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

CONTENTS

MONITORING REPORT
Version 01; 08/10/2012
YARA Köping S2 N_2O Abatement Project in Sweden
Reference Number: 0221
Monitoring period: Nr. 03, 01/03/2012 - 30/09/2012

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 project activity is to significantly reduce former levels of N_2O emissions from the production of nitric acid at the Syra 2 nitric acid plant of Yara in Köping, Sweden, by the implementation of a secondary N_2O abatement catalyst

2. Brief description of the installed technology and equipments

The employed secondary N_2O abatement catalyst technology is supplied and optimized for atmospheric plants by Yara. The base metal catalyst installed comprises 6.1 tons of base metal catalyst material which is filled in batches underneath the Pt-Rh ammonia oxidation gauze packs in each of the plants 6 ammonia burner reactors (AORs).

Continuous monitoring of emission reductions is assured by an state of the art Automated Measuring System (AMS), consisting of stack gas volume flow meter, N_2O analyser, and respective data logging facilities. The AMS, as well as its installation, complies with the requirements of the European Norm EN 14181 as required by the applied methodology AM0034 v. 03.4.

3. Relevant dates for the project activity

Table 1: Relevant Dates for the project activity

Dates	Actions undertaken
1955	Construction of Syra II plant with 4 Ammonia Oxidation reactors
1969	Upgrade of the plant with 2 more Ammonia Oxidation reactors
12/10/2009	Start of project activity
01/10/2010	Start of crediting period
31/12/2012	End of crediting period
07/11/2010 – 12/11/2010	Installation of first batch of N_2O catalyst in burner 1&2
21/11/2010 – 26/11/2010	Installation of second catalyst batch in burners 5&6
26/11/2010 – 17/12/2010	Installation of second catalyst batch in burners 3&4
12/11/2010 – 31/07/2011	1st Monitoring Period
01/08/2011 – 29/02/2012	2nd Monitoring Period
01/03/2013 – 30/09/2012	3rd Monitoring Period

4. Total emission reductions achieved in this monitoring period

Table 2: Emission Reduction Units achieved in this monitoring period distributed to yearsERU per year 2012 (total)	123,851	ERUs (tCO$_2$e)	Emission Reduction Units awarded to the project for year 2012 (MP2+MP3) (tCO2e)
ERU per year 2012 (MP2)	29,518	ERUs (tCO$_2$e)	Emission Reduction Units awarded to the project for year 2012 (MP2) (tCO2e)
ERU per year 2012 (MP3)	94,333	ERUs (tCO$_2$e)	Emission Reduction Units awardable to the project for year 2012 (MP3) (tCO2e)

A.2. Project Participants

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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:

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

Plant Coordinates[1]*:*

Ammonia burners: 59°29’54.86” N & 16°00’29.69” E

Tail gas stack: 59°29’55.29” N & 16°00’31.09” E

A.4. Technical description of the project

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The main parts of the plant as currently set up are the three sets of two ammonia burners (total 6 burners), inside which the ammonia oxidation reaction takes place, the 9 absorption towers where the gas mix from the burner is led through water in order to form nitric acid and the one tail gas stack through which the off-gasses are vented into the atmosphere.

The precious metal gauze packs – i.e. the primary catalyst required for the formation of NO in the first step of the nitric acid production process – are manufactured by KAR Rasmussen, located in Norway.

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[1] Coordinates according to Google Earth©

The project activity entails the implementation of:

- Secondary N_2O abatement technology that will be inserted in the ammonia oxidation reactors; and
- Specialised monitoring equipment to be installed at the stack

1. Catalyst Technology

The plant operated by YARA Köping S2 is an atmospheric pressure plant. Therefore, Yara developed and installed an optimised catalyst for installation in atmospheric plants. It is installed below the standard precious metal gauze packs in the ammonia burners. Yara filled the catalyst baskets with batches of the new secondary catalyst (a total of approximately 6.1 tonnes for all 6 burners) in three consecutive steps from the beginning of the production campaign in November 2010 (for exact dates please see Table 1).

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

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

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

The materials used in the new YARA secondary abatement catalyst for atmospheric plants are the same as those used for the standard YARA catalyst, which is successfully installed in many CDM and JI projects all over the world. This material has been proven by industrial testing not to have any significant influence on plant production levels[2]. 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.

Due to the lack of experience in industrial application of this new type of catalyst, if any unforeseen problems should occur during its operation, the project participants reserve the right to replace it with the standard Yara N_2O abatement catalyst that is widely installed in medium pressure plants in order to continue the project activity.

2. N_2O abatement catalyst installation

The secondary catalyst itself was installed during routine plant shut-downs.

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

YARA's Köping S2 nitric acid plant operates at atmospheric pressure inside the ammonia oxidation reactors. 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 small reduction in nitric acid output. In practice, this reduction is unlikely to be significant.

3. Technology operation and safety issues

As mentioned before, the Yara secondary abatement material has been tested in several industrial trials and has proven to be a reliable and environmentally safe method of reducing N_2O.

The catalyst and the AMS is operated, maintained and supervised by the employees of YARA Köping according to standards that are normally used in the European industry[3].

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[2] This was confirmed by the catalyst manufacturer in official correspondence dated 23.02.2010. The relevant information was made available to the determining AIE. Also 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.

[3] See section D.3 below.

Due to the fact that the catalyst is developed by Yara itself, 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 can be managed in accordance with the JI requirements.

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

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This project activity is largely based on Approved Baseline and Monitoring methodologies 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 (in its most recent version) for the baseline scenario selection and employs the “Tool for the demonstration and assessment of additionality” (Version 04.2).

However, as is permitted under JI, the project participants have chosen to take a JI-specific approach in some areas of project implementation, where the application of AM0034 was not appropriate. Further details of these JI-specific approaches are addressed below in the table under ‘Explanation and Justification for deviations from AM0034’.

1. Explanation and Justification for deviations from AM0034

The following aspects of the approved CDM baseline & monitoring methodology AM0034, version 03.4, “Catalytic reduction of N2O inside the ammonia burner of nitric acid plants” are either not applied or applied in a modified manner:

Table 3: Deviations and modifications from AM0034 v.03.4

Project Implementation Aspect	**AM0034**	**Adjustment in JI project specific context**	**Explanation / Justification**
Continuous N_2O measurement	Continuous measurements of N_2O concentration & total gas volume flow are carried out in the stack prior to the installation of the secondary catalyst for one campaign	No continuous measurement of N_2O concentration & total gas volume flow is necessary prior to the installation of the secondary catalyst	In order to overcome the difficulty of defining one production campaign (as explained in A.4.3.1), the project proponents are taking a project-specific approach to the determination of the baseline emissions factor. The conservative lowest IPCC default emissions factor for N_2O emissions from nitric acid plants will be applied as the baseline emissions factor, and therefore the measurement of N_2O concentration & total gas volume flow in the stack for one campaign prior to the installation of secondary catalyst is no longer necessary.
Baseline campaign	Baseline emissions established based on distinct baseline campaign.	The IPCC default emissions factor for N_2O emissions from nitric acid plants is used for determining the baseline emissions factor	For establishing the baseline, a project-specific approach has been adopted: the conservative IPCC default emissions factor for N_2O from nitric acid plants that have not installed destruction measures - 4.5kg N_2O /tHNO3 – shall be applied for the proposed project. However, in order to show that historic plant emissions are higher than the

			default emissions factor, a ‘Business-as-Usual’ (BAU) emissions factor has been defined. See section A.4.3.1 for details.
Baseline Emissions	Baseline Emissions are based on the factual business as usual emissions.	The IPCC default value is applied as the Baseline Emissions Factor for assessing the amount of emission reductions for which ERUs will be allocated.	In order to overcome the difficulty of establishing the definition of one ‘production campaign’ at Syra 2 (as explained in section A.4.3.1), this alternative approach for establishing the assumed baseline scenario ensures conservativeness. The chosen value is the lowest and most conservative value for an N_2O emissions factor within the nitric acid industry, and one that is moreover suggested as a fallback value in case of missing data according to AM0034.
Permitted range of operational parameters	These are established in order to prevent “baseline gaming” (i.e. manipulation of baseline emissions) by plant operators aiming to unduly increase their emission reduction potential.	No permitted range of operational parameters is established.	In theory, a plant operator could increase N_2O emission levels by modifying the plant’s operational parameters (e.g. increasing the ammonia to air ratio). This would unduly increase the emission reduction potential of the project activity, because baseline emissions would not represent the business-as-usual scenario. As no baseline campaign is measured, but the baseline emissions factor is instead based on the conservative IPCC default emissions factor, there is no possibility for the operator for ‘baseline gaming’.
Statistical Analysis of baseline and project emissions data	Collected baseline and project campaign data is subject to statistical analysis in order to eliminate values which are not representative for standard plant operation.	No statistical analysis of baseline and project emissions is undertaken.	As no baseline campaign is measured, there is no baseline campaign data that could be subject to statistical analysis. Project emissions are calculated based on verification periods and not on standard production campaigns (see ‘Monitoring periods based on campaigns’ below). In order to ensure a conservative approach in this context, project emissions will be calculated in accordance with the methodology AM0028, which advocates calculating emissions on an hourly basis (and not on a campaign basis with statistical analysis).
Calculation of project emissions	Project campaign data is subject to statistical	No such step is undertaken.	In order to ensure conservativeness (since project emissions are calculated based on verification periods and not on standard production campaigns),

	analysis in order to eliminate values which are not representative for standard plant operation.		project emissions will be calculated in accordance with the methodology AM0028. Emissions will be calculated on an hourly basis, using hourly average values for NCSG and VSG.
Cap on baseline campaign length	Maximum allowable nitric acid production is capped for the baseline campaign.	No baseline campaign is conducted.	In an AM0034 project, baseline emissions could be increased by extending the baseline campaign beyond its business-as-usual production. This is due to N_2O emission levels generally increasing the longer a primary catalyst gauze is used. In the project-specific scenario, no baseline campaign is conducted.
Deduction of AMS uncertainty from baseline emissions factor	Combined uncertainty for all parts of the AMS is deducted from EF_{BL}.	Uncertainty is not taken into account.	No baseline campaign is conducted and emission reductions achieved by the project will not be assessed based on measured factual baseline emissions, but on the non-measured IPCC default value instead. Applying uncertainty is not appropriate, as the IPCC default emissions factor is already sufficiently conservative.
Recalculation of EF_{BL}-value in case of shorter project campaign.	In case a project campaign is shorter than the baseline campaign, EF_{BL} is re-calculated for that campaign.	Recalculation of the EF_{BL} in case of shorter project campaign is not applicable.	EF_{BL} is not determined based on the factual emissions of the plant measured during one campaign, but using a fixed default value as described above.
Monitoring Periods based on campaigns	Verifications can only be undertaken for full campaigns, not merely for parts of campaigns.	This restriction does not apply.	Under AM0034, emission reductions are assessed by comparing project campaign emissions to those of the baseline campaign. Due to the modification of not assessing emission reductions based on factual emissions (and thus not being dependent on a baseline campaign) and also due to the difficulty of defining a campaign in the context of the more complex plant layout, emission reductions can also be determined for parts of campaigns. This will be defined as a ‘Verification Period’.
Moving Average Emissions Factor	Project emissions are compared to the average emission factor of all previous	This step is not being applied.	Since this project is calculating emissions reductions based on verification periods and not on standard production campaigns, this measure is not appropriate. Since primary catalyst gauzes will be of varying ages during

	project campaigns (of the first 10 campaigns only). The higher value applies for calculating emission reductions.		each verification period, the EFn value can vary significantly and thus the moving average emissions factor will lead to unrealistic and unrepresentative emissions factors.
Minimum project emissions factor after 10th campaign	No project emissions factor after the 10th project campaign may be higher than the lowest recorded during these campaigns.	This restriction does not apply.	Since this project is calculating emissions reductions based on verification periods and not on standard production campaigns, this measure is not appropriate. Since primary catalyst gauzes will be of varying ages during each verification period, the EFn value can vary significantly and thus the minimum project emissions factor will lead to unrealistic and unrepresentative emissions factors.
AMS downtime	AM0034 states: In the event that the monitoring system is down, the lowest between the conservative 4.5 kg $N_2O/tHNO_3$ IPCC default factor or the last measured value will be valid and applied for the downtime period for the baseline emission factor, and the highest measured value in the campaign will be applied for the downtime period for the campaign emission factor.	In the case of a period of AMS downtime that constitutes a malfunction of the AMS, the missing data from the relevant hour should be replaced with either a) the highest value measured during the whole of the relevant verification period or b) the highest value measured during the whole of the previous complete verification period, whichever is the higher. The assessment should be based on values measured during periods of standard AMS operation and recording after elimination of mavericks. This replacement of	Firstly there is no distinction between downtime during the baseline and downtime during the project, since no baseline is being measured. The sentence regarding application of the conservative 4.5 kg N_2O /$tHNO_3$ IPCC default factor or the last measured value is therefore not applicable. Secondly, AM0034 does not distinguish between times when the AMS was malfunctioning and periods of standard calibration. The approach taken here differentiates between these two scenarios. In addition, the approach taken here with regard to replacement values during the project is more conservative, since it recommends using the highest value measured - either during the relevant verification period or during the whole of the previous complete verification period, whichever is the higher.

		missing data will be done on the basis of hourly average values. In the case of equipment downtime due to a routine calibration for any part of one hour, the hourly average value will be calculated pro-rata from the remaining available data from the hour in question. If the remaining available data from that hour constitutes less than 2/3 of the hour (less than 40 minutes), that hour should be considered missing. Each time it is impossible to calculate one hour of valid data, substitute values should be used instead of the missing hour for the further calculations of emissions reductions. As a substitute value, the last valid hourly average value before the calibration will be used for the calculation of emissions reductions.	

A.6. Registration date of the project activity:>

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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):

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The crediting period commenced on 01/10/2010 and will end on 31/12/2012.

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

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Responsible for completing the monitoring report form:

Mr. Wolfgang Brückner

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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

Table 4: Relevant dates of the project activity

Registration Date:	27/01/2011		
Start of crediting period	01/10/2010		
End of crediting period	31/12/2012		
Starting date of Project Activity	12/10/2009		
1st monitoring period	12/11/2010 –31/07/2011		
2nd monitoring period	01/08/2011 –29/02/2012		
3rd monitoring period	01/03/2012 –30/09/2012		
AOR	1 & 2	3 & 4	5 & 6
Installation of abatement catalyst	07/11/2010 – 12/11/2010	29/11/2010 – 17/12/2010	21/11/2010 – 26/11/2010

Measurements of Emission Reductions commenced upon the installation of the first batch of the catalyst.

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.

Table 5: Plant Events

From	To	Event	Explanation/Action	impact on data 1 = excluded 0 = none
Plant Events				
2012.04.03	2012.04.05	Planned stop compressor + gauze change	start up	1
2012.05.27	2012.06.03	Stop due to leakage in absorption section		1
2012.09.16	2012.09.24	Planned inspection stop		1
2012.05.14	2012.05.15	no data available		1

Table 6: AMS downtimes and Maintenance deviations from BAU

From	To	Event	Explanation/Action	impact on data 1 = highest measured value 2 = last valid hour 0 = none
AMS downtime				
2012.03.15 08:00	2012.03.15 08:00	Maintenance signal < (2/3)	-	2
2012.04.12 10:00	2012.04.12 10:00	Maintenance signal < (2/3)	-	2
2012.04.16 12:00	2012.04.16 12:00	Signal Analyser <1	-	1
2012.04.25 18:00	2012.04.25 18:00	Signal Analyser <1	-	1
2012.04.27 10:00	2012.04.27 10:00	Maintenance signal < (2/3)	-	2
2012.04.30 16:00	2012.04.30 16:00	Signal Analyser <1	-	1
2012.05.10 10:00	2012.05.10 11:00	Signal Analyser <1	-	1
2012.06.07 08:00	2012.06.07 08:00	Maintenance signal < (2/3)	-	2
2012.06.12 10:00	2012.06.12 15:00	Signal Analyser <1	-	1
2012.06.12 13:00	2012.06.12 15:00	Maintenance signal < (2/3)	-	2
2012.06.14 09:00	2012.06.14 12:00	Maintenance signal < (2/3)	-	2
2012.06.14 23:00	2012.06.14 23:00	Signal Analyser <1	-	1
2012.06.19 13:00	2012.06.19 16:00	Maintenance signal < (2/3)	QAL2	2
2012.07.09 22:00	2012.07.10 00:00	Signal Analyser <1	-	1
2012.07.19 08:00	2012.07.19 08:00	Maintenance signal < (2/3)	-	2
2012.08.02 11:00	2012.08.02 11:00	Maintenance signal < (2/3)	-	2
2012.08.02 15:00	2012.08.02 15:00	Signal Analyser <1	-	1
2012.08.08 08:00	2012.08.08 11:00	Signal Analyser <1	-	1
2012.08.08 13:00	2012.08.08 13:00	Maintenance signal < (2/3)	-	2
2012.08.16 08:00	2012.08.16 08:00	Maintenance signal < (2/3)	-	2
2012.08.31 13:00	2012.08.31 13:00	Maintenance signal < (2/3)	-	2
2012.09.21 16:00	2012.09.23 21:00	Signal Analyser <1	-	1
2012.09.24 06:00	2012.09.24 06:00	Signal Analyser <1		1
2012.09.28 08:00	2012.09.28 08:00	Maintenance signal < (2/3)	-	2

For 93 out of the 4819 hourly average results, the NCSG analyser was considered out of operation (downtime) if status signal indicated a value below 1 or maintenance signal was below (2/3) of an hour. Respective NCSG measurement readings were replaced by substitute values.

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

B.2. Revision of the monitoring plan

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N/A

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

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No request for deviation was applied to this monitoring period.

B.4. Notification or request of approval of changes

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No request of approval changes

SECTION C. Description of the monitoring system

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1. General Description of the AMS

YARA Köping S2 plant is equipped with an EN-14181 compliant state-of-the-art AMS consisting of the following devices:

- Dr. Födisch MCA 04 Continuous Emissions Analyser;
- Sample probe;
- Heated filter and heated sample-line connected directly to the analyser; and
- Dr. Födisch FMD 99 Stack Gas Flow meter. The new analyser is connected to the plant's existing data collection system (Emerson DeltaV).

Since this nitric acid plant has been in operation since 1955, 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 7: 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.

Service has been performed according to vendor specifications. 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 9001:2000, which is regularly audited by an independent auditing organisation accredited for ISO 9001 certification[4].

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 S2 is downstream of the tail gas expander in the vertical section of the tail gas pipe.

The suitability of the chosen VSG sampling points has been verified during the QAL2 audit, finalized on 03/06/2010.

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[4] External auditor: DNV

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 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[5] 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".[6]

The QAL2 test was conducted following commissioning of the analyser on 01/06/2010 (independent laboratory with EN ISO/IEC 17025 accreditation) 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

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

[6] TÜV Rheinland Energie und Umwelt (report number 936/21211571/B from 25/03/2010)

Conservation and Reactor Safety on suitability testing of measuring equipment for continuous measuring of emissions[7] 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.

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.

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[7] TÜV Rheinland Sicherheit und Umweltschutz GmbH, Köln (report number 936/808 005/C from 18/02/2000) and TÜV Immissionsschutz und Energiesysteme GmbH, Köln (report number 936/rö from 15/10/2003).

6. The data acquisition system

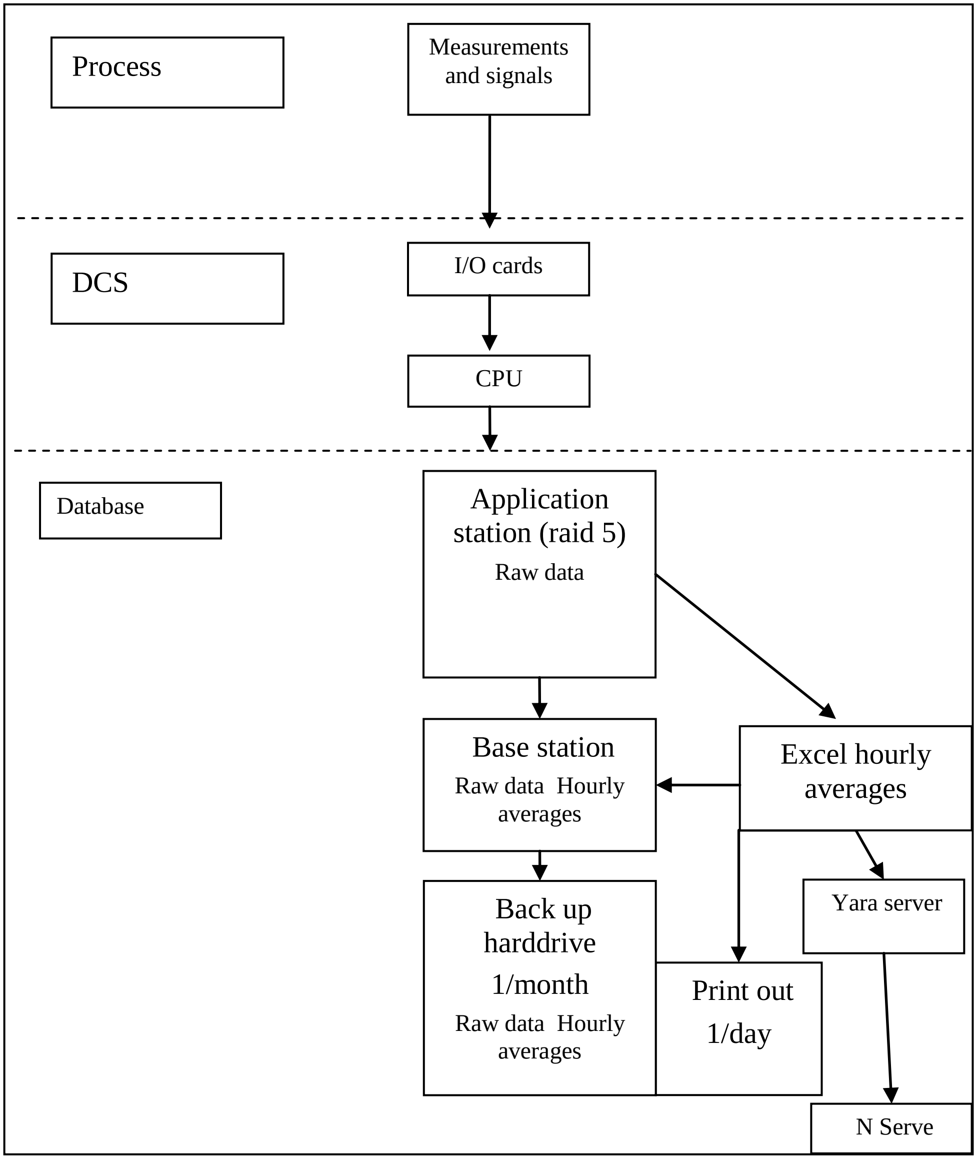
The YARA Köping S2 nitric acid plant is currently equipped with an Emerson DeltaV data collection and storage system that collects and stores the values for all the relevant monitoring parameters, as well as different status signals of the AMS and the NH_3 valve status signal from the nitric acid plant that defines whether or not the plant is in operation.

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.

From the beginning of the baseline campaign onwards (beginning May), the plant has installed a PIMS data management system, which allows quicker and more efficient management and import/export of the recorded data.

The flow chart below shows this system in more detail:

Figure 1: flow chart of PIMS data management system



7. Data evaluation

The nitric acid plant operator derives hourly averages for all of the monitored parameters from the Emerson DeltaV data collection 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.

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 AM0034 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

The following section describes how the procedures given in EN14181 for QAL1, 2 and 3 have been adapted and are practically applied at the YARA nitric acid plant.

QAL1

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[8] 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, SO2, HC1, NH3, H2O. The QAL1 test for N_2O has been completed and was published on 28/07/2010 in the German “Bundesanzeiger”.[9] 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[10].

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 QAL 1 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 EN 14181, both the QAL2

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[8] TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A from 13/07/2005

[9] TÜV Rheinland Energie und Umwelt (report number 936/21211571/B from 25/03/2010)

[10] TÜV Rheinland Sicherheit und Umweltschutz GmbH, Köln (report number 936/808 005/C from 18/02/2000) and TÜV Immissionsschutz und Energiesysteme GmbH, Köln (report number 936/rö from 15/10/2003

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. A full QAL2 test is performed (at least every 3 years), including AST thus no additional AST test is required 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

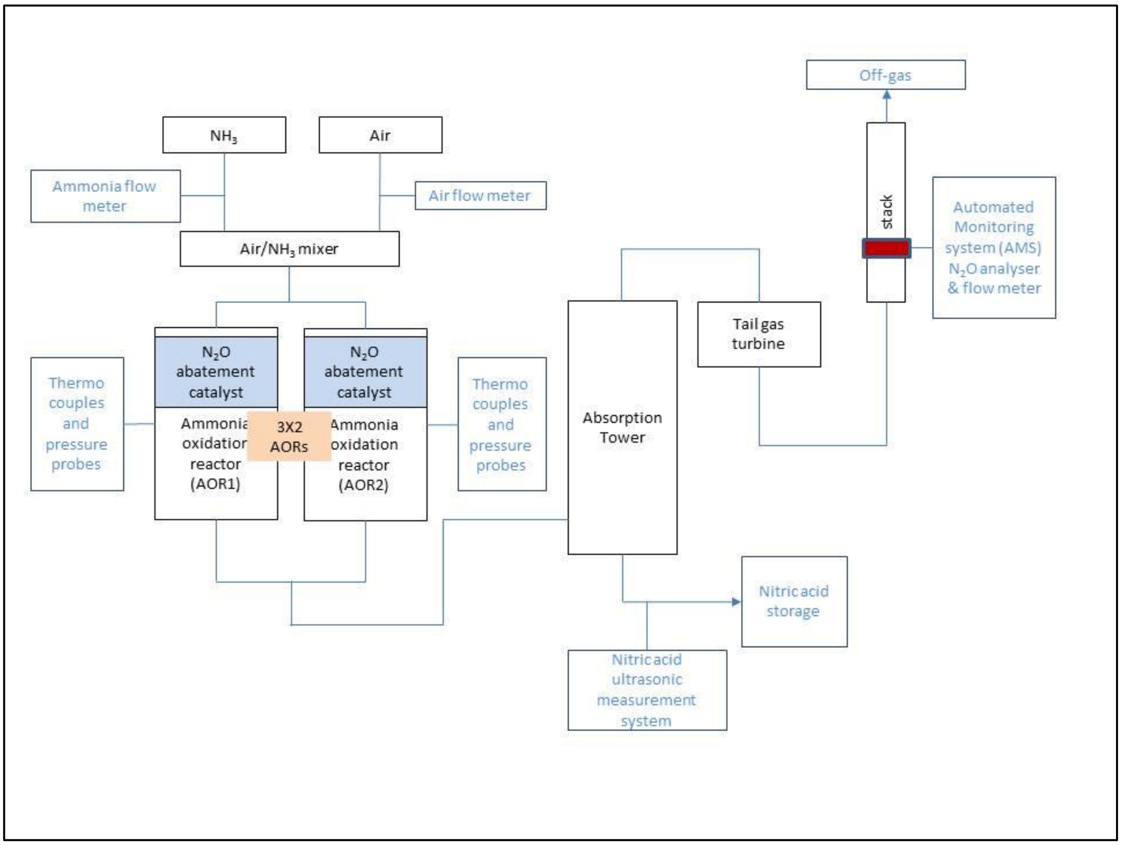
Manual span checks are done with certified calibration gas at least once every four weeks. Span adjustments or maintenance may be necessary depending on the results of the check (the calibration frequency might be adjusted if necessary).

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 2: Monitoring Points for all relevant Parameters (NCSG, VSG, TSG, PSG, NAP)



10. NAP measurement

At YARA Köping S2, the nitric acid production was usually monitored by a differential-pressure flow meter for continuous HNO_3-flow and HNO_3 concentration measurement. Since 31/05/2011 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.

Since 01/08/2011 a 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.

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

$$11.\ Production\ Syra\ 2 = \frac{Q_{501} * \rho_{NH3}}{K_1 * 1000}$$

Where:

Q_{501} = NH_3- inflow to the AORs in $Nm3/h$
ρ_{NH3} = Density of ammonia: 0.771 $kg/Nm3$.
K_1 = constant conversion factor (0.298 $kgNH3/kgHNO3$)

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 verified determined during the determination of the project. Please note that the final determination has not yet been concluded.

Data / Parameter:	**EF_{BL}**[11]
Data unit:	*kg/tHNO_3*
Description:	*Baseline Emissions Factor - conservative IPCC default emissions factor for N_2O from nitric acid plants*
Source of data used:	*2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3,*
Value(s) :	**4.5**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
Additional comment:	Used to calculate the emissions reductions from the project that are eligible to receive ERUs.

Data / Parameter:	**$AIFR_{trip}$**
Data unit:	*%*
Description:	*Maximum ammonia to air ratio in the ammonia burner (trip point value)*
Source of data used:	*Plant documentation*
Value(s) :	**13.1**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
Additional comment:	Used to determine periods where the plant was operating outside the trip point values during the project.

Data / Parameter:	**OT_{range}**
Data unit:	°C
Description:	*Trip point value range for the operating temperature in the AORs*
Source of data used:	*Plant documentation*
Value(s) :	**780-900**
Indicate what the data are used for (Baseline/ Project/ Leakage emission	Baseline / Project Emission Calculation.

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[11] The project specific approach at this plant including the application of the 4.5kg N_2O/t HNO_3 baseline emission factor has been approved during the determination of the PDD. See: Determination Report: Determination of the JI-Track-2project: “YARA Köping S2 N_2O abatement project in Sweden. Report No. 600500445. November 15th, 2010, page 14.

calculations)	
Additional comment:	Used to determine periods where the plant was operating outside the trip point values during the project.

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

<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 the monitoring period.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured/Calculated - every 2 sec. used for calculation of hourly mean values.</td></tr>
<tr><td>Source of data:</td><td>Dr. Födisch MCA 04 hot extractive emissions analyser</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>**139.08**</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 MCA 04 hot extractive emissions analyser</td></tr>
<tr><td>Serial Number:</td><td>09134 / SNF 43 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 – 21/06/2012
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>*± 0,51 % (ppm) (source: QAL2 reports 18/08/2010, 21/06/2012)*</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:</td></tr>
</table>

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

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

Where:
$NCSG$: N_2O concentration in the stack gas (mg/Nm^3)
$ppmv$: parts per million in volume
RMM: relative molecular mass of N_2O (44.013 mg)
v : standard volume of an ideal gas (22.4 Nm^3)
The resulting hourly average NCSG values are now expressed in mg/Nm^3 and are used for further data processing and calculation the calculation of EF_n and PE_n.
QAL2 correction factor for NCSG:
<table>
<tr><th>Time Period</th><th>value</th></tr>
<tr><td><i>01/03/2012 – 19/06/2012</i></td><td>1.0132</td></tr>
<tr><td><i>19/06/2012 – 30/09/2012</i></td><td>1.01</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure N°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><th>Data / Parameter:</th><th>VSG</th></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 verification period.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured/Calculated - every 2 seconds. Hourly mean values from the 2 seconds data are used for further emission reduction calculations.</td></tr>
<tr><td>Source of data:</td><td>Stack Gas Volume Flow Meter</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>61,029.37</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 (FMD 99 N, Update to FMD 09 in June 2012)</td></tr>
<tr><td>Serial Number<i>:</i></td><td>BR 14160</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 – 21/06/2012
AST: 14/07/2011</td></tr>
<tr><td>Validity</td><td>QAL2: 18/06/2016</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td><table>
<tr><td></td><td>AST: 18/06/2013</td></tr>
<tr><td>Overall measurement accuracy</td><td>± 0,51 % (ppm) (source: QAL2 reports 18/08/2010, 21/06/2012)</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>VSG is continuously monitored with a flow meter and monitoring results are recorded continuously (every 2 seconds) from which hourly mean value are built for the calculation of EF_n and PE_n.
The resulting hourly average values for VSG are now expressed in Nm^3/h.
QAL2 correction factor for VSG:<table>
<tr><th>Time Period</th><th></th></tr>
<tr><td>01/03/2012 – 19/06/2012</td><td>1.03</td></tr>
<tr><td>19/06/2012 – 30/09/2012</td><td>0.97</td></tr>
</table></td></tr>
<tr><td>QA/QC procedures applied:</td><td>Plant internal procedure AGRI-26665.
The flow meter is calibrated annually by AST and QAL2 test according to EN 14181.</td></tr>
</table>

<table>
<tr><th>Data / Parameter:</th><th>TSG</th></tr>
<tr><td>Data unit:</td><td>°C</td></tr>
<tr><td>Description:</td><td>Temperature in the stack gas</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Stack temperature probe located directly next to the volume flow meter;</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Not applicable, directly used for normalization of tail gas volume flow measurement.</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 (FMD 99 N, Update to FMD 09 in June 2012)</td></tr>
<tr><td>Serial Number:</td><td>BR 14160</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 – 21/06/2012
AST: 14/07/2011</td></tr>
<tr><td>Validity</td><td>QAL2: 18/06/2016</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>AST: 18/06/2013</td></tr>
<tr><td>Overall measurement accuracy</td><td>*± 0,51 % (ppm) (source: QAL2 reports 18/08/2010, 21/06/2012)*</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.
QAL2 correction factor for TSG:
<table>
<tr><th>Time Period</th><th></th></tr>
<tr><td>*01/03/2012 – 19/06/2012*</td><td>0.97</td></tr>
<tr><td>*19/06/2012 – 30/09/2012*</td><td>0.97</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>**Data / Parameter:**</td><td>**PSG**</td></tr>
<tr><td>Data unit:</td><td>**Bar**</td></tr>
<tr><td>Description:</td><td>Pressure in the stack</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured.</td></tr>
<tr><td>Source of data:</td><td>Stack temperature probe situated directly next to the volume flow meter.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>Not applicable, directly used for normalization of tail gas volume flow measurement.</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></td><td>
<table>
<tr><td>Type</td><td>Dr. Födisch FMD 99 (FMD 99 N, Update to FMD 09 in June 2012)</td></tr>
<tr><td>Serial Number*:*</td><td>BR 14160</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</td><td>QAL2: 01/06/2010 – 03/06/2010, 19/06/2012 –</td></tr>
</table>
</td></tr>
</table>

calibrations	21/06/2012 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, 21/06/2012)*

Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).
Calculation method (if applicable):	N/A
QA/QC procedures applied:	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. QAL2 correction factor for PSG:

Time Period	
01/03/2012 – 19/06/2012	1
19/06/2012 – 30/09/2012	1

Data / Parameter:	**PE_n**
Data unit:	**kgN_2O**
Description:	Total mass N_2O emissions in each verification period
Measured /Calculated /Default:	Calculated.
Source of data:	Calculated from measured values.
Value(s) of monitored parameter:	

Time period	**Value**
01/03/2012 – 30/09/2012	40,878.85

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):	$PE_n = \sum_{x=1}^{x=vmp}(NCSG_x * VSG_x * M_x * 10^{-6})$ Where: PE_n Total N_2O emissions during the specific verification period $(kgN2O)$ VSG_x Mean tail gas volume flow rate during the verification period (Nm^3/h) $NCSG_x$ Mean concentration of N_2O in the tail gas stream during one hour *x* in the verification period $(mgN2O/m^3)$ M_x Length of measurement internal in operation hours x (h) x Each measurement interval during the verification measurement period vmp verification measurement period
QA/QC procedures applied:	N/A

Data / Parameter:	**OH_n**
Data unit:	**Hours**
Description:	Total operating hours during each verification period
Measured /Calculated /Default:	Measured.
Source of data:	Production log.
Value(s) of monitored parameter:	**Time period** / **Value**: *01/03/2012 – 30/09/2012* 4,819
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)	Not applicable.
Measuring/ Reading/ Recording frequency:	Hourly.
Calculation method (if applicable):	The plant's operational status can be determined by whether or not NH_3 is still flowing into the AOR. When the ammonia valve status signal indicates that the plant's ammonia valve is closed, the plant is considered to be off-line. However, if the plant exceeds certain design parameters, it will automatically shut down. ("trip limits"). $AIFR_{trip}$: 13,1% OT_{range}: 780°C – 900°C When 2/3 of the temperature measure points exceed the trip values the plant will automatically shut down. Planned downtimes of single burner sets (e.g. for gauze changes) do not lead to a shutdown of the

	whole plant and will not turn the plants status signal into offline.
QA/QC procedures applied:	N/A

<table>
<tr><td>Data / Parameter:</td><td>NAP</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 verification period.</td></tr>
<tr><td>Measured /Calculated /Default:</td><td>Measured / Calculated.</td></tr>
<tr><td>Source of data:</td><td>Nitric acid flow measurement system:
1. Flexim ultrasonic measurement system 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>01/03/2012 – 30/09/2012</i></td><td>76,706.71</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 CD1</td></tr>
<tr><td>Serial Number<i>:</i></td><td><i>0746029</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>Date of last calibrations</td><td>06/12/2011
11/05/2012</td><td>N/A</td></tr>
<tr><td>Overall measurement accuracy</td><td>± <i>1.6% reading ± 0.01</i> m/s <i>(source: manufacturer)</i></td><td><i>0,1% of span</i></td></tr>
<tr><td>Sound velocity</td><td><i>0.25 % of reading ±0.33 ft/s</i></td><td><i>N/A</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>The new Flexim measurement system has been in operation for the whole of the project campaign. As a cross-check the nitric acid production had been ascertained by means of a mass balance calculation, taking into account ammonia consumption measured by <i>the Rosemount 3051 DP</i> as follows:</td></tr>
</table>

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

$$Production\ Syra\ 2 = \frac{Q_{501} * \rho_{NH3}}{K_1 * 1000}$$

Where:

Q_{501} = NH_3- inflow to the AORs in Nm^3/h
ρ_{NH3} = Density of ammonia: 0.771 kg/ Nm^3.
K_1 = Constant conversion factor (0.298 kg NH_3/kg HNO_3)

</td></tr>
<tr><td>QA/QC procedures applied:</td><td>

Plant internal procedure N° AGRI-26594

Cross checking on basis of the Ammonia mass balance calculation (formula 11)for this monitoring period results in the following amount of nitric acid produced:

74,083 t HNO_3

Applicable NAP cap according to PDD: 139,200 t/ year

<table>
<tr><td>Year</td><td>NAP</td><td>Monitoring Period</td></tr>
<tr><td>2012 (MP2)</td><td>23,980t</td><td>MP2</td></tr>
<tr><td>2012 (MP3)</td><td>76,707</td><td>MP3</td></tr>
</table>

The NAP cap was not reached during 2012. All NAP produced is therefore eligible for potential Emission Reduction Unit generation.

</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 verification period.</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 period 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><i>01/03/2012 – 30/09/2012</i></td><td>0.533</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</td><td>N/A</td></tr>
</table>

frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	N/A
Calculation method (if applicable):	$EF_n = \left({PE_n}/{NAP_n}\right)$ $(kgN2O/tHNO3)$ Where: PE_n Total N_2O emissions during the verification period n $(kgN2O)$ EF_n Emissions factor to calculate the emissions from verification period n $(kgN2O/tHNO3)$ NAP_n Nitric acid production during the verification period n $(tHNO3)$
QA/QC procedures applied:	N/A

<table>
<tr><td>Data / Parameter:</td><td>OP_h</td></tr>
<tr><td>Data unit:</td><td>kPa</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>N/A</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>N/A</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>Rosemount 1144</td></tr>
<tr><td>Serial Number:</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 reactors (AOR).
Measured /Calculated /Default:	Measured.
Source of data:	Thermocouple inside Ammonia Oxidation Reactors (AOR)
Value(s) of monitored	**N/A. Only used for monitoring OT_{range}.**

parameter:	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission Calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table><tr><th></th><th>***Device***</th></tr><tr><td>Type</td><td>PR electronics 5111</td></tr><tr><td>Serial Number*:*</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 *(source: manufacturer)*</td></tr></table>
Measuring/ Reading/ Recording frequency:	Continuously.
Calculation method (if applicable):	N/A
QA/QC procedures applied:	Thermocouples are replaced in case of malfunctioning.

Data / Parameter:	**AFR**
Data unit:	**tNH_3/h**
Description:	Ammonia gas flow rate to the ammonia oxidation reactors.
Measured /Calculated /Default:	Measured.
Source of data:	Continuously measured by Rosemount Type:1151 DP
Value(s) of monitored parameter:	**Not applicable.**
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)	<table><tr><td>Type</td><td>Rosemount Type: 3051 CD1</td></tr><tr><td>Serial Number*:*</td><td>N/A</td></tr><tr><td>Calibration frequency:</td><td>At stops > 6 h</td></tr><tr><td>Accuracy</td><td>0,1% of span</td></tr></table>
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:	**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.
Value(s) of monitored parameter:	**N/A**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	See AFR. N/A
Measuring/ Reading/ Recording frequency:	See AFR.
Calculation method (if applicable):	N/A
QA/QC procedures applied:	N/A

Data / Parameter:	$\mathbf{GS_{project}}$
Data unit:	**Name of Supplier**
Description:	Gauze supplier for the project campaign
Measured /Calculated /Default:	N/A
Source of data:	Monitored / Invoices
Value(s) of monitored parameter:	**KA Rasmussen, Norway**
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

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:	**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)	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

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.
Source of data used:	Verify data
Value(s) :	**N/A**
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline / Project emission calculations.
Additional comment:	

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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For establishing the baseline, a project-specific approach has been adopted: the conservative IPCC default emissions factor for N_2O from nitric acid plants that have not installed destruction measures - 4.5kg $N_2O/tHNO_3$ – has been applied for the proposed project. However, in order to show that historic plant emissions are higher than the default emissions factor, a 'Business-as-Usual' (BAU) emissions factor has been defined.

The factual emission reductions depend on the factual emissions of the plant prior to installation of the catalyst and the amount of nitric acid produced. In accordance with AM0034 ver 03.4, emission reductions are determined per unit of product measured in metric tonnes of 100% concentrated nitric acid produced.

At YARA Köping S2, the nitric acid production was usually monitored by a differential-pressure flow meter for continuous HNO_3-flow and HNO_3 concentration measurement. Since 31/05/2011 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.

The following formula was applied:

$$Production\ Syra\ 2\ = \frac{Q_{501} * \rho_{NH3}}{K_1 * 1000}$$

Where:

Q_{501} = NH_3- inflow to the AORs in $Nm3/h$

ρ_{NH3} = Density of ammonia: 0.771 $/Nm3.$

K_1 = constant conversion factor (0.298 $kgNH3/kgHNO3$)

A cross-check was carried out once per month with a mass balance calculation, taking into account the NH_3 consumption of the plant, the weight of solid ammonium nitrate produced from the nitric acid, and the weight of nitric acid that is exported off-site.

Table 8 below displays the expected nitric acid production amounts for the years 2010 to 2012 and the estimated N_2O emissions in the absence of the secondary abatement catalyst.

Hourly average measurements of stack gas volume flow, N_2O concentration and HNO_3 flow have been used to calculate daily average N_2O values (kg/$tHNO_3$). This data was recorded during the first 7 days following the installation of a new set of primary catalyst gauzes in one of the AOR systems (04/06/2010 to 10/06/2010), and the daily design capacity of the plant was not exceeded on any of the 7 days. The recorded data shows an average value of 7.27 kg $N_2O/tHNO_3$ and the lowest daily average value recorded during this period was 6.96 kg $N_2O/tHNO_3$. These values are considered to be conservative, since N_2O emissions are lowest after the installation of new primary gauzes. The data was recorded using the EN14181-compliant Automated Monitoring System (AMS), which is a Dr. Foedisch MCA 04 hot extractive analyser. This analyser successfully passed a QAL2 test on 1st June 2010. For more details on the QAL2 test please refer to Section C.

In addition, an analysis was conducted to establish that the plant was operating within its normal operating parameters during the 7-day measurement period. All standard plant operating data for all 6 burners, recorded since the installation of the new AMS, was subjected to a statistical analysis and compared with the operating parameters recorded from 04/06/2010 to 10/06/2010.

Analysed data: May to August 2010 (4 months)

1) Taking into account the relevant trip point parameters, an average figure was calculated for each of the operating parameters for the period May to August
2) The standard deviation of each parameter was calculated
3) Taking into account the relevant trip point parameters, an average figure was calculated for each of the operating parameters for the period 04/06/2010 to 10/06/2010
4) The two averages derived from steps 1 and 3 above were then compared to see whether the average figure for the period 04/06/2010 to 10/06/2010 lay within the average for the period May to August, +/- the standard deviation.

It could be concluded from the above statistical analysis that the plant was operating within its normal operating ranges for the 7-day measurement period. Evidence of this analysis has been provided to the Determining AIE.

Lastly, the composition of the primary catalyst gauze pack installed at the beginning of June 2010 was compared with the previous pack installed in the same AOR system (system 1) back in September 2008 and it can be seen that the gauze design has not been changed. The gauze weights and compositions are of a very confidential nature, but more detailed information has been provided to the determining AIE.

This Business-as-Usual (BAU) emissions factor of 7.27 $kgN_2O/tHNO_3$, in conjunction with the predicted abatement efficiency of the catalyst (90%), was used in this PDD in order to make realistic assumptions on the likely factual emissions reductions that might be expected during the project.

Table 8: Planned nitric acid production and estimated Business-as-Usual N_2O emissions at Köping S2

Year	Budgeted nitric acid production ($tHNO_3/y$)	BAU Emissions factor ($kgN_2O/tHNO_3$)	Expected BAU emissions (tCO_2e/y)
2010 (Oct to Dec)	34,000	7.27	76,626
2011	136,000	7.27	306,503
2012	136,000	7.27	306,503
Following years	136,000	7.27	306,503

However, as a result of the very specific and unusual layout of the S2 plant and its complex gauze changeover schedule, it was extremely difficult to establish the definition of a standard production ‘campaign’ in accordance with AM0034.

The methodology AM0034 v. 03.4 states that

> *"the start of a campaign is characterized by the installation of a new set of primary catalyst gauzes in the oxidation reactor [...] the period of time beginning from the installation of a new gauze pack until the subsequent plant shut down is defined as a 'campaign'".*

However, in the case of Syra 2 the pattern is more complex: There are three sets of two ammonia oxidation reactors (a total of 6 burners), named systems 1, 2 & 3. Since all 3 systems lead jointly into 9 absorption columns and subsequently into one stack, it is impossible to monitor which N_2O emissions and which HNO_3 production can be attributed to which individual burner or system.

The primary catalyst gauzes are changed in rotation in each of these systems at intervals of several months, with each individual set of gauzes being replaced approximately once every two years.

In order to overcome the difficulty of defining one ‘production campaign’ and to ensure conservativeness throughout the project, the conservative IPCC default emissions factor for N_2O from nitric acid plants that have not installed destruction measures - **4.5kg $N_2O/tHNO_3$** – has been applied for the proposed project[12]. Thus, the lowest and most conservative value for an N_2O emissions factor within the nitric acid industry (and one that is moreover suggested as a fallback value in case of missing data according to AM0034) shall serve as the baseline Emissions Factor for the project at Köping S2.

E.2. Project emissions calculation

Project emissions are calculated according to the following formula:

$$PE_n = \sum_{x=1}^{x=vmp} (NCSG_x * VSG_x * M_x * 10^{-6}) \qquad (kgN2O)$$

Where:

PE_n	Total N_2O emissions during the specific verification period $(kgN2O)$
VSG_x	Mean tail gas volume flow rate during the verification period (m^3/h)
$NCSG_x$	Mean concentration of N_2O in the tail gas stream during one hour *x* in the verification period $(mgN2O/m^3)$
M_x	Length of measurement internal in operating hours x (h)
x	Each measurement interval during the verification measurement period
vmp	verification measurement period

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 verification period n $(kgN2O)$
EF_n	Emissions factor to calculate the emissions from verification period n $(kgN2O/tHNO3)$
NAP_n	Nitric acid production during the verification period n $(tHNO3)$

Table 9 below displays the relevant monitoring data allowing to trace back the above results of Project Emissions Calculation.

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[12] The actual specified default value is 5kg $N_2O/tHNO_3$, but there is a 10% variability factor that should be deducted.

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use, Chapter 3: Chemical Industry Emissions, paragraph 3.3.2.2, table 3.3.

Table 9: Summary of the relevant Monitoring data of this verification period

PE_n	40,878.85	kgN_2O	total N_2O emissions during the specific Verification Period
OH_n	4,819	h	Operating hours of the plant during the Verification Period
NAP_n	76,706.71	$tHNO_3$	Nitric acid production during the Verification Period
NAP_{cross}	74,083.03	$tHNO_3$	Nitric acid production cross check during the Verification Period based on NH_3 mass balance consumption
NAP 2012 (MP2)	23,980.00	$tHNO_3$	Nitric acid production during 2012 (MP2)
NAP_{2012}	100,687	$tHNO_3$	Nitric acid production during 2012 (MP3)
EF_n	0.53292	kg N_2O /$tHNO_3$	Emissions factor used to calculate the emissions from the defined Verification Period n
EF_{BL}	4.50	kg N_2O /$tHNO_3$	Benchmark Emissions Factor
GWP_{N2O}	310	tCO_2e/tN_2O	IPCC default factor
ERU	**94,333**	**ERUs (tCO_2e)**	**Emission Reduction Units awardable to the project for this Verification Period (tCO_2e)**
ERU per year 2012 (MP2)	29,518	ERUs (tCO_2e)	Emission Reduction Units awarded to the project for year 2012 (MP2) (tCO2e)
ERU per year 2012 (MP3)	94,333	ERUs (tCO_2e)	Emission Reduction Units awardable to the project for year 2012 (MP3) (tCO2e)

E.3. Leakage calculation

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No leakage occurs under this project type.

E.4. Emission reductions calculation

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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.

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

Table 10: ERUs awardable to the project for the verification period

ERU	**94,333**	**ERUs (tCO_2e)**	**Emission Reduction Units awardable to the project for this Verification Period (tCO_2e)**

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

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This section includes a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Table 11: Comparison between ex-ante and ex-post calculation of ERUs

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	**159,070 during 348 days** **96,905 during 212 days** (Monitoring period length)	**94,333 during 212 days** (Monitoring period length)

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

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The emission reductions achieved during this monitoring period was lower than the ex-ante estimation of the PDD due to the following reasons:

- the abatement efficiency was slightly lower;
- Some unexpected downtimes occurred.

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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		