N.serve Environmental Services GmbH

CDM Monitoring Report No. 1

"Project for the catalytic reduction of N2O emissions with a secondary catalyst inside the ammonia reactor of the No. 9 nitric acid plant at African Explosives Ltd ("AEL"), South Africa"

UNFCCC Ref No. 1171

Monitoring period

From: 05.11.2007

To: 10.02.2008

Date of report : 17.03.2008

Update :

Contents Page

1. Introduction

African Explosives Ltd. ("AEL"), and N.serve Environmental Services GmbH have implemented a GHG emission reduction project at the AEL No. 9 nitric acid production plant in Modderfontein, east of the City of Johannesburg, South Africa. The GHG emission reductions are achieved by catalytic destruction of N_2O.

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

The monitoring period covered by this report is 05/11/2007 – 10/02/2008. The begin of the project activity with start of the first project campaign was 14/11/2007. The first project campaign started 14/11/2007 and ended 10/02/2008. The emission reductions achieved during this first project campaign are assessed by this report.

Starting date of the project activity :	14/11/2007
Registration date at UNFCCC:	05/11/2007
Registration No. at UNFCCC:	1171
Crediting period is:	05/11/2007 – 04/11/2017
Project scale:	large
Sectoral scope:	5: "Chemical Industry"
Host Party for the Project activity:	South Africa
City/ Town:	Modderfontein 1645

2. General description of the project activity

The sole purpose of the proposed project activity is to significantly reduce former levels of N_2O emissions from the production of nitric acid at one of AELs' nitric acid plants (the "AEL No. 9 Plant") at Modderfontein, South Africa. The AEL No. 9 nitric acid plant was designed by Chimico and commissioned in 1968, it is a single burner high pressure plant operated at 8,6 – 9,1 bar gauge.

AEL is a principal developer, producer and supplier of commercial explosives, initiating systems and blasting services for all mining, quarrying and construction markets in Africa.

To produce nitric acid, ammonia (NH_3) is reacted with air over precious metal – normally a platinum/rhodium (Pt-Rh) alloy – catalyst gauze pack in the ammonia oxidation reactor of nitric acid plants. The main product of this reaction is NO, which is metastable at the conditions present in the ammonia oxidation reactor and therefore reacts with the available oxygen to form NO_2, which is later absorbed in water to form HNO_3 – nitric acid. Simultaneously, undesired side reactions yield nitrous oxide (N_2O), nitrogen and water. N_2O is a potent greenhouse gas with a

Global Warming Potential (GWP) of 310. The project activity involves the installation of a new N_2O abatement technology; a pelletised catalyst that will be installed inside the ammonia oxidation reactor, underneath the precious metal gauzes. This catalyst will in large part reduce the baseline N_2O emissions.
By implementing the project activity, a new, clean technology has been transferred to South Africa that is not even common industrial practice in Annex 1 countries. Also, the project leads to an enhancement of skills as employees are trained to operate both the N_2O abatement catalyst and the Automated Monitoring System.

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 financial benefits from the sale of Certified Emission Reductions ("CERs") will be used to offset the capital and operating costs of the project to provide for its continued operation throughout the crediting period.

Through the sale of CERs, AEL will also be able to improve its profitability and ensure employment, contribute to economic prosperity in the region as well as invest in further clean technologies to improve its environmental performance.

2.1. Project participants

Name of Party involved (*) ((host) indicates a host Party)	**Private and/or public entity(ies) project participants (*) (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)**
South Africa (host)	African Explosives Ltd ("AEL")	No
United Kingdom	N.serve Environmental Services GmbH, Germany ("N.serve").	No

3. Technology employed by the project activity

The project activity entails a transfer of

- State-of-the art N_2O abatement technology which is not even applied in Annex I countries.
- Specialised monitoring equipment
- Staff training for installation, operation and maintenance of catalyst & monitoring equipment, etc.

A number of N_2O abatement technologies have become available in the past 2 years after some 10 years of research, development and industrial testing. Only now that N_2O regulation is going to be introduced in the EU by 2007 and with the incentives provided by the Kyoto Protocol nitric acid plant operators are considering adopting these technologies. N_2O abatement technology is now commercially available from a number of catalyst manufacturers, mainly from Germany and the UK. These technologies are proprietary and are sold or leased to nitric acid plants. The financing of this technology is facilitated by the CDM. Hence, the CDM enables nitric acid plants in non-Annex 1 countries to become the pioneers of N_2O abatement of the global nitric acid industry.

AEL has installed a secondary abatement catalyst a few days before the successful registration of the AEL No. 9 plant as a CDM project.

3.1. Catalyst Technology

AEL has contracted with Heraeus to install its N_2O reduction catalyst (HR-SC) system that consists of a standard precious metal gauze pack with an additional base metal catalyst made of precious metal coated mini raschig rings (Al_2O_3).

No contamination of the nitric acid with Cobalt or any of the other catalyst materials has been observed.

The catalyst does not require additional heat or other energy over and above the temperature that is present inside the Ammonia Oxidation Reactor anyway. There are no additional greenhouse gases or other emissions generated by the reactions on at the N_2O abatement catalyst.

3.2. N_2O abatement catalyst installation

The secondary catalyst itself is easily installable during a routine plant shut-down and gauze change. The mini raschig rings 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.

3.3. Technology transfer and safety issues

The catalyst implementation does not lead to increased NOX emissions. Neither is the environment directly or indirectly harmed in any other way. AEL will ensure that the chosen N2O abatement catalyst vendor will take back the catalyst at the end of

its useful life and refine, recycle or dispose of it according to the then prevailing EU standards.

Once installed, the catalyst itself and the AMS is operated by the local AEL-employees.

4. Project boundary of the project activity

The boundary of the project activity includes the complete process equipment of the AEL No.9 nitric acid plant.

The gases relevant to the proposed project activity (and the nitric acid plant which is subject to it) originate from the ammonia oxidation process that takes place at approximately 900℃ and between 8,6 and 9,1 bar at the precious metal gauzes inside the plant's ammonia oxidation reactor.

The main product of this reaction is NO created by oxidising ammonia (NH_3) with atmospheric oxygen (O_2) (reaction 1). NO readily oxidises further to form NO_2 (reaction 2) and thereafter put to react with water to form a mix of nitric and nitrous acid (reaction 3). Finally, nitrous acid is also transformed into nitric acid (reaction 4), entailing an emission of NO, which is partially oxidised to NO_2 (reaction 2). These intended chemical reactions (main reactions) are the following:

(1) $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$
(2) $2\ NO + O_2 \rightarrow 2\ NO_2$
(3) $2\ NO_2 + H_2O \rightarrow HNO_3 + HNO_2$
(4) $3\ HNO_2 \rightarrow HNO_3 + NO + H_2O$

The ammonia oxidation process (see reaction 1 above) yields the desired NO molecules with a 90 to 95% probability, depending on the maintenance of the accurate temperature and pressure parameters inside the ammonia burner.

However, these main reactions entail the formation of several unwanted gaseous by-products that usually are emitted into the atmosphere. The undesired by-products result from the following reactions (side reactions) that also occur in the ammonia oxidation process:

(a) $4\ NH_3 + 3\ O_2 \rightarrow 6\ H_2O + 2\ N_2$
(b) $4\ NH_3 + 4\ O_2 \rightarrow 6\ H_2O + 2\ N_2O$

Side reaction (a) is irrelevant as it only results in the formation of water vapour and nitrogen, both present in the atmosphere in abundance. Reaction (b), however, leads to the emission of N_2O.

On leaving the ammonia oxidation reactor some of the N_2O generated may decompose

- In the high temperature homogenous gas phase inside the ammonia oxidation reactor (especially if the heat exchanger coils are inefficient or not placed directly underneath the ammonia oxidation section)
- At platinum deposits downstream of the ammonia oxidation reactor (provided that sufficient temperature levels coincide with substantial traces of platinum and the gas flow velocity allows a sufficient contact time)
- In sections of the plant downstream of the ammonia oxidation reactor, where temperatures above 300℃ allow N_2O to spontaneously decompose.

An overview of all emission sources within the project boundary is provided below:

	Source	Gas	Included?	Justification / Explanation
Baseline	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 or CH_4 emissions
		CH_4	No	
		N_2O	Yes	
		CO_2		
		CH_4		
		N_2O		
		CO_2		
		CH_4		
		N_2O		
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 or CH_4 emissions
		CH_4	No	
		N_2O	Yes	
	Leakage emissions	CO_2	No	No leakage emissions are expected.
		CH_4	No	
		N_2O	No	

5. Baseline and monitoring methodology applied to the project activity

This project is based on Approved Baseline and Monitoring methodologies AM0034 (Version 02): “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants”.

The project draws on approved baseline methodology AM0028 for the baseline scenario selection and uses the “Tool for the demonstration and assessment of additionality”.

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

In order to avoid the possibility that the operating conditions of the nitric acid production plant are modified in such a way that increases N_2O generation during the baseline campaign, the normal ranges for operating conditions were determined for the following parameters: (i) oxidation temperature; (ii) oxidation pressure; (iii) ammonia gas flow rate, and (iv) air input flow rates. The permitted range has been established using the procedures described below. Note that data for these parameters is routinely logged in the process control systems of the plant.

i. Oxidation temperature and pressure:

Process parameters monitored:

OT_h	Oxidation temperature for each hour (℃)
OP_h	Oxidation pressure for each hour (Pa)
OT_{normal}	Normal range for oxidation temperature (℃)
OP_{normal}	Normal range for oxidation pressure (Pa)

For the determination of the permitted operating conditions, the methodology suggests that historic operating data as logged by the process control system should be used. However, there is no requirement by South African law or by AEL management to record and store the above operating parameters of the nitric acid plants. 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. 9 nitric acid plant were used to derive these normal ranges. See Annex 1 for details.

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

Parameters monitored:

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

Historic data of daily NH_3 consumption was used to obtain determine the range of AFR for the five historic campaigns (excluding abnormal campaigns). After removing the top 2.5 percentile values the maximum daily flow rate was derived which was then converted into an hourly Ammonia flow rate Nm^3/hr, which was used to determine AIFR.

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

N_2O concentration and gas volume flow have been monitored throughout the baseline campaign by an Automated Monitoring System (AMS) which was installed and operated using European Norm 14181 (2004) as guidance where applicable. The AMS provides separate readings for N_2O concentration (NCSG) and gas volume flow (VSG) for every two seconds of operation of the plant. Error readings (e.g.

downtime or malfunction) and extreme values are to be eliminated from the output data series.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is to be applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure will be applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

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

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

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

The plant specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign has been derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid for that period. The overall uncertainty of the monitoring system (*UNC*) has been determined. The N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) was be reduced by the estimated percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100)$$

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

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

The plant was operating within the permitted range of normal operating conditions for more than 50% of the time, therefore the baseline campaign is valid and the resulting EF_{BL} can be applied to calculate the resulting emission reductions of the project.

5.3. Campaign Length

In order to take into account the variations in campaign length and its influence on N_2O emission levels, the historic campaign lengths and the baseline campaign length are to be determined and compared to the project campaign length. Campaign length

is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.

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

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”).

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}.

5.4. Statistical Tests comparing Baseline Campaign with “normal” operating conditions

In accordance with AM0034, statistical tests should be performed to compare the average values of the permitted operating conditions with the average values obtained during the baseline campaign.

Since no specific statistical tests are prescribed in AM0034, the project proponents used the statistical tests that are already being used in AM0034 to ensure a consistent approach.

If the mean values for OT_h, OP_h, AFR and AIFR obtained during the baseline campaign fall within the 95% confidence interval (1.96 times the standard deviation) of the normal operating conditions, then the baseline campaign is considered to be representative of a normal campaign.

The result of these tests was that the baseline campaign is representative of a normal campaign because all four mean values obtained during the baseline campaign fall within the 95% confidence interval of the normal operating conditions.

5.5. Leakage

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

5.6. Project Emissions

Over the duration of the project activity, N_2O concentration and gas volume flow in the stack of the nitric acid plant as well as the temperature and pressure of ammonia gas flow and ammonia-to-air ratio will be measured continuously.

The same statistical evaluation that was applied to the baseline data series is applied to the project data series of NCSG and VSG:

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

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

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

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

$EF_n = PE_n / NAP_n$

Step 2: A moving average emissions factor be calculated at the end of a campaign n as follows:

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

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

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

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

5.7. Minimum Project Emissions Factor

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}). EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period ($N_2O/tHNO_3$). 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 used EF_{min} and not EF_n.

5.8. Project Campaign Length

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

5.9. Emission Reductions

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

$ER = (EF_{BL} – EF_P) * NAP *GWP_{N2O}$

According to AM0034, the value for Nitric acid production (NAP) during the project campaign shall not exceed the design capacity of the nitric acid plant.

The existing production capacity is 106 621 metric tonnes of 100% concentrated nitric acid per year (based on 365[1] operating days per year and a daily nameplate capacity of 292,1 $tHNO_3$). Therefore, the AEL No. 9 nitric acid plant shall not be eligible to earn CERs for any tonnes of nitric acid produced exceeding 106 621 in any one year.

It shall be noted however, that the “design” or “nameplate” capacity is the capacity figure that is guaranteed by the plant constructor, which is therefore conservative in nature, allowing for some safety margin for the guarantee. Back in 1968 the guaranteed nameplate capacity was given as 300 short tons, which converts to 272.2 metric tonnes. Immediately after commissioning, the constructor tested the plant and determined that the actual capacity of the plant is approximately 322 short tons[2], which converts to 292.1 metric tonnes. This is approximately the average daily production that the plant has been performing in an average campaign for many years. Therefore, this value should be used to derive the maximum annual nitric acid production output (NAP) for which CERs may be earned.

[1] As per AM0034 page 11.

[2] Commissioning Report from Chemico, the plant constructor. Available onsite at AEL for inspection.

5.10. Data and parameters for calculation of Baseline campaign emissions

See Annex 1

5.11. Data and parameters for calculation of Project campaign emissions

See Annex 2

6. Monitoring plan:

6.1. General description of the monitoring plan

The emission reductions achieved by the project activity are monitored based on the approved monitoring methodology AM0034 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 N_2O inside the ammonia burner of nitric acid plants". Its applicability depends on the same prerequisites as the mentioned baseline methodology.

AM0034 requires the use of the European Norm EN14181 (2004) *"Stationary source emissions - Quality assurance of automated measuring systems"*[3] as a guidance[4] for installing and operating the Automated Monitoring System (AMS) in the nitric acid plants for the monitoring of N_2O emissions.

A complete Automated Monitoring System (AMS) to monitor the mass emissions of N2O at the stack of AELs No.9 nitric acid plant was installed and has been operated since January 2006. The Manufacturer and type of the first N2O Analyser was Environnement S.A. MIR 9000. Due to repeated technical problems with the analyser probably due to damage during transportation to the site it was replaced by a ABB AO2000 Uras 14 NDIR analyser in 2007. A new flow meter was installed in June 2006.

As an operator of the nitric acid plants since 1932 and of the No. 9 nitric acid plant since 1968, AEL staff in general and its Instrument Department in particular is accustomed to operating technical equipment to a high level of quality standards.

The responsibilities within AEL for the operation and maintenance of the AMS are set out in the internal AEL Nitrates Operations Instructions (Document Ref. NIT 002) "CDM Project Data Accuracy Procedure". According to this, the Production Manager (PM) has the overall responsibility for the ongoing operation of the project.
The Engineering Team Manager Electrical/Instrument (ETM E/I) is responsible for the day-to-day calibration procedure and any adjustments required to the instruments as a result of the calibrations.
The Process Controller (PC) checks the analyser boxes every day during the morning shift 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

[3] This standard describes the quality assurance procedures needed to assure that an Automated Measuring System (AMS) installed to measure emissions to air are capable of meeting the uncertainty requirements on measured values given by legislation, e.g. EU Directives, or national legislation, and more generally by competent authorities.

[4] See page 8, last paragraph of AM0034 version 2: "The monitoring system is to be installed using the guidance document EN 14181 …"

and under the guidance of internationally relevant environmental standards, in particular EN 14181 (2004) and EN ISO 14956 (2002).

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

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

6.2. Application of EN 14181 procedures to the project

In the following, it is described how the procedures given in EN14181 for QAL1, 2 and 3 have been practically applied at AEL No. 9 plant.

<u>QAL 1</u>

In accordance with EN14181 an AMS shall have been proven suitable for its measuring task (parameter and 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.

The analyser installed at AEL No. 9 nitric acid plant to continuously monitor N_2O concentration in the stack is an ABB AO2000 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 certified[5] as meeting the requirements of the German emissions standards 17th BImSchV and 13th BImSchV (waste incineration plants, large furnaces and others) for the components NO, CO and SO_2. At the time of commissioning of the AMS by AEL no AMS was available that had been certified according with EN 14181 QAL1 for N_2O measurements. However, ABB has conducted and successfully completed the QAL1 tests[6] for the follow-up model of this analyser module within the same analyser series (ABB AO2000 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. 9 nitric acid plant meets the requirements of the QAL1 test in the same way as the follow-up model.

The Analyser and Flow Meter were calibrated by the vendors (ABB and Emerson Rosemount) prior to shipment and installation in the nitric acid plant[7].

---

[5] TÜV Süddeutschland Bau und Betrieb GmbH (Report number 170 608), March 2003

[6] TÜV Süd Industrie Service GmbH, München (Report number 821029) June 2006

[7] The calibration report can be reviewed by the DOE during the site visit as part of the verification.

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

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

A series of QAL2 specific reference measurements using a the SRM method as per EN 14181 for guidance has been carried out at the plant in February 2008 by an accredited testing house (TÜV SÜD Industrie Service GmbH, Germany) to ensure the AMS' suitability, establish the calibration curve and test the variability of the measurements. The results of these SRM are available to the DOE as part of the verification process. The AMS calibration function as well as the total uncertainty of the AMS was determined. The results were applied in the calculation of EF_{BL} and EF_n.

6.3. AMS calibration and QA/QC procedures

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

Calibration Gas
Calibration gas with a concentration of 1005 ppm N2O (balance being N_2) with a precision of ± 2% is used in the span calibrations. The calibration gas is certified by the manufacturer.

The certified calibration gas used for the span calibration of the analyser is checked against another certified calibration gas by Modderfontein lab. This second cylinder of certified calibration gas has previously been checked against a standard N_2O calibration gas which was produced by Modderfontein lab for that purpose.

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

Analyser Zero and Span Calibrations
Zero and span calibrations are conducted manually twice per week. For the zero calibration pure nitrogen is used, for the span calibration a certified calibration gas is used. The results of the calibrations are recorded according to the related CDM procedure.

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

If the deviation exceeds indicated flow by 450 m3/hr (equal to 1% of range), then the pressure transmitter is recalibrated and the previous procedure repeated.

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

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

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

QAL 3
QAL3 is a procedure which is used to check drift and precision in order to demonstrate that the AMS is in control during its operation so that it continues to function within the required specifications for uncertainty.
This is achieved by conducting periodic zero and span checks on the AMS and then evaluating the results obtained using control charts. Zero and span adjustments or maintenance of the AMS, may be necessary depending on the results of this evaluation. In addition, Annual Surveillance Tests (AST) should be conducted in accordance with EN14181, these are a series of measurements that need to be conducted by independent measurement equipment in parallel to the existing AMS.

6.4. Data acquisition system

The analogue signal (4 to 20 mA) output from the Analyser and Flow meter are converted by the Programmable Logic Controller (PLC) into a digital signal which is then fed into the SCADA data acquisition and database system.
Each of AEL's two nitric acid plants has its own SCADA system on a dedicated PC near the respective plant itself. However, the two SCADA PCs are directly connected to each other and each of the PCs receives all of the measured data from the AMS and stores them. That way there is a constant redundancy of data acquisition and storage. In addition, the instrumentation engineer transfers the data at least once a week into AEL's main IT system as well as making a complete copy of that weeks data (2-second, hourly and daily averages) onto an external discdrive. That way there are already four copies of the original and unchanged data stored in four

different locations. In addition, the hourly and daily data are sent to N.serve on a regular basis (e. g. after each campaign) where they are also stored.

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

6.5. Description of the 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 a 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.

6.6. Monitoring Procedures for parameters other than NCSG and VSG

Throughout the crediting period of the project the following parameters shall be monitored and recorded as described in Annex 1 and Annex 2: OT_h, OP_h, AFR, AIFR, NAP, GS, GC, CL, incoming N_2O regulation and changes in the NO_X regulations.

All of the data obtained and used as part of the baseline and during the crediting period of the project will be archived electronically for at least 2 years in at least 2 different locations.

7. GHG Calculations

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

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

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

NCSG and VSG adjustment factors
A special adjustment factor is applied to the mean NCSG and VSG values derived. During the QAL2 reference measurements it was determined that the N_2O analyzer installed at AEL No. 9 measured higher N_2O concentration than those determined by each of the reference measurements conducted by the QAL2 auditor in February 2007.

The calibration curve for the analyzer resulting from these reference measurements has a slope of 0,97 i.e. the analyzer was measuring on average 3 % less N_2O than the reference method. Therefore, the NCSG values, when applied in the PE calculation, are corrected by a factor of 0,97.

Likewise, the installed flow meter was overstating the actual flow measured by the reference method by 3,8 % and hence, the VSG values are adjusted by a factor of 0,962 before going into the PE calculation

N.DBMS Project Campaign Calculation	**Project:**	**AEL No. 9, Johannesburg, South Africa**				**Campaign: H 16 P1**			
Project campaign 1	**Query 1: Without parameter limits**								17
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	%	bar-g	oC	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	2.113	2.113	2.113	2.113	2.113	2.061		2.113	2.113
Minimum		0,00	0,00	304	800	4	*9*	3.050	
Maximum		3,41	0,67	910.798	902	893	*1.754*	42.927	
Mean		3,27	0,08	871.119	900	309	*607*	41.161	
Standard deviation		0,28	0,04	73.472	9	69	*135*	3.074	
95% confidence level *(1.96 * Std.dev.)*		*0,55*	*0,07*	*144.006*	*17*	*135*	*264*	*6.024*	
Sum	2.113								24.809
Limits acc. to consistency check									
Lower limit									
Upper limit									
Correction factors based on TÜV SÜD QAL2 reference measurements						0,970		0,962	
Campaign emissions	**PE**		*= VSG * NCSG * Oh*					t N2O	**49,3**
Emission factor	**EF_P**		*= PE / NAP*					kg N2O / t HNO3	**1,99**

Query 2: Elimination of faulty data outside operational limits

In this query (Query 2), the operational limits of the plant are applied. Lines of data in which at least one value indicates that the plant is out of operation (trip values) are completely eliminated from further analysis. The design “trip” temperature, i.e. the temperature inside the ammonia oxidation reactor below which the plant shuts down automatically has been applied to exclude such lines of data. During the project, the “trip temperature” of 810℃ will be applied as the exclusion criterion for determining those hours during which the plant was offline during a campaign.

N.DBMS Project Campaign Calculation	**Project:**	**AEL No. 9, Johannesburg, South Africa**				**Campaign: H 16 P1**			
Project campaign 1	**Query 2: With operational limits**								24
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	%	bar-g	oC	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count	2.097	2.097	2.097	2.097	2.097	2.058		2.097	2.097
Remaining share of data sets	99%	99%	99%	99%	99%	100%		99%	99%
Minimum		2,03	0,00	578.367	858	118	*232*	28.836	
Maximum		3,41	0,08	910.798	902	893	*1.754*	42.927	
Mean		3,29	0,08	877.366	900	309	*608*	41.418	
Standard deviation		0,05	0,00	15.372	1	68	*134*	677	
95% confidence level *(1.96 * Std.dev.)*		0,09	0,01	30.129	2	134	*262*	1.327	
Sum	2.097								24.809
Limits acc. to consistency check									
Lower limit					810				
Upper limit									
Correction factors based on TÜV SÜD QAL2 reference measurements						0,970		0,962	
Campaign emissions	**PE**		*= VSG * NCSG * Oh*					t N2O	**49,2**
Emission factor	**EF_P**		*= PE / NAP*					kg N2O / t HNO3	**1,98**

Query 6: application of confidence intervall to eliminate outliers

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

N.DBMS Project Campaign Calculation	**Project:**	**AEL No. 9, Johannesburg, South Africa**				**Campaign: H 16 P1**			
Project campaign 1	**Q6: Q2 + confidence levels**					31		38	24
Parameter	**OH**	**AFR**	**AIFR**	**Oph**	**OTh**	**NCSG**	**NCSG**	**VSG**	**NAP**
Unit	h	t NH3 / h	%	bar-g	oC	ppm	mg N2O / Nm3	Nm3 / h	t HNO3
Count						1.323		1.001	2.097
Minimum		2,03	0,00	578.367	858	305	*599*	41.418	
Maximum		3,41	0,08	910.798	902	418	*822*	42.728	
Mean		3,29	0,08	877.366	900	350	*688*	41.941	
Standard deviation		0,05	0,00	15.372	1	25	*49*	354	
95% confidence level *(1.96 * Std.dev.)*		0,09	0,01	30.129	2	49	*97*	694	
Sum	2.097								24.809
Limits acc. to consistency check									
Lower limit					810	309		41.418	
Upper limit						443		42.745	
Correction factors based on TÜV SÜD QAL2 reference measurements						0,970		0,962	
Campaign emissions	**PE**		*= VSG * NCSG * Oh*					t N2O	**56,4**
Emission factor	**EF_P**		*= PE / NAP*					kg N2O / t HNO3	**2,27**

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 egulations shall be compared to the calculated baseline 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 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 describedin 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.

Emission reductions

The emission reductions for the project activity during the 1st 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:

$$ER = (EF_{BL} – EF_P) * NAP * GWP_{N2O} (tCO_2e)$$

Where:

ER	Emission reductions of the project for the specific campaign (tCO_2e)
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 ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of EFma,n and EFn)

N.DBMS Project Campaign Calculation	Project:	AEL No. 9, Johannesburg, South Africa	Campaign: H 16 P1		
Project campaign 1			31	38	24
Emission factor Baseline	EF_BL			kg N2O / t HNO3	3,74
Emission factor Project Campaign	EF_P			kg N2O / t HNO3	2,27
NAP	NAP			t HNO3	24.809
Greenhouse warming potential N2O	GWP				310
Emission reduction	**ER**			**t CO2e**	**11.288**

The total amount of emission reductions for the project activity of the "Project for the catalytic reduction of N2O emissions with a secondary catalyst inside the ammonia reactor of the No. 9 nitric acid plant at African Explosives Ltd ("AEL"), South Africa" during the 1st monitoring period is: 11.288 tCO_2e.

Annex 1: Data and parameters for calculation of Baseline campaign emissions

All of the monitoring equipment used to derive the data for this Monitoring Report has been made part of the ISO 9001/14001 procedures.

All of the data obtained and used as part of the baseline and during the crediting period of the project will be archived electronically for at least 2 years in at least 2 different locations.

Data / Parameter:	**B.1 / $NCSG_{BC}$**
Data unit:	**mg/Nm3**
Description:	N_2O concentration in the stack gas during the baseline campaign.
Source of data used:	NDIR N_2O gas analyser (ABB AO2040-Uras14)
Value applied:	**1.284**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the determination of the concentration of N_2O in the stack gas. NCSG is continuously monitored with an NDIR gas analyser[8] 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 operating outside the permitted operating range were eliminated. The remaining hourly average values where 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
Any comment:	The first analysr installed at AEL No. 9 nitric acid plant was a Environnement S. A. MIR 9000 The Environnement gas analyser. The S.A. MIR 9000 gas analyser was found to be too inaccurate to be used for the determination of a baseline. Therefore, the NCSG data collected so far was used as an indication for the baseline emissions indicated in the PDD. In 2006 it was decided to purchase a new analyser (ABB AO2040 – URAS 14) that was installed in 2007 and the baseline campaign was repeated subsequently from which the actual NCSG values were be derived in accordance with AM0034. EFBL shall then be checked and approved by the verifying DOE and not the validating DOE. A complete QAL2 audit in accordance with EN 14181 was conducted on the AMS in February 2008.

Data / Parameter:	**B.2 VSG_{BC}**
Data unit:	**Nm^3/h**
Description:	Normal gas volume flow rate of the stack gas during the baseline campaign.
Source of data used:	Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485 combined

8 The ABB AO2000 Uras 14 has been certified by TÜV Süddeutschland in accordance with the German 27th BImSchV (waste incineration plants, large furnaces and others). An NDIR analyser very similar to the AO2000 Uras 14 has since been certified as suitable for N_2O measurements under QAL1 of ISO14956.

	with pressure transmitter Rosemount 3051S
Value applied:	**43.134**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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. VSG data taken during times when the plant was operating outside the permitted operating range were eliminated. The resulting hourly average VSG values are now expressed in Nm^3/h as required by AM0034 and where subsequently 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) e) Calculate the new sample mean from the remaining VSG values
Any comment:	None

Data / Parameter:	**B.3 BE_{BC}**
Data unit:	**tN_2O**
Description:	Total N_2O gas flow for baseline campaign
Source of data used:	Calculation from measured data.
Value applied:	**90,9**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The total mass N_2O emissions during the baseline campaign are determined as a product of NSCG, VSG and the total hours of operation during that baseline campaign: $BE_{BC} = VSG_{BC} * NCSG_{BC} *$ QAL2 correction factors $* 10^{-9} * OH_{BC}$ A special adjustment factor is applied to the mean NCSG and VSG values derived. During the QAL2 reference measurements it was determined that the N_2O analyzer installed at AEL No. 9 measured higher N_2O concentration than those determined by each of the reference measurements conducted by the QAL2 auditor. The calibration curve for the analyzer resulting from these reference measurements has a slope of 0,97, i.e. the analyzer was measuring on average 3 % more N_2O than the reference method. Therefore, the NCSG values, when applied in the BE calculation, are corrected by a factor of 0,97. Likewise, the installed flow meter was overstating the actual flow measured by the reference method by 3,8 % and hence, the VSG values are adjusted by a factor of 0,962 before going into the BE calculation.
Any comment:	None

Data / Parameter:	**B.4 OH_{BC}**
Data unit:	**hours**
Description:	Operating hours
Source of data used:	Process Control System.
Value applied:	**1.760**
Justification of the	Required by AM0034 to determine the total mass emissions of N_2O during the

choice of data or description of measurement methods and procedures actually applied :	baseline. Since the design plant operating temperature is between 800°C and 915°C, by definition the plant is offline if the temperature recorded is at or below 800°C. For practical purposes, each hour for which the ammonia oxidation temperature (OTh) was recorded to be below 810°C is excluded from the determination of OHBC. Also, the baseline data were reduced by eliminating any data from 06.08.2007 at 08:27 hours onwards as that was the point in time at which the NAP production during the baseline was exceeding CL_{normal}.
Any comment:	None

Data / Parameter:	**B.5 NAP_{BC}**
Data unit:	**$tHNO_3$**
Description:	Metric tonnes of 100% concentrated nitric acid produced during the baseline campaign.
Source of data used:	Mass balance calculation and coriolis flow measurements at the No. 9 plant.
Value applied:	**31.278**
Justification of the choice of data or description of measurement methods and procedures actually applied :	Required by AM0034 to calculate the average baseline emissions factor (EFBL) per tonne of 100% concentrated nitric acid produced during that baseline campaign. NAP is determined in the following way: 1. Mass Balance calculation for both plants combined Both of AEL's nitric acid plants feed into one single storage tank. 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. Currently roughly 5% of the nitric acid production are delivered to consumers outside of AEL. A pipeline delivers nitric acid to external consumers based on the same site as the No. 9 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. 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. The total nitric acid delivered is then calculated by a mass balance calculation. Using all these figures the total mass of nitric acid produced is calculated to derive the Calculated Production. Because both of AEL's nitric acid plants on site (No. 9 and No. 11) produce into the same storage tank, the Calculated Production is a combined result for both plants. 2. Apportionment to No. 9 and No. 11 Each of the two plants has a coriolis flow meter installed at the nitric acid product outlet before it goes into the production storage tank to determine the mass of nitric acid produced from each plant. However, these coriolis flow meters are

	experiencing a drift which makes their measurements less accurate. Therefore, AEL uses the calculated values for its financial planning and reporting and uses the flow meter results only for plausibility checks. Nevertheless, the coriolis flow meter results are a useful tool to apportion the Calculated Production resulting from the mass balance calculation to each of the two nitric acid plants by determining the ratio of production resulting from the two coriolis flow meters and applying that to the Calculated Production. NAP $\neq$ CLBL 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 the baseline of AEL No. 9, the 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).
Any comment:	None

Data / Parameter:	**B.6 TSG**
Data unit:	**°C**
Description:	Temperature in the stack gas
Source of data used:	Stack temperature probe situated directly next to the volume flow meter.
Value applied:	**Not applicable**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 nor-mal 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.
Any comment:	None

Data / Parameter:	**B.7 PSG**
Data unit:	**bar**
Description:	Pressure in the stack
Source of data used:	Stack pressure probe situated directly next to the volume flow meter.
Value applied:	**Not applicable**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 nor-mal conditions, the actual pressure in the stack has to be determined and ap-plied to each hourly mean VSG value.
Any comment:	None

Data / Parameter:	**B.8 EF_{BL}**
Data unit:	**tN2O / tHNO3**
Description:	Emissions factor for baseline period
Source of data used:	Calculated from measured data (tons of nitric acid produced / tons of N_2O emitted)
Value applied:	**0,00374**

Justification of the choice of data or description of measurement methods and procedures actually applied :	As required by AM0034 the plant specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid during the baseline campaign is derived by dividing the total mass of N_2O 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_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) is then reduced by the percentage uncertainty as follows: $EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$
Any comment:	None

Data / Parameter:	**B.9 UNC**
Data unit:	**%**
Description:	Calculated uncertainty of the overall Automated Monitoring System (AMS)
Source of data used:	Engineering reports and calculations conducted by the manufacturer of the components of the AMS.
Value applied:	**3,97**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 the overall measurement uncertainty of the AMS is applied in the calculation of the baseline emissions factor (EF_{BL}). The overall total uncertainty of the AMS has been determined by TÜV SÜD Industrie Service GmbH, Germany (an accredited ISO 17025 testing house) during the on-site QAL2 audit. The QAL2 audit report and the uncertainty calculation are available to the DOE on request.
Any comment:	None.

Data / Parameter:	**B.10 AFR**
Data unit:	**tNH3/h**
Description:	Mean Ammonia gas flow rate to the ammonia oxidation reactor
Source of data used:	Orifice plate
Value applied:	**Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR_{max}.**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The monitoring of AFR is required by AM0034 in order to determine AFR_{max}.
Any comment:	None

Data / Parameter:	**B.11 AFR_{max}**
Data unit:	**tNH3/h**
Description:	Maximum Ammonia gas flow rate to the ammonia oxidation reactor
Source of data used:	AFR data
Value applied:	**3,877**
Justification of the	AFR_{max} is used to determine those periods where the plant may be operating

choice of data or description of measurement methods and procedures actually applied :	outside of the permitted operating conditions. Historic data of daily NH_3 consumption was used to obtain determine the range of AFR for the five historic campaigns. Table: Maximum NH_3 gas flow to the AOR (see table below) After removing the top 2.5 percentile values the maximum daily flow rate was 93.037 tons. This corresponds to an hourly flow rate of 3,877kg/hr or 5,110Nm³/hr. The ammonia flow in Nm³/hr is used in the ratio calculation.
Any comment:	None

Campaign No.	Start Date	End date	Total NH_3 consumed	Maximum NH_3 consumed per day
			tonnes	tonnes
H6	4-Jun-04	16-Sep-04	7448.377	93.131
H7	24-Sep-04	27-Dec-04	7372.149	89.508
H8	14-Mar-04	21-Jun-05	7828.5427	92.187
H9	23-Sep-05	20-Dec-05	6838.168	90.425
H10	17-Feb-06	20-Jul-06	6907.924	91.204

Data / Parameter:	**B.12 AIFR**
Data unit:	**% v/v**
Description:	Mean Ammonia to air ratio into the ammonia oxidation reactor
Source of data used:	Measurements of AFR and primary air flow rates (measured by orifice plate).
Value applied:	**8.4 to 11.5 (AIFR will be used to determine $AIFR_{max}$).**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The monitoring of AIFR is required by AM0034 in order to determine $AIFR_{max}$. The allowable NH_3 to Air ratio is taken from the controller data sheet (No. 9 Ratio Controller, August 1997). The range is 8.4 % v/v - 11.5 % v/v.
Any comment:	None

Data / Parameter:	**B.15 $AIFR_{max}$**
Data unit:	**% v/v**
Description:	Maximum Ammonia to air ratio into the ammonia oxidation reactor during the baseline campaign.
Source of data used:	Plant operating manual
Value applied:	**11.5**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 $AIFR_{max}$ is used to determine those periods where the plant may be operating outside of the permitted operating conditions. The upper limits for ammonia flow and ammonia to air ratio shall be determined using one of the following three options, in preferential order: 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. Since no historical data where recorded and available, the allowable NH_3 to Air ratio is taken from the controller data sheet (No 9 Ratio Controller, August 1997). The range is 8.4 % v/v - 11.5 % v/v, therefore the maximum ammonia to air ratio is 11.5%.
Any comment:	None

Data / Parameter:	**B.13 CL_{BL}**
Data 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 used:	NAP_{BC}
Value applied:	**31.278**
Justification of the choice of data or description of measurement methods and procedures actually applied :	CL_{BL} is comprised of each and every tonne of nitric acid produced during the baseline campaign, regardless of whether the measured NCSG and VSG data were excluded from the relevant period. CL_{BL} is then compared with CL_{normal} and shortened by the appropriate number of tonnes of nitric acid by which CL_{BL} exceeds CL_{normal} to derive the correct value of NAP that can be applied in the EF_{BL} calculation.
Any comment:	None

Data / Parameter:	**B.14 CL_{normal}**
Data unit:	**tHNO3**
Description:	Average length of the historic campaigns measured in metric tonnes of 100% concentrated nitric acid produced during that baseline campaign.
Source of data used:	Mass Balance calculations and flow meter measurements as described in NAP.
Value applied:	**23.337**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 the average historic campaign length (CLnormal) is defined as the average campaign length for the historic campaigns that were used to define operating condition. CLnormal presents the cap on the length of the baseline campaign from which the baseline emissions factor will be derived. During the five historic campaigns, the following amounts of metric tonnes of 100% concentrated nitric acid have been produced:

Campaign	Start	End	Production (tHNO3)
H6	04-Jun-04	16-Sep-04	23,753.0
H7	24-Sep-04	27-Dec-04	23,909.2
H8	14-Mar-04	21-Jun-05	25,849.4
H9	23-Sep-05	20-Dec-05	22,986.9
H10	17-Feb-06	20-Jul-06	20,186.3
Mean			**23,337.0**

Therefore, the average historic campaign length (CL_{normal}) is 23,337.0 tonnes of

	100% concentrated nitric acid.
Any comment:	None.

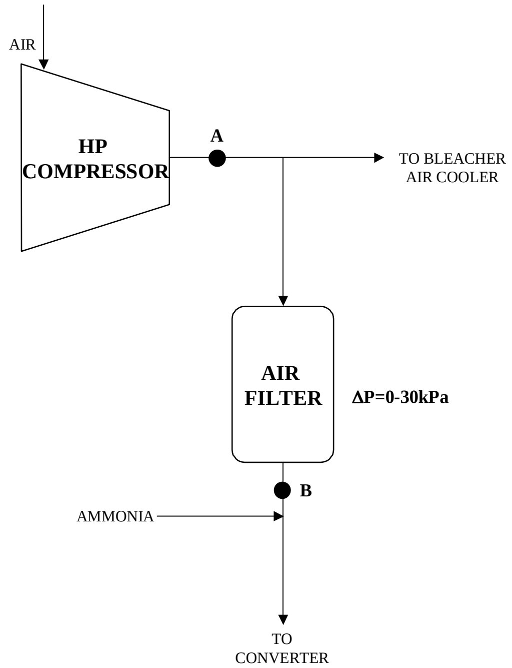
Data / Parameter:	**B.16 OT_h**
Data unit:	**°C**
Description:	Oxidation temperature for each hour during the baseline campaign
Source of data used:	Monitoring results of three thermocouples inside the ammonia oxidation reactor and recorded by the data acquisition system.
Value applied:	**Not applicable**
Justification of the choice of data or description of measurement methods and procedures actually applied :	In accordance with AM0034 the oxidation temperature in the ammonia oxidation reactor (OTh) has to be monitored and compared to the Normal range for oxidation temperature (OT_{normal}). VSG and NCSG data obtained during times when OTh was above or below OT_{normal} has to be eliminated from the calculation of EF_{BL}.
Any comment:	None

Data / Parameter:	**B.17 OT_{normal}**
Data unit:	**°C (min and max)**
Description:	Normal range operating temperature
Source of data used:	Design specifications and operating manual of the No. 9 nitric acid plant (Technical Manual (TM24 June 1977, p94)[9].
Value applied:	**810°C (min.) and 915°C (max.)**
Justification of the choice of data or description of measurement methods and procedures actually applied :	AM0034 requires the establishment of the normal range of operating temperatures in the ammonia oxidation reactor. Since no historical data for the No. 9 plant are available, the range of operating temperature of between 800°C and 915°C, as stipulated in the operating manual was applied to derive OT_{normal}. 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 800°C. For practical purposes, all VSG and NCSG values taken during times when the plant was operating at below 810°C will be excluded.
Any comment:	None

Data / Parameter:	**B.18 OP_h**
Data unit:	kPa (gauge)
Description:	Oxidation Pressure for each hour
Source of data used:	Design specifications and operating manual of the No. 9 nitric acid plant (Technical Manual (TM24 June 1977, p94)[10].
Value applied:	**Not applicable.**
Justification of the choice of data or description of measurement methods	In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (OPh) has to be monitored and compared to the Normal range for oxidation temperature (OP_{normal}). VSG and NCSG data obtained during times when OPh was above or below OP_{normal} has to be eliminated from the calculation

[9] Technical plant manuals will be available for validation during site visit of the DOE .

[10] Technical plant manuals will be available for validation during site visit of the DOE.

and procedures actually applied :	of EF_{BL}. AM0034 prescribes the monitoring and recording of the Oxidation Pressure for each hour (OPh) 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 OPh. 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). Figure: Pressure points for No. 9.  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.
Any comment:	The uncertainty of the pressure sensor is 0.125% according to the vendor. However, since the measurement uncertainty during the baseline campaign and during the project campaigns is the same, the two data series will always be comparable.

Data / Parameter:	**B.19 OP_{normal}**
Data unit:	kPa (gauge)
Description:	Normal operating pressure of the ammonia oxidation reactor.
Source of data used:	Plant operating manual.
Value applied:	**860 kPa – 910 kPa (gauge)**
Justification of the choice of data or description of measurement methods	AM0034 requires the establishment of the normal range of operating pressure in the ammonia oxidation reactor. Since no historical data for the No. 9 plant are available, the range of temperature stipulated in the operating manual was applied to derive OP_{normal}.

and procedures actually applied :	The pressure range for the HP compressor (see drawing for B.18 OPh above) as stated in the HP compressor design data sheet is 890 – 910 kPa (g). The pressure drop (P) across the air filter ranges from 0 to 30 kPa (g) (AEL No. 9 logsheets[11]). Hence, the pressure range at point **B** is 860 kPa – 910 kPa (g). This range also falls within the range given in literature. For high-pressure processes, the pressure range suggested is 700 -1100 kPa (Ullmann's Encyclopedia of Industrial Chemistry, 6th Ed, Vol. 23, p3).
Any comment:	None

Data / Parameter:	**B.20 GS_{normal}**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the operating condition campaigns
Source of data used:	Monitored / Invoices
Value applied:	**W.C. Heraeus**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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. AEL has been using ammonia oxidation catalyst gauzes ("FTCplus") supplied by Heraeus for the past several years, except for three campaigns (01. Jan to 15. Mar 05, 22. Jun to 18. Sep 05 and 23.12.05 to 15 Feb 06) where ammonia oxidation catalyst gauzes supplied by Johnson Matthey were used. The composition of the Johnson Matthey gauzes was different from the Heraeus FTCplus gauze normally used at the plant. 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. 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. Therefore, it is more appropriate to use only those historic campaigns where this type of gauze was used for the determination of the permitted operating conditions.
Any comment:	None

Data / Parameter:	**B.21 GS_{BL}**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the baseline condition campaign
Source of data used:	Monitored / Invoices
Value applied:	**W.C. Heraeus**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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.
Any comment:	None

[11] These are available on request from AEL/N.serve

Data / Parameter:	B.23 GC_{normal}
Data unit:	%
Description:	Gauze composition during the five historic operating campaigns expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value applied:	**Platinum (Pt) 59%** **Rhodium (Rh) 4%** **Palladium (Pd) 37%**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 N_2O baseline emissions. Record of Gauze compositions installed during the historic campaigns[12]: (see table below)
Any comment:	None

Campaign	Gauze Supplier	Gauze Composition		
		Pt (%)	Rh (%)	Pd (%)
H6	Heraeus	59	4	37
H7	Heraeus	59	4	37
H8	Heraeus	59	4	37
H9	Heraeus	59	4	37
H10	Heraeus	59	4	37
Average		**59**	**4**	**37**

Data / Parameter:	B.24 GC_{BL}
Data unit:	%
Description:	Gauze composition during the baseline campaign expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value applied:	**Platinum (Pt) 59%** **Rhodium (Rh) 4%** **Palladium (Pd) 37%**
Justification of the choice of data or description of measurement methods and procedures actually applied :	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 N_2O baseline emissions if the following conditions are met (i) The baseline catalyst composition is considered as common practice in the industry, or (ii) The change in catalyst composition is justified by its availability, performance, relevant literature etc. Otherwise, the baseline emission factor shall be set to the conservative IPCC

[12] 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.

	default emission factor for N2O from nitric acid plants which have not installed N_2O destruction measures (4.5 kg-N2O / t HNO3). GC_{BL} at AEL's No. 9 nitric acid plant is the same as GC_{normal}, therefore, the results of the baseline campaign are fully valid and applicable.
Any comment:	None

Data / Parameter:	**B.26 EF_{reg}**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Emissions cap for N_2O from nitric acid production set by government regulation
Source of data used:	Department of Environmental Affairs and Tourism
Value applied:	**None**
Justification of the choice of data or description of measurement methods and procedures actually applied :	There is currently no regulation in South Africa that limits the emissions of N_2O from nitric acid production.
Any comment:	None.

Annex 2: Data and parameters for calculation of Project campaign emissions

All of the monitoring equipment used to derive the data for this Monitoring Report has been made part of the ISO 9001/14001 procedures.

All of the data obtained and used as part of the baseline and during the crediting period of the project will be archived electronically for at least 2 years in at least 2 different locations.

Data / Parameter:	**P.1 NCSG**
Data unit:	**mg / m³**
Description:	N_2O concentration in the stack gas during each project campaign.
Source of data to be used:	NDIR N_2O gas analyser (ABB AO2040 Uras-14)
Value of data applied	**688**
Description of measurement methods and procedures to be applied:	AM0034 requires the determination of the concentration of N_2O 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 where 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 to be applied:	Manual zero and span calibrations are carried out by the instrumentation departement of AEL twice per week. See Monitoring Plan for more details.
Any comment:	None

Data / Parameter:	**P.2 VSG**
Data unit:	**Nm³/h**
Description:	Normal gas volume flow rate of the stack gas during each project campaign.
Source of data to be used:	Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485 combined with pressure transmitter Rosemount 3051S
Value of data applied	**41.941**
Description of measurement methods and procedures to be applied:	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). VSG data taken during times when the plant was out of operation were eliminated.

	The resulting hourly average VSG values are now expressed in Nm^3/h as required by AM0034 and where subsequently 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 VSG values
QA/QC procedures to be applied:	The flow meter is calibrated at least annually. See Monitoring Plan for more details.
Any comment:	None.

Data / Parameter:	**P.3 PE_n**
Data unit:	**tN_2O**
Description:	Total mass N_2O emissions in each project campaign.
Source of data to be used:	Calculated from the measurements from measured data.
Value of data applied	**56,4**
Description of measurement methods and procedures to be applied:	Not applicable, calculated value as per the following formula: $PE_n = VSG * NCSG * 10^{-9} * OH$ A special adjustment factor is applied to the mean NCSG and VSG values derived. During the QAL2 reference measurements it was determined that the N_2O analyzer installed at AEL No. 9 measured higher N_2O concentration than those determined by each of the reference measurements conducted by the QAL2 auditor. The calibration curve for the analyzer resulting from these reference measurements has a slope of 0,97, i.e. the analyzer was measuring on average 3 % more N_2O than the reference method. Therefore, the NCSG values, when applied in the BE calculation, are corrected by a factor of 0,97. Likewise, the installed flow meter was overstating the actual flow measured by the reference method by 3,8 % and hence, the VSG values are adjusted by a factor of 0,962 before going into the PE_n calculation.
QA/QC procedures to be applied:	Not applicable. Calculated value.
Any comment:	None.

Data / Parameter:	**P.4 OH_n**
Data unit:	**hours**
Description:	Total operating hours during each project campaign
Source of data to be used:	Process Control System.
Value of data applied	**2097**
Description of measurement methods and procedures to be applied:	Required by AM0034 to determine the total mass emissions of N_2O during the baseline. During the project, the “trip temperature” of 810°C will be applied as the exclusion criterion for determining those hours during which the plant was offline during a

	campaign.
QA/QC procedures to be applied:	Subject to ISO 9001/14001 procedures.
Any comment:	None.

Data / Parameter:	**P.5 NAP**
Data unit:	**$tHNO_3$**
Description:	Metric tonnes of 100% concentrated nitric acid during each project campaign.
Source of data to be used:	Mass balance calculation and flow measurements at the No. 9 plant.
Value of data applied	**24.809**
Description of measurement methods and procedures to be applied:	NAP is determined in the following way: 1. Mass Balance calculation Both of AEL's nitric acid plants feed into one single storage tank. 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. On average 5% of the nitric acid production are delivered to consumers outside of AEL. A pipeline delivers nitric acid to external consumers based on the same site as the No. 9 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. 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. The total nitric acid delivered is then calculated by a mass balance calculation. Using all these figures the total mass of nitric acid produced is calculated to derive the Calculated Production. Because both of AEL's nitric acid plants on site (No. 9 and No. 11) produce into the same storage tank, the Calculated Production is a combined result for both plants. 2. Apportionment to No. 9 and No. 11 Each of the two plants has a coriolis flow meter installed at the nitric acid product outlet before it goes into the production storage tank to determine the mass of nitric acid produced from each plant. However, these coriolis flow meters are experiencing a drift which makes their measurements less accurate. Therefore, AEL uses the calculated values for its financial planning and reporting and uses the flow meter results only for plausibility checks. Nevertheless, the coriolis flow meter results are a useful tool to apportion the Calculated Production resulting from the mass balance calculation to each of the two nitric acid plants by determining the ratio of production resulting from the two coriolis flow meters and applying that to the Calculated Production.

	If one of the coriolis flow meters is taken out for maintenance (which may be the case from time to time), then the remaining coriolis flow meter results will be set in relation to the Calculated Production to determine the ratio of production between the two plants. If both flow meters are taken out for maintenance (which has never happened so far), then the ammonia consumption and conversion efficiency of each of the two nitric acid plants will be used to determine the ratio of production between the two in order to apportion the Calculated Production.
QA/QC procedures to be applied:	Subjected to complete SABS testing loops as part of the ISO 9001/14001 procedures.
Any comment:	The combined results of the Calculated Production and Measured Production are used and accepted for both the delivery records to nitric acid consumers and for the financial reporting and planning of AEL.

Data / Parameter:	**P.6 TSG**
Data unit:	**°C**
Description:	Temperature in the stack gas
Source of data to be used:	Stack temperature probe situated directly next to the volume flow meter.
Value of data applied	**Not applicable**
Description of measurement methods and procedures to be applied:	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 directly next to the flow meter.
QA/QC procedures to be applied:	ISO9001/14001 procedures and documented in the applicable ISO handbooks.
Any comment:	None.

Data / Parameter:	**P.7 PSG**
Data unit:	**bar**
Description:	Pressure in the stack
Source of data to be used:	Stack pressure probe situated directly next to the volume flow meter.
Value of data applied	**Not applicable.**
Description of measurement methods and procedures to be applied:	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 to be applied:	ISO9001/14001 procedures and documented in the applicable ISO handbooks.
Any comment:	None.

Data / Parameter:	**P.8 EF_n**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Emissions factor for campaign n.
Source of data to be	Calculation from total mass N_2O emissions of campaign n (PE_n) and total nitric

used:	acid production (NAP_n).
Value of data applied	0,00227
Description of measurement methods and procedures to be applied:	The campaign specific emissions factor for each campaign during the project's crediting period is calculated by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign. For campaign n the campaign specific emission factor would be: $EF_n = PE_n / NAP_n$
QA/QC procedures to be applied:	Not applicable.
Any comment:	None

Data / Parameter:	**P.9 $EF_{ma,n}$**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Moving average emissions factor derived over time from campaign specific emissions factors.
Source of data to be used:	Calculation from campaign specific emissions factors EF_n.
Value of data applied	0,00227
Description of measurement methods and procedures to be applied:	In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach a moving average emission factor shall be estimated as follows: $EF_{ma,n} = (EF_1 + EF_2 + \ldots + EF_n) / n$ 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 to be applied:	Not applicable.
Any comment:	None

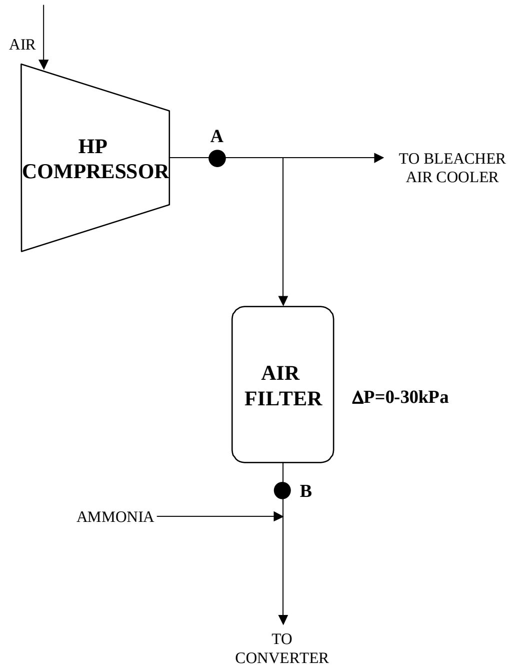
Data / Parameter:	**P.12 CL_n**
Data unit:	**$tHNO_3$**
Description:	Length of each project campaign measured in metric tonnes of 100% concentrated nitric acid produced during that campaign.
Source of data to be used:	NAP
Value of data applied	**24.809**
Description of measurement methods and procedures to be applied:	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_2O values measured during the baseline campaign can be used for the calculation of EF (subject to the elimination of data from the Ammonia/Air analysis). If $CL_n < CL_{normal}$, recalculate EF_{BL} by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_n.
QA/QC procedures to	See comments for NAP.

be applied:	
Any comment:	None.

Data / Parameter:	**P.13 EF_p**
Data unit:	**$tN_2O/tHNO_3$**
Description:	Emissions factor used for the specific campaign n to determine the emission reductions of that campaign
Source of data to be used:	Calculation of EF_n and $EF_{ma,n}$.
Value of data applied	0,00227
Description of measurement methods and procedures to be applied:	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 to be applied:	Not applicable.
Any comment:	None

Data / Parameter:	**P.14 EF_{min}**
Data unit:	**$tN_2O/tHNO_3$**
Description:	EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period.
Source of data to be used:	Calculations of $EF_{ma,n}$.
Value of data applied	0,00227
Description of measurement methods and procedures to be applied:	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 used EF_{min} and not EF_n.
QA/QC procedures to be applied:	Not applicable.
Any comment:	None.

Data / Parameter:	**OP_h**
Data unit:	**bar**
Description:	Oxidation Pressure for each hour
Source of data to be used:	Discharge of the air compressor before the ammonia to air mixer
Value of data applied	**Not applicable. Used to determine when plant is operating outside of permitted range.**
Description of measurement methods and procedures to be	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

applied:	above or below OP_{normal} has to be eliminated from the calculation of EF_{BL}. 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 OPh. 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). Figure: Pressure points for No. 9.  During the 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.
QA/QC procedures to be applied:	Subject to ISO 9001/14001 procedures.
Any comment:	None.

Data / Parameter:	**OTh**
Data unit:	**°C**
Description:	Oxidation temperature in the ammonia oxidation reactor (AOR).
Source of data to be used:	Monitoring results of three thermocouples inside the ammonia oxidation reactor and recorded by the data acquisition system.
Value of data applied	**Not applicable. Used to determine when plant is operating outside of permitted range.**
Description of measurement methods and procedures to be applied:	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}. In case of a project campaign the Oth is used to define if the plant is in operation or not. It OTh is below 810° the plant is defined to be out of operation. In that case all date series when OTh is below 810°C are eliminated from further calculations.
QA/QC procedures to be applied:	Subject to ISO 9001/14001 procedures.
Any comment:	None.

Data / Parameter:	**AFR**
Data unit:	**tNH_3/h**
Description:	Ammonia gas flow rate to the ammonia oxidation reactor.
Source of data to be used:	Orifice plate
Value of data applied	**Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR_{max}.**
Description of measurement methods and procedures to be applied:	The ammonia flow is continuously measured by orifice plate.
QA/QC procedures to be applied:	Subject to ISO 9001/14001 procedures.
Any comment:	None.

Data / Parameter:	**AIFR**
Data unit:	**% v/v**
Description:	Ammonia to air ratio into the ammonia oxidation reactor
Source of data to be used:	Calculation for each hour of plant operation based on measurements of AFR and primary air flow rates.
Value of data applied	**Not applicable**
Description of measurement methods and procedures to be applied:	The monitoring of AIFR is required by AM0034 in order to determine whether the plant was operating within the permitted operating range. In the baseline procedures $AIFR_{max}$ was determined to be 11.5% v/v. During the analysis of the measured data, any of the NCSG and VSG data obtained from an hour during which the AIFR was above $AIFR_{max}$ will be eliminated from the calculation of EF_{BL}. AIFR is calculated from AFR and the primary air flow to the ammonia oxidation reactor. The airflow rate is measured by orifice plate and expressed in kg/hr and is then converted to Nm^3/h, which is used in the ratio calculation
QA/QC procedures to be applied:	Subject to ISO 9001/14001 procedures.
Any comment:	None.

Data / Parameter:	**$GS_{project}$**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the project campaign
Source of data used:	Monitored / Invoices
Value applied:	**W.C. Heraeus**
Justification of the	AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst

choice of data or description of measurement methods and procedures actually applied :	gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.
Any comment:	None

Data / Parameter:	**$GC_{project}$**
Data unit:	**%**
Description:	Gauze composition during the project campaign expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Source of data used:	Monitored / Gauze supplier invoices
Value applied:	**Platinum (Pt) 59%** **Rhodium (Rh) 4%** **Palladium (Pd) 37%**
Justification of the choice of data or description of measurement methods and procedures actually applied :	The gauze composition during the baseline and historic campaigns is the same as during the project campaign. Therefore the results of the baseline campaign and the project campaign are fully valid and applicable.
Any comment:	None