

MONITORING REPORT FORM (CDM-MR) *

Version 01 - in effect as of: 28/09/2010

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MONITORING REPORT

Version 02; 27/01/2012

YARA Köping S2 N₂O Abatement Project in Sweden

Reference Number: 0221

Monitoring period: Nr. 01, 12/11/2010 - 31/07/2011

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 N₂O 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 N₂O abatement catalyst

2. Brief description of the installed technology and equipments

The employed secondary N₂O 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 a state of the art Automated Measuring System (AMS), consisting of stack gas volume flow meter, N₂O analyzer, and respective data logging facilities. The AMS, as well as its installation, complies with the requirements of the European 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 ₂ O 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
31/07/2011	End of first monitoring period

4. Total emission reductions achieved in this monitoring period

Table 2: Emission Reduction Units achieved in this monitoring period distributed to years

Year	Emission Reduction Units (ERUs)
2010	11,918

2011	84,028
Sum	95,946

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 Coordinates¹:

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.

The project activity entails the implementation of:

- Secondary N₂O abatement technology that will be inserted in the ammonia oxidation reactors; and
- Specialised monitoring equipment to be installed at the stack

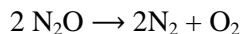
1. Catalyst Technology

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

¹ Coordinates according to Google Earth©

consecutive steps from the beginning of the production campaign in November 2010 (for exact dates please see Table 1

The secondary catalyst will reduce N₂O 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 N₂O 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:



If operated properly, the secondary catalyst system is expected to significantly reduce N₂O 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 levels². 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 N₂O 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 N₂O abatement catalyst that is widely installed in medium pressure plants in order to continue the project activity.

2. N₂O 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 N₂O.

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 industry³.

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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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.

This project activity is largely based on Approved Baseline and Monitoring methodologies AM0034 (Version 03.4): “Catalytic reduction of N₂O 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 ₂ O measurement	Continuous measurements of N ₂ O 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 ₂ O 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 ₂ O emissions from nitric acid plants will be applied as the baseline emissions factor, and therefore the measurement of N ₂ O 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 ₂ O 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 ₂ O from nitric acid plants that have not installed destruction measures - 4.5kg N ₂ O /tHNO ₃ – 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	The IPCC default value is applied as the Baseline Emissions Factor for assessing the amount of	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

	emissions.	emission reductions for which ERUs will be allocated.	conservativeness. The chosen value is the lowest and most conservative value for an N ₂ O 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 ₂ O 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 analysis in order to eliminate values which are not representative for standard plant operation.	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), 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	No baseline campaign is conducted.	In an AM0034 project, baseline emissions could be increased by extending the baseline campaign

	is capped for the baseline campaign.		beyond its business-as-usual production. This is due to N ₂ O 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 project campaigns (of the first 10 campaigns only). The higher value applies for calculating emission reductions.	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 each verification period, the EF _n value can vary significantly and thus the moving average emissions factor will lead to unrealistic and unrepresentative emissions factors.

<p>Minimum project emissions factor after 10th campaign</p>	<p>No project emissions factor after the 10th project campaign may be higher than the lowest recorded during these campaigns.</p>	<p>This restriction does not apply.</p>	<p>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.</p>
<p>AMS downtime</p>	<p>AM0034 states: In the event that the monitoring system is down, the lowest between the conservative 4.5 kg N₂O/tHNO₃ 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.</p>	<p>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 missing data will be done on the basis of hourly average values.</p> <p>In the case of equipment downtime due to a routine calibration for any part of one</p>	<p>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 N₂O /tHNO₃ IPCC default factor or the last measured value is therefore not applicable.</p> <p>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.</p> <p>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.</p>

		<p>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.</p>	
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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:

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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:	To be filled in after successful registration		
Start of crediting period	01/10/2010		
End of crediting period	31/12/2012		
Starting date of Project Activity	12/10/2009		
1 st verification period	12/11/2010 – 31/07/2011		
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 = excuded 0 = none
Plant Events				
2010.11.07	2010.11.12	Shutdown of burners	reduction in NA production	0

16:00	03:00	1&2		
2010.11.21 15:00	2010.11.26 10:00	Shutdown of burners 5&6	Catalyst installation in system 2	0
2010.11.29 19:00	2010.12.17 22:00	Shutdown of burners 3&4	Catalyst installation in system 3	0
2010.12.01 11:00	2010.12.02 10:00	Plant shut down	problems with steam supply	1
2010.12.03 06:00	2010.12.06 10:00	running at reduced capacity	to regulate stock	0
2010.12.11 00:00	2011.01.12 15:00	running at reduced capacity	to regulate stock	0
2010.12.16 18:00	2010.12.17 19:00	plant shut down	to regulate stock	1
2010.12.18 19:00	2010.12.20 14:00	Plant shut down	compressor problems	1
2010.12.28 10:00	2010.12.28 12:00	plant shut down	to fix water leakage	1
2011.02.08 11:00	2011.02.10 08:00	plant stop system 3	steam leakage	1
2011.02.18 17:00	2011.02.25 14:00	running at reduced capacity	to regulate stock	0
2011.03.20 17:00	2011.03.20 20:00	Plant shut down	compressor	1
2011.03.23 22:00	2011.03.24 03:00	Plant shut down	cleaning compressor	1
2011.03.25 08:00	2011.03.25 15:00	Plant shut down		1
2011.04.30 09:00	2011.05.11 14:00	Plant shut down	overhaul	1
2011.05.16 13:00	2011.05.16 16:00	Plant shut down	due to level in ammonia filter (LZ519)	1
2011.05.25 22:00	2011.05.29 03:00	Plant shut down	work in absorption and compressor	1
2011.06.22 10:00	2011.06.22 15:00	Plant shut down		1
2011.06.23 05:00	2011.06.24 04:00	plant shut down		1
2011.06.25 16:00	2011.06.25 20:00	plant shut down		1
2011.07.17 02:00	2011.07.17 08:00	plant shut down		1
2011.07.25 23:00	2011.07.29 04:00	plant shut down		1

Table 6: AMS downtimes and Maintenance deviations from BAU

From	To	Event/Reasons for downtime	Explanation/Action	impact on data 1 = highest measured value 2 = last valid hour 0 = none
AMS downtime				
2010.11.1 6 15:00	2010.11.1 6 17:00	Signal Analyser <1	Maintenance	1
2010.11.1 7 08:00	2010.11.1 7 19:00	Signal Analyser <1	Maintenance	1
2010.11.1 8 09:00	2010.11.1 8 16:00	Signal Analyser <1	Maintenance	1
2010.11.2 5 14:00	2010.11.2 5 14:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2010.12.2 0 14:30	2010.12.2 0 14:50	PLC problem	Restart	1
2010.12.2 1 06:00	2010.12.2 1 10:30	Ice in exhaust pipe	Remove plug and shortened hose	1
2011.01.2 1 11:00	2011.01.2 1 11:00	PLC problem	Restart	1
2011.02.2 1 06:00	2011.02.2 1 10:00	Signal Analyser <1	Maintenance	1
2011.03.0 3 12:50	2011.03.0 3 13:50	PLC Problem	Restart	1
2011.03.0 8 07:10	2011.03.0 8 07:50	PLC Problem	Restart	1
2011.03.0 3 13:00	2011.03.0 3 13:00	Signal Analyser <1	substitute value applies	1
2011.03.1 6 10:00	2011.03.1 6 10:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.03.3 1 07:00	2011.03.3 1 08:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.04.1 3 05:15	2011.04.1 3 09:00	PLC Problem	Analysis Dr. Födisch; Restart; substitute applies	1
2011.04.1 3 13:00	2011.04.1 3 13:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.04.2 7 11:00	2011.04.2 7 11:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.05.0 8 00:00	2011.05.2 1 20:00	bad analyser	changed into spare analyser fro Dr. Födisch	1
2011.05.1 2 10:00	2011.05.1 2 10:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2

2011.05.1 4 00:00	2011.05.1 4 00:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.05.1 7 16:00	2011.05.1 7 22:00	Signal Analyser <1	substitute value applies	1
2011.05.1 8 06:00	2011.05.1 8 06:00	Signal Analyser <1	substitute value applies	1
2011.05.1 8 08:00	2011.05.1 8 08:00	Signal Analyser <1	substitute value applies	1
2011.05.2 0 13:00	2011.05.2 0 16:00	Signal Analyser <1	substitute value applies	1
2011.05.2 0 17:00	2011.05.2 0 17:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.05.2 1 09:00	2011.05.2 1 09:00	Signal Analyser <1	substitute value applies	1
2011.05.2 3 07:00	2011.05.2 3 08:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.05.2 7 18:00	2011.05.2 8 15:00	Electricity failure due to thunder storm	Restart	1
2011.05.2 9 20:30	2011.05.2 9 21:00	Control Regulation	Change pump membrane	1
2011.05.3 0 07:00	2011.05.3 0 11:00	Analyser in Maintenance	substitute value applies	1
2011.05.3 1 06:00	2011.05.3 1 07:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2
2011.06.2 3 05:15	2011.06.2 3 06:45	General electric failure	Restart	1
2011.06.2 5 16:30	2011.06.2 5 22:30	Electricity failure due to thunder storm	Restart	1
2011.07.0 5 09:00	2011.07.0 5 15:00	Installation of fixed analyser	substitute value applies	1
2011.07.1 3 10:00	2011.07.1 3 14:00	QAL2	substitute value applies	1
2011.07.1 4 01:00	2011.07.1 4 08:00	cooler blocked with ice due to increased load from QAL2 instruments	venting and defrosting of cooling machine	1
2011.07.2 0 10:00	2011.07.2 0 10:00	Maintenance signal longer than 1/3 of an hour	substitute value applies	2

In total there were 133 hours where a substitute value applies. In 83 of these the maintenance signal was below “1” and the highest measured plausible value applied instead. In 50 hours of this monitoring period the maintenance signal was longer than 1/3 of an hour. Therefore the last valid value before that hour was applied as a substitute.

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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Description of the revision on the Monitoring Plan

During the monitoring period the monitoring plan had to be revised with regard to the Nitric acid flow measurement. According to the PDD a differential pressure nitric acid flow meter was to be used for the measurement for nitric acid flow and concentration. The measured amount was afterwards to be calculated at 100 percent concentration. However, a drift in the meter could be detected by May 2011. Therefore, the flow meter has been put out of operation and nitric acid measurement was replaced by ascertaining the nitric acid production via the ammonia inflow measured by the Rosemount 1151DP. The measured value is then put in a production figure of nitric acid applying the following formula:

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

Where:

Q_{501} = NH₃- inflow to the AORs in Nm³/h

ρ_{NH3} = Density of ammonia: 0,771 kg/ Nm³.

K_1 = constant conversion factor (0,298 kg NH₃/kg HNO₃)

The following table list the time periods for which the different meters have been in use for the measurement of the nitric acid produced:

Table 7: Time periods and applicable metering devices

Time period	Value	device
12/11/2010 – 31/05/2011	63,134.87	Flow meter with operator concentration measurement
01/06/2011- 31/07/2011	19,811.40	Rosemount 1151 DP
Date of installation 14/04/2011 Date of calibration 21/06/2011	Not yet in use for official figures	Flexim Piox TS374

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 meter 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.

Justification for the revision of the Monitoring Plan

The malfunctioning flow meter delivered wrong production figures, which could be detected through the applied cross check mechanisms. The produced amount of ammonia nitrate exceeded the highest possible production with the measured amount of nitric produced. In order to correct this error the

most appropriate, immediately available method has been the consideration of the ammonia inflow measurements and the application of the plant typical conversion factor which was derived from monthly mass balance experience and NOx analysis for the determination of the gauze efficiency of the plant.

The following method has been applied to determine the applicable conversion factor in the case of Syra 2:

Several Gas analyses undertaken over several years have been showing Ammonia - NOx-conversions of at least 97.5%, which is therefore 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 7% in the tail gas.⁴ This value has been deducted from the minimum gauze efficiency level and totals to a 90.5% ammonia – nitric acid conversion rate.⁵ Given a 100% conversion rate 270 kg NH₃ would be consumed for the production of 1 tonne of nitric acid (chemically ideal consumption). The conversion rate of 90.5 is divided by the ideal consumption rate resulting in conversion factor of 298 kg per produced tonne of Nitric Acid.

Table 8: Establishment of NH₃-conversion factor

	Syra 2
Gauze efficiency	97.5
NOX slip (to De-Nox level)	7%
TOT	90.5
Ideal consumption NH ₃ /HNO ₃	0.270
NH₃conversion factor	0.298

The results of the calculation method have been continuously cross checked against the quantity of HNO₃ exported off-site (SAP billing information), the quantity of ammonium nitrate produced from nitric acid on-site and the tank level measurements.⁶

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

⁴ 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 90.5% ammonia-nitric acid rate is therefore to be considered as conservative.

⁵ Evidence was provided to the verifying entity during on-site visit.

⁶ Evidence was provided to the verifying entity during on-site visit.

SECTION C. Description of the monitoring system

>>

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 analyzer; and
- 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 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 9: Responsibilities and Staff in Charge

Responsibility	Persons
Overall implementation of the project	Mr. Jon Sletten (Site Manager) Mr. Axel Sylvén (Process Engineer)
Quality assurance, operation and maintenance of the N ₂ O 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 certification⁷.

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 N₂O 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.

⁷ External auditor: DNV

3. Analyser

The Dr. Födisch MCA 04 Continuous Emissions Analyser is capable of analysing N₂O 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 N₂O, gas filter correlation technique is used.

According to EN 14181 the Analyser is QAL1⁸ 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, HCl, NH₃, H₂O. The QAL1 test for N₂O has been completed and was published on 28/07/2010 in the German "Bundesanzeiger".⁹ A QAL2 audit was performed by an independent laboratory with EN ISO/IEC 17025 accreditation following commissioning of the analyser on 3rd June 2010.

A hot extractive analyser was chosen in order to address a particular safety concern. Since the analyzer 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 analyzer solid nitrate/nitrite deposits could block the sampling lines, harm the analyzer and, in the worst case, lead to explosions when mechanically removed during maintenance works. In case of the MCA 04 analyzer 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-Analyzer for N₂O 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 emissions¹⁰ 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.

⁸ TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A vom 13. Juli 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 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

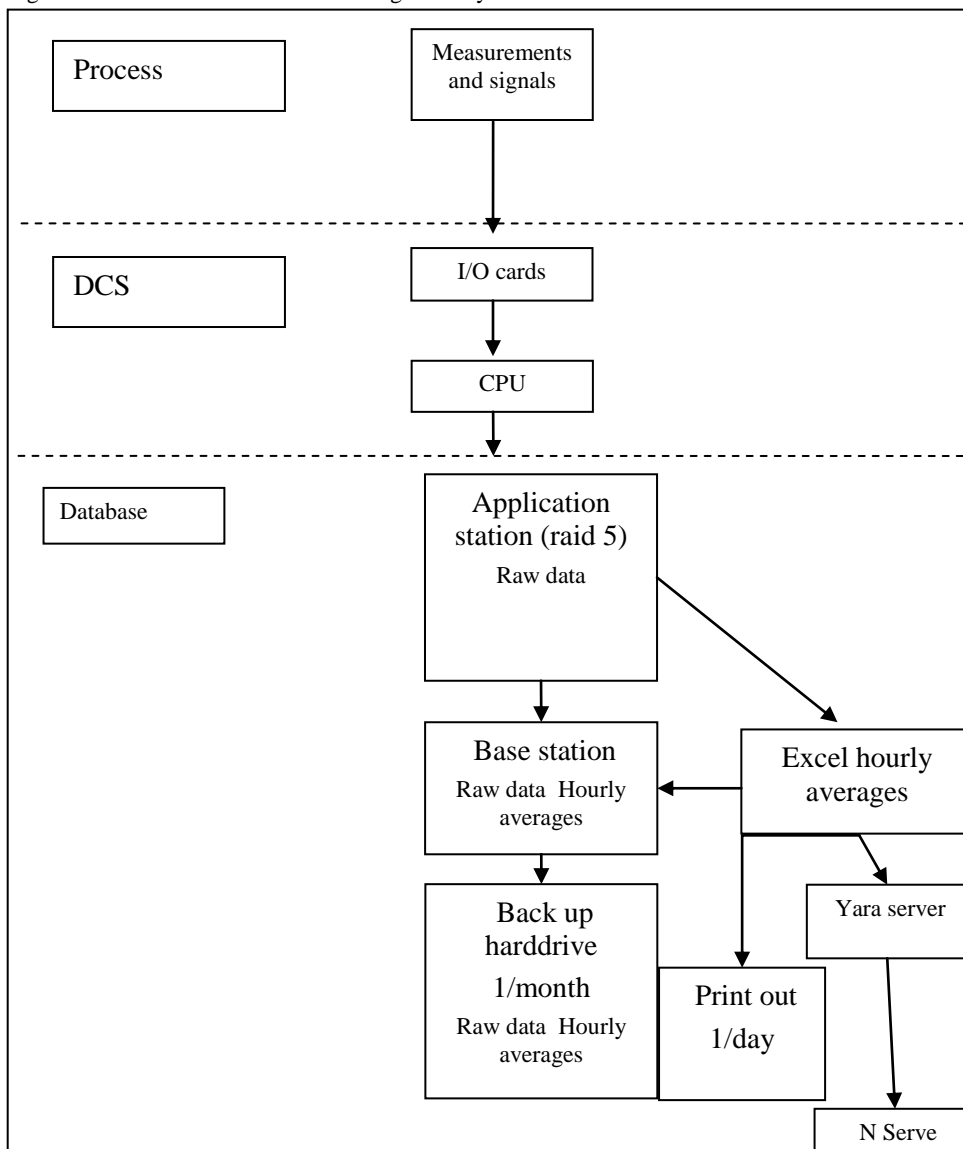
The YARA Köping S2 nitric acid plant is currently equipped with an Emerson DeltaV data collection and storage system that collects and stores the values for all the relevant monitoring parameters, as well as different status signals of the AMS and the NH₃ valve status signal from the nitric acid plant 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. 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

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.

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 QAL1¹¹ 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, HCl, NH₃, H₂O. The QAL1 test for N₂O has been completed and was published on 28/07/2010 in the German "Bundesanzeiger".¹² 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, Germany¹³.

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 years¹⁴ according to EN 14181 (or following any major change to the monitoring system).

¹¹ TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A from 13. July 2005

¹² TÜV Rheinland Energie und Umwelt (report number 936/21211571/B from 25. 03.2010)

¹³ 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)

¹⁴ Due to the fact that conducting the QAL2 and AST both require the plant being in operation some flexibility in regard to actual date of conduction is required. Events such as plant shut-down along with the aspects of availability and required

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 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 1st June 2010.

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 QAL 2 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 N₂O emissions data for this project will be made part of the ISO 9001 procedures.

N₂O-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).

N₂O-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).

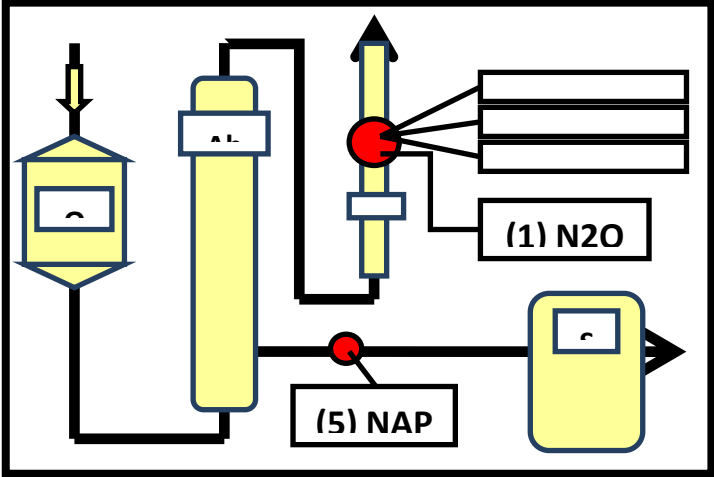
The results and subsequent actions are all documented as part of the QAL3 documentation. In addition, the analyser room and equipment is visually inspected at least once a week and the results are documented in analyser specific log-books.

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).

planning time (the test is to be carried out by an independent 3rd party holding respective accreditation, which usually comes from overseas) as well as customs check of the equipment, etc can easily delay execution of the test. This means that although once every year either QAL2 or AST shall be conducted the actual time period between 2 consecutive performances is not mandatorily bound to strictly one year (365 days) but allows for some tolerance. Nevertheless, under consideration of operating conditions and practical reasons it is generally aimed on performing the tests one to another as close to one year as possible.

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



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} ¹⁵
Data unit:	kg/tHNO ₃
Description:	<i>Baseline Emissions Factor - conservative IPCC default emissions factor for N₂O from nitric acid plants</i>
Source of data used:	<i>2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3,</i>
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:	<i>Maximum ammonia to air ratio in the ammonia burner (trip point value)</i>
Source of data used:	<i>Plant documentation</i>
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:	<i>Trip point value range for the operating temperature in the AORs</i>
Source of data used:	<i>Plant documentation</i>
Value(s) :	780-900
Indicate what the data are used for (Baseline/ Project/ Leakage emission)	Baseline / Project Emission Calculation.

¹⁵ The project specific approach at this plant including the application of the 4.5kg N₂O/t HNO₃ baseline emission factor has been approved during the determination of the PDD. See: Determination Report: Determination of the JI-Track-2project: "YARA Köping S2 N₂O 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.

Data / Parameter:	EF_{reg}
Data unit:	tN₂O/tHNO₃
Description:	N ₂ O Emissions cap for N ₂ O 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:	

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

Data / Parameter:	NCSG													
Data unit:	mg /Nm³													
Description:	Mean N ₂ O concentration in the stack gas during the monitoring period.													
Measured /Calculated /Default:	Measured/Calculated - every 2 sec. used for calculation of hourly mean values.													
Source of data:	Dr. Födisch MCA 04 hot extractive emissions analyser													
Value(s) of monitored parameter:	196.52													
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)	<table border="1"> <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 years¹⁶ AST in years in between QAL2</td> </tr> <tr> <td>date of last calibration</td> <td>QAL 2: 01/06/2010 – 03/06/2010 AST: 14/07/2011</td> </tr> <tr> <td>Validity</td> <td>QAL 2: June 2013 AST: July 2012</td> </tr> <tr> <td>Overall</td> <td></td> </tr> </table>		Type	Dr. Födisch MCA 04 hot extractive emissions analyser	Serial Number:	09134 / SNF 43 LWK	Calibration frequency:	Internal calibration: Weekly manual zero and span calibrations External calibrations QAL2 test at least every 3 years ¹⁶ AST in years in between QAL2	date of last calibration	QAL 2: 01/06/2010 – 03/06/2010 AST: 14/07/2011	Validity	QAL 2: June 2013 AST: July 2012	Overall	
Type	Dr. Födisch MCA 04 hot extractive emissions analyser													
Serial Number:	09134 / SNF 43 LWK													
Calibration frequency:	Internal calibration: Weekly manual zero and span calibrations External calibrations QAL2 test at least every 3 years ¹⁶ AST in years in between QAL2													
date of last calibration	QAL 2: 01/06/2010 – 03/06/2010 AST: 14/07/2011													
Validity	QAL 2: June 2013 AST: July 2012													
Overall														

¹⁶ Please see footnote 14.

	measurement accuracy	$\pm 0,51 \% (ppm)$ (source: QAL2 report 18/08/2010)				
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).					
Calculation method (if applicable):	<p>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.</p> <p>The analyser reads ppmv (parts per million in volume); in order to obtain mg/Nm³ the values are transferred by application of the following equation:</p> $NCSG = ppmv * \frac{RMM}{v}$ <p>Where:</p> <p>NCSG: N₂O concentration in the stack gas (mg/Nm³)</p> <p>ppmv: parts per million in volume</p> <p>RMM: relative molecular mass of N₂O (44.013 mg)</p> <p>v : standard volume of an ideal gas (22.4 Nm³)</p> <p>The resulting hourly average NCSG values are now expressed in mg/Nm³ and are used for further data processing and calculation the calculation of EF_n and PE_n.</p> <p>QAL2 correction factor for NCSG:</p> <table border="1"> <thead> <tr> <th>Time Period</th> <th>value</th> </tr> </thead> <tbody> <tr> <td>01/10/2010 - 31/07/2011</td> <td>1.0132</td> </tr> </tbody> </table>		Time Period	value	01/10/2010 - 31/07/2011	1.0132
Time Period	value					
01/10/2010 - 31/07/2011	1.0132					
QA/QC procedures applied:	<p>Plant internal procedure N° AGRI-26665.</p> <p>Manual zero and span calibrations, AST and QAL2 test according to EN 14181. QAL3 procedures according to EN 14181 applied through documentation and evaluation on site.</p>					

Data / Parameter:	VSG				
Data unit:	Nm³/h				
Description:	Normal gas volume flow rate of the stack gas during each verification period.				
Measured /Calculated /Default:	Measured/Calculated - every 2 seconds. Hourly mean values from the 2 seconds data are used for further emission reduction calculations.				
Source of data:	Stack Gas Volume Flow Meter				
Value(s) of monitored parameter:	56,739.91				
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	<table border="1"> <tr> <td>Type</td> <td>Dr. Födisch FMD 99</td> </tr> <tr> <td>Serial</td> <td>BR 14160</td> </tr> </table>	Type	Dr. Födisch FMD 99	Serial	BR 14160
Type	Dr. Födisch FMD 99				
Serial	BR 14160				

calibration, validity)	Number:					
	Calibration frequency:	Internal calibration: Weekly manual zero and span calibrations External calibrations QAL2 test at least every 3 years ¹⁷ AST in years in between QAL2				
	date of last calibration	QAL 2: 01/06/2010 – 03/06/2010 AST: 14/07/2011				
	Validity	QAL 2: June 2013 AST: July 2012				
	Overall measurement accuracy	± 0,51 % (ppm) (source: QAL2 report 18/08/2010)				
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).					
Calculation method (if applicable):	<p>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.</p> <p>The resulting hourly average values for VSG are now expressed in Nm³/h.</p> <p>QAL 2 correction factor for VSG:</p> <table border="1"> <thead> <tr> <th>Time Period</th> <th></th> </tr> </thead> <tbody> <tr> <td>01/10/2010 - 31/07/2011</td> <td>1.03</td> </tr> </tbody> </table>		Time Period		01/10/2010 - 31/07/2011	1.03
Time Period						
01/10/2010 - 31/07/2011	1.03					
QA/QC procedures applied:	<p>Plant internal procedure AGRI-26665.</p> <p>The flow meter is calibrated annually by AST and QAL2 test according to EN 14181.</p>					

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)	Project Emission calculations.						
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table border="1"> <tr> <td>Type</td> <td>Dr. Födisch FMD 99</td> </tr> <tr> <td>Serial Number:</td> <td>BR 14160</td> </tr> <tr> <td>Calibration</td> <td>Internal calibration: Weekly manual zero and span</td> </tr> </table>	Type	Dr. Födisch FMD 99	Serial Number:	BR 14160	Calibration	Internal calibration: Weekly manual zero and span
Type	Dr. Födisch FMD 99						
Serial Number:	BR 14160						
Calibration	Internal calibration: Weekly manual zero and span						

¹⁷ Please see footnote 14.

	frequency:	calibrations External calibrations QAL2 test at least every 3 years ¹⁸ AST in years in between QAL2				
	date of last calibration	QAL 2: 01/06/2010 – 03/06/2010 AST: 14/07/2011				
	Validity	QAL 2: June 2013 AST: July 2012				
	Overall measurement accuracy	± 0,51 % (ppm) (source: QAL2 report 18/08/2010)				
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).					
Calculation method (if applicable):	Not applicable.					
QA/QC procedures applied:	<p>Plant internal procedure AGRI-26665.</p> <p>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.</p> <p>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.</p> <p>QAL 2 correction factor for TSG:</p> <table border="1"> <thead> <tr> <th>Time Period</th> <th></th> </tr> </thead> <tbody> <tr> <td>01/10/2010 – 31/07/2011</td> <td>0.97</td> </tr> </tbody> </table>		Time Period		01/10/2010 – 31/07/2011	0.97
Time Period						
01/10/2010 – 31/07/2011	0.97					

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/ Leakage emission calculations)	Project emission calculations.				
	<table border="1"> <tr> <td>Type</td> <td>Dr. Födisch FMD 99</td> </tr> <tr> <td>Serial</td> <td>BR 14160</td> </tr> </table>	Type	Dr. Födisch FMD 99	Serial	BR 14160
Type	Dr. Födisch FMD 99				
Serial	BR 14160				

¹⁸ Please see footnote 14.

	Number:					
	Calibration frequency:	Internal calibration: Weekly manual zero and span calibrations External calibrations QAL2 test at least every 3 years ¹⁹ AST in years in between QAL2				
	date of last calibration	QAL 2: 01/06/2010 – 03/06/2010 AST: 14/07/2011				
	Validity	QAL 2: June 2013 AST: July 2012				
	Overall measurement accuracy	± 0,51 % (ppm) (source: QAL2 report 18/08/2010)				
Measuring/ Reading/ Recording frequency:	Continuously (every 2 seconds).					
Calculation method (if applicable):	N/A					
QA/QC procedures applied:	<p>Plant internal procedure AGRI-26665.</p> <p>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.</p> <p>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.</p> <p>QAL 2 correction factor for PSG:</p> <table border="1" data-bbox="564 1317 1291 1417"> <thead> <tr> <th>Time Period</th> <th></th> </tr> </thead> <tbody> <tr> <td>01/10/2010 - 31/07/2011</td> <td>1</td> </tr> </tbody> </table>		Time Period		01/10/2010 - 31/07/2011	1
Time Period						
01/10/2010 - 31/07/2011	1					

Data / Parameter:	PE_n	
Data unit:	kgN₂O	
Description:	Total mass N ₂ O emissions in each verification period	
Measured /Calculated /Default:	Calculated.	
Source of data:	Calculated from measured values.	
Value(s) of monitored parameter:	Time period	Value
	01/10/2010 – 31/07/2011	63,753.49
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations.	

¹⁹ Please see footnote 14.

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):	$PE_n = \sum_{x=1}^{x=vmp} (NCSG_x * VSG_x * M_x * 10^{-6})$ <p>Where:</p> <p>PE_n Total N₂O emissions during the specific verification period (<i>kgN2O</i>)</p> <p>VSG_x Mean tail gas volume flow rate during the verification period (<i>Nm³/h</i>)</p> <p>NCSG_x Mean concentration of N₂O in the tail gas stream during one hour x in the verification period (<i>mgN2O/m³</i>)</p> <p>M_x Length of measurement interval in operation hours x (<i>h</i>)</p> <p>x Each measurement interval during the verification measurement period</p> <p>vmp verification measurement period</p>
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	
	01/10/2010 – 31/07/2011	5,691	
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):	<p>The plant's operational status can be determined by whether or not NH₃ 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.</p> <p>However, if the plant exceeds certain design parameters, it will</p>		

	<p>automatically shut down. (“trip limits”).</p> <p>AIFR_{trip}: 13,1%</p> <p>OT_{range}: 780°C – 900°C</p> <p>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.</p>
QA/QC procedures applied:	N/A

Data / Parameter:	NAP			
Data unit:	tHNO₃			
Description:	Metric tonnes of 100% concentrated nitric acid during each verification period.			
Measured /Calculated /Default:	Measured / Calculated.			
Source of data:	Nitric acid flow meters: <ol style="list-style-type: none"> 1. Flow meter with operator concentration measurement 2. Flexim ultrasonic analyser Piox TS374 3. Rosemount 1151 DP 			
Value(s) of monitored parameter:	Time period	Value	device	
	<i>Start – 31/05/2011</i>	63,134.87	Flow meter with operator concentration measurement	
	<i>01/06/2011-31/07/2011</i>	19,811.40	Rosemount 1151 DP	
	<i>Date of installation 14/04/2011</i> <i>Date of calibration 21/06/2011</i>	Not yet in use for official figures	Flexim Piox TS374	
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)		Device 1	Device 2	Device 3
	Type	Flow meter with operator concentration measurement	Flexim Piox TS374	Mass flow meter: Rosemount 1151 DP
	Serial Number:	N/A	0746029	N/A
	Calibration frequency:	N/A	Every 6 month	At stops > 6 h
	date of last	N/A	21/06/2011	N/A

	calibration			
	Overall measurement accuracy	N/A	± 1.6% reading ± 0.01 m/s (source: manufacturer)	±0,25% of 20-100% of flow (±0,2°C)
Measuring/ Reading/ Recording frequency:	hourly			
Calculation method (if applicable):	<p><i>Device 1</i> and <i>device 2</i> devices continuously measure the nitric acid flow. Since an accurate and reliable HNO₃ flow meter has not been installed at the plant (the first flow meter started malfunctioning in April 2011), the nitric acid production is currently ascertained by means of a mass balance calculation, taking into account ammonia consumption measured by <i>the Rosemount 1151 DP</i> as follows:</p> $\text{Production Syra 2} = \frac{Q_{501} * \rho_{NH3}}{K_1 * 1000}$ <p>Where:</p> <p>Q₅₀₁ = NH₃- inflow to the AORs in Nm³/h ρ_{NH₃} = Density of ammonia: 0,771 kg/ Nm³. K₁ = Constant conversion factor (0,298 kg NH₃/kg HNO₃)</p> <p>This result is then cross-checked against the quantity of HNO₃ exported off-site (SAP billing information), the quantity of ammonium nitrate produced from nitric acid on-site and the tank level measurements.</p> <p>For further details on the revision of the monitoring plan and the calculation method please refer to section B.2.</p>			
QA/QC procedures applied:	Plant internal procedure N° AGRI-26594			

Data / Parameter:	EF_n		
Data unit:	kgN ₂ O/tHNO ₃		
Description:	Emissions factor for verification period.		
Measured /Calculated /Default:	Calculated.		
Source of data:	Calculation from total mass N ₂ O emissions of period n (PE _n) and total nitric acid production (NAP _n).		
Value(s) of monitored parameter:	Time period	Value	
	01/10/2010 - 31/07/2011	0.76861	
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/	N/A		

Recording frequency:	
Calculation method (if applicable):	$EF_n = \left(\frac{PE_n}{NAP_n} \right) \quad (kgN_2O / tHNO_3)$ <p>Where:</p> <p>PE_n Total N₂O emissions during the verification period n (kgN₂O)</p> <p>EF_n Emissions factor to calculate the emissions from verification period n (kgN₂O/tHNO₃)</p> <p>NAP_n Nitric acid production during the verification period n (tHNO₃)</p>
QA/QC procedures applied:	N/A

Data / Parameter:	OPh										
Data unit:	kPa										
Description:	Oxidation Pressure for each hour										
Measured /Calculated /Default:	Measured.										
Source of data:	N/A										
Value(s) of monitored parameter:	N/A										
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 border="1"> <thead> <tr> <th></th> <th><i>Device</i></th> </tr> </thead> <tbody> <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> </tbody> </table>		<i>Device</i>	Type	Rosemount 1144	Serial Number:	N/A	Calibration frequency:	At stops > 6 h	Overall measurement accuracy	±0,5% of calibration span, ±0,25% of 20-100% of flow
	<i>Device</i>										
Type	Rosemount 1144										
Serial Number:	N/A										
Calibration frequency:	At stops > 6 h										
Overall measurement accuracy	±0,5% of calibration span, ±0,25% of 20-100% of flow										
Measuring/ Reading/ Recording frequency:	N/A										
Calculation method (if applicable):	N/A										
QA/QC procedures applied	N/A										

Data / Parameter:	OTh
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 parameter:	N/A. Only used for monitoring OT_{range}.
Indicate what the data are used for (Baseline/ Project/	Project Emission Calculation.

Leakage emission calculations)											
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table border="1"> <thead> <tr> <th></th> <th><i>Device</i></th> </tr> </thead> <tbody> <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 (<i>source: manufacturer</i>)</td> </tr> </tbody> </table>		<i>Device</i>	Type	PR electronics 5111	Serial Number:	N/A	Calibration frequency:	At stops > 6 h (exchange of thermocouples)	Overall measurement accuracy	± 0,5°C (<i>source: manufacturer</i>)
	<i>Device</i>										
Type	PR electronics 5111										
Serial Number:	N/A										
Calibration frequency:	At stops > 6 h (exchange of thermocouples)										
Overall measurement accuracy	± 0,5°C (<i>source: manufacturer</i>)										
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:	tNH₃/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 border="1"> <tbody> <tr> <td>Type</td> <td>Rosemount Type:1151 DP</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>±0,25% of 20-100% of flow</td> </tr> </tbody> </table>	Type	Rosemount Type:1151 DP	Serial Number:	N/A	Calibration frequency:	At stops > 6 h	Accuracy	±0,25% of 20-100% of flow
Type	Rosemount Type:1151 DP								
Serial Number:	N/A								
Calibration frequency:	At stops > 6 h								
Accuracy	±0,25% of 20-100% of flow								
Measuring/ Reading/ Recording frequency:	Continuously.								
Calculation method (if applicable):	N/A								
QA/QC procedures applied:	<p>Plant internal procedures AGRI-25391, AGRI-25417.</p> <p>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.</p>								

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:	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

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 N₂O from nitric acid plants that have not installed destruction measures - 4.5kg N₂O/tHNO₃ – 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 HNO₃-flow and HNO₃ concentration measurement. Since 31/05/2011 the meter has been drifting and therefore has not been used anymore for NAP-measurement. Alternatively, the measured NH₃-inflow was combined with a conversion factor for calculating back the HNO₃ production to substitute the direct measurement for the time being.

The following formula was applied:

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

Where:

Q₅₀₁ = NH₃- inflow to the AORs in Nm³/h

ρ_{NH₃} = Density of ammonia: 0,771 kg/Nm³.

K₁ = constant conversion factor (0,298 kgNH₃/kgHNO₃)

On 14/04/2011 a FLEXIM ultrasonic flow meter has been installed in order to harmonize the HNO₃-measurement approaches of Syra 2 and Syra 3. It was calibrated on 21/06/2011 but was not yet used for official figures.

A cross-check is carried out once per month with a mass balance calculation, taking into account the NH₃ 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 10 below displays the expected nitric acid production amounts for the years 2010 to 2012 and the estimated N₂O emissions in the absence of the secondary abatement catalyst.

Hourly average measurements of stack gas volume flow, N₂O concentration and HNO₃ flow have been used to calculate daily average N₂O values (kg/tHNO₃). 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 (4th to 10th June 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 N₂O/tHNO₃ and the lowest daily average value recorded during this period was 6.96 kg N₂O/tHNO₃. These values are considered to be conservative, since N₂O 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 QAL 2 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 4th to 10th June 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 4th to 10th June
- 4) The two averages derived from steps 1 and 3 above were then compared to see whether the average figure for the period 4th – 10th June 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 kgN₂O/tHNO₃, 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 10: Planned nitric acid production and estimated Business-as-Usual N₂O emissions at Köping S2

Year	Budgeted nitric acid production (tHNO ₃ /y)	BAU Emissions factor (kgN ₂ O/tHNO ₃)	Expected BAU emissions (tCO ₂ e/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 N₂O emissions and which HNO₃ 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 N₂O from nitric acid plants that have not installed destruction measures - **4.5kg N₂O/tHNO₃** – has been applied for the proposed project²⁰. Thus, the lowest and most conservative value for an N₂O 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:

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

Where:

PE _n	Total N ₂ O emissions during the specific verification period (<i>kgN2O</i>)
VSG _x	Mean tail gas volume flow rate during the verification period (<i>m³/h</i>)
NCSG _x	Mean concentration of N ₂ O in the tail gas stream during one hour x in the verification period (<i>mgN2O/m³</i>)
M _x	Length of measurement interval in operating hours x (<i>h</i>)
x	Each measurement interval during the verification measurement period
vmp	verification measurement period

Based on the total N₂O emissions of each project campaign the specific project campaign emission factor is calculated as:

$$EF_n = \left(\frac{PE_n}{NAP_n} \right) \quad (kgN2O/tHNO3)$$

Where:

PE _n	Total N ₂ O emissions during the verification period n (<i>kgN2O</i>)
EF _n	Emissions factor to calculate the emissions from verification period n (<i>kgN2O/tHNO3</i>)
NAP _n	Nitric acid production during the verification period n (<i>tHNO3</i>)

Table 11 below displays the relevant monitoring data allowing to trace back the above results of Project Emissions Calculation.

Table 11: Summary of the relevant Monitoring data of this verification period

PE _n	63,753.49	kgN2O	total N2O emissions during the specific Verification Period
OH _n	5,691	h	Operating hours of the plant during the Verification Period
NAP _n	82,946.27	tHNO3	Nitric acid production during the Verification Period
EF _n	0.76861	kg N2O /tHNO3	Emissions factor used to calculate the emissions from the defined Verification Period n

²⁰ The actual specified default value is 5kg N₂O/tHNO₃, but there is a 10% variability factor that should be deducted.

EF _{BL}	4.50	kg N ₂ O /tHNO ₃	Benchmark Emissions Factor
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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 CO₂e emission reductions eligible for issuance of Emission Reduction Units (ERUs) is calculated by applying the difference between the applicable Baseline N₂O Emission Factor (EF_{BL}) and the project specific N₂O Emission Factor (EF_n) to the respective amount of Nitric Acid Production (NAP_n).

Applying the specific global warming potential of N₂O (310 tCO₂e/tN₂O) results in the respective amount of achieved CO₂e emission reductions that are claimed for issuance of ERUs.

$$ERU = \left(\frac{EF_{BM} - EF_n}{1000} * NAP * GWP_{N_2O} \right) \quad (tCO_2e)$$

Table 12: ERUs awardable to the project for the verification period

ERU	95,946	ERUs (tCO ₂ e)	Emission Reduction Units awardable to the project for the verification period (tCO ₂ e)
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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 13: 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 ₂ e)	159,070 during 348 days 119,303 during 261 days (Monitoring period length)	95,946 during 261 days (Monitoring period length)

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

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N/A

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		