO ₃] * 141,281 [t HNO ₃] * 10 ⁻³ * 298 =	150,311	[tCO₂e]

Note that small deviations occur due to rounding. The figures stated here reflect the correct values as of the excel calculation. 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 ₂ O/tHNO ₃)
GWP _{N₂O}	Global Warming Potential of N ₂ O (tCO ₂ e/tN ₂ O)

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

		Project campaign 15 (PC15): 23/10/2014 - 25/05/2015	Project campaign 16 (PC16): 28/05/2015 - 05/01/2016
NCSG _{BL}	mg/Nm ³	1,630.03	1,630.03
QAL2 NCSG		1.104	1.104
VSG _{BL}	Nm ³ /h	72,468	72,468
QAL2 VSG		1.010	1.010
OH _{BL}	h	4,950	4,950
NAP _{BL}	t HNO ₃	134,700	134,700
BE	t N ₂ O	651.983	651.983
UNC		3.99	3.99
EF_{BL}	kg N₂O/t HNO₃	4.647	4.647
NCSG _n	mg/Nm ³	361.87	408.37
QAL2 NCSG		1.01	1.0058
VSG _n	Nm ³ /h	79,878	81,355
QAL2 VSG		0.992	0.992
OH _n	h	4,569	4,590
NAP _n	t HNO ₃	138,055	141,281
PE _n	t N ₂ O	131.773	152.150
EF _n	kg N ₂ O/t HNO ₃	0.954	1.077
EF _{ma,n}	kg N ₂ O/t HNO ₃	0.952	0.960
EF _{min}	kg N ₂ O/t HNO ₃	0.42	0.42
EF_p	kg N₂O/t HNO₃	0.954	1.077
GWP	tCO ₂ e/tN ₂ O	298	298
ER	tCO₂e	151,916	150,311
Total	tCO₂e	302,227	

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	GHG emission reductions or net GHG removals by sinks (t CO ₂ e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
PC15	191,185	39,268	0	0	151,916	151,916
PC16	195,652	45,341	0	0	150,311	150,311
Total	386,837	84,609	0	0	302,227	302,227

Note that small deviations might occur due to rounding. The figures stated here reflect the correct values as of the excel calculation. Please refer to the calculation excel file for details. The final result for each campaign is rounded down.

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.

Comparison of design capacity and actually achieved production during this monitoring period

The design capacity of the plant is 775 metric tonnes per day, operating 365 days per year. This equals a total production of 341,000 tonnes for a period of 440 days. Therefore the factual production of 279,335 tonnes during this monitoring period is below the design capacity of the plant.

E.5. Comparison of actual emission reductions or net 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 (t CO ₂ e)	320,007 (calculated for a monitoring period of 440 days)	302,227 (calculated for a monitoring period of 440 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.

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

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for completing the CDM-MR-FORM
Organization name	AEL Mining Services Limited
Street/P.O. Box	PO Modderfontein
Building	Acid House
City	Modderfontein
State/Region	Gauteng Province
Postcode	1645
Country	South Africa
Telephone	
Fax	
E-mail	
Website	www.explosives.co.za
Contact person	Trevor Roberts
Title	Executive Director Global Business Services
Salutation	Mr
Last name	Roberts
Middle name	
First name	Trevor
Department	AEL Mining Services
Mobile	+27 82 373 2270
Direct fax	+27 11 605 0004
Direct tel.	+27 11 606 0489
Personal e-mail	Trevor.roberts@aelms.com

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for completing the CDM-MR-FORM
Organization name	Nordic Environment Finance Corporation
Street/P.O. Box	Fabianinkatu 34, P.O. Box 241
Building	
City	Helsinki
State/Region	
Postcode	00171
Country	Finland
Telephone	
Fax	
E-mail	
Website	http://www.nefco.org/
Contact person	Helle Lindegaard
Title	Vice President
Salutation	Mrs
Last name	Lindegaard

Middle name	
First name	Helle
Department	Carbon Finance and Funds
Mobile	+358 50 575 6691
Direct fax	
Direct tel.	+358 10 618 0664
Personal e-mail	helle.lindegaard@nefco.fi

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Responsible person/ entity for completing the CDM-MR-FORM
Organization name	N.serve Environmental Services GmbH
Street/P.O. Box	Grosse Theaterstr. 14
Building	-
City	Hamburg
State/Region	Hamburg
Postcode	20354
Country	Germany
Telephone	+494030997860
Fax	+4940309978610
E-mail	contact@nserve.net
Website	www.nserve.net
Contact person	Nikolaus Gutknecht-Stöhr
Title	Head of Portfolio Manager
Salutation	Mr
Last name	Gutknecht-Stöhr
Middle name	
First name	Nikolaus
Department	Portfoliomanagement
Mobile	+49163 314 2825
Direct fax	+4940309978610
Direct tel.	+4940309978615
Personal e-mail	gutknecht@nserve.net