



**JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006**

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SECTION A. General description of the project**A.1. Title of the project:**

YARA Siilinjärvi N₂O abatement project in Finland

Version: 7th April 2010 (Version #5)

A.2. Description of the project:

The sole purpose of the proposed project activity is to significantly reduce current levels of N₂O emissions from the production of nitric acid at YARA's nitric acid plant at Siilinjärvi (near Kuopio), Finland.

The nitric acid plant was designed by Uhde. Commercial nitric acid production started in 1973. It is a 3.8 bar mono pressure plant with an annual design production output of 149,500 metric tonnes of HNO₃ (100% conc.)¹. YARA Siilinjärvi runs plant campaigns of 355 days. Depending on whether or not the plant is shut down for maintenance purposes or exchange of the primary catalyst gauze, the plant is operated between 341 and 351 days per year.

To produce nitric acid, ammonia (NH₃) is reacted with air over precious metal – normally a platinum-rhodium- (Pt-Rh) alloy – catalyst gauze pack in the ammonia oxidation reactor of the nitric acid plant. The main product of this reaction is NO, which is metastable at the conditions present in the ammonia oxidation reactor and therefore it reacts with the available oxygen to form NO₂, which is later absorbed in water to form HNO₃ – nitric acid. Simultaneously, undesired side reactions yield nitrous oxide (N₂O), nitrogen and water. N₂O is a potent greenhouse gas with a Global Warming Potential (GWP) of 310². The plant currently emits an average of 7.69kgN₂O/tHNO₃ which means that the continued operation of the plant without any N₂O abatement technology installed could entail emissions of as much as 356,393 tCO₂e annually³. Until the end of December 2012, this is considered to be the business as usual scenario⁴.

The project activity involves the installation of a new N₂O abatement technology: a pelleted catalyst that will be installed inside the ammonia oxidation reactor, underneath the precious metal gauzes. It is expected that this catalyst will reduce approximately 85% of current N₂O emissions on average over its lifetime.

The N₂O abatement catalyst applied to the proposed project has been developed by YARA. Industrial trial runs have been undertaken at various YARA plants (mainly in France) over the last four years. By now, the YARA management considers the technology as sufficiently mature for full application in nitric acid plants.

For tracking the N₂O emission levels, YARA Siilinjärvi will install and operate an Automated Monitoring System according to EU standards⁵.

¹ All nitric acid amounts are provided in metric tonnes of 100% concentrated HNO₃, unless otherwise indicated.

² IPCC Second Assessment Report (1995); applicable according to UNFCCC-decision 2/CP.3, paragraph 3. After 2012 the GWP of N₂O will be 298, as defined by the IPCC Fourth Assessment Report in connection with Art 5 paragraph 3 Kyoto Protocol.

³ Based on the design capacity of the plant as 149,500t per year. See section A 4.3.1 for more details

⁴ See section A.4.3.1 and B.2 for detailed information.

⁵ See section D.1 for detailed information.

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YARA Siilinjärvi adheres to ISO 9001 / 14001 management standards⁶ and will implement procedures for monitoring, regular calibrations and QA/QC in line with the requirements of these standards.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Finland (host)	YARA Suomi Kemphos Oy (Helsinki)	No
Norway	YARA International ASA, Oslo (Norway)	No
Germany	N.serve Environmental Services GmbH (Germany)	No

This JI project will be developed as a party verified activity in accordance with UNFCCC decision 9/CMP.1, paragraph 23 by the host country Finland.

A.4. Technical description of the project:**A.4.1. Location of the project:****A.4.1.1. Host Party(ies):**

Finland

A.4.1.2. Region/State/Province etc.:

Kuopio

A.4.1.3. City/Town/Community etc.:

Siilinjärvi

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

⁶ Yara Siilinjärvi had a new audit at the end of June for ISO 9001, ISO 14001 and OHSAS 18001 certificates. All quality management documents are stored on the internal YARA Siilinjärvi database and will be made available to the AIEs upon request.



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The picture below illustrates the location of the plant. The coloured mark is set at the stack of the respective plant. The ammonia burner is located inside the building just north east of the stack and the two absorption towers.



Figure 1: Location of YARA Siilinjärvi plant

Plant absorption towers: $63^{\circ} 05'49.79''N, 27^{\circ}44'35.44''E$

A.4.2. Technology (ies) to be employed, or measures, operations or actions to be implemented by the project:

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

The precious metal gauze pack – i.e. the primary catalyst required for the actual production of nitric acid – is currently supplied by KAR Rasmussen located in Norway.

The project activity entails the implementation of:



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- N₂O abatement technology, until recently only applied on industrial trial level within the European Union that will be inserted into the ammonia oxidation reactor after slight modifications to its interior structure; and
- Specialised monitoring equipment to be installed at the stack (detailed information on the AMS is contained in section D.1).

Catalyst Technology

A number of N₂O abatement technologies have become commercially available in the past 4 years after several years of research, development and industrial testing. Since the end of 2005, several CDM project activities employing various kinds of N₂O abatement catalysts have been registered with the CDM EB. But these activities are naturally limited to plants located in developing nations.

Due to lack of incentives for voluntary reductions before 2008 and the absence of legal limits on industrial N₂O emissions in nearly all the European Union member states, the vast majority of EU based plant operators have so far not invested in N₂O abatement devices. YARA International ASA (Norway) is a noteworthy exception to this general rule, because the company conducted long term industrial trial runs of its self-developed catalyst system YARA58 Y 1 ® in various plants in France since 2005. However, these trials have recently been completed.

Until now, the longer term use of the catalyst system could only be facilitated by the incentives set by the CDM.

The plant operated by YARA Siilinjärvi has not been part of the catalyst industrial trial programme. Thus, the proposed JI project activity entails a first time installation of secondary catalyst technology at the plant.



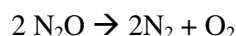
Figure 2: Installation of secondary catalyst



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YARA Siilinjärvi will install the YARA 58 Y 1® catalyst system consisting of an additional base metal catalyst that is positioned below the standard precious metal gauze pack in the ammonia burner. Operation with a full batch of catalyst installed began on 26th June 2009.

A 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 58 Y 1® abatement catalyst is made of cylindrical pellets containing cobalt as an active ingredient. The abatement efficiency has been shown to be more than 80% in the following reaction:



If operated properly, the secondary catalyst system may significantly reduce N₂O emissions for up to three years, before the catalyst material needs to be replaced.

The YARA 58 Y 1® abatement catalyst has been proven by industrial testing not to affect plant production levels⁷. Also, only traces of the catalyst material at concentrations of parts per billion could be found in the nitric acid product⁸. 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.

Basket modifications and Heat Shield design

Most nitric acid plants have some sort of basket structure that gives structural support to the precious metal gauzes. The ammonia oxidation reaction in YARA's Siilinjärvi nitric acid plant normally operates at temperatures between 860 and 915°C, which causes the basket assembly to expand compared to when the plant is not operational (i.e. during installation of the catalyst).

This effect increases the basket diameter by 1 to 1.5%. The ammonia oxidation reactor of the plant has a diameter of 2640 mm that expands by 26.4 to 39.6 mm when in operation. The pelleted ceramic abatement catalyst does not expand in the same fashion and therefore a gap at the perimeter of the catalyst may occur under normal operation, which would significantly reduce the efficiency of the abatement catalyst. To counter this occurrence, the basket that supports the catalyst installation and the gauze pack will have to be modified⁹ to provide containment of the pelleted bed in a manner, which will prevent preferential gas flow at the circumference and to optimise the N₂O abatement efficiency of the catalyst.

⁷ 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 152 therein. This source states that NO yields for the ammonia oxidation reaction remain unchanged when operating secondary N₂O abatement catalysts.

⁸ This has been proven in industrial testing. The underlying information is commercially sensitive and will be made available to the DOE mandated with the determination procedure upon request. General information on this question is contained in the European IPPC Bureau publication „Integrated Pollution Prevention and Control; Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilizers (August 2007), page 152 therein (available for downloading under <http://eippcb.jrc.ec.europa.eu/pages/FActivities.htm>)

⁹ The modifications required to prevent preferential gas flow are of commercially sensitive nature. The AIE representative will be allowed to verify this information during the on-site visit.



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N₂O abatement catalyst installation

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

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

YARA's Siilinjärvi nitric acid plant operates at a pressure of around 3.8 bars inside the ammonia oxidation reactor. Through the introduction of the secondary catalyst into the ammonia reactor, a slight pressure drop (ΔP) is expected to occur. This ΔP may lead to a slight reduction in ammonia conversion efficiency and hence a very small reduction in nitric acid output. In practice, this loss of production is likely to be insignificant.

Technology operation and safety issues

As mentioned before, the secondary abatement technology has been tested in several industrial trials and has proven to be a reliable and environmentally safe method of reducing N₂O. Once installed, the catalyst and the AMS will be operated, maintained and supervised by the employees of YARA Siilinjärvi according to standards that are normally used in the European industry¹⁰. Due to the long-term catalyst development phase, there is expert know-how readily available within the YARA group. Therefore, YARA Siilinjärvi is 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. Adherence to the applicable standards will be ensured by thorough and regularly repeated training sessions for the YARA employees involved.

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

Without JI participation, present emission levels would

- have remained unchanged until end of December 2012, because
 - there is no legal requirement for YARA Siilinjärvi to reduce the emissions of its plant before 1st January 2013;
 - implementing N₂O reduction catalyst technology requires significant investments, may result in some technical difficulties with regard to the plant's operation, potentially even causing a reduction in production output; and
 - implementing N₂O catalyst technology does not yield any other benefits besides potential revenues from ERU sales.

More detail on these assumptions will be provided in section B.2 below.

¹⁰ See section D.3 below Detailed information about the supervision procedure will be available during the on-site determination.



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A.4.3.1. Estimated amount of emission reductions over the crediting period:

The following paragraph describes the **factual** emission reductions achievable by the project activity.

Nitric acid production and factual emissions

The factual emission reductions will 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, emission reductions are determined per unit of product measured in metric tonnes of 100% concentrated nitric acid produced.

At YARA Siilinjärvi, the nitric acid production is monitored by a coriolis flow meter for continuous HNO₃-flow and HNO₃ concentration measurement. The uncertainty ranges between +/- 0.2 %. The concentration measurement is checked once a shift by the operator and twice a month by a central laboratory. As displayed in table 1, the historic production ranged in between 136,756 and 142,812 tHNO₃

Yara Sillinjärvi has been reporting calculated N₂O emissions based on random day spot checks to the local environmental authorities the North Savo Regional Environment Centre¹¹ on a yearly basis. Between 2003 and 2008, yearly N₂O emissions ranged between 1101 (min) and 1354 (max) tN₂O¹². Based on the annual nitric acid production¹³ between 2003 and 2008, pre-project emissions factors have been calculated to range between 7.75 (min) and 9.59 (max) kgN₂O/tHNO₃ (see table 1).

Year	Nitric Acid production [tHNO ₃ /y]	Annual emissions (tN ₂ O)	Pre-project emissions N ₂ O [kg/tHNO ₃]	Pre-project emissions [tCO ₂ e]
2003	141,137	1,354	9.59	419,740
2004	142,812	1,200	8.40	372,000
2005	136,756	1,300	9.51	403,000
2006	141,210	1,350	9.56	418,500
2007	139,301	1,300	9.33	403,000
2008	142,009	1,101	7.75	341,310

Table 1: Siilinjärvi historic nitric acid production and annual emissions based on random day spot values that were reported to the local environmental authorities

Table 2 displays the budgeted production amounts for the years 2009 to 2012 and the estimated N₂O emissions. Please note that due to the current economic situation, the production figures and

¹¹ <http://www.ymparisto.fi/default.asp?contentid=16971&lan=en>

¹² The figures can be found in the official data base of VAHTI (www.tyvi.fi). The data is also publically available on the European EPER database, which is updated every three years. Data for 2007 are not available yet.

Data 2004: http://eper.ec.europa.eu/eper/facility_details.asp?id=196450&year=2004&CountryCode=FI year 2004

¹³ The nitric acid production has been monitored with a coriolis flow meter since 2003.

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N₂O emissions in table 2 might have to be adjusted during the project activity, especially in 2009 and 2010.

Since 1st April 2008, a Servomex 4900 infrared analyser has been installed that measures the N₂O concentration continuously before and after the De-NO_x system¹⁴. The measurements of the first 147 days (5 months) of the current campaign (campaign starting date: 12.06.2008; campaign length: 355 days) reveal an average N₂O concentration equal to 7.69 kgN₂O/tHNO₃. Unfortunately, data collected between 5th November 2008 and 26th of March 2009 were destroyed due to technical problems within the analyser system. However, reliable data was gathered over a period of 147 days, which represents 2/5 of the total campaign. Moreover, this data was taken from the first part of the campaign, and therefore 7.69 kgN₂O/tHNO₃ represents a conservative value as emissions tend to increase towards the end of a campaign¹⁵.

One of the main purposes for establishing a pre-project emissions factor for the project activity is to prove that the historic plant emissions are indeed higher than the highest benchmark value, as described in section A.5 below. Please note that all calculated historic emissions factors shown in table 1 are higher than the defined pre-project emissions factor of 7.69 kgN₂O/tHNO₃, also proving that this figure is sufficiently conservative.

This pre-project emissions factor, in conjunction with the predicted abatement efficiency of the catalyst, will be used in order to make realistic assumptions on the emissions factor that might be expected during the project activity.

Year	Budgeted nitric acid production (tHNO ₃ /y)	tN ₂ O (baseline / business as usual emissions)	Emissions factor (kgN ₂ O/tHNO ₃)
2009	127,000	976.6	7.69
2010	147,000	1130.4	7.69
2011	147,000	1130.4	7.69
2012	147,000	1130.4	7.69
Following years	147,000	1130.4	7.69

Table 2: Planned nitric acid production and estimated N₂O emissions at Siilinärvi's plant

Estimation of the emissions reductions eligible to receive ERUs

Deviating from AM0034, factual (historic) emission reductions will not serve as a basis for determining the amount of ERUs issued¹⁶ to the Project Participants for their free use.

For the reasons described in section A.5 below, a benchmark value will be applied by the national Environmental Protection Department of the Finnish Ministry of the Environment¹⁷. Accordingly,

¹⁴ This analyser will be replaced in June 2009 by a Foedisch MCA 04 hot extractive analyser. For more details, see section D.1

¹⁵ See IPCC Reference document on Best Available Techniques for the Manufactures of Large Volume Inorganic Chemicals- Ammonia, Acids and Fertilisers 2006, p.110/111.

¹⁶ See section A5 & E.6 below for detailed information.

¹⁷ <http://www.ymparisto.fi/default.asp?node=6039&lan=en>

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the **following assumptions** apply to the establishment of the emissions reductions eligible for ERUs:

- The project activity starts on 26th June 2009;
- YARA Siilinjärvi produces the amounts of nitric acid according to the production budget provided above, each year's production being equally distributed throughout the period;
- Factual emissions from the plant without catalyst would be higher than the highest benchmark level of 2.5kgN₂O/tHNO₃;
- The secondary catalyst employed performs with an expected abatement efficiency of 80% throughout the project's lifetime (resulting in an average project emissions factor of 1.538kgN₂O/tHNO₃);
- The ERU figures included in this PDD are conservative *estimations* only. ERUs will therefore finally be awarded for those factual emissions reductions achieved below the applicable benchmark emissions factor and subsequently verified by the responsible AIE, and not in accordance with the preliminary estimations provided in this PDD.

The following tables 3 and 4 display the emissions reductions expected during the crediting period.

Crediting Period (years)	Nitric Acid Production [tHNO₃]	Emission Reductions [tCO₂e]
2009	65,264	19,463
2010	147,000	43,838
2011	147,000	43,838
2012	147,000	14,218
Subtotal (estimated)	506,264	121,358
Average per year (until end 2012)	144,075	34,537

Table 3 (part A): Estimated emission reductions with applied benchmark factor until 2012



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Crediting Period (years)	Nitric Acid Production [tHNO ₃]	Emission reductions [tCO ₂ e]
2013	147,000	13,667
2014	147,000	13,667
2015	147,000	13,667
2016	147,000	13,667
2017	147,000	13,667
2018	147,000	13,667
2019	71,458	6,644
Total number of crediting years		10
Total estimated (2009 to 2019)	1,459,722	210,006
Annual average (2009 to 2019)	145,972	21,001

Table 4 (part B): Estimated emission reductions with applied benchmark factor from 2013 onwards.

* Due to the likely inclusion of N₂O emissions emanating from nitric acid production into the EU ETS from 1st January 2013 onwards, the project may not be eligible to earn ERUs after that time or continuing the project under the JI may not be economically viable. Also, from 2013 onwards a GWP of 298 for N₂O as defined by the IPCC Third Assessment Report will be applied. This is why this PDD differentiates in between prospective emission reductions achieved until 31st December 2012 and emissions reductions generated from 1st January 2013 onwards.

A.5. Project approval by the Parties involved:

On the basis of the Project Idea Note (PIN) submitted on 12th of March 2009, the Finnish DFP (Environmental Protection Department of the Finnish Ministry of the Environment) has stated not to have any objections against the realization of the planned JI project. However, this indication is legally not binding.

A final decision regarding approval of the JI project will be taken at the end of the official project approval procedures that will be initiated upon the submission of the full project dossier.

The project proponents will apply the approved CDM baseline & monitoring methodology AM0034, version 03.4, “Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants” to the intended project activity. However, some amendments were made in order to take the project-specific context into account. The most decisive deviation is the implementation of a benchmark value used for calculating the emission reductions for which ERUs will be awarded. The project proponents will only receive ERUs in so far as the project activity achieves emission levels below that benchmark value. All emission reductions achieved from the business-as-usual emission level down to the benchmark value result in freed AAUs, which count towards the Finnish Kyoto target¹⁸. The concept of a benchmark value is outlined in the illustration below.

¹⁸ If ERUs were issued for these, the equivalent amount of AAUs would have to be cancelled; see Art 3 paragraph 11 Kyoto Protocol.



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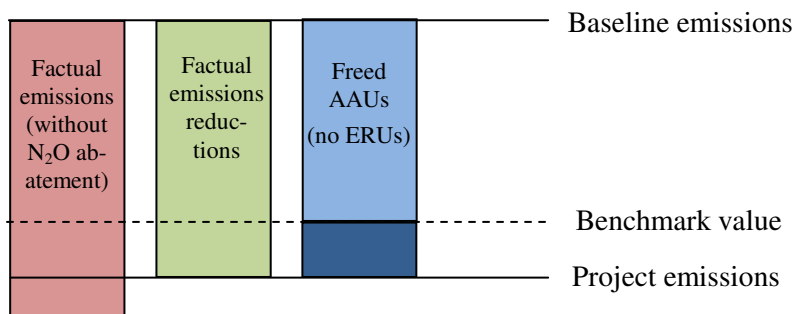


Illustration: Benchmark value

The applicable benchmark emissions factors for N₂O abatement projects in Finnish nitric acid plants were finally decided by the Finnish DFP on 7th April 2010 and are to be applied as follows:

2009	2010	2011	2012
2.5kg	2.5kg	2.5kg	1.85kg

Table: Applicable JI project benchmark emissions factors for Finnish nitric acid plants

If the above values are subsequently revised during the course of the project activity, the project proponents explicitly reserve the right to apply such new benchmark values for the respective project periods.

In addition, the project proponents understand that they may have to apply for an additional host country LoA if ERUs are to be claimed for the crediting period from 2013 onwards, depending on whether or not a JI Project would be viable under any new applicable legislation.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

Regulatory framework

The regulatory framework for implementing JI projects in Finland is influenced by several acts of law. The fundamental framework is provided by the Kyoto Protocol to the United Nations Framework Convention on Climate Change (“UNFCCC”) and subsequent decisions by UNFCCC-entities, most importantly the decisions of the Conference of the UNFCCC Parties serving as the Meeting of Parties to the Kyoto Protocol (“CMP”) and the Joint Implementation Supervisory Committee (“JI SC”).

In addition, there is the European Union legislation adapting the Kyoto JI framework for application in its member states such as the Emissions Trading Directive¹⁹, the Linking Directive²⁰ and

¹⁹ 2003/87/EC, published in the internet under http://ec.europa.eu/environment/climat/emission/implementation_en.htm

²⁰ 2004/101/EC, published in the internet under http://ec.europa.eu/environment/climat/emission/implementation_en.htm

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various JI relevant decisions by EU bodies²¹. Besides acts of law of direct relevance, there are also Directives that have an indirect influence on JI implementation such as the IPPC Directive²².

EU Directives do not entail direct consequences on private entities located in the EU member states. In order to be enforceable on member state level, they generally have to be transformed into national legislation by the respective member state. These national transformation acts, as well as other national legislation, are the third layer of the regulatory framework relevant for JI project implementation. In Finland, the most relevant transformation laws are the ‘Act on the use of the Kyoto Mechanisms’ (Act 109/2007, dated 2nd February, 2007) and the ‘Ministry of the Environment Decree on Joint Implementation projects’, dated the 28th September, 2007.



Illustration: Three layers of jurisdiction relevant for the implementation and subsequent operation of N₂O nitric acid JI projects in Finland

The JI SC has specified that JI project proponents may choose between two options when implementing JI projects: they may either (i) use a multi project emission factor (ii) or establish a project specific baseline²³. Due to the significant variances typically observable in different nitric acid plants, it would not be appropriate to derive a multi-project emission factor. Instead, the project proponents apply a pre-project-emission factor as defined in section A.5.

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:

²¹ Such as the Double Counting decision 2006/780/EC, published in the internet under http://ec.europa.eu/environment/climat/emission/pdf/1_31620061116en00120017.pdf

²² 2008/1/EC, published in the internet under <http://ec.europa.eu/environment/air/pollutants/stationary/ippc/index.htm>

²³ The requirements for this approach are outlined in the 4th JI SC Meeting Report, Annex 6 “Guidance in the Criteria for Baseline Setting and Monitoring” (Version 01), section B; paragraphs 18 ff. (see the internet under http://ji.unfccc.int/Sup_Committee/Meetings/index.html for reference).



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Project Implementation Aspect	AM0034	Adjustment in JI project specific context	Explanation / Justification
Applicability criteria	Applicability criteria include some aspects which are not required in the JI context	Applicability criteria have been in part modified or not applied.	<p>(a) exclusion of projects resulting in shut-down of N₂O abatement Unchanged.</p> <p>(b) no effect on HNO₃ production This criterion has been eliminated since it has been consistently proven that N₂O abatement does not affect nitric acid production.</p> <p>(c) no increased NO_x emissions Unchanged.</p> <p>(d) no other GHG emissions This criterion does not apply, because secondary catalyst technology does not lead to any non-N₂O GHG emissions.</p> <p>(e) continuous N₂O measurement possible This criterion does not address a question of applicability as such. If monitoring is not possible / is complicated, a more appropriate and differentiating discussion can take place within the discussion of the monitoring aspects associated with the project.</p>
Baseline campaign	Baseline emissions established based on distinct baseline campaign.	Benchmark factors are used for determining reference case emissions.	Establishing a baseline on a set of pre-catalyst campaign data (i.e. the baseline approach) is not used in the context of the proposed JI project activity. Instead, a benchmark of 2.5kgN ₂ O/tHNO ₃ from 2009 to 2011 and 1.85kg in 2012 has been decided by the Finnish DFP. However, in order to prove that historic plant emissions are higher than the benchmark emissions factors, a 'pre-project emissions factor' will be defined. See section A.5. -
Baseline Emis-	Baseline Emissions	For this project, a	This approach for establishing the assumed reference case sce-



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sions	are based on the factual business as usual emissions.	benchmark value is applied for assessing the amount of emission reductions for which free ERUs will be allocated.	nario is based on European standards (such as the IPPC directive), even though no compulsory national legislative caps on N ₂ O emissions from nitric acid production are currently in force anywhere in the European Union.
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 used, but emission reductions are calculated based on the conservative Benchmark Emissions Factors instead, there is no possibility for the operator for “baseline gaming” and hence, there is no need to establish a permitted range of operational parameters.
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 such step is undertaken.	As no baseline campaign is undertaken, 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. 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 emis-			In order to ensure conservativeness (since project emissions are calculated based on verification periods and not on standard pro-



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sions			duction 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 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 ₂ O emission levels increasing the longer a primary catalyst gauze is used. In the project specific scenario, no baseline campaign is conducted.
Cap on HNO ₃ production for which ERUs can be earned	The maximum value of NAP eligible for ERU issuance shall not exceed the design capacity. “By nameplate (design) implies the total yearly capacity (considering 365 days of operation per year) as per the documentation of the plant technology provider”. “If the plant has been modified to increase production...before De-	Nameplate capacity was increased from 141,000 tHNO ₃ /year to 149,500t in 1994 following installation of a new compressor.	Plant documentation from the compressor installation in 1994 shows the annual production capacity increase to 149,500t and ERUs can therefore only be claimed for tonnes of nitric acid produced up to that capacity.



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	ember 2005...then the new capacity is considered name-plate, provided proper documentation is available”.		
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 non-measured benchmark values instead. Applying uncertainty is not appropriate, as the benchmark emissions factors are 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.	EF_{BL} is not being applied.	Because emission reductions are not assessed based on factual emissions, this measure is not needed.
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), 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	This step is not being applied.	AM0034 uses this measure to account for the possible effect that platinum deposits, formed downstream of the ammonia oxidation reactor, would have had on N_2O concentrations in the off-gas in



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	factor of all previous project campaigns (of the first 10 campaigns only). The higher value applies for calculating emission reductions.		<p>the identified baseline scenario (assuming that the plant would have been operated without any N₂O abatement devices in the absence of the proposed project activity). In effect, this step aims to include platinum deposit- related changes to the baseline emissions.</p> <p>Because emission reductions are not assessed based on factual emissions (i.e. a baseline campaign), this step is no longer necessary.</p>
Minimum project emissions factor after 10 th campaign	No project emissions factor after the 10 th project campaign may be higher than the lowest recorded during these campaigns.	This restriction does not apply.	<p>AM0034 uses this measure to account for the possible effect that platinum deposits, formed downstream of the ammonia oxidation reactor, would have had on N₂O concentrations in the off-gas in the identified baseline scenario (assuming that the plant would have been operated without any N₂O abatement devices in the absence of the proposed project activity). In effect, this step aims to include platinum deposit-related changes to the baseline emissions.</p> <p>Because emission reductions are not assessed based on factual emissions (i.e. a baseline campaign), this step is no longer necessary.</p>
AMS downtime	AM0034 states: In the event that the monitoring system is down, the lowest between the conservative 4.5 kgN ₂ O/tHNO ₃ IPPC default factor or the	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 meas-	<p>Firstly there is no distinction between downtime during the baseline and downtime during the project, since no baseline is being measured.</p> <p>Secondly, the default factor contained in AM0034 would not be appropriate in the case where a benchmark factor lower than the default value is being used.</p> <p>In addition, AM0034 does not distinguish between times when the</p>



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	<p>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>ured during the whole of the relevant verification period or b) the highest value measured during the whole of the previous complete production campaign, 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 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 consti-</p>	<p>AMS was malfunctioning and periods of standard calibration. The approach taken here differentiates between these two scenarios. Furthermore, it 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 production campaign, whichever is the higher. .</p>
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		tutes 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.	
Recording and storage interval for the parameters NCSG, VSG, TSG and PSG	AM0034 requires to use a recording frequency of 2 seconds for these parameters.	A recording frequency of 5 seconds will be applied	Due to the stable operating conditions in the plant and very low variations of N ₂ O emission values the interval of 5 seconds is sufficient in order to establish high quality hourly mean values. A higher density of recorded values is not necessary.



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Applicability of AM0034 taking into account the above modifications

The methodology is applicable to project activities aiming to install secondary N₂O abatement at a nitric acid plant. YARA Siilinjärvi consists of one ammonia burner feeding into two absorption towers and the off-gasses are emitted through one stack. The secondary N₂O catalyst system was inserted into the ammonia reactor during a shut down; the abatement system is installed underneath the primary catalyst gauzes. This corresponds to the defined scope of the methodology. Also, the project activity does not lead to the shutdown of any N₂O abatement devices already installed. There was no N₂O abatement technology in place prior to the implementation of the project activity.

Moreover, the project activity will not increase NO_x emissions. The secondary catalyst technology installed has no effect on NO_x emission levels. This has been scrutinised in industrial testing over extended industrial process application²⁴. In addition, the regular and compulsory NO_x tests conducted by YARA under the supervision of the responsible local environmental authority would reveal any changes in NO_x emission levels.

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:
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Identification of the baseline scenario

The approved baseline methodology AM0034 (Version 03.4) refers to AM0028 (Version 04) with regard to the identification of the baseline scenario. These methodologies were adapted to the JI specific context as described in section B.1 above. Furthermore, the following steps are based on the “Combined Tool to identify the baseline scenario and demonstrate additionality” (Version 02.2)²⁵.

Step 1a – Identification of alternative scenarios to the project activity

1.1 Assessment of the present situation

There has been no N₂O abatement technology installed in the plant prior to the implementation of the project activity. Therefore, all scenario alternatives dealing with continuing the operation of N₂O abatement catalysts already installed do not apply in the context of this project.

1.2 Most realistic scenario in the absence of JI revenues for N₂O reductions achieved

²⁴ 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 f. therein. This source states that NO yields for the ammonia oxidation reaction remain unchanged when operating secondary N₂O abatement catalysts.

²⁵ AM_Tool_02, provided by the CDM EB in its 28th Meeting; published on the UNFCCC web site under <http://cdm.unfccc.int/Reference/tools/index.html>



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The realistically feasible scenario alternatives are:

- Status quo: The continuation of the current situation, without installing any N₂O abatement technology in the plant
- Installation of Non-Selective Catalytic Reduction (NSCR) De-NO_x system
- Installation of an N₂O destruction or abatement technology:
 - Tertiary measure for N₂O destruction
 - Primary or secondary measures for N₂O destruction or abatement

In principle, none of these scenario alternatives are *ex ante* unrealistic or technically unfeasible. Scenario alternatives such as changing to another production method or using the N₂O emitted for other purposes that have to be dealt with under AM0034 are not taken into account here, because they do not present realistic alternatives given the present plant layout and the general procedures of nitric acid production.

Changing the production process would require setting up a new production facility, because the present plant cannot be amended to employ a different production procedure. Choosing another production procedure would also not be state of the art, because the presently operated procedure is the most advanced method available.

Using N₂O for other purposes other than just emitting it into the atmosphere is not done anywhere in the world, because N₂O cannot be put to any economic use at the concentrations at which it occurs in the stack gas of nitric acid plant. Neither can it be used as a feedstock for the production process itself, as N₂O is not a raw material in nitric acid production.

Step 1b – Consistency with mandatory applicable laws and regulation

There are currently no national and no regional regulatory requirements for YARA Siilinjärvi in Finland regarding N₂O emissions.

NO_x-emissions are regulated by the operational permit for the YARA Siilinjärvi plant. According to the Environmental permit, Nro79/06/2 DnroISY-2004-Y-272, Itä-Suomen Ympäristölupavirasto, the permitted level is 200 ppm. According to continuous measurements taken since 2007²⁶, the plant is in compliance with these requirements.

YARA Siilinjärvi's NO_x emissions will remain constant and in compliance with the regulatory limit also after the installation of the secondary catalyst. This is safeguarded by the fact that NO_x emissions are online monitored by the responsible local environmental authority²⁷.

In consequence, all scenarios are in compliance with all applicable laws and regulatory requirements.

Step 2 – Barrier Analysis

At the next step, baseline alternatives that face prohibitive barriers are eliminated from the further baseline identification process (barrier analysis).

²⁶ NO_x-readings were provided to the AIE during the on-site Determination.

²⁷ The operational permit for the plant was made available for inspection by the AIE during the on-site Determination.



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On the basis of the alternatives that are technically feasible and in compliance with all legal and regulatory requirements, a complete list of barriers that would prevent alternatives to occur in the absence of JI is established.

Barriers include, among others:

Investment barriers

The investment barriers analysis asks which of the remaining scenario alternatives is likely to be prevented by the costs associated with it becoming reality. The assumption is that these scenarios would be unlikely to be the business as usual scenario.

None of the N₂O destruction technology options (including NSCR) are expected to generate any financial or economic benefits other than JI related income. Their operation does not create any marketable products or by-products. However, any operator willing to install and thereafter operate such technology faces significant investment and additional operating costs.

Therefore, plant operators would face significant investment requirements, if they decided to install N₂O abatement (including NSCR) technology. Unless there is a legal obligation to reduce N₂O emission levels (NO_x limits already being complied with), there is no need to overcome these barriers.

Accordingly, the NSCR scenario alternative could be triggered by NO_x regulation. From this perspective, YARA Siilinjärvi could be forced to reduce N₂O in a business as usual scenario if NO_x regulation forced the plant operators to install NSCR technology. Such technology would be useful for reducing NO_x emission levels, but would also lower N₂O emissions.

However, the installation of a Non-Selective Catalytic Reduction (NSCR) NO_x catalyst unit is un-economic, because YARA Siilinjärvi is already in compliance with the prevailing NO_x regulations²⁸. Also, NSCR units require additional natural gas or ammonia to achieve sufficient tail gas temperatures and/or the right reducing environment inside the catalyst leading to comparably high operational costs. By being led through the absorption tower the gas mix has been cooled down to a temperature level below that required for NSCR abatement catalysts to function²⁹. Because of this, an NSCR³⁰ abatement system would only work if the stack gas mix is re-heated.

If even lower NO_x levels were introduced, the most economical option would be to upgrade the existing SCR NO_x abatement units already installed at the plant instead. However, YARA Siilinjärvi is currently achieving NO_x-emission levels (170 ppm) below the applicable limit of 200 ppm so that such scenario is unlikely, because the regulatory levels would need to be significantly lower in order to enforce any additional adaptation requirements upon YARA Siilinjärvi.

As the existing SCR-NO_x abatement system is already very efficient, there would be no point in also installing NSCR, even if this technology was considered an alternative option.

²⁸ Environmental permit, Nro79/06/2 Dnro ISY-2004-Y-272, Itä-Suomen Ympäristölupavirasto

²⁹ NSCR abatement catalysts require a minimum gas mix temperature of at least 550°C in order to operate effectively; see the booklet no. 2 of the European Fertilizer Manufacturers Association (EFMA), published in the internet under http://www.efma.org/EPUB/easnet.dll/ExecReq/Page?eas:template_im=000BC2&eas:dat_im=000EAE (page 17 therein) for further information.

³⁰ For other disadvantages of NSCR technology see an EFMA-booklet published in the internet under http://www.efma.org/EPUB/easnet.dll/ExecReq/Page?eas:template_im=000BC2&eas:dat_im=000EAE (page 18 therein).



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For all these reasons, the only alternative that does not face significant investment barriers is the “continuation of the status quo”.

Technological barriers

All of the available N₂O abatement technologies have to be integrated in the nitric acid plant. Primary and secondary abatement technologies are installed inside the ammonia oxidation reactor where they may, if not correctly designed and installed, interfere with the nitric acid production process by causing a deterioration of product quality or a loss of production output. Tertiary measures require the installation of a complete reactor between the absorption column and the stack as well as a re-heating system, which may cause significant downtime of the plant during construction and commissioning.

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

For these reasons, all the above scenarios, with the sole exception of the continuation of the status quo, face significant technological barriers.

Barriers due to prevailing practice

This test reconfirms the previous assessments: If the steps taken so far have led to the conclusion that one or more baseline scenario alternatives meet investment related or technological barriers, these scenarios should be excluded. Of course, similar plants that use ERU revenues gained by participating in the JI, and can thus overcome the identified barriers by using the additional financial means available, are not to be taken into account.

So far, secondary catalyst technology has only been operated in some European countries on an industrial trial basis. Researching this technology made sense due to the prospective revenues obtainable under the Kyoto Protocol’s Clean Development Mechanism (CDM) by employing it in nitric acid plants located in developing nations on a voluntary basis. Also, it is expected that N₂O emissions from nitric acid production may be included in the European Union Emissions Trading Scheme (“EU ETS”)³¹ or regulated otherwise. Both aspects provided some incentive for developing N₂O abatement technology.

However, now that research and development has been completed and secondary catalyst technology is being employed successfully in several CDM projects worldwide, plant operators would no longer be willing to incur the costs associated with the continued operation of such technology. For European nitric acid producers, the only incentive to operate such technology before the likely inclusion of N₂O emissions into the EU ETS from 2013 onwards is to take advantage of the incentives available under the Kyoto Protocol’s Joint Implementation (“JI”) mechanism. While this op-

³¹ On 23rd January 2008, the EU Commission published a communication on its post-2013 climate change strategy (see <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0035:FIN:EN:PDF>), which announces the determination to expand the EU ETS beyond its present scope, especially mentioning the inclusion of non-CO₂ gasses into the system. This development is no news to the industry, because responding to Article 30 of the EU ETS Directive 2003/87/EC, the Commission had submitted a report to the European Parliament and the Council considering the inclusion of non-CO₂ GHGs into the EU ETS already in November 2006. See the EU homepage under http://ec.europa.eu/environment/climat/emission/pdf/com2006_676final_en.pdf for this report which expressly considers extending the EU ETS into N₂O emissions (see page 6 therein).



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tion has in principle been available since the beginning of 2008, EU member states took some time developing a coherent policy approach on whether or not to allow JI participation in their respective territories, and if so, under which conditions. This process has not been fully completed yet.

Such JI projects are currently being developed across the EU, e.g. Poland, Lithuania, Hungary, Romania, Bulgaria, France, Finland and Germany.

Conclusion

All scenarios face significant investment barriers as well as some technological barriers and therefore have to be excluded from further analysis.

Step 3 – Investment Analysis

In this step, the JI project's additionality is ascertained. Project proponents need to demonstrate that the intended JI activity could only be realized if ERU sales revenues were available to offset the investments to be made. Because the project has no revenues other than JI related revenues, a simple cost analysis is sufficient for demonstrating additionality³².

The proposed project activity aims to install secondary catalyst technology at the plant and to operate this catalyst throughout the crediting period. In order to assess the project emissions, an Automated Monitoring System (AMS) has to be installed and operated. For initiating the project activity and for maintaining it throughout the project's lifetime, YARA Siilinjärvi's employees and management will have a significant additional work load to cope with. Starting with the necessary adjustments to the process parameters of the plant, the required training for catalyst and AMS operation has to be undertaken by the responsible staff, and the regular AMS calibration and other JI-related audits have to be arranged, facilitated and paid for. Also, the catalyst pellets will have to be replaced whenever the catalyst efficiency decreases due to the material becoming less effective over the system's lifetime.

All these measures entail significant investment requirements.

Conclusion

As previously assessed, YARA Siilinjärvi has no need to invest in any N₂O destruction or abatement technology at present. Neither are there any national incentives to promote similar project activities. Without the sale of the ERUs generated by the project activity, no revenue would be generated from the project activity.

In consequence, no income other than ERU sales revenues could be used to pay back the investment costs. The registration of the project activity as a JI Project and the resulting expected ERU revenues are the single source of project revenues. JI registration is therefore the decisive factor for the realization of the proposed project activity.

The proposed JI project activity is undoubtedly additional, since it passes all the steps of the Additionality assessment as defined by section B.2 above.

The identification of the baseline scenario and assessment of additionality should be re-assessed following any changes in legislation that may affect the JI project activity.

³² See the "Tool for the demonstration and assessment of additionality" (Version 05.1); CDM EB 39th Meeting Report, Annex 10; published under http://cdm.unfccc.int/EB/039/eb39_repan10.pdf.

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- 5 = Tail gas stack
6 = Coriolis HNO₃ flow measurement device
7 = N₂O concentration & Tail gas flow measurement points (in stack)

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

The baseline scenario is that, given the absence of any N₂O regulations at the plant, Siilinjärvi would not install any N₂O reduction technology and would continue emitting N₂O at the current levels for the foreseeable future. This baseline scenario was established on 25/03/2009 by Mrs Sarah Debor of N.serve Environmental Services GmbH.

In the absence of a measured historic baseline emissions factor, a 'pre-project' emissions factor has been established, as described in section A.4.3.1 above. The historic, pre-catalyst installation emissions of the plant have been monitored on a continuous basis since August 2008. The average value of 1230 ppm (7.69kgN₂O/tHNO₃) is based on daily values of normalised N₂O concentration over a period of 4 months. N₂O data has been obtained using a Servomex 4900 analyser. This analyser is officially QAL1 tested and approved by MCERTS UK. The stack gas flow was calculated, based on operational parameters of the plant.

The value of 7.69kgN₂O/tHNO₃ has been used for estimating the expected factual emission reductions that will result from the project activity if it is successful.

This pre-project emissions factor was calculated by Mrs Sarah Debor of N.serve Environmental Services GmbH on 29/05/2009.

SECTION C. Duration of the project / crediting period**C.1. Starting date of the project:**

Project start date: 26/06/2009.

The N₂O abatement catalyst can only be installed during a shut-down. At YARA Siilinjärvi's plant, a shut-down only takes place every 11-12 months in order to exchange the primary catalyst gauzes or for maintenance purposes. A shut-down took place in June 2009 and therefore the official starting date of the project is the 26th June 2009, when the plant re-started production with the abatement catalyst installed. Since the official approval of the Finnish government will only be received later in the year, the project proponents would have had to delay the installation of the N₂O abatement catalyst until the next shut-down in June 2010, leading to a long delay of the JI-project's commencement. Thus, the Project Participants have asked to be allowed to claim ERUs for emission reductions achieved from the installation of the catalyst onwards (retro-active ERUs), even if the final approval of the JI project is received at a later date. This has already been stated in the PIN document.



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The Finnish Administration of Environment has stated not to have fundamental objections against retroactive crediting from the start of the project activity and that project participants shall be entitled to ERUs for emission reductions physically achieved in so far as:

- The N₂O emission reductions have been physically achieved after 1st January 2008;
- The LoA has been issued later than the completion of the catalyst and monitoring equipment installation and emission reductions were successfully verified; and
- Project proponents can provide sufficient evidence that waiting for the final approval being granted before implementing the project activity would most probably have delayed the project's commencement to a date later than the date for which the issuance of the DFP's approval could reasonably have been expected.

C.2. Expected operational lifetime of the project:

Since the expected lifetime of the catalyst is three years, it will probably need to be replaced in June 2012 and will run again until June 2015. The total anticipated duration of the project's operational life is therefore 6 years.

In reality however, the project is expected to run for only 3 years and 6.17 months (until the end of December 2012), since it is expected that N₂O emissions from HNO₃ plants will be covered by the EU ETS from 2013 onwards and that the project will no longer be viable³³. If this is not the case, and N₂O is not otherwise regulated in a way that prohibits the continuation of the project, the catalyst will continue to be replaced every 3 years for the total operational lifetime of the plant, which is around 25 years.

C.3. Length of the crediting period:

The Project Participants herewith apply for a crediting period of 10 years. The JI project will be terminated earlier, if there is a legal requirement to do so. All laws relevant for this project³⁴ will be complied with at all times during the chosen crediting period.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

The emission reductions achieved by the project activity will be monitored using the approved monitoring methodology AM0034 as prepared by N.serve Environmental Services GmbH, Germany. It is the appropriate monitoring methodology to be used in conjunction with the baseline methodology AM0034, "Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants". Its applicability depends on the same prerequisites as the mentioned baseline methodology.

³³ See footnote 32

³⁴ See section B.1 above for more detailed information.



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AM0034 requires the use of the European Norm EN14181 (2004) “*Stationary source emissions - Quality assurance of automated measuring systems*”³⁵ as a guidance for installing and operating the Automated Monitoring System (AMS) in the nitric acid plants for the monitoring of N₂O emissions.

An Automated Measuring System (AMS) consisting of the following shall be used for monitoring:

- An automated gas analyzer system that will continuously measure the concentration of N₂O in the tail gas of the nitric acid plant; and
- A gas volume flow meter that uses differential-pressure, to continuously monitor the gas volume flow, temperature and pressure, in the tail gas of the nitric acid plant.

Sampling shall be carried out continuously using a multiple-point sampling tube that is optimised to the specific width and height of the tail gas duct, and the expected gas velocities in the tail gas. Temperature and pressure in the tail gas will also be measured continuously and used to calculate the gas volume flow at standard conditions.

Description of the AMS installed at YARA Siilinjärvi`s nitric acid plant.

1. General Description of the AMS

Since August 2008, YARA Siilinjärvi`s plant is equipped with 2 state of the art Servomex 4900 infrared analysers for parallel measurements before and after the DeNO_x system. Data has been collected by a Metso DNA Information system that is capable of measuring at a very high sampling rate. A Coriolis flow meter has been used for measuring continuous HNO₃-flow and HNO₃-concentration.

However, on 22nd July 2009, YARA Siilinjärvi`s plant was equipped with a state of the art AMS consisting of a Dr. Födisch MCA 04 Continuous Emissions Analyser, a sample probe, heated filter and heated sample-line connected directly to the analyzer, a Dr. Födisch FMD 99 Stack Gas Flow meter. The plant will continue to use their existing data collection system for the duration of the project activity.

Since this nitric acid plant has been in operation since 1972, YARA Siilinjärvi`s staff in general and its instrument department in particular is accustomed to operating technical equipment adhering to high quality standards.

The production manager for the nitric acid plant, Janne Laukkanen, is responsible for the ongoing operation of the project. Harri Hyvönen is responsible for quality assurance and maintenance of the N₂O monitoring system installed at the plant. Operation, maintenance and calibration intervals are being carried out by staff from the instrument department according to the vendor`s specifications and under the guidance of internationally relevant environmental standards, in particular EN 14181 (2004). Service will be performed by the supplier of the AMS. YARA is in the process of developing an AMS checking procedure schedule for the duration of the crediting period, strictly adhering to the named standards³⁶.

³⁵ This standard describes the quality assurance procedures needed to assure that an Automated Measuring System (AMS) installed to measure emissions to air are capable of meeting the uncertainty requirements on measured values given by legislation, e.g. EU Directives, or national legislation, and more generally by competent authorities.

³⁶ These procedures will be made available during the first verification.



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All monitoring procedures at YARA are also conducted and recorded in accordance with the procedures under ISO 9001:2000 and ISO 14001:2004, which is regularly audited by an independent auditing organisation accredited for ISO 9001 certification.

2. Sample points

The sample points are chosen in accordance with the AMS requirements, EN 14181 requirements and the plant design specifications to allow an optimum of data collecting quality. The sample points for the N₂O (NCSG) and VSG (gas volume flow) measurements must be located downstream of all process equipment. To ensure homogeneity of gas flow at the sample points, it is recommended that there is an undisturbed straight length of pipe before the sampling points, of around 5 times the diameter of the stack, at a point where the tail gas temperature is less than 300C (N₂O is unstable at temperatures above 300C). These points are also at suitable distance from the calibration ports to ensure no interference occurs during the reference measurements. Yara Siilinjärvi has set up sample points in the vertical section of the stack at a distance of 6.5m after any previous bend in the pipe (the pipe diameter is 0.905m).

3. Analyser

The Servomex 4900 will be used for calculating the emissions reductions achieved during the first month of the project, until the connection of the Dr. Födisch MCA 04 analyser on the 22nd July. This analyser is QAL1 certified and its suitability for the project was further proven during a successful QAL2 audit at the plant in September 2009. The raw data during this period has been stored.

From the 22nd July onwards, the Dr. Födisch MCA 04 Continuous Emissions Analyser is being used for the project measurements. The analysis system MCA 04 is an extractive, continuous measuring system. The analysis system MCA 04 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 QAL1³⁷ 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 is currently ongoing and is expected to be completed in the near future. A successful QAL2 audit was performed in September 2009 by an independent laboratory with EN ISO/IEC 17025 accreditation (Müller BBM).

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

³⁷ TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A vom 13. Juli 2005



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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 FMD99 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 emissions³⁸ 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 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.

For the first month of the project period before the installation of the FMD 99 (26th June to 22nd July) the gas volume flow was calculated. These calculations will be made available to the responsible AIE during the first verification.

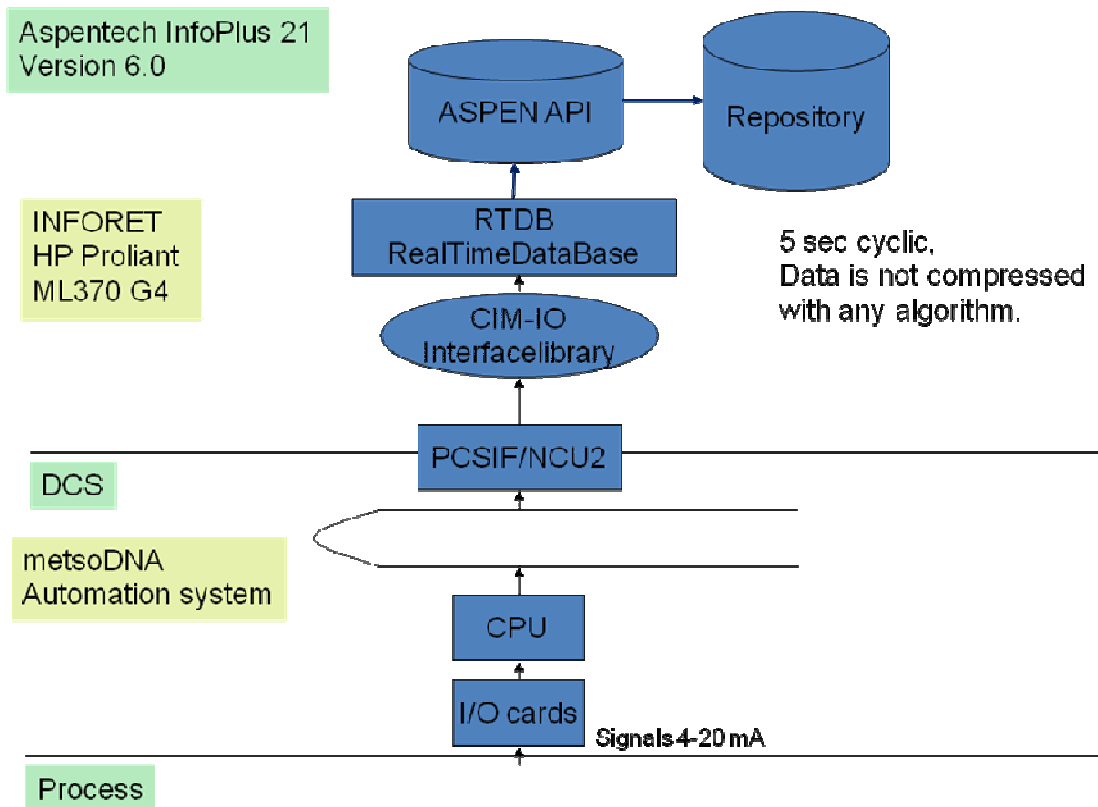
6. The data acquisition system

The YARA Siilinjärvi nitric acid plant is equipped with a Metso DNa InfoPlus.21 (Version 6.0 / DNA historian 6.1.2) data acquisition system that collects and stores all the values for NCSG, VSG, TSG, PSG as well as different status signals of the AMS and, if applicable, a status signal from the nitric acid plants that defines whether or not the plant is in operation (the AOR temperature). The data is stored simultaneously on different hard disks to prevent the loss of data in case one hard disk fails.

³⁸ 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).

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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 stored in the same data logging system. The flow chart below shows this system in more detail:



7. Data evaluation

The nitric acid plant operator derives hourly averages for all of the monitored parameters from the data management system (Metso DNa InfoPlus.21 (Version 6.0 / DNA historian 6.1.2)). This data is exported to EXCEL-format and delivered by email or CD from the plant operator to N.serve. N.serve, 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 responsible for the correct data handling and processing.

After a first plausibility-check, the data is transferred to a special data bank system. All necessary calculations and necessary 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 data bank tool.



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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

In accordance with EN14181 an AMS shall have been proven suitable for its measuring task (parameter and composition of the flue gas) by use of the QAL1 procedure as specified by EN ISO 14956. 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 QAL1³⁹ 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 N₂O is currently ongoing and is expected to be completed in the near future. A QAL2 audit will be performed by an independent laboratory with EN ISO/IEC 17025 accreditation.

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, Germany⁴⁰.

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.

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. There is a problem in fully complying with EN14181 since there is no regulation on N₂O emissions level and measurement uncertainty limit. According to EN14181, the QAL2 test including the SRM need to be conducted by an independent "testing house" or laboratory which has to be accredited to EN ISO/IEC 17025. A successful QAL2 test was conducted in September 2009.

³⁹ TÜV Immissionsschutz und Energiesysteme GmbH, Köln TÜV Rheinland Group Report No. 936/21203173/A from 13. July 2005

⁴⁰ 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)



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In addition, Annual Surveillance Tests (AST) should be conducted in accordance with EN 14181; these are a series of measurements that need to be conducted with independent measurement equipment in parallel to the existing AMS. The AST tests are performed annually. If a full QAL 2 test is performed (at least every 3 years), an additional AST test is not necessary in that same year.

QAL3

QAL3 describes the ongoing quality assurance and maintenance procedures and documentation for the AMS conducted by the plant operator. With this documentation it can be demonstrated that the AMS is in control during its operation so that it continues to function within the required specifications for uncertainty.

This is achieved by conducting periodic zero and span checks on the AMS. Zero and span adjustments or maintenance of the AMS, may be necessary depending on the results of the evaluation. In essence, YARA staff performs QAL3 procedures through the established calibration procedures described below.

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 Calibration

Conditioned ambient air is used as reference gas for zero calibration. The zero calibration is conducted automatically every 24 hours. Manual calibrations are done at least once per month (the calibration frequency might be adjusted if necessary).

N₂O-Analyser Span calibration

Manual span calibrations are done with certified calibration gas at least once per month (the calibration frequency might be adjusted if necessary).

The calibration 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. Födösch 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).



D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

Please note that only the monitoring of the emissions in the project scenario is applicable since a benchmark value will be applied and not a baseline emissions factor.

D.1.1.1. Data to be collected in order to monitor emissions from the <u>project</u>, and how these data will be archived:								
ID number <i>(Please use numbers to ease cross-referencing to D.2.)</i>	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment
<i>P.1</i>	<i>NCSG_n</i> <i>Hourly average N₂O concentration in the tail gas.</i>	<i>N₂O analyser (part of AMS)</i>	<i>mgN₂O/Nm³</i>	<i>Measured</i>	<i>Hourly average value based on a monitoring frequency of 5 seconds or less.</i>	<i>100%</i>	<i>Electronic</i>	<i>none</i>



<p>P.2</p>	<p>VSG_n</p> <p>Hourly average Volume flow rate of the tail gas</p>	<p>Gas volume flow meter (part of AMS)</p>	<p>Nm^3/h</p>	<p>Measured</p>	<p>Hourly average value based on a monitoring fre- quency of 5 sec- onds or less.</p>	<p>100%</p>	<p>Electronic</p>	<p>The data output from the tail gas flow meter will be processed using appropri- ate software. Corrected for standard condi- tions (273.15 °K, 1013.25 hPa) using TSG (P.10) and PSG (P.11) data. For the first part of the first pro- ject campaign the VSG results will be based on calculations based on opera- tional parame- ters</p>
<p>P.3</p>	<p>PE_n</p> <p>N_2O emissions during project Verification Pe- riod n.</p>	<p>Calculation from measured data.</p>	<p>tN_2O</p>	<p>calculated</p>	<p>Calculated after Verification Pe- riod has been defined by the project propo- nents</p>	<p>100%</p>	<p>Electronic</p>	



P.4	OH_n Total operating hours of Verification Period	Production Log, plant status signal	Hours	Recorded	Daily, compiled for entire verification period	100%	Electronic	Electronically recorded, based on plant status signal
P.5	NAP_n Metric tonnes of 100% concentrated nitric acid during any Verification Period	Nitric acid flow meter	$tHNO_3$	Measured	Hourly average value based on a monitoring frequency of 30 seconds or less.	100%	Electronic	
P.6	OT_n Oxidation temperature in the ammonia oxidation reactor (AOR).	Thermocouples inside the AOR	$^{\circ}C$	Measured, if applicable (see comments).	Hourly average value based on a monitoring frequency of 30 seconds or less.	none	Electronic	
P.7	AFR Ammonia Flow rate to the ammonia oxidation reactor (AOR)	Ammonia flow meter	$kgNH_3/h$	Measured, if applicable (see comments).	Hourly average value based on a monitoring frequency of 30 seconds or less.	none	Electronic	
P.8	AIFR Ammonia to air ratio going into the ammonia oxidation reactor (AOR)	Ammonia & Air flow meters	%	Calculated, if applicable (see comments)	Hourly average value based on a monitoring frequency of 30 seconds or less.	none	Electronic	



P.9	TSG Temperature of tail gas	Probe (part of the AMS gas volume flow meter).	°C	Monitored.	Hourly average value based on a monitoring frequency of 5 seconds or less.	100%	Electronic	Used for normalization of VSG measurement to standard conditions see P.2
P.10	PSG Pressure of tail gas	Probe (part of the AMS gas volume flow meter).	Pa	Monitored.	Hourly average value based on a monitoring frequency of 5 seconds or less.	100%	Electronic	Used for normalization of VSG measurement to standard conditions see P.2
P.11	EF_n Emissions factor calculated for project Verification Period n	Calculated from measured data	$tN_2O / tHNO_3$	Calculated	After each Verification Period	100%	Electronic	
P.12	EF_{BM} Emissions Factor Benchmark that will be applied to calculate the emissions reductions from a specific Verification Period	Determined according to host country approval	$kgN_2O / tHNO_3$	Not applicable	Continuous	100%	Paper	To be determined for each verification period in accordance with the host country approval See section A.5



P.13	EF_{reg} Emissions cap for N_2O from nitric acid production set by government or local regulation	Finnish Environmental Law	$kgN_2O/tHNO_3$ (converted, if necessary)	Not applicable	Continuous.	100%	Paper	Continuous surveillance throughout crediting period.
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D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO₂ equivalent):

>>

The project emissions will not be estimated but monitored using the parameters described above in D.1.1.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:

ID number (Please use numbers to ease cross-referencing to D.2.)	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO₂ equivalent):

>>

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):



Not applicable

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO₂ equivalent):

Estimation of Verification Period specific project emissions

The project emission factor is assessed based on N₂O concentration (NCSG_n) and gas volume flow (VSG_n) measurements conducted throughout any period of time for which the project proponents decide to undertake a Verification (the “Verification Period”). Project proponents are free to decide what period of time they would like to define as a Verification Period as long as the following pre-requisites are met:

- The first Verification Period commences with the crediting period starting date.
- Any Verification Period after the first one will start at the termination date of the previous Verification Period.
- No Verification Period may exceed the crediting period ending date.

Over the duration of the project activity, N₂O concentration and gas volume flow in the stack of the nitric acid plant, as well as the nitric acid production of the plant, will be measured continuously and an **Emissions Factor (EF_n)** – given as kgN₂O/tHNO₃ – can be established at any given time for any period of time.

Because higher N₂O emissions during the project’s lifetime will lead to a reduced amount of ERUs issued, the methodology does not need to provide measures against any abusive practices. Project operators will be sufficiently incentivised to run their plants at emission levels as low as possible in order not to lose ERU-revenues. In case a plant is emitting more N₂O than the Benchmark Emissions Factor, no additional environmental consequences are to be feared, as the only effect from this would be that the project activity will not generate any ERUs during such times⁴¹ that would subsequently become available to carbon markets.

For these reasons, it is not relevant for which period of the production cycle ERUs are claimed.

Measuring of N₂O data sets for the calculation of project emissions

⁴¹ For the avoidance of doubt, ERU reductions for production periods with emission levels above the applicable Benchmark Emissions Factor DO NOT apply!



Throughout the project's crediting period, N_2O concentration ($NCSG_n$) and volume flow in the stack gas (VSG_n) are to be monitored. The monitoring system provides separate hourly average values for $NCSG_n$ and VSG_n based on 5-second interval readings. These N_2O data sets (consisting of $NCSG_n$ and VSG_n average values for each operating hour) can be identified by means of a unique time / date key indicating when exactly the values were observed.

- Furthermore, the operating hours (OH_n) as recorded by the plant's process control system and the nitric acid production output (NAP_n) are required for calculating the project emissions.

Because the reference Benchmark Value (EF_{BM}) (unlike the Emissions Factor Baseline EF_{BL} in AM0034) was not determined based on certain plant operating parameters, there is no need to monitor those plant operating parameters and establish the comparability of the two data sets by adjusting the EF_{BM} for each Verification Period.

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 production campaign, 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.

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.

Measurement during plant operation

Only those data sets collected during operation of the plant shall be used as a basis for determining the Verification Period specific project emissions. Status signals from the plant operation system (AOR temperature range and maximum ammonia to air ratio) will be constantly monitored in order to decide automatically whether the plant is in operation or not. The trip point range for AOR temperature is $860^{\circ}C$ (min) to $915^{\circ}C$ (max), while the maximum ammonia to air ratio is 12%.

Consequently, any $NCSG$ and VSG data sets that were recorded at times when plant was shut down are automatically excluded from the derivation of EF_n . The number of operating hours (OH_n) will be reduced accordingly.

For the avoidance of doubt, data sets containing values during shut down of the plant are not to be regarded as AMS downtime readings (as defined above).



Application of instrument correction factors / elimination of implausible values

The correction factors derived from the calibration curve of the QAL2 audit for all components of the AMS as determined during the QAL2-test in accordance with EN14181 must be applied onto both VSG and NCSG, unless these were already automatically applied to the raw data recorded by the data storage system at the plant.

For all N₂O data sets a plausibility check is conducted in accordance with current best practice monitoring standards. All data sets containing values that are implausible are eliminated and replaced by default values according to the above-mentioned practice.

Calculation of the EF_n-value

The total mass of N₂O emissions in a Verification Period (PE_n) is calculated based on the continuous measurement of the N₂O concentration in the tail gas and the volume flow rate of the tail gas stream. The N₂O mass-flow is calculated on the basis of the hourly average results, in accordance with the following equation:

$$PE_n = \sum_{x=1}^{x=vmp} NCSG_x \times VSG_x \times 10^{-9} \times M_x \quad (tN_2O)$$

The plant-specific project emissions factor representing the average N₂O emissions per tonne of nitric acid over the respective Verification Period is derived by dividing the total mass of N₂O emissions by the total output of 100% concentrated nitric acid for that period.

The average N₂O emissions per metric ton of 100% concentrated nitric acid for the Verification Period (EF_n) shall then be calculated as follows:

$$EF_n = (PE_n / NAP_n) \quad (tN_2O/tHNO_3)$$

where:

Variable	Definition
PE _n	total specific N ₂ O emissions during the Verification Period (tN ₂ O)
EF _n	Emissions factor used to calculate the emissions from the defined Verification Period n (tN ₂ O/tHNO ₃)
NCSG _x	Hourly average concentration of N ₂ O in the tail gas stream in each measurement time interval of 1 hour during the verification measurement period (vmp) (mgN ₂ O/m ³)
VSG _x	Hourly average tail gas volume flow rate in each measurement time interval of 1 hour during the verification measurement period (vmp) (m ³ /h)
NAP _n	Nitric acid production during the Verification Period (tHNO ₃)



M_x	Length of measurement interval x (h)
x	Each measurement interval during the verification period (1h)
vmp	Verification measurement period

Allocation of ERUs

The **emission reductions based on which ERUs will be issued** for the project activity are determined by deducting the project-specific emission factor from the Benchmark Value and multiplying the result by the production output of 100% concentrated nitric acid over the period for which ERUs are to be claimed and the GWP of N₂O, as follows:

$$ERU = (EF_{BM} - EF_n) / 1000 \times NAP \times GWP_{N_2O} \quad (tCO_2e)$$

Where:

Variable	Definition
ERU =	Emission reductions awardable for of the project for the Verification Period that are at the project operator's free disposal (tCO ₂ e)
NAP =	Nitric acid production for the Verification Period (tHNO ₃).
EF _{BM} =	Benchmark Emissions factor according to host country approval (kgN ₂ O/tHNO ₃); see section A.5 (last paragraph) of the PDD for further information.
EF _n =	Emissions factor used to calculate the emissions from the defined Verification Period n (kgN ₂ O/tHNO ₃).
GWP _{N₂O} =	310 tCO ₂ e/tN ₂ O

For the avoidance of doubt, ERU reductions for production periods with emission levels above the applicable Benchmark Emissions Factor DO NOT apply! No leakage calculation is required.



D.1.3. Treatment of leakage in the monitoring plan:

>> not applicable

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

ID number <i>(Please use numbers to ease cross-referencing to D.2.)</i>	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	Comment

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO₂ equivalent):

>> not applicable

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO₂ equivalent):

The following equation is used for estimating the emissions reductions to be achieved by the project:

$$EF_{Pest} = EF_{PP} * (1 - AE) \quad (kgN_2O/tHNO_3)$$

Where:



Variable	Definition
EF_{Pest} =	Estimated Project Emissions Factor (kgN ₂ O/tHNO ₃)
EF_{PP} =	Pre-Project Emissions Factor, calculated in accordance with section A.4.3.1 (kgN ₂ O/tHNO ₃)
AE =	Estimated Abatement Efficiency of secondary catalyst (%)

$$ERU_{PIS} = (EF_{BM} - EF_{Pest}) \times NAP_{yr} / 1000 \times GWP_{N2O} \quad (tCO2e)$$

ERU_{PIS} =	Estimated number of ERUs to be issued to the project (tCO ₂ e)
EF_{BM} =	Benchmark Emissions factor according to expected host country approval (kgN ₂ O/tHNO ₃); see section A.5 (last paragraph) of the PDD for further information.
NAP_{yr} =	Budgeted or Estimated Annual Nitric Acid Production (tHNO ₃)
GWP_{N2O} =	Global Warming Potential of N ₂ O (310 tCO ₂ e/tN ₂ O)

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

For detailed information on good monitoring practice and performance characteristics see Annex 3.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data <i>(Indicate table and ID number)</i>	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.



<i>D.1.1.1.: P1, P2, P9, P10</i>	<i>low</i>	Regular calibrations according to vendor specifications and recognised industry standards (EN 14181). Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up. Third party audits by laboratories with EN ISO/IEC 17025 Accreditation
<i>D.1.1.1.: P3,P11</i>	<i>low</i>	Calculated values included in evaluation by third party AIE
<i>D.1.1.1.: P4, P5, P6, P7, P8</i>	<i>low</i>	Included in plant internal Quality Assurance program as validated by third party during ISO 9001/ ISO 14001 audit
<i>D.1.1.1.: P12, P13</i>	<i>low</i>	Constant factors included in evaluation by third party AIE

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

General Responsibilities

Yara level project coordination

- Peter Fauconnier (TPO Nitric Acid)
 - General coordination
- Øystein Nirisen (Catalyst department)
 - Catalyst development

N-Serve

- Rebecca Cardani-Strange (Project Manager)
 - Project implementation and official project documentation
- Martin Stilkenbaeumer (Monitoring Expert)



- Data analysis from hourly averages

Site management

- Ismo Haaparanta (Site Manager)
- Janne Laukkanen (Production manager Sulphuric Acid and Energy Production)
- Virpi Puustinen (EQ manager)
 - Environmental permit responsibilities

Nitric acid operation and local project responsibility

- Jukka Heino (Nitric acid specialist)

Monitoring equipment follow-up responsibility

- Harri Hyvönen (Automation engineer)
 - Calibrations for analyzers, QAL3 procedures
 - Analyzer reliability follow-up
 - Instrumentation calibration procedures
 - DCS-systems
- Miika Uusitalo (Process Engineer)
 - Data handling (5s data → hourly averages) & provision to N-serve

Instrumentation calibration & follow up procedures

- Pekka Räsänen, Kalevi Hakkarainen & Lenni Kuosmanen (instrumentation specialists)
 - Instrument calibrations
 - Instrument condition monitoring



Data handling responsibilities

- Miika Uusitalo (raw data handling)
- Harri Hyvönen (data collection technique follow up)
- Martin Stilkenbaeumer (N-Serve, data calculations)
- Sakari Kivivuori, Automation development manager (Data storing, back-up procedures)

Operation, maintenance, calibration and service intervals are being carried out by staff from the instrument department according to the vendor's specifications and under the guidance of internationally relevant environmental standards, in particular EN 14181 (2004).

YARA Siilinjärvi is currently defining an AMS checking procedure schedule for the duration of the crediting period, strictly adhering to the named standards. A training schedule for JI-associated tasks at the plant is also being integrated into the internal training procedures. These procedures will be made available to the AIE during the first verification.

Trouble-shooting procedure: If the critical alarm to DCS "Analyzer not ok" occurs, the responsible person (Harri Hyvonen) will be automatically contacted. If the problem lies outside his area of expertise, he will immediately call the AMS supplier, Dr Foedisch.

All monitoring procedures at YARA Siilinjärvi are also conducted and recorded in accordance with the procedures under ISO 9001 which is regularly audited by an independent auditing organisation accredited for ISO 9001 certification (see section D.1.)

**D.4. Name of person(s)/entity(ies) establishing the monitoring plan:**

N.serve Environmental Services GmbH
Grosse Theaterstr. 14
20354 Hamburg
Germany
www.nerve.net
contact@nserve.net

SECTION E. Estimation of greenhouse gas emission reductions**E.1. Estimated project emissions:**

Using the assumptions from section A.4.3.1 above, the following project emissions are estimated for the project activity in the crediting period. The first crediting period would start on 26th June 2009:

Crediting Period (years)	Nitric Acid Production [tHNO3]	Project Emissions [tCO₂e]
2009	65,264	31,117
2010	147,000	70,087
2011	147,000	70,087
2012	147,000	70,087
Total estimated (until end 2012)	506,264	241,376
Annual average (until end 2012)	144,075	68,692

Table 5 (part A): Hypothetic project emissions until 2012



Crediting Period (years)	Nitric Acid Production [tHNO ₃]	Project emissions [tCO ₂ e]
2013	147,000	67,374
2014	147,000	67,374
2015	147,000	67,374
2016	147,000	67,374
2017	147,000	67,374
2018	147,000	67,374
2019	71,458	32,751
Total number of crediting years		10
Total estimated (2009 to 2019)	1,459,722	678,369
Annual average (2009 to 2019)	145,972	67,837

Table 6 (part B): Hypothetic project emissions from 2013 onwards

E.2. Estimated leakage:

No leakage emissions do occur.

E.3. The sum of E.1. and E.2.:

See E.1.

E.4. Estimated baseline emissions:*Benchmark emissions*

Please note that emissions reductions eligible for ERUs will be calculated from the applicable Benchmark Emissions Factor⁴² and not from the business as usual emissions. These benchmark emissions are displayed in tables 7 and 8.

⁴² See section A.5 for additional information.



Crediting Period (years)	Nitric Acid Production [tHNO ₃]	Benchmark Emissions [tCO ₂ e]
2009	65,264	50,580
2010	147,000	113,925
2011	147,000	113,925
2012	147,000	84,305
Subtotal (estimated)	506,264	362,734
Average per year (until end 2012)	144,075	103,229

Table 7 (part A): Estimated benchmark emissions until 2012

Crediting Period (years)	Nitric Acid Production [tHNO ₃]	Benchmark Emissions [tCO ₂ e]
2013	147,000	81,041
2014	147,000	81,041
2015	147,000	81,041
2016	147,000	81,041
2017	147,000	81,041
2018	147,000	81,041
2019	71,458	39,395
Total number of crediting years		10
Total estimated (2009 to 2019)	1,459,722	888,376
Annual average (2009 to 2019)	145,972	88,838

Table 8 (part B): Hypothetic business as usual emissions from 2013 onwards.

* Due to the likely inclusion of N₂O emissions emanating from nitric acid production into the EU ETS from 1st January 2013 onwards, the project may not be eligible to earn ERUs after that time or continuing the project under the JI may not be economically viable. Also, from 2013 onwards a GWP of 298 for N₂O as defined by the IPCC Third Assessment Report will be applied. This is why this PDD differentiates in between prospective emission reductions achieved until 31st December 2012 and emissions reductions generated from 1st January 2013 onwards..

E.5. Difference between E.4. and E.3. representing the emission reductions of the project:

*Emission reductions eligible for earning ERUs*

The ERU estimations included in this PDD are conservative *estimations* only. ERUs will therefore be awarded for those factual emissions reductions achieved below the applicable benchmark emissions factor and subsequently verified by the responsible AIE, and not in accordance with the conservative estimations provided in this PDD. However, in accordance with the methodology AM0034, the maximum value of NAP eligible for ERU issuance “shall not exceed the design capacity. By nameplate (design) implies the total yearly capacity (considering 365 days of operation per year) as per the documentation of the plant technology provider”. In the case of Siilinjärvi, documentation from the plant shows an annual production capacity of 149,500t and ERUs can therefore only be claimed for tonnes of nitric acid produced up to that capacity.

The below tables show the estimated emission reductions taking into account the benchmark emissions factors that will be applied.

Crediting Period (years)	Nitric Acid Production [tHNO₃]	Emission Reductions [tCO₂e]
2009	65,264	19,463
2010	147,000	43,838
2011	147,000	43,838
2012	147,000	14,218
Subtotal (estimated)	506,264	121,358
Average per year (until end 2012)	144,075	34,537

Table 9 (part A): Emissions reductions until 2012 (taking into account the benchmark value)

Crediting Period (years)	Nitric Acid Production [tHNO3]	Emission reductions [tCO ₂ e]
2013	147,000	13,667
2014	147,000	13,667
2015	147,000	13,667
2016	147,000	13,667
2017	147,000	13,667
2018	147,000	13,667
2019	71,458	6,644
Total number of crediting years		10
Total estimated (2009 to 2019)	1,459,722	210,006
Annual average (2009 to 2019)	145,972	21,001

Table 10 (part B): Emission reductions from 2013 onwards (taking into account the benchmark value)

* Due to the likely inclusion of N₂O emissions emanating from nitric acid production into the EU ETS from 1st January 2013 onwards, the project may not be eligible to earn ERUs after that time or continuing the project under the JI may not be economically viable. Also, from 2013 onwards a GWP of 298 for N₂O as defined by the IPCC Third Assessment Report will be applied. This is why this PDD differentiates in between prospective emission reductions achieved until 31st December 2012 and emissions reductions generated from 1st January 2013 onwards.

E.6. Table providing values obtained when applying formulae above:

Crediting Period [years]	Project Emissions [tCO ₂ e]	Benchmark Emissions [tCO ₂ e]	Leakage [tCO ₂ e]	Emission Reductions entitled to ERUs [tCO ₂ e]
2009	31,117	50,580	-	19,463
2010	70,087	113,925	-	43,838
2011	70,087	113,925	-	43,838
2012	70,087	84,305	-	14,218
Subtotal (estimated)	241,376	362,734	-	121,358
Average per year (until end 2012)	68,692	103,229	-	34,537

Table 11 (part A): Summary of calculation of emissions reductions entitled to ERUs until 2012



Crediting Period (years)	Project Emissions [tCO ₂ e]	Benchmark Emissions [tCO ₂ e]	Leakage [tCO ₂ e]	Emission Reductions entitled to ERUs [tCO ₂ e]
2013	67,374	81,041	-	13,667
2014	67,374	81,041	-	13,667
2015	67,374	81,041	-	13,667
2016	67,374	81,041	-	13,667
2017	67,374	81,041	-	13,667
2018	67,374	81,041	-	13,667
2019	32,751	39,395	-	6,644
Total number of crediting years				10
Total estimated (2009 to 2019)	678,369	888,376	-	210,006
Annual average (2009 to 2019)	67,837	88,838	-	21,001

Table 12 (part B): Summary of calculation of emissions reductions entitled to ERUs from 2013

* Due to the likely inclusion of N₂O emissions emanating from nitric acid production into the EU ETS from 1st January 2013 onwards, the project may not be eligible to earn ERUs after that time or continuing the project under the JI may not be economically viable. Also, from 2013 onwards a GWP of 298 for N₂O as defined by the IPCC Third Assessment Report will be applied. This is why this PDD differentiates in between prospective emission reductions achieved until 31st December 2012 and emissions reductions generated from 1st January 2013 onwards.

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

The project will reduce gaseous emissions of nitrous oxide (N₂O) from the plant tail gas and will therefore contribute to international efforts to reduce greenhouse gas emissions. The project will have no effects on local air quality.

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

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

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

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to supporting documentation of an envi-



ronmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>> not applicable

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

>>

As the JI project does not have any relevance for local air, water or soil emissions a local stakeholder consultation has not been undertaken.

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Annex 2

BASELINE INFORMATION

Annex 3

MONITORING INFORMATION

Background on EN14181

The objective is to achieve the highest practically possible level of accuracy in conducting those measurements and transparency in the evaluation process.

While EN14181 provides the most advanced procedures, its practical application is currently limited for the following reasons:

- Specific procedures for N₂O are not yet defined in EN14181;
- Only very limited experience exists with monitoring systems for N₂O emissions;
- In the context of conducting some of the calculations and tests of EN14181, no applicable regulatory N₂O levels exist in the EU (or elsewhere).

Therefore, it is currently not possible to fully comply with the letter of EN14181, neither in the EU, nor in a non-Annex 1 country to the Kyoto Protocol.

Despite all this, EN14181 provides very useful guidance in conducting a logical, step-by-step approach to selecting, installing, adjusting and operating the N₂O AMS for CDM and JI projects.

The monitoring procedures developed for this project aim to provide workable and practical solutions that take into account the specific situation at each nitric acid plant. Wherever possible, EN14181 is applied as guidance for the development and implementation of the monitoring procedures for this JI project in order to achieve highest possible measuring accuracy and to implement a quality control system that assures transparency and credibility.

Scope of EN 14181

This European Standard specifies procedures for establishing quality assurance levels (QAL) for automated measuring systems (AMS) installed at industrial plants for the determination of the flue gas components and other flue gas parameters.

This standard is designed to be used after the AMS has been accepted according to the procedures specified in EN ISO 14956 (QAL1).

EN14181 specifies:

- a procedure (QAL2) to calibrate the AMS and determine the variability of the measured values obtained by it, so as to demonstrate the suitability of the AMS for its application, following its installation;
- a procedure (QAL3) to maintain and demonstrate the required quality of the measurement results during the normal operation of an AMS, by checking that the zero and span characteristics are consistent with those determined during QAL1;



- a procedure for the annual surveillance tests (AST) of the AMS in order to evaluate (i) that it functions correctly and its performance remains valid and (ii) that its calibration function and variability remain as previously determined.

This standard is restricted to quality assurance (QA) of the AMS, and does not include the QA of the data collection and recording system (Metso DNA InfoPlus.21 (Version 6.0 / DNA historian 6.1.2)) of the plant.

For a full description of the AMS to be installed at YARA Siilinjärvi nitric acid plant, as well as details on the quality assurance and control procedures to be undertaken, see section D.1 above.