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

CONTENTS

MONITORING REPORT
Version 01; 08/10/2012
YARA Köping S3 N_2O Abatement Project in Sweden
Reference Number: 0220
Monitoring period: Nr. 03, 04/01/2012 - 16/09/2012

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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

The sole purpose of the proposed project activity is to reduce former levels of N_2O emissions from the production of nitric acid at YARA's nitric acid plant Syra 3 at Köping, Sweden by the implementation of a secondary N_2O abatement catalyst.

2. Brief description of the installed technology and equipments

The project activity involves the installation of a new N_2O abatement technology: a pelleted catalyst that is installed inside the Ammonia Oxidation Reactor (AOR), underneath the precious metal gauzes. It was expected that this catalyst reduces approximately 90% of N_2O emissions on average over its lifetime.

The N_2O abatement catalyst applied to the proposed project has been developed by YARA.

For monitoring the N_2O emission levels, YARA Köping S3 has installed and operates an Automated Monitoring System according to EU standards.

YARA Köping adheres to ISO 9001 and ISO 14001 management standards[1] and will implement procedures for monitoring, regular calibrations and QA/QC in line with the requirements of these standards.

Table 1: Relevant Dates for the project activity

Date of Final Determination:	27/01/2012
Start of crediting period	01/05/2010
End of crediting period	31/12/2012
Starting date of project activity	12/10/2009
1st verification period	09/05/2010 – 06/05/2011
2nd verification period	07/05/2011 – 03/01/2012
3rd verification period	04/01/2012 – 16/09/2012
Installation of abatement catalyst for the 1st project campaign	06/05/2010
1st project campaign	09/05/2010 –02/11/2010
Installation of abatement catalyst for the 2nd	02/11/2010- 03/11/2010

---

[1] All quality management documents are stored on the internal YARA Köping database and will be made available to the AIEs upon request.

project campaign	
2nd project campaign	03/11/2010 – 06/05/2011
Installation of abatement catalyst for the 3rd project campaign	07/05/2011
3rd project campaign	07/05/2011 – 03/01/2012
Installation of abatement catalyst for the 4th project campaign	03/01/2012- 04/01/2012
4th project campaign	04/01/2012 – 16/09/2012

3. Total emission reductions achieved in this monitoring period

Table 2: Emission Reduction Units achieved distributed to Monitoring Periods

Project Campaign	ERUs
PC 4	**268,686**

Table 3: Emission Reduction Units achieved distributed to years

Project Campaign	ERUs
2012 (PC4)	**268,686**

A.2. Project Participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Sweden (host)	YARA AB (Sweden)	No
Netherlands	N.serve Environmental Services GmbH (Germany)	No

A.3. Location of the project activity:

The project activity is located in the municipality of Köping, Sweden.

Plant Coordinates[2]*:*

Ammonia burner: 59°29’53.71”N & 16°00’28.99”E
Tail gas stack: 59°29’53.40”N & 16°00’29.42”E

---

[2] Coordinates according to Google Earth©

A.4. Technical description of the project

The main parts of the plant as set up before the project implementation were the ammonia burner inside which the ammonia oxidation reaction takes place, the absorption tower where the gas mix from the burner is led through water in order to form nitric acid and the stack through which the off-gasses are vented into the atmosphere.

The precious metal gauze pack – i.e. the primary catalyst required for the formation of NO in the first step of the nitric acid production process – is manufactured by KAR Rasmussen, located in Norway and the same primary catalyst composition and supplier will continue is been used throughout the project crediting period with its two project campaigns.

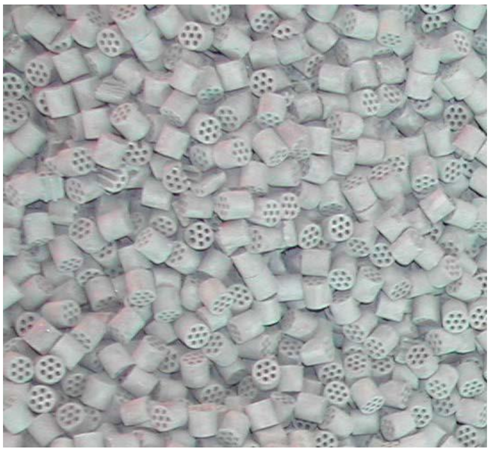
The project activity entails the implementation of:

- N_2O abatement technology inserted into the ammonia oxidation reactor; and
- Specialised monitoring equipment to be installed at the stack (detailed information on the AMS is contained in *Section C* and *Annex 1*)

1. Catalyst Technology

Following the measurement of a historic baseline to establish the factual emissions of the plant in the absence of any N_2O abatement technology, the basket was filled with a new batch of catalyst (approximately 1,400 kg) to achieve optimum abatement of N_2O.

Figure 1: Close up image of YARA secondary catalyst



YARA Köping S3 installed the YARA catalyst system, consisting of an additional base metal catalyst, below the standard precious metal gauze pack in the ammonia burner. Operation with the full batch of catalyst installed started on 09/05/2010.

A secondary catalyst reduce N_2O levels in the gas mix resulting from the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied effectiveness in N_2O abatement catalysts. The YARA abatement catalyst is made of cylindrical pellets containing cobalt as an active ingredient. The abatement efficiency has been shown to be more than 90% in the following reaction:

$$2\ N_2O \longrightarrow 2N_2 + O_2$$

If operated properly, the secondary catalyst system may significantly reduce N_2O emissions for up to three years before the catalyst material needs to be replaced.

The YARA abatement catalyst has been proven by industrial testing not to have any positive effect on plant production levels[3]. Also, only traces of the catalyst material at concentrations of parts per billion could be found in the nitric acid product[4].

No additional heat or other energy input is required, because the temperature levels present inside the ammonia oxidation reactor suffice to ensure the catalyst's optimum abatement efficiency. There are no additional greenhouse gases or other emissions generated by the reactions at the N_2O abatement catalyst.

2. N_2O abatement catalyst installation

The secondary catalyst itself can easily be installed during a routine plant shut-down and gauze change. The pellets are poured into the support basket / perforated plate arrangement and levelled. The gauze pack is then installed above the levelled catalyst pellets.

After the end of its useful life, the catalyst will be refined, recycled or disposed of according to EU regulations.

YARA's Köping S3 nitric acid plant operates at a pressure of around 4.8 bars inside the ammonia oxidation reactor. Through the introduction of the secondary catalyst into the ammonia reactor, a slight pressure drop (ΔP) is expected to occur. This ΔP may lead to a slight reduction in ammonia conversion efficiency and hence a very small reduction in nitric acid output. In practice, this loss of production is likely to be insignificant.

3. Technology operation and safety issues

The secondary abatement technology has been tested in several industrial trials and has proven to be a reliable and environmentally safe method of reducing N_2O.

Once installed, the catalyst and the AMS is been operated, maintained and supervised by the employees of YARA Köping according to standards that are normally used in the European industry.

Due to the long-term catalyst development phase, there is expert know-how readily available within the YARA group. Therefore, YARA Köping can be very confident that the effective operation of the catalyst technology, the operation of the monitoring system and the data collection, storage and processing is managed in accordance with the JI requirements. Adherence to the applicable standards is ensured by a thorough training session for the YARA employees involved.

---

[3] See the European IPPC Bureau publication „Integrated Pollution Prevention and Control; Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilizers (August 2007), page 124 therein.

[4] This has been proven in industrial testing. The underlying information is commercially sensitive and will be made available to the AIE mandated with the determination procedure upon request. General information on this question is contained in the European IPPC Bureau publication „Integrated Pollution Prevention and Control; Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilizers (August 2007), page 124 therein (available for downloading under http://eippcb.jrc.ec.europa.eu/pages/FActivities.htm)

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

>>

This project is based on Approved Baseline and Monitoring methodology AM0034 (Version 03.4): “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants”.

Furthermore, the project draws on approved baseline methodology AM0028 (Version 04.2) for the baseline scenario selection and employs the “Tool for the demonstration and assessment of additionality” (Version 05.2).

A.6. Registration date of the project activity:

>>

Determination reports are deemed valid since 27/01/2012.

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

>>

The crediting period for this project activity starts on 01/05/2010 and ends on 31/12/2012.

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

>>

Responsible for completing the monitoring report form:

Mr. Wolfgang Brückner

Contact details:

N.serve Environmental Services GmbH
Grosse Theaterstr. 14
20354 Hamburg

phone: +49 (0)40 309 97 86-16
fax: +49 (0)40 309 97 86-10
e-mail: brueckner@nserve.net

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

Table 4: Relevant Dates for the project activity

Date of Final Determination:	27/01/2012
Start of crediting period	01/05/2010
End of crediting period	31/12/2012
Starting date of project activity	12/10/2009
1st verification period	09/05/2010 – 06/05/2011
2nd verification period	07/05/2011 – 03/01/2012
3rd verification period	04/01/2012 – 16/09/2012
Installation of abatement catalyst for the 1st project campaign	06/05/2010
1st project campaign	09/05/2010 –02/11/2010
Installation of abatement catalyst for the 2nd project campaign	02/11/2010- 03/11/2010
2nd project campaign	03/11/2010 – 06/05/2011
Installation of abatement catalyst for the 3rd project campaign	07/05/2011
3rd project campaign	07/05/2011 – 03/01/2012
Installation of abatement catalyst for the 4th project campaign	03/01/2012 – 04/01/2012
4th project campaign	04/01/2012 – 16/09/2012

As to the characteristics of this specific project type certain production related events and incidents may affect the performance of the project or influence the monitoring of emission reductions in addition to possible failure of the installed monitoring equipment.

The tables below lists all relevant events and incidents related to production and/or emission monitoring which have occurred during actual operation within this specific monitoring period, as well as the measures taken for addressing any resulting problems and issues.

Historic Campaigns

Table 5: Plant Events for historic Campaigns 1 to 5

From	**To**	**Event**	**Explanation/Action**	**impact on data 1 = excluded 0 = none**
plant events	Historic campaigns			
2003.11.05		Plant stop	Gauze change	1

2004.04.19	2004.04.20	Plant stop	Gauze change	1
2004.05.23	2004.05.27	Plant stop	Overhaul	1
2004.06.21	2004.06.23	Trip due to	power supply	1
2004.07.12	2004.07.22	Stop	NOx leakage, boiler leakage	1
2004.08.07	2004.08.10	Planned stop E870		1
2004.08.11	2004.08.13	Stop	boiler leakage	1
2004.10.07		Plant stop	Gauze change (early shutdown due to problems with burner basket)	1
2004.11.05		Plant trip		1
2005.01.26		Plant stop	Gauze change	1
2005.05.04	2005.05.05	Ratio control?		1
2005.05.21	2005.06.08	Plant stop	Gauze change, overhaul	1
2005.06.09	2005.06.10	?		1

Baseline campaign

Table 6: Plant Events for the baseline campaign

From	**To**	**Event**	**Explanation/Action**	**impact on data 1 = excluded 0 = none**
plant events	Baseline campaign			
2009.12.18	2009.12.19	Trip due to	failure of instrumentation on air compressors	1
2010.01.27	2010.01.27	Planned stop to	clean air compressor	1
2010.03.16	2010.03.16	Planned stop to	clean air compressor and filter	1
2010.03.19	2010.03.19	Operator error	input wrong values into DCS	1

Table 7: AMS downtime periods for baseline campaign

From	**To**	**Event**	**Explanation/Action**	**impact on data 1 = no data 0 = none**
AMS downtime	Baseline campaign			
2010.01.13 07:00	2010.01.13 18:00	QAL test		1

Project Campaign 4

Table 8: Plant Events for project campaign 3

Plant events	**Project campaign 4**			
From	**To**	**Event/Reasons for downtime**	**Explanation/Action**	**impact on data** **1 = excluded** **0 = none**
2012.01.03 04:00	2012.01.04 02:00	plant downtime	gauze change and restart	1
2012.01.13 20:00	2012.01.14 03:00	plant downtime	Trip low temp in NH3 preheater	1
2012.02.12 09:00	2012.02.13 01:00	plant downtime	Cooling water leakage	1
2012.02.25 12:00	2012.02.25 18:00	plant downtime	-	1
2012.02.25 12:00	2012.02.25 18:00	plant downtime	-	1
2012.05.14 14:00	2012.05.15 22:00	no data at all available	-	1
2012.05.27 18:00	2012.05.27 23:00	plant downtime	Trip due to human error.	1
2012.05.28 01:00	2012.05.28 03:00	plant downtime	-	1
2012.07.09 22:00	2012.07.10 05:00	plant downtime	Trip due to thunder storm	1
2012.07.15 12:00	2012.07.16 16:00	plant downtime	Stop due to high storage and cleaning	1
2012.09.09 09:00	2012.09.16 22:00	plant downtime	Planned inspection stop	1
	2012.09.17	plant downtime	**gauze change**	1

Table 9: AMS downtimes and Maintenance deviations from BAU for project campaign 3

AMS downtime	**Project Campaign 4**			
From	**To**	**Event**	**Explanation/Action**	**impact on data** **1 = highest measured value** **2 = last valid hour** **0 = none**
2012.01.13 16:00	2012.01.14 01:00	Analyzer downtime	application of substitute value	1
2012.02.15 08:00	2012.02.15 14:00	Analyzer downtime	application of substitute value	1
2012.03.15 08:00		Analyzer downtime	application of substitute value	1
2012.05.10 08:00	2012.05.10 10:00	Analyzer downtime	application of substitute value	1
2012.06.12 11:00	2012.06.12 12:00	Analyzer downtime	application of substitute value	1
2012.06.13 09:00		Analyzer downtime	application of substitute value	1
2012.06.19 09:00		Analyzer downtime	application of substitute value	1
2012.06.19 11:00		Analyzer downtime	application of substitute value	1
2012.07.10 06:00	2012.07.10 08:00	Analyzer downtime	application of substitute value	1
2012.08.08 08:00	2012.08.08 10:00	Analyzer downtime	application of substitute value	1
2012.07.09 22:00	2012.07.10 08:00	Analyzer downtime	application of substitute value	1
periods in which the maintenance last longer than 1/3 of an hour				
2012.01.04 11:00	2012.01.04 12:00	maintenance signal below (2/3)	-	2
2012.01.19 07:00		maintenance signal below (2/3)	application of substitute value	2
2012.02.02 10:00		maintenance signal below (2/3)	application of substitute value	2
2012.02.16 11:00		maintenance signal below (2/3)	application of substitute value	2
2012.03.15 07:00		maintenance signal below (2/3)	application of substitute value	2
2012.03.29 07:00	2012.03.29 08:00	maintenance signal below (2/3)	application of substitute value	2
2012.04.12 08:00		maintenance signal below (2/3)	application of substitute value	2
2012.06.07 08:00		maintenance signal below (2/3)	application of substitute value	2
2012.06.12 13:00	2012.06.12 15:00	maintenance signal below (2/3)	application of substitute value	2
2012.06.13 10:00	2012.06.13 14:00	maintenance signal below (2/3)	application of substitute value	2
2012.06.19 10:00	2012.06.19 10:00	maintenance signal below (2/3)	application of substitute value	2
2012.07.05 11:00		maintenance signal below (2/3)	application of substitute value	2
2012.07.19 07:00		maintenance signal below (2/3)	application of substitute value	2
2012.08.02 08:00		maintenance signal below (2/3)	application of substitute value	2
2012.08.16 08:00		maintenance signal below (2/3)	application of substitute value	2
2012.08.31 13:00		maintenance signal below (2/3)	application of substitute value	3

B.2. Revision of the monitoring plan

>>

The monitoring plan has not been revised.

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

>>

No request for deviation was applied to this monitoring period.

B.4. Notification or request of approval of changes

>>

No request of approval changes.

SECTION C. Description of the monitoring system

>>

1. General Description of the AMS

From the shutdown and gauze change in mid-November 2009, YARA Köping S3 plant has been equipped with an EN 14181 compliant state of the art AMS consisting of a Dr. Födisch MCA 04 Continuous Emissions Analyser, a sample probe, heated filter and heated sample-line connected directly to the analyzer, and a Dr. Födisch FMD 99 Stack Gas Flow meter. The new analyzer is connected to the plant's existing data collection system (Emerson DeltaV).

Since this nitric acid plant has been in operation since 1982, YARA Köping's staff in general, and its instrument department in particular, is accustomed to operating technical equipment adhering to high quality standards.

During this monitoring period the following people have been responsible for the overall implementation of the project activity.

Table 10: Responsibilities and Staff in Charge

Responsibility	Persons
Overall implementation of the project	Mr. Pär Höök (Site Manager) Mr. Axel Sylvén (Process Engineer)
Quality assurance, operation and maintenance of the N_2O monitoring system installed at the plant	Mr. Axel Sylvén Mr. Jozef Meglic Mr. Andreas Whern

Operation, maintenance and calibration intervals are being carried out by staff from the instrument department according to the vendor's specifications and under the guidance of internationally relevant environmental standards, in particular EN 14181 (2004). Service will be performed by the supplier of the AMS. YARA has defined an AMS checking procedure schedule and will continue to plan ahead for the remaining years of the crediting period, strictly adhering to the relevant standards.

All monitoring procedures at YARA are also conducted and recorded in accordance with the procedures under ISO 9001 and ISO 14001, which is regularly audited by an independent auditing organisation accredited for ISO 9001 certification[5].

2. Sample points

The sample points were chosen in accordance with the AMS requirements, EN 14181 requirements and the plant design specifications to allow an optimum of data collecting quality. The location of the sample points for the N_2O measurement [NCSG] and tail gas flow measurements [VSG] was selected to provide ease of access in a location close to the analyser. The most suitable location at Köping S3 is downstream of the tail gas expander in an upwards-sloping diagonal straight section of the tail gas pipe.

This section of pipe is 10.9 m in length. The VSG sampling point is positioned at 5.6 m along this pipe, while the NCSG sampling point is located at 6.1 m. The calibration ports are a little further downstream in the same section of the pipe, at 6.85 m.

3. Analyser

The Dr. Födisch MCA 04 Continuous Emissions Analyser is capable of analysing N_2O concentration in gas mixtures. The analysis system MCA 04 is an extractive, continuous measuring system. It extracts a partial gas flow from the flue gas, which is led to the analyser through a heated line (all heated components of the measuring system are regulated at 185 °C). This state of the art gas sampling

---

[5] External auditor: DNV.

and conditioning system and the most advanced photometer technology ensure high reliability and long operating times with short maintenance intervals.

The MCA 04 is a single beam photometer. It is based on the absorption of infrared light. For the calculation of a component's concentration the measuring technology registers unattenuated and attenuated intensity in the range of absorption wave lengths. For measurement of N_2O, Gas filter correlation technique is used.

According to EN 14181 the Analyser is QAL1[6] tested for the measurement of all standard components that usually are measured in the waste gas of large combustion plants, waste incineration plants or mechanical biological waste treatment plants. The QAL1 tested components are: CO, NO, SO_2, HCl, NH_3, H_2O. The QAL1 test for N_2O has been completed and was published on 28/07/2010 in the German "Bundesanzeiger".[7]

The QAL2 test was conducted following commissioning of the analyser on 01/06/2010 and repeated on 19/06/2012 due to a correction of the gas density factor applied in the stack gas flow meter, which was required by YARA holding.

A hot extractive analyser was chosen in order to address a particular safety concern. Since the analyser will be installed downstream of the SCR unit where ammonia is used for NO_x abatement purposes, there is a possibility of the formation of ammonium nitrate/nitrite. In case of a cold measurement system, as usually applied in other plants, it is possible that due to the low temperature in the gas cooler and the analyser solid nitrate/nitrite deposits could block the sampling lines, harm the analyser and, in the worst case, lead to explosions when mechanically removed during maintenance works. In case of the MCA 04 analyser all parts of the system that come into contact with the waste gas are heated well above 180°C. Therefore no solid deposits of nitrate/nitrite are possible. At the moment no QAL1 tested NDIR-Analyser for N_2O is available on the market that fulfils the requirements of hot measurements according to the YARA internal safety rules.

4. Sample Conditioning System

As the gas sample is extracted, particles are removed with a heated filter unit at the sampling point and the clean sampling gas is delivered through a heated sampling line directly to the analyser in its cabinet, via the sampling pump. The temperature of the sampling gas is always maintained at 185 °C. The minimum flow rate to the analyser is controlled and connected to a general alarm. The alarm is connected to the data acquisition system.

5. Flow Meter

The Dr. Födisch FMD 99 measuring system allows continuous determination of the flow rate of stack gas. It is type tested to the guidelines of the German Federal Ministry for the Environment, Nature Conservation and Reactor Safety on suitability testing of measuring equipment for continuous measuring of emissions[8] and is therefore officially QAL1 approved.

The flow measuring device FMD 99 is a highly sensitive system for continuous, in-situ flow measurement of the exhaust gas. The differential pressure is continuously measured via the dynamic pressure probe of the FMD 99.

---

[6] TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A vom 13. Juli 2005.

[7] TÜV Rheinland Energie und Umwelt (report number 936/21211571/B from 25. 03.2010).

[8] TÜV Rheinland Sicherheit und Umweltschutz GmbH, Köln (report number 936/808 005/C vom 18. Februar 2000) and TÜV Immissionsschutz und Energiesysteme GmbH, Köln (report number 936/rö vom 15. Oktober 2003).

The signal resulting from the differential pressure is a degree of the velocity respective to the flow of the exhaust gas. The flow meter is combined with the internal measurement of the absolute stack gas pressure (PSG) and the stack gas temperature (TSG).

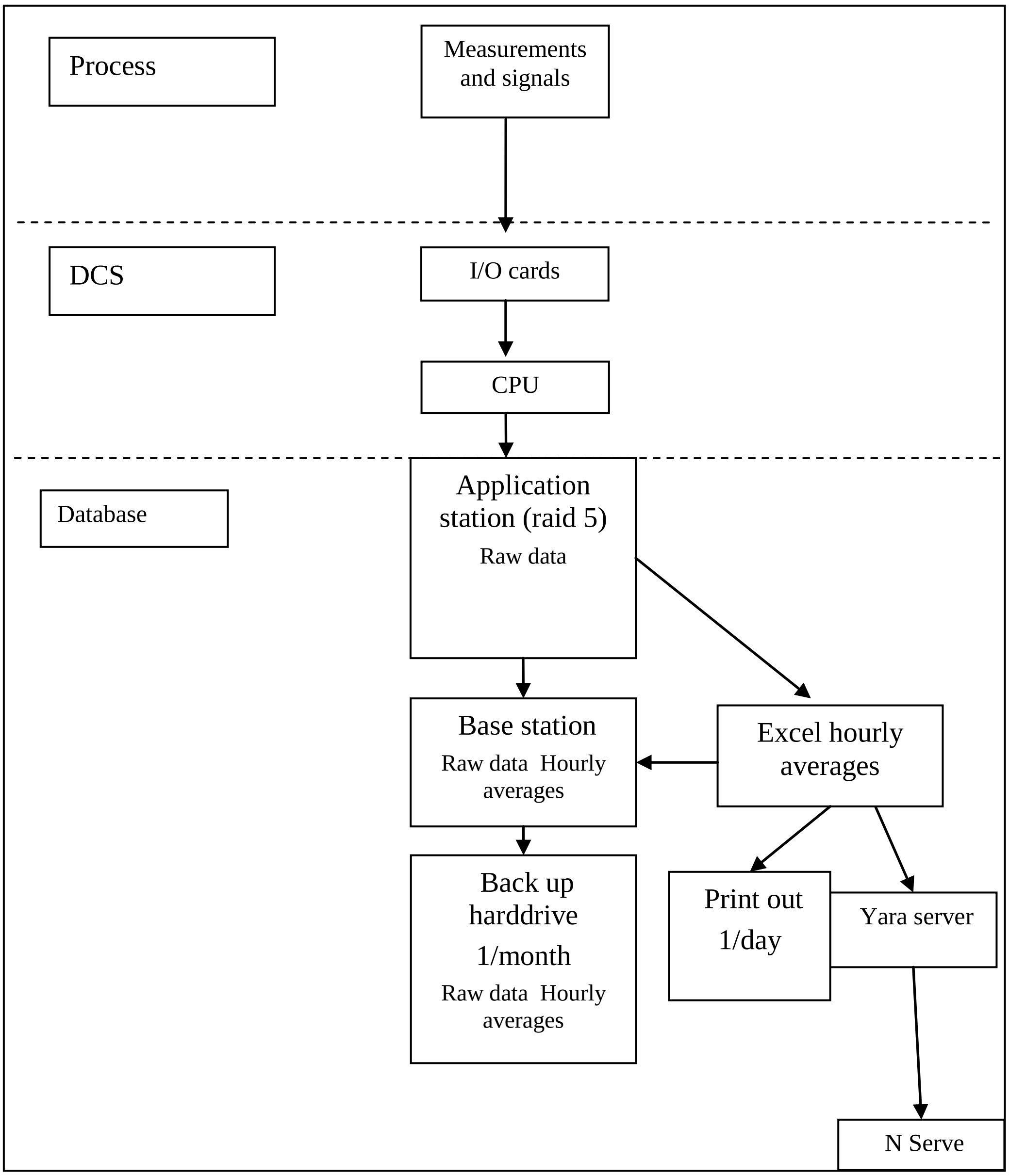
Linking this device with the Emerson DeltaV data acquisition system, the data flows can be converted from operating to standard conditions, taking into account the other flow parameters, such as temperature and pressure.

6. The data acquisition system

The YARA Köping S3 nitric acid plant is equipped with an Emerson DeltaV data collection and storage system that collects and stores the values for all the relevant monitoring parameters, as well as different status signals of the AMS and the NH_3 valve status signal from the nitric acid plant that defines whether or not the plant is in operation.

The data is stored simultaneously on 2 hard drives to prevent the loss of data in case one hard drive fails. Data that is directly related to plant operation, such as oxidation temperature, oxidation pressure, ammonia flow rate, ammonia to air ratio and nitric acid production rate, is also stored. The flow chart below shows this system in more detail:

Figure 2: flow chart of the data acquisition and storage system



7. Data evaluation

The nitric acid plant operator derives hourly averages for all of the monitored parameters from the Emerson DeltaV data management system. This data is exported to EXCEL-format and delivered by email or CD from the plant operator to N.serve, who is responsible for the correct analysis of the delivered data in accordance with the PDD.

At N.serve the received data is stored on the N.serve fileserver in a special section for the storage of monitoring data separately for each project. The files are protected against manipulation by a password. Mr Martin Stilkenbäumer at N.serve is currently responsible for the correct data handling and processing, but this may change throughout the course of the project crediting period.

After a first plausibility-check, the data is transferred to a special database system. All necessary calculations and steps of data analysis of the monitoring data according to AM 0034 regulations, as well as other regulations outlined in this PDD, are carried out by N.serve using the database tool.

The results of the data analysis are transferred to an Excel spreadsheet. The results are used for definition of Project emissions as well as for the preparation of the Monitoring reports.

8. AMS QA procedures

QAL 1

An AMS shall ideally 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. This standard's objective is to prove 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 the AMS. The AMS has to be tested in the laboratory and field.

The chosen Dr. Födisch MCA 04 gas analyser is QAL1 [9] tested for the measurement of all standard components that usually are measured in the waste gas of large combustion plants, waste incineration plants or mechanical biological waste treatment plants. The QAL1 tested components are: CO, NO, SO_2, HC1, NH_3, H_2O. The QAL1 test for N_2O has been completed and was published on 28/07/2010 in the German "Bundesanzeiger".[10] A hot extractive analyser was chosen in order to address a particular safety concern. As described above, this is a YARA internal safety precaution.

The chosen Dr. Födisch FMD 99 stack gas flow meter has fulfilled the requirements of the QAL1 and was successfully tested by TÜV Rheinland Sicherheit und Umweltschutz GmbH, Köln, Germany[11].

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 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 3 years according to EN 14181 (or following any major change to the monitoring system).

A calibration function is established from the results of a number of parallel measurements performed with a Standard Reference Method (SRM). The variability of the measured values obtained with the AMS is then evaluated against the required uncertainty. According to EN14181, both the QAL2

---

[9] TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A from 13. July 2005

[10] TÜV Rheinland Energie und Umwelt (report number 936/21211571/B from 25. 03.2010)

[11] TÜV Rheinland Sicherheit und Umweltschutz GmbH, Köln (report number 936/808 005/C vom 18. Februar 2000) and TÜV Immissionsschutz und Energiesysteme GmbH, Köln (report number 936/rö from 15. October 2003

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

The QAL2 test was conducted following commissioning of the analyser on 01/06/2010 and repeated on 19/06/2012 due to a correction of the gas density factor applied in the stack gas flow meter, which was required by YARA holding.

AST

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 with independent measurement equipment in parallel to the existing AMS. The AST tests are performed annually. If a full QAL2 test is performed (at least every 3 years), an additional AST test is not necessary in that same year.

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.

9. AMS calibration and QA/QC procedures

The monitoring equipment used to derive the N_2O emissions data for this project will be made part of the ISO 9001 procedures.

N_2O-Analyser Zero Adjustments/Calibration

Conditioned ambient air is used as reference gas for the zero check. The zero adjustment is conducted automatically every 24 hours. Manual checks are done at least once every four weeks. Zero adjustments or maintenance may be necessary depending on the results of the check (the calibration frequency might be adjusted if necessary).

N_2O-Analyser Span Adjustments/Calibration

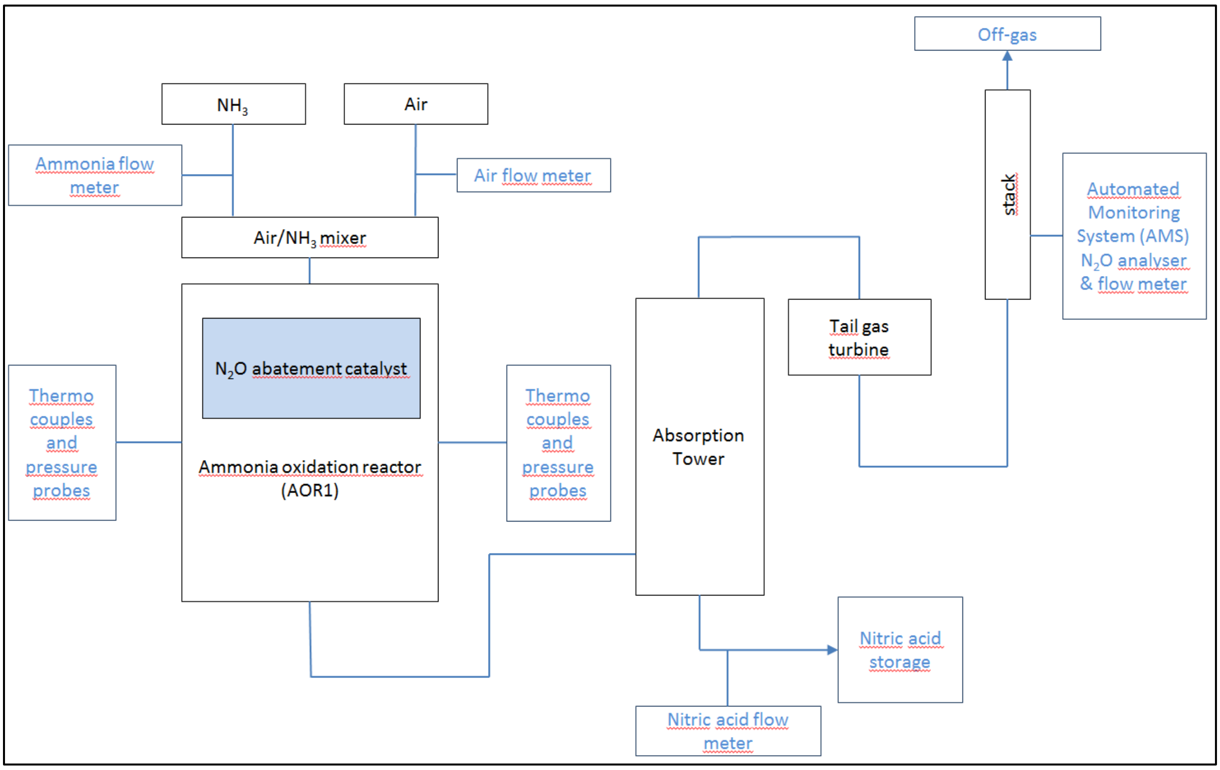
Manual span checks are done with certified calibration gas at least once every four weeks. Span adjustments or maintenance may be necessary depending on the results of the check (the calibration frequency might be adjusted if necessary).

The results and subsequent actions are all documented as part of the QAL3 documentation. In addition, the analyser room and equipment is visually inspected at least once a week and the results are documented in analyser specific log-books.

Flow meter calibration procedures

The flow meter FMD 99 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 Dr. Födisch FMD. It is checked regularly for the following: Visual check; electric check; cleaning of probe, if necessary. In addition the flow meter is checked during the QAL2 and AST tests by an independent laboratory by comparison to a standard reference method (SRM).

Figure 3: Monitoring Points for all relevant parameters (NCSG, VSG, TSG, PSG, NAP)



10. NAP measurement

At YARA Köping S3, the nitric acid production was usually monitored by a differential-pressure flow meter for continuous HNO_3-flow and HNO_3 concentration measurement. At the beginning of the crediting period the meter had been drifting and therefore has not been used anymore for NAP-measurement. Alternatively, the measured NH_3-inflow was combined with a conversion factor for calculating back the HNO_3 production to substitute the direct measurement for the time being.

For this monitoring period the new Flexim ultrasonic Piox TS374 measurement system has been used for data reporting. The system applies a precise bi-directional flow measurement and contains features to determine the concentration and density of the transported acid.

Therefore, the above mentioned mass balance calculation method was applied as cross-check procedure, as follows:

11. $$Production\ Syra\ 3 = \frac{Q_{801} * \rho_{NH3}}{K_2 * 1000}$$

Where:

Q_{801} = NH_3- inflow to the AORs in $Nm3/h$
ρ_{NH3} = Density of ammonia: 0.771 $kg/Nm3$.
K_2 = constant conversion factor (0.287 $kgNH3/kgHNO3$)

The results are provided in the “NAP” table of section D.2.

SECTION D. Data and parameters

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

The below data have been determined during the determination of the project. Please note that the final determination has not yet been concluded.

Data / Parameter:	**GWP_{N2O}**
Data unit:	**tCO_2e**
Description:	Global warming potential of nitrous oxide (N_2O)
Source of data used:	IPCC Second Assessment Report (1995); applicable according to UNFCCC-decision 2/CP.3, paragraph 3.
Value(s) :	310
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and Project Emissions
Additional comment:	After 2012 the GWP of N_2O will be 298, as defined by the IPCC Fourth Assessment Report in connection with Art 5 paragraph 3 Kyoto Protocol.

D.2. Data and parameters monitored in the historical campaigns, baseline scenario and project scenarios

Data that have been monitored during historical campaigns and baseline campaign

<table>
<tr><td>Data / Parameter:</td><td>$NCSG_{BC}$</td></tr>
<tr><td>Data unit:</td><td>mg/Nm^3</td></tr>
<tr><td>Description:</td><td>Mean N_2O concentration in the stack gas during the baseline campaign.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td></td></tr>
<tr><td>Source of data:</td><td>Dr. Födisch MCA 04 hot extractive analyzer</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Value applicable for regular project campaigns with $CL_{normal} \geq CL_{BL}$:

2,942.59</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Baseline emission calculations</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Type</td><td>Dr. Födisch MCA 04 hot extractive emissions analyzer</td></tr>
<tr><td>Serial</td><td>09125 / SNF 36 LWK</td></tr>
</table>
</td></tr>
</table>

	Number*:*	
	Calibration frequency:	Internal calibration: Weekly manual zero and span calibrations External calibrations QAL2 test at least every 3 years AST in years in between QAL2
	date of last calibrations	QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 – 22/06/2012 AST: 14/07/2011
	Validity	QAL2: 18/06/2016 AST: 18/06/2013
	Overall measurement accuracy	*± 0,51 % (ppm) (source: QAL2 reports 18/08/2010, 22/06/2012)*
Measuring/ Reading/ Recording frequency:		
Calculation method (if applicable):		
QA/QC procedures applied:	Plant internal procedure N°AGRI-26665. Application of QAL2 correction factors.	

Data / Parameter:	**VSG_{BC}**	
Data unit:	**Nm^3/h**	
Description:	Normal gas volume flow rate of the stack gas during the baseline campaign.	
Measured /Calculated /Default:	measured	
Source of data:	Dr. Födisch FMD 99	
Value(s) of monitored parameter:	**57,451**	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type	Dr. Födisch FMD 99 N
	Serial Number*:*	BR14160
	Calibration frequency:	Internal calibration: Weekly manual zero and span calibrations External calibrations QAL2 test at least every 3 years AST in years in between QAL2
	date of last calibrations	QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 – 22/06/2012 AST: 14/07/2011
	Validity	QAL2: 18/06/2016 AST: 18/06/2013

<table>
<tr><td></td><td><table><tr><td>Overall measurement accuracy</td><td><i>± 0,51 % (ppm) (source: QAL2 reports 18/08/2010, 22/06/2012)</i></td></tr></table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Continuously.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>The stack gas volume measurements are normalized to standard conditions by parallel measurement of temperature (TSG) and pressure (PSG) of the stack gas.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure AGRI-26665.
Application of QAL2 correction factors.</td></tr>
</table>

Data / Parameter:	**TSG**
Data unit:	**°C**
Description:	Temperature in the stack gas
Measured /Calculated /Default:	measured
Source of data:	Stack temperature probe situated directly next to the volume flow meter.
Value(s) of monitored parameter:	**N/A**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	continuously
Calculation method (if applicable):	Used for normalization of stack gas volume flow to standard conditions.
QA/QC procedures applied:	Plant internal procedure AGRI-26665. If malfunctioned, the thermocouples would be replaced.

Data / Parameter:	**PSG**
Data unit:	**bar**
Description:	Pressure in the stack
Measured /Calculated /Default:	measured
Source of data:	Stack pressure probe situated directly next to the volume flow meter.
Value(s) of monitored parameter:	**N/A**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type,	

accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	Continuously.
Calculation method (if applicable):	Used for normalization of stack gas volume flow to standard conditions.
QA/QC procedures applied:	Plant internal procedure AGRI-26665.

Data / Parameter:	**OH_{BC}**
Data unit:	**Hours**
Description:	Operating hours
Measured /Calculated /Default:	measured
Source of data:	Production log
Value(s) of monitored parameter:	**3,870**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures applied:	

Data / Parameter:	**NAP_{BC}**
Data unit:	**$tHNO_3$**
Description:	Metric tonnes of 100% concentrated nitric acid produced during the baseline campaign.
Measured /Calculated /Default:	Measured / Calculated.
Source of data:	1. Mass flow meter from AFR inflow: Rosemount 1151 DP Nitric acid flow meter 2. Nitric acid flow meter : Flexim Piox TS374 (used for cross check but not yet for official figures)
Value(s) of monitored parameter:	**62,866**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.

<table>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th></th><th>***Device***</th><th>***Device***</th></tr>
<tr><td>Type</td><td>Rosemount 1151 DP</td><td>Flexim Piox TS374</td></tr>
<tr><td>Serial Number*:*</td><td>*N/A*</td><td>*07460203*</td></tr>
<tr><td>Calibration frequency:</td><td>At stops > 6 h</td><td>Every 6 month</td></tr>
<tr><td>date of last calibration</td><td>N/A</td><td>21/06/2011
14/05/2012</td></tr>
<tr><td>Overall measurement accuracy</td><td>*±0.25% of 20-100% of flow (±0.2°C 5331) (source: manufacturer)*</td><td>*± 1.6% reading ± 0.01* m/s</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>hourly</td></tr>
<tr><td>Calculation method (if applicable):</td><td>
Since an accurate and reliable HNO_3 flow had not been yet installed at the beginning of the crediting period (the old flow meter often malfunctioned), the nitric acid production has been ascertained by means of a mass balance calculation, taking into account ammonia consumption measured by *the* ***Rosemount 1151 DP*** as follows:

$$Production\ Syra\ 3 = \frac{Q_{801} * \rho_{NH3}}{K_2 * 1000}$$

Where:

Q_{801} = NH_3- inflow to the AOR in Nm^3/h
ρ_{NH3} = Density of ammonia: 0.771 kg/ Nm^3.
K_2 = constant conversion factor (0.287 kg NH_3/kg HNO_3)

After installation and calibration of the Flexim Piox ultrasonic flow meter its figures have been used as a cross check of the calculated values. However, in all subsequent monitoring periods the Flexim system will be used as a primary device for NAP measurements while the calculation via ammonia inflow will be used as a method to cross check the meter.

The following method has been applied to determine the applicable conversion factor in the case of Syra 3:

Gas analyses undertaken over several years have been showing Ammonia - NOx-conversions of at least 94.5%, which can therefore be considered a conservative assumption of the gauze efficiency. Another gas analysis taken after the absorption column and right before the DeNOx unit which is placed before the tail gas stack has shown a NOx level of maximum 0.5 % in the tail gas.[12] This value has been deducted from the minimum gauze efficiency level and totals to a 94% ammonia – nitric acid conversion rate.[13]
</td></tr>
</table>

---

[12] The NOx in the tail gas, after having passed the DeNOx system, is been redirected to the nitric acid production process and will be converted to nitric acid. Assuming a 94% ammonia-nitric acid rate is therefore to be considered as conservative.

[13] Evidence was provided to the verifying entity during on-site visit.

	Given a 100% conversion rate 270 kg NH_3would be consumed for the production of 1 tonne of nitric acid (chemically ideal consumption). The conversion rate of 94 % is divided by the ideal consumption rate resulting in conversion factor of 287 kg per produced tonne of Nitric Acid.
QA/QC procedures applied:	Plant internal procedure N° AGRI-26594

Table 11: Establishment of NH_3-conversion factor

	Syra 3
Gauze efficiency	94.5
NOX slip (to De-Nox level)	0.5%
TOT	94%
Ideal consumption NH_3/HNO_3	0.270
NH_3conversion factor	**0.287**

The results of the calculation method were cross checked against the quantity of HNO_3 exported off-site (SAP billing information), the quantity of ammonium nitrate produced from nitric acid on-site and the tank level measurements.[14]

Data / Parameter:	**UNC**
Data unit:	**%**
Description:	Calculated uncertainty of the overall Automated Monitoring System (AMS)
Measured /Calculated /Default:	calculated
Source of data:	Calculation of combined uncertainty of the applied monitoring equipment
Value(s) of monitored parameter:	5.48
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	According to QAL2 report M84 153/4 with measurement date 01/06/2010.
QA/QC procedures applied:	

Data / Parameter:	**AFR**

---

[14] Evidence was provided to the verifying entity during on-site visit.

Data unit:	**$kgNH_3/h$**
Description:	Mean Ammonia gas flow rate to the ammonia oxidation reactor
Measured /Calculated /Default:	measured
Source of data:	Mass flow transmitters
Value(s) of monitored parameter:	**Not applicable, monitored data of AFR is used to determine if plant was operating outside of AFR_{max}.**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Historic campaigns No. one to five provided the data for the determination of AFR_{max}.
Measuring/ Reading/ Recording frequency:	Continuously.
Calculation method (if applicable):	N/A
QA/QC procedures applied:	Plant internal procedures AGRI-25391, AGRI-25417. There is one orifice meter installed with two parallel transmitters, continuously measuring the AFR. In case of a malfunctioning of one of the transmitters the plant trips. There is no possibility to start up the plant again since two functioning transmitters are required as part of the safety system. The transmitters are checked during downtime periods of more than 6 hours.

Data / Parameter:	**AFR_{max}**
Data unit:	**tNH_3/h**
Description:	Maximum Ammonia gas flow rate to the ammonia oxidation reactor
Measured /Calculated /Default:	measured
Source of data:	AFR data from historic campaigns
Value(s) of monitored parameter:	**6,303.60**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	continuously
Calculation method (if applicable):	Calculated from the Historic campaigns No. one to five.

QA/QC procedures applied:	See AFR.

Data / Parameter:	**AIFR**
Data unit:	% V/V
Description:	Mean Ammonia to air ratio into the ammonia oxidation reactor
Measured /Calculated /Default:	calculated
Source of data:	Measurements of AFR and primary air flow rates
Value(s) of monitored parameter:	**Not applicable, monitored data of AIFR will be used to determine if plant was operating outside of AIFR$_{max}$.**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See AFR.
Measuring/ Reading/ Recording frequency:	See AFR.
Calculation method (if applicable):	Calculated from the Historic campaigns No. one to five.
QA/QC procedures applied:	See AFR.

Data / Parameter:	**AIFR$_{max}$**
Data unit:	% V/V
Description:	Maximum Ammonia to air ratio into the ammonia oxidation reactor.
Measured /Calculated /Default:	
Source of data:	AIFR
Value(s) of monitored parameter:	10.72
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See AFR.
Measuring/ Reading/ Recording frequency:	See AFR.
Calculation method (if applicable):	Calculated from the Historic campaigns No. one to five.
QA/QC procedures applied:	See AFR.

Data / Parameter:	**CL$_{BL}$**
Data unit:	**tHNO$_3$**

<table>
<tr><td>Description:</td><td>Length of the baseline campaign measured in metric tonnes of 100% concentrated nitric acid produced during the baseline campaign.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>N/A</td></tr>
<tr><td>Source of data:</td><td>NAP_{BC}</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>**62,866**</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Baseline emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th></th><th>***Device***</th><th>***Device***</th></tr>
<tr><td>Type</td><td>Rosemount DP 1151</td><td>Flexim Piox TS374</td></tr>
<tr><td>Serial Number*:*</td><td>*N/A*</td><td>*07460203*</td></tr>
<tr><td>Calibration frequency:</td><td>At stops > 6 h</td><td>Every 6 month</td></tr>
<tr><td>Date of last calibration</td><td>N/A</td><td>21/06/2011
14/05/2012</td></tr>
<tr><td>Overall measurement accuracy</td><td>*±0.25% of 20-100% of flow (±0.2°C 5331) (source: manufacturer)*</td><td>*± 1.6% reading ± 0.01* m/s</td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>hourly</td></tr>
<tr><td>Calculation method (if applicable):</td><td>See NAP_{BC}</td></tr>
<tr><td>QA/QC procedures applied:</td><td>See NAP_{BC}</td></tr>
</table>

Data / Parameter:	**CL_{normal}**
Data unit:	**$tHNO_3$**
Description:	Average length of the historic campaigns measured in metric tonnes of 100% concentrated nitric acid produced.
Measured /Calculated /Default:	measured
Source of data:	Production logs
Value(s) of monitored parameter:	**53,536.36**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A

Calculation method (if applicable):	Calculated from the Historic campaigns No. one to five.
QA/QC procedures applied:	N/A

<table>
<tr><td>Data / Parameter:</td><td>OT_h</td></tr>
<tr><td>Data unit:</td><td>°C</td></tr>
<tr><td>Description:</td><td>Oxidation temperature in the ammonia oxidation reactors (AOR).</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>measured</td></tr>
<tr><td>Source of data:</td><td>Thermocouple inside Ammonia Oxidation Reactors (AOR)</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Used to determine whether OT_h during baseline campaign falls outside OT_{normal}.</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Baseline emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td></td><td><i>Device</i></td></tr>
<tr><td>Type</td><td>PR electronics 5111</td></tr>
<tr><td>Serial Number<i>:</i></td><td>N/A</td></tr>
<tr><td>Calibration frequency:</td><td>At stops > 6 h (exchange of thermocouples)</td></tr>
<tr><td>Overall measurement accuracy</td><td>± 0.5°C <i>(source: manufacturer)</i></td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>continuously</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Thermocouples are replaced in case of malfunctioning.</td></tr>
</table>

Data / Parameter:	**OT_{normal}**
Data unit:	**°C (min and max)**
Description:	Normal range operating temperature during the historic campaigns
Measured /Calculated /Default:	
Source of data:	Thermocouples inside Ammonia Oxidation Reactor (AOR)
Value(s) of monitored parameter:	**892.5 (min.) and 902.9 (max.)** *)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last	thermocouples

calibration, validity)	
Measuring/ Reading/ Recording frequency:	continuously
Calculation method (if applicable):	Historic campaign No. one to five provided the underlying data. *) Historic data was re-evaluated excluding start up and shutdown periods. As a consequence the results for normal operating conditions may differ from the values indicated in the PDD.
QA/QC procedures applied:	Thermocouples are replaced in case of malfunctioning.

Data / Parameter:	**OP_h**
Data unit:	**Bar**
Description:	Oxidation Pressure for each hour.
Measured /Calculated /Default:	measured
Source of data:	Pressure transmitter on the ammonia oxidation reactor (AOR)
Value(s) of monitored parameter:	Used to determine whether OP_h during baseline campaign falls outside OP_{normal}.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**OP_{normal}**
Data unit:	**kPa**
Description:	Oxidation Pressure for each hour during the five historic campaigns.
Measured /Calculated /Default:	calculated
Source of data:	Pressure transmitter on the ammonia oxidation reactor (AOR)
Value(s) of monitored parameter:	**404.8 (min.) and 495.5 (max.)** *)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Historic campaigns No. one to five provided the underlying data. *) Historic data was re-evaluated excluding start up and shutdown periods. As a consequence the results for normal operating conditions may differ from the values indicated in the PDD.

Measuring/ Reading/ Recording frequency:	continuously
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**GS_{normal}**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the five historic campaigns
Measured /Calculated /Default:	Monitored / Invoices
Source of data:	
Value(s) of monitored parameter:	**K.A. Rasmussen Norway**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Historic campaigns No. one to five provided the underlying data.
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**GS_{BL}**
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the baseline condition campaign
Measured /Calculated /Default:	Monitored / Invoices
Source of data:	
Value(s) of monitored parameter:	**K.A. Rasmussen Norway**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if	N/A

applicable):	
QA/QC procedures applied:	N/A

Data / Parameter:	**GC_{normal}**
Data unit:	**%**
Description:	Gauze composition during the 5 historic operating campaigns expressed as percentage by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Measured /Calculated /Default:	Monitored
Source of data:	Gauze supplier invoices
Value(s) of monitored parameter:	Baseline emission calculations.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Historic campaigns No. one to five provided the underlying data. *) The exact gauze composition differs during the 5 relevant historic campaigns. Therefore, the applied values are averaged and rounded from the underlying gauze compositions.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**GC_{BL}**
Data unit:	**%**
Description:	Gauze composition during the baseline campaign expressed as percentage by weight of the precious metals Platinum, Rhodium and Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Measured /Calculated /Default:	monitored
Source of data:	Gauze supplier invoices
Value(s) of monitored parameter:	**This information is kept strictly confidential. Evidence has been provided to the verifying AIE.**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/	N/A

Recording frequency:	
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**EF_{reg}**
Data unit:	**$tN_2O/tHNO_3$**
Description:	N_2O Emissions cap for N_2O from nitric acid production set by national government regulation.
Measured /Calculated /Default:	monitored
Source of data:	N/A
Value(s) of monitored parameter:	N/A
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline / Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**BE_{BC}**
Data unit:	**kgN_2O**
Description:	Total N_2O mass flow during baseline campaign.
Measured /Calculated /Default:	Calculation from measured data.
Source of data:	N/A
Value(s) of monitored parameter:	Value applicable for **regular project campaigns** exceeding CL_{normal} or CL_{BL}: **654.241**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A

Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**EF_{BL}**
Data unit:	**$kgN_2O / tHNO_3$**
Description:	N_2O Emission factor for baseline period
Measured /Calculated /Default:	Calculated from measured data (tons of N_2O emitted / tons of nitric acid produced)
Source of data:	
Value(s) of monitored parameter:	Value applicable for **regular project campaigns** exceeding CL_{normal} or CL_{BL}: **9.8367**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations. Please note that the preliminary baseline emissions factors reported in the PDD were different from the final and verified baseline emissions factors presented above. This is mainly due to the data basis at determination which consisted of only some spot measurements taken between June 2005 and April 2007. Those were combined with predicted abatement efficiency for the estimations in the PDD. Additionally, the QAL2 factors for NCSG and VSG had not been applied to the PDD EF_{BL} values.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data that have been monitored during project campaigns

<table>
<tr><td>Data / Parameter:</td><td>NCSG</td></tr>
<tr><td>Data unit:</td><td>mg /Nm^3</td></tr>
<tr><td>Description:</td><td>Mean N_2O concentration in the stack gas during each project campaign.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured/Calculated - every 2 sec. used for calculation of campaign mean (average, after exclusion of extreme values and outliers)</td></tr>
<tr><td>Source of data:</td><td>Dr. Födisch MCA04 hot extractive emissions analyzer</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td><table><tr><th>Time period</th><th>value</th></tr><tr><td>PC 4</td><td>333.57</td></tr></table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
</table>

<table>
<tr>
<td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td>
<td>
<table>
<tr><td>Type</td><td>Dr. Födisch MCA 04 hot extractive emissions analyzer</td></tr>
<tr><td>Serial Number<i>:</i></td><td>09125 / SNF 36 LWK</td></tr>
<tr><td>Calibration frequency:</td><td>Internal calibration: Weekly manual zero and span calibrations
External calibrations QAL2 test at least every 3 years
AST in years in between QAL2</td></tr>
<tr><td>Date of last calibrations</td><td>QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 – 22/06/2012
AST: 14/07/2011</td></tr>
<tr><td>Validity</td><td>QAL2: 18/06/2016
AST: 18/06/2013</td></tr>
<tr><td>Overall measurement accuracy</td><td>± <i>0.51 % (ppm) (source: QAL2 reports 18/08/2010, 22/06/2012)</i></td></tr>
</table>
</td>
</tr>
<tr>
<td>Measuring/ Reading/ Recording frequency:</td>
<td>Continuously (every 2 seconds).</td>
</tr>
<tr>
<td>Calculation method (if applicable):</td>
<td>

NCSG is continuously monitored and recorded every 2 seconds. Hourly mean values for NCSG are derived from the collected data. NCSG data taken during times when the respective plant was out of operation are eliminated.

The analyser reads ppmv (parts per million in volume); in order to obtain mg/Nm^3 the values are transferred by application of the following equation:

$$NCSG = ppmv * \frac{RMM}{v}$$

Where:

<table>
<tr><td><i>NCSG</i>:</td><td>N_2O concentration in the stack gas (mg/Nm^3)</td></tr>
<tr><td><i>ppmv:</i></td><td>parts per million in volume</td></tr>
<tr><td><i>RMM:</i></td><td>relative molecular mass of N_2O (44.013 mg)</td></tr>
<tr><td><i>v</i> :</td><td>standard volume of an ideal gas (22.4 Nm^3)</td></tr>
</table>

The resulting hourly average NCSG values are now expressed in mg/Nm^3 as required by AM0034. Subsequently the following statistical analysis is applied:

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

</td>
</tr>
</table>

<table>
<tr><td></td><td>Before being fed to the above statistical analysis a correction factor as determined during the latest QAL2 test is applied to each hourly average value for NCSG.
QAL2 correction factor for NCSG:
<table>
<tr><th>Time Period</th><th>value</th></tr>
<tr><td>PC4 (04/01/2012 - 19/06/2012)</td><td>1.16</td></tr>
<tr><td>PC4 (19/06/2012 - 16/09/2012)</td><td>1.01</td></tr>
</table></td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure AGRI-26665.
Manual zero and span calibrations, AST and QAL2 test according to EN 14181. <i>QAL3 procedures according to EN 14181 applied through documentation and evaluation on site.</i></td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>VSG</td></tr>
<tr><td>Data unit:</td><td>Nm^3/h</td></tr>
<tr><td>Description:</td><td>Normal gas volume flow rate of the stack gas during each project campaign.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured/Calculated - every 2 sec. used for calculation of campaign mean (average, after exclusion of extreme values and outliers)</td></tr>
<tr><td>Source of data:</td><td>Gas Volume Flow meter, Dr. Födisch FMD 99</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th>Time Period</th><th>value</th></tr>
<tr><td>PC4</td><td>52,052.68</td></tr>
</table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Type</td><td>Dr. Födisch FMD 99 N (updated to FMD 09 in June 2012)</td></tr>
<tr><td>Serial Number<i>:</i></td><td>BR14160</td></tr>
<tr><td>Calibration frequency:</td><td>Internal calibration: Weekly manual zero and span calibrations
External calibrations QAL2 test at least every 3 years
AST in years in between QAL2</td></tr>
<tr><td>Date of last calibrations</td><td>QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 – 22/06/2012
AST: 14/07/2011</td></tr>
<tr><td>Validity</td><td>QAL2: 18/06/2016
AST: 18/06/2013</td></tr>
<tr><td>Overall measurement accuracy</td><td>± <i>0.51 % (ppm) (source: QAL2 reports 18/08/2010, 22/06/2012)</i></td></tr>
</table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Continuously (every 2 seconds).</td></tr>
</table>

<table>
<tr>
<td>Calculation method (if applicable):</td>
<td>
<p>VSG is continuously monitored with a flow meter and monitoring results are recorded continuously (every 2 seconds).</p>
<p>The Measuring System works according to the principle of mechanical effect. The probe has two different chambers, between which a pressure difference, caused by the flow in the duct, builds up. The differential pressure resulting at the probe is proportional to the square of the gas speed. Due to the probe’s special shape, a highest possible differential pressure is produced, whereby the linearity of the measuring signal is guaranteed.</p>
<p>The resulting hourly average values for VSG are now expressed in Nm^3/h as required by AM0034 and are subjected to the following statistical analysis:</p>
<p>a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining VSG values</p>
<p>Before being fed to the above statistical analysis a correction factor as determined during the latest QAL2 test is applied to each hourly average VSG value.</p>
<p>QAL 2 correction factor for VSG:</p>
<table>
<tr><th>Time Period</th><th>value</th></tr>
<tr><td>PC4 (04/01/2012 - 19/06/2012)</td><td>0.89</td></tr>
<tr><td>PC4 (19/06/2012 - 16/09/2012)</td><td>0.87</td></tr>
</table>
</td>
</tr>
<tr>
<td>QA/QC procedures applied:</td>
<td>
<p>Plant internal procedure AGRI-26665.</p>
<p>The flow meter is calibrated annually by AST and QAL2 test according to EN 14181.</p>
</td>
</tr>
</table>

Data / Parameter:	**TSG**
Data unit:	**°C**
Description:	Temperature in the stack gas
Measured /Calculated /Default:	Measured.
Source of data:	Stack temperature probe located directly next to the volume flow meter;
Value(s) of monitored parameter:	Not applicable, directly used for normalization of tail gas volume flow measurement.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial	

<table>
<tr><td>number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Type</td><td>Dr. Födisch FMD 99 N (updated to FMD 09 in June 2012)</td></tr>
<tr><td>Serial Number<i>:</i></td><td>BR14160</td></tr>
<tr><td>Calibration frequency:</td><td>Internal calibration: Weekly manual zero and span calibrations
External calibrations QAL2 test at least every 3 years
AST in years in between QAL2</td></tr>
<tr><td>date of last calibration</td><td>QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 – 22/06/2012
AST: 14/07/2011</td></tr>
<tr><td>Validity</td><td>QAL2: 18/06/2016
AST: 18/06/2013</td></tr>
<tr><td>Overall measurement accuracy</td><td><i>± 0.51 % (ppm) (source: QAL2 reports 18/08/2010, 22/06/2012)</i></td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Continuously (every 2 seconds).</td></tr>
<tr><td>Calculation method (if applicable):</td><td>Not applicable.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure AGRI-26665.
The QAL2 test as well as the AST 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 (as displayed by the flow meter transmitter at the stack) with the results of the reference measurement instruments of the testing laboratory. Moreover during the QAL2 and AST tests 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.
QAL 2 correction factor for VSG:
<table>
<tr><th>Time Period</th><th>value</th></tr>
<tr><td>PC4 (04/01/2012 - 19/06/2012)</td><td>1.01</td></tr>
<tr><td>PC4 (19/06/2012 - 16/09/2012)</td><td>1</td></tr>
</table>
</td></tr>
</table>

Data / Parameter:	**PSG**
Data unit:	**Bar**
Description:	Pressure in the stack
Measured /Calculated /Default:	Measured.
Source of data:	Stack temperature probe situated directly next to the volume flow meter.
Value(s) of monitored parameter:	Not applicable, directly used for normalization of tail gas volume flow measurement.
Indicate what the data are used for (Baseline/ Project/	Project emission calculations.

<table>
<tr><td>Leakage emission calculations)</td><td></td></tr>
<tr><td></td><td>
<table>
<tr><td>Type</td><td>Dr. Födisch FMD 99 N (updated to FMD 09 in June 2012)</td></tr>
<tr><td>Serial Number<i>:</i></td><td>BR14160</td></tr>
<tr><td>Calibration frequency:</td><td>Internal calibration: Weekly manual zero and span calibrations
External calibrations QAL2 test at least every 3 years
AST in years in between QAL2</td></tr>
<tr><td>date of last calibration</td><td>QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 – 22/06/2012
AST: 14/07/2011</td></tr>
<tr><td>Validity</td><td>QAL2: 18/06/2016
AST: 18/06/2013</td></tr>
<tr><td>Overall measurement accuracy</td><td><i>± 0.51 % (ppm) (source: QAL2 reports 18/08/2010, 22/06/2012)</i></td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Continuously (every 2 seconds).</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure AGRI-26665.
The QAL2 test as well as the AST 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 (as displayed by the flow meter transmitter at the stack) with the results of the reference measurement instruments of the testing laboratory. Moreover during the QAL2 and AST tests 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.
QAL 2 correction factor for VSG:
<table>
<tr><th>Time Period</th><th>value</th></tr>
<tr><td>PC4 (04/01/2012 - 19/06/2012)</td><td>1.00</td></tr>
<tr><td>PC4 (19/06/2012 - 16/09/2012)</td><td>1.01</td></tr>
</table>
</td></tr>
</table>

Data / Parameter:	**PE_n**
Data unit:	**kgN_2O**
Description:	Total mass N_2O emissions in each project campaign.
Measured /Calculated /Default:	Calculated.
Source of data:	Calculated from measured values.

Value(s) of monitored parameter:	Time Period: PC 4 value: 101,836.54
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	$PE_n = NCSG * VSG * OH * 10^{-6}$ Where: PE_n Total N_2O emissions during the specific production campaign $(kgN2O)$ VSG Mean tail gas volume flow rate during the production campaign (Nm^3/h) NCSG Mean concentration of N_2O in the tail gas stream during the production campaign $(mgN2O/m^3)$ OH Operational hours (h)
QA/QC procedures applied:	N/A

Data / Parameter:	**OH_n**
Data unit:	**Hours**
Description:	Total operating hours during each project campaign
Measured /Calculated /Default:	Measured.
Source of data:	Production log.
Value(s) of monitored parameter:	Time Period: PC 4 value: 5,865
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	Hourly.
Calculation method (if applicable):	Every hour of operation for which there is a record of nitric acid produced will be considered as an operational hour for the purposes of PE calculation. However, if the plant exceeds certain design parameters, it will automatically shut down (“trip limits”). Periods during the ongoing campaign during which the plant was considered not in operation will be eliminated from the determination of OH. The

	plant was considered to be not in operation when any of the following parameters are recorded outside the “trip” limits as determined by the plant manuals: upper limit $AIFR_{trip}$: 11.5 % lower limit OT_h: 830 °C upper limit OT_h: 925 °C (These values for lower limit OT_h were chosen arbitrarily with a view to capture and exclude such values that where obviously not valid or nonsensical.)
QA/QC procedures applied:	N/A

<table>
<tr><td>Data / Parameter:</td><td>NAP_n</td></tr>
<tr><td>Data unit:</td><td>$tHNO_3$</td></tr>
<tr><td>Description:</td><td>Metric tonnes of 100% concentrated nitric acid during each project campaign.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured / Calculated.</td></tr>
<tr><td>Source of data:</td><td>1. Nitric acid flow measurement system :
Flexim Piox TS374</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>
<table>
<tr><th>Time period</th><th>Value</th><th>device</th></tr>
<tr><td><i>PC4</i></td><td>94,528.79</td><td>Flexim Piox TS374</td></tr>
</table>
</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><th></th><th><i>Device 1</i></th><th><i>Device 2(cross check)</i></th></tr>
<tr><td>Type</td><td>Flexim Piox TS374</td><td>Rosemount 3051 CD2</td></tr>
<tr><td>Serial Number<i>:</i></td><td><i>07460203</i></td><td><i>N/A</i></td></tr>
<tr><td>Calibration frequency:</td><td>Every 6 month</td><td>At stops > 6 h</td></tr>
<tr><td>dates of last calibration</td><td>20/12/2011
14/05/2012</td><td>N/A</td></tr>
<tr><td>Overall measurement accuracy</td><td><i>± 1.6% reading ± 0.01</i> m/s</td><td><i>±0.075% of span (source: manufacturer)</i></td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>hourly</td></tr>
<tr><td>Calculation method (if applicable):</td><td>NAP cap
According to the PDD the maximum amount of nitric acid that can be produced on an annual basis is 134,000 $tHNO_3$. In 2012 an overall amount of 2,363 $tHNO_3$ (MP2) plus 94,528.79 $tHNO_3$ (MP3) totalling to 96,891.79 $tHNO_3$ have been produced. Since the production has not yet exceeded the benchmark no cap had to be implemented.</td></tr>
</table>

NAP measurement cross-check

Since an accurate and reliable HNO_3 flow meter had not yet been installed at the beginning of the crediting period (the old flow meter often malfunctioned), the nitric acid production has been ascertained by means of a mass balance calculation, taking into account ammonia consumption measured by *the* ***Rosemount 3051 CD2*** as follows:

$$Production\ Syra\ 3 = \frac{Q_{801} * \rho_{NH3}}{K_2 * 1000}$$

Where:

Q_{801} = NH_3- inflow to the AOR in Nm^3/h
ρ_{NH3} = Density of ammonia: 0.771 kg/ Nm^3.
K_2 = constant conversion factor (0.287 kg NH_3/kg HNO_3)

After installation and calibration of the Flexim Piox ultrasonic flow measurement system its figures have been used as a cross check of the calculated values. It has now been used as a primary device for NAP measurements while the calculation via ammonia inflow has been applied as a method to cross check the measurement system.

The cross check for this monitoring period results in the following amount of nitric acid produced:

96,476 $tHNO_3$ (100% concentration)

The following method has been applied to determine the applicable conversion factor in the case of Syra 3:

Gas analyses undertaken over several years have been showing Ammonia - NOx-conversions of at least 94.5%, which can therefore be considered a conservative assumption of the gauze efficiency. Another gas analysis taken after the absorption column and right before the DeNOx unit which is placed before the tail gas stack has shown a NOx level of maximum 0.5 % in the tail gas.[15] This value has been deducted from the minimum gauze efficiency level and totals to a 94% ammonia – nitric acid conversion rate.[16]

Given a 100% conversion rate 270 kg NH_3would be consumed for the production of 1 tonne of nitric acid (chemically ideal consumption). The conversion rate of 94 % is divided by the ideal consumption rate resulting in conversion factor of 287 kg per produced tonne of Nitric Acid.

Table 12: Establishment of NH_3-conversion factor

	Syra 3

---

[15] The NOx in the tail gas, after having passed the DeNOx system, is been redirected to the nitric acid production process and will be converted to nitric acid. Assuming a 94% ammonia-nitric acid rate is therefore to be considered as conservative.

[16] Evidence was provided to the verifying entity during on-site visit.

<table>
<tr><td></td><td><table>
<tr><td>Gauze efficiency</td><td>94.5</td></tr>
<tr><td>NOx slip (to De-NOx level)</td><td>0.5%</td></tr>
<tr><td>TOT</td><td>94%</td></tr>
<tr><td>Ideal consumption NH_3/HNO_3</td><td>0.270</td></tr>
<tr><td>NH_3conversion factor</td><td>0.287</td></tr>
</table></td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure N° AGRI-26594.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>EF_n</td></tr>
<tr><td>Data unit:</td><td>$kgN_2O/tHNO_3$</td></tr>
<tr><td>Description:</td><td>Emissions factor for production campaign n.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Calculated.</td></tr>
<tr><td>Source of data:</td><td>Calculation from total mass N_2O emissions of campaign n (PE_n) and total nitric acid production (NAP_n).</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td><table>
<tr><td>Time Period</td><td>value</td></tr>
<tr><td>PC 4</td><td>1.07731</td></tr>
</table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>N/A</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>N/A</td></tr>
<tr><td>Calculation method (if applicable):</td><td>The campaign specific emissions factor for each campaign during the project’s crediting period is calculated by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign. For campaign <i>n</i> the campaign specific emission factor is:
$EF_n = \left({PE_n}/{NAP_n} \right) \qquad (kgN2O/tHNO3)$
Where:
PE_n Total N_2O emissions during the production campaign n $(kgN2O)$
EF_n Emissions factor to calculate the emissions from production campaign n $(kgN2O/tHNO3)$
NAP_n Nitric acid production during the production campaign n $(tHNO3)$</td></tr>
<tr><td>QA/QC procedures applied:</td><td>N/A</td></tr>
</table>

Data / Parameter:	**$EF_{ma,n}$**
Data unit:	**$kgN_2O/tHNO_3$**
Description:	Moving average emissions factor derived over time from campaign specific emissions factors.

<table>
<tr><td>Measured /Calculated /Default:</td><td>Calculated.</td></tr>
<tr><td>Source of data:</td><td>Calculation from project emission factors of all project campaigns.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td><table><tr><th>Time Period</th><th>value</th></tr><tr><td>PC 1</td><td>0.44317</td></tr><tr><td>PC 2</td><td>0.54586</td></tr><tr><td>PC 3</td><td>0.53204</td></tr><tr><td>PC 4</td><td>0.66774</td></tr></table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>N/A</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>N/A</td></tr>
<tr><td>Calculation method (if applicable):</td><td>In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach the moving average emission factor is determined as follows:
$EF_{ma,n} = \frac{(EF_1 + EF_2 + \cdots + EF_n)}{n}$
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.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>N/A</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>EF_p</td></tr>
<tr><td>Data unit:</td><td>$kgN_2O/tHNO_3$</td></tr>
<tr><td>Description:</td><td>Emissions factor used for the specific campaign n to determine the emission reductions of that campaign</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Calculated.</td></tr>
<tr><td>Source of data:</td><td>Calculation of EF_n and $EF_{ma,n}$.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td><table><tr><th>Time Period</th><th>value</th></tr><tr><td>PC 4</td><td>1.07731</td></tr></table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>N/A</td></tr>
</table>

Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	To calculate the total emission reductions achieved in a campaign, the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reductions (EF_P). Thus: If $EF_{ma,n} > EF_n$ then $EF_p = EF_{ma,n}$ If $EF_{ma,n} < EF_n$ then $EF_p = EF_n$
QA/QC procedures applied:	N/A

Data / Parameter:	**EF_{min}**
Data unit:	**$kgN_2O/tHNO_3$**
Description:	EF_{min} is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period.
Measured /Calculated /Default:	Calculated.
Source of data:	Calculations from EF_n
Value(s) of monitored parameter:	Not applicable.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	A campaign-specific emissions factor shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in a EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall use EF_{min} and not EF_n.
QA/QC procedures applied:	N/A

Data / Parameter:	**CL_n**
Data unit:	**$tHNO_3$**
Description:	Length of each project campaign measured in metric tonnes of 100% concentrated nitric acid produced during that campaign.
Measured /Calculated /Default:	Measured.

<table>
<tr><td>Source of data:</td><td>Calculation from project emission factors of all project campaigns.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td><table><tr><th>Time Period</th><th>value</th></tr><tr><td>PC 4</td><td>94,528.79</td></tr></table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>See description for NAP measurement.</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>See description for NAP measurement.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>See description for NAP measurement.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>ISO9001/14001 procedures and documented in the applicable ISO handbooks.</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>OP_h</td></tr>
<tr><td>Data unit:</td><td>Bar</td></tr>
<tr><td>Description:</td><td>Oxidation Pressure for each hour</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Monitored by Rosemount 1144</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Not applicable.</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project Emission Calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td><table><tr><th></th><th><i>Device</i></th></tr><tr><td>Type</td><td>Rosemount 1144</td></tr><tr><td>Serial Number<i>:</i></td><td>N/A</td></tr><tr><td>Calibration frequency:</td><td>At stops > 6 h</td></tr><tr><td>Overall measurement accuracy</td><td>±0.5% of calibration span, ±0.25% of 20-100% of flow</td></tr></table></td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>N/A</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures applied:</td><td>N/A</td></tr>
</table>

Data / Parameter:	**OT_h**
Data unit:	**°C**
Description:	Oxidation temperature in the ammonia oxidation reactor (AOR).

<table>
<tr><td>Measured /Calculated /Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Thermocouple inside Ammonia Oxidation Reactor (AOR) supplied by PR electronics, type 5111.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Not applicable. Eventually used to determine whether the plant is in operation or not.</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>N/A</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td></td><td><i>Device</i></td></tr>
<tr><td>Type</td><td>PR electronics 5111</td></tr>
<tr><td>Serial Number<i>:</i></td><td>N/A</td></tr>
<tr><td>Calibration frequency:</td><td>At stops > 6 h (exchange of thermocouples)</td></tr>
<tr><td>Overall measurement accuracy</td><td>± 0.5°C <i>(source: manufacturer)</i></td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>N/A</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures applied:</td><td>N/A</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>AFR</td></tr>
<tr><td>Data unit:</td><td>tNH$_3$/h</td></tr>
<tr><td>Description:</td><td>Ammonia gas flow rate to the ammonia oxidation reactors.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Continuously measured by Rosemount 3051 CD2.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Not applicable.</td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)</td><td>Project emission Calculations.</td></tr>
<tr><td>Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)</td><td>
<table>
<tr><td>Type</td><td>Rosemount
Type:3051 CD2</td></tr>
<tr><td>Serial Number<i>:</i></td><td>N/A</td></tr>
<tr><td>Calibration frequency:</td><td>At stops > 6 h</td></tr>
<tr><td>Accuracy</td><td><i>±0.075% of span</i></td></tr>
</table>
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency:</td><td>Continuously.</td></tr>
<tr><td>Calculation method (if</td><td>N/A</td></tr>
</table>

applicable):	
QA/QC procedures applied:	Plant internal procedures AGRI-25391, AGRI-25417. There is one orifice meter installed with two parallel transmitters, continuously measuring the AFR. In case of a malfunctioning of one of the transmitters the plant trips. There is no possibility to start up the plant again since two functioning transmitters are required as part of the safety system. The transmitters are checked during downtime periods of more than 6 hours.

Data / Parameter:	**AIFR**
Data unit:	**% v/v**
Description:	Ammonia to air ratio into the ammonia oxidation reactor
Measured /Calculated /Default:	Calculated.
Source of data:	Calculation for each hour of plant operation based on measurements of AFR and primary air flow rates by a Rosemount 3051 CD2.
Value(s) of monitored parameter:	**Not applicable. Eventually used to determine whether the plant is in operation or not.**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See AFR.
Measuring/ Reading/ Recording frequency:	See AFR.
Calculation method (if applicable):	N/A
QA/QC procedures applied:	See AFR.

<table>
<tr><th>Data / Parameter:</th><th>GS_{project}</th></tr>
<tr><td>Data unit:</td><td>Name of Supplier</td></tr>
<tr><td>Description:</td><td>Gauze supplier for the project campaign</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Not applicable.</td></tr>
<tr><td>Source of data:</td><td>Monitored / Invoices</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td><table><tr><th>Time period</th><th>Supplier</th></tr><tr><td>PC 1</td><td>KA Rasmussen, Norway</td></tr><tr><td>PC 2</td><td>KA Rasmussen, Norway</td></tr><tr><td>PC 3</td><td>KA Rasmussen, Norway</td></tr><tr><td>PC 4</td><td>KA Rasmussen, Norway</td></tr></table></td></tr>
<tr><td>Indicate what the data are used for (Baseline/ Project/ Leakage emission</td><td>N/A</td></tr>
</table>

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	**$GC_{project}$**
Data unit:	**%**
Description:	Gauze composition during the project campaign expressed as % by weight of the precious metals Platinum, Rhodium and, if applicable, Palladium comprising the Ammonia Oxidation Catalyst gauzes.
Measured /Calculated /Default:	N/A
Source of data:	Monitored / Gauze supplier invoices
Value(s) of monitored parameter:	**The gauze composition has been checked during on-site visit of the verification. The gauze composition during the project campaign and the baseline campaign was proven identical. Evidence has been provided to the verifying AIE.**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	N/A
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	N/A
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

>>

Analysis of historical campaign data and determination of permitted operating ranges

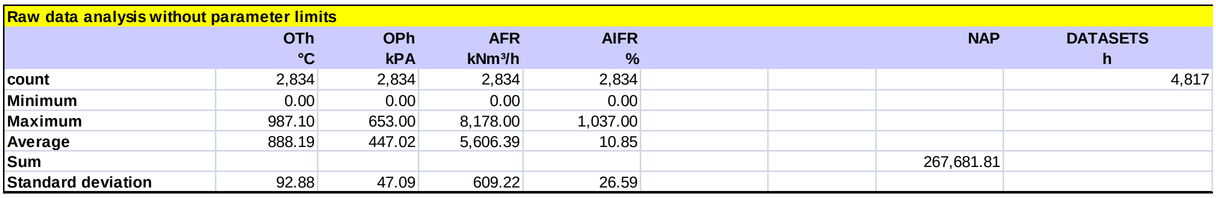
In a first step, a number of raw data sets are monitored in four of five historical campaigns in order to determine the operational limits of the plant for normal operations in the baseline campaign. For that purpose a number of statistical analyses were undertaken:

- 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 plant was considered to be not in operation when any of the following parameters are recorded outside the “trip” limits as determined by the plant manuals:

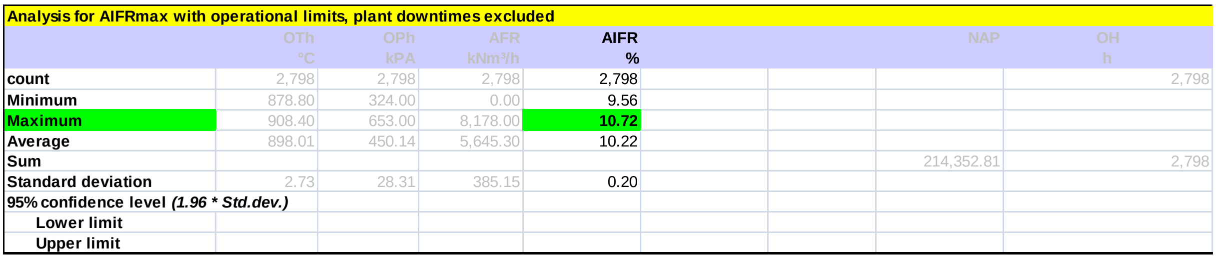
$AIFR_{trip}$: 11.5 %
lower limit OT_h: 830 °C
upper limit OT_h: 925 °C

1. Historical Data monitored without any operational limits



Raw data analysis without parameter limits								
	OTh °C	OPh kPA	AFR kNm³/h	AIFR %			NAP	DATASETS h
count	2,834	2,834	2,834	2,834				4,817
Minimum	0.00	0.00	0.00	0.00				
Maximum	987.10	653.00	8,178.00	1,037.00				
Average	888.19	447.02	5,606.39	10.85				
Sum							267,681.81	
Standard deviation	92.88	47.09	609.22	26.59				

2. Application of trip values for the extraction of $AIFR_{max}$ monitored under normal operational conditions (excluding downtimes)



Analysis for AIFRmax with operational limits, plant downtimes excluded								
	OTh °C	OPh kPA	AFR kNm³/h	AIFR %			NAP	OH h
count	2,798	2,798	2,798	2,798				2,798
Minimum	878.80	324.00	0.00	9.56				
Maximum	908.40	653.00	8,178.00	**10.72**				
Average	898.01	450.14	5,645.30	10.22				
Sum							214,352.81	2,798
Standard deviation	2.73	28.31	385.15	0.20				
95% confidence level *(1.96 * Std.dev.)*								
Lower limit								
Upper limit								

$AIFR_{max}$: 10.72%

3. Application of trip values for the extraction of AFR_{max} monitored under normal operational conditions (excluding downtimes)

Analysis for AFRmax with operational limits, plant downtimes excluded

	OTh °C	OPh kPA	AFR kNm³/h	AIFR %			NAP	DATASETS h
count	2,796	2,796	2,796	2,796				2,796
Minimum	878.80	324.00	4,438.00	9.56				
Maximum	908.40	653.00	**8,178.00**	10.72				
Average	898.02	450.15	5,649.34	10.22				

AFR_{max}: 8,178.0 Nm^3/h

4. NAP count for the determination of CL_{normal}

Analysis for NAP plant downtimes excluded

	OTh °C	OPh kPA	AFR kNm³/h	AIFR %			NAP	OH h
count	2,834	2,834	2,834	2,834				4,817
Minimum	0.00	0.00	0.00	0.00				
Maximum	987.10	653.00	8,178.00	1,037.00				
Average	888.19	447.02	5,606.39	10.85				
Sum							267,681.81	

CL_{normal}= 267,681.81 t / 5 campaigns

CL_{normal}: 53,535.36 $tHNO_3$

5. Determination of permitted operational limits for OP_h and OT_h

The remaining historical data were analysed in order to determine the upper and lower 2.5% percentiles for OP_h and OT_h:

As a result of the statistical analysis the “permitted operating ranges” for OT_h and OP_h based on the analysed historical data are as follows:

OPh_{max}: 495.0 KPa

OPh_{min}: 404.80 KPa

OTh_{max}: 902.9 °C

OTh_{min}: 892.5 °C

6. Summary of permitted operational limits of the plant for the baseline campaign

Normal operating limits

AIFRmax %	AFRmax kNm³/h	AFRmax t/h	Clnormal t HNO3	OPhmax KPA	OPhmin KPA	OThmax °C	OThmin °C
10.72	8,178.00	6,303.60	53,536.36	495.50	404.80	902.9	892.5

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

These permitted ranges are then applied to the baseline data.

Analysis of Baseline campaign data

1. Data count monitored without any operational limits to determine NAP

Raw data analysis without parameter limits								
	OTh °C	OPh kPA	AFR kNm³/h	AIFR %	NCSG mg/Nm³	VSG Nm³/h	NAP t/h	OH h
count	3,870.00	3,870.00	3,870.00	3,870.00	3,581.00	3,870.00	3,870.00	3,870.00
Minimum	871.88	284.33	4,392.62	9.60	2,106.39	39,394.57		
Maximum	901.72	493.61	6,493.38	10.40	3,422.15	60,275.88		
Average	899.42	458.03	6,046.86	9.84	2,956.28	56,270.26		
Sum							62,865.62	
Standard deviation	1.33	14.30	162.14	0.09	179.90	4,525.47		

NAP: 62,865.62 $tHNO_3$

2. Analysis with permitted operational limits (plant downtimes excluded), calculation of OH, NCSG + VSG confidence interval

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 all parameters (AFR, AIFR, OP_h and OT_h) were within the determined "permitted operating ranges". Also NCSG data that were recorded after NAP_{BL} exceeded CL_{normal} were excluded from the calculation. NAP_{BL} exceeded CL_{normal} at following time:

15/04/2010 18:00

Analysis with operational limits (plant downtimes excluded), calculation of NAP, OH, NCSG+VSG confidence levels								
	OTh °C	OPh kPA	AFR kNm³/h	AIFR %	NCSG mg/Nm³	VSG Nm³/h	NAP t/h	OH h
count	3,863.00	3,863.00	3,863.00	3,863.00	3,574.00	3,863.00	3,863.00	3,863.00
Minimum	894.77	404.88	5,396.75	9.60	2,444.37	39,394.57		
Maximum	901.72	493.61	6,493.38	10.34	3,422.15	60,275.88		
Average	899.43	458.20	6,048.45	9.84	2,956.77	56,285.75		
Sum							62,768.59	3,863.00
Standard deviation	1.25	13.64	156.64	0.09	178.48	4,511.87		
95% confidence level *(1.96 * Std.dev.)*					349.82	8,843.26		
Lower limit					2,606.95	47,442.00		
Upper limit					3,306.60	65,129.00		

3. Recalculation of NCSG mean after elimination of data that lies outside the 95% confidence interval.

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 are applied.

Recalculation of NCSG mean after elimination of data that lies outside the 95% confidence interval								
	OTh °C	OPh kPA	AFR kNm³/h	AIFR %	NCSG mg/Nm³	VSG Nm³/h	NAP t/h	OH h
count	2,851.00	2,851.00	2,851.00	2,851.00	2,851.00	2,851.00	2,851.00	2,851.00
Minimum	894.77	417.25	5,602.56	9.60	2,609.54	39,394.57		
Maximum	901.72	493.61	6,493.38	10.34	3,298.03	60,275.88		
Average	899.40	457.99	6,062.16	9.86	2,942.59	56,475.23		

Recalculation of VSG mean after elimination of data that lies outside the 95% confidence interval								
	OTh °C	OPh kPA	AFR kNm³/h	AIFR %	NCSG mg/Nm³	VSG Nm³/h	NAP t/h	OH h
count	3,016.00	3,016.00	3,016.00	3,016.00	2,786.00	3,016.00	3,016.00	3,016.00
Minimum	894.77	404.88	5,396.75	9.60	2,444.37	51,675.54		
Maximum	901.72	493.61	6,493.38	10.34	3,374.41	60,275.88		
Average	899.53	458.55	6,067.75	9.86	2,945.30	57,451.00		
Sum								

NCSG: 2,942.59 mg/Nm^3

VSG: 57,451.0 Nm^3/h

4. Application of 95% confidence interval, AMS UNC, summary of findings and calculation of EF_{BL}

Calculation of EF_{BL}						
$NCSG_{BL}$	VSG_{BL}	NAP_{BL}	OH_{BL}	$BE_{(11/09-05/010)}$	UNC	EF_{BL} kg N_2O/ t
mg/Nm³	Nm³/h	t	h	kg N_2O	%	HNO_3
2942.59	57,451	62,866	3,870	654,241	5.48	9.8367

The EF_{BL} derived from this analysis of historic and baseline data is:

EF_{BL} = 9.8367 kgN_2O/tHNO_3.

Statistical test if the baseline is representative of a normal campaign

In order to further ensure that operating conditions during the baseline campaign are representative of normal operating conditions, Hypothesis testing was performed to compare the average values of the permitted operating conditions with the average values obtained during the baseline determination period. If it can be concluded with 95% confidence level, in any of the tests, that the two values are different, then the baseline determination should be repeated.

Method: **hypothesis testing**

Hypothesis 0: statistical value of average values of the permitted operating conditions, indicated in PDD, and average of all values obtained during the baseline period are the same or close to zero

$\mu_1 = \mu_0$

Hypothesis 1: statistical value of average values of the permitted operating conditions, indicated in PDD and average of all values obtained during the baseline period are not the same and not close to zero

$\mu_1 \neq \mu_0$

Whereas:

Hypothesis 0	$\mu_1 = \mu_0$
Hypothesis 1	$\mu_1 \neq \mu_0$

Parameters considered:

Oxidation temperature (OTh)

Oxidation pressure (OP) (Mpa)
Amonia gas flow rate(AFR) (kg/h)
Air NH_3 ratio (AIFR) (%)

Parameters considered:

Oxidation temperature (OT_h)

	OTH
Historical minimum	892.5
Historical maximum	902.9
Mean of permitted range	897.7
Number of values	3922

t-criterion:	
#NV	#NV
0.453244	0.906488014
0.234901	0.47147169

H_0: $\mu_1 = \mu_0$

H_1: $\mu_1 \neq \mu_0$ (α=0,05)

$\Sigma\ OT_{BL}$ = 3498691.79

$\Sigma\ OT_{PDD}$ = 1795.4

$\Sigma\ OT_{BL}{}^{2}$ = 1.2241E+13

$\Sigma\ OT_{PDD}{}^{2}$ = 3223461

Mean (OT_{BL})= 892.068

Mean (OT_{PDD})= 897.7

S_{BL} = 1.2238E+13

S_{PDD} = 1611731

S= 55859.436

$|t_o|$= 0.000143 < 0.47147169

Conclusion: t is close to zero, $|t_o| < t\ (n_1 + n_2 - 2, \alpha)$, so the H_0 is correct.

Oxidation pressure (OP_h) (MPa)

	Oxidation Pressure
Historical minimum	404.80
Historical maximum	495.50
Mean of permitted range	450.15
Number of values	3922

t-criterion:	
#NV	#NV
0.4686637	0.9373274
0.480929	0.960665

H_0: $\mu_1 = \mu_0$

H_1: $\mu_1 \neq \mu_0$ (α=0,05)

$\Sigma\ OP_{BL}$ = 1776157.919

$\Sigma\ OP_{PDD}$ = 900.3

$\Sigma\ OP_{BL}{}^{2}$ = 3.15474E+12

$\Sigma\ OP_{PDD}{}^{2}$ = 810540.1

Mean (OP_{BL})= 452.870

Mean (OP_{PDD})= 450.15

S_{BL} = 3.15393E+12

S_{PDD} = 405270

S= 28357.794

t_o= 0.000068 < 0.960664905

Conclusion: t is close to zero, $|t_o| < t\ (n_1 + n_2 - 2, \alpha)$, so the H_0 is correct.

Ammonia gas flow rate(AFR) (kg/h)

	NH3 flow rate
Historical minimum	4,438
Historical maximum	6,304
Mean of permitted range	5370.8012
Number of values	3922

t-criterion:	
#NV	#NV
0.1054411	0.2108821
0.317904394	0.635300541

H_0: $\mu_1 = \mu_0$

H_1: μ_1 ? μ_0 (α=0,05)

Σ AFR $_{BL}$ =	23419899.08	Σ AFR$_{PDD}$ =	10741.6024
Σ AFR $_{BL}{}^2$ =	5.48492E+14	Σ AFR$_{PDD}{}^2$ =	115382022.1
Mean (AFR $_{BL}$)=	5971.417	Mean (AFR$_{PDD}$)=	5370.8012
S $_{BL}$ =	5.48352E+14	S $_{PDD}$ =	57691011.06
S=	373917.571		
t_o=	0.001136	<	0.635300541

Conclusion: t is close to zero, $|t_o| < t\,(n_1 + n_2 - 2, \alpha)$, so the H_0 is correct.

Air NH_3 ratio (AIFR) (%)

	AIFR %
Historical minimum	9.56
Historical maximum	10.72
Number of values	3922

t-criterion:	
#NV	#NV
0.41236740	0.82473480
0.264904541	0.53093508

H_0: $\mu_1 = \mu_0$

H_1: μ_1 ? μ_0 (α=0,05)

Σ AIFR $_{BL}$ =	37702.61585	Σ AIFR$_{PDD}$ =	20.28
Σ AIFR $_{BL}{}^2$ =	1421487242	Σ AIFR$_{PDD}{}^2$ =	411.2784
Mean (AIFR $_{BL}$)=	9.613	Mean (AIFR$_{PDD}$)=	10.14
S $_{BL}$ =	1421124803	S $_{PDD}$ =	205.6392
S=	601.953		
t_o=	-0.000619	<	0.530935

Conclusion: t is close to zero, $|t_o| < t\,(n_1 + n_2 - 2, \alpha)$, so the H_0 is correct.

Adjustment of Baseline emissions factor due to EF_{reg}

Should N_2O emissions regulations that apply to nitric acid plants be introduced in the host country or jurisdiction covering the location of the project activity, such regulations shall be compared to the calculated baseline emission factor for the project (EF_{BL}). If the regulatory limit is lower than the baseline factor determined for the project, the regulatory limit shall serve as the new baseline emission factor, that is:

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

then the baseline N_2O emission factor shall be EF_{reg} for all calculations.

where:

Variable Definition

EF_{BL} Baseline emissions factor $(kgN2O/tHNO3)$

EF_{reg}	Emissions level set by newly introduced policies or regulations ($kgN2O/tHNO3$)

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

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

E.2. Project emissions calculation

Project emissions are calculated according to the following formula:

$$PE_n = VSG_n * NCSG_n * OH_n * 10^{-6} \qquad (kgN2O)$$

Where:

PE_n	Total N_2O emissions during the specific Verification Period ($kgN2O$)
VSG_n	Mean tail gas volume flow rate during the Verification Period (m^3/h)
$NCSG_n$	Mean concentration of N_2O in the tail gas stream during the Verification Period ($mgN2O/m^3$)
OH_n	Operating hours of the plant during the Verification Period (h)

Based on the total N_2O emissions of each project campaign the specific project campaign emission factor is calculated as:

$$EF_n = \left({}^{PE_n}/_{NAP_n}\right) \qquad (kgN2O/tHNO3)$$

Where:

PE_n	Total N_2O emissions during the specific Verification Period (kg_{N2O})
EF_n	Emissions factor to calculate the emissions from Verification Period in ($kgN2O/tHNO3$)
NAP_n	Nitric acid production during the Verification Period ($tHNO3$)

Analysis of project campaign 4 data (03/01/2012 – 16/09/2012)

1. Data count monitored without any operational limits to determine NAP

Raw data analysis without parameter limits									
	OTh	**OPh**	**AFR**	**AIFR**	**NCSG**	**VSG**	**NAP**	**NAPcross**	**OH**
	°C	**bar**	**Nm^3/h**	**%**	**mg/Nm³**	**Nm³/h**	**t/h**	**t/h**	**h**
count	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153	6,153
Minimum	17.69	0.28	-0.06	-38.50	-1.70	-122.63			
Maximum	1,193.67	512.40	6,829.19	117.28	1,451.43	109,244.45			
Average	859.05	462.40	5,843.96	9.49	397.39	50,575.37			
Sum							94,660.49	96,597.60	
Standard deviation	161.66	98.23	1,289.00	3.97	332.79	11,808.26			

2. Analysis with permitted operational limits (plant downtimes excluded), calculation of OH, NCSG + VSG confidence interval

The plant was considered to be not in operation when any of the following parameters are recorded outside the “trip” limits as determined by the plant manuals:

$AIFR_{trip}$:	11.5 %
lower limit OT_h:	830 °C
upper limit OT_h:	925 °C

Analysis with operational limits (plant downtimes excluded), calculation of NAP, OH, NCSG+VSG confidence levels									
	OTh	**OPh**	**AFR**	**AIFR**	**NCSG**	**VSG**	**NAP**	**NAPcross**	**OH**
	°C	**bar**	**Nm^3/h**	**%**	**mg/Nm³**	**Nm³/h**	**t/h**	**t/h**	**h**
count	5,865	5,865	5,865	5,865	5,865	5,865	5,865	5,865	5,865
Minimum	875.17	297.02	4,343.74	9.62	85.17	35,154.03			
Maximum	903.15	512.40	6,829.19	10.78	1,451.43	109,244.45			
Average	893.80	483.44	6,123.23	9.92	415.04	52,832.35			
Sum							94,529	96,476	5,865
Standard deviation	4.15	16.75	229.54	0.12	329.58	5,535.94			
95% confidence level *(1.96 * Std.dev.)*					645.98	10,850.45			
Lower limit					-230.94	41,982.00			
Upper limit					1,061.03	63,683.00			

3. Recalculation of NCSG and VSG mean after elimination of data that lies outside the 95% confidence interval

Recalculation of NCSG mean after elimination of data that lies outside the 95% confidence interval									
	OTh	**OPh**	**AFR**	**AIFR**	**NCSG**	**VSG**	**NAP**	**NAPcross**	**OH**
	°C	**bar**	**Nm^3/h**	**%**	**mg/Nm³**	**Nm³/h**	**t/h**	**t/h**	**h**
count	5,314	5,314	5,314	5,314	5,314	5,314	724	724	724
Minimum	875.17	297.02	4,343.74	9.62	85.17	35,154.03			
Maximum	903.15	512.40	6,829.19	10.78	1,059.76	109,244.45			
Average	894.50	483.93	6,140.57	9.93	333.57	52,798.77			

Recalculation of VSG mean after elimination of data that lies outside the 95% confidence interval									
	OTh	**OPh**	**AFR**	**AIFR**	**NCSG**	**VSG**	**NAP**	**NAPcross**	**OH**
	°C	**bar**	**Nm^3/h**	**%**	**mg/Nm³**	**Nm³/h**	**t/h**	**t/h**	**h**
count	5,667	5,667	5,667	5,667	5,667	5,667	721	721	721
Minimum	883.25	381.28	5,140.35	9.62	107.13	42,205.92			
Maximum	903.15	512.40	6,829.19	10.41	1,451.43	57,677.50			
Average	893.86	483.39	6,123.02	9.92	417.43	52,052.68			
Sum									

4. Summary of relevant results of the project emission calculation from PC4

$$PE_n = VSG_n * NCSG_n * OH_n * 10^{-6} \qquad (kgN2O)$$

$$EF_n = \left({}^{PE_n}/_{NAP_n} \right) \qquad (kgN2O/tHNO3)$$

Calculation of EFn and ERUs									
NCSGn	VSGn	NAPn	OHn	PEn	EFn	EFma,n	NAPcross	EFBL	ERUn
mg/Nm^3	Nm^3/h	t	h	kg N_2O	kg N_2O/ t HNO_3	kg N_2O/ t HNO_3	t	kg N_2O/ t HNO_3	t CO_2e
333.57	52,053	94,529	5,865	101,836.54	1.07731	0.66774	96,476	9.8367	268,686

Relevant Project Emissions (PE_n) and Emission Factors ($EF_n + EF_{ma,n}$):

Project Campaign	**EF_n**	**$EF_{ma,n}$**	**PE_n**
PC4	1.07731	0.66774	101,836.54

E.3. Leakage calculation

>>

No leakage occurs under this project type.

E.4. Emission reductions calculation

>>

Emission reductions

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

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

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

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

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

Project Campaign	**EF_n**	**$EF_{ma,n}$**
1	0.44317	0.44317
2	0.64855	0.54586
3	0.50440	0.53204
4	1.07731	0.66774

In addition a campaign-specific ***minimum emissions factor*** (EF_{min}) shall be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum emission factor (EF_{min}). If any of the later project campaigns results in an EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign shall use EF_{min} and not EF_n.

This does not apply to the current Verification period as this report does only cover PC4.

Further the project campaign lengths CL_3 has to be compared with CL_{normal} in order to determine whether all NCSG values can be used for the calculation of Emission reductions. The campaign length is determined as the Nitric acid produced in the respective campaign. One of the following options has to be applied accordingly:

a) Longer Project Campaign

If $CL_n \geq CL_{normal}$ then all NCSG values can be used for the calculations

b) Shorter Project Campaign

If $CL_n < CL_{normal}$ those NCSG values will be that were obtained during the production of tonnes of nitric acid beyond the CL_n

CL_{normal}	CL_4
53,536.36	94,528.79

According to the above analysis option a) applies for the project campaign PC4.

The amount of CO_2e emission reductions eligible for issuance of Emission Reduction Units (ERUs) is calculated by applying the difference between the applicable Baseline N_2O Emission Factor (EF_{BL}) and the project specific N_2O Emission Factor (EF_n) to the respective amount of Nitric Acid Production (NAP_n).

Applying the specific global warming potential of N_2O (310 tCO_2e/tN_2O) results in the respective amount of achieved CO_2e emission reductions that are claimed for issuance of ERUs.

$$ERU = \left(\frac{(EF_{BL} - EF_n)}{1000} * NAP * GWP_{N2O}\right) \qquad (tCO2e)$$

Where:

EF_{BL}	Baseline emissions factor $\left(tN2O/_{tHNO3}\right)$
EF_n	Baseline emissions factor$\left(tN2O/_{tHNO3}\right)$
NAP_n	Nitric acid production during the production campaign n $(tHNO3)$
GWP_{N2O}	Global Warming Potential of N_2O valid for the commitment period 310 $\left(tCO2e/_{tN2O}\right)$

The emission reductions for the project campaign covered by this monitoring report results in the following numbers of ERUs:

Project Campaign 4

ERU	268,686	ERUs (tCO_2e)	Emission Reduction Units awardable to the project for the Verification Period (tCO_2e)

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

Item	**Values applied in ex-ante calculation of the registered CDM-PDD**	**Actual values reached during the monitoring period**
Emission reductions (tCO_2e)	282,057 per year equal to 207,288 in 256 days (monitoring period).	268,686 in 256 days.

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

The generated Emission Reductions over this verification period are above the estimates undertaken in the PDD. This is mainly due to the following reasons:

- Higher Baseline Emission Factor after full statistical analysis than anticipated during time of PDD writing;
- Slightly better abatement performance as expected at time of PDD writing;
- Slightly longer production period and shorter downtime periods during one year.

- - - - -

History of the document

Version	**Date**	**Nature of revision**
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		