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

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

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Reduction of N_2O Emissions from Nitric Acid Production at OJSC “AZOT”, Cherkasy, Ukraine

Sectoral scopes to which the project pertains is Chemical industry (5); Group III

Version 04
6September 2010

A.2. Description of the project:

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Open Joint Stock Company (OJSC) “AZOT” (hereafter called “Cherkasy AZOT”) is one of the largest chemical enterprises in Ukraine manufacturing mineral fertilizers, ion-exchange resins, ammonia, weak nitric acid, caprolactam and other chemical products.

Cherkasy AZOT owns ten high pressure lines of UKL-7 type for nitric acid production. The total design capacity is 1,200,000 tonnes per year (120,000 tonnes[1]/yr*10 units) based on 100% HNO_3.

Nitrous oxide (N_2O) is an undesired by-product gas from the manufacture of nitric acid. Nitrous oxide is formed during the catalytic oxidation of ammonia. Over a suitable catalyst, a maximum 98% (typically 92-96%) of the fed ammonia is converted to nitric oxide (NO). The remainder participates in undesirable side reactions that lead to the production of nitrous oxide, among other compounds.

Waste N_2O from nitric acid production is normally released into the atmosphere, as it does not have any economic value or toxicity at typical emission levels. N_2O is an important greenhouse gas (GHG) and has a high Global Warming Potential (GWP) of 310.

The project activity involves the installation of a secondary catalyst for catalytic destruction of most of the nitrous oxide (N_2O) produced in the nitric acid plant. The expected outcome of the project is 85% reduction in the N_2O emissions, which corresponds to approximately 500-900 thousand tonnes of CO_2 emissions per year, depending on the nitric acid production levels.

The project will not disturb the nitric acid production process and will not affect the level of other emissions such as NO_x. It will not result in any significant increase in fuel consumption and leakage effect.

The project does not impact the local communities or access of services in the area. The project activity will not cause job losses at Cherkasy AZOT plant.

The baseline scenario is determined to be the release of N_2O emissions to the atmosphere at the currently measured rate, in the absence of regulations to restrict N_2O emissions (currently there is no legislation requiring the limitation of N_2O emissions associated with nitric acid production in Ukraine). If regulations on N_2O emissions are introduced during the crediting period, the baseline scenario shall be adjusted accordingly.

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[1] In accordance with AM0034, annual production shall be calculated on the basis of 365 days of operation. As per plant design documentation, annual production is calculated on the basis of 8000 operational hours (330 days) per year. 1,200,000 tonnes per year – is the production capacity, which is calculated for 10 lines on the basis of 330 operational days per year in accordance with the operating manual of the production units.

The baseline emission rate will be determined by measuring the N_2O emission factor (kg N_2O/tonne HNO_3) during typical operation of the plant before project implementation. To ensure that the data obtained during the initial N_2O measurement campaign for baseline emission factor determination are representative of the actual GHG emissions from the source plant, a set of process parameters known to affect N_2O generation and under the control of the plant operator will be controlled within certain limits.

Baseline emissions will be dynamically adjusted from activity levels on an ex-post basis through monitoring the amount of nitric acid production. Additional N_2O monitoring and recording facilities will be installed to measure the amount of N_2O emitted by the project activity. All project-related N_2O emissions will be monitored directly in real time.

Project additionality is determined using the "Tool for the demonstration and assessment of additionality", version 05.2 approved at the 39th meeting of the CDM Executive Board.

The project was initiated in early 2006, and the Letter of Endorsement was obtained from the Host Party Designated Focal Point (DFP) in August 2006. Although the first steps were taken early, the implementation of the project was delayed due to the changes in the plant management.

Cherkasy AZOT contracted MGM Worldwide in June 2008 to develop and support the JI project, which is considered as the project start. The initial draft PDD was prepared in December 2008. At the same time, the plant invited tenders for the suppliers of the Automatic Monitoring System (AMS) and the secondary catalyst for N_2O destruction. In January 2009 AZOT ordered AIRTEC to take sample measurements of N_2O emissions in order to determine the estimates of expected emission reductions. The plant is planning to order AMS in April 2010, which should be installed by the end of summer 2010. The contract with a supplier of the secondary catalyst is planned to be closed in August 2010. The secondary catalyst will be installed at each production unit upon completion of baseline emissions monitoring, starting from November 2010.

A.3. Project participants:

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Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Ukraine (host)	OJSC "AZOT" (Ukraine).	No
Denmark	Dong Naturgas AS	No

Cherkasy AZOT is one of the largest chemical enterprises in Ukraine manufacturing mineral fertilizers, ion-exchange resins, caprolactam and other chemical products. Its construction started in 1962, and the first ammonia production line was launched in March 1965. After the collapse of the Soviet Union the plant was privatized and registered as an Open Joint-Stock company "Azot" on July 14th , 1994, Reg. # 1 026 120 0000 000004. Currently Cherkasy AZOT produces about one third of all fertilizers in Ukraine.

DONG Naturgas is a wholly owned subsidiary of DONG Energy. DONG Energy is one of the leading energy groups in Northern Europe headquartered in Denmark. DONG Energy's business is procuring, distributing and trading in energy and related products in Northern Europe.

This project design document (PDD) has been developed by MGM Worldwide LLC, an affiliated company of MGM International Inc., an experienced Clean Development Mechanism (CDM) and Joint Implementation (JI) project developer.

A.4. Technical description of the project:

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A.4.1. Location of the project:

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A.4.1.1. Host Party(ies):

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Ukraine is located in South-Eastern Europe

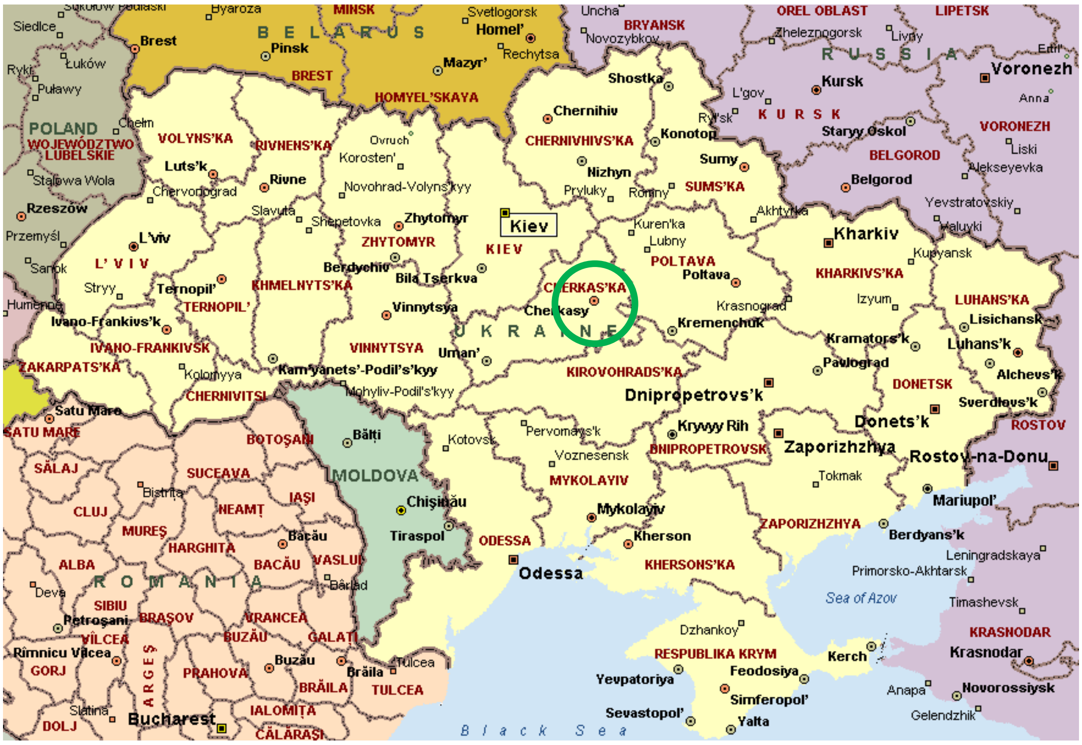

Figure 1. Map of Ukraine showing project location.

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

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Cherkas'ka oblast (region) is situated in the central part of Ukraine; it extends for 238 km from the west to the east and for 200 km from the north to the south. It borders with Kyivs'ka, Poltavs'ka, Kirovohrads'ka and Vinnyts'ka oblasts (regions).

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

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The project is located in the City of Cherkasy, postal code 18014. Cherkasy is a regional centre of Cherkas'ka oblast. The city is located on the Dnieper River, approximately 186 km (122 miles) to the south-west from Kyiv. The estimated population is more than 300,000 people. Cherkasy has many factories and is also an important chemical production centre. The city has a local airport.

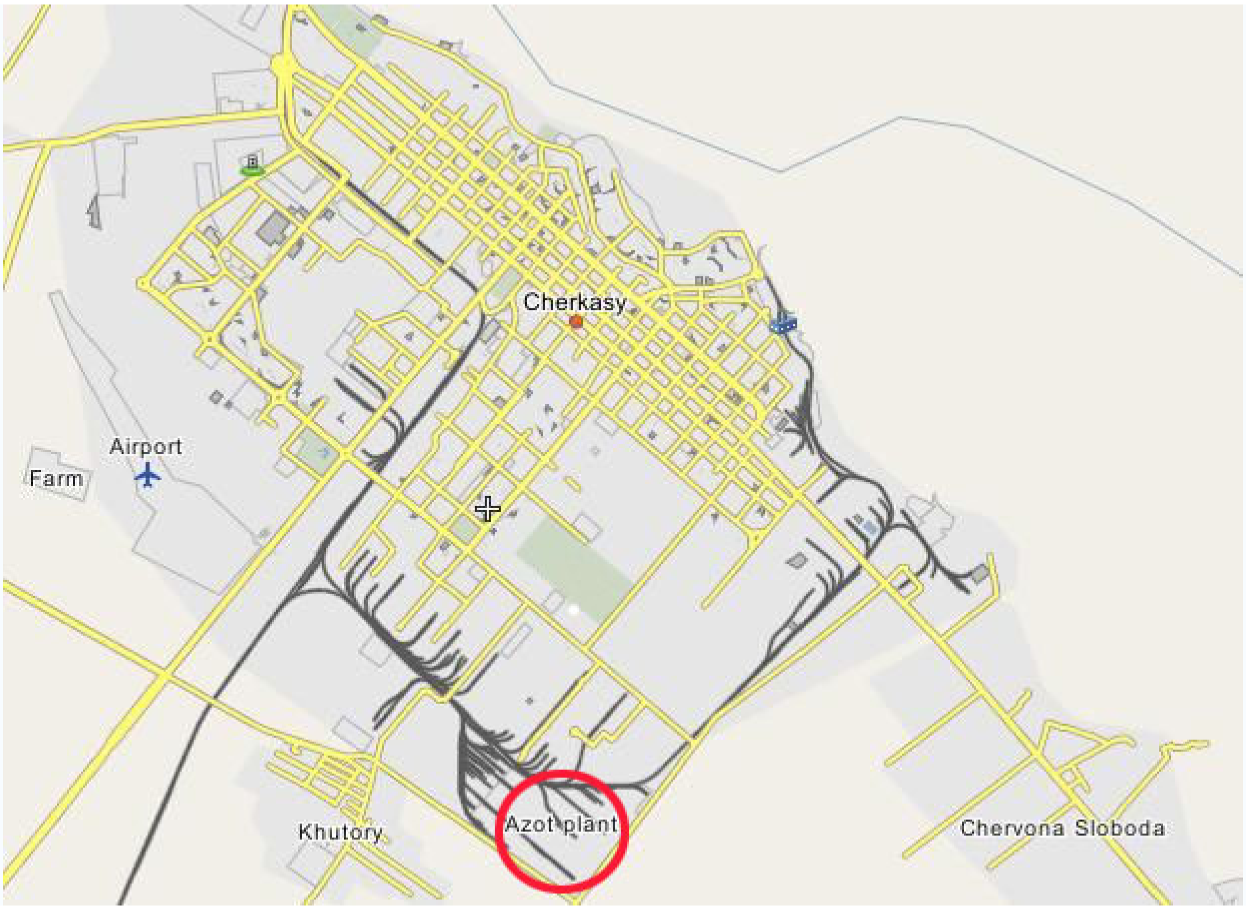

Figure 2. Map of Cherkasy city showing project location.

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

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The GPS coordinates of the plant are:

49°27'53" northern latitude and
32°11'25" eastern longitude.

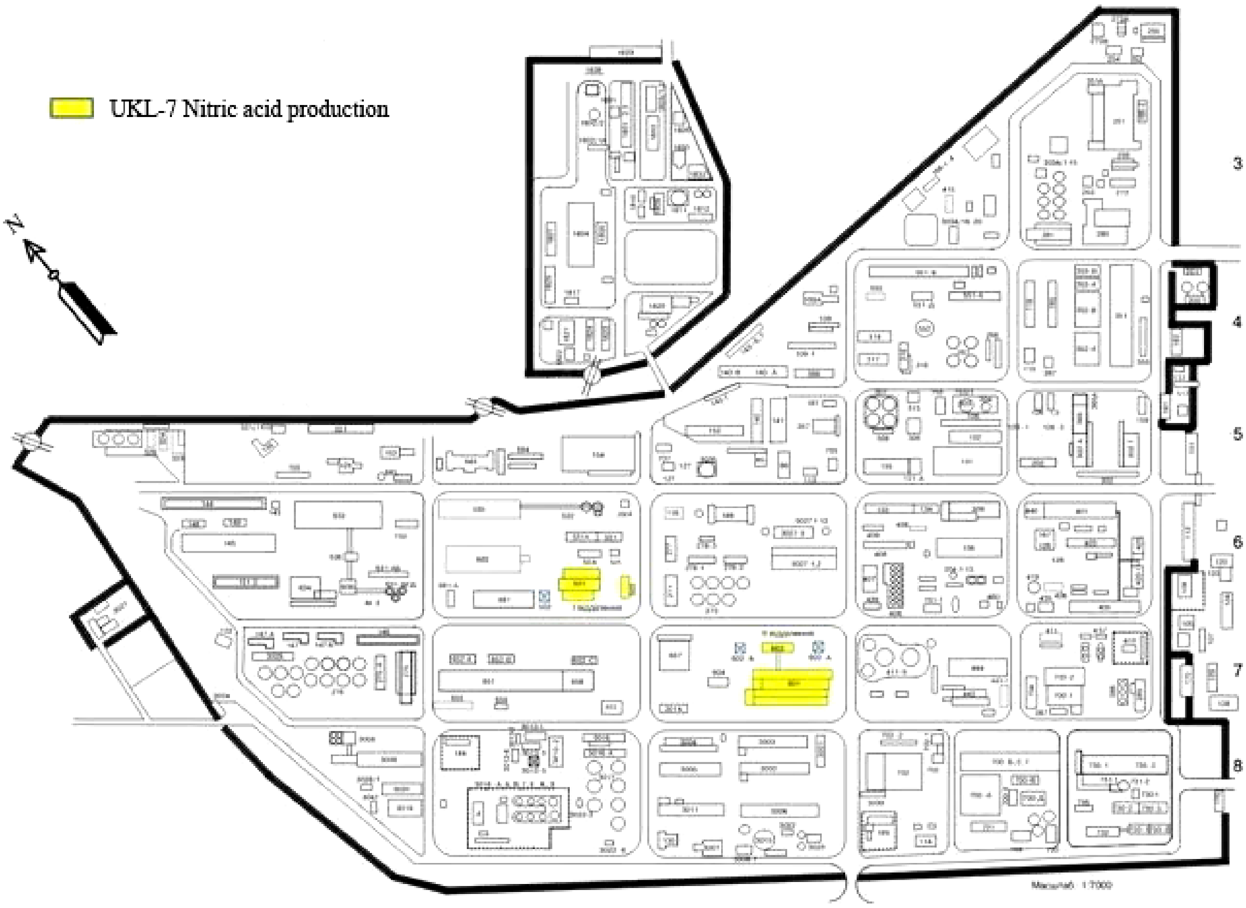

Figure 3. The location of UKL-7 ammonia oxidation reactors at Cherkasy AZOT.

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

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The Ostwald process

Nowadays, all commercial nitric acid is produced by the oxidation of ammonia, and subsequent reaction of the oxidation products with water, through the Ostwald process.

The basic Ostwald process involves 3 chemical steps:

A) Catalytic oxidation of ammonia with atmospheric oxygen, to yield nitrogen monoxide (or nitric oxide).

(1) $4 NH_3 + 5 O_2 \rightarrow 4 NO + 6 H_2O$

B) Oxidation of nitrogen monoxide to nitrogen dioxide or dinitrogen tetroxide

(2) $2 NO + O_2 \rightarrow 2 NO_2 \rightarrow N_2O_4$

C) Absorption of the nitrogen oxides in water to yield nitric acid

(3) $3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$

Reaction 1 is favoured by lower pressure and higher temperature. Nevertheless, at too high a temperature, secondary reactions take place that lower yield (affecting nitric acid production). Thus, an optimal reaction temperature is found between 850 and 950°C, affected by other process conditions and catalyst chemical composition (Figure 4). Reactions 2 and 3 are favoured by higher pressure and lower temperatures.

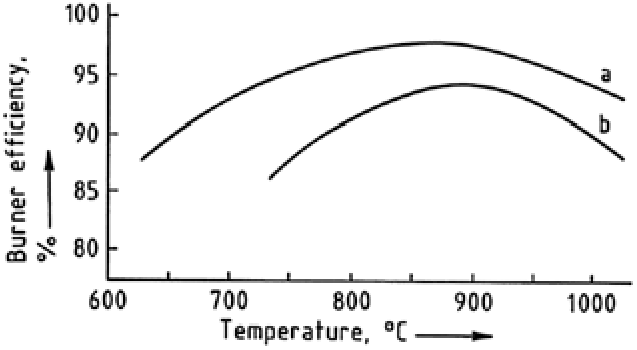

Figure 4. Conversion of ammonia to nitrogen monoxide on platinum gauze as a function of temperature at (a) 100 kPa; (b) 400 kPa[2].

The way in which these three steps are implemented characterizes the various nitric acid processes found throughout the industry. In mono-pressure or single pressure processes ammonia combustion and nitrogen oxide absorption take place at the same working pressure. In dual pressure or split pressure plants the absorption pressure is higher than the combustion pressure.

Nitrous oxide formation

Nitrous oxide is formed during the catalytic oxidation of ammonia. Over a suitable catalyst, a maximum 98% (typically 92-96%) of the fed ammonia is converted to nitric oxide (NO) according to reaction (1) above. The remainder participates in undesirable side reactions that lead to nitrous oxide (N_2O), among other compounds.

Side reactions during oxidation of ammonia:

(4) $4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$ (nitrous oxide formation).

(5) $4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$

(6) $2\ NO \rightarrow N_2 + O_2$

(7) $4\ NH_3 + 6\ NO \rightarrow 5\ N_2 + 6\ H_2O$

N_2O abatement technology classification

The potential technologies (proven and under development) to treat N_2O emissions at nitric acid plants have been classified as follows, on the basis of the process location of the control device:

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[2] Thieman et al., "Nitric Acid, Nitrous Acid, and Nitrogen Oxides", *Ullmann's Encyclopedia of Industrial Chemistry 6th Edition,* Wiley-VCH Verlag GmbH & Co. KGaA. All rights reserved.

- Primary: N_2O is prevented from forming in the oxidation gauzes.
- Secondary: N_2O once formed is eliminated anywhere between the outlet of the ammonia oxidation gauzes and the inlet of the absorption tower.
- Tertiary: N_2O is removed at the tail gas, after the absorption tower and before the expansion turbine.
- Quaternary: N_2O is removed following the expansion turbine and before the stack.

Selected technology for the project activity

The current project activity involves the installation of a new (not previously installed) catalyst below the oxidation gauzes, inside the reactor (a “secondary catalyst”) (Figure 5), whose sole purpose is the decomposition of N_2O.

In order to monitor the emission reductions generated by the project an uninterrupted automatic monitoring system (AMS) will be installed.

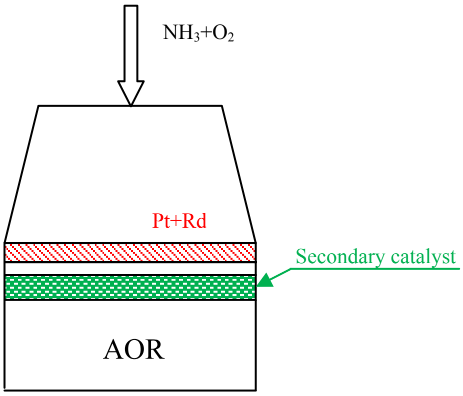

Figure 5. Location of the secondary catalyst inside the Ammonia Oxidation Reactor (AOR).

The secondary approach has the following advantages:

- The catalyst does not consume electricity, steam, fuels or reducing agents (all sources of leakage) to eliminate N_2O emissions; thus, operating costs are negligible and the overall energy balance of the plant is not affected.
- Installation of the secondary catalyst is relatively simple and does not require any new process unit or re-design of existing ones (only the reactor basket needs some modifications to accommodate the new catalyst).
- Installation can be done simultaneously with a primary gauze changeover; thus, the loss in production due to incremental downtime will be limited.
- Considerably lower capital cost when compared to other approaches.
- Secondary catalyst does not affect NO yield.
- Secondary catalyst does not increase NO_x emissions.

The secondary abatement technology has been tested in several industrial trials in which it has proven to be reliable in reducing N_2O emissions and environmentally safe. Especially, its implementation does not lead to increased NO_x emissions. Nor is the environment directly or indirectly harmed in any other way.

Cherkasy AZOT will ensure that the N_2O abatement catalyst is returned to the supplier at the end of its useful life to be refined, recycled or disposed of according to the prevailing EU standards.

The corresponding secondary catalyst installation works will be coordinated among the catalyst supplier's team and Cherkasy AZOT staff, and will be performed by plant technical personnel. Design and installation of a new catalyst support system or modification, for secondary catalyst installation including choice of material, their strength properties, mounting of equipment and all other related documentation will be done by the secondary catalyst supplier according to the applicable rules and standards in Ukraine. The timing of the installation will be correlated with the plant maintenance schedule.

Once the secondary catalyst is installed, the modified reactor and the automated measuring system (AMS) will be operated by the local employees of Cherkasy AZOT. All the suppliers will work together on training Cherkasy AZOT staff to reliably supervise the effective operation of the catalyst technology, operate the installed monitoring system to measure the emission levels and collect the data in a manner that allows the successful completion of each verification procedure.

Cherkasy AZOT has selected BASF as the supplier of the secondary catalyst for the project. The supplier offers 85% destruction of N_2O, with minimum 75% rate guaranteed. However, the plant may use a different supplier of the secondary catalyst in case it offers better performance or price.

The implementation schedule of the project is as follows:

- July 2010: Installation of the monitoring system and start of baseline monitoring.
- September 2010: QAL2 of the monitoring system.
- November 2010: start of the project campaigns at those production lines where the baseline monitoring is completed.
- Second half of 2011: preparation of GHG emission reduction monitoring reports and first verification for those production lines where the first project campaigns are completed.

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:

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The project activity consists of the installation of a secondary catalyst inside the ammonia burner beneath the primary catalyst, whose sole purpose is to reduce the N_2O emissions. Due to high temperature and the presence of the secondary catalyst, the N_2O previously formed is converted into N_2 and O_2.

N_2O is typically released into the atmosphere as common practice in the industry, since it does not have any economic value or toxicity at typical emission levels.

Currently, there are no national regulations or legal obligations in Ukraine concerning N_2O emissions. It is unlikely that any such limits on N_2O emissions will be imposed in the near future.

The abatement of N_2O involves significant investment. Without the project activity as a JI project activity, the N_2O formed would be emitted to the atmosphere, as there are neither economic incentives nor regulatory requirements to abate N_2O emissions.

From what is stated earlier, it is concluded that N_2O would not be removed in the absence of the proposed project activity.

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

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Estimates of emission reductions over the crediting period are calculated taking into account the following factors:

- Annual production of nitric acid is based on the Plan for Production of Nitric Acid for the Years 2009-2015 adopted by the plant management. It envisages that during the period of 2010-2012 the plant will produce around 590 000 tonnes of nitric acid per year. Currently, the plant is operating significantly below its design capacity of 1 200 000 t of nitric acid per year due to frequent failures of compressor turbines. The plant management plans to carry out repairs of the equipment by the end of the year 2012 in order to decrease the frequency of interruptions and restore production output to meet the expected increase in demand for nitrogenous fertilizers. From the year 2013 onwards it is expected that the production will increase to approximately 800 000 – 1 000 000 tonnes HNO_3 per year. For the conservativeness of the emission reduction estimates, the lower figure of 800 000 of nitric acid per year is used for the period of 2013-2022.
- For baseline emissions an average estimated emission factor of 4.23 kg N_2O/t HNO_3 is assumed for all UKL-7 lines. This factor is based on actual N_2O concentration measurements taken in January 2009 at 6 lines by a certified organization AIRTEC, and stack gas volume flow calculated using mass balance approach based on the data provided by the plant's production control unit.
- It is assumed that the secondary catalyst will be provided by BASF, which guarantees at least 75% N_2O destruction efficiency (expected efficiency is 85%). For the purpose of estimation of emission reductions in a conservative way, the project emission factor will be equal to 25% of baseline emission factor ($EF_P = 0.25 * EF_{BL}$).
- Project campaigns will start in November 2010.

Based on the above, the estimated amount of emission reductions over the first crediting period of the Kyoto Protocol is the following:

	Years
Length of the crediting period	2 years and 2 months
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2010	96,708
2011	580,250
2012	580,250
Total estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	1,257,208
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	580,250

Subject to approval by the host country, the crediting period may be extended beyond the first crediting period of the Kyoto Protocol. Estimated amount of emission reductions for the 10-year period after 2012 is the following:

	Years
Length of the crediting period	10 years
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2013	786,780
2014	786,780
2015	786,780
2016	786,780
2017	786,780
2018	786,780
2019	786,780
2020	786,780
2021	786,780
2022	786,780
Total estimated emission reductions over the crediting period (tonnes of CO2 equivalent)	7,867,800
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	786,780

A.5. Project approval by the Parties involved:

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Letter of Endorsement (LoE) was issued to Cherkasy AZOT N_2O abatement JI project by the Ministry of Environmental Protection on August 21st, 2006, by communication No. 7064/09-10.

Letters of Approval of the Host Party and Investor Party will be applied for after the issuance of draft determination report, which is required for the application. During the preparation of the current PDD the National requirements of Host Party[3] were taken into account in addition to the guidelines provided by the Joint Implementation Supervisory Committee.

Status of the project approval by the Parties involved

Host Party: Ukraine	Letter of Endorsement was issued by the Ukrainian Government. The Letter of Approval will be applied for.
Investor Party: Denmark	Letter of Approval and Letter of Authorization for Dong Naturgas AS will be applied for.

SECTION B. Baseline

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

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Following Guidance on Criteria for Baseline Setting and Monitoring version 2 adopted by the Joint Implementation Supervisory Committee (JISC), a JI specific approach may use selected elements or combinations of approved CDM baseline and monitoring methodologies or approved CDM methodological tools.

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[3] Order No. 33 of the National Environmental Investment Agency of Ukraine dated June 25th, 2008 “Regarding the Approval of the Requirements to the Preparation of Joint Implementation Projects”.

This project uses a JI specific approach based on the main elements of the approved CDM baseline and monitoring methodology AM0034 version 03.4 “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants” adopted at 50th meeting of the CDM Executive Board (EB).

The baseline scenario is chosen following the procedures stated in AM0034.

Applicability of baseline methodology AM0034.

The proposed project activity meets the applicability conditions of AM0034:

- The application of the methodology is limited to existing nitric acid production plants installed no later than December 31, 2005. Cherkasy AZOT’s lines were installed prior to this date: one line was installed in 1970, two lines in 1971, three lines in 1972, three more lines in 1973 and the latest line was installed in 1980.
- The current and envisaged repairs and maintenance operations at the plant will not result in construction of new ammonia oxidization reactors and the production of nitric acid at the existing ammonia oxidization reactors will remain within the design capacity of 1 200 000 t of nitric acid per year.
- The project activity will not affect the level of nitric acid production.
- The project activity will not result in the shutdown of any existing N_2O destruction or abatement facility or equipment in the plant.
- There are currently no regulatory requirements or incentives to reduce levels of N_2O emissions from nitric acid plants in Ukraine.
- The project activity will not increase NO_x emissions.
- Cherkasy AZOT’s plant has selective catalytic reduction (SCR) $DeNO_x$ abatement system installed prior to the start of the project activity.
- Operation of the secondary N_2O abatement catalyst installed under the project activity does not lead to any process emissions of greenhouse gases, directly or indirectly.
- Continuous real-time measurements of N_2O concentration and total gas volume flow will be carried out in the stack:
  - Before the installation of the secondary catalyst, and
  - After the installation of the secondary catalyst throughout the chosen crediting period of the project activity.

The table below summarizes the applicability condition analysis for the proposed project activity as per baseline methodology AM0034.

Table 1. Checks of applicability conditions of baseline methodology AM0034

Applicability condition of the methodology	Conclusion
1. This baseline methodology is applicable to project activities that install a secondary N_2O abatement catalyst inside the ammonia burner of a nitric acid plant, underneath the precious metal gauze pack.	Condition satisfied
2. The applicability is limited to existing nitric acid production facilities installed no later than 31 December 2005	Condition satisfied
3. The project activity shall not affect the level of nitric acid production.	Condition satisfied
4. The project activity will not result in the shutdown of any existing N_2O destruction or abatement facility or equipment in the plant;	Condition satisfied
5. There are currently no regulatory requirements or incentives to reduce levels of N_2O emissions from nitric acid plants in the host country.	Condition satisfied
6. No N_2O abatement technology is currently installed in the plant.	Condition satisfied
7. The project activity will not increase NO_X emissions	Condition satisfied
8. NO_X abatement catalyst installed, if any, prior to the start of the project activity is not a Non-Selective Catalytic Reduction (NSCR) $DeNO_X$ unit	Condition satisfied
9. Operation of the secondary N_2O abatement catalyst installed under the project activity does not lead to any process emissions of greenhouse gases, directly or indirectly	Condition satisfied
10. Continuous real-time measurements of N_2O concentration and total gas volume flow can be carried out in the stack; • Prior to the installation of the secondary catalyst for one campaign, and • After the installation of the secondary catalyst throughout the chosen crediting period of the project activity.	Condition satisfied

Identification of baseline scenario

The baseline methodology AM0034 “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants” version 03.4 first involves an identification of possible baseline scenarios, and eliminating those that would not qualify. AM0034 refers to AM0028 version 4.2 “Catalytic N_2O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants” (41st meeting of EB) the procedures of which have to be followed for baseline scenario selection. For the text of the abovementioned methodologies see the following link to the UNFCCC website:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

The analysis of baseline scenarios involves five steps:

Step 1. Identify technically feasible baseline scenario alternatives to the project activity

The first step in determining the baseline scenario is to analyze all options available to project participants. This *first step* can be further broken down into two sub-steps:

Sub-step 1a: The baseline scenario alternatives should include all possible options that are technically feasible to handle N_2O emissions. These options include:

- Continuation of *status quo.* The continuation of the current situation, where there will be no installation of technology for the destruction or abatement of N_2O.
- Switch to an alternative production method not involving the ammonia oxidation process.
- Alternative use of N_2O, such as:
    - Recycling N_2O as a feedstock
    - Use of N_2O for external purposes.

- Installation of a Non-Selective Catalytic Reduction (NSCR) DeNOx unit[4];
- The installation of an N_2O destruction or abatement technology:
  - Primary measure for N_2O destruction.
  - Secondary measure for N_2O destruction
  - Tertiary measure for N_2O destruction

The options include the JI project activity not implemented as a JI project.

Sub-step 1b: In addition to the baseline scenario alternatives of Sub-step 1a, all possible options that are technically feasible to handle NO_X emissions should be considered, since some NO_X technical solutions could also have an effect on N_2O emissions. The alternatives include:

- The continuation of the current situation, where a $DeNO_X$ unit is installed
- Installation of a new non-selective catalytic reduction (NSCR) $DeNO_X$ unit
- Installation of a new tertiary measure that combines NO_X and N_2O emission reduction

Step 2: Eliminate baseline alternatives that do not comply with legal or regulatory requirements:

Currently, there are no national regulations or legal obligations in Ukraine concerning N_2O emissions. It is unlikely that any such limits on N_2O emissions will be imposed in the near future. In fact, given the cost and complexity of suitable N_2O destruction and abatement technologies, it is unlikely that a limit would be introduced in Ukraine considering it has ratified the Kyoto Protocol and actively participates in JI.

In accordance with Resolution № 710296 of December 30th, 2005 and Letter from State Department of Environmental Protection in Cherkasy region №6034/04 of December 31, 2009 the limit for NO_x emissions in 2009-2010 is set as 103 mg/m^3. As Cherkasy AZOT plant has installed SCR $DeNO_x$ units to reduce NO_x emissions, the actual emissions of NO_x do not exceed the above mentioned limit.

None of the baseline alternatives can be eliminated in this step because they are all in compliance with legal and regulatory requirements.

Step 3: Eliminate baseline alternatives that face prohibitive barriers (barrier analysis):

Sub-Step 3a: 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 the deployment of alternatives in the absence of JI is established.

The identified barriers are:

- Investment barriers, inter alia:
  - Debt funding is not available for this type of innovative project activity;
  - Limited access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented.

- Technological barriers, inter alia:
  - Technical and operational risks of alternatives;
  - Technical efficiency of alternatives (e.g., N_2O destruction, abatement rate);

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[4] A NSCR $DeNO_X$-unit will reduce N_2O emissions as a side reaction to the NO_X--reduction, consequently, new NSCR installation can be seen as an alternative N_2O reduction technology.

  - Skilled and/or properly trained labour to operate and maintain the technology is not available and no education/training institution in the host country provides the needed skill, leading to equipment disrepair and malfunctioning
  - Lack of infrastructure for implementation of the technology.

Sub-Step 3b: We will show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed JI project activity):

- Primary abatement technology. Currently, there is no technology from the primary approach group that reaches removal efficiency high enough to represent a potential N_2O abatement solution in itself.

- Switch to an alternative production method not involving the ammonia oxidation process: This is not an option because there is no other commercially viable alternative to produce nitric acid.

- The use of N_2O for external purposes: This is technically not feasible at Cherkasy AZOT's plant, as the quantity of gas to be treated is extremely high, compared to the amount of nitrous oxide that could be recovered. The use of N_2O for external purposes is practiced neither in Ukraine nor anywhere else.

- Recycling N_2O as a feedstock: We can discard recycling of N_2O as a feedstock for the nitric acid plant because nitrous oxide is not a feedstock for nitric acid production. Nitrous oxide is not recycled at nitric acid plants either in Ukraine, or anywhere else.

Therefore the following baseline alternatives are not eliminated in this step:
- Installation of a secondary catalytic DeN_2O;
- Continuation of the *status quo*;
- Installation of a new Selective Catalytic Reduction (SCR) $DeNO_x$ unit;
- Installation of a tertiary abatement technology.

Step 4: Identify the most economically attractive baseline scenario alternative:

The following sub-steps are used to identify the most economically attractive baseline scenario:

Sub-step 4a: Determine appropriate analysis method:

Since the project alternatives generate no financial or economic benefits other than JI-related income, simple cost analysis should be applied.

Sub-step 4b: Apply simple cost analysis:

The possible alternatives listed in Sub-step 1a above, and not discarded in the barrier analysis stage, include: the continuation of the *status quo*, the installation of new Selective Catalytic Reduction (SCR) $DeNO_X$ unit, the installation of the tertiary abatement technology and the installation of some form of secondary DeN_2O system

The installation of a secondary DeN_2O system involves substantial investment costs (which are summarized in Annex 4), and would need to provide benefits (other than JI revenue) in order to qualify as valid baseline. No income from any kind of potential product or by-product except Emission Reduction Units (ERUs) are able to pay back investment costs and running costs for the installation of any such abatement systems as no marketable products or by-products are generated by these treatment methods. Thus, there is no incentive to install a secondary catalyst for the abatement of N_2O.

Cherkasy AZOT's plant has currently installed a Selective Catalytic Reduction DeNO$_X$ unit in accordance with Ukraine's and EU standards. This unit does not consume natural gas for heating the tail gas in the process of NO$_X$ decomposition and has low operational costs. Therefore, the installation of a new Selective Catalytic Reduction DeNO$_X$ unit is not necessary.

Application of available tertiary abatement technology include the NSCR (non-selective catalytic reduction) and the EnviNOx® process commercialized by Uhde GmbH (Germany), which require considerable additional costs. The expenses on the installation of this system and the increase in operating expenses for a plant like Cherkasy AZOT are not justifiable. As mentioned above, a low temperature SCR system is already installed at the plant, which works effectively with minimum operating costs. Tertiary abatement technology would require additional natural gas consumption for heating the tail gases from temperatures below 100ºC to the reaction temperature of about 350 ºC, which would lead to significantly higher operational costs. Considering high investment and operational costs, the use of a tertiary abatement technology is not practically feasible at Cherkasy AZOT.

According to the baseline methodology, "If all alternatives do not generate any financial or economic benefits, then the least costly alternative among these alternatives is pre-selected as the most plausible baseline scenario candidate.*"*

As a result of the analysis, the only feasible baseline is a continuation of the *status quo*, which meets current regulations, and requires neither additional investments nor additional running costs.

Sub-step 4c: is not applied, since a simple cost analysis is adequate for this project.

Sub-step 4d: Sensitivity analysis:

Since the economic analysis is based on simple cost analysis, the baseline methodology does not require a sensitivity analysis: the results are not sensitive to such factors as inflation rate and investment costs, since there are no economic benefits.

Step 5: **Re-assessment of baseline scenario in the course of proposed project activity lifetime:**

At the start of a crediting period, a re-assessment of the baseline scenario due to new or modified NO$_X$ or N_2O emission regulations in Ukraine will be executed as follows:

Sub-step 5a: New or modified NO$_X$ emission regulations

If new or modified NO$_X$ emission regulations are introduced after the project start, the baseline scenario will be re-assessed at the start of a crediting period. Baseline scenario alternatives to be analyzed will include, inter alia:

- Selective catalytic reduction (SCR);
- Non-selective catalytic reduction (NSCR);
- Tertiary measures incorporating a selective catalyst for destroying N_2O and NO$_x$ emissions;
- Continuation of baseline scenario

For the determination of the adjusted baseline scenario, the baseline determination process will be applied as stipulated above (Steps 1-5)

Sub-step 5b: New or modified N_2O regulations
If legal regulations on N_2O emissions are introduced or changed during the crediting period, the baseline emissions will be adjusted at the time the legislation is legally implemented.

Conclusion: the only alternative is business as usual (status quo), i.e. the continuation of N_2O emission to the atmosphere, without the installation of N_2O destruction or abatement technologies and technologies that indirectly reduce N_2O emissions (e.g., NSCR $DeNO_X$ units).

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:

>>

Cherkasy AZOT Nitrous Oxide Abatement Project involves the installation of several secondary catalysts the only purpose and effect of which is the decomposition of nitrous oxide once it is formed.

Following the selected methodology, project emissions are determined from N_2O measurements in the stack gas of the nitric acid plant.

Baseline will be determined by calculating the N_2O baseline emission factor (kg N_2O/tonne HNO_3) before project implementation during *baseline monitoring period*, which is described in Section D.1.1.4.

To ensure that data obtained during such initial campaign represent actual GHG emissions from the source plant, a number of process parameters that could affect N_2O emission and which could (to a certain degree) be under the control of the plant operator are monitored and compared to limits or ranges called “normal operating conditions”.

Normal operating conditions are defined on the basis of historical operating conditions of the plant, and/or plant design data. A range or maximum value for any given parameter has been established considering the specific control capabilities of Cherkasy AZOT. In order to properly characterize baseline emission rates, operation during the initial campaign is controlled within the specified range (a maximum or range that has been established for each parameter).

Only N_2O emissions that are obtained under permitted ranges will be considered in the calculation of baseline emissions. The level of uncertainty determined for the N_2O monitoring equipment will be deducted from the baseline emission factor.

The emission factor determined during the baseline campaign will be presented for crediting of emission reductions.

The additionality of the project activity is demonstrated and assessed using the “Tool for demonstration and assessment of additionality” version 5.2 (EB39). We will demonstrate that the baseline scenario is the continuation of the current situation.

Step 1 of the tool can be avoided since the selection of alternative scenarios was already covered in the analysis carried out in Section B.1 above.

Step 2. Investment analysis:

Sub-step 2a. Determine appropriate analysis method:

As catalytic N_2O destruction facilities generate no financial or economical benefits other than JI-related income, a simple cost analysis is applied.

Sub-step 2b. Apply simple cost analysis

Project scenario: No income from any kind of potential product or by-product except ERUs are able to pay back investment costs as well as running costs for the installation of the secondary catalyst as no marketable product or by-product exists.

The investment (excluding potential financing costs) consists of the engineering, construction, shipping, installation and commissioning of the secondary catalyst and the measurement equipment. The running costs consist of the regular change of the catalysts, personnel costs for the supervision and cost of the measurement equipment.

Baseline scenario: The baseline scenario “The continuation of the current situation” will neither require any additional investments costs nor any additional running costs.

Therefore, the proposed JI project activity is, without the revenues from the sale of ERUs, obviously less economically and financially attractive than the baseline scenario.

Step 3. Barrier analysis is not used for demonstrating additionality in this project.

Step 4. Common practice analysis

The nitric acid industry in Ukraine typically releases into the atmosphere the N_2O generated as a by-product, as it does not have any economic value or toxicity at typical emission levels. Lately several other nitric acid plants in Ukraine initiated similar JI projects that intend to reduce nitrous oxide emissions. In particular, a Project Design Document has been developed for a JI project at JSC “Rivne Azot”[5]. Another JI project is being implemented at CJSC “Severodonetsk Azot”, where the PDD determination is successfully completed and monitoring of the baseline is in progress[6]. This shows that the installation of N_2O abatement technology at nitric acid plants in Ukraine is only feasible with JI component. Thus, in the absence of JI N_2O emissions through the stack gas can be considered the business-as-usual activity as it is a widespread practice around the country.

The proposed project activity is not common practice in the country since similar project activities are not implemented without JI component.

Conclusion:

Currently, there are no national regulations or legal obligations in Ukraine concerning N_2O emissions. It is unlikely that any such limits on N_2O emissions will be imposed in the near future. In fact, given the cost and complexity of suitable N_2O destruction and abatement technologies, it is unlikely that a limit would be introduced by Ukraine, which has ratified the Kyoto Protocol and actively participates in JI.

Cherkasy AZOT has no need to invest in any N_2O destruction or abatement technology. Nor are there any national incentives or sectoral policies to promote similar project activities.

Without the sale of the ERUs generated by the project activity no revenue would be generated and the technology would not be installed. The secondary catalyst technology when installed will reduce nitrous oxide emissions by 75-85 % below what they would otherwise be without the catalyst technology installed.

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[5] http://ji.unfccc.int/UserManagement/FileStorage/E6H3MNA6TVL0KJPJ8QS75DG2GKQR12

[6] http://www.netinform.net/KE/Wegweiser/Guide22.aspx?ID=6148&Ebene1_ID=50&Ebene2_ID=1982&mode=5 ; the project is also developed by MGM Worldwide LLC.

The proposed JI project activity is undoubtedly additional, since it passes all the steps of the "Tool for demonstration and assessment of additionality" (Version 5.2), approved by the CDM Executive Board.

The approval of the project activity as a JI project, and the attendant benefits and incentives derived from the project activity, will offset the cost of the secondary catalyst, and any plant modifications and will enable the project activity to be undertaken.

On the basis of the *ex-ante* estimation of N_2O emission reductions, it is expected that the income from selling of ERUs of the determined JI project activity is at least as high as the investment, financing and running costs. Therefore Cherkasy AZOT is willing to finance the project activity under the condition of the determination of the JI project activity.

B.3. Description of how the definition of the project boundary is applied to the project:

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The project boundary encompasses the physical, geographical site of Cherkasy AZOT's nitric acid plant and equipment for the complete nitric acid production process from the inlet to the ammonia burner to the stack.

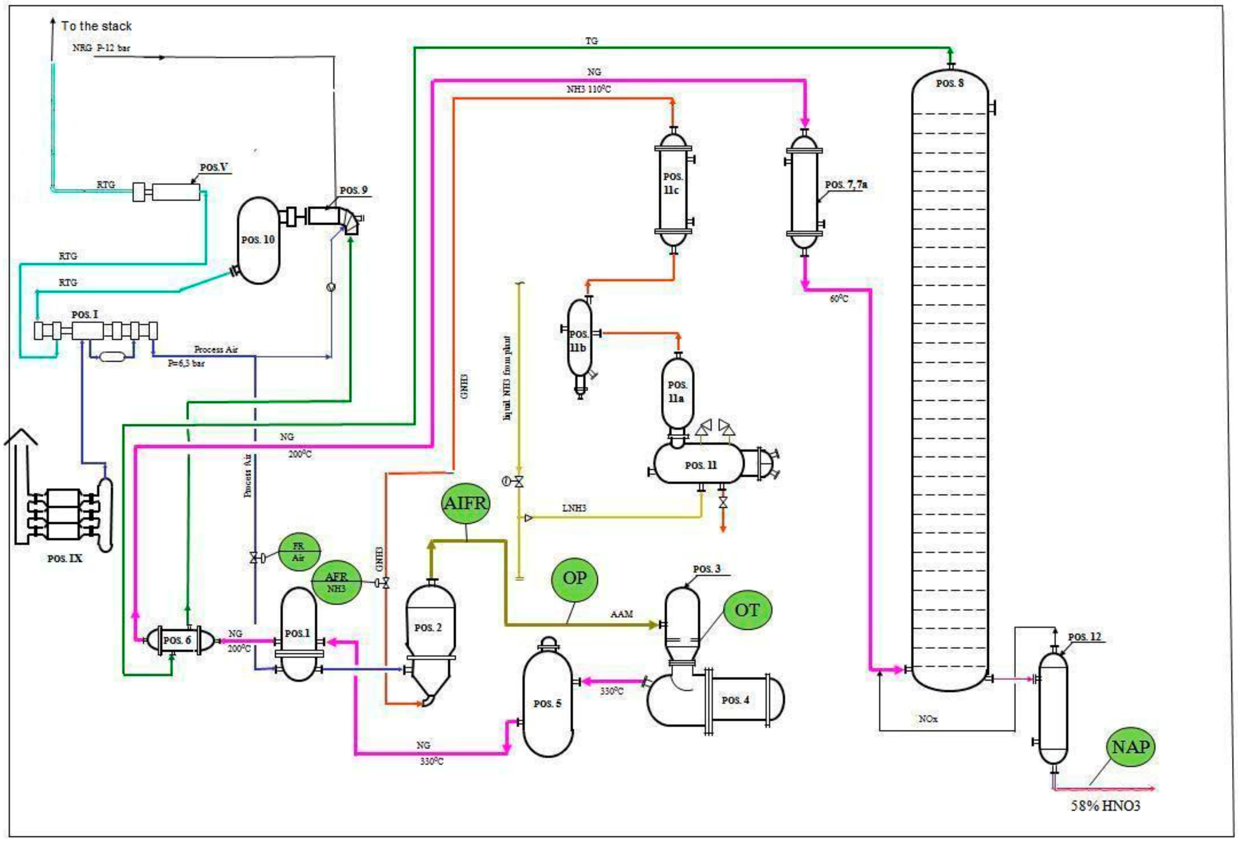
Nitric acid production facility at Cherkasy AZOT consists of 10 production lines of UKL-7 type that belong to the Weak Nitric Acid Production Shop No.M-5, which corresponds to the project boundary. Each UKL-7 line consists of one reactor, one absorption tower, one DeNOx unit, and one tail turbine.

The production lines are operated independently and located in two divisions: division No.1 consists of 3 lines and Division No.2 consists of 7 lines. N_2O is emitted into the atmosphere as part of stack gases after the turbines from 10 lines through 3 common stacks: one stack in Division No.1 and two stacks in Division No.2 (the first stack is connected to 3 lines and the second one serves the other 4 lines) (see Figure 7).

The only GHG emission relevant to the project activity is N_2O contained in the waste stream exiting the stack. The abatement of N_2O is the only GHG emission under the control of the project participants.

The secondary catalyst utilizes the heat liberated by the highly exothermal oxidation reaction (which occurs on the precious metal gauzes of the primary catalyst) to reach its effective operating temperature. Once the operating temperature is reached, no incremental energy is necessary to sustain the reaction.

	Source	Gas	Included / Excluded	Justification / Explanation
Baseline	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	Excluded	The project does not lead to any change in CO_2 or CH_4 emissions, and, therefore, these are not included.
		CH_4	Excluded	
		N_2O	Included	
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	Excluded	The project does not lead to any change in CO_2 or CH_4 emissions.
		CH_4	Excluded	
		N_2O	Included	
	Leakage emissions from production, transport, operation and decommissioning of the catalyst	CO_2	Excluded	No leakage emissions are expected.
		CH_4	Excluded	
		N_2O	Excluded	



1	Air heater
2	Ammonia-Air mixer
3	Ammonia oxidation reactor
4	Utility boiler
5	NO oxidation reactor
6	TG heater
7, 7a	Coolers condensers
8	Absorption column
9	Universal combustion chamber
11	NH_3 boiler
11a	NH_3 filter
11b	NH_3 heater
11c	Distillation column NH_3
12	Desorption column
I	Turbo-compressor
V	Utility boiler
IX	Air filter

→ NA - Nitric Acid
→ LNH3 - Liquid NH3
→ GNH3 - Gas Ammonia
→ Air - Process Air
→ AAM - Ammonia-Air Mixture
→ NG - Nitrous Gas
→ TG - Tail Gas
→ RTG - Reduced Tail Gas
→ NRG - Natural Gas
→

Figure 6. Project boundary (individual UKL-7 line).

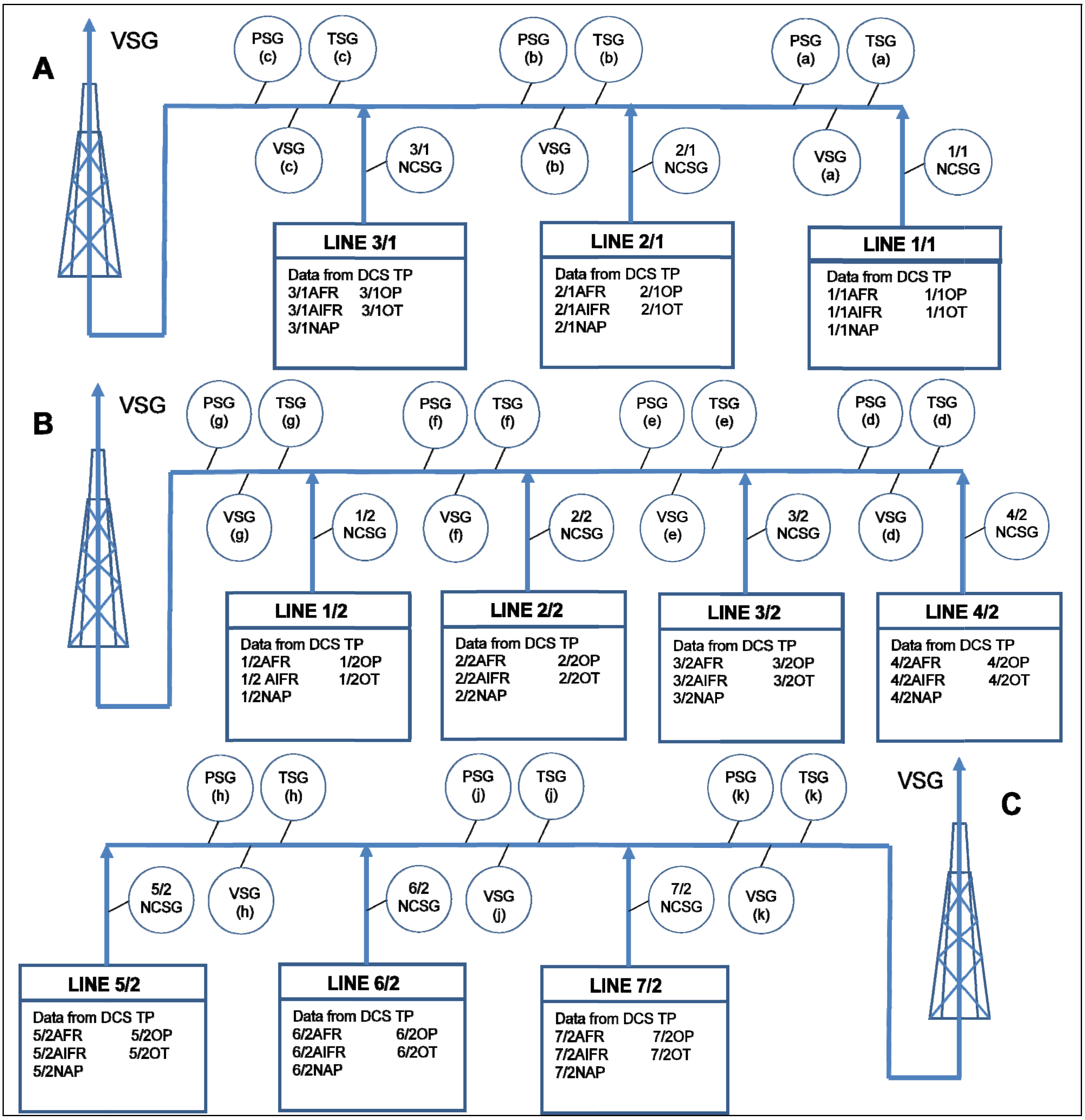


Figure 7. Project boundary (general view, including the layout of tale gas ducts and measurement points).

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

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The baseline for the project activity has not been set yet. This PDD presents preliminary estimates of the baseline and project emissions.

The baseline and monitoring methodology has been applied by:
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MGM Worldwide LLC is not a project participant.

SECTION C. Duration of the project / crediting period

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C.1. Starting date of the project:

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The starting date of the project is June 20th , 2008, the date on which the project development contract was signed between AZOT and MGM Worldwide. The contract envisages legally binding obligations on both sides and thus can be considered as the beginning of real action regarding project implementation.

C.2. Expected operational lifetime of the project:

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The project will continue until the end of the operation of the existing ammonia oxidation reactors, provided there is an incentive to reduce N_2O emissions and the catalyst is replaced regularly. So far, there is no exact planned date for the decommissioning of the ammonia oxidation reactors, but it is expected that they will remain in operation for at least 21 years. Thus, the expected operational lifetime of the project is 21 years 0 months.

C.3. Length of the crediting period:

>>
The crediting period of the project shall be 12 years and 2 months, of which 2 years and 2 months will be within the first commitment period of the Kyoto Protocol. The status of the emission reductions after the end of the first commitment period of the Kyoto Protocol will be determined by any relevant agreement under the UNFCCC and is subject to the approval by the host Party. Currently, the host Party can acknowledge emission reductions for the period up to 31 December 2022, or later according to project's lifetime (Decree of the Cabinet of Ministers of Ukraine N 1313 dated 25 November 2009).

The starting date of the crediting period is November 1st, 2010, when the secondary catalyst is planned to be installed and the project is expected to start generating emission reductions. The end date of the crediting period is 31 December 2022.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

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AM0034 “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants” version 03.4 was designed for and applicable to nitric acid production with one production line, i.e. one reactor, one absorption tower, one turbine, one $DeNO_x$ unit and one monitoring system. The production facility at Cherkasy AZOT consists of 10 individual lines, for which ten sets of monitoring equipment are required. For this reason AM0034 cannot be applied to the current project in its totality, but its main elements served as a basis for a project-specific baseline and project monitoring plan described in the relevant sections below.

The proposed JI project will be closely monitored, metered and recorded. Being a large producer of mineral fertilizer and products of organic synthesis, Cherkasy AZOT has highly qualified and experienced personnel, who will perform project monitoring. The production of weak nitric acid in Division No.2 is operated with a Distributed Control System of the Technological Process (DCS TP), which is served by skilled operators, providing a high standard of work quality. Technical maintenance of the production plant is provided by the specialized service divisions of the enterprise, including mechanical and electrical services, automation services, and the central plant laboratory. Cherkasy AZOT follows the following international standards: ISO 9001-2000, ISO 14001-2004, BSI-OHSAS 18001:1999.

The project activity includes the installation of an Automated Monitoring System (AMS) which will be supplied by a company called Engineering Systems. The system will be manufactured in accordance with DIN EN ISO 14956 and EN 14181. The AMS will include:

1) Gas analyzer system which will continuously measure the concentration of N_2O in the stack gas of each nitric acid production line. It will include gas analyzer model ULTRAMAT 23 produced by Siemens, which is based on the principle of non-dispersive infrared (NDIR) absorption, and includes probes, pipes (gas lines) and sample conditioning system. A probe extracts the homogeneously mixed gas directly from the tail gas stream from a point in the stack, from which it is pumped through gas lines to the analyzer. The probes extract the gas continuously using the pipe specially optimized to the width and height of the stack for sampling at different points. Measuring points will be placed at locations with easy access after the recovery boiler of each line prior to gas release into the common pipeline.

2) Gas flow meters which will continuously monitor tail gas flow from each production line. They will be based on pitostatic probes, which use the principle of differential pressure. The signal resulting from the differential pressure is proportional to the velocity of the stack gas flow. A pressure transmitter of SITARNS DS-III series produced by Siemens will be installed. The temperature and pressure of the gas in the stack will also be continuously measured for calculating the volume flow rate of the stack gas at normal conditions. The calculations will be carried out automatically by the monitoring system.

3) Data collection system is an integrated computer system for data acquisition, processing and storage. It will register N_2O concentration and normalized stack gas flow every 2 seconds, as well as temperature and pressure in ammonia oxidation reactor, ammonia flow, ammonia-to-air ratio, and operation hours of each line. The system will perform calculations in accordance with formulae described in the sections below and the requirements of AM0034, version 03.4.

DCS TP will provide data on nitric acid production at each line, based on measurements of nitric acid flow and density meters. DCS TP will calculate 100% HNO_3 output based on the volume of weak nitric acid produced (usually 57-58% HNO_3). The data will be transmitted from DCS TP to AMS and stored.

In summary, the AMS will monitor the following parameters for each production line:

- N_2O concentration in stack gas;
- Stack flow rate, temperature and pressure;
- Pressure and temperature at AOR
- Ammonia and air flow, ammonia-to-air ratio
- Nitric acid production (calculated as 100% HNO_3)

The operation, maintenance, calibration and service of AMS will be carried out in accordance with the manufacturer's specifications and international standards (EN14181, see also QA/QC section below). The staff of Cherkasy AZOT will be trained during the commissioning phase to perform the monitoring procedures, and a reliable technical support infrastructure will be established.

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

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be 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

P.1	*$NCSG_{n,i}$* *N_2O concentration in the stack gas in campaign n of line i*	*N_2O analyzer*	*mg N_2O/m^3 at normal conditions (101.325 kPa, 0 deg C), (converted from ppm if needed)*	*m*	*Every 2 seconds*	*100%*	*Electronically and on paper for at least 2 years*	*The data output from the analyzer will be processed using appropriate software.*
P.2	*$VSG_{n,i}$* *Volume flow rate of the stack gas in campaign n of line i*	*Gas volume flow meter*	*m^3/hour at normal conditions (101.325 kPa, 0 deg C).*	*m c*	*Every 2 seconds*	*100%*	*Electronically and on paper for at least 2 years*	*The data output from the stack flow meter will be processed using appropriate software.*
P.3	*$PE_{n,i}$* *N_2O emission n^{th} project campaign of line i*	*Calculated from measured data*	*t N_2O*	*c*	*At least once at the end of each campaign*	*100%*	*Electronically and on paper for at least 2 years*	
P.4	*$OH_{n,i}$* *Operating hours in campaign n of line i*	*Production log*	*Hours*	*m*	*Daily, compiled for the entire campaign*	*100%*	*Electronically and on paper for at least 2 years*	*Technical divisions of the plant record the hours of full operation of a line during a campaign based on NH_3 and air input in AOR, and AOR t °C*
P.5	*$NAP_{n,i}$* *Nitric acid production (100% concentrated) in campaign n of line i*	*Production logs*	*t HNO_3*	*m*	*Daily, compiled for the entire campaign*	*100%*	*Electronically and on paper for at least 2 years*	*Total production over project campaign*

P.6	TSG_i Temperature of the stack gas of line i	Probe (part of gas volume flow meter)	ºC	m	Every 2 seconds	100%	Electronically and on paper for at least 2 years	
P.7	PSG_i Pressure of the stack gas of line i	Probe (part of gas volume flow meter)	Pa	m	Every 2 seconds	100%	Electronically and on paper for at least 2 years	
P.8	$EF_{n,i}$ Emissions factor calculated for n^{th} campaign of line i	Calculated from measured data	$tN_2O/t\ HNO_3$	c	After end of each campaign			
P.9	$EF_{ma.n,i}$ Moving average emissions factor after campaign n of line i	Calculated from campaign emission factors for each line	$tN_2O/t100\%\ HNO_3$	c	After end of each campaign			For the first campaign EF and EF_x will be equal
P.10	$CL_{n,i}$ Campaign length of line i	Calculated from nitric acid production data	$t100\%\ HNO_3$	c	After end of each campaign	100%	Electronically and on paper for at least 2 years	
P.11	$EF_{P,n,i}$ Emission factor used to determine emission reductions of campaign n at line i	Determined from campaign emission factors	$tN_2O/tHNO_3$	c	After end of each campaign			Determined from campaign emission factor
P.12	$EF_{min,i}$ Minimum emission factor after 10 campaigns for line i	Determined from campaign emission factors	$tN_2O/t\ HNO_3$	c	After end of 10th campaigns			Determined from campaign emission factor

P. 13	$GS_{project,i}$ *Gauze supplier for the project campaigns of line i*	*Monitored*		*m*	*Each campaign*		*Electronic records and paper for the crediting period*	*To be obtained during the project campaign*
P.14	$GC_{project,i}$ *Gauze composition during project campaigns of line i*	*Monitored*		*m*			*Electronic records and paper for the crediting period*	*To be obtained during the project campaign*

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

>>

Actual project emissions will be determined during the project activity based on continuous measurements of N_2O concentration and flow rate in the stack gas at individual nitric acid production lines. Emission factor will be calculated separately for each line. Project emissions will be calculated as a sum of emissions of each line.

Project measurements are subject to exactly the same procedure as the baseline measurements in order to be coherent.

Estimation of campaign-specific project emissions for individual lines

The monitoring system will provide separate reading for N_2O concentration and gas flow for a given period of time (e.g., every hour of operation, i.e., an average of the measured values of the past 60 minutes). Error readings (e.g., downtime or malfunction) and extreme values are eliminated from the output data series. Next, the same statistical evaluation that was applied to the baseline data series has to be applied to the project data series:

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

The mean values of N_2O concentration and total flow rate are used in the following formula to calculate project emissions:

$PE_{n,i} = VSG_{n,i} \bullet NCSG_{n,i} \bullet 10^{-9} \bullet OH_{n,i}$ (Eq. 1)

Where:

$PE_{n,i}$	Project emissions of the n^{th} campaign on i line, tN_2O
$VSG_{n,i}$	Mean stack gas volume flow rate for the n^{th} project campaign on i line , m^3/h
$NCSG_{n,i}$	Mean concentration of N_2O in the stack gas for the n^{th} project campaign on i line, mgN_2O/ m^3
$OH_{n,i}$	Number of operating hours in the n^{th} project campaign on i line, hours

<u>Calculation of stack gas volume flow rate</u>

Data on tail gas volume flow rate will be collected for each production line (VSG_i). It will be based on measurements of gas flow meters installed at the stack. The points of measurement are presented at Figure 7.

The production lines of Division No.1 are connected to stack A. The volume of stack gas of line 1 of Division No.1 ($VSG_{1/1}$) is measured directly, i.e. it is equal to the total flow in the stack at the measurement point $VSG_{(a)}$:

$VSG_{1/1} = VSG_{(a)}$ (Eq. 2)

The volume of the tail gas produced by line 2 of Division No.1 ($VSG_{2/1}$) is calculated as a difference between the total gas flow at the measurement point $VSG_{(b)}$ (i.e. after the inlet of gas from Line 2/1 to the common stack) and gas flow generated by Line 1/1 (measurement point $VSG_{(a)}$, i.e. the flow before the connection of Line 2/1):

$VSG_{2/1} = VSG_{(b)} – VSG_{(a)}$ (Eq. 3)

The volume of gas produced by line 3 of Division No.1 ($VSG_{3/1}$) is calculated likewise, as a difference between the total gas flow at the end of the stack - the measurement point $VSG_{(c)}$ (which includes gas from all lines of Division No.1) and the gas flow of previous two lines ($VSG_{(b)}$), before the connection of flow from Line 3/1):

$VSG_{3/1}=VSG_{(c)} – VSG_{(b)}$ (Eq. 4)

Tail gas volume of lines of Division No.2 will be measured and calculated in a similar way. For lines connected to Stack B the following formulae will be used (in the order of connection to the stack):

Line 4/2: $VSG_{4/2}=VSG_{(d)}$ (Eq. 5)
Line 3/2: $VSG_{3/2}=VSG_{(e)} - VSG_{(d)}$ (Eq. 6)
Line 2/2: $VSG_{2/2}=VSG_{(f)} - VSG_{(e)}$ (Eq. 7)
Line 1/2: $VSG_{1/2}=VSG_{(g)} - VSG_{(f)}$ (Eq. 8)

For lines connected to Stack C the calculations will be done as follows:

Line 5/2: $VSG_{5/2}=VSG_{(h)}$ (Eq. 9)
Line 6/2: $VSG_{6/2}=VSG_{(j)} -VSG_{(h)}$ (Eq. 10)
Line 7/2: $VSG_{7/2}=VSG_{(k)} - VSG_{(j)}$ (Eq. 11)

The automated monitoring system software will apply the abovementioned calculation procedures for VSG_i . The values of actual conditions will be converted to normal conditions based on the temperature (TSG) and pressure of stack gas (PSG) measured simultaneously at the points presented at Figure 7.

It should be noted that even though in some cases the stack gas volume flow rate for individual lines is obtained through calculation that involves the measurement of the total gas flow from one or several other lines, the figures for each line can be obtained independently of the operation of other lines. For example, VSG for line 6/2 ($VSG_{6/2}$) can be obtained even if line 5/2 is not in operation. The flow at point $VSG_{(h)}$ (that is required for the calculation of $VSG_{6/2}$) equals zero when line 5/2 is not in operation; then according to the Equation 10 $VSG_{6/2}$ will be equal to $VSG_{(j)}$. Therefore the monitoring of tail gas volume flow rate can be performed independently for each production line, which in some cases is based on multiple measurements at the common stack.

Calculation of total project emissions

Total project emissions over a specific monitoring period for the whole JI project are calculated as a sum of emissions of the production lines that were in operation and have completed campaigns within the specified period:

$$PE_{total} = \sum_{i=1}^{i=10} PE_{n,i} \quad \text{(Eq. 12)}$$

Where:
PE_{total} Total project emissions over a specific monitoring period for the whole JI project, tN2O

$PE_{n,i}$	Project emissions of the n^{th} campaign on i line, tN_2O

<u>Derivation of a moving average emission factor</u>

In order to take into account possible long-term emission trends over the duration of the project activity and to take a conservative approach a moving average emission factor is estimated as follows:

Step 1. Estimate campaign-specific emission factor for each campaign during the project's crediting period by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign.

For example, for the n^{th} campaign on line i the campaign-specific emission factor would be:

$$EF_{n,i} = \frac{PE_{n,i}}{NAP_{n,i}} \qquad \text{(Eq. 13)}$$

Where:

$EF_{n,i}$	Emission factor calculated for the n^{th} campaign on i line, $t\ N_2O/t\ HNO_3$
$PE_{n,i}$	Total project emissions of the n^{th} campaign on i line, tN_2O
$NAP_{n,i}$	Nitric acid production in the n^{th} campaign on i line, $t\ HNO_3$

Step 2: Estimate a moving average emission factor calculated at the end of the n^{th} project campaign as follows:

$$EF_{ma,n,i} = (EF_{1,i} + EF_{2,i} + \ldots + EF_{n,i})/n_i \qquad \text{(Eq. 14)}$$

Where:

$EF_{ma,n,i}$	Moving average (ma) of emission factor after n^{th} campaigns, including the current campaign on i line, $tN_2O/tHNO_3$
$EF_{n,i}$	Emission factor calculated for a specific project campaign on i line, $tN_2O/tHNO_3$
n_i	Number of campaigns to date on i line

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

To calculate the emission reductions achieved in the n^{th} campaign on i line, the higher of the two values $EF_{ma,n,i}$ and $EF_{n,i}$ shall be applied as the emission factor relevant for that particular campaign $EF_{p,i}$).

If $EF_{ma,n,i} > EF_{n,i}$, then $EF_{p,i} = EF_{ma,n,i}$
If $EF_{ma,n,i} < EF_{n,i}$, then $EF_{p,i} = EF_{n,i}$ (Eq. 15)

Minimum project emission factor

Minimum project emission factor will be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential build-up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest $EF_{n,i}$ observed during those campaigns will be adopted as a minimum ($EF_{min,i}$). If any of the later project campaigns results in an $EF_{n,i}$ that is lower than $EF_{min,i}$, the calculation of the emission reductions for that particular campaign will use $EF_{min,i}$ and not $EF_{n,i}$. However, if the decrease in N_2O emissions is clearly attributable to the use of a new (different from previous) secondary catalyst composition or type, which has a higher efficiency of N_2O destruction, previously calculated minimum emission factor will not apply, and a new $EF_{min,i}$ shall be established after the first ten campaigns from the start of the use of a new secondary catalyst.

Composition of the ammonia oxidation catalyst

To ensure the conservativeness and adequacy of emission reduction calculation, ammonia oxidation catalyst used in the project campaigns ($GC_{project,\ i}$) should be identical to that used during the measurement of baseline emissions ($GC_{BC,\ i}$) at the respective production line. If the plant has to change the composition of the ammonia oxidation catalyst in a project campaign at line *i* to a composition not used in the baseline measurements at this line (e.g. switch from catalyst composition called '*A*' to catalyst composition '*B*' at line *i*), the project proponent shall apply the following options:

(i) Set the baseline emissions factor to the conservative IPCC default emission factor for N_2O from nitric acid plants which have not installed N_2O destruction measures (4.5 kg N_2O/t HNO_3), as suggested by the approved methodology AM0034. However, the preliminary measurements of baseline emissions showed that emission factors at some production lines may be lower than 4.5 kg N_2O/t HNO_3, which suggests that the IPCC default emission factor may not be conservative for them. Therefore, the IPCC default emission factor can be only applied to those production lines where the baseline measurements showed an emission factor higher than 4.5 kg N_2O/t HNO_3. For other production lines where the baseline emission factor was lower than 4.5 kg N_2O/t HNO_3, the following options must be used.

(ii) If the catalyst composition that was not used in the baseline measurements at line *i* (the new catalyst composition called '*B*') was already applied for baseline measurements at least at three other production lines, the results of these baseline measurements can be used for line *i* in the following way. Select the lowest baseline emission factor obtained at other three or more production lines with the same catalyst composition '*B*', compare it to the previous baseline emissions factor obtained for line *i* with catalyst composition '*A*', and adopt the lower figure as $EF_{BL,\,i}$. If no representative baseline data exists from at least three other lines with the catalyst composition '*B*' the following option must be used.

(iii) Repeat the baseline campaign to determine a new baseline emissions factor at line *i* when catalyst '*B*' is used, compare it to the previous baseline emissions factor obtained with catalyst '*A*' and adopt the lower figure as $EF_{BL,\,i}$.

Project Campaign Length

a. Longer Project Campaign

If the length of each individual project campaign $CL_{n,i}$ is greater than or equal to the average historic campaign length $CL_{normal,i}$, then all N_2O values measured during the baseline campaign can be used for the calculation of $EF_{n,i}$ (subject to the elimination of data from the ammonia/air analysis).

b. Shorter Project Campaign

If $CL_{n,i} < CL_{normal,i}$, recalculate $EF_{BL,\,i}$ by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the $CL_{n,\,i}$ (i.e., the last tonnes produced during the campaign) from the calculation of $EF_{n,\,i}$. In the case the baseline data was collected from the consecutive parts of two campaigns, $CL_{n,\,i}$ will set the limit for the first of the two consecutive campaigns (campaign A at Figure 8). Thus, N_2O values at the end of the first campaign used to establish baseline beyond the length of $CL_{n,\,i}$ will be eliminated from the calculation of $EF_{BL,\,i}$.

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
B.1	*$NCSG_{BC\,i}$* *N_2O concentration in the stack gas in baseline measurement*	*N_2O analyzer*	*mg N_2O/m^3 at normal conditions (101.325 kPa, 0 deg C) (converted from*	*m*	*Every 2 seconds*	*100%*	*Electronically and on paper for the entire crediting period*	*The data output from the analyzer will be processed using appropriate software*

	period of line i		*ppmv if necessary)*					
B.2	$VSG_{BC\ i}$ *Volume flow rate of the stack gas in baseline campaign of line i*	*Gas volume flow meter*	m^3*/hour at normal conditions (101.325 kPa, 0 deg C)*	*m c*	*Every 2 seconds*	*100%*	*Electronically and on paper for the entire crediting period*	*The data output from the stack flow meter will be processed using appropriate software*
B.3	$BE_{BC\ i}$ *Total* N_2O *emissions for baseline campaign of line i*	*Calculated from measured data*	tN_2O	*c*	*At least once after baseline campaign*	*100%*	*Electronically and on paper for the entire crediting period*	
B.4	$OH_{BC\ i}$ *Operating hours in baseline campaign of line i*	*Production log*	*Hours*	*m*	*Daily compiled for the entire campaign*	*100%*	*Electronically and on paper for the entire crediting period*	*Technical divisions of the plant record the hours of full operation of a line during a campaign based on* NH_3 *and air input in AOR, and AOR t °C*
B.5	$NAP_{BC\ i}$ *Nitric acid (100% concentrated) in baseline campaign of line i*	*Production log*	$t\ HNO_3$	*m*	*Daily compiled for the entire campaign*	*100%*	*Electronically and on paper for the entire crediting period*	
B.6	TSG_i *Temperature of the stack gas of line i*	*Probe (part of gas volume flow meter)*	*ºC*	*m*	*Every 2 seconds*	*100%*	*Electronically and on paper for the entire crediting period*	

B.7	*PSG_i Pressure of the stack gas of line i*	*Probe (part of gas volume flow meter)*	*Pa*	*m*	*Every 2 seconds*	*100%*	*Electronically and on paper for the entire crediting period*	
B.8	*$EF_{BL,\ i}$ Baseline emission factor of line i*	*Calculated from monitored data*	*t N_2O/t HNO_3*	*c*	*Once, at the end of the baseline campaign*		*Electronically and on paper for the entire crediting period*	
B.9	*UNC_i Overall measurement uncertainty of the monitoring system*	*Calculation of the combined uncertainty of the applied monitoring equipment*	*%*	*c*	*Once, after monitoring system is commissioned*		*Electronically and on paper for the duration of the project activity*	
B.10	*AFR_i Ammonia gas flow rate to the AOR of line i*	*Monitored*	*kg NH_3/h*	*m*	*Continuously*	*100%*	*Electronically and on paper for at least 2 years*	*To be obtained from the operating condition campaign*
B.11	*$AFR_{max\ i}$ Maximum ammonia flow rate of line i*	*Plant records*	*kg NH_3/h*	*m*	*Once*	*100%*	*Electronically and on paper for at least 2 years*	
B.12	*$AIFR_i$ Ammonia to Air Flow Ratio of line i*	*Calculated from monitored data*	*%*	*mc*	*Every hour*	*100%*	*Electronically and on paper for at least 2 years*	*To be obtained from the operating condition campaign*
B.13	*$CL_{BL\ i}$ Length of the baseline campaign of line i*	*Calculated from nitric acid production data*	*t HNO_3*	*c*	*After end of each campaign*	*100%*	*Electronically and on paper for at least 2 years*	
B.14	*$CL_{normal\ i}$ Normal campaign length*	*Calculated from nitric acid production data or*	*t HNO_3*	*c*	*Once, prior to end of baseline campaign*		*Electronically and on paper for at least 2 years*	*Average historical campaign length*

	of line i	*ammonia consumption data*						*during the operating conditions campaign*
B.15	$AIFR_{max\ i}$ *Maximum ammonia to air ratio of line i*	*Calculated from historical process data*	*%*	*c*	*Once*	*100%*	*Electronically and on paper for at least 2 years*	
B.16	OTh_i *Oxidation temperature for each hour of line i*	*Monitored*	*ºC*	*m*	*Every hour*	*100%*	*Electronically and on paper for at least 2 years*	*To be obtained from the operating condition campaign*
B.17	$OT_{normal\ i}$ *Normal Operating Temperature*	*Historical monitoring*	*ºC*	*m*	*Once*	*100%*	*Electronically and on paper for at least 2 years*	
B.18	OPh_i *Oxidation Pressure for each hour*	*Monitored*	*Pa*	*m*	*Every hour*	*100%*	*Electronically and on paper for at least 2 years*	*To be obtained from the operating condition campaign*
B.19	$OP_{normal\ i}$ *Normal Operating Pressure*	*Historical monitoring*	*Pa*	*m*	*Once*	*100%*	*Electronically and on paper for at least 2 years*	
B.20	$GS_{normal\ i}$ *Normal gauze supplier for the operation condition campaigns of line i*	*Monitored*		*m*	*Each campaign*	*100%*	*Electronically and on paper during project crediting period*	*To be obtained from the operating condition campaign*
B.21	$GS_{BL\ i}$ *Gauze supplier for the baseline*	*Monitored*		*m*	*Once*	*100%*	*Electronically and on paper during project*	*To be obtained during the baseline*

	campaign of line i						*crediting period*	*campaign*
B.22	$GC_{normal\ i}$ *Normal gauze composition for the operation condition campaigns of line i*	*Historical monitoring*		*m*	*Once*	*100%*	*Electronically and on paper during project crediting period*	
B.23	$GC_{BL\ i}$ *Gauze composition during baseline campaign of line i*	*Monitored*		*m*	*Once*	*100%*	*Electronically and on paper during project crediting period*	*To be obtained during the baseline campaign*
B.24	EF_{reg} *Emissions level set by incoming policies or regulations*	*Monitored*		*m*	*Prior to the preparation of each monitoring report*	*100%*	*Electronically and on paper during project crediting period (if introduced)*	*Updated if new regulations come into force*
B.25	$AC_{ave,\ i}$ *Average ammonia consumption over historic campaigns on i line*	*Calculated based on plant records*	tNH_3	*mc*	*Once*	*100%*	*Electronically and on paper during project crediting period*	
B.26	*APN* *Standard ammonia consumption per tonne of nitric acid*	*Obtained from design documents*	$tNH_3/ tHNO_3$	*m*	*Once*	*100%*	*Electronically and on paper during project crediting period*	

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

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AM0034 “Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants” Version 03.4 suggests that baseline emissions are established through continuous monitoring of both N_2O concentration and gas volume flow in the stack of the nitric acid plant for *one complete campaign* prior to project implementation. However, the production lines at Cherkasy AZOT are operated independently, and the schedules for the start and the end of campaigns at each of the 10 lines do not coincide with each other. In fact, the time difference between the campaigns can be up to 5-6 months. Measurement of baseline emissions from the start to the end of one full campaign at each line would significantly extend the baseline monitoring period and postpone the installation of the secondary catalyst, losing on opportunity to reduce a considerable amount of GHG emissions. Hence, for this project, it is proposed to start baseline emissions measurement immediately after the installation of AMS simultaneously at each production line.

The installation of the monitoring system may coincide with the campaign start at some lines, where the baseline data will be collected during the whole campaign as described in AM0034 (see Figure 8, example #1). For other production lines where the launch of the AMS takes place during the production campaign baseline emissions will be measured in two consecutive periods of successive campaigns, so that the total length of measurement will be equivalent to the length of a typical production campaign (Figure 8, examples #2 and #3). In other words, the baseline emission measurement will start when a production line re-starts operation after AMS installation, and will be completed as soon as the total length of the two periods of the consecutive campaigns are equal to the normal campaign length (CL_{normal}), after which the secondary catalyst can be installed.

In the latter case, the baseline data for the calculation of baseline emission factor will be obtained from the two consecutive campaigns as follows:

(i) Monitored data for the last “x” hours of the first campaign (closer to the end of a campaign, when usually ammonia conversion efficiency is lower and N_2O formation is higher), and

(ii) Monitored data for the first “y” hours of the next campaign (at the beginning of a campaign, when usually ammonia conversion efficiency is slightly higher and N_2O formation is lower).

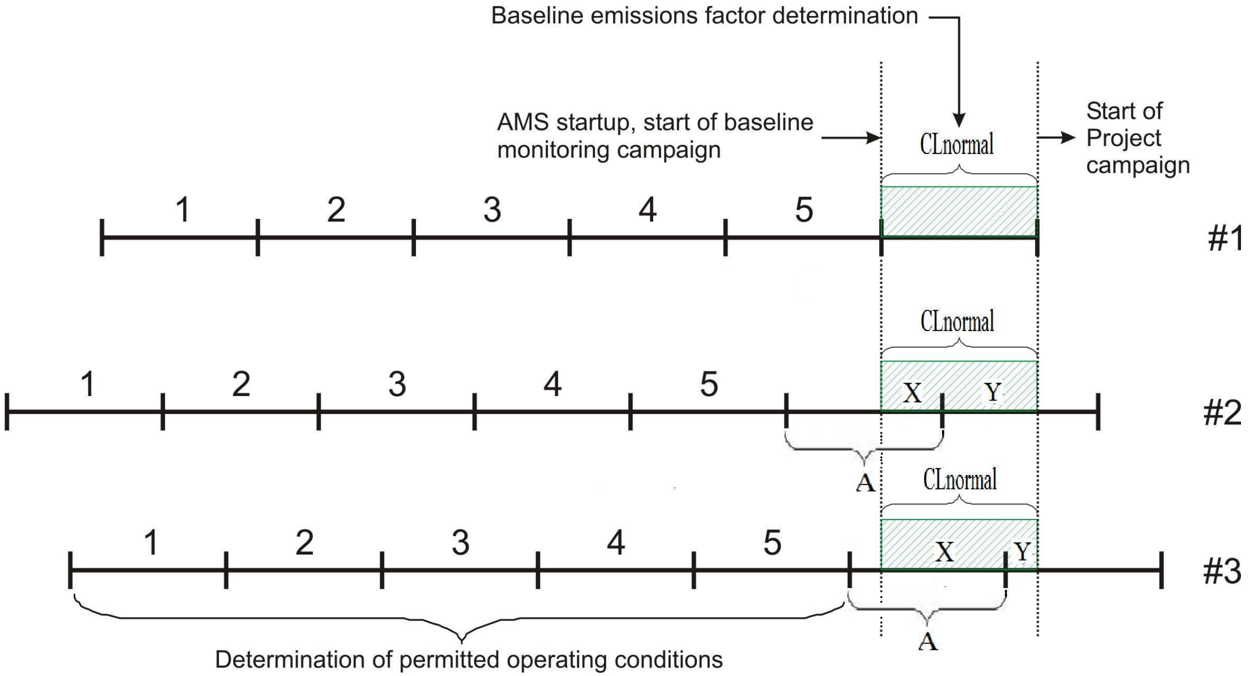

Figure 8. Determination of baseline emission factor.

Thus, the *baseline measurement period* for each line will be either:

a) one complete baseline campaign, as described in AM0034
b) two consecutive periods of successive campaigns, where the total length of the periods is equivalent to the to the normal campaign length (CL_{normal}) .

Determination of the permitted operating conditions of the nitric acid plant to avoid overestimation of baseline emissions:

To ensure the conservativeness of the baseline emission factor and to avoid the possibility that the operating conditions of the nitric acid production plant are modified in such a way that increases N_2O generation during the baseline measurement period, the provisions and limitations of AM0034 are applied. In particular, the normal ranges for operating conditions shall be determined for the following parameters: (i) oxidation temperature; (ii) oxidation pressure; (iii) ammonia gas flow rate, and (iv) ammonia-to-air ratio. The permitted range shall be established using the procedures described below.

Once the permitted ranges for pressure, temperature, ammonia flow rate and ammonia to air ratio are determined, they should be observed during the measurement period used to determine baseline N_2O emission factor. However, under certain circumstances, the operating conditions may be outside the permitted range or limit corresponding to normal operating conditions. In this case, any N_2O baseline data that is measured during hours where the operating conditions are outside the permitted range, except OH_{BC} and NAP_{BC}, will be eliminated from the calculation of the baseline emissions factor. The baseline measurement will not be valid and must be repeated if the plant operates outside of the permitted range for more than 50% of the duration of the baseline measurement period.

Oxidation temperature and pressure

The permitted range for oxidation temperature and pressure is to be determined based on the historical data for the operating range of temperature and pressure from the previous five campaigns (or fewer, where the production lines have not been operating for five campaigns). This range is determined through a statistical analysis in which the time series data is to be interpreted as a sample for a stochastic variable. All data that falls within the upper and lower 2.5% percentiles of the sample distribution is defined as abnormal and will be eliminated. The permitted range of operating temperature and pressure is then assigned as the historical minimum (value of parameter below which 2.5% of the observations lie) and maximum operating conditions (value of parameter exceeded by 2.5% of observations).

At the time of the preparation of the current PDD the historical campaigns were in progress, and the historical data used to define permitted range of operating temperature and pressure will be available for a verifying AIE at the first ER verification.

Ammonia gas flow rate and ammonia-to-air ratio input into the ammonia oxidation reactor

The upper limits for ammonia flow and ammonia-to-air ratio are determined using historical maximum operating data for hourly ammonia gas and ammonia-to-air ratio for the previous five campaigns (or fewer, where the production lines have not been operating for five campaigns).

At the time of the preparation of the current PDD the historical campaigns were in progress, and the historical data used to define the upper limits for ammonia flow and ammonia-to-air ratio will be available for a verifying AIE at the first ER verification.

Determination of baseline emission factor: measurement procedure for N_2O concentration and gas volume flow

For the determination of the baseline emission factor N_2O concentration and gas volume flow will be monitored throughout a *baseline measurement period*, which is either one full campaign, or two consecutive parts of successive campaigns as described above. The monitoring system will provide separate readings for N_2O concentration and gas volume flow for a defined period of time (for every hour of operation, it will provide an average of the measured values for the previous 60 minutes). Error readings (e.g., downtime or malfunction) and extreme values will be eliminated from the output data series. The duration of the baseline measurement period will be will be determined based on the amount of nitric acid produced over a typical campaign, expressed in tonnes of 100% HNO_3.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to maverick data. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is to be applied to the complete data series of N_2O concentration and the data series for gas volume flow. The statistical procedure will be applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Then, the average mass of N_2O emissions per hour is estimated as product of NCSG and VSG. The N_2O emissions per campaign are estimated as the product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC,i} = VSG_{BC,i} \bullet NCSG_{BC,i} \bullet 10^{-9} \bullet OH_{BC,i} \qquad \text{(Eq. 16)}$$

Where:

$BE_{BC,i}$	Baseline emissions in the baseline measurement period on *i* line, tN_2O
$VSG_{BC,i}$	Mean stack gas volume flow rate in the baseline measurement period on *i*-line, m^3/h
$NCSG_{BC,i}$	Mean concentration of N_2O in the stack gas in the baseline measurement period on *i*-line, mg N_2O/m^3
$OH_{BC,i}$	Number of operating hours in the baseline measurement period on *i*-line, h

The plant-specific baseline emission factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid for that period.

The overall measurement uncertainty of the monitoring system, expressed as a percentage (*UNC*) will be used to reduce the N_2O emission factor per tonne of nitric acid produced in the baseline measurement period ($EF_{BL,\,i}$) as follows:

$$EF_{BL,i} = \frac{BE_{BC,i}}{NAP_{BC,i}}(1 - \frac{UNC_i}{100}) \qquad \text{(Eq. 17)}$$

Where:

$EF_{BL,i}$	Baseline emission factor on *i* line, in $tN_2O/tHNO_3$
$NAP_{BC,i}$	Nitric acid production during the baseline measurement period on *i* line, $tHNO_3$
UNC_i	Overall measurement uncertainty of the monitoring system on *i* line, in %, calculated as the combined uncertainty of the applied monitoring equipment

Impact of regulations

Should N_2O emission regulations that apply to nitric acid plants be introduced in Ukraine or the jurisdiction covering the location of the nitric acid plant change, such regulations shall be compared to the calculated baseline emission factor ($EF_{BL,\,i}$), regardless of whether the regulatory level is expressed as:

- An absolute cap on the total volume of N_2O emissions for a set period;
- A relative limit on N_2O emissions expressed as a quantity per unit of output; or
- A threshold value for specific N_2O mass flow in the stack.

In this case, a corresponding plant-specific emission factor cap (maximum allowed $tN_2O/tHNO_3$) is to be derived from the regulatory level. If the regulatory limit is lower than the baseline factor determined for the project activity, the regulatory limit (EF_{reg}) will become the new baseline emission factor, that is:

If $EF_{BL,\,i} > EF_{reg}$, then $EF_{BL,\,i} = EF_{reg}$ for all the calculations.

The changes in regulation related to NO_x and N_2O emissions will be monitored by the Environmental Department of Cherkasy AZOT, which will inform JI Project Coordinator accordingly (see Figure 9). The availability of new regulations or changes introduced by the Government of Ukraine or relevant authorities shall be checked each time prior to the preparation of a monitoring report.

Composition of the ammonia oxidation catalyst

To ensure the conservativeness of the baseline emission factor and to avoid the possibility of artificial increases in N_2O generation during the baseline measurement the composition of the ammonia oxidation catalyst used for the baseline measurement should identical to that used in the campaigns for setting the

normal operating conditions (previous five or fewer campaigns). A change in the composition of the ammonia oxidation catalyst in the baseline measurement period to a composition other than that used in the previous five campaigns, is permissible without any limitation on the N_2O baseline emissions if the following conditions are met:
(i) The baseline catalyst composition is considered as common practice in the industry; or
(ii) The change in catalyst composition is justified by its availability, performance, relevant literature etc.

Otherwise, the baseline measurements have to be repeated with the ammonia oxidation catalyst of the composition identical to that used in the campaigns for setting the normal operating conditions (previous five or fewer campaigns).

For this purpose, the composition of the catalyst gauze ($GC_{normal, i}$) and its suppliers ($GS_{normal, i}$) are to be monitored for each production line in the previous five campaigns (or fewer, where the production lines have not been operating for five campaigns), and in the baseline measurement period ($GC_{BC, i}$ and $GS_{BC, i}$, respectively).

At the time of the preparation of the current PDD the historical campaigns were in progress, and the historical data on the composition of the catalyst gauze and its suppliers will be available for a verifying AIE at the first ER verification.

Campaign length

In order to take into account variations in campaign length and their influence on N_2O emission levels, the historic campaign lengths and the baseline campaign length are to be determined and compared to the project campaign length. Campaign length is defined as the total number of tonnes of nitric acid at 100% concentration produced with one set of gauzes.

Historic Campaign Length

The average historic campaign length of an individual production line ($CL_{normal, i}$) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns excluding abnormal campaigns or fewer, where a production line has not been operating for five campaigns) will be used as a cap on the length of the baseline campaign for the respective line.

The amount of nitric acid production to establish the historic campaign lengths for each production line will be obtained from the plant records, based on measurement with nitric acid flow meters, where available (seven production lines of Division No.2). Three production lines of Division No.1 currently are not equipped with nitric acid flow meters, so the amount of nitric acid production for establishing the historic campaign lengths will be calculated based on the plant records of ammonia use. To calculate average historic campaign length the average ammonia use per historic campaign will be divided by the standard ammonia consumption per tonne of nitric acid produced. The standard ammonia consumption per tonne of nitric acid produced is obtained from the design documents for the high-pressure ammonia oxidation reactors, and is equal to 0.293 tNH_3/ $tHNO_3$.

$$CL_{normal,\ i} = \frac{AC_{ave\ i}}{APN} \qquad \text{(Eq. 18)}$$

Where:

$CL_{normal,i}$	Normal campaign length of line *i*, in $tHNO_3$
$AC_{ave,\ i}$	Average ammonia consumption over historic campaigns on *i* line, tNH_3
APN	Standard ammonia consumption per tonne of nitric acid, tNH_3/ $tHNO_3$

At the time of the preparation of the current PDD the historical campaigns were in progress. The procedures and figures used to define historic campaign length will be verified by a verifying AIE at the first ER verification.

Baseline Campaign Length

If the baseline campaign length of line *i* ($CL_{BL,\ i}$) is lower than or equal to $CL_{normal,\ i}$ for this line, all N_2O values measured during the baseline campaign can be used for the calculation of $EF_{BL,\ i}$ (subject to the elimination of data that was monitored during times where the plant was operating outside of the “permitted range”).

If baseline campaign length of line *i* ($CL_{BL,\ i}$) is higher than $CL_{normal,\ i}$ for this line, all N_2O values that were measured beyond the length of $CL_{normal,\ i}$ during the production of the quantity of nitric acid (i.e., the final tonnes produced) will be eliminated from the calculation of $EF_{BL,\ i}$. This provision applies to both cases, when the baseline is measured during one complete campaign and when the baseline data is collected from the consecutive parts of the two campaigns. In the latter case, $CL_{normal,\ i}$ will set the limit for the first of the two consecutive campaigns (campaign A at Figure 8). In case campaign A exceeds the average historic campaign length, N_2O values at the end of campaign A beyond the length of $CL_{normal,\ i}$ will be eliminated from the calculation of $EF_{BL,\ i}$.

Nitric acid flow meters will be installed at all production lines before the start of baseline measurement, so for the calculation of the baseline emission factor, nitric acid production and campaign length will be based on actual measurements at each production line.

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

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Not applicable

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be 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.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

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The emission reductions for each production line over a specific campaign are determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER_{n,i} = (EF_{BL,i} - EF_{p,i}) \bullet NAP_{n,i} \bullet GWP_{N2O} \qquad \text{(Eq. 19)}$$

Where:

$ER_{n,i}$	Emission reductions for the n^{th} campaign on i-line , tCO_2e
$EF_{BL,i}$	Baseline emission factor for i-line, $tN_2O/tHNO_3$
$EF_{p,i}$	Project emission factor for i-line, $tN_2O/tHNO_3$
$NAP_{n,i}$	Nitric acid production during the n^{th} campaign of the project activity on i-line, $tHNO_3$.
GWP_{N2O}	Global warming potential for the N_2O as per IPCC default value

Note: the nitric acid production used to calculate emission reduction should not exceed the design capacity (nameplate) of the nitric acid plant.

Calculation of total emission reductions and overlapping monitoring periods

The current project consists of identical emission reduction measures at ten independent production lines. Each production line has its schedule for production campaigns, gauze replacement, maintenance and operation. Some production lines may not be in operation for certain periods due to changes in fertilizer demand and repair needs. At the same time, the applied monitoring methodology envisages the calculation of emission factor for full production campaigns, which means that monitoring report can be only prepared for completed campaigns. Considering the differences in operation schedules of the production lines, the preparation of a monitoring report that would include of all emission reductions up to one specific date becomes impossible.

This issue is addressed in the clarification of JI Supervisory Committee (Report of 13th meeting of the JISC, Annex 13), which allows for overlapping of the project monitoring periods. Only emission reductions of completed project campaigns will be included in monitoring reports, whereas those which are in progress at the date of preparation of the monitoring report, will be left for inclusion in the following monitoring report.

The project meets the requirements of the abovementioned clarification of the JISC:

(a) The project is composed of clearly identifiable production lines for which emission reductions will be calculated independently;

(b) Monitoring will be performed independently for each of the production lines, so that the data /parameters monitored for one line are not dependent on and do not effect data/parameters monitored for another line;

(c) The monitoring will be performed for all production lines in accordance with the requirements of the JI guidelines and further guidance by the JISC regarding monitoring.

The monitoring periods of each individual production line will be clearly specified in the monitoring reports and will not overlap to ensure that double-counting of emission reductions is avoided.

During the verification process, two verification reports covering (part of) the same monitoring period will not be published through the UNFCCC secretariat at the same time. The earlier verification should be final before a new verification report can be published through the UNFCCC secretariat, as requested in the Report of 13th meeting of the JISC, Annex 13.

Total emission reductions for the project over a specific monitoring period are calculated as a sum of emission reductions of individual lines with completed project campaigns:

$$ER_{total} = \sum_{i=1}^{i=10} ER_{n,i} \qquad \text{(Eq. 20)}$$

Where:

ER_{total}	Total emission reductions for the project over a specific monitoring period, tCO_2e
$ER_{n,i}$	Emission reductions for the n^{th} campaign on i-line , tCO_2e

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

No leakage calculation is required

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 *(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.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

>>
No leakage calculation is required.

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 CO_2 equivalent):

>>
Ex ante estimation of emission reductions are calculated using the following formula:

$$ER_y = (EF_{BL} - EF_p) \cdot NAP_y \cdot GWP_{N2O} \qquad \text{(Eq. 21)}$$

Where:

ER_y	Emission reductions for year y, tCO_2e
EF_{BL}	Baseline emission factor, estimated, $tN_2O/tHNO_3$
EF_p	Project emission factor, estimated, $tN_2O/tHNO_3$
NAP_y	Nitric acid production at all production lines for year y, $tHNO_3$.
GWP_{N2O}	Global warming potential for N_2O as per IPCC default value

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:

>>

Not applicable

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:

Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
P.1; B.1; P.2; B.2; P.6; B.6; P.7; B.7	*Low*	*Regular calibrations according to vendor specifications and industry standard EN14181. Staff will be trained in monitoring procedures and a reliable technical support infrastructure will be set up.*
Automated Monitoring System	*Low*	*Please refer to Quality Control and Quality Assurance Section in the Monitoring Plan (Annex 3)*
P.4; P.5, P.8, P.9, B.4, B.5, B.8, B.9, B.10	*Low*	*Included in evaluation by a third party validator*

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

>>

In order to ensure the successful operation of the project and the credibility and verifiability of the emission reductions achieved, the project will have a well-defined management and operational system.

The management and operation of the proposed nitrous oxide abatement project will be the responsibility of Cherkasy AZOT. The Shop foreman and technical divisions of the plant will be responsible for the ongoing operation and maintenance of the monitoring system. JI project developer will provide support of the project, in particular, supervision of the monitoring process, preparation of the monitoring reports, support during verification of emission reductions etc. The emission reductions will be verified at least annually by an Accredited Independent Entity (AIE).

A general scheme of the operational and management structure that will monitor the proposed JI project activity is depicted below. More detailed description of the project management structure, reporting, connections and responsibilities of the personnel and organizations involved in the project will be included in JI monitoring manual, which will be presented at the first verification of emission reductions to a verifying AIE.

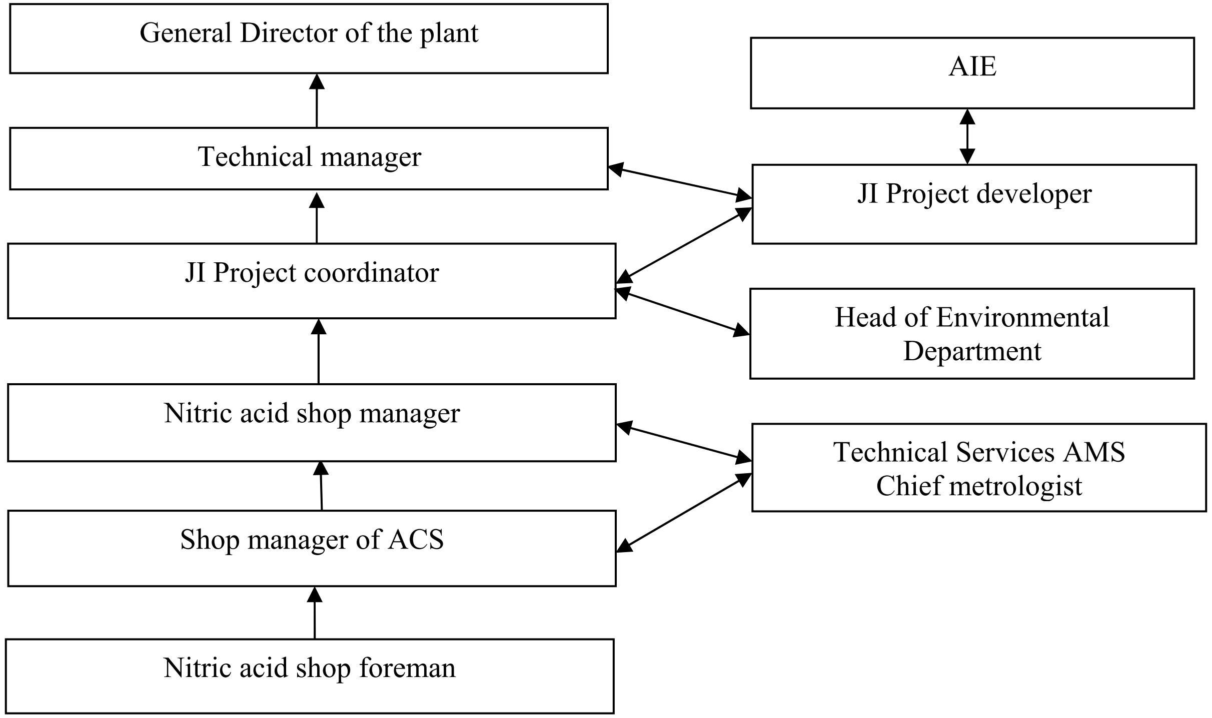

Figure 9. The scheme of the operational and management structure.

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

>>

The monitoring plan has been established by:
Mr. Vladymyr Ivashchenko, MGM Worldwide (ivladymyr @ mgminter.com, phone +380-50-380-9174)
Mr. Walter Hügler, MGM Worldwide (whugler @ mgminter.com, phone +54-11-5219-1230)
Ms. María Inés Hidalgo, MGM Worldwide (ihidalgo @ mgminter.com, phone +54-11-5219-1230)
Mr. Vladyslav Zhezherin, MGM Worldwide (vzhezherin@mgminter.com, phone +380-50-384-9696)

MGM Worldwide LLC is not a project participant.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

>>

Annual estimated project emissions are calculated by the following formula:

$PE_y = EF_p \bullet NAP_y \bullet GWP_{N2O}$ (Eq. 22)

Where:

PE_y	Project emissions during the year *y* of the project activity, tCO_2
EF_p	Project emission factor, $tN_2O/tHNO_3$
NAP_y	Nitric acid production by the plant (all production lines that are in operation) during the year *y* of the project activity, $tHNO_3$
GWP_{N2O}	N_2O global warming potential

The values of the parameters assumed for calculation of emission reductions are discussed in Chapter A.4.3.1 and summarized in the table below:

Parameters	Estimated values	
NAP_y, $tHNO_3/yr$[7]	For the period 2010-2012: For the period 2013-2022:	590,000 800,000
EF_P, $tN_2O/tHNO_3$		0.0010575
GWP_{N2O}, tCO_2e/tN_2O		310

Considering that in 2010 the project will be in operation for only 2 months the amount of nitric acid produced is adjusted accordingly by multiplying the annual estimated HNO_3 output by the factor of 2/12 (2 of 12 months in a year).

$PE_{2010} = 0.0010575tN_2O/tHNO_3 * (590{,}000tHNO_3/year * 2/12) * 310tCO_2e/tN_2O = 32{,}236\ tCO_2e/year$

For the period of 2011-2012 the annual estimated project emissions are:

$PE_{2011\text{-}2012} = 0.0010575tN_2O/tHNO_3 * 590{,}000tHNO_3/year * 310tCO_2e/tN_2O = 193{,}417tCO_2e/year$

For the period of 2013-2022 the annual estimated project emissions are:

$PE_{2013\text{-}2022} = 0.0010575tN_2O/tHNO_3 * 800{,}000tHNO_3/year * 310tCO_2e/tN_2O = 262{,}260tCO_2e/year$

E.2. Estimated leakage:

>>

Not applicable

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

>>

As there is no leakage the sum of E.1 and E.2 is equal to E.1

E.4. Estimated baseline emissions:

>>

Baseline emissions are estimated in accordance with the following formula:

---

[7] This NAP corresponds to the total output of all production lines.

$BE_y = EF_{BL} \bullet NAP_y \bullet GWP_{N2O}$ (Eq. 23)

Where

BE_y	Baseline emissions during the year *y* of the project activity, tCO_2
EF_{BL}	Baseline emission factor, $tN_2O/tHNO_3$
NAP_y	Nitric acid production by the plant (all production lines that are in operation) during the year *y* of the project activity, $tHNO_3$
GWP_{N_2O}	N_2O global warming potential

The values of the parameters assumed for the calculation of emission reductions are discussed in Chapter A.4.3.1 and summarized in the table below:

Parameters	Estimated values	
NAP_y , $tHNO_3/yr$	For the period 2010-2012: For the period 2013-2022:	590,000 800,000
EF_{BL} , $tN_2O/tHNO_3$		0.00423
GWP_{N2O} , tCO_2e/tN_2O		310

Considering that in 2010 the project will be in operation for only 2 months the amount of nitric acid produced is adjusted accordingly by multiplying the annual estimated HNO3 output by the factor of 2/12 (2 of 12 months in a year).

$BE_{2010}=0.00423tN_2O/tHNO_3*(590,000tHNO_3/year*2/12)*310tCO_2e/tN_2O = 128,945tCO2e/year$

For the period of 2011-2012 the annual estimated baseline emissions are:

$BE_{2011\text{-}2012}=0.00423tN_2O/tHNO_3 *590,000tHNO_3/year*310tCO_2e/tN_2O = 773,667tCO2e/year$

For the period of 2013-2022 the annual estimated baseline emissions are:

$BE_{2013\text{-}2022}=0.00423tN_2O/tHNO_3 *800,000tHNO_3/year*310tCO_2e/tN_2O = 1,049,040tCO2e/year$

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

>>

Annual estimated emission reductions are calculated by the following formula:

$ER_y = (EF_{BL} – EF_p) \bullet NAP_y \bullet GWP_{N2O}$ (Eq. 24)

Where

ER_y	Emission reductions for the year *y*, tCO_2e
EF_{BL}	Baseline emission factor, $tN_2O/tHNO_3$
EF_p	Project emission factor, $tN_2O/tHNO_3$
NAP_y	Nitric acid production by the plant (all production lines that are in operation) during the year *y* of the project activity, $tHNO_3$
GWP_{N_2O}	N_2O global warming potential

The values of the parameters assumed for the calculation of emission reductions are the same as those used for the estimation of project and baseline emissions:

Parameters	Estimated values

NAP_y , $tHNO_3/yr$	For the period 2010-2012: For the period 2013-2022:	590,000 800,000
EF_P , $tN_2O/tHNO_3$		0.0010575
EF_{BL} , $tN_2O/tHNO_3$		0.00423
GWP_{N2O} , tCO_2e/tN_2O		310

Considering that in 2010 the project will be in operation for only 2 months the amount of nitric acid produced is adjusted accordingly by multiplying the annual estimated HNO3 output by the factor of 2/12 (2 of 12 months in a year).

$ER_{2010}=(0.00423tN_2O/tHNO_3 - 0.0010575tN_2O/tHNO_3)*(590{,}000tHNO_3/year*2/12)*310tCO_2e/tN_2O =$
$= 96{,}708\ tCO2e/year$

For the period of 2011-2012 the annual estimated emission reductions are:

$ER_{2011-2012}=(0.00423tN_2O/tHNO_3 - 0.0010575tN_2O/tHNO_3)*590{,}000tHNO_3/year*310tCO_2e/tN_2O =$
$= 580{,}250tCO2e/year$

For the period of 2013-2022 the annual estimated emission reductions are:

$ER_{2013-2022}=(0.00423tN_2O/tHNO_3 - 0.0010575tN_2O/tHNO_3)*800{,}000tHNO_3/year*310tCO_2e/tN_2O =$
$= 786{,}780tCO2e/year$

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

For the first crediting period of the Kyoto Protocol:

Year	Estimated project emissions (tonnes of CO2 equivalent)	Estimated leakage (tonnes of CO2 equivalent)	Estimated baseline emissions (tonnes of CO2 equivalent)	Estimated emission reductions (tonnes of CO2 equivalent)
2010	32,236	0	128,945	96,708
2011	193,417	0	773,667	580,250
2012	193,417	0	773,667	580,250
Total (tonnes of CO2 equivalent)	419,070	0	1,676,279	1,257,208

For the period after the end of the first crediting period of the Kyoto Protocol, subject to approval by the host country:

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2013	262,260	0	1,049,040	786,780
2014	262,260	0	1,049,040	786,780
2015	262,260	0	1,049,040	786,780
2016	262,260	0	1,049,040	786,780
2017	262,260	0	1,049,040	786,780
2018	262,260	0	1,049,040	786,780
2019	262,260	0	1,049,040	786,780
2020	262,260	0	1,049,040	786,780
2021	262,260	0	1,049,040	786,780
2022	262,260	0	1,049,040	786,780
Total (tonnes of CO_2 equivalent)	2,622,600	0	10,490,400	7,867,800

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:

>>

Environmental impact assessment (EIA) has been carried out based on the decision of the State Environmental Protection Authority in Cherkas'ka Oblast, which requested the preparation of EIA for the N_2O abatement project at Cherkasy AZOT by their Letter No. 20/06 dated January 11, 2010.

The EIA has been performed in accordance with Order No. 33 of the National Environmental Investment Agency of Ukraine dated June 25th, 2008 "Regarding the Approval of the Requirements to the Preparation of Joint Implementation Projects" (paragraph 4.8) and the State Construction Norms DBN A.2.2-1-2003 approved by Order of the State Construction Committee No. 214 dated December 15, 2003.

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

>>

EIA has addressed all potential impacts of the proposed project activity and arrived at the following conclusions:

1) The project will result in reduction of N_2O concentration in tale gas by 75%;
2) The project does not envisage:
    - Any growth in NO_x emissions or other damage to the environment;
    - Loss of jobs at Cherkasy AZOT;
    - Use of any new explosive or harmful raw materials and auxiliary materials;
    - Any increase in quantity of explosive or harmful raw materials, that simultaneously take part in the technological process;
    - Changes in chemical and critical parameters of the technological process;
    - Any increase in number and volume of available explosive technological sectors.
3) The project will not require any additional resources, such as land, raw materials, energy and labour. They only additional resource needed is the secondary catalyst.
4) It will not increase the likelihood of emergency situations and will not change the explosive and fire hazard status / category of the existing production.

5) The only waste material resulting from the project is used secondary catalyst, which will be returned to the supplier at the end of its useful life to be refined, recycled or disposed of according to the prevailing EU standards.

The EIA confirmed that the project is not expected to have any significant impact on the environment other than reduction of N_2O emissions.

SECTION G. Stakeholders' comments

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

>>

The stakeholder's consultations have been carried out in accordance with Order No. 33 of the National Environmental Investment Agency of Ukraine dated June 25th, 2008 "Regarding the Approval of the Requirements to the Preparation of Joint Implementation Projects" (paragraph 4.10) and the Guidelines for the implementation of Article 6 of the Kyoto Protocol (Decision 9/CMP.1).

Cherkasy AZOT has implemented the following steps to inform stakeholders:

- Publication informing stakeholders about the proposed project in mass media (in Azot, a local newspaper).
- Submission of the information about the project to the relevant trade union and obtaining of its opinion about the project.
- Informing the employees of Cherkasy AZOT about the planned JI project at a conference and a meeting of the department, where they had an opportunity to ask questions and provide comments.

Cherkasy AZOT published an article about the project in a weekly newspaper called "Azot" on March 23rd, 2010. The article provides information about the Kyoto Protocol and its mechanism, the rationale for the implementation of the JI project, a short description of the proposed activity and expected outcomes. At the date of preparation of the current version of the PDD no comments have been submitted. In case Cherkasy AZOT receives any comments, the management of the plant will respond and address submitted comments as necessary.

The relevant Trade Union of Chemical and Petrochemical Industry at Cherkasy AZOT was informed about the project and requested to provide comments regarding it. The Trade Union of Cherkasy AZOT held a meeting on February 26th, 2010 where the proposed JI project was considered, and the Union concurred with the implementation of the project.

Cherkasy AZOT informed its employees about the proposed JI project during the labour conference on March 10th, 2010. The management communicated the main objectives of the Kyoto Protocol and its mechanisms, economic and environmental background of the project, proposed technological solutions and implementation schedule. The decision of the conference was to go ahead with the project implementation. Also, a special meeting of the employees of the nitric acid production department was held on December 23, 2009, where the employees had an opportunity to ask questions and provide comments. In particular, some clarifying questions concerning the purpose of the project, financing sources, environmental impacts of the secondary catalyst and project schedule were raised. The JI project manager provided comprehensive response and explanation.

The JI PDD was published on the official JI UNFCCC web site for stakeholder comments for 30 days from 5th of February 5, 2010 to 6th of March, as required by the JI Guidelines. No comments were received.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	Open Joint Stock Company “AZOT”,
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Represented by:	Andriy A. Koval
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E-mail:	carbon@dongenergy.dk
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Represented by:	
Title:	Head of CO_2 Funds and Purchases
Salutation:	Ms.
Last name:	Clausen
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First name:	Cilla
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Mobile:	+45 99552190
Personal e-mail:	cicla@dongenergy.dk, carbon@dongenergy.dk

Annex 2

BASELINE INFORMATION

Baseline emissions will be calculated for each line from an emission factor measured during a baseline measurement period before the implementation of the project activity, under normal operating conditions. The values which are outside the permitted range of these parameters will be excluded and estimation of volume flow rate of stack gas and N_2O concentration in stack gas will be done only for data which is found to be within the permitted range and lie within the 95% confidence interval.

Ex-ante estimations of the key baseline parameters are listed in the following table:

Parameter	2010-2012	2013-2022
Typical nitric acid production output (t 100% HNO_3/year)	590,000	800,000
Maximum historic nitric acid production for 1 line (t 100% HNO_3/day)	360	360
N_2O baseline emission factor (kg N_2O/t 100% HNO_3)	4.23	4.23
N_2O destruction factor (%)	75	75%
UNC (%)*		
Operating days	330	330

* Overall measurement uncertainty of the monitoring system, in %, will be calculated as the combined uncertainty of all the installed monitoring equipment. It will be established for each individual line based on the results of QAL2, and presented to a verifying AIE at the time of the first ER verification.

The baseline measurements will be performed with normal ammonia oxidation catalysts that were used during the historical campaigns to establish normal operating conditions. GC_{normal} and GS_{normal} are to be established for each line prior to the start of baseline measurements). Currently, Cherkasy AZOT applies the following types of ammonia oxidation catalysts (*ex-ante* estimations):

- Umicore: Pt-95%, Rh-5%
- Umicore: Pt-89.5%, Rh-4.1%, Pd 6.4%
- Johnson Mathey: Pt-95%, Rh-5% or (Pt-95%, Rh-5%) + (Pt-81%, Rh-3%, Pd-16%)

Annex 3

MONITORING PLAN

The current JI project will measure the N_2O mass flow from the nitric acid plant on a quasi-continuous basis (uninterrupted sampling of flue gases with concentration and normalized flow analysis on short, discrete time periods) through an automated measuring system (AMS)[8] using project-specific technologies and procedures based on AM0034 "Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants", version 03.4. Monitoring procedures (which are the integral part of the monitoring plan) will be fully integrated in the plant's Quality control and Environment protection systems.

The Shop Foreman, Shop manager of ACM (DCS TP) and technical divisions of the plant will be responsible for the ongoing operation and maintenance of the N_2O monitoring system. Operation, maintenance, calibration and service intervals will be carried out according to the manufacturer's specifications and international standards (BS EN 14181 "Quality assurance of automated measuring systems", see also QA/QC section), and incorporated into the management structure of ISO 9001-2000 standard procedures.

The proposed JI project will be closely monitored, metered and recorded. The management and operation of the proposed nitrous oxide abatement project will be the responsibility of the plant. The emission reductions will be verified at least annually by an Accredited Independent Entity (AIE).

Tables in Sections D.1.1.1 and D.1.1.3 of the PDD describe the parameters to be acquired and recorded as per the current monitoring plan, for both baseline campaign and (future) project campaigns. The baseline methodology requires that certain process parameters are monitored (to be compared vs. the permitted operating conditions) during the baseline campaign; such process parameters are also described in those tables. Only those N_2O measurements taken when the plant is operating within the permitted range will be considered during the calculation of baseline emissions. Also, monitoring of operating hours of each production line will be performed. The operation on a line will be established based on the supply of ammonia and air into the ammonia oxidation reactor, and process temperature and pressure inside the AOR.

All the relevant instrumentation to measure process parameters will be calibrated on a routine basis. The signals generated by these instruments will be acquired and logged by AMS. The specific data generated by the AMS will be stored on a dedicated data collection system at specified time intervals. The system automatically provides an hourly average, which is then transferred onto a common spreadsheet (Excel) for further analysis/calculations and reporting purposes. Actual emission reduction calculation will use values from such spreadsheet. Due to space constraints on the system hard drive, from time to time, historical data will be archived on a separate hard drive or CDs/DVDs, to be safeguarded for at least 2 years.

All parameters measured during the baseline campaign will be archived in electronic format during the entire crediting period.

All parameters measured during project campaigns will also be archived in electronic format and on paper for at least two years or during the entire crediting period as described in Section D.1.1 of the PDD.

---

[8] As per "terms and definitions" of EN 14181:2004 (E), AMS is a measuring system permanently installed on site for continuous monitoring of emissions. An AMS is a method which is traceable to a reference method. Apart from the analyzer, an AMS includes facilities for taking samples and for sample conditioning. This definition also includes testing and adjusting devices that are required for regular functional checks.

1. Emission reduction calculations

The amount of mass (tonnes) of N_2O that the project actually avoids being vented to the atmosphere during each production campaign, expressed in tonnes of carbon dioxide equivalent (or tCO_2e), will be calculated by applying the following formulas:

$$BE_{BC,i} = VSG_{BC,i} \cdot NCSG_{BC,i} \cdot 10^{-9} \cdot OH_{BC,i}$$

Where:

$BE_{BC,i}$	Baseline emissions in the baseline measurement period on *i* line, tN_2O
$VSG_{BC,i}$	Mean stack gas volume flow rate in the baseline measurement period on *i*-line, m^3/h
$NCSG_{BC,i}$	Mean concentration of N_2O in the stack gas in the baseline measurement period on *i*-line, mg N_2O/m^3
$OH_{BC,i}$	Number of operating hours in the baseline measurement period on *i*-line, h

$$EF_{BL,i} = \frac{BE_{BC,i}}{NAP_{BC,i}}\left(1 - \frac{UNC_i}{100}\right)$$

Where:

$EF_{BL,i}$	Baseline emission factor on *i* line, $tN_2O/tHNO_3$
$NAP_{BC,i}$	Nitric acid production during the baseline measurement period on *i* line, $tHNO_3$
UNC_i	Overall measurement uncertainty of the monitoring system on *i* line, in %, calculated as the combined uncertainty of the applied monitoring equipment

Project emissions are calculated for each line from mean values of N_2O concentration and total flow rate:

$$PE_{n,i} = VSG_{n,i} \cdot NCSG_{n,i} \cdot 10^{-9} \cdot OH_{n,i}$$

Where:

$PE_{n,i}$	Project emissions of the n^{th} campaign on *i* line, tN_2O
$VSG_{n,i}$	Mean stack gas volume flow rate for the n^{th} project campaign on *i* line , m^3/h
$NCSG_{n,i}$	Mean concentration of N_2O in the stack gas for the n^{th} project campaign on *i* line, $mgN_2O/\ m^3$
$OH_{n,i}$	Number of operating hours in the n^{th} project campaign on *i* line, hours

For the n^{th} campaign for each line, the campaign specific emission factor would be:

$$EF_{n,i} = \frac{PE_{n,i}}{NAP_{n,i}}$$

Where:

$EF_{n,i}$	Emission factor calculated for the n^{th} campaign on *i* line, t N_2O/t HNO_3
$PE_{n,i}$	Project emissions of the n^{th} campaign on *i* line, tN_2O
$NAP_{n,i}$	Nitric acid production in the n^{th} campaign on *i* line, t HNO_3

Then,

$$ER_{n,i} = (EF_{BL,i} - EF_{p,i}) \cdot NAP_{n,i} \cdot GWP_{N2O}$$

Where:

$ER_{n,i}$	Emission reductions for the n^{th} campaign on i-line , tCO_2e
$EF_{BL,i}$	Baseline emission factor for *i* line, $tN_2O/tHNO_3$
$EF_{p,i}$	Project emission factor for *i* line, $tN_2O/tHNO_3$
$NAP_{n,i}$	Nitric acid production during the n^{th} campaign of the project activity on i-line, $tHNO_3$.
GWP_{N2O}	Global warming potential for the N_2O as per IPCC default value

Calculation of total emissions reduction for the project:

Total emission reductions for the project over a specific monitoring period are calculated as a sum of emission reductions at individual lines with completed project campaigns:

$$ER_{total} = \sum_{i=1}^{i=10} ER_{n,i}$$

Where:

ER_{total}	Total emission reductions for the project over a specific monitoring period, tCO_2e
$ER_{n,i}$	Emission reductions for the n^{th} campaign on *i*-line , tCO_2e

Following AM0034, several restrictions and adjustments will be applied to the formulas (above), among others:

1. All data series are filtered to eliminate mavericks and outliers.

The monitoring system will provide separate reading for N_2O concentration and gas flow for a defined period of time (e.g., every hour of operation, i.e., an average of the measured values of the past 60 minutes). Error readings (e.g., downtime or malfunction) and extreme values are eliminated from the output data series. Next, the same statistical evaluation that was applied to the baseline data series will be applied to the project data series:
a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

2. NAP (nitric acid production) cannot exceed nameplate capacity of the plant.

Nitric acid production will be compared to nameplate capacity. If nitric acid production at a given campaign is larger than nameplate, then emission reductions will be calculated ignoring data generated after production exceeds nameplate.

3. A moving average of the emission factors (EF_{ma}) must be calculated.

The campaign specific emission factor ($EF_{n,\,i}$) for each campaign at each line during the project's crediting period is compared to a moving average emission factor calculated as the average emission factor of the factors generated in the previous campaigns at the respective line ($EF_{ma,n\ i}$).

To calculate the emission reductions achieved in the n^{th} campaign at line *i*, the higher of the two values $EF_{ma,n,i}$ and $EF_{n,i}$ shall be applied as the emission factor relevant for that particular campaign ($EF_{p,i}$).

4. A minimum project emission factor should also be determined (EF_{min}), defined as the lowest among the emission factors of the first 10 campaigns with the same secondary catalyst.

After the first ten campaigns of the crediting period of the project, the lowest $EF_{n,i}$ observed during those campaigns will be adopted as a minimum ($EF_{min,i}$). If any of the later project campaigns results in an $EF_{n,i}$ that is lower than $EF_{min,i}$, the calculation of the emission reductions for that particular campaign will use $EF_{min,i}$ and not $EF_{n,i}$. However, if the decrease in N_2O emissions is clearly attributable to the use of a new (different from previous) secondary catalyst composition or type, which has a higher efficiency of N_2O destruction, previously calculated minimum emission factor will not apply, and a new $EF_{min,i}$ shall be established after the first ten campaigns from the start of the use of a new secondary catalyst.

5. The emission factor to be applied for a particular campaign calculation (EF_p) must be the higher between the abovementioned moving average and the specific campaign emission factor (and not lower than minimum emission factor, after 10 project campaigns with the same secondary catalyst).

This will be checked according to procedures detailed in Steps 4 and 5 above.

6. The level of uncertainty (*UNC*) determined for the AMS installed must be deducted from the baseline emission factor.

The overall measurement uncertainty (*UNC*), calculated by summing in an appropriate manner (using Gauss's law of error propagation) all the relevant uncertainties arising from the individual performance characteristics of the AMS components, will be used to reduce the baseline emission factor. The following formula will be applied:

$$EF_{BL,i} = EF_{BC,i} \bullet (1 - \frac{UNC_i}{100})$$

Where:

$EF_{BL,i}$	Baseline emission factor on *i* line, $tN_2O/tHNO_3$
$EF_{BC,i}$	Emission factor on *i* line obtained during the baseline campaign, $tHNO_3$
UNC_i	Overall measurement uncertainty of the monitoring system on *i* line, %, calculated as the combined uncertainty of the applied monitoring equipment

7. If production during a given campaign at each line is lower than normal campaign length for the same line ($CL_{normal,i}$), then the baseline is recalculated by ignoring the data generated after production exceeds duration of the given campaign.

The production during a given campaign at each line will be compared to normal campaign length for the same line ($CL_{normal,i}$). If the length of each individual project campaign $CL_{n,i}$ is shorter than the average historic campaign length, then $EF_{BL,i}$ will be re-calculated by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the $CL_{n,i}$ (i.e., the last tonnes produced) from the calculation of $EF_{n,i}$. In case the baseline measurements were taken during two parts of consequent campaigns, the data at the end of the first campaign is eliminated.

Quality Control and Quality Assurance

Cherkasy AZOT will install the automated monitoring system which complies with BS EN 14181 "Quality assurance of automated measuring systems". It envisages four levels of quality assurance: QAL1, QAL2, QAL3 and AST.

QAL1: Suitability of the AMS for the specific measuring task.

The suitability evaluation and its measuring procedure are described in ISO 14956:2002 "Air quality – Evaluation of the suitability of a measurement procedure by comparison with a required measuring uncertainty". Using this standard, it will be proven that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in the applicable regulations (e.g., EU Directives 2000/76/EU or 2001/80/EU). Since European regulations do not yet cover the measurement of N_2O at nitric acid plants, there is no official specification for uncertainty available. Then, considering official specification of uncertainties defined for equivalent pollutants (e.g., NO_x, SO_2) as per EU regulations, 20% of the ELV (emission limit value) has been considered by the equipment manufacturer as the required measurement quality for N_2O, for the purpose of expanded uncertainty calculations. The specific performance characteristics of the monitoring system chosen by the project will be listed in the Project Design Document, as per AM0034.

The complete EN 14181: 2004 QAL1 reports are provided by the equipment manufacturers considering the performance characteristics as measured by a qualified Technical Inspection Authority and the specific installation characteristics and site conditions at the plant. The QAL1 report confirms the N_2O analyzer is suitable to perform the indicated analysis (N_2O concentration), and provides a conservative estimate for expanded uncertainty.

The overall measurement uncertainty (*UNC*) is calculated by summing (using Gauss's law of error propagation) all the relevant uncertainties arising from the individual performance characteristics of the AMS components (thus UNC = $((N_2O \text{ analyzer uncertainty})^2 + (\text{flow meter uncertainty})^2)^{1/2}$).

QAL2: Validation of the AMS following its installation.

The next level of quality assurance prescribed on EN14181:2004 (QAL2) describes a procedure for the determination of the calibration function and its variability, by means of certain number of parallel measurements (meaning simultaneously with the AMS), performed with a standard reference method (SRM) (which should be a proven and accurate[9] analytical protocol as per relevant norms or legislation). The variability of the measured values obtained with the AMS is then compared with the uncertainty given by the applicable legislation. If the measured variability is lower than the permitted uncertainty, it is concluded that the AMS has passed the variability test. Since (as explained above), official uncertainty is not available, an appropriate level is determined on the basis of those that do exist for similar pollutants and techniques (in this case 20% of ELV). The testing laboratories performing the measurements with the standard reference method will have an accredited quality assurance system according to EN ISO/IEC 17025 or relevant (national) standards.

Preliminary consideration of the project documentation on monitoring system installation at the Cherkasy AZOT plant (preliminary testing on QAL2 conformity) has been conducted by an independent certified organization AIRTEC, which gave a positive conclusion. An independent certified organization will conduct the final testing of AMS on QAL2 conformity after completion of monitoring system installation.
The monitored data will be corrected through proper application of the resulting calibration functions. The UNC as determined during the QAL2 test will be deducted from the baseline emission factor according to the equations provided by the methodology.

QAL3: Ongoing quality assurance during operation

Procedures described in QAL3 of EN 14181: 2004 checks for drift and precision, in order to demonstrate that the AMS is in control during its operations so that it continues to function within the required specification for uncertainty. This is achieved by conducting periodic zero and span checks on the AMS, and evaluating results obtained using control charts. Zero and span adjustments or maintenance of the

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[9] Considering EN 14181 does not specify what SRM to use for each specific compound, there is controversy as to which method is suitable as SRM for N_2O, since the best available technology (and hence the most accurate instrument) is the actual online instrument which is the subject of calibration by this method.

AMS may be implemented as a result of such evaluation. The implementation and performance of the QAL3 procedures given in this standard are the responsibility of the plant owner.

The standard deviation according to QAL3 will be calculated by the equipment manufacturer on the basis of equipment performance characteristics and actual conditions at Cherkasy AZOT nitric acid plant. The data is used to monitor that the difference between measured values and true values of zero and span reference materials are equal to or smaller than the combined drift and precision value of the AMS multiplied by a coverage factor of 2 (2 times standard deviation of AMS, as described in QAL3 section of EN14181) with the aid of Shewart charts. Documented calibration procedure for zero and span checks and resulting Shewart charts will be available on site for future verifications.

All monitoring equipment will be serviced and maintained according to the manufacturer's instructions and international standards by qualified personnel (both Cherkasy AZOT's staff and any third parties that may be involved during such activities). Maintenance and service logs will be well kept at Cherkasy AZOT plant and available for auditing purposes.

The staff of Cherkasy AZOT will be responsible for regular performing of QAL3 procedures to ensure the required quality of the AMS data measurements during its normal operation. Calibration of the NDIR will be conducted regularly in accordance with requirements of EN14181, which involves zero and span checks. The latter will be done with certified calibration gas where N_2O concentration is within 80% of the measurement scale. The results of the checks will be recorded in service maintenance logbook. The records of service and maintenance will be stored at Cherkasy AZOT and presented to a verifying AIE upon request.

AST: Annual Surveillance Test (ongoing quality assurance).

The AST is a procedure to evaluate whether the measured values obtained from the AMS still meet the required uncertainty criteria, as evaluated during the QAL2 test. As the QAL2, it also requires a limited number of parallel measurements using an appropriate Standard Reference Method. Although the total expected uncertainty of the AMS is well below the selected required uncertainty, an AST will be performed to the AMS once per year. If at a later time, the Accredited Independent Entity agrees the AST is not required on a yearly basis (considering the consistent performance of the AMS), the periodicity will be modified accordingly.

Description of the AMS to be installed at Cherkasy AZOT.

Cherkasy AZOT will install in its nitric acid plant an automated monitoring system at each production line, which will consist of sample probes, sample conditioning system, NDIR gas analyzer (for N_2O concentration measurement of stack gas), flow meters (for stack gas flow measurement), and data collection system.

<u>Sample probes.</u>
Stack gas sample probes are automatically extracted on a continuous basis. The position of sample points for collection of samples meets the requirements of EN 14181. In particular, the following issues are considered: temperature of the gas has to be below 300ºC (N_2O inert), assurance of homogeneity of the volume gas flow at the measuring points throughout the diameter in terms of velocity of flow and mass composition of gas flow, possible turbulences in the gas flow stream (e.g., at the stack walls). If heterogeneities exist, measuring of the gas flow is conducted with specific measuring equipment that minimizes uncertainties and heterogeneities to a minimum (e.g., multiple probe measuring units that allow for a representative coverage of the gas flow across the stack diameter). The measuring points are the points of the plant with easy access behind the gas expander turbine where the gas flow streams are consistent.

The sample points have been selected in coordination with the supplier, and verified by an independent certified organization AIRTEC as part of preliminary testing on QAL2 conformity, which confirmed their correctness.

Sample conditioning system
The gas sample is extracted at the sampling point, particles are removed by the heated filter unit and the clean sample gas is delivered through a heated sampling line to the analyzer cabinet. Before being fed to the analyzer, moisture is removed by the sample gas cooler and sample gas feed unit installed side-by-side in the analyzer cabinet. The sample gas cooler unit maintains a constant dew point of the sample gas of 3°C and efficiently separates the moisture from the sampling gas. The minimum flow rate to the analyzer is controlled and connected to an alarm. The dry gas after the cooler is controlled for moisture breakthrough.

Gas analyzer.
N_2O concentration will be continuously measured in stack gas mixture with gas analyzer ULTRAMAT 23 produced by SIEMENS. ULTRAMAT 23 is a continuous NDIR industrial photometer that can selectively measure concentrations of up to four sample components. In this case it will be equipped for the measurement of N_2O. The analyzer is QAL1 tested for the measurement of N_2O.

Flow meter.
The SDF flow measuring system will provide continuous determination of the flow rate of stack gas. It is performance tested (test report No. 936/802015, TUV Rheinland 1993) for use in plants. The SDF flow sensor, which is a flow measuring device, is a highly sensitive system for continuous, in-situ flow measurement. The stack gas flow is measured in the stack by measuring the dynamic differential pressure generated by the SDF flow sensor probe rod. The signal resulting from the differential pressure is proportional to the velocity of the stack gas flow. The stack gas pressure and temperature are also measured separately by transmitters for calculating the volume flow rate of the stack gas at normal conditions. The conversion of the stack flow from operating to normal conditions will be done automatically by the software.

Data collection system
AMS will have data transfer unit which will transfer data to a storage device and to the register system appointed to the project. Data processing system will be programmed in accordance with the formulae described in the current Monitoring Plan and requirements of AM0034 version 03.4. The system will include at minimum a specially adapted personal computer, hard disks with an automatic backup system, Ethernet, operating system (e.g. Microsoft Windows SERVER) and software, including software for EN14181-QAL3-monitoring. The software will be designed to conduct all the statistical analyses and calculations required by the current PDD in order to derive the baseline and project emission factors and to calculate the amount of emission reductions resulting from the project activity. The PC will perform data evaluation and storage. The data will be stored simultaneously on different hard disks to prevent the loss of data in case one hard disk fails.

The system will be designed to be operated automatically. No operator is required for the daily operation of the system. However, monitoring engineer will ensure that the system is in normal operation and take necessary action to follow the Monitoring Plan.

Downtime of the Automated Measuring System
In the event that the monitoring system is down, the lowest measured value in the baseline measurement period under normal operating conditions 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 project emission factor.

Frequency of monitoring and storage of the data
Data on N_2O concentration and volume flow rate of the stack gas obtained for each line will be recorded every 2 seconds. It will be compiled into hourly and daily data and stored in the electronic media. Other parameters will be monitored periodically and recorded into electronic media in accordance with the requirement of the current JI PDD.

The logging data and all reports printed out from the system are kept for the period required by AM0034 Version 03.4:

- Main project emissions parameters: Electronic and paper for at least 2 years or during the entire crediting period as described in Section D.1.1 of the PDD.
- Main baseline emissions parameters: Electronic and paper for the entire crediting period
- AOR operation parameters related to baseline emissions: Electronic and paper for at least 2 years
- Ammonia oxidation gauze's parameters related to baseline emissions: For the project's crediting period.

Annex 4

EXPECTED PROJECT COSTS

Estimated costs of the main equipment that is required for the project implementation are presented in the table below.

Equipment	Estimated cost, Euro
Automatic Monitoring System (AMS) (equipment, installation, software, etc.)	1 400 000
Secondary catalyst for N_2O destruction at 10 production lines	2 200 000
Supporting systems for the secondary catalyst at 10 production lines	150 000