



**Project design document form for  
CDM project activities  
(Version 07.0)**

*Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.*

**PROJECT DESIGN DOCUMENT (PDD)**

|   |   |
|---|---|
| <b>Title of the project activity</b>  | N2O ABATEMENT PROJECT AT NITRIC ACID PLANT NO. 11 AT AFRICAN EXPLOSIVES LTD. (AEL), SOUTH AFRICA  |
| <b>Version number of the PDD</b>  | Version <del>1.02</del>   |
| <b>Completion date of the PDD</b>   | 08/07/2016  |
| <b>Project participant(s)</b>   | - <del>African Explosives Ltd ("AEL")</del> AEL Mining Services Limited<br>- N.serve Environmental Services GmbH<br>- <del>Nordic Environment Finance Corporation</del> |
| <b>Host Party</b>   | South Africa  |
| <b>Applied methodology(ies) and, where applicable, applied standardized baseline(s)</b> | AM0034 (Version 2)  |
| <b>Sectoral scope(s) linked to the applied methodology(ies)</b>                         | Chemical industries (5)   |
| <b>Estimated amount of annual average GHG emission reductions</b>                       | <del>320,007</del> <u>306,103</u> tCO <sub>2</sub> e  |

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

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The sole purpose of the proposed project activity is to significantly reduce current levels of N<sub>2</sub>O emissions from the production of nitric acid at one of AEL's nitric acid plants (the "No. 11 Plant") at Modderfontein, South Africa. The No. 11 nitric acid plant was designed by Uhde and commissioned in 1979, it is a single burner dual pressure oxidation plant operated at 4.5 bar gauge.

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

Established in 1896, AEL is one of the world's leading suppliers of explosives and initiating systems. The nitric acid produced by AEL is mainly utilized by AEL's own Ammonium Nitrate ("AN") production plant which produces both porous prilled AN and dense prilled AN for commercial explosives manufacturing, mainly for mining purposes. In addition, some AN is supplied as an aqueous solution to local fertiliser manufacturers in South Africa.

To produce nitric acid, ammonia (NH<sub>3</sub>) 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<sub>2</sub>, which is later absorbed in water to form HNO<sub>3</sub> – nitric acid. Simultaneously, undesired side reactions yield nitrous oxide (N<sub>2</sub>O), nitrogen and water. N<sub>2</sub>O is a potent greenhouse gas with a Global Warming Potential (GWP) of 310<sup>1</sup>.

The project activity involves the installation of a new N<sub>2</sub>O abatement technology; a pelletised catalyst that will be installed inside the ammonia oxidation reactor, underneath the precious metal gauzes. It is expected that this catalyst will reduce between 80% and 95% of current N<sub>2</sub>O emissions.

The project transfers a new, clean technology to South Africa that is not even common industrial practice in Annex 1 countries. Also, the project will lead to an enhancement of skills as employees will be trained to operate both the N<sub>2</sub>O abatement catalyst and the Automated Monitoring System.

AEL is an ISO 9001 and 14001 certified company. 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.

AEL's shares are owned by AECL and Tiso (a "black empowerment" investment company). A share of AEL's CDM profits will go to the Tiso-AEL Community Development Trust which benefits two local communities near Modderfontein: Alexandra and Tembisa; especially an Environmental Education Project (EEP) aimed at local schoolchildren<sup>2</sup>. The EEP will improve social structures and social amenities in the community.

Furthermore, the project activity may well stimulate the implementation of further CDM projects in South Africa. Compared to tertiary catalyst technology, which requires additional natural gas for its

<sup>1</sup> IPCC Second Assessment Report (1995)

<sup>2</sup> See Annex 5 for more detailed information on the Environmental Education Project.

operation, the implementation of secondary catalyst technology also indirectly contributes to the South African Government's Energy Efficiency Strategy<sup>3</sup>.

In these aspects, the project will contribute to the sustainable development objectives of South Africa in accordance with the National Environmental Management Act No. 107 of 1998. The project has already received Letters of Endorsement from the Ministry of Minerals and Energy in South Africa and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. A letter of Approval from the South African government is only obtainable once the project has been validated<sup>4</sup>.

## **A.2. Location of project activity**

### **A.2.1. Host Party**

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South Africa

### **A.2.2. Region/State/Province etc.**

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Province of Gauteng, South Africa

### **A.2.3. City/Town/Community etc.**

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Modderfontein, east of the City of Johannesburg

### **A.2.4. Physical/Geographical location**

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AEL operates an industrial complex at Modderfontein, approximately 20 km north-east from the centre of the City of Johannesburg. The postal address is PO Modderfontein 1645. This PDD covers the larger of the two nitric acid plants – named No. 11 – operated at this location. The exact longitude and latitude of the plant's location is 26° 05' 50" South and 28° 10' 26" East<sup>5</sup>.

**A regional map shows the location of Modderfontein near Johannesburg**

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<sup>3</sup> See <http://www.dme.gov.za/energy/efficiency.stm>

<sup>4</sup> See [http://www.dme.gov.za/dna/dna\\_approvalprocess.stm](http://www.dme.gov.za/dna/dna_approvalprocess.stm) under "mandatory submission".

<sup>5</sup> Coordinates according to Google Earth©, version 4.0.291 (beta)



Aerial photograph shows the location of the No. 11 plant in relation to the No. 9 plant on the site



No. 9 Nitric Acid Plant

No. 11 Nitric Acid Plant

Photograph of the No. 11 nitric acid plant



The No. 9 nitric acid plant operated on the AEL production site has been developed as a separate CDM project. The No. 9 PDD has been submitted to the validator for the purpose of initiating the Global Stakeholder Consultation process on the 16<sup>th</sup> December 2006 for publication on the UNFCCC web site<sup>6</sup>.

### A.3. Technologies and/or measures

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The project activity entails a transfer of

- state-of-the art N<sub>2</sub>O abatement technology which is not even commonly applied in Annex I countries.
- Specialised monitoring equipment
- Training of staff for installation, operation and maintenance of catalyst and AMS, etc.

A number of N<sub>2</sub>O abatement technologies have become available in the past 2 years after some 10 years of research, development and industrial testing. Only now that N<sub>2</sub>O regulation is likely to be introduced in the EU in the near future<sup>7</sup> and with the incentives provided by the Kyoto Protocol nitric acid plant operators are considering adopting these technologies. N<sub>2</sub>O abatement technology is now commercially available from a number of catalyst manufacturers, mainly from Germany and the UK. These technologies are proprietary and will be sold or leased to nitric acid plants. The financing of this technology is facilitated by the CDM. Hence, the CDM will enable nitric acid plants in non-Annex 1 countries to become the pioneers of N<sub>2</sub>O abatement of the global nitric acid industry.

AEL will install a secondary N<sub>2</sub>O abatement catalyst system upon successful registration as a CDM project, but has not yet finally decided on the catalyst vendor.

<sup>6</sup> See <http://cdm.unfccc.int/Projects/Validation/DB/OWXM15OTRAUOL7A4HIUTR6AO7VCP81/view.html>.

<sup>7</sup> Responding to Article 30 of the EU ETS Directive 2003/87/EC, the Commission has submitted a report to the European Parliament and the Council considering the functioning of the Scheme. See the EU homepage under [http://ec.europa.eu/environment/climat/emission/pdf/com2006\\_676final\\_en.pdf](http://ec.europa.eu/environment/climat/emission/pdf/com2006_676final_en.pdf) for this report which expressly considers extending the EU ETS into N<sub>2</sub>O emissions (see page 6 therein).

## Technology transfer and safety issues

As mentioned before, the secondary abatement technology has been tested in several industrial trials in which it has proven to be reliable in reducing N<sub>2</sub>O and environmentally safe. Especially, its implementation does not lead to increased NO<sub>x</sub> emissions. Neither is the environment directly or indirectly harmed in any other way.

AEL will ensure that the chosen N<sub>2</sub>O 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 ought to be operated by the local AEL-employees. All project participants will work together on training the AEL workers to reliably supervise the effective operation of the catalyst technology, apply the installed monitoring system to measure the emission levels and collect the data in a manner that allows a successful completion of each verification procedure.

### A.4. Parties and project participants

| Party involved<br>(host) indicates host Party | Private and/or public<br>entity(ies) project<br>participants<br>(as applicable)  | Indicate if the Party involved<br>wishes to be considered as<br>project participant (Yes/No) |
|---|--|--|
| South Africa <u>(host)</u>                    | <del>African Explosives Ltd (“AEL”):<br/>AEL is the owner and operator<br/>of the No. 11 nitric acid plant in<br/>South Africa. <u>AEL Mining<br/>Services Limited</u></del> | No   |
| United Kingdom <sup>8</sup>                   | <del>N.serve Environmental<br/>Services GmbH, <u>Germany</u><br/> (“N.serve”) is a developer and<br/>financer of CDM and JI<br/>projects.</del>                              | No   |
| <u>Switzerland</u>                            | <del>- <u>N.serve Environmental<br/>Services GmbH</u><br/>- <u>AEL Mining Services Limited</u></del>   | <u>No</u>  |
| <u>Norway</u>                                 | <u>Nordic Environment Finance<br/>Corporation</u>  | <u>No</u>  |

### A.5. Public funding of project activity

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No public funding has been or will be received in the development, implementation or operation of this project. The complete financing of the project will be borne by the Project Participants.

<sup>8</sup> The UK DNA also accepts Non-UK entities as potential project participants, if they are located in a EU member state; due to the extraordinarily high fees presently charged by the German DNA, the project participants have agreed to apply to the UK for obtaining investor country approval.

## **SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline**

### **B.1. Reference of methodology and standardized baseline**

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This project is based on Approved Baseline and Monitoring methodologies AM0034 (Version 02): “Catalytic reduction of N<sub>2</sub>O inside the ammonia burner of nitric acid plants”.

Furthermore, the project draws on approved baseline methodology AM0028 (Version 04.1) for the baseline scenario selection and employs the “Tool for the demonstration and assessment of additionality” (Version 03).

### **B.2. Applicability of methodology and standardized baseline**

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The chosen baseline methodology AM0034 is applicable to project activities that install a secondary abatement catalyst inside the ammonia burner of a nitric acid plant, underneath the precious metal gauze pack. This corresponds with the proposed project activity.

The use of the chosen methodology is applicable as

1. The proposed project activity will be applied to an existing production facility installed prior to the 31<sup>st</sup> December 2005. The plant has been commissioned and is in operation since 1979. The existing nameplate production capacity is 282,875 metric tonnes of 100% concentrated nitric acid per year (based on 365<sup>9</sup> operating days per year and a daily nameplate capacity of 775 t/HNO<sub>3</sub>)
2. Currently, the plant does not have any N<sub>2</sub>O destruction or abatement facilities that could be affected by the project activity.
3. The project activity has no influence on the plant’s nitric acid production levels.
4. The host country does not have any legal requirements to reduce N<sub>2</sub>O emissions from nitric acid plants.
5. Presently, no N<sub>2</sub>O abatement technology is installed in the plant.
6. The project activity will not increase NO<sub>x</sub> emissions.
7. There is no NSCR De NO<sub>x</sub>-unit installed in the plant.
8. The installation of the secondary N<sub>2</sub>O abatement catalyst will not lead to any additional direct or indirect GHG emissions within the project boundary.
9. A complete Automated Monitoring System (AMS) comprised of an N<sub>2</sub>O analyser and a volume flow meter, has been installed in the appropriate location as per AM0034. The AMS has been continuously operated since January 2006 to collect the baseline data and will continue to measure concentration and total gas volume flow in the stack during the plant’s operation throughout the crediting period of the project activity.

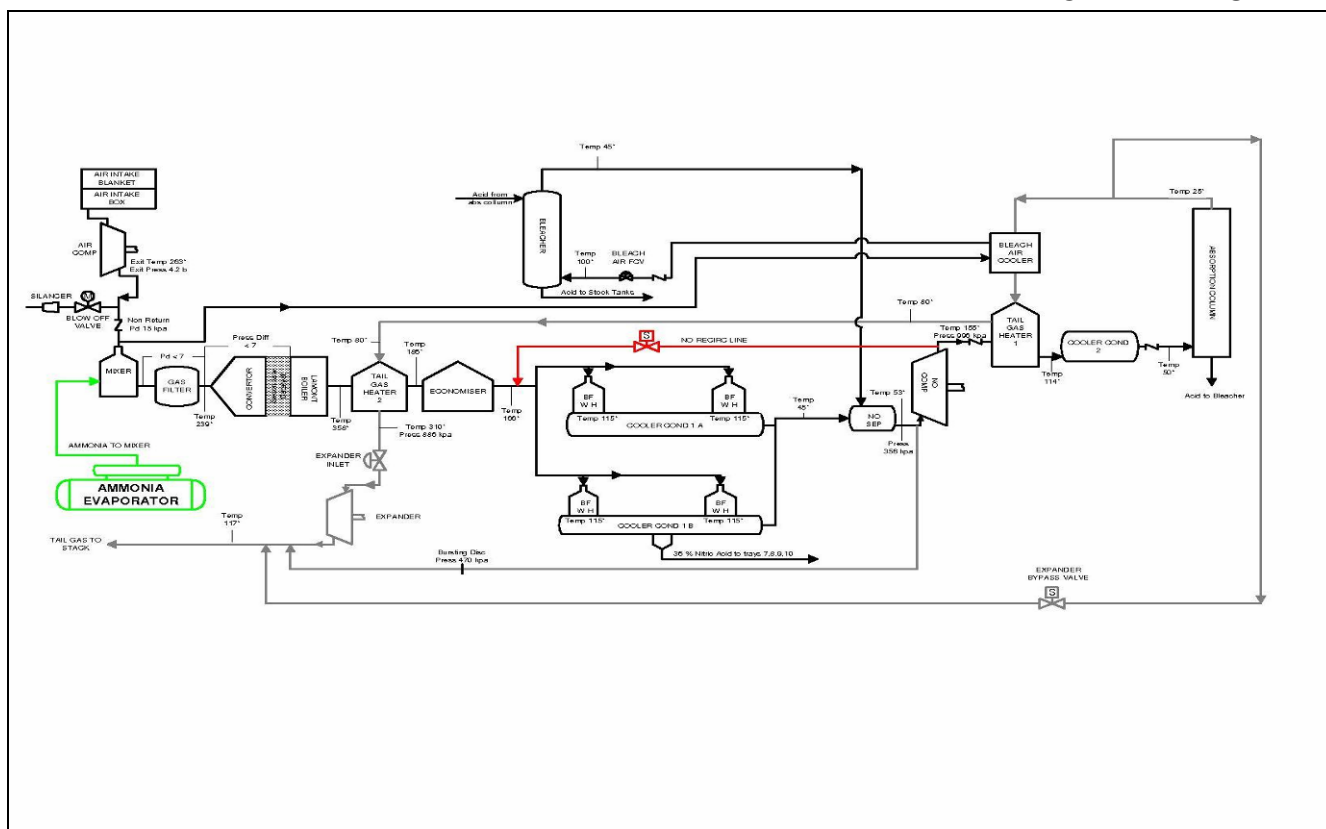
### **B.3. Project boundary**

The following flow chart displays the No. 11 nitric acid plant on which the project activity is to be applied<sup>10</sup>. The boundary of the project activity includes the complete process equipment of the No. 11 nitric acid plant as shown on the flow chart below.

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<sup>9</sup> As per AM0034 page 11.

<sup>10</sup> A more legible hard copy version of the flow chart will be made available to the validator during the on-site validation. Upon request, it can also be sent to the CDM EB.



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 about 900°C and 4.5 bar (gauge) 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<sub>3</sub>) with atmospheric oxygen (O<sub>2</sub>) (reaction 1). NO readily oxidises further to form NO<sub>2</sub> (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<sub>2</sub> (reaction 2). These intended chemical reactions (main reactions) are the following:

- (1)  $4 \text{ NH}_3 + 5 \text{ O}_2 \rightarrow 4 \text{ NO} + 6 \text{ H}_2\text{O}$
- (2)  $2 \text{ NO} + \text{O}_2 \rightarrow 2 \text{ NO}_2$
- (3)  $2 \text{ NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$
- (4)  $3 \text{ HNO}_2 \rightarrow \text{HNO}_3 + \text{NO} + \text{H}_2\text{O}$

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)  $4 \text{ NH}_3 + 3 \text{ O}_2 \rightarrow 6 \text{ H}_2\text{O} + 2 \text{ N}_2$
- (b)  $4 \text{ NH}_3 + 4 \text{ O}_2 \rightarrow 6 \text{ H}_2\text{O} + 2 \text{ N}_2\text{O}$

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<sub>2</sub>O.

On leaving the ammonia oxidation reactor some of the N<sub>2</sub>O 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°C may allow N<sub>2</sub>O to spontaneously decompose.

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

| Source            |   | GHGs             | Included? | Justification/Explanation   |
|-------------------|---|------------------|-----------|---|
| Baseline scenario | Source 1: Nitric Acid Plant (Burner inlet to Stack) | CO <sub>2</sub>  | No        | The process does not lead to any CO <sub>2</sub> or CH <sub>4</sub> emissions |
|                   |   | CH <sub>4</sub>  | No        | The process does not lead to any CO <sub>2</sub> or CH <sub>4</sub> emissions |
|                   |   | N <sub>2</sub> O | Yes       |   |
|                   |   | ...              |           |   |
|                   | Source 2  | CO <sub>2</sub>  |           |   |
|                   |   | CH <sub>4</sub>  |           |   |
|                   |   | N <sub>2</sub> O |           |   |
|                   |   | ...              |           |   |
|                   | ...   | ...              |           |   |
|                   |   | ...              |           |   |
|                   |   | ...              |           |   |
| Project scenario  | Source 1: Nitric Acid Plant (Burner inlet to Stack) | CO <sub>2</sub>  | No        | The process does not lead to any CO <sub>2</sub> or CH <sub>4</sub> emissions |
|                   |   | CH <sub>4</sub>  | No        | The process does not lead to any CO <sub>2</sub> or CH <sub>4</sub> emissions |
|                   |   | N <sub>2</sub> O | Yes       |   |
|                   |   | ...              |           |   |
|                   | Source 2: Leakage emissions                         | CO <sub>2</sub>  | No        | No leakage emissions are expected.  |
|                   |   | CH <sub>4</sub>  | No        | No leakage emissions are expected.  |
|                   |   | N <sub>2</sub> O | No        | No leakage emissions are expected.  |
|                   |   | ...              |           |   |
|                   | ...   | ...              |           |   |
|                   |   | ...              |           |   |
|                   |   | ...              |           |   |
|                   |   | ...              |           |   |

#### B.4. Establishment and description of baseline scenario

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The approved baseline methodology AM0034 (Version 02) refers to AM0028 with regard to the identification of the baseline scenario. The following steps are taken from this methodology's version 4.01, adapted to the project activity in question and applied in a four-step-procedure: after the identification of all principally viable alternatives to the proposed project activity – combining technical solutions for N<sub>2</sub>O- (step 1a) and NO<sub>x</sub>- (step 1b) abatement for reasons explained in the second next paragraph below –, those that would not comply with applicable legal standards are eliminated (step 2). After conducting a barrier analysis (step 3a), it is shown that at least one of the remaining scenario alternatives (which is not the project activity) is viable in spite of the identified

barriers (step 3b). It will be demonstrated below that only one scenario alternative meets these criteria. This is the most likely “business as usual” scenario, the assumed baseline scenario.

**Step 1:** Identification of all realistic, credible and technically feasible baseline scenario alternatives to the project alternative.

The AM0028-procedure suggests assessing N<sub>2</sub>O and NO<sub>x</sub> abatement scenarios separately (steps 1a and b). This is omitted, because NO<sub>x</sub> abatement options are only relevant if the NO<sub>x</sub> regulations in South Africa would require an amendment of the plant. However, AEL is in compliance with South Africa’s NO<sub>x</sub> regulations without any such technical amendment.

Currently the regulator NO<sub>x</sub> emissions limit for AEL’s No. 11 nitric acid plant is 200 ppmv. AEL does not normally exceed this limit and is therefore in full compliance of the prevailing NO<sub>x</sub> regulations in South Africa.

The baseline scenario alternatives should include all possible options that are technically feasible to handle N<sub>2</sub>O emissions. For the No. 11 plant, the principally debatable options are:

- 1) Status quo: The continuation of the current situation, without installing any N<sub>2</sub>O abatement technology in the plant
- 2) Switch to alternative production method not involving ammonia oxidation process
- 3) Alternative use of N<sub>2</sub>O such as:
  - a) recycling of N<sub>2</sub>O as feedstock for the plant;
  - b) The use of N<sub>2</sub>O for external purposes.
- 4) Installation of a Non-Selective Catalytic Reduction (NSCR) De NO<sub>x</sub>-unit<sup>11</sup>
- 5) Installation of an N<sub>2</sub>O abatement or reduction technology
  - a) Primary or tertiary measures to prevent the formation or reduce N<sub>2</sub>O
  - b) A secondary facility to reduce N<sub>2</sub>O (like proposed project activity without registration as CDM project activity)

These options should also include the CDM project activity not implemented as CDM project. From a technological point of view, the scenario 5 b) is identical with the proposed project alternative. However, implementing secondary catalyst technology without CDM-project registration could in principle be an alternative. The project’s registration with UNFCCC entails considerable additional costs that could be avoided by not having the activity registered as a CDM project. The last baseline scenario alternative provides for this option.

The following options are technically not feasible:

Baseline scenario alternative 2) is not an option, because there is no other commercially viable alternative for producing nitric acid. In history, there have been other methods for producing nitric acid:

The *Birkland & Eyde* method applied electrical discharge on air to produce small quantities of NO<sub>2</sub> that could be reacted with water for equally small amounts of nitric acid. This procedure requires large amounts of electricity. It was applied for industrial production in Norway between 1902 and 1930. This method did not prevail as it entails significant production costs.

The same is to be said for nitric acid production according to the *Glauber* methodology. This was the main procedure used before now predominant *Ostwald* process was introduced. It entailed reacting saltpetre with sulphuric acid and required large amounts of both to match current production levels.

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<sup>11</sup> Non-Selective Catalytic Reduction (NSCR): As a NSCR DeNO<sub>x</sub>-unit would reduce N<sub>2</sub>O emissions as a side reaction to the NO<sub>x</sub>-reduction, a new NSCR installation can be regarded as an alternative N<sub>2</sub>O reduction technology.

Even if one considered these methods as viable options, amending an existent nitric acid production facility to operate using another process would not be possible. Thus, AEL could not switch to an alternative production method without building a completely new plant.

The use of N<sub>2</sub>O as a feedstock for the AEL plant – as suggested by scenario 3) a) – is technically not practicable as it is not possible to produce nitric acid from N<sub>2</sub>O. The recovery of N<sub>2</sub>O for the sake of gaining feedstock for the production process is not practiced in any known nitric acid plant.

Scenario 3) b), the use of N<sub>2</sub>O for external purposes, is economically not viable as the quantity of exhaust gas to be filtered would be enormous compared to the amount of nitrous oxide that could be recovered at the prevailing N<sub>2</sub>O concentrations in the tail gas of AEL's No. 11 plant.

Therefore, the baseline alternatives 2) as well as 3) a) and b) can be excluded from further assessment.

**Step 2:** Elimination of all baseline scenario alternatives that are not in compliance with applicable legal or regulatory requirements. This step may also include laws and regulations that have another objective than GHG reduction, such as national or local NO<sub>x</sub> regulations.

There is no legal national, provincial or local government requirement for AEL to reduce NO<sub>x</sub> emissions, neither under the National Environmental Management Air Quality Act (No.39 of 2004), nor under the Atmospheric Pollution Prevention Act, Act No. 45 of 1965.

Neither of AEL's nitric acid plants has NO<sub>x</sub> abatement systems installed. AEL uses cooling water for heat removal in the NO<sub>2</sub> absorption process.

So far, the NO<sub>x</sub> emissions statutory limit for AEL's No. 11 nitric acid plants is 200 ppmv, and the average NO<sub>x</sub> emission for this plant is 186 (2006 average) ppmv. AEL's nitric acid plants both have an atmospheric emissions certificate issued under the Atmospheric Pollution Prevention Act, Act No. 45 of 1965 that certifies that emission levels are in compliance with environmental standards<sup>12</sup>.

Recently, AEL has experienced occasional difficulties with maintaining NO<sub>x</sub>-emission levels below the statutory limit. This problem has been discussed with the DOE-representative during the on-site validation visit. AEL has assessed a leakage in the plant's tail gas heaters to be the cause for the increased NO<sub>x</sub> levels in tail gas. This assumption was accepted by the auditor.

In order to resolve this problem, AEL has ordered a new tail gas heating system which will be installed in the plant in August 2007. The local environmental authority has been informed about the increased emission levels and the solution sought by AEL in advance. The authority approved this procedure.

All supporting documents have been submitted during the on-site validation conducted by the DOE, whose representative declared these sufficient for satisfying the validation prerequisites.

Therefore, it can be concluded that the continuation of the current situation or status quo is in full compliance with the current regulations.

The secondary abatement catalysts on the market have not shown to lead to any change in the levels of NO<sub>x</sub> emissions of the nitric acid plants where they were tested. Therefore, it can safely be assumed that AEL's NO<sub>x</sub> emissions will remain unaffected by the installation of the secondary catalyst. In any case, NO<sub>x</sub> emissions are currently monitored by an NDIR analyser using extractive gas technology as installed for monitoring N<sub>2</sub>O concentration. Therefore, any change in NO<sub>x</sub> emission levels could easily be detected and investigated.

The above scenarios are in compliance with all applicable laws and regulatory requirements. Currently, there are no laws or regulations in place that would prohibit implementing any of the remaining scenario alternatives.

Therefore, this step does not lead to the exclusion of any of the aforementioned baseline scenario alternatives.

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<sup>12</sup> Department of Environmental Affairs and Tourism, Registration in terms of the Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965), Registration Certificate No. 135/22.

**Step 3:** Identification of those baseline scenario alternatives that face prohibitive barriers (step 3a) and naming of the most likely scenario alternative (step 3b).

In **Step 3a** of the baseline identification process, all baseline scenario alternatives that face prohibitive barriers (investment related, technical or incompatibility with the prevailing practice) are to be eliminated.

#### **Investment barriers (economic/financial)**

Scenario 4), the installation of a Non-Selective Catalytic Reduction (NSCR) De NO<sub>x</sub> unit is not economically viable since AEL generally is operating in compliance with the prevailing NO<sub>x</sub> regulations in South Africa.

Should these NO<sub>x</sub> regulations change in a way that would require AEL to install a NO<sub>x</sub> abatement unit, the installation of an outdated technology (NSCR) cannot be conceived as a viable alternative to installing a state-of-the-art Selective Catalytic Reduction (SCR) NO<sub>x</sub> abatement unit. NSCR units require additional natural gas or ammonia to achieve sufficient tail gas temperatures and/or the right reducing environment inside the catalyst leading to comparably high operational costs. By being led through the absorption tower the gas mix has been cooled down to a temperature level below what is required for N<sub>2</sub>O abatement catalysts to function<sup>13</sup>. Because of this, a stack-mounted catalyst abatement system would only work if the stack gas mix is re-heated. This is been done by combustion of additionally added natural gas.

The necessity to purchase additional gas would significantly contribute to overall operational expenses. Moreover, fitting NSCR units would halt production for a significant time, because tail gas heating systems needed to be installed in the stack<sup>14</sup>. Therefore, baseline scenario alternative 4) faces significant investment barriers.

Also, none of the N<sub>2</sub>O destruction technology options – scenarios 5 a) and b) – would require considerable additional investment without generating any financial or economic benefits to compensate for this. Compared to the investment requirements for installing the catalyst technology, the costs for the UNFCCC registration procedure are negligible. This is why scenario 5 b) would be slightly less costly than the proposed project activity, but nevertheless economically unattractive. The only option for gaining additional revenues would require a registration as CDM project activity.

There is no other revenue potential in implementing such technologies other than CDM related income. Their operation does not create any marketable products or by-products. However, any operator willing to install and thereafter operate such technology faces significant investment and additional operating costs. The legislative and regulatory environment in South Africa does not require any investment in N<sub>2</sub>O abatement technology. Thus, any investment would be entirely voluntary.

It is unlikely that any plant operator would install such technologies on a voluntary basis without the incentive of any regulatory requirements (emissions caps) or financial benefits (such as revenues from the sale of CERs).

Therefore, any baseline scenario alternatives that include the implementation of N<sub>2</sub>O abatement catalysts will entail considerable investment barriers. Thus, scenario alternatives 4), 5) a) and b) all are hampered by significant investment barriers.

#### **Technical barriers**

Any of the available N<sub>2</sub>O abatement technologies are integrated in the nitric acid plant. In Annex I countries the installation and operation of N<sub>2</sub>O abatement catalysts has been developed to a degree that renders risks to plant functionality to a very low degree. However, there is a – at least

<sup>13</sup> N<sub>2</sub>O abatement catalysts require a minimum gas mix temperature of at least 550°C in order to operate effectively; see the booklet no. 2 of the European Fertilizer Manufacturers Association (EFMA), published in the internet under <http://www.efma.org/Publications/BAT%202000/Bat02/booklet2.pdf> (page 17 therein) for further information.

<sup>14</sup> For other disadvantages of NSCR technology see an EFMA-booklet (also footnote 13) published in the internet under <http://www.efma.org/Publications/BAT%202000/Bat02/booklet2.pdf> (page 18 therein).

theoretical – risk that primary and secondary abatement technologies if not correctly designed and installed, interfere with the nitric acid production process by causing a deterioration of product quality or a loss of production output. This principally negligible risk may be slightly increased if maintenance standards are below those of Annex I countries.

Assuming that all catalyst technology option could be installed in a fashion that guarantees full operational functionality without any such negative effects, there would be no technical barriers to any of these baseline scenario alternatives with regard to these causes.

### Barriers due to prevailing practice

The installation of N<sub>2</sub>O abatement technology currently is neither industrial practice in South Africa nor anywhere else in Africa or even the industrialised parts of the world. However, currently all nitric acid producers in South Africa are pursuing the implementation of N<sub>2</sub>O abatement technologies in order to participate in the CDM. Thus, it can be assumed that these activities would not take place in the absence of CDM related revenues.

**Step 3b** demonstrates that the identified barriers would not prevent the implementation of at least one of the remaining alternatives (which is not the proposed project activity).

Under step 3a it was demonstrated that those baseline scenario alternatives entailing the installation of N<sub>2</sub>O abatement catalysts face considerable barriers.

The only baseline alternative that is not prevented by any one of the barriers and that is in full compliance with the prevailing laws and regulations in South Africa is baseline scenario 1): the continuation of the current situation without installing any N<sub>2</sub>O abatement technology in the plant. Therefore, this is identified as the applicable baseline scenario for the proposed project activity.

All other alternatives are eliminated and Step 4 (Identify the economically most attractive baseline alternative) can therefore be omitted.

The table below summarises the findings of section B.4.:

|       | Baseline Scenario Alternative  | Legal / Technical preclusion | Identified barriers |            |                         | Probability |
|-------|--|------------------------------|---------------------|------------|-------------------------|-------------|
|       |  |                              | Investment related  | Technical  | Common practice related |             |
| 1     | Continued plant operation without change                                 | No                           | No                  | No         | No                      | Likely      |
| 2     | Switch to alternative HNO <sub>3</sub> production methodology            | Yes                          | Irrelevant          | Irrelevant | Irrelevant              | Excluded    |
| 3 a   | External use of N <sub>2</sub> O   | Yes (Technical)              | Irrelevant          | Irrelevant | Irrelevant              | Excluded    |
| 3 b   | N <sub>2</sub> O re-cycling as feedstock for production                  | Yes (Technical)              | Irrelevant          | Irrelevant | Irrelevant              | Excluded    |
| 4     | Installation of a NSCR DeNO <sub>x</sub> unit                            | No                           | Yes                 | No         | Yes                     | Very Low    |
| 5 a/b | Catalytic N <sub>2</sub> O abatement technology without CDM registration | No                           | Yes                 | No         | Yes                     | Very Low    |

**B.5. Demonstration of additionality**

&gt;&gt;

This section employs the “Tool for the demonstration and assessment of additionality” (Version 03) as agreed by the CDM Executive Board and published in February 2007 (“Additionality Tool”).

**Step 1:** As suggested by AM0034 (Version 02), step 1 of procedure proposed by the Additionality Tool has been omitted. The identification of scenarios in alternative to the project activity has been conducted within the baseline scenario identification process (see B.4. above).

**Steps 2 and 3:** To establish additionality, the Additionality Tool requires an investment or a barrier analysis, focussing on the comparison of the proposed project activity with the identified baseline scenario. Alternatively project applicants can select to do both.

Here, an investment analysis is chosen to carry out this part of the procedure. This corresponds with step 2 of the Additionality Tool; thus, step 3 (comprising the option of a barrier analysis) is omitted.

**Step 2: Investment Analysis**

**Step 2a:** At first, the appropriate investment evaluation methodology has to be chosen to conduct the comparative investment analysis between the identified baseline scenario and the proposed project activity.

As demonstrated above (B.4.), none of the two alternatives generates any additional financial or economic benefits besides those obtainable from the sale of CERs, which implies the applicability of a simple cost analysis. This evaluation method is chosen here.

**Step 2b – Option I. Simple Cost Analysis:**

The proposed project activity will lead to significant investment and operating costs for the engineering, construction, shipping, installation and commissioning of the secondary N<sub>2</sub>O abatement catalyst and any necessary modifications of the basket currently holding the rashig rings. In addition, AEL will have to pay a regular lease fee for the continued operation and regular replacement of the secondary N<sub>2</sub>O abatement catalyst. The investment and operating costs for the Automated Monitoring System (AMS) amount to approximately EUR 80,000 (AMS purchasing price, plus costs for maintenance and replacement parts, excluding any labour costs) throughout the crediting period.

The estimated costs of the project amount to EUR 2.7 million of which an estimated EUR 1.4 million are for the N<sub>2</sub>O abatement catalyst, approximately EUR 1 million for the purchasing of the AMS and the operation of the project by AEL staff and EUR 0.2 million for validations and verifications<sup>15</sup>.

The identified baseline scenario alternative – the continuation of the current situation, operating the nitric acid plant without an N<sub>2</sub>O abatement catalyst – does not incur any additional costs.

Therefore, the proposed project activity is financially and economically less attractive than the baseline scenario.

**(Step 3, Barrier Analysis is omitted, see above)**

**Step 4 Common Practice Analysis**

Step 4 assesses the common industrial practice in the area, where the project activity is to be implemented and thus allows verifying the results obtained in the previous steps. If the technology that is to be installed is the common industrial practice in the region already, this would indicate that the project activity is financially and economically more attractive than the baseline scenario alternative and / or that there are no considerable barriers for its implementation.

Market studies (e.g. by EFMA, EU IPPC, US EPA, IPCC) show that N<sub>2</sub>O abatement technologies have not yet spread out into the nitric acid industry even in Annex 1 countries, apart from

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<sup>15</sup> More accurate and detailed confidential information on investment and operation costs can be disclosed to the DOE and the CDM EB upon request.

occasional industrial testing. The main reason for this is a lack of regulation / incentive to reduce N<sub>2</sub>O emissions.

The research and development work done so far have been driven by a general expectation that industrialised countries – especially the EU, USA, Japan and Canada – may eventually introduce N<sub>2</sub>O emission caps. EU legislation initiating such a limit is under way already and will probably enter into force in 2007.

The proposed project activity would lead to a first time installation of N<sub>2</sub>O abatement technology for nitric acid plants in the region. Up until today, the common practice in the area is to operate such facilities without any N<sub>2</sub>O abatement technology. This situation is changing now, since other nitric acid plant operators are also planning to implement N<sub>2</sub>O abatement technologies as a CDM project activity.

Therefore, the analysis of the common industrial practice indicates that the proposed project activity is additional to the baseline scenario.

#### **Conclusion:**

Currently, there are no national regulations or legal obligations in South Africa concerning N<sub>2</sub>O emissions. It is unlikely that any such limits on N<sub>2</sub>O emissions will be imposed in the near future.

AEL is in no need to invest in any N<sub>2</sub>O destruction or abatement technology. Neither are there any national incentives to promote similar project activities. Without the sale of the CER's generated by the project activity no revenue would be generated and the technology would not be installed. No income from any kind of potential product or by-product except CERs are able to pay back investment costs as well as running costs for the installation of the proposed project activity as no marketable product or by product exists. The proposed CDM project activity is undoubtedly additional, since it passes all the steps of the "Tool for demonstration and assessment of additionality".

The registration of the project activity as a CDM Project and the resulting expected CER revenues are the single source of project revenues. CDM registration is therefore the decisive factor for the realization of the proposed project activity.

## **B.6. Emission reductions**

### **B.6.1. Explanation of methodological choices**

>>

#### **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<sub>2</sub>O generation during the baseline campaign, the normal ranges for operating conditions shall be 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 shall be 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 to be monitored are the following:

OT<sub>h</sub> Oxidation temperature for each hour (°C)

OP<sub>h</sub> Oxidation pressure for each hour (Pa)

OT<sub>normal</sub> Normal range for oxidation temperature (°C)

OP<sub>normal</sub> 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 such

data available at AEL<sup>16</sup>. Because neither South African law nor AEL management practices required recording and storing of the above operating parameters, the historic values are unknown. 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 appropriate values contained in the technical manuals of the No. 11 nitric acid plant were used to derive these normal ranges<sup>17</sup>. See section B.6.2, B.16, 17, 18 and 19 for details.

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

Parameters to be monitored

AFR Ammonia gas flow rate to the AOR (tNH<sub>3</sub>/h)

AFRmax Maximum ammonia gas flow rate to the AOR (tNH<sub>3</sub>/h)

AIFR\_ Ammonia to air ratio (%)

AIFRmax\_ Maximum ammonia to air ratio (%)

Historic data of daily NH<sub>3</sub> consumption was used to obtain determine the range of AFR for the five historic campaigns (excluding abnormal campaigns). Due to an inappropriately adjusted monitoring range of the data acquisition system installed at the plant, the measured values had to be adjusted by factoring the obtained results; this procedure and the underlying reasons are explained below<sup>18</sup>.

## **2. Determination of baseline emission factor: measurement procedure for N<sub>2</sub>O concentration and gas volume flow**

N<sub>2</sub>O concentration and gas volume flow are to be monitored throughout the baseline campaign by an Automated Monitoring System (AMS) which is to be installed and operated using European Norm 14181 (2004) as guidance where applicable. The AMS provides separate readings for N<sub>2</sub>O concentration (NCSG) and gas volume flow (VSG) for every two seconds of operation of the plant.

Error readings (e.g. downtime or malfunction) are indicated by the digital alarm conditions of the analyser.

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 calculation steps are to be applied to the complete data series of N<sub>2</sub>O concentration as well as to the data series for gas volume flow. This 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<sub>2</sub>O concentration of stack gas (NCSG))

The average mass of N<sub>2</sub>O emissions per hour is estimated as product of the NCSG and VSG. The N<sub>2</sub>O emissions per campaign are estimates product of N<sub>2</sub>O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

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<sup>16</sup> This has been confirmed by means of a written statement from AEL's project representative Mr Leon Aucamp. This statement is to be found in [Annex-6Appendix 5](#) below.

Also, AEL made available to the validating DOE some log-sheets that were used for recording the plant parameters prior to the installation of the first AMS. Data into these log-sheets was manually inserted. The parameters relevant for AM0034 stated as being unavailable within this PDD were not contained in the log-sheet template used at that time. Upon request, the sample log-sheets can be made available to the CDM EB.

<sup>17</sup> See AM0034: Baseline Emissions, 1.i.b)

<sup>18</sup> See section B.6.2 (tables B.10 AFR, B.11 AFR<sub>max</sub>, B.12 AIFR and B.15 AIFR<sub>max</sub>) for further information.

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

The plant specific baseline emissions factor representing the average N<sub>2</sub>O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N<sub>2</sub>O emissions by the total output of 100% concentrated nitric acid for that period. The overall uncertainty of the monitoring system shall also be determined and the measurement error will be expressed as a percentage (*UNC*). The N<sub>2</sub>O emission factor per tonne of nitric acid produced in the baseline period ( $EF_{BL}$ ) shall then 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<sub>2</sub>O emissions in South Africa, the resulting  $EF_{BL}$  will be used as the baseline emission factor.

The gauze supplier and gauze composition during the baseline campaign is the same as during the historic campaigns used to establish the permitted operating conditions. 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. Also, the operating conditions during the baseline can be regarded as representative of normal operating conditions, because – with a statistical confidence level of 95% – the average values of the permitted operating range fall within the average values obtained during the baseline campaign. Therefore the baseline campaign is valid and the resulting  $EF_{BL}$  can be applied to calculate the resulting emission reductions of the project.

### Campaign Length

In order to take into account the variations in campaign length and its influence on N<sub>2</sub>O 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), will be used as a cap on the length of the baseline campaign. Data of nitric acid production during the historic campaigns has been recorded for the No. 11 plant and was used for calculate the average historic campaign length.

**If  $CL_{BL} \leq CL_{normal}$ , then** all N<sub>2</sub>O 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” of operating parameters).

**If  $CL_{BL} > CL_{normal}$ , then** N<sub>2</sub>O values that were measured beyond the length of  $CL_{normal}$  during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of  $EF_{BL}$ .

Although historic operating parameter data are unavailable, the production output (i.e. the NAP values) of both AEL plants had been recorded. Therefore, it is possible to compare  $CL_{BL}$  and  $CL_{normal}$  for this project activity as required by AM0034.

### Leakage

As per methodology AM0034, no leakage emission calculation is required since no leakage emissions are expected to occur as a result of the project activity.

### Project Emissions

Over the duration of the project activity, N<sub>2</sub>O 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 calculation steps 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<sub>2</sub>O 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:* estimate a moving average emissions factor be calculated at the end of a campaign n as follows:

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

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

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

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

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

#### Minimum Project Emissions Factor

N<sub>2</sub>O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest  $EF_n$  observed during those campaigns will be adopted as a minimum ( $EF_{min}$ ).  $EF_{min}$  is equal to the lowest  $EF_n$  observed during the first 10 campaigns of the project

crediting period (N<sub>2</sub>O/tHNO<sub>3</sub>). 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  $EF_n$ .

#### 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<sub>2</sub>O 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<sub>2</sub>O values that were obtained during the production of tonnes of nitric acid beyond the  $CL_n$  (i.e. the last tonnes produced) from the calculation of  $EF_n$ .

#### 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<sub>2</sub>O:

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

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 282,875 metric tonnes of 100% concentrated nitric acid per year (based on 365<sup>19</sup> operating days per year and a daily nameplate capacity of 775 t/HNO<sub>3</sub>). Therefore, the No. 11 nitric acid plant shall not be eligible to earn CERs for any tonnes of nitric acid produced exceeding 282,875 in any one year.

The No 11 nitric acid plant was commissioned in 1979. The basis of the plant design was to guarantee a production of 650 metric tons of 100% acid per day. In 1996 trials were carried out to up-rate the capacity of the plant. The limiting factor identified was the airflow through the plant. Trials involved the installation of a dedicated air compressor to supply the bleach airflow. This was not successful due to the failure of this air compressor. Subsequent investigations into the compressor train revealed that the plant can be operated up to 775 tHNO<sub>3</sub>/day acid by speeding up the compressor train, without having to run a secondary compressor. This is the current mode of operation. Currently plant output is however restricted as a result of a high pressure drop through a number of vessels. These vessels are going to be replaced in the shutdown to be carried out in August 2007, with the intention of returning the plant to the abovementioned higher production rates at best. However, the plant has been operated according to maximum and even beyond<sup>20</sup> daily design capacity for short periods of time in the past.

Therefore, the currently valid value of 775 tHNO<sub>3</sub> per day provides an adequate basis for deriving the maximum annual nitric acid production output (NAP) for which CERs may be earned.

### N.serve Database Management System (N.DBMS)

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

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

A detailed example of the source data fed into the N.DBMS is contained in Annex 3: Baseline information.

### B.6.2. Data and parameters fixed ex ante

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

Detailed information on the AMS installed at the plant is contained in section B.7.2 below as well as in Annex 4. These parts of the PDD also deal with QA/QC-issues.

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

| Data / Parameter | B.1 / NCSG <sub>BC</sub>  |
|------------------|---|
| Unit             | mgN <sub>2</sub> O/Nm <sup>3</sup>  |
| Description      | N <sub>2</sub> O concentration in the stack gas during the baseline campaign. |
| Source of data   | NDIR N <sub>2</sub> O gas analyser (Environnement S.A. MIR 9000)              |
| Value(s) applied | <u>1,6281,630.03</u>  |

<sup>19</sup> As per AM0034 page 11.

<sup>20</sup> AEL has on occasion produced more than 775 tHNO<sub>3</sub> per day; for example on 14<sup>th</sup> June 2002 AEL produced 781 tHNO<sub>3</sub>.

|   |  |
|---|--|
| <b>Choice of data or Measurement methods and procedures</b> | <p>AM0034 requires the determination of the concentration of N<sub>2</sub>O in the stack gas. NCSG is continuously monitored with an NDIR gas analyser<sup>21</sup> and monitoring results are taken and recorded for every two seconds of plant operation. Hourly means for NCSG are derived by the SCADA data acquisition system. NCSG data taken during times when the plant was operating outside the permitted operating range were eliminated. The remaining hourly average values were subjected to the following calculation steps:</p> <ul style="list-style-type: none"> <li>a) Calculate the sample mean (x)</li> <li>b) Calculate the sample standard deviation (s)</li> <li>c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)</li> <li>d) Eliminate all data that lie outside the 95% confidence interval</li> <li>e) Calculate the new sample mean from the remaining NCSG values</li> </ul> <p>The value is converted from ppmv (the mean being 828.87 ppmv) as permitted by AM0034<sup>22</sup>.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |

<sup>21</sup> The Environnement S.A. MIR 9000 gas analyser has been certified according to ISO 14956, QAL1 procedures as suitable for stack gas concentration monitoring of NO, NO<sub>2</sub>, SO<sub>2</sub> and various other gasses. At the time of installation of the AMS at AEL's No. 11 plant, no analyser was available on the market that had already passed the QAL1 suitability certification for N<sub>2</sub>O.

<sup>22</sup> See page 16 of AM0034 (table: Baseline emission parameters, row B.1)

|                           |   |
|---------------------------|---|
| <b>Additional comment</b> | <p>After significant difficulties with the N<sub>2</sub>O analyser on the No. 9 nitric acid plant, AEL has decided in February 2007 to replace the existing Environnement MIR9000 analysers in both the No. 9 and No. 11 plant with new ABB Uras 14 analysers.</p> <p>For the No. 11 plant, this substitution will take place after the Environnement analyser has been QAL2-tested in order to ensure the validity of the data sets recorded during the baseline campaign.</p> <p><u>A complete QAL2 audit in accordance with EN 14181 was conducted on the AMS in February 2008. During the QAL2 reference measurements it was determined that the analyser consistently underestimates the N<sub>2</sub>O concentration in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.104 has to be applied to all NCSG measurements. Therefore, the mean NCSG value will be multiplied by 1.104 before going into the calculation of BE<sub>BC</sub>.</u></p> <p><u>Calibration information</u><br/> <u>During Baseline period 20/07/2006 – 18/02/2007:</u><br/> <u>Bi-weekly Zero and span check and calibration in case of deviation &gt;1% of range of analyzer against zero gas and certified calibration gas cylinder (internal calibration by AEL) Documentation in form of calibration reports and shewart charts.</u><br/> <u>First check for baseline period: 18/07/2006</u><br/> <u>During the baseline period: check performed twice per week</u><br/> <u>Last check for baseline period: 17/02/2007</u><br/> <u>Next check after baseline period: 20/02/2007</u></p> <p><u>Date of last external calibration:</u><br/> <u>QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012</u><br/> <u>The calibration error as determined during the QAL2 test was retroactively applied to the NCSG results for the baseline period in order to correct the underestimation. Moreover the overall uncertainty of the AMS was applied in a conservative manner to the results of baseline emissions.</u></p> |
|---------------------------|---|

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>B.2 VSG<sub>BC</sub></b>  |
| <b>Unit</b>             | Nm <sup>3</sup> /h   |
| <b>Description</b>      | Normal gas volume flow rate of the stack gas during the baseline campaign. |
| <b>Source of data</b>   | Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485                |
| <b>Value(s) applied</b> | <u>72,468</u> <del>70,824</del>  |

|   |  |
|---|--|
| <b>Choice of data or Measurement methods and procedures</b> | <p>AM0034 requires the determination of the gas volume flow (VSG) in the stack. VSG is continuously monitored with a flow meter and monitoring results are taken and recorded for every two seconds of plant operation. Hourly means for VSG are derived by the SCADA data acquisition system. VSG data taken during times when the plant was operating outside the per-mitted operating range were eliminated.</p> <p>The flow meter is ranged to a maximum flow of 150,000m<sup>3</sup>/h (corresponding to normal m<sup>3</sup> at a stack temperature of 113°C and stack pressure of 85.6 kPa (absolute) or 856 mbar) and a maximum differential pressure of 1.898 kPa (gauge). The flow meter was not re-ranged during the baseline campaign in order to avoid a confusion of the baseline date. Therefore, the measured VSG data have to be multiplied with a standard factor of 0.9594 in order to give the normal flow for the above assumed conditions.</p> <p>This factor will be readjusted in the QAL2-testing process that the AMS in-installed at the No. 11 plant will be subject to. This test will be conducted – in accordance with the requirements of AM0034 – for N2O concentration and stack gas volume as specified by EN 14181.</p> <p>For the project campaigns, the flow meter will be readjusted to the appropriate range so that this factoring of the measured value is no longer necessary.</p> <p>Also, the corrected measured data need to be compensated for the actual prevailing temperature and pressure in the stack through the following calculation:</p> $\frac{P_s * V_s}{T_s} = \frac{P_a * V_a}{T_a}$ <p>Where:<br/> P refers to the Pressure (mbar) [conversion from kPa to mbar is a factor of 10]<br/> V the volumetric flow rate (m<sup>3</sup>/hr)<br/> T the temperature in Kelvin (Note 1 K = T (°C) + 273).<br/> Subscript “s” refers to the actual stack values<br/> Subscript “a” refers to the assumed stack conditions.</p> <p>This simplifies to:</p> $V_s = V_a * \frac{P_a}{T_a} * \frac{T_s}{P_s}$ <p>As an example</p> <p>The assumed stack temperature and pressure values are 113°C and 846 mbar. The measured values are: 115.16 °C and 842.59 mbar. Using a flow from the acquisition system of 73,165.32 and the conversion of 0.9594 gives a final flow of 70,873.28 Nm<sup>3</sup>/hr.</p> $73165.32 * 0.9594 * \frac{846 * (115.16 + 273)}{(273 + 113) * 842.59} = 70873.28$ |
|---|--|

|                           |  |
|---------------------------|--|
|                           | <p>The resulting hourly average VSG values are now expressed in Nm<sup>3</sup>/h as required by AM0034 and where subsequently subjected to the following calculation steps:</p> <ol style="list-style-type: none"> <li>Calculate the sample mean (x)</li> <li>Calculate the sample standard deviation (s)</li> <li>Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)</li> <li>Eliminate all data that lie outside the 95% confidence interval</li> <li>Calculate the new sample mean from the remaining VSG values</li> </ol>   |
| <b>Purpose of data</b>    | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b> | <p><u>The QAL2 test, performed by an independent 3rd party laboratory with EN ISO/IEC 17025 accreditation, include the test of the correct measurement of stack gas temperature and stack gas pressure by comparison of the AMS results of these parameters with the results of the reference measurement instruments of the testing laboratory. Moreover during the QAL2 test the correct normalization of the stack gas flow (VSG) to standard conditions is verified by comparison of the AMS results for normalized flow with the reference measurement results for normalized flow.</u></p> <p><u>During the QAL2 reference measurements it was determined that the flow meter consistently underestimates the total gas volume flow in the stack. As a result from the QAL2 calibration curve, it was determined that a correction factor of 1.01 will have to be applied to all VSG measurements. Therefore, the result of the above statistical analysis, i.e. the mean VSG value will be multiplied by 1.01 before going into the calculation of BE<sub>BC</sub>.</u></p> <p><u>Calibration information</u></p> <p><u>During Baseline period 20/07/2006 – 18/02/2007:</u></p> <p><u>Internal calibrations: after each campaign</u></p> <p><u>Date of internal calibration :19/07/2006</u></p> <p><u>Date of internal calibration :23/02/2007</u></p> <p><u>Date of last external calibration:</u></p> <p><u>QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012</u></p> <p><u>The calibration error as determined during the QAL2 test was retroactively applied to the NCSG results for the baseline period in a conservative manner. Moreover the overall uncertainty of the AMS was applied in a conservative manner to the results of baseline emissions.</u>None</p> |

|   |   |
|---|---|
| <b>Data / Parameter</b>                                     | <b>B.3 BE<sub>BC</sub></b>  |
| <b>Unit</b>   | tN <sub>2</sub> O   |
| <b>Description</b>  | Total N <sub>2</sub> O gas flow for baseline campaign   |
| <b>Source of data</b>                                       | Calculation from measured data.   |
| <b>Value(s) applied</b>                                     | <u>524.35651.983</u>  |
| <b>Choice of data or Measurement methods and procedures</b> | <p>The total mass N<sub>2</sub>O emissions during the baseline campaign are determined as a product of NSCG, VSG and the total hours of operation during that baseline campaign:</p> $BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}$ |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

|   |  |
|---|--|
| <b>Data / Parameter</b>                                     | <b>B.4 OH<sub>BC</sub></b>   |
| <b>Unit</b>   | hours  |
| <b>Description</b>  | Operating hours  |
| <b>Source of data</b>                                       | Process Control System.  |
| <b>Value(s) applied</b>                                     | <u>4,5214,950</u>  |
| <b>Choice of data or Measurement methods and procedures</b> | <p>Required by AM0034 to determine the total mass emissions of N<sub>2</sub>O during the baseline.</p> <p>Since the design plant operating temperature is between 820°C and 905°C, by definition the plant is offline if the temperature recorded is at or below 800°C. For practical purposes, each hour for which the ammonia oxidation temperature (OT<sub>h</sub>) was recorded to be below 830°C is excluded from the determination of OH<sub>BC</sub>.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b>                                   | None   |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>B.5 NAP<sub>BC</sub></b>  |
| <b>Unit</b>             | tHNO <sub>3</sub>  |
| <b>Description</b>      | Metric tonnes of 100% concentrated nitric acid produced during the baseline campaign.  |
| <b>Source of data</b>   | <u>Nitric acid flow meter</u><br><u>Manufacturer: EMERSON,</u><br><u>Type: Coriolis mass flow meter CMF 300</u><br><u>Laboratory results for verification purposes</u> <del>Mass balance calculation</del> |
| <b>Value(s) applied</b> | <u>436,476</u> <u>134,700</u>  |

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| <b>Choice of data or Measurement methods and procedures</b> | <p>Required by AM0034 to calculate the average baseline emissions factor (<math>EF_{BL}</math>) per tonne of 100% concentrated nitric acid produced during that baseline campaign. NAP is determined by a mass balance calculation according to the following procedures:</p> <p><u>NAP is determined by a mass flow meter according to the following procedures:</u></p> <p><u>The density and temperature as measured by the mass flow meter is used to calculate the concentration of the nitric acid produced. This value is then used to convert the total mass flow to 100% nitric acid produced. The correct measurement of acid concentration is checked by manual tests.</u></p> <p><del>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.</del></p> <p><del>Currently roughly 5% of the nitric acid production is delivered to consumers outside of AEL. A pipeline delivers nitric acid to external consumers based on the same site as the No. 11 nitric acid plant. The delivery volumes are measured by flow meters. Deliveries of nitric acid to consumers by tanker truck are checked and recorded on a weighbridge.</del></p> <p><del>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.</del></p> <p><del>The total nitric acid delivered is then calculated by a mass balance calculation.</del></p> <p><del>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. 11 and No. 9) produce into the same storage tank, the Calculated Production is a combined result for both plants.</del></p> <p><del>There is also a coriolis flow meter installed, which continuously measures the production output of nitric acid into the storage tank. However, this flow meter is quite unreliable which is why AEL uses the calculated values for its financial planning and reporting and uses the flow meter results only for plausibility checks.</del></p> <p><del>The value of NAP has to be adjusted in accordance with the results of a comparison between <math>CL_{BL}</math> and <math>CL_{normal}</math>. In the case of AEL No. 11, the baseline campaign was longer than the normal historic campaign length. Therefore, <math>NAP_{BC}</math> as stated herein is not used for the calculation of <math>EF_{BL}</math>, but rather <math>CL_{normal}</math> is applied. The same adjustment will be applied to the value of operational hours (OH).</del></p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |

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|---------------------------|--|
| <b>Additional comment</b> | <u>The nitric acid flow meter is subject of external calibration procedures every 3 years.</u><br><u>Calibration information</u><br><u>During Baseline period 20/07/2006 – 18/02/2007:</u><br><br><u>External calibration by:</u><br><u>ALPRET Controls Specialists Date 25/04/2006 and 06/09/2007;</u><br><u>although the calibration is valid for 3 years, it is done more frequently</u><br><u>None</u> |
|---------------------------|--|

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|---|---|
| <b>Data / Parameter</b>                                     | <b>B.6 TSG</b>  |
| <b>Unit</b>   | °C  |
| <b>Description</b>  | Temperature in the stack gas  |
| <b>Source of data</b>                                       | Stack temperature probe situated next to the volume flow meter.   |
| <b>Value(s) applied</b>                                     | Not applicable  |
| <b>Choice of data or Measurement methods and procedures</b> | AM0034 requires the determination of gas volume flow at normal conditions in the stack. In order to calculate from the measured VSG values to VSG at normal conditions, the actual temperature in the stack is measured by temperature probes inserted directly next to the flow meter inside the stack. The resulting measurements are applied to each hourly mean VSG value for calculation of normal volume flow.  |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | <u>The TSG result is automatically applied for calculating VSG at standard conditions</u><br><u>Calibration information</u><br><u>Calibration information</u><br><u>During Baseline period 20/07/2006 – 18/02/2007</u><br><br><u>Internal calibrations: after each campaign</u><br><u>Date of internal calibration :19/07/2006</u><br><u>Date of internal calibration :23/02/2007</u><br><br><u>Date of last external calibration:</u><br><u>QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012</u><br><u>None</u> |

|   |  |
|---|--|
| <b>Data / Parameter</b>                                     | <b>B.7 PSG</b>   |
| <b>Unit</b>   | mbar (absolute)  |
| <b>Description</b>  | Pressure in the stack  |
| <b>Source of data</b>                                       | Stack pressure probe situated directly next to the volume flow meter.  |
| <b>Value(s) applied</b>                                     | Not applicable   |
| <b>Choice of data or Measurement methods and procedures</b> | 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. |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |

|                           |  |
|---------------------------|--|
| <b>Additional comment</b> | <u>The PSG result is automatically applied for calculating VSG at standard conditions</u><br><u>Calibration information</u><br><u>Calibration information</u><br><u>During Baseline period 20/07/2006 – 18/02/2007</u><br><br><u>Internal calibrations: after each campaign</u><br><u>Date of internal calibration :19/07/2006</u><br><u>Date of internal calibration :23/02/2007</u><br><br><u>Date of last external calibration:</u><br><u>QAL2 Test – 01/08/2007 - 04/08/2007 valid until August 2012</u> <u>None</u> |
|---------------------------|--|

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|---|---|
| <b>Data / Parameter</b>                                     | <b>B.8 EF<sub>BL</sub></b>  |
| <b>Unit</b>   | tN <sub>2</sub> O / tHNO <sub>3</sub>   |
| <b>Description</b>  | Emissions factor for baseline period  |
| <b>Source of data</b>                                       | Calculated from measured data (tons of nitric acid produced / tons of N <sub>2</sub> O emitted)   |
| <b>Value(s) applied</b>                                     | <del>0.004030</del> <u>0.004647</u>   |
| <b>Choice of data or Measurement methods and procedures</b> | <p>As required by AM0034 the plant specific baseline emissions factor representing the average N<sub>2</sub>O emissions per tonne of nitric acid during the baseline campaign is derived by dividing the total mass of N<sub>2</sub>O emissions by the total output of 100% concentrated nitric acid during the baseline campaign. The overall uncertainty of the monitoring system shall also be determined and the measurement error will be expressed as a percentage (<i>UNC</i>). The N<sub>2</sub>O emission factor per tonne of nitric acid produced in the baseline period (EF<sub>BL</sub>) shall then be reduced by the percentage uncertainty as follows:</p> $EF_{BL} = (BE_{BC} / NAP_{BC}) (1 - UNC/100) (tN_2O/tHNO_3)$ <p><del>The given value is based on the preliminary assumption that the UNC value equals 5%. This estimate will be substituted by the accurate value based on the QAL2 test yet to be conducted.</del></p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>B.9 UNC</b>  |
| <b>Unit</b>             | %   |
| <b>Description</b>      | Calculated uncertainty of the overall Automated Monitoring System (AMS)   |
| <b>Source of data</b>   | Engineering reports and calculations conducted by the manufacturer of the components of the AMS.                              |
| <b>Value(s) applied</b> | <del>5 (estimated value; will be substituted by obtained value from QAL2 test as soon as this is available)</del> <u>3.99</u> |

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| <b>Choice of data or Measurement methods and procedures</b> | <p>In accordance with AM0034 the overall measurement uncertainty of the AMS is applied in the calculation of the baseline emissions factor (<math>EF_{BL}</math>).</p> <p><u>The overall total uncertainty of the AMS has been determined by an accredited ISO 17025 testing house during the on-site QAL2 audit.</u></p> <p><del>No uncertainty data was available from the analyser vendor. Therefore, Calibration data from the analyser vendor was used to calculate the expected uncertainty.</del></p> <p><del>The calculated values provided by the vendors of the flow meter (Rosemount engineering report), stack temperature (uncertainty according to SABS standard specifications) and pressure probes (Rosemount data sheet), the flow meter DP cell (Rosemount engineering report), the temperature transducer (calculation calibration data), the analogue input card as well as the rounding errors resulting in the data acquisition system (SCADA) were used to calculate the overall uncertainty of the AMS by taking the square root of the sum of the squares of these values.</del></p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>B.10 AFR</b>  |
| <b>Unit</b>             | <u>tNH<sub>3</sub>/h (converted from originally measured Nm<sup>3</sup>/h)</u> <del>kgNH<sub>3</sub>/h</del>           |
| <b>Description</b>      | Mean Ammonia gas flow rate to the ammonia oxidation reactor  |
| <b>Source of data</b>   | Orifice plate  |
| <b>Value(s) applied</b> | Not applicable, monitored data of AFR will be used to determine if plant was operating outside of AFR <sub>max</sub> . |

**Choice of data or Measurement methods and procedures**

Normally, the monitoring of AFR is required by AM0034 in order to determine  $AFR_{max}$  based on the historic campaigns. The  $AFR_{max}$ -value thus obtained is then used to determine those periods during the baseline and the subsequent project campaigns where the plant is operating outside of the permitted operating conditions.

As direct historic hourly values on gaseous ammonia flow to the plant's converter is unavailable for the No. 11 plant, AEL has determined the AFR values based on liquid ammonia consumption per day.

The daily  $NH_3$  consumption has been used to calculate the maximum AFR for the five historic campaigns.

Table: Maximum  $NH_3$  gas flow to the AOR per day

| Campaign No.      | Start Date | End date  | Total $NH_3$ consumed | Maximum $NH_3$ consumed per day |
|-------------------|------------|-----------|-----------------------|---------------------------------|
|                   |            |           | tonnes                | tonnes                          |
| C10               | 29 May 03  | 24 Nov 03 | 34,914                | 219                             |
| C12 <sup>23</sup> | 27 May 04  | 12 Dec 04 | 38,492                | 211                             |
| C13               | 15 Dec 04  | 24 Jul 05 | 43,187                | 206                             |
| C14               | 27 Jul 05  | 28 Jan 06 | 34,623                | 206                             |
| C15               | 03 Feb 06  | 31 Jul 06 | 28,824                | 198                             |

The maximum daily flow rate was  $218^{24}$  t $NH_3$ . This corresponds to an hourly maximum flow rate of 9,094 kg $NH_3$ /h.

For measuring AFR values during the baseline campaign, the installed AMS has been used. However, when setting up the data acquisition system for the baseline campaign, it was wrongly assumed that the data control system ("DCS") indicates the ammonia flow in m<sup>3</sup>/h. In order to obtain the values required by AM0034, the measured results need to be converted to kg $NH_3$ /h.

Thus, the following formula is used for converting kg/h into m<sup>3</sup>/h and vice versa:

$$F_v = F_m * 22.41 / M_w$$

Where:

$F_v$  – Volumetric flow rate in Nm<sup>3</sup>/hr

$F_m$  – Mass flow rate in kg/hr

$M_w$  – molar mass

<sup>23</sup> AEL does a statutory shutdown every 3 years. These shutdowns usually take place during a time that AEL predicts low customer demand. The last statutory shutdown was done during May 2004. Because of the timing of this shutdown, the campaign before the shutdown (C11) had to be made shorter. Since this shorter campaign was not representative of normal operation, it was excluded from the analysis.

<sup>24</sup> This value corresponds to the C10 value provided in the table, after the top 2.5 percentile data sets have been eliminated.

|                           |  |
|---------------------------|--|
|                           | <p>This is based on the following assumptions:</p> <ol style="list-style-type: none"> <li>1) The molar mass of ammonia (NH<sub>3</sub>) is 17g/mol.</li> <li>2) The molar mass of air is 28.84 g/mol.</li> <li>3) The volume of 1 mol of ideal gas at standard temperature and pressure ("STP") is 22.41 l/mol.</li> <li>4) For the example calculation below, the ammonia flow to the converter is 5,774 kg/h.</li> </ol> <p>The illustration below on how the adjustment is applied to the data sets obtained from the DCS, is based on the following reference values:</p> <p>To acquire the correct volumetric flow for the ammonia flow in the example value, the following adjustment has to be made:</p> $F_v = F_m * \left( \frac{22.41}{M_w} \right)^2$ <p>Using the sample values for ammonia:</p> $F_v = 5774 * \left( \frac{22.41}{17} \right)^2 = 10034 m^3 / hr$ <p>Along these lines, all the data obtained from the DCS is converted in order to obtain the correct units.</p> |
| <b>Purpose of data</b>    | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b> | <u>Calibration information</u><br><u>During Baseline period 20/07/2006 – 18/02/2007</u><br><u>Calibration frequency: Once every six months.</u><br><u>(only during plant shutdown between campaigns)</u><br><u>Date of last calibrations: 31/05/2006, 01/11/2006: 19/02/2007</u> <del>None</del>   |

|   |   |
|---|---|
| <b>Data / Parameter</b>                                     | <b>B.11 AFR<sub>max</sub></b>   |
| <b>Unit</b>   | <u>tNH<sub>3</sub>/h (converted from originally measured Nm<sup>3</sup>/h) kgNH<sub>3</sub>/h</u>   |
| <b>Description</b>  | Maximum Ammonia gas flow rate to the ammonia oxidation reactor  |
| <b>Source of data</b>                                       | AFR data  |
| <b>Value(s) applied</b>                                     | 9,094   |
| <b>Choice of data or Measurement methods and procedures</b> | AFR <sub>max</sub> has been determined according to the description in table B.10 above. It is based on the maximum daily consumption of ammonia. Maximum AFR values based on daily (rather than hourly) values are more conservative in nature, because composite values are on average lower than single hourly peak values would be. |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>B.12 AIFR</b>  |
| <b>Unit</b>             | % v/v   |
| <b>Description</b>      | Mean Ammonia to air ratio into the ammonia oxidation reactor                |
| <b>Source of data</b>   | Measurements of AFR and primary air flow rates (measured by orifice plate). |

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

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| <b>Data / Parameter</b> | <b>B.13 CL<sub>BL</sub></b>  |
| <b>Unit</b>             | tHNO <sub>3</sub>  |
| <b>Description</b>      | Length of the baseline campaign measured in metric tonnes of 100% concentrated nitric acid produced during that baseline campaign. |
| <b>Source of data</b>   | NAP <sub>BC</sub>  |
| <b>Value(s) applied</b> | <del>136,476</del> <u>134,700</u>  |

|   |  |
|---|--|
| <b>Choice of data or Measurement methods and procedures</b> | <p>In accordance with AM0034 the baseline campaign length (<math>CL_{BL}</math>) has to be compared to the established average historic campaign length (<math>CL_{normal}</math>) measured in <math>tHNO_3</math> which has been recorded for No. 11 in the past; and</p> <p>If <math>CL_{BL} \leq CL_{normal}</math>, then all <math>N_2O</math> values measured during the baseline campaign can be used for the calculation of <math>EF_{BL}</math> (subject to the elimination of data that was monitored during times where the plant was operating outside of the “permitted range”).</p> <p>If <math>CL_{BL} &gt; CL_{normal}</math>, then <math>N_2O</math> values that were measured beyond the length of <math>CL_{normal}</math> during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of <math>EF_{BL}</math>.</p> <p><u><math>CL_{normal}</math> for AEL No. 11 is: 127,302.4 tonnes of <math>HNO_3</math></u></p> <p><u><math>CL_{BL}</math> for AEL No. 11 is: 134,700 tonnes of <math>HNO_3</math></u></p> <p><u>Therefore <math>CL_{BL} &gt; CL_{normal}</math> and all NCSG datasets were excluded from that operating hour onwards when the nitric acid production during the baseline campaign exceeded the <math>CL_{normal}</math> value.</u></p> <p><u>For No. 11 the average historic campaign production was 123,290 <math>tHNO_3</math>, see table B.14 below. Thus, for the calculation of <math>EF_{BL}</math>, only those values below this margin are to be taken into account.</u></p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b>                                   | None   |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>B.14 <math>CL_{normal}</math></b>  |
| <b>Unit</b>             | $tHNO_3$  |
| <b>Description</b>      | Average length of the historic campaigns measured in metric tonnes of 100% concentrated nitric acid produced during that baseline campaign. |
| <b>Source of data</b>   | Mass Balance calculations as described in NAP.  |
| <b>Value(s) applied</b> | <u>127,302.4</u> <del>123,290</del>   |

|   |   |                                 |  |
|---|---|---------------------------------|--|
| <b>Choice of data or Measurement methods and procedures</b> | In accordance with AM0034 the average historic campaign length ( $CL_{normal}$ ) is defined as the average campaign length for the historic campaigns that were used to define operating condition. $CL_{normal}$ presents the cap on the length of the baseline campaign from which the baseline emissions factor will be derived. |                                 |  |
|   | During the five historic campaigns, the following amounts of metric tonnes of 100% concentrated nitric acid have been produced:   |                                 |  |
|   | <b>Campaign No</b>  | <b>Start Date</b>               | <b>End Date</b>                          |
|   |   |                                 | <b>Total <math>HNO_3</math> produced</b> |
|   |   |                                 | <b>tons</b>                              |
|   | C10   | <del>29/05/2003</del><br>May-03 | <del>24/11/2003</del><br>Nov-03          |
|   | C12 <sup>25</sup>   | <del>27/05/2004</del><br>May-04 | <del>12/12/2004</del><br>Dec-04          |
|   | C13   | <del>15/12/2004</del><br>Dec-04 | <del>24/07/2005</del><br>Jul-05          |
|   | C14   | <del>27/07/2005</del><br>Jul-05 | <del>28/01/2006</del><br>Jan-06          |
|   | C15   | <del>03/02/2006</del><br>Feb-06 | <del>31/07/2006</del><br>Jul-06          |
|   | <b>Average</b>  |                                 | <b><del>123,290</del>127,302.4</b>       |
|   | Therefore, the average historic campaign length ( $CL_{normal}$ ) is <del>123,290</del> 127,302.4 tonnes of 100% concentrated nitric acid.  |                                 |  |
| <b>Purpose of data</b>                                      |   |                                 |  |
| <b>Additional comment</b>                                   | None  |                                 |  |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>B.15 AIFR<sub>max</sub></b>                                   |
| <b>Unit</b>             | % v/v  |
| <b>Description</b>      | Maximum Ammonia to air ratio into the ammonia oxidation reactor. |
| <b>Source of data</b>   | Plant operating manual   |
| <b>Value(s) applied</b> | 11.5   |

<sup>25</sup> See footnote 23 for information on why C11 was omitted.

|   |  |
|---|--|
| <b>Choice of data or Measurement methods and procedures</b> | <p>In accordance with AM0034 AIFR<sub>max</sub> is used to determine those periods where the plant may be operating outside of the permitted operating conditions.</p> <p>The upper limits for ammonia flow and ammonia to air ratio shall be determined using one of the following three options, in preferential order:</p> <ol style="list-style-type: none"> <li>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,</li> <li>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</li> <li>If information for (b) above is not available, based on a relevant technical literature source.</li> </ol> <p>Since no historical data were recorded and available, the allowable NH<sub>3</sub> to Air ratio is taken from the controller data sheet (No 11 Technical Manual, TM4, p250, June 1977). The range is 8.3% v/v - 11.5% v/v, therefore the maximum ammonia to air ratio is 11.5% v/v.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b>                                   | None   |

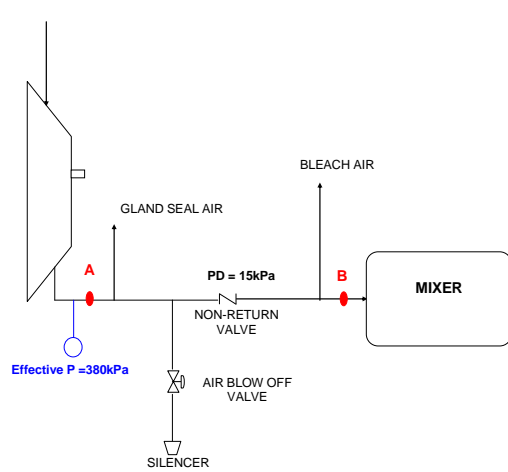
|   |   |
|---|---|
| <b>Data / Parameter</b>                                     | <b>B.16 OT<sub>h</sub></b>  |
| <b>Unit</b>   | °C  |
| <b>Description</b>  | Oxidation temperature for each hour during the baseline campaign  |
| <b>Source of data</b>                                       | Monitoring results of a composite thermocouple inside the ammonia oxidation reactor and recorded by SCADA.  |
| <b>Value(s) applied</b>                                     | Not applicable  |
| <b>Choice of data or Measurement methods and procedures</b> | <p>In accordance with AM0034 the oxidation temperature in the ammonia oxidation reactor (OT<sub>h</sub>) has to be monitored and compared to the Normal range for oxidation temperature (OT<sub>normal</sub>). VSG and NCSG data obtained during times when OT<sub>h</sub> was above or below OT<sub>normal</sub> has to be eliminated from the calculation of EF<sub>BL</sub>.</p> <p>Oxidation temperature is set and is never actively changed during operation. The composite thermocouple is made up of six individual temperature probes and continuously measures OT<sub>h</sub>. OT<sub>h</sub> is dependent on AIFR which is a controlled parameter and should stay as constant as possible. OT<sub>h</sub> is therefore a control parameter for AIFR.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | <u>Calibration information</u><br><u>During Baseline period 20/07/2006 – 18/02/2007</u><br><u>Calibration frequency: Once every six months, validity 8 month</u><br><u>(only during plant shutdown between campaigns)</u><br><u>Date of last calibrations: 17/08/2006, 14/03/2007</u> <del>None</del>   |

|                         |                                 |
|-------------------------|---------------------------------|
| <b>Data / Parameter</b> | <b>B.17 OT<sub>normal</sub></b> |
| <b>Unit</b>             | °C (min and max)                |

|   |   |
|---|---|
| <b>Description</b>  | Normal range operating temperature  |
| <b>Source of data</b>                                       | Design specifications and operating manual of the No. 11 nitric acid plant (Technical Manual (TM4 June 1977, p. 250) <sup>26</sup> .  |
| <b>Value(s) applied</b>                                     | 820°C (min.) and 905°C (max.)   |
| <b>Choice of data or Measurement methods and procedures</b> | <p>AM0034 requires the establishment of the normal range of operating temperatures in the ammonia oxidation reactor. Since no historical data for the No. 11 plant are available, the range of operating temperature of between 820°C and 905°C, as stipulated in the operating manual was applied to derive OT<sub>normal</sub>.</p> <p>The measuring range of the thermocouples determining the oxidation temperatures is set accordingly, i.e. when the plant is offline, the temperature reading will continue to show 820°C.</p> <p>For practical purposes, all VSG and NCSG values taken during times when the plant was operating at below 820°C will be excluded.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>B.18 OP<sub>h</sub></b>   |
| <b>Unit</b>             | kPa (gauge)  |
| <b>Description</b>      | Oxidation Pressure for each hour   |
| <b>Source of data</b>   | <u>Monitoring results of a pressure transmitter on the ammonia oxidation reactor (ammonia to air mixer). Design specifications and operating manual of the No. 11 nitric acid plant (Drawing No. D31-113-4, Sheet 2, December 1977; Operating Instructions No. M69.0300.2008, 1978; No 11 Plant Understanding, p. 10).</u> |
| <b>Value(s) applied</b> | Not applicable.  |

<sup>26</sup> Copies of the technical plant manuals can be provided to the DOE upon request.

|   |   |
|---|---|
| <b>Choice of data or Measurement methods and procedures</b> | <p>In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (<math>OP_h</math>) has to be monitored and compared to the Normal range for oxidation temperature (<math>OP_{normal}</math>). VSG and NCSG data obtained during times when <math>OP_h</math> was above or below <math>OP_{normal}</math> has to be eliminated from the calculation of <math>EF_{BL}</math>.</p> <p>AM0034 prescribes the monitoring and recording of the Oxidation Pressure for each hour (<math>OP_h</math>) 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 <math>OP_h</math>.</p> <p>The pressure for the oxidation reactor is taken as the pressure at point <b>B</b> (air to mixer pressure). The permitted range for the oxidation pressure is inferred from the values given for point <b>A</b> (HP compressor discharge pressure range).</p> <p>Figure: Pressure points for No. 11</p>  <p>During the baseline campaign (as well as for project campaigns) OP is monitored as air pressure to the ammonia to air mixer. Unlike during historic campaigns, these data will be archived and analysed as required by AM0034.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | <u>Calibration information</u><br><u>During Baseline period 20/07/2006 – 18/02/2007</u><br><u>Calibration frequency: Once every six months.</u><br><u>(only during plant shutdown between campaigns)</u><br><u>Date of last calibrations: 31/05/2006, 01/11/2006: 19/02/2007</u> <del>None</del>  |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>B.19 <math>OP_{normal}</math></b>                        |
| <b>Unit</b>             | kPa (gauge)   |
| <b>Description</b>      | Normal operating pressure of the ammonia oxidation reactor. |
| <b>Source of data</b>   | Plant operating manual.                                     |

|   |  |
|---|--|
| <b>Value(s) applied</b>                                     | 365 – 450  |
| <b>Choice of data or Measurement methods and procedures</b> | <p>AM0034 requires the establishment of the normal range of operating pressure in the ammonia oxidation reactor. Since no historical data for the No. 11 plant are available, the range of temperature stipulated in the operating manual was applied to derive OP<sub>normal</sub>.</p> <p>The upper limit is 450 kPa. The lower limit is inferred from the effective discharge set point pressure, 380 kPa (Operating Instructions No. M69.0300.2008, 1978) and the pressure drop across the non-return valve (No 11 HNO<sub>3</sub> Plant Understanding, p. 10). The pressure recorded as the oxidation pressure is taken from Point A as contained in Figure 1 in table B. 18 above. The pressure drop given is 15 kPa. Since the NH<sub>3</sub>-Air mixer appears down stream of the non-return valve it is assumed that the lower pressure limit in the mixer is 365 kPa. The oxidation pressure is measured in kPa.</p> <p>For dual-pressure processes, the pressure range suggested is 400 - 600 kPa (Ullmann's Encyclopedia of Industrial Chemistry, 6<sup>th</sup> Ed, Vol. 23, p3).</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b>                                   | None   |

|   |  |
|---|--|
| <b>Data / Parameter</b>                                     | <b>B.20 GS<sub>normal</sub></b>  |
| <b>Unit</b>   | Name of Supplier   |
| <b>Description</b>  | Gauze supplier for the operating condition campaigns   |
| <b>Source of data</b>                                       | Monitored / Invoices   |
| <b>Value(s) applied</b>                                     | W.C. Heraeus   |
| <b>Choice of data or Measurement methods and procedures</b> | <p>AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.</p> <p>AEL has been using ammonia oxidation catalyst gauzes ("FTCplus") supplied by Heraeus for the past several years. The Heraeus FTCplus gauze contains significant levels of Palladium (approximately one third). The main motivation for this is that it leads to a weight reduction of the (more expensive) Platinum. A side effect of this gauze type is that the generation of N<sub>2</sub>O in the ammonia oxidation process tends to be lower than with gauzes containing little or no Palladium.</p> <p>AEL has used FTCplus gauzes supplied by Heraeus during the baseline campaign and intends to continue using the same or very similar composition of gauzes for the foreseeable future.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b>                                   | None   |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>B.21 GS<sub>BL</sub></b>                          |
| <b>Unit</b>             | Name of Supplier                                     |
| <b>Description</b>      | Gauze supplier for the operating condition campaigns |
| <b>Source of data</b>   | Monitored / Invoices                                 |
| <b>Value(s) applied</b> | W.C. Heraeus   |

|   |   |
|---|---|
| <b>Choice of data or Measurement methods and procedures</b> | 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. |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

| Data / Parameter                                     | B.23 GC <sub>normal</sub>  |          |                |                   |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
|--|--|----------|----------------|-------------------|--|--|--------|--------|--------|-----|---------|------|-----|------|-----|---------|------|-----|------|-----|---------|------|-----|------|-----|---------|------|-----|------|-----|---------|------|-----|------|---------|--|------|-----|------|
| 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                                       | Monitored / Gauze supplier invoices  |          |                |                   |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| Value(s) applied                                     | Platinum (Pt) 56.5%<br>Rhodium (Rh) 3.8%<br>Palladium (Pd) 37%   |          |                |                   |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| Choice of data or Measurement methods and procedures | <p>In accordance with AM0034, if the composition of the ammonia oxidation catalyst used for the baseline campaign and after the implementation of the project are identical to that used in the campaign for setting the operating conditions (previous five campaigns), then there shall be no limitations on N<sub>2</sub>O baseline emissions.</p> <p>Record of Gauze compositions installed during the historic campaigns<sup>27</sup>:</p> <table><tr><th rowspan="2">Campaign</th><th rowspan="2">Gauze Supplier</th><th colspan="3">Gauze Composition</th></tr><tr><th>Pt (%)</th><th>Rh (%)</th><th>Pd (%)</th></tr><tr><td>C10</td><td>Heraeus</td><td>58.3</td><td>3.9</td><td>37.9</td></tr><tr><td>C12</td><td>Heraeus</td><td>56.1</td><td>3.8</td><td>40.1</td></tr><tr><td>C13</td><td>Heraeus</td><td>56.4</td><td>3.8</td><td>39.8</td></tr><tr><td>C14</td><td>Heraeus</td><td>56.1</td><td>3.8</td><td>40.1</td></tr><tr><td>C15</td><td>Heraeus</td><td>55.4</td><td>3.8</td><td>40.8</td></tr><tr><td colspan="2">Average</td><td>56.5</td><td>3.8</td><td>39.7</td></tr></table> | Campaign | Gauze Supplier | Gauze Composition |  |  | Pt (%) | Rh (%) | Pd (%) | C10 | Heraeus | 58.3 | 3.9 | 37.9 | C12 | Heraeus | 56.1 | 3.8 | 40.1 | C13 | Heraeus | 56.4 | 3.8 | 39.8 | C14 | Heraeus | 56.1 | 3.8 | 40.1 | C15 | Heraeus | 55.4 | 3.8 | 40.8 | Average |  | 56.5 | 3.8 | 39.7 |
| Campaign   | Gauze Supplier   |          |                | Gauze Composition |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
|  |  | Pt (%)   | Rh (%)         | Pd (%)            |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| C10  | Heraeus  | 58.3     | 3.9            | 37.9              |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| C12  | Heraeus  | 56.1     | 3.8            | 40.1              |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| C13  | Heraeus  | 56.4     | 3.8            | 39.8              |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| C14  | Heraeus  | 56.1     | 3.8            | 40.1              |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| C15  | Heraeus  | 55.4     | 3.8            | 40.8              |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| Average  |  | 56.5     | 3.8            | 39.7              |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| Purpose of data                                      | Calculation of baseline emissions  |          |                |                   |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |
| Additional comment                                   | None   |          |                |                   |  |  |        |        |        |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |     |         |      |     |      |         |  |      |     |      |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>B.24 GC<sub>BL</sub></b>   |
| <b>Unit</b>             | %   |
| <b>Description</b>      | 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. |
| <b>Source of data</b>   | Monitored / Gauze supplier invoices   |

<sup>27</sup> 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.

|   |  |
|---|--|
| <b>Value(s) applied</b>                                     | Platinum (Pt) 56.0%<br>Rhodium (Rh) 3.8%<br>Palladium (Pd) 40.2%   |
| <b>Choice of data or Measurement methods and procedures</b> | <p>A change in the composition of the ammonia oxidation catalyst in the baseline campaign to a composition other than that used in the previous five campaigns, is permissible without any limitation on the N<sub>2</sub>O baseline emissions if the following conditions are met</p> <p>(i) The baseline catalyst composition is considered as common practice in the industry, or</p> <p>(ii) The change in catalyst composition is justified by its availability, performance, relevant literature etc.</p> <p>Otherwise, the baseline emission factor shall be set to the conservative IPCC default emission factor for N<sub>2</sub>O from nitric acid plants which have not installed N<sub>2</sub>O destruction measures (4.5 kgN<sub>2</sub>O/tHNO<sub>3</sub>).</p> <p>GC<sub>BL</sub> at AEL's No. 11 nitric acid plant is the same as GC<sub>normal</sub>; therefore, the results of the baseline campaign are fully valid and applicable.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>   |
| <b>Additional comment</b>                                   | None   |

|   |   |
|---|---|
| <b>Data / Parameter</b>                                     | <b>B.26 EF<sub>reg</sub></b>  |
| <b>Unit</b>   | tN <sub>2</sub> O/tHNO <sub>3</sub>   |
| <b>Description</b>  | Emissions cap for N <sub>2</sub> O from nitric acid production set by government regulation   |
| <b>Source of data</b>                                       | Department of Environmental Affairs and Tourism   |
| <b>Value(s) applied</b>                                     | None  |
| <b>Choice of data or Measurement methods and procedures</b> | <p>There is currently no regulation in South Africa that limits the emissions of N<sub>2</sub>O from nitric acid production.</p> <p>However, the regulatory situation will be monitored by liaising with the responsible South African Environmental Authorities on a continuous basis. AEL has a well established working relationship with the responsible authorities and exchanges information with their officials on a regular basis.</p> |
| <b>Purpose of data</b>                                      | <u>Calculation of baseline emissions</u>  |
| <b>Additional comment</b>                                   | None  |

### B.6.3. Ex ante calculation of emission reductions

>>

#### 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.

Relation DBMS organize all data in tables. N.DBMS mainly consists of three such tables, labelled PROJECTS, CAMPAIGNS, and DATA\_CROSS.

The first table, PROJECTS, serves as an anchor for all data stored. Each CDM project must be defined here, before any related data can be stored. Table PROJECTS provides a unique identifier and a short name for each project. In addition, project specific data such as owner and location may be stored.

Structure of table PROJECTS

| Field Name  | Field Type | Comment                                       |
|-------------|------------|---|
| ProjId      | Integer    | <i>Unique identifier for the project</i>      |
| ProjName    | Text       | <i>Short name of the project</i>              |
| ProjOwner   | Text       | <i>Operator of the installation</i>           |
| ProjLoc     | Text       | <i>Location of the installation (City)</i>    |
| ProjCountry | Text       | <i>Location of the installation (Country)</i> |

Sample content of table PROJECTS

| Projects |          |                    |               |              |
|----------|----------|--------------------|---------------|--------------|
| ProjId   | ProjName | ProjOwner          | ProjLoc       | ProjCountry  |
| 1        | No. 11   | African Explosives | Modderfontein | South Africa |
| 2        |          |                    |               |              |
| 3        |          |                    |               |              |

Table CAMPAIGNS defines the individual production campaigns and contains data which describe the campaign as a whole, such as date and time of start and stop and the physical units in which the data are stored. Each campaign must be defined here, before time series of related data can be stored.

Structure of table CAMPAIGNS

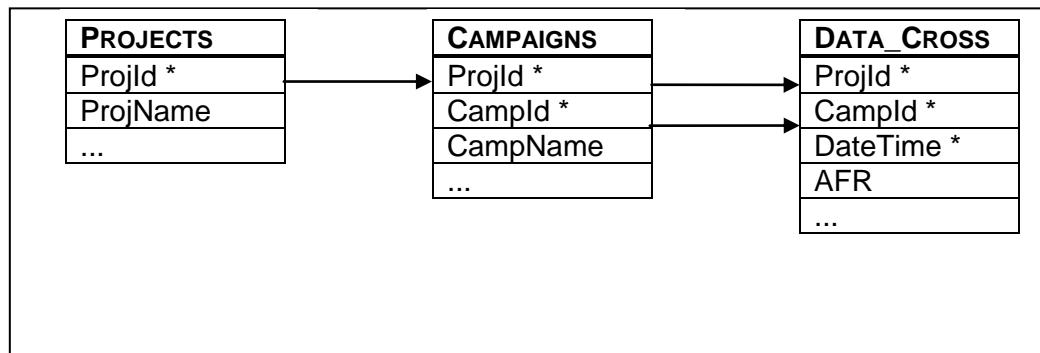
| FieldName  | FieldType | Comment  |
|------------|-----------|--|
| ProjId     | Integer   | Identifier of the project, to which the campaign belongs   |
| CampId     | Integer   | Identifier of the campaign   |
| CampName   | Text      | Campaign name defined by owner   |
| CampType   | Text      | Type of campaign: H (historical), B (baseline), I (Intermediate, between BL and CDM registration), P (Project) |
| DateStart  | Date      | Starting day of the campaign   |
| TimeStart  | Date      | Starting time of the campaign  |
| DateStop   | Date      | Stopping day of the campaign   |
| TimeStop   | Date      | Stopping time of the campaign  |
| Period     | Text      | Length of measurement period: hours, minutes, seconds  |
| CampLength | Number    | Length of campaign (measured in tons of nitric acid produced)  |
| AFR_Unit   | Text      | Physical unit of AFR data  |
| AIFR_Unit  | Text      | Physical unit of AIFR data   |
| NAP_Unit   | Text      | Physical unit of NAP data  |
| NCSG_Unit  | Text      | Physical unit of NCSG data   |
| Oph_Unit   | Text      | Physical unit of OPh data  |
| OTh_Unit   | Text      | Physical unit of OTh data  |
| VSG_Unit   | Text      | Physical unit of VSG data  |

Finally, the times series of the parameter values listed above are stored in table DATA\_CROSS. Each set of values for the different parameters is identified by the ProjId, CampId and a date/time-stamp.

Structure of table DATA\_CROSS

| FieldName | FieldType | Comment  |
|-----------|-----------|--|
| ProjId    | Integer   | Identifier of the project, to which the campaign belongs |
| CampId    | Integer   | Identifier of the campaign to which the data belong      |
| DateTime  | Date      | Date and time stamp                                      |
| AFR       | Number    | AFR value  |
| AIFR      | Number    | AIFR value   |
| NAP       | Number    | NAP value  |
| NCSG      | Number    | NCSG value   |
| Oph       | Number    | Oph value  |
| OTh       | Number    | OTh value  |
| VSG       | Number    | VSG value  |

The tables PROJECTS, CAMPAIGNS, and DATA\_CROSS are linked by so-called 1:n relationships. That is, for each project, there may be n campaigns and for each campaign, m sets of data may be stored, where n and m indicated the number of campaign and data sets, respectively. Other than in Excel, for the purpose of the calculations required by the methodology, there is no practical limit for n and m when using a DBMS such as Access.

*Data model*

Stars (\*) indicate the primary keys of the three tables, which make sure, that data sets are unique.

Using the database structure outlined above, it is now possible to analyse the data stored in many different ways using the database query mechanisms provided by Access. All calculation steps and exclusions of parameter sets required by AM0034 will be carried out by appropriately designed database queries, which will be described in detail below.

### Calibration using historical campaigns and calculation of the baseline emissions factor with N.DBMS

The database would normally first be applied to conduct a “calibration” of N.DBMS in accordance with the historic data obtained from the previous 5 campaigns. In the case of AEL No. 11, no such historical data are available and therefore, this calibration is not carried out.

#### Queries from N.DBMS to determine $EF_{BL}$

As the baseline campaign for AEL No11 the campaign AEL No 11 C16 was used. The baseline campaign was in operation in the period 20.07.2006 – 18.02.2007.

#### Baseline Query 1 (Raw data): Analysis of the raw baseline data without any operating limits applied

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

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

The resulting Access table is shown below:

#### AEL No 11:

##### **Query 1: Without parameter limits**

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

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

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

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

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

### Baseline Query 2: Elimination of faulty data outside operational limits

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

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

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

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

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

After conducting Queries 2 and 5 which effect the elimination of

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

94% of all original data sets remain.

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

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

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

CL<sub>normal</sub> for AEL No. 11 is: 127,302.4 tonnes of HNO<sub>3</sub>

CL<sub>BL</sub> for AEL No. 11 is: 134,700 tonnes of HNO<sub>3</sub>

Therefore CL<sub>BL</sub> > CL<sub>normal</sub> and all NCSG datasets were excluded from that operating hour onwards when the nitric acid production during the baseline campaign exceeded the CL<sub>normal</sub> value.

The remaining share of the operating data after Query 5 is 94% of the raw data and therefore meets the criterion set by AM0034 that the plant must be operating within the permitted range at least 50% of the time during the baseline campaign.

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

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

| N.DBMS                                 | AEL No. 11 Johannesburg, South Africa          |                            |       |           |     | Campaign:    | C16             | 20.07.06 - 18.02.07 |
|--|--|----------------------------|-------|-----------|-----|--------------|-----------------|---------------------|
| Baseline campaign                      | Query 6a+b: Confidence levels for NCSG and VSG |                            |       |           |     |              |                 |                     |
| Parameter                              | OH   | AFR                        | AIFR  | Oph       | OTh | NCSG         | VSG             | NAP                 |
| Unit                                   | h  | t NH3 / h                  | ratio | Pa        | °C  | mg N2O / Nm3 | Nm3 / h         | t HNO3              |
| Count                                  |  |                            |       |           |     | 4,323        | 4,810           |                     |
| Minimum                                |  | 7.036                      | 0.099 | 365,059.0 | 894 | 1,210        | 64,035          |                     |
| Maximum                                |  | 8.584                      | 0.108 | 425,428.0 | 902 | 1,909        | 82,563          |                     |
| Mean                                   |  | 7.636                      | 0.103 | 393,955.8 | 899 | 1,630        | 72,468          |                     |
| Standard deviation                     |  |                            |       |           |     | 110          | 4,839           |                     |
| 95% Confidence Interval                |  |                            |       |           |     |              |                 |                     |
| Sum                                    | 4,950  |                            |       |           |     |              |                 | 134,700             |
| Limits acc. to consistency check       |  |                            |       |           |     | 6.2.07 21:00 |                 |                     |
| Lower limit                            |  |                            | 0     | 365,000   | 820 | 1,209.2      | 62,827          |                     |
| Upper limit                            |  | 9.094                      | 0.115 | 450,000   | 905 | 1,965.6      | 82,571          |                     |
| Correction factors resulting from QAL2 |  |                            |       |           |     | 1.104        | 1.010           |                     |
| Baseline emissions                     | BE   | = VSG * NCSG * OH          |       |           |     |              | t N2O           | 651.983             |
| Emission factor                        | EF   | = BE / NAP * (1 - UNC/100) |       |           |     |              | kg N2O / t HNO3 | 4.647               |
| Uncertainty                            | UNC  |                            |       |           |     |              |                 | 3.99                |

**Resulting EF<sub>BL</sub>**

The EF<sub>BL</sub> derived from this analysis of historic and baseline data is 4.647 kg N<sub>2</sub>O/tHNO<sub>3</sub>.

**Query 1<sup>28</sup>: Results from Raw Data for exact campaign duration**

The table below illustrates the N.DBMS table after query 1 which contains the raw data sets as taken from the data acquisition system on-site after adapting them to the requirements of the N.DBMS format.

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<sup>28</sup> All queries are available and can be provided to the DOE upon request.

| N.DBMS Baseline Calculation |                   | Project: African Explosives No. 11, Johannesburg, South Africa |       |        |       |       |                 |         |         |  |
|-----------------------------|-------------------|--|-------|--------|-------|-------|-----------------|---------|---------|--|
| Baseline campaign           |                   | Query 1: Without parameter limits, invalid data sets excluded  |       |        |       |       |                 |         |         |  |
| Parameter                   | OH                | AFR  | AIFR  | Oph    | OTh   | NCSG  | NCSG            | VSG     | NAP     |  |
| Unit                        | h                 | kg NH3 / h   | 1     | kPa-g  | oC    | ppm   | mg N2O / Nm3    | Nm3 / h | t       |  |
| Count                       | 5,002             | 5,002  | 5,002 | 5,002  | 5,002 | 5,002 |                 | 5,002   |         |  |
| Minimum                     |                   | 7  | 0.00  | 0.14   | 801   | 1.7   | 3.4             | 0       |         |  |
| Maximum                     |                   | 7,933  | 0.99  | 846.44 | 903   | 1,581 | 3,106           | 81,671  |         |  |
| Mean                        |                   | 5,563  | 0.11  | 378.67 | 895   | 784   | 1,540           | 67,870  |         |  |
| Standard deviation          |                   | 1,160  | 0.05  | 77.03  | 19    | 174   | 342             | 14,537  |         |  |
| Sum                         | 4,987             |  |       |        |       |       |                 |         | 136,476 |  |
|                             | (-> Sheet NAP_BL) |  |       |        |       |       |                 |         |         |  |
| Baseline emissions          | BE                | = VSG * NCSG * Oh  |       |        |       |       | t N2O           |         | 521     |  |
| Emission factor             | EF                | = BE / NAP   |       |        |       |       | kg N2O / t HNO3 |         | 3.82    |  |

The campaign started on 17<sup>th</sup> July 2006 and ran until 18<sup>th</sup> February 2007. Any data in the database before or after those dates were excluded.

The two columns for NCSG in this and the following N.DBMS tables contain the same values, only in different units. The ppmv-values are provided in grey. The original raw data as collected and stored by the on-site system is based on ppmv-values. The conversion into mgN<sub>2</sub>O/Nm<sup>3</sup> is performed by the N.DBMS which is why the source-values for this conversion step need to be contained in the N.DBMS-tables. The conversion formula used is

$$\text{ppmv} = \frac{44}{22.4} \text{ mgN}_2\text{O/Nm}^3$$

This procedure is explicitly permitted by AM0034<sup>29</sup>.

#### Query 2: Determination of NAP and OH

Since the baseline campaign (NAP<sub>BC</sub>) was longer than the historic normal campaign length (CL<sub>normal</sub>), the NAP value for the baseline campaign had to be adjusted. This was done by excluding as many of the final days of the baseline campaign as needed in order for the NAP value to be equivalent to CL<sub>normal</sub>.

Because NAP is only determined for each whole day of production, CL<sub>normal</sub> as contained in the N.DBMS is slightly lower than CL<sub>normal</sub> as calculated based on the total campaign productions (123,469 instead of 123,290), see below.

#### Query 3: Application of limits from "permitted operating range"

In the next step, the limits provided by the permitted operating range, derived from the plant operating manual, were applied.

AM0034 monitoring methodology actually suggests that in the event that the monitoring system is down, the lowest between the conservative IPCC (4.5 kgN<sub>2</sub>O/tHNO<sub>3</sub>) or the last measured value will be valid and applied for the downtime period for the baseline emissions factor.

To fulfil this criterion, it would be necessary to convert the last measured value into the equivalent of kgN<sub>2</sub>O/tHNO<sub>3</sub> in order to check if it is lower or higher than 4.5 kgN<sub>2</sub>O/tHNO<sub>3</sub>. It is impossible to determine this for a 2-second value because the volume of nitric acid produced is not attributable to this specific instant.

<sup>29</sup> See table on page 14, section P.1., under "data unit".

Therefore, it is appropriate to exclude the measured values from the calculation of the NCSG mean rather than trying to guess whether to apply the last measured value or the 4.5 kg value.

#### Query 4: Confidence Intervals and determination of BE and EF

| N.DBMS Baseline Calculation            |                   | Project: African Explosives No. 11, Johannesburg, South Africa |       |       |       |       |              |                 |         |  |
|--|-------------------|--|-------|-------|-------|-------|--------------|-----------------|---------|--|
| Baseline campaign                      |                   | Query 5: Permitted range from operating manual, CL cut         |       |       |       |       |              |                 |         |  |
| Parameter                              | OH                | AFR  | AIFR  | Oph   | OTh   | NCSG  | NCSG         | VSG             | NAP     |  |
| Unit                                   | h                 | kg NH3 / h   | 1     | kPa-g | oC    | ppm   | mg N2O / Nm3 | Nm3 / h         | t       |  |
| Count                                  | 4,345             | 4,345  | 4,345 | 4,345 | 4,345 | 4,345 |              | 4,345           |         |  |
| Remaining share of data sets           | 87%               | 87%  | 87%   | 87%   | 87%   | 87%   |              | 87%             |         |  |
| Minimum                                |                   | 5,337  | 0.10  | 365   | 892   | 447   | 877          | 63,221          |         |  |
| Maximum                                |                   | 6,512  | 0.11  | 425   | 903   | 993   | 1,950        | 81,671          |         |  |
| Mean                                   |                   | 5,805  | 0.10  | 395   | 899   | 808   | 1,587        | 70,965          |         |  |
| Standard deviation                     |                   | 237  | 0.00  | 13.5  | 1     | 95    | 186          | 4,620           |         |  |
| 95% confidence level (1.96 * Std.dev.) |                   | 464  | 0     | 26.4  | 2     | 186   | 365          | 9,056           |         |  |
| Sum                                    | 4,521             |  |       |       |       |       |              |                 | 122,830 |  |
| Limits acc. to consistency check       | <29.1.2007        |  |       |       |       |       |              |                 |         |  |
| Lower limit                            |                   | ?  | 0.083 | 365   | 820   |       |              |                 |         |  |
| Upper limit                            |                   | ?  | 0.12  | 450   | 905   |       |              |                 |         |  |
|  | (-> Sheet NAP_BL) |  |       |       |       |       |              |                 |         |  |
| Baseline emissions                     | BE                | = VSG * NCSG * Oh  |       |       |       |       |              | t N2O           | 509     |  |
| Emission factor                        | EF                | = BE / NAP   |       |       |       |       |              | kg N2O / t HNO3 | 4.15    |  |

The 95% confidence level of NCSG and VSG baseline values is derived, thereby excluding outliers and determining the mean values that are to be applied to the calculation of BE:

$$\bullet \text{Mean}_{Q5}(\text{NCSG}) - \text{StdDev}_{Q5}(\text{NCSG}) < \text{NCSG} < \text{Mean}_{Q5}(\text{NCSG}) + \text{StdDev}_{Q5}(\text{NCSG})$$

$$\bullet \text{Mean}_{Q5}(\text{VSG}) - \text{StdDev}_{Q5}(\text{VSG}) < \text{VSG} < \text{Mean}_{Q5}(\text{VSG}) + \text{StdDev}_{Q5}(\text{VSG})$$

The line "Remaining share of data sets" in the excel table indicates how many data sets remain after application of the queries. Since this value is well above the 50% required by AM0034, the baseline is valid.

Also, the determined uncertainty for the AMS will be applied to the EF calculation. Currently, a preliminary value of 5% is taken. This value will be adjusted at a later stage according to the results obtained from the EN 14181 QAL2 tests.

| N.DBMS Baseline Calculation            |           | Project: African Explosives No. 11, Johannesburg, South Africa                                     |                            |       |       |       |       |              |                 |         |
|--|-----------|--|----------------------------|-------|-------|-------|-------|--------------|-----------------|---------|
| Baseline campaign                      |           | Query 6a: Q5 + confidence levels applied to NCSG - Query 6b: Q5 + confidence levels applied to VSG |                            |       |       |       |       |              |                 |         |
|  | Parameter | OH   | AFR                        | AIFR  | Oph   | OTh   | NCSG  | NCSG         | VSG             | NAP     |
|  | Unit      | h  | kg NH3 / h                 | 1     | kPa-g | oC    | ppm   | mg N2O / Nm3 | Nm3 / h         | t       |
| Count                                  |           | 4,345  | 4,345                      | 4,345 | 4,345 | 4,345 | 4,045 |              | 4,281           |         |
| Remaining share of data sets           |           | 87%  | 87%                        | 87%   | 87%   | 87%   | 81%   |              | 86%             |         |
| Minimum                                |           | 0  | 5,337                      | 0.10  | 365   | 892   | 622   | 1,222        | 63,221          |         |
| Maximum                                |           | 0  | 6,512                      | 0.11  | 425   | 903   | 993   | 1,950        | 80,002          |         |
| Mean                                   |           | 0  | 5,805                      | 0.10  | 395   | 899   | 829   | 1,628        | 70,821          |         |
| Standard deviation                     |           | 0  | 237                        | 0.00  | 13    | 1     | 55    | 109          | 4,501           |         |
| 95% confidence level (1.96 * Std.dev.) |           |  |                            |       |       |       |       |              |                 |         |
| Sum                                    |           | 4,521  |                            |       |       |       |       |              |                 | 122,830 |
| Limits acc. to consistency check       |           | <29.1.2007   |                            |       |       |       |       |              | not blank       |         |
| Lower limit                            |           |  | ?                          | 0.083 | 365   | 820   | 622   |              | 61,909          |         |
| Upper limit                            |           |  | ?                          | 0.12  | 450   | 905   | 994   |              | 80,021          |         |
|  |           | (-> Sheet NAP_BL)  |                            |       |       |       |       |              |                 |         |
| Baseline emissions                     |           | BE   | = VSG * NCSG * Oh          |       |       |       |       |              | t N2O           | 521     |
| Emission factor                        |           | EF   | = BE / NAP * (1 - UNC/100) |       |       |       |       |              | kg N2O / t HNO3 | 4.03    |
| Uncertainty                            |           | UNC  |                            |       |       |       |       |              |                 | 5.00    |

The resulting baseline emissions factor is 4.03 kgN<sub>2</sub>O/tHNO<sub>3</sub>.

During the EF<sub>p</sub> and ER<sub>n</sub> calculation, the same procedures will be applied in the N.DBMS as described in this section in accordance with AM0034.

#### Ex-ante calculation of Emission Reductions

Several of the parameters necessary to calculate the emission reductions expected from the project activity will only be established during the operation of the project.

Therefore, certain assumptions had to be made for the calculations (see section A.4.4 above for details), such as:

- Production output of nitric acid (NAP) per year being 236,097 tHNO<sub>3</sub> (based on the average production during the past four years and the present year forecast)
- Emissions Factor during each of the project campaigns (EF<sub>P</sub>) which is mainly influenced by the abatement efficiency of the N<sub>2</sub>O abatement catalyst, which is assumed to be at least 80% of baseline N<sub>2</sub>O emissions. Taking EF<sub>BL</sub> of ~~4.03~~ 4.647 kgN<sub>2</sub>O/tHNO<sub>3</sub> and applying a realistic 90% abatement efficiency, the annual baseline emissions would be ~~294,956~~ 340,114 tCO<sub>2</sub>e and the annual emission reductions ~~265,460~~ 306,103 tCO<sub>2</sub>e.
- The crediting period will begin in December 2007
- The overall uncertainty of the AMS is 53.99%.

These assumptions underline in the calculations for table B.6.4 below.

#### B.6.4. Summary of ex ante estimates of emission reductions

| Year  | Baseline emissions (t CO <sub>2</sub> e) | Project emissions (t CO <sub>2</sub> e) | Leakage (t CO <sub>2</sub> e) | Emission reductions (t CO <sub>2</sub> e) |
|---|--|---|-------------------------------|---|
| 2007 <sup>30</sup>                              | <del>28,343</del> <u>24,580</u>          | <del>2,834</del> <u>2,458</u>           | 0                             | <del>25,509</del> <u>22,122</u>           |
| 2008  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2009  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2010  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2011  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2012  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2013  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2014  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2015  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2016  | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del><br><u>29,496</u>      | 0                             | <del>306,103</del><br><u>265,460</u>      |
| 2017  | <del>311,771</del><br><u>270,376</u>     | <del>31,177</del> <u>27,038</u>         | 0                             | <del>280,594</del> <u>243,338</u>         |
| <b>Total</b>                                    | <del>3,401,143</del><br><u>2,949,560</u> | <del>340,114</del><br><u>293,490</u>    | 0                             | <del>3,061,028</del><br><u>2,654,600</u>  |
| <b>Total number of crediting years</b>          | 10                                       |   |                               |   |
| <b>Annual average over the crediting period</b> | <del>340,114</del><br><u>294,956</u>     | <del>34,011</del> <u>29,349</u>         | 0                             | <del>306,103</del> <u>265,460</u>         |

<sup>30</sup> CERs in 2007 are fewer due to estimated project start in December 2007. Therefore, project will run into 2017.

## B.7. Monitoring plan

### B.7.1. Data and parameters to be monitored

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

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.

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

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>NCSG</b>   |
| <b>Unit</b>                               | mgN <sub>2</sub> O/m <sup>3</sup>   |
| <b>Description</b>                        | N <sub>2</sub> O concentration in the stack gas during each project campaign.   |
| <b>Source of data</b>                     | NDIR N <sub>2</sub> O gas analyser (ABB Uras 14 analyser)   |
| <b>Value(s) applied</b>                   | As required by AM0034, this value will be used for determining PE <sub>n</sub> for each project campaign.<br>The project participants expect that it will be at least 80% less than the value measured during the baseline campaign.  |
| <b>Measurement methods and procedures</b> | AM0034 requires the determination of the concentration of N <sub>2</sub> O in the stack gas. During the crediting period, NCSG will be continuously monitored with an ABB Uras 14 NDIR gas analyser <sup>31</sup> and monitoring results will be taken and recorded for every two seconds of plant operation during all project campaigns. Hourly means for NCSG are derived by the SCADA data acquisition system. NCSG data taken during times when the plant was operating outside the permitted operating range were eliminated. The remaining hourly average values were subjected to the following calculation steps: <ul style="list-style-type: none"> <li>a) Calculate the sample mean (x)</li> <li>b) Calculate the sample standard deviation (s)</li> <li>c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)</li> <li>d) Eliminate all data that lie outside the 95% confidence interval</li> <li>e) Calculate the new sample mean from the remaining NCSG values</li> </ul> |
| <b>Monitoring frequency</b>               | <u>Continuously (every 2 seconds)</u>   |

<sup>31</sup> Due to performance related deficits of the Environnement S.A. MIR 9000 gas analyser installed at the No. 9 plant, AEL has decided to substitute the analysers at both plants. This will be done after the Environnement analyser presently installed at No.11 has been QAL2-tested according to EN 14181 in order to prove the validity of the baseline data sets previously collected.

Subsequently, the new analyser – probably an ABB Uras 14 – will be QAL2-tested after its installation has been completed.

|                           |   |
|---------------------------|---|
| <b>QA/QC procedures</b>   | <p><b>Analyser Zero Calibration</b></p> <p>Dry oil-free instrument air with a dew point of &lt; 50 °C or better must be used as a reference signal. This commodity is crucial to the operation of the analyser since the dry air is used as a zero gas as well as for emergency purging of the measuring cell should the sample gas contain more than a certain amount of moisture that could be harmful to the analyser. The dry air is also used to either dilute or remove moisture from the sample at the sample probe, depending on what type of sampling system is used. Dry air of a good quality must thus always be available and connected to both the “Zero Ref.” port on the analyser as well as to the sample probe via the designated connections.</p> <p>The zero calibration of the ABB Uras 14 is performed fully automatically and is done on programmable intervals. The analyser at No. 11 plant is set to the standard default time interval, which means that an automatic zero calibration is done every 3 hrs.</p> <p><b>Analyser Span calibration</b></p> <p>The span calibration of the analyser can only be performed manually. Calibration gas supplied by AFROX and certified by Modderfontein Laboratory is always connected to the analyser to conduct the regular analyser span calibration. The span calibration is conducted at least twice per week (usually Tuesdays and Fridays) with the calibration gas being injected into the analyser sample cell. As a result of the span calibration, the K-factors used to adjust the measured result before being sent to the DCS data acquisition system are readjusted if the span error is more than 2% (of range).</p> <p><b>New cal factor = (Concentration of the calibration gas x Old calibration factor) / (Reading of the analyser once stabilised)</b></p> <p>Once per month the span calibration is also performed on the whole sample system where the calibration gas is manually injected at the sample probe and then passed through the sample conditioning system and the analyser.</p> |
| <b>Purpose of data</b>    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b> | See comments under B.1 above  |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>VSG</b>  |
| <b>Unit</b>             | Nm <sup>3</sup> /h  |
| <b>Description</b>      | Normal gas volume flow rate of the stack gas during each project campaign.  |
| <b>Source of data</b>   | Gas Volume Flow meter, Emerson Rosemount Annubar® Model 485   |
| <b>Value(s) applied</b> | <p>As required by AM0034, this value will be used for determining PE<sub>n</sub> for each project campaign.</p> <p>The project participants expect this value to remain on a similar level as during the baseline campaign.</p> |

|   |   |
|---|---|
| <b>Measurement methods and procedures</b> | <p>AM0034 requires the determination of the gas volume flow (VSG) in the stack. VSG is continuously monitored with a flow meter and monitoring results are taken and recorded for every two seconds of plant operation during all project campaigns. Hourly means for VSG are derived by the SCADA data acquisition system. VSG data taken during times when the plant was operating outside the permitted operating range are to be eliminated. The remaining VSG data series will have to be subjected to the following adjustment.</p> <p>Also, the corrected measured data need to be compensated for the actual prevailing temperature and pressure in the stack through the following calculation:</p> $\frac{P_s * V_s}{T_s} = \frac{P_a * V_a}{T_a}$ <p>Where:</p> <p>P refers to the Pressure (mBar) [conversion from kPa to mbar is a factor of 10]</p> <p>V the volumetric flow rate (m<sup>3</sup>/hr)</p> <p>T the temperature in Kelvin (Note 1 K = T(°C) + 273).</p> <p>Subscript “s” refers to the actual stack values</p> <p>Subscript “a” refers to the assumed stack conditions.</p> <p>This simplifies to:</p> $V_s = V_a * \frac{P_a}{T_a} * \frac{T_s}{P_s}$ <p>(Going forward after the baseline campaign, this calculation will automatically be performed by the SCADA data acquisition system)</p> <p>The resulting hourly average VSG values are now expressed in Nm<sup>3</sup>/h as required by AM0034 and where subsequently subjected to the following calculation steps:</p> <ol style="list-style-type: none"> <li>Calculate the sample mean (x)</li> <li>Calculate the sample standard deviation (s)</li> <li>Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)</li> <li>Eliminate all data that lie outside the 95% confidence interval</li> <li>Calculate the new sample mean from the remaining VSG values</li> </ol> <p>The inappropriate range adjustment that necessitated the application of a correction factor during the baseline campaign has been amended.</p> |
| <b>Monitoring frequency</b>               | <u>Continuously (every 2 seconds)</u>   |

|                           |   |
|---------------------------|---|
| <b>QA/QC procedures</b>   | <p>The flow meter is calibrated at least every 6 months between campaigns (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).</p> <p>If the deviation exceeds indicated flow by 450 m<sup>3</sup>/hr (equal to 1% of range), then the pressure transmitter is recalibrated and the previous procedure repeated.</p> <p>The Annubar itself does not need to be calibrated since it is a physical device which will not have drift. Therefore, it is sufficient to regularly inspect the physical condition of the Annubar. Therefore, the Annubar is taken out of the stack once per year for physical inspection.</p> <p>The results of these calibration procedures are then recorded in the Calibration Procedure log sheet.</p> |
| <b>Purpose of data</b>    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b> | None.   |

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>PE<sub>n</sub></b>   |
| <b>Unit</b>                               | tN <sub>2</sub> O   |
| <b>Description</b>                        | Total mass N <sub>2</sub> O emissions in each project campaign.   |
| <b>Source of data</b>                     | Calculated from the measurements from measured data.  |
| <b>Value(s) applied</b>                   | Assumed that the project campaigns are of similar length in comparison to the baseline campaign, the project participants expect the data values to be at least 80% lower than BE <sub>BC</sub> as observed during the baseline campaign. The PE <sub>n</sub> value is used for calculating EF <sub>n</sub> . |
| <b>Measurement methods and procedures</b> | Not applicable, calculated value as per the following formula:<br>$PE_n = VSG * NCSG * 10^{-9} * OH$  |
| <b>Monitoring frequency</b>               | <u>Not applicable.</u>  |
| <b>QA/QC procedures</b>                   | Not applicable. Calculated value.   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b>                 | None  |

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>OH<sub>n</sub></b>   |
| <b>Unit</b>                               | Hours   |
| <b>Description</b>                        | Total operating hours during each project campaign  |
| <b>Source of data</b>                     | Process Control System.   |
| <b>Value(s) applied</b>                   | The project participants expect this value to remain constant in comparison to the baseline campaign. As required by AM0034, this value will be used for determining PE <sub>n</sub> for each project campaign.   |
| <b>Measurement methods and procedures</b> | <p>Required by AM0034 to determine the total mass emissions of N<sub>2</sub>O during a project campaign.</p> <p>Each hour for which the ammonia oxidation temperature (OT<sub>h</sub>) is recorded to be 820°C or above will be included. Since the design plant operating temperature is between 820°C and 905°C, by definition the plant is offline if the temperature recorded is at or below 820°C.</p> |

|                      |   |
|----------------------|---|
| Monitoring frequency | <u>The total operating hours are logged continuously.</u> |
| QA/QC procedures     | Subject <del>to SABS</del> ISO 9001/14001 procedures.     |
| Purpose of data      | <u>Calculation of project emissions</u>                   |
| Additional comment   | None  |

|                                    |   |
|------------------------------------|---|
| Data / Parameter                   | <b>NAP<sub>n</sub></b>  |
| Unit                               | tHNO <sub>3</sub>   |
| Description                        | Metric tonnes of 100% concentrated nitric acid during each project campaign.  |
| Source of data                     | Mass balance calculation and flow measurements at the No. 11 plant.   |
| Value(s) applied                   | The project participants expect this value to remain constant in comparison to the baseline campaign. This value serves as a basis for calculating EF <sub>n</sub> for each project campaign.   |
| Measurement methods and procedures | <p>Required by AM0034 to calculate the project emissions factor (EF<sub>n</sub>) per tonne of 100% concentrated nitric acid produced during that project campaign, NAP is determined by a mass balance calculation according to the following procedures:</p> <p>The opening and closing stock are determined by tank level measurements of the plant operator for each production day and recorded in the production logs.</p> <p>Currently roughly 5% of the nitric acid production is delivered to consumers outside of AEL. A pipeline delivers nitric acid to external consumers based on the same site as the No. 11 nitric acid plant. The delivery volumes are measured by flow meters. Deliveries of nitric acid to consumers by tanker truck are checked and recorded on a weighbridge.</p> <p>The majority of nitric acid produced (approximately 95%) is supplied to AEL's own Ammonium Nitrate (AN) plants on the same site via pipeline. The transferred volumes of nitric acid are determined by tank level measurements before and after the transfer. Normally there is no nitric acid production supplied into the tanks during times of transfer to on-site consumers. Should that be the case, the tank levels at the receiving plant are checked for received nitric acid volumes instead to determine the delivered nitric acid volumes.</p> <p>The total nitric acid delivered is then calculated by a mass balance calculation.</p> <p>Using all these figures the total mass of nitric acid produced is calculated to derive the <u>Calculated Production</u>. Because both of AEL's nitric acid plants on site (No. 11 and No. 9) produce into the same storage tank, the Calculated Production is a combined result for both plants.</p> <p>There is also a coriolis flow meter installed, which continuously measures the production output of nitric acid into the storage tank. However, this flow meter is quite unreliable which is why AEL uses the calculated values for its financial planning and reporting and uses the flow meter results only for plausibility checks.</p> |
| Monitoring frequency               | <u>NAP is determined by continuous measurement of the HNO<sub>3</sub> production and concentration</u>  |

|                           |  |
|---------------------------|--|
| <b>QA/QC procedures</b>   | <p>The procedures for determining NAP will be exactly the same during the project campaigns as they were during the baseline campaign (and the historic campaigns). Therefore, any uncertainty of NAP determination by this procedure will affect project NAP (used for calculating the <math>EF_n</math>) in exactly the same way as baseline NAP and therefore the uncertainties would cancel each other out and can be ignored.</p> <p>The flow meter measurements can from time be used to conduct plausibility checks of the calculated NAP values.</p> |
| <b>Purpose of data</b>    | <u>Calculation of project emissions</u>  |
| <b>Additional comment</b> | None.  |

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>TSG</b>  |
| <b>Unit</b>                               | °C  |
| <b>Description</b>                        | Temperature in the stack gas  |
| <b>Source of data</b>                     | Stack temperature probe situated next to the volume flow meter.   |
| <b>Value(s) applied</b>                   | The project participants expect this value to remain constant in comparison to the baseline campaign. This value is recorded in order to assess periods, during which the plant was operated outside permitted operating parameters.  |
| <b>Measurement methods and procedures</b> | 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. |
| <b>Monitoring frequency</b>               | <u>Continuously (every 2 seconds)</u>   |
| <b>QA/QC procedures</b>                   | Subjected to complete <del>SABS</del> —testing loops as part of the ISO 9001/14001 procedures. The temperature probe is taken out and replaced by a new, calibrated temperature probe at each gauze change between the campaigns.   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b>                 | None  |

|   |  |
|---|--|
| <b>Data / Parameter</b>                   | <b>PSG</b>   |
| <b>Unit</b>                               | mbar (absolute)  |
| <b>Description</b>                        | Pressure in the stack  |
| <b>Source of data</b>                     | Stack pressure probe situated directly next to the volume flow meter.  |
| <b>Value(s) applied</b>                   | The project participants expect this value to remain constant in comparison to the baseline campaign. This value is recorded in order to assess periods, during which the plant was operated outside permitted operating parameters.   |
| <b>Measurement methods and procedures</b> | 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. |
| <b>Monitoring frequency</b>               | <u>Continuously (every 2 seconds)</u>  |

|                    |   |
|--------------------|---|
| QA/QC procedures   | <p>Subjected to complete <del>SABS</del> testing loops as part of the ISO 9001/14001 procedures. The pressure probe is taken out and replaced by a new, calibrated temperature probe at each gauge change between the campaigns.</p> <p>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 <del>South Africa Bureau of Standards (SABS)</del> <u>testing house in charge of the procedure</u>.</p> |
| Purpose of data    | <u>Calculation of project emissions</u>   |
| Additional comment | None  |

|                                    |  |
|------------------------------------|--|
| Data / Parameter                   | $EF_n$   |
| Unit                               | tN <sub>2</sub> O/tHNO <sub>3</sub>  |
| Description                        | Emissions factor for campaign n.   |
| Source of data                     | Calculation from total mass N <sub>2</sub> O emissions of campaign n (PE <sub>n</sub> ) and total nitric acid production (NAP <sub>n</sub> ).  |
| Value(s) applied                   | <p>The project participants expect that it will be at least 80% less than the value measured during the baseline campaign.</p> <p>This value is used for calculating EF<sub>P</sub> by taking into account EF<sub>ma,n</sub>.</p>  |
| Measurement methods and procedures | <p>The campaign specific emissions factor for each campaign during the project's crediting period is calculated by dividing the total mass of N<sub>2</sub>O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign. For campaign n the campaign specific emission factor would be:</p> $EF_n = PE_n / NAP_n$ |
| Monitoring frequency               | <u>Not applicable.</u>   |
| QA/QC procedures                   | Not applicable.  |
| Purpose of data                    | <u>Calculation of project emissions</u>  |
| Additional comment                 | None   |

|                                    |   |
|------------------------------------|---|
| Data / Parameter                   | $EF_{ma,n}$   |
| Unit                               | tN <sub>2</sub> O/tHNO <sub>3</sub>   |
| Description                        | Moving average emissions factor derived over time from campaign specific emissions factors.   |
| Source of data                     | Calculation from campaign specific emissions factors EF <sub>n</sub> .  |
| Value(s) applied                   | <p>The project participants expect that these values will be similar to EF<sub>n</sub> in the first project campaign.</p> <p>This value is used for adjusting EF<sub>n</sub> as required by AM0034 and thus determining EF<sub>P</sub>.</p>   |
| Measurement methods and procedures | <p>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:</p> $EF_{ma,n} = (EF_1 + EF_2 + \dots + EF_n) / n$ <p>This process is repeated for each campaign such that a moving average, EF<sub>ma,n</sub> is established over time, becoming more representative and precise with each additional campaign.</p> |
| Monitoring frequency               | <u>Not applicable.</u>  |
| QA/QC procedures                   | Not applicable.   |

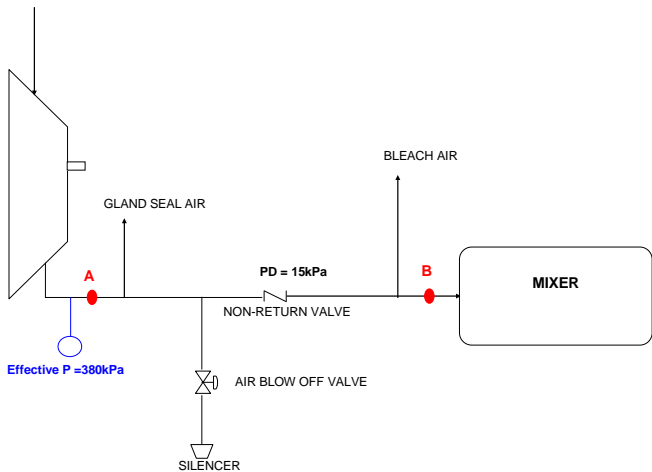
|                           |  |
|---------------------------|--|
| <b>Purpose of data</b>    | <a href="#">Calculation of project emissions</a> |
| <b>Additional comment</b> | None   |

|   |  |
|---|--|
| <b>Data / Parameter</b>                   | <b>CL<sub>n</sub></b>  |
| <b>Unit</b>                               | tHNO <sub>3</sub>  |
| <b>Description</b>                        | Length of each project campaign measured in metric tonnes of 100% concentrated nitric acid produced during that campaign.  |
| <b>Source of data</b>                     | NAP  |
| <b>Value(s) applied</b>                   | The project participants expect this value to remain constant in comparison to the baseline campaign's CL <sub>BL</sub> -value.<br>This value is used for comparing a project campaign's length (in tHNO <sub>3</sub> ) with CL <sub>BL</sub> in order to assess whether or not AM0034 requires the partial elimination of data sets recorded during the project campaign before calculating EF <sub>n</sub> .   |
| <b>Measurement methods and procedures</b> | In accordance with AM0034 the project length (CL <sub>n</sub> ) has to be compared to the established average historic campaign length (CL <sub>normal</sub> ); and<br><br>If the length of each individual project campaign CL <sub>n</sub> is longer than or equal to the average historic campaign length CL <sub>normal</sub> , then all N <sub>2</sub> O 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).<br><br>If CL <sub>n</sub> < CL <sub>normal</sub> , recalculate EF <sub>BL</sub> by eliminating those N <sub>2</sub> O values that were obtained during the production of tonnes of nitric acid beyond the CL <sub>n</sub> (i.e. the last tonnes produced) from the calculation of EF <sub>n</sub> . |
| <b>Monitoring frequency</b>               | <a href="#">See comments for NAP above</a>   |
| <b>QA/QC procedures</b>                   | See comments for NAP.  |
| <b>Purpose of data</b>                    | <a href="#">Calculation of project emissions</a>   |
| <b>Additional comment</b>                 | None   |

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>EF<sub>p</sub></b>   |
| <b>Unit</b>                               | tN <sub>2</sub> O/tHNO <sub>3</sub>   |
| <b>Description</b>                        | Emissions factor used for the specific campaign n to determine the emission reductions of that campaign   |
| <b>Source of data</b>                     | Calculation of EF <sub>n</sub> and EF <sub>ma,n</sub> .   |
| <b>Value(s) applied</b>                   | The project participants expect that these values will be similar to EF <sub>n</sub> in the first project campaign.<br>This value serves as a basis for calculating the emission reductions achieved by the project activity.   |
| <b>Measurement methods and procedures</b> | To calculate the total emission reductions achieved in a campaign, the higher of the two values EF <sub>ma,n</sub> and EF <sub>n</sub> shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reductions (EF <sub>p</sub> ). Thus:<br><br>If EF <sub>ma,n</sub> > EF <sub>n</sub> then EF <sub>p</sub> = EF <sub>ma,n</sub><br>If EF <sub>ma,n</sub> < EF <sub>n</sub> then EF <sub>p</sub> = EF <sub>n</sub> |
| <b>Monitoring frequency</b>               | <a href="#">Not applicable</a>  |
| <b>QA/QC procedures</b>                   | Not applicable  |
| <b>Purpose of data</b>                    | <a href="#">Calculation of project emissions</a>  |
| <b>Additional comment</b>                 | None  |

|   |  |
|---|--|
| <b>Data / Parameter</b>                   | <b>EF<sub>min</sub></b>  |
| <b>Unit</b>                               | tN <sub>2</sub> O/tHNO <sub>3</sub>  |
| <b>Description</b>                        | EF <sub>min</sub> is equal to the lowest EF <sub>n</sub> observed during the first 10 campaigns of the project crediting period.   |
| <b>Source of data</b>                     | Calculations of EF <sub>ma,n</sub> .   |
| <b>Value(s) applied</b>                   | The project participants expect that this value will be similar to EF <sub>n</sub> in the first project campaign.<br>This value serves as a floor value for EF <sub>n</sub> throughout the crediting period.   |
| <b>Measurement methods and procedures</b> | A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N <sub>2</sub> O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF <sub>n</sub> observed during those campaigns will be adopted as a minimum (EF <sub>min</sub> ). If any of the later project campaigns results in an EF <sub>n</sub> that is lower than EF <sub>min</sub> , the calculation of the emission reductions for that particular campaign shall use EF <sub>min</sub> and not EF <sub>n</sub> . |
| <b>Monitoring frequency</b>               | <u>Not applicable</u>  |
| <b>QA/QC procedures</b>                   | Not applicable.  |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>  |
| <b>Additional comment</b>                 | None   |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>OP<sub>h</sub></b>  |
| <b>Unit</b>             | kPa (gauge)  |
| <b>Description</b>      | Oxidation Pressure for each hour   |
| <b>Source of data</b>   | Pressure probe at ammonia to air mixer.  |
| <b>Value(s) applied</b> | The project participants expect this value to remain constant in comparison to the baseline campaign.<br>It is used to determine when plant is operating outside of permitted range. |

|   |   |
|---|---|
| <b>Measurement methods and procedures</b> | <p>In accordance with AM0034 the oxidation pressure in the ammonia oxidation reactor (<math>OP_h</math>) has to be monitored and compared to the normal range for oxidation temperature (<math>OP_{normal}</math>). VSG and NCSG data obtained during times when <math>OP_h</math> was above or below <math>OP_{normal}</math> has to be eliminated from the calculation of <math>EF_p</math>.</p> <p>AM0034 prescribes the monitoring and recording of the Oxidation Pressure for each hour (<math>OP_h</math>) during the project campaigns. 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 <math>OP_h</math>.</p> <p>The pressure for the oxidation reactor is taken as the pressure at point <b>B</b> (air to mixer pressure). The permitted range for the oxidation pressure is inferred from the values given for point <b>A</b> (HP compressor discharge pressure range).</p> <p>Figure: Pressure points for No. 11</p>  <p>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.</p> |
| <b>Monitoring frequency</b>               | <u>The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages.</u>   |
| <b>QA/QC procedures</b>                   | <p>Subjected to complete <del>SABS</del>—testing loops as part of the ISO 9001/14001 procedures.</p> <p>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 <del>South Africa Bureau of Standards (SABS)</del><u>testing house in charge of the procedure.</u></p>  |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b>                 | <u>None</u>   |

|                  |        |
|------------------|--------|
| Data / Parameter | $OT_h$ |
| Unit             | °C     |

|   |  |
|---|--|
| <b>Description</b>                        | Oxidation temperature in the ammonia oxidation reactor (AOR).  |
| <b>Source of data</b>                     | Thermocouples inside the AOR.  |
| <b>Value(s) applied</b>                   | The project participants expect this value to remain constant in comparison to the baseline campaign.<br>It is used to determine when plant is operating outside of permitted range.   |
| <b>Measurement methods and procedures</b> | Oxidation temperature is set and is never actively changed during operation. The composite thermocouple is made up of six individual temperature probes and continuously measures $OT_h$ . $OT_h$ is controlled by AIFR which is a controlled parameter and should stay as constant as possible. $OT_h$ is therefore a control parameter for AIFR. |
| <b>Monitoring frequency</b>               | <u>The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages.</u>  |
| <b>QA/QC procedures</b>                   | Subjected to complete <del>SABS</del> —testing loops as part of the ISO 9001/14001 procedures. The temperature probe is taken out and replaced by a new, calibrated temperature probes at each gauze change between the campaigns.   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>  |
| <b>Additional comment</b>                 | None   |

|   |  |
|---|--|
| <b>Data / Parameter</b>                   | <b>AFR</b>   |
| <b>Unit</b>                               | kgNH <sub>3</sub> /h   |
| <b>Description</b>                        | Ammonia gas flow rate to the ammonia oxidation reactor.  |
| <b>Source of data</b>                     | Orifice plate  |
| <b>Value(s) applied</b>                   | The calculated values of AFR will be used to determine if plant is operating outside of AFR <sub>max</sub> . See table B. 10 in section B.6.2 for procedural details.<br>The project participants expect this value to remain constant in comparison to the baseline campaign. |
| <b>Measurement methods and procedures</b> | The ammonia flow is continuously measured by orifice plate.  |
| <b>Monitoring frequency</b>               | <u>The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages.</u>  |
| <b>QA/QC procedures</b>                   | Subjected to complete <del>SABS</del> —testing loops as part of the ISO 9001/14001 procedures.   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>  |
| <b>Additional comment</b>                 | None   |

|                         |  |
|-------------------------|--|
| <b>Data / Parameter</b> | <b>AIFR</b>  |
| <b>Unit</b>             | % v/v  |
| <b>Description</b>      | Ammonia to air ratio into the ammonia oxidation reactor  |
| <b>Source of data</b>   | Calculation for each hour of plant operation based on measurements of AFR and primary air flow rates.  |
| <b>Value(s) applied</b> | The project participants expect this value to remain constant in comparison to the baseline campaign.<br>It is used to determine when plant is operating outside of permitted range. |

|   |  |
|---|--|
| <b>Measurement methods and procedures</b> | <p>The monitoring of AIFR is required by AM0034 in order to determine whether the plant is operating within the permitted operating range. In the baseline procedures AIFR<sub>max</sub> has been established 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<sub>max</sub> will be eliminated from the calculation of EF<sub>P</sub>.</p> <p>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<sup>3</sup>/hr, which is used in the ratio calculation.</p> |
| <b>Monitoring frequency</b>               | <u>The measurement results are taken by the data acquisition and evaluation system. The system directly calculates hourly averages.</u>  |
| <b>QA/QC procedures</b>                   | Subjected to complete <del>SABS</del> —testing loops as part of the ISO 9001/14001 procedures.   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>  |
| <b>Additional comment</b>                 | None   |

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>GS<sub>PC</sub></b>  |
| <b>Unit</b>                               | Name of supplier.   |
| <b>Description</b>                        | Gauze supplier for the project campaign   |
| <b>Source of data</b>                     | Monitored / Invoices  |
| <b>Value(s) applied</b>                   | This information is used to deduct the ammonia oxidation catalyst's physical characteristics and verify GC <sub>n</sub> -values.  |
| <b>Measurement methods and procedures</b> | <p>AM0034 requires the monitoring of the supplier of the ammonia oxidation catalyst gauze. The recorded information is not further processed in the methodology but it is used as a plausibility check against the information for GC.</p> <p>AEL has been using ammonia oxidation catalyst gauzes ("FTCplus") supplied by Heraeus for the past several years. The Heraeus FTCplus gauze contains significant levels of Palladium (approximately one third). The main motivation for this is that it leads to a weight reduction of the (more expensive) Platinum. A side effect of this gauze type is that the generation of N<sub>2</sub>O in the ammonia oxidation process tends to be lower than with gauzes containing little or no Palladium.</p> <p>AEL intends to continue using gauzes with the same or very similar composition for the foreseeable future.</p> |
| <b>Monitoring frequency</b>               | <u>Not applicable.</u>  |
| <b>QA/QC procedures</b>                   | <u>Not applicable.</u>  |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b>                 | None  |

|                         |   |
|-------------------------|---|
| <b>Data / Parameter</b> | <b>GC<sub>n</sub></b>   |
| <b>Unit</b>             | %   |
| <b>Description</b>      | Gauze composition during each project campaign expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes. |
| <b>Source of data</b>   | Monitored / Invoices  |

|   |  |
|---|--|
| <b>Value(s) applied</b>                   | To be obtained during the project campaigns. The project participants intend to leave the gauze composition unchanged, i.e. as in the baseline campaign.<br>The information on gauze composition is used – as required by AM0034 – to ensure that emission levels are not manipulated by changing the gauze composition.                     |
| <b>Measurement methods and procedures</b> | The gauze composition during the project needs to be monitored and compared to GC <sub>BL</sub> . If the operator has changed the gauze composition during a project campaign to a composition not used during the baseline campaign, the baseline campaign may have to be repeated or a conservative IPCC default emissions factor applied. |
| <b>Monitoring frequency</b>               | <u>Not applicable.</u>   |
| <b>QA/QC procedures</b>                   | <u>Not applicable.</u>   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>  |
| <b>Additional comment</b>                 | None   |

|   |   |
|---|---|
| <b>Data / Parameter</b>                   | <b>EF<sub>reg</sub></b>   |
| <b>Unit</b>                               | tN <sub>2</sub> O/tHNO <sub>3</sub>   |
| <b>Description</b>                        | Emissions factor derived from incoming regulation for N <sub>2</sub> O emissions.   |
| <b>Source of data</b>                     | N <sub>2</sub> O regulation   |
| <b>Value(s) applied</b>                   | Not applicable as there is no regulation on N <sub>2</sub> O emissions in South Africa. However, the regulatory situation will be monitored by liaising with the responsible South African Environmental Authorities on a continuous basis. AEL has a well established working relationship with the responsible authorities and exchanges information with their officials on a regular basis. |
| <b>Measurement methods and procedures</b> | The project participants have no information about any plans to introduce N <sub>2</sub> O regulation in South Africa.<br>This value may lead to a change of EF <sub>BL</sub> , if legislation changes.   |
| <b>Monitoring frequency</b>               | <u>Not applicable.</u>  |
| <b>QA/QC procedures</b>                   | Not applicable.   |
| <b>Purpose of data</b>                    | <u>Calculation of project emissions</u>   |
| <b>Additional comment</b>                 | None  |

### B.7.2. Sampling plan

&gt;&gt;

Not applicable.

### B.7.3. Other elements of monitoring plan

&gt;&gt;

The emission reductions achieved by the project activity will be monitored using 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<sub>2</sub>O 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 EN 14181 (2004) "*Stationary source emissions - Quality assurance of automated measuring systems*" as a guidance for installing and operating the Automated Monitoring System (AMS) in the nitric acid plants for the monitoring of N<sub>2</sub>O emissions.

A complete Automated Monitoring System (AMS) to monitor the mass emissions of N<sub>2</sub>O at the stack of AEL's No. 11 nitric acid plant was ordered in the second half of 2005 and has been installed and operated since January 2006. As an operator of the nitric acid plants since 1932 and of the No. 11 nitric acid plant since June 1979, AEL staff in general and its Instrument Department in particular is accustomed to operating technical equipment to a high level of quality standards.

The plant manager is responsible for the ongoing operation and maintenance of the N<sub>2</sub>O monitoring system. Operation, maintenance, calibration and service intervals are being carried out by staff from the instrumentation department according to the vendor's specifications 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.

Please see Annex 4 for a detailed description of the Automated Monitoring System (AMS) installed at AEL's No. 11 nitric acid plant as well as for background information on EN 14181 and the practical implications for using this standard for guidance in the implementation of this CDM project activity.

In the following, it is described how the procedures given in EN 14181 for QAL1, 2 and 3 have been practically applied at AEL's No. 11 plant.

#### QAL 1

In accordance with EN 14181 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.

At the time of purchasing of the AMS by AEL, no AMS vendors had yet conducted the QAL 1 suitability testing for N<sub>2</sub>O and it was not known if any vendors were in the process of obtaining this. The chosen gas analyser MIR9000 from Environnement however, has passed the QAL1 suitability for measurements of NO<sub>x</sub> and other gaseous emissions.

The new analyser to be installed and integrated into the No. 11 AMS – an ABB Uras 14 analyser – is QAL1-tested according to EN 14181.

The AMS was calibrated by the vendor, Environnement S.A. prior to shipment and installation in the nitric acid plant<sup>32</sup>, the calibration report also contains information about the cross sensitivities of the analyser.

Because of some technical difficulties with the Environnement MIR9000 analyser on the No. 9 plant, AEL has decided to install two completely new analysers (ABB Uras 14) in both the No. 9 and the No. 11 plant in mid 2007. The new analyser type has been suitability tested for N<sub>2</sub>O under EN 14181's QAL1.

#### Pre-validation of the AMS by a DOE

While this is not explicitly required by either AM0034 or EN 14181, a pre-validation of the AMS installation and operation was conducted on site in June 2006 by TÜV SÜD to help ensure that the AMS output and the monitoring procedures implemented in the plant are going to be acceptable to the DOE upon validation of the project.

#### QAL2

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

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<sup>32</sup> The calibration report can be provided to the DOE upon request.

legislation. The QAL2 tests are performed on suitable AMS that have been correctly installed and commissioned on-site (as opposed to QAL1 which is conducted off-site). QAL2 tests are to be performed at least every 5 years according to EN 14181 but also after major changes to the plant or changes or repairs to the AMS, which will influence the results obtained significantly.

A calibration function is established from the results of a number of parallel measurements performed with a Standard Reference Method (SRM). The variability of the measured values obtained with the AMS is then evaluated against the required uncertainty.

According to EN 14181, both the QAL2 procedures and the SRM need to be conducted by an independent "testing house" or laboratory which has to be accredited to ISO 17025.

The QAL2 tests on the No. 11 AMS will be conducted by TÜV SÜD in 2007. All parts of the AMS were found to be in compliance with EN 14181<sup>33</sup>. TÜV SÜD is accredited under ISO 17025 for conducting such tests.

### Standard Reference Method (SRM)

In order to provide an additional source for verifying the ongoing functionality of the AMS, gas samples from the stack were taken at intervals and over a time period as described for the reference measurements under EN 14181. These samples were then sent for analysis to Modderfontein Laboratory Services (Pty) Ltd., which is an independent chemical analysis laboratory which is certified by the South African Bureau of Standards (SABS).

An N<sub>2</sub>O standard gas sample with a known concentration is injected first and its area and height are recorded. Then the sample is injected and its area and height are also recorded. The concentration of the sample is obtained using the equation below<sup>34</sup>.

$$C_{sample} = \frac{Area_{sample} / Height_{sample}}{Area_{standard} / Height_{standard}} \times 0.2$$

Modderfontein lab independently takes two samples from the plant three times per week (normally on Mondays, Wednesdays and Fridays). One sample is taken from the exit of the analyser and one is taken from the sampling point before the SEC sample conditioning system. The analyser readings shown at that particular time are also recorded.

The two samples are then analysed in the Modderfontein Lab by a gas chromatograph (GC). The GC is calibrated with standard calibration gas with a certified N<sub>2</sub>O calibration (the balance being N<sub>2</sub>) before two GC measurements are done on each of the two samples.

The results are compared to the plant results to check if there is a significant difference between the two figures using the t-test. Ideally, when there are significant differences between the laboratory results and plant results, the laboratory analysis should be re-done. If there are still some differences, then another span calibration is performed on the analyser and the analyser calibration factors are checked.

The series of lab sample measurements are set against the corresponding analyser results recorded at the time of sampling. An accredited ISO 17025 testing house has conducted the necessary QAL2 SRM procedures on these data series to derive the calibration curve for the analyser and to determine the total uncertainty of the analyser measurements.

In order to ensure compliance with EN 14181, the full QAL2 procedures will be repeated on site by an accredited testing house, once the new ABB Uras 14 analyser has been commissioned.

<sup>33</sup> The QAL2 testing report can be made available to the DOE / the CDM EB upon request.

<sup>34</sup> The results of this reference measurement method are available to the DOE during the on site validation

**AMS calibration and QA/QC procedures**

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

Currently, an Environnement MIR 9000 multigas infra red analyser is installed on the No11 nitric acid plant to measure the N<sub>2</sub>O emissions. Due to the unreliability of the No. 9 nitric acid plant MIR 9000 analyser, a decision was made to replace both nitric acid plant's analysers with QAL 1 certified ABB URAS 14 analysers. The URAS 14 analyser will be installed on No11 nitric acid at the end of the current project campaign.

**Zero Calibration of the Environnement MIR 9000 analyser**

Dry oil-free instrument air with a dew point of < 50 °C or better must be used as a reference signal. This commodity is crucial to the operation of the analyser since the dry air is used as a zero gas as well as for emergency purging of the measuring cell should the sample gas contain more than a certain amount of moisture that could be harmful to the analyser. The dry air is also used to either dilute or remove moisture from the sample at the sample probe, depending on what type of sampling system is used. Dry air of a good quality must thus always be available and connected to both the "Zero Ref." port on the analyser as well as to the sample probe via the designated connections.

The zero calibration of the MIR 9000 is performed fully automatically and is done on programmable intervals. The analyser at No. 11 plant is set to the standard default time interval, which means that an automatic zero calibration is done every 3 hrs.

**Span calibration of the Environnement MIR 9000 analyser**

The span calibration of the analyser can only be performed manually. Certified calibration gas, supplied by AFROX with a known and certified concentration is always connected to the analyser to conduct the regular analyser span calibration. 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<sub>2</sub>O calibration gas which was produced by Modderfontein lab for that purpose using Worstoff pumps.

The span calibration is conducted at least twice a week (normally on Tuesdays and Fridays) with the calibration gas being injected into the analyser sample cell. As a result of the span calibration, the K-factors used to adjust the measured result before being sent to the DCS data acquisition system are readjusted.

**New cal factor = Concentration of the calibration gas x Old calibration factor  
Reading of the analyser once stabilised**

Once per month the span calibration is also performed on the whole sample system where the calibration gas is manually injected at the sample probe and then passed through the sample conditioning system and the analyser.

**Zero Calibration of the ABB URAS 14 analyser**

The zero calibration of the URAS 14 is performed fully automatically and is done on programmable intervals. The analyser at No. 11 plant is set to the standard default time interval, which means that an automatic zero calibration will be done every 3 hours.

**Span calibration of the ABB URAS 14 analyser**

The full scale calibration of the ABB URAS 14 is also performed fully automatically and is done on programmable intervals using gas-filled calibration cells.

QAL3 software supplied by ABB will work automatically in conjunction with the URAS 14 analyser to record all calibration checks on both zero and span checks. The software will log all characteristic values for the determination of precision of drift. Any adjustments will be carried out by the analyser itself and all values will be recorded in the software. Shewhart and CASUM Control charts will be used for displaying the precision of drift. All records will be archived and backed up on a weekly basis.

#### Flow meter calibration procedures

The flow meter is calibrated at least every 6 months between campaigns (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 the indicated flow by 450 m<sup>3</sup>/h (equal to 1% of range) the pressure transmitter is recalibrated and the previous procedure repeated.

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

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

#### QAL3

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 EN 14181; these are a series of measurements that need to be conducted by independent measurement equipment in parallel to the existing AMS.

In essence, AEL staff performs QAL3 procedures through the established calibration procedures described above. However, similarly to QAL2, there is no independent, qualified and certified entity in South Africa that could conduct the QAL3 procedures and particularly the AST in accordance with EN 14181. Therefore, either a sufficiently qualified (but not certified in accordance with EN 14181) technical surveillance company or laboratory could perform the independent QAL3 procedures. Or alternatively an accredited auditor from Europe will have to be called in to conduct the QAL3 procedures.

#### **SCADA 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 week's data (2-second, hourly and daily averages) onto an external disc drive. That way there are already four copies of the original and unchanged data stored in four different locations. In addition, the hourly and daily data are sent to N.serve once per week 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.

### **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 section B.7.1 above: OT<sub>h</sub>, OP<sub>h</sub>, AFR, AIFR, NAP, GS, GC, CL, incoming N<sub>2</sub>O regulation and changes in the NO<sub>x</sub> 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.

### **B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities**

>>

4<sup>th</sup> May 2007

African Explosives Ltd.

Mr. Clive Greger, now responsible: Mr. Trevor Roberts

N.serve Environmental Services GmbH

Mr. Albrecht von Ruffer (Database management by Dr. Helmuth Groscurth), now responsible: Mr. Nikolaus Gutknecht-Stöhr

## **SECTION C. Duration and crediting period**

### **C.1. Duration of project activity**

#### **C.1.1. Start date of project activity**

>>

Expected: January 2006

#### **C.1.2. Expected operational lifetime of project activity**

>>

AEL's No. 11 nitric acid plant has a remaining operational lifetime of at least 15 years and is not expected to be decommissioned before that time.

### **C.2. Crediting period of project activity**

#### **C.2.1. Type of crediting period**

>>

The project participants have chosen a fixed term crediting period of ten years.

#### **C.2.2. Start date of crediting period**

>>

01. December 2007 (or any later date at which project is registered AND the N<sub>2</sub>O abatement catalyst installed)

**C.2.3. Length of crediting period**

10 years

**SECTION D. Environmental impacts****D.1. Analysis of environmental impacts**

>>

The project will reduce gaseous emissions of nitrous oxide (N<sub>2</sub>O) from the plant tail gas and will therefore contribute to international efforts to reduce greenhouse gas emissions. The project will have no effects on local air quality.

The project will have no impact on water pollution. No additional water is required for the project activity's implementation or operation. Therefore, there is no impact on the sustainable use of water.

Also, the project does not impact on the community's access to other natural resources as it will not require any additional resources. Also, there is no impact on the efficiency of resource utilization.

The N<sub>2</sub>O abatement catalyst will be leased from an overseas supplier. The catalyst will be replaced from time to time and the spent catalyst returned to the supplier for recycling, if possible.

There are no other positive or negative impacts on the environment.

**D.2. Environmental impact assessment**

>>

The Gauteng Department of Agriculture, Conservation and Environment has confirmed by letter dated 19<sup>th</sup> September 2006, that based on the information supplied, the project is not listed in terms of the Environmental Impact Assessment Regulations, 2006, published under the National Environmental Management Act (Act 107, 1998) as amended in Government Notice R385. Therefore, it does not legally require environmental authorisation from the Department<sup>35</sup>.

**SECTION E. Local stakeholder consultation****E.1. Solicitation of comments from local stakeholders**

>>

AEL has conducted a stakeholder consultation process by hiring a local consultancy<sup>36</sup> for facilitating this process. The process was initiated in mid-August and lasted until the end of September 2006. Whilst some addressees received individual information, the essential key points were compiled in a Background Information Document (BID).

The following stakeholder groups were identified and addressed:

- authorities
- the general residential urban public in nearby towns and villages
- the commercial and industrial tenants
- national and regional NGOs
- local focussed interest groups
- AEL employees

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<sup>35</sup> See letter of the Gauteng Provincial Government (Department for Agriculture, Conservation and Environment) dated the 19<sup>th</sup> of September 2006, confirming that an Environmental Impact Assessment is not required. This letter is available during the on site audit by the DOE.

<sup>36</sup> Willchem cc, Environmental & Risk Consultants; the consultant's Stakeholder Engagement Report can be found in Annex 5.

The diversity of stakeholders that had to be informed was addressed by a corresponding broad mix of communication paths.

AEL's Environment Manager had informed environmental authorities – such as the Department of Environment, Provincial and Metro Environmental Authorities and the National Department of Environment's Regional Air Pollution control officer – prior to the actual stakeholder consultation process. Thereafter, these participants were updated by E-mail on a regular basis. Also, they received the BID.

Local residents were addressed by circulating detailed information on several local newspapers. Readers were invited to contact the AEL environment officer, whose contact details were provided as well.

Other commercial and industrial tenants on the Modderfontein industrial site as well as local, regional and national NGO's were informed either via E-mail or by letter (including BID).

AEL employees were integrated by electronic newsletter using the AEL intranet. The BID was circulated the same way. Additionally, large notices were placed at all the entry gates to the AEL site.

## **E.2. Summary of comments received**

>>

Only very few responses were obtained. One stakeholder wanted to know more about N<sub>2</sub>O and its implications for climate change, two asked to be kept informed, two others just confirmed to have received the information. AEL provided the information requested by them.

## **E.3. Report on consideration of comments received**

>>

As these comments were not aimed at influencing the implementation of the project activity in any way, it was not considered necessary to take them into account other than keeping those who asked for this informed.

AEL is committed to further societal welfare in the Modderfontein area and is involved in several community projects. It is planned to launch a new initiative which will provide experiential environmental education to large numbers of local schoolchildren. The venue for this programme will be the Modderfontein Conservation Area, which is an approximately 280 ha park which AECL plans to set aside for conservation at Modderfontein. It is intended to link this environmental education initiative to the proposed N<sub>2</sub>O abatement project. The environmental education programme will respond to contemporary environmental education theory and practice and provide a centre that responds to environmental issues or concerns of focus such as education for sustainability.

Thus, AEL will continue to involve the local community and promote the proliferation of environmental knowledge.

## **SECTION F. Approval and authorization**

>>

The letters of approval have already been provided to the DOE and the UNFCCC.

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

|  |  |
|--|--|
| <b>Project participant and/or responsible person/ entity</b> | <input checked="" type="checkbox"/> Project participant<br><input checked="" type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity |
| <b>Organization name</b>                                     | <del>African Explosives Ltd.</del> <u>AEL Mining Services Limited</u>  |
| <b>Street/P.O. Box</b>                                       | PO Modderfontein   |
| <b>Building</b>  | Acid House   |
| <b>City</b>  | Modderfontein  |
| <b>State/Region</b>  | Gauteng Province   |
| <b>Postcode</b>  | 1645   |
| <b>Country</b>   | South Africa   |
| <b>Telephone</b>   |  |
| <b>Fax</b>   |  |
| <b>E-mail</b>  |  |
| <b>Website</b>   | <a href="http://www.explosives.co.za">www.explosives.co.za</a>   |
| <b>Contact person</b>  | <u>Trevor Roberts</u>  |
| <b>Title</b>   | <u>Executive Director Global Business Services</u> <del>Section Manager</del>  |
| <b>Salutation</b>  | Mr.  |
| <b>Last name</b>   | <del>Aucamp</del> <u>Roberts</u>   |
| <b>Middle name</b>   |  |
| <b>First name</b>  | <del>Leon</del> <u>Trevor</u>  |
| <b>Department</b>  | <del>Nitrates</del> <u>AEL Mining Services</u>   |
| <b>Mobile</b>  | <u>+27 82 373 2270</u>   |
| <b>Direct fax</b>  | <u>+27 11 605 0004</u> <u>+27 (0)11 606 2426</u>   |
| <b>Direct tel.</b>   | <u>+27 11 606 0489</u> <u>+24 (0)11 606 3287</u>   |
| <b>Personal e-mail</b>                                       | <u>Trevor.roberts@aelms.com</u> <del>AucampL@ael.co.za</del>   |

|  |  |
|--|--|
| <b>Project participant and/or responsible person/ entity</b> | <input checked="" type="checkbox"/> Project participant<br><input checked="" type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity |
| <b>Organization name</b>                                     | N.serve Environmental Services GmbH  |
| <b>Street/P.O. Box</b>                                       | <u>Grosse Theaterstr. 14</u> <del>Grubesallee 12</del>   |
| <b>Building</b>  |  |
| <b>City</b>  | Hamburg  |
| <b>State/Region</b>  | <u>Hamburg</u>   |
| <b>Postcode</b>  | <u>22143</u> <u>20354</u>  |
| <b>Country</b>   | Germany  |
| <b>Telephone</b>   | <u>+494030997860</u>   |
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|   |   |
|---|---|
| <b><u>Project participant and/or responsible person/ entity</u></b> | <input checked="" type="checkbox"/> Project participant<br><input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity |
| <b><u>Organization name</u></b>                                     | <a href="#">Nordic Environment Finance Corporation</a>  |
| <b><u>Street/P.O. Box</u></b>                                       | <a href="#">Fabianinkatu 34, P.O. Box 241</a>   |
| <b><u>Building</u></b>  |   |
| <b><u>City</u></b>  | <a href="#">Helsinki</a>  |
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| <b><u>Postcode</u></b>  | <a href="#">00171</a>   |
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## Appendix 2. Affirmation regarding public funding

No public funding was received by the project participants for the development, implementation and operation of the project.

## Appendix 3. Applicability of methodology and standardized baseline

| None

## Appendix 4. Further background information on ex ante calculation of emission reductions

| None

## Appendix 5. Further background information on monitoring plan

### MONITORING INFORMATION

#### Description of the AMS installed at AEL's No. 11 nitric acid plant.

Currently, an Environnement MIR 9000 multigas infra red analyser is installed on the No. 11 nitric acid plant to measure the N<sub>2</sub>O emissions. Due to the unreliability of the No. 9 nitric acid plant MIR 9000 analyser, a decision was made to replace both nitric acid plant's analysers with QAL 1 certified ABB URAS 14 analysers. The URAS 14 analyser will be installed on No11 nitric acid at the end of the current project campaign.

#### 1. General Description of the AMS (Environnement MIR 9000)

The system currently installed at AEL's No. 11 nitric acid plant consists of an air dryer unit, a sample conditioning system and the analyser itself. The sampling system and analyser were designed to operate for extended periods between the regular maintenance intervals and communicate constantly with each other to ensure that all systems are fully operational during the plant's operation. Any alarm conditions are displayed and logged on the analyser for ease of identification and maintenance.

During operation, plant instrument air at 6-7 bar pressure is continuously pumped into the air dryer system where all moisture is extracted by means of a hydrophobic filter arrangement to provide clean and dry air with a dew point of -70 °C and a porosity of 0.45 micron. The physical condition of the air is crucial to the operation of the entire system. The air is continuously sent to both the

sample probe as well as to the analyser's zero port. The air supply must at all times be open and available when the system is on-line.

## 2. Sample point

The location of the sample point was selected to provide ease of access and a location close to the analyser. The most suitable position is in the horizontal section of the exit stack. At this point, the gas is still hot (above dew point) and well mixed.

The sampling points for both NCSG and VSG are at least 3 times the stack diameter distance after any previous bend in the stack and behind the tail gas expander turbine.

## 3. Sample Conditioning System

The SEC sample conditioning system consists of a sample probe, fine filter, a heated section and a moisture removal device. The sample is drawn in from the process at a rate of 15-20 l/hr through a coarse 5-micron sinter-metal filter situated in the centre of the exit stack by means of an air-driven ejector. The sample is heated already in the probe to 180 °C in order to keep its temperature above the dew point throughout the analytic process.

Once the hot sample enters the sample box it is filtered further down to 0.5 micron and exposed in an oven to a temperature of 220 °C in order to prevent any formation of condensation. The dry air received from the air-drying system is piped through a dual-stage permeation drying tube that allows only the water molecules to permeate through the walls. The hot filtered sample flows in one direction through the permeation dryer. Simultaneously, the dry instrument air flows in the opposite direction removing the moisture that permeated through the dryer. A second dryer mounted in the "cool" area outside of the oven further dries the gas whilst cooling it down at the same time. This method of moisture removal has several advantages compared to the conventional electric cooling methods: firstly, it removes only the moisture and not any of the components to be analysed. Secondly, the sample is already conditioned at the take-off point and can thereafter be transported to the remote analyser. In the case of AEL's No. 11 nitric acid plant this is done using an ordinary unheated high-density nylon or teflon tube allowing a high velocity gas flow at a comparatively low volume of sampled gas.

Because of the low sample volumes the loading on the primary and secondary filters in the SEC system is much lower than in the case of a conventional system. This is one of the main reasons why the system can stay operational for extended periods of time. Both air pressure and gas flow velocity at the filter, as well as the temperatures of both the probe and the oven are constantly monitored. Any fault conditions are displayed and logged at the analyser in the alarm menu.

**Photographs of the sample conditioning unit (pump and dryer) at No. 11 and the lab sample point**



## 4. Analyser

### **a. The Environnement MIR 9000 gas analyser installed in the historic and baseline campaign(s)**

The MIR 9000 (Multi-component InfraRed analyser) is capable of analysing up to 12 components simultaneously. It employs the InfraRed filter correlation principle, which is one of the most suitable measuring techniques available for the elimination of interferences from any unknown background components in the process. The optical bench (inside the measuring chamber) has an internal structure consisting of a range of parabolic mirrors that provide it with an effective measuring length of 12 meters, which gives the analyser a very sensitive and stable performance with minimal long-term drift. The pressure, the gas flow velocity and the temperature of the bench are constantly monitored and the necessary corrections applied to the analysis results. The temperature of the chamber is accurately controlled at 49 °C whilst the other two parameters are just measured. Besides the three components of interest that the analyser is equipped for in this case (N<sub>2</sub>O, NO and NO<sub>2</sub>) it also analyses for moisture in the sample as well as the CO<sub>2</sub> concentration.

These additional parameters are used by the system for correction purposes and to protect the analyser (mainly the sensitive optical bench) in case the sample conditioning system suffers operational failure. Moisture could principally disadvantageously affect the gas sample analysis: water vapour is capable of absorbing IR waves and thereby skewing analysis-results; furthermore it can – when exposed to NO<sub>x</sub>-gasses – form acidic compounds capable of damaging the analytic devices.

Moisture can in principle negatively affect the gas sample analysis as it is absorbed across the infrared spectrum and can also create acidic conditions when condensing and thereby absorbing some of the corrosive components in the sample.

The MIR 9000 analyser was designed with a standard safety feature that constantly analyses moisture levels. In the event of a faulty condition at the SEC sample conditioning unit (such as a loss or decrease in the condition of the dry air) it will automatically detect any increase in moisture. At a preset level (10,000 ppmv in the case of AEL No. 11 plant) the analyser will raise an alarm, freeze all outputs to the control room and switch over from sample into zero mode. The optical bench will then be flushed with dry air from the dryer until the moisture conditions are back to normal, thereafter the unit will switch back to sampling mode and continue to analyse.

The dry air is also constantly piped to the “Zero Reference” port of the analyser. At preset intervals (Currently set for every 3 hrs) the analyser switches over to zero reference mode and allow the optical bench to be flooded with dry air for 4 minutes. Once the bench is clean the electronics compare the status of all measuring parameters at zero conditions against the original conditions when the analyser was set up. The system will automatically adjust for any possible offsets to re-base itself on the original settings.

Once all settings are corrected the system switches back to sampling mode and allows the readings to stabilise before the outputs are switched back to active again. This method of constantly checking and adjusting the optical parameters is one of the outstanding features of the system. It thus can provide a very stable zero baseline with minimal drift over several months. The analysis results are delivered on the local display in terms of ppmv. The 4-20 mA outputs to the control room are scaled according to the programmed ranges (0-2,000 ppmv for N<sub>2</sub>O during the baseline campaign, which will be adjusted downwards for the project campaigns).

Also, a measurement for O<sub>2</sub> concentration is part of the system. By piping the vent from the measuring chamber in a flow-through arrangement over an electrochemical oxygen cell, oxygen concentrations can be assessed. The oxygen cell is powered from the control room via a 2-wire arrangement. Once the parameters are analysed (except for the O<sub>2</sub>) the microprocessor applies the necessary corrections based on the actual temperature and pressure of the sample in the measuring chamber. A standard factor is then applied to the final raw value to convert the reading to normal conditions. A further selection option allows the readings as well as the associated outputs to be converted in terms of mass. Because of the in-built automatic checks and the resulting stability of the analyser, re-adjustment intervals are longer than for conventional process analysers (see section on Monitoring Procedures below).

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

The system to be installed at AEL's No. 11 nitric acid plant consists of an air dryer unit, a sample conditioning system and the analyser itself. The sampling system and analyser were designed to operate for extended periods between the regular maintenance intervals and communicate constantly with each other to ensure that all systems are fully operational during the plant's operation. Any alarm conditions are displayed and logged on the analyser for ease of identification and maintenance.

During operation, plant instrument air at 6-7 bar pressure is continuously pumped into the air dryer system where all moisture is extracted by means of an aluminium oxide filter arrangement to provide clean and dry air with a dew point of 5 °C and a porosity of 0.3 micron. The physical condition of the air is crucial to the operation of the entire system. The air is continuously sent to both the sample probe as well as to the analyser's zero port. The air supply must at all times be open and available when the system is on-line.

## 2. Sample point

The location of the sample point was selected to provide ease of access and a location close to the analyser. The most suitable position is in the horizontal section of the exit stack. At this point, the gas is still hot (above dew point) and well mixed. The probe will be installed at the same location as the currently installed sampling probe. A heated sample line will be installed to insure that the dry gas sample does not condense before entering the analyser.

## 3. Sample Conditioning System

The SCC-F sample conditioning system consists of a sample probe, aluminium oxide filter, a heated section and a moisture removal device. The sample is drawn in from the process at a rate of 30 to 500 l/hr through a 0.3-micron aluminium oxide-metal filter situated in the centre of the exit stack by means of an air-driven ejector. The sample is heated already in the probe to 180 °C in order to keep its temperature above the dew point throughout the analytic process.

The hot filtered sample flows in one direction through a heated trace line to the analyser. Any fault conditions are displayed and logged at the analyser in the alarm menu.

## 4. Analyser

The URAS 14 (Multi-component Infrared analyser) is capable of analysing up to 4 components simultaneously. It employs the Non-dispersive infrared absorbs ion principle in the  $\lambda = 2.5 - 8 \mu\text{m}$  wave length. Besides the three components of interest that the analyser is equipped for in this case ( $\text{N}_2\text{O}$ , NO and  $\text{NO}_2$ ) it also analyse for moisture in the sample gas.

These additional parameters are used by the system for correction purposes and to protect the analyser (mainly the sensitive optical bench) in case the sample conditioning system suffers operational failure. Moisture could principally disadvantageously affect the gas sample analysis: water vapour is capable of absorbing IR waves and thereby skewing analysis-results; furthermore it can – when exposed to  $\text{NO}_x$ -gasses – form acidic compounds capable of damaging the analytic devices.

Moisture can in principle negatively affect the gas sample analysis as it is absorbed across the infrared spectrum and can also create acidic conditions when condensing and thereby absorbing some of the corrosive components in the sample.

The dry air is also constantly piped to the "Zero Reference" port of the analyser. At preset intervals (Currently set for every 3 hrs) the analyser switches over to zero reference mode and allow the optical bench to be flooded with dry air for 4 minutes. Once the bench is clean the electronics compare the status of all measuring parameters at zero conditions against the original conditions when the analyser was set up. The system will automatically adjust for any possible offsets to re-base itself on the original settings.

Once all settings are corrected the system switches back to sampling mode and allows the readings to stabilise before the outputs are switched back to active again. This method of constantly checking and adjusting the optical parameters is one of the outstanding features of the system. It thus can provide a very stable zero baseline with minimal drift over several months. The

analysis results are delivered on the local display in terms of ppmv. The 4-20 mA outputs to the control room are scaled according to the programmed ranges (0-2,000 ppmv for N<sub>2</sub>O during the baseline campaign, which will be adjusted downwards for the project campaigns).

**Photographs of the contents of the housing for the analyser and the front cover with display of the analyser.**



**b. The ABB Uras 14 analyser that will be installed before the beginning of the crediting period**

Information on the ABB Uras analyser that is scheduled to be installed in the next two months will be provided after the installation has been completed.

## **5. Flow Meter**

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



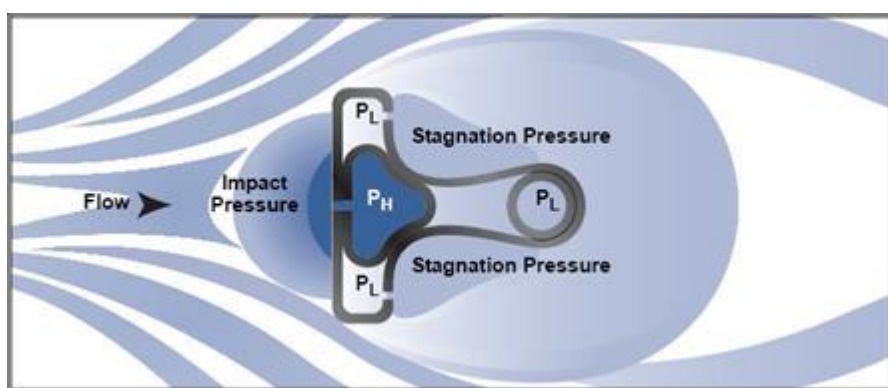
The Rosemount Annubar® 485 is a device used to measure the flow-velocity of a liquid, gas or steam fluid that passes through a pipe. It measures by creating a differential pressure (DP) that is

proportional to the square of the velocity of the fluid in the pipe, in accordance with Bernoulli's theorem. This DP is measured and converted into a flow rate using a secondary device, such as a DP pressure transmitter.

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

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

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



## 6. Historic parameters

### STATEMENT FROM AEL'S PROJECT REPRESENTATIVE CONCERNING THE UNAVAILABILITY OF HISTORIC OPERATIONAL PARAMETER DATA

2007-07-12

To Whom It May Concern:

#### Data and Operational Parameters

As the Nitrates Manager and on behalf of African Explosives Limited, I herewith certify that prior to the installation of the Environnement Automated Monitoring System (AMS) at the stack of the No 11 Nitric Acid plant in January 2006, no recording of all the parameters as required by AM0034 for implementing a CDM project activity was taking place. Thus the historic operational parameters required by AM0034 for implementing a CDM activity are unavailable, requiring the project participants to use plant design parameters as a substitute.

Yours sincerely


**L AUCAMP**NITRATES BUSINESS MANAGERNITRATES DEPARTMENTAELDirect Tel +27 11 606 3287Fax +27 11 606 2426E-mail [aucamp@ael.co.za](mailto:aucamp@ael.co.za)**Appendix 6. Summary of post registration changes****The following changes have been made to the PDD:****1. Template**

- The PDD was copied into the applicable template. This was not marked in track changes.

**2. Summary**

- Version number 1.c to 2
- Inserted completion date
- Name change African Explosives Ltd to AEL Mining Services Limited as previously accepted by UNFCCC
- Estimated amount of annual average GHG Emission reductions
- Addition of Nordic Environment Finance Corporation as project participant as previously accepted by UNFCCC

**3. A.4. Parties and project participants**

- Name change African Explosives Ltd to AEL Mining Services Limited as previously accepted by UNFCCC
- Addition of Norway as Party and Nordic Environment Finance Corporation as project participant as previously accepted by UNFCCC
- Addition of Switzerland as Party and N.serve Environmental Services GmbH as project participant as previously accepted by UNFCCC

**4. B.6.1 Explanation of methodological choices**

- Footnote 16: the statement was previously in Annex 6 and is now part of Appendix 5.

**5. B.6.2 Data and parameters fixed ex ante**

- "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." has been deleted as SABS is not always the designated auditor.
- Completed tables (mainly added "Purpose of data") as per new template

- Changed “Value(s) applied” to depict the values of the actual baseline for all relevant parameters.
- Added to “Additional comment” of B.1 NCSG<sub>BC</sub>, B.2 VSG<sub>BC</sub>, B.5 NAP<sub>BC</sub>, B.6 TSG, B.7 PSG, B.10 AFR, B.12 AIFR, B.16 OT<sub>h</sub>, B.18 OP<sub>h</sub>
- Source of data: B.5 NAP<sub>BC</sub>, B.18 OP<sub>h</sub>
- Choice of data: B.8 EF<sub>BL</sub>, B.9 UNC, B.13 CL<sub>BL</sub>, B.14 CL<sub>normal</sub>.
- Unit: B.10 AFR and B.11 AFR<sub>max</sub>

6. B.6.3 Ex ante calculation of emission reductions

- Changed tables and data to reflect actual baseline campaign
- Changed assumptions in section “Ex-ante calculation of Emission Reductions”

7. B.6.4 Summary of ex ante estimates of emission reductions

- Values of table updated

8. B.7.1 Data and parameters to be monitored

- SABS:
  - o Deleted “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.” from first paragraph as SABS is not always the designated auditor.
  - o Deleted reference from OH<sub>n</sub>, TSG, PSG, OP<sub>h</sub>, OT<sub>h</sub>, AFR, AIFR.
- Completed tables (mainly added “Purpose of data” and “Monitoring frequency”) as per new template

9. B.7.2 Sampling plan

- Added “not applicable” to sampling plan as per new template

10. B.8 Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

- Added names of the people responsible by now

11. Section F Approval and authorization

- Completed section F as per the new template.

12. Appendix 1

- Updated contact information and added details for new project participant

13. Appendix 5

- Merged former Annex 6 into Appendix 5, point 6

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**Document information**

| <i>Version</i> | <i>Date</i>    | <i>Description</i>  |
|----------------|----------------|---|
| 07.0           | 15 April 2016  | Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).  |
| 06.0           | 9 March 2015   | Revisions to: <ul style="list-style-type: none"> <li>• Include provisions related to statement on erroneous inclusion of a CPA;</li> <li>• Include provisions related to delayed submission of a monitoring plan;</li> <li>• Provisions related to local stakeholder consultation;</li> <li>• Provisions related to the Host Party;</li> <li>• Editorial improvement.</li> </ul>  |
| 05.0           | 25 June 2014   | Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-PDD</i> to <i>CDM-PDD-FORM</i>;</li> <li>• Editorial improvement.</li> </ul> |
| 04.1           | 11 April 2012  | Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b  |
| 04.0           | 13 March 2012  | Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).  |
| 03.0           | 26 July 2006   | EB 25, Annex 15   |
| 02.0           | 14 June 2004   | EB 14, Annex 06b  |
| 01.0           | 03 August 2002 | EB 05, Paragraph 12<br>Initial adoption.  |

Decision Class: Regulatory  
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Business Function: Registration  
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