Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Catalytic N2O destruction project in the tail gas of the Nitric Acid Plant of Abu Qir Fertilizer Co.
Scale of the project activity	x Large-scale ☐ Small-scale
Version number of the PDD	05.2
Completion date of the PDD	02/06/2021
Project participants	CARBON Egypt Ltd. RWE Power AG CARBON Climate Protection GmbH
Host Party	Arab Republic of Egypt
Applied methodologies and standardized baselines	ACM0019 version 4.0 (N2O abatement from nitric acid production) No standardized baselines applicable.
Sectoral scopes	5 – Chemical industries
Estimated amount of annual average GHG emission reductions	1,110,125 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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(1) <u>Purpose of project activity</u>

The CDM project activity for GHG emission reduction by catalytic N_2O destruction was implemented in Abu Qir, Egypt in year 2006. The project activity includes development, design, engineering, procurement, finance, construction, operation and maintenance of a system for catalytic reduction of N_2O. The EnviNOx® process used in the nitric acid (hereinafter called "NA") plant II of Abu Qir Fertilizer Co. (hereinafter called "AFC") is based on the catalytic reduction of NOx (NO and NO_2) with ammonia (NH_3) and of nitrous oxide (N_2O) with a hydrocarbon. The hydrocarbon used is natural gas of which the main constituent is methane (CH_4). The reactions take place over two iron zeolite catalyst beds.

a. Scenario existing prior to the implementation of the project activity

NA plants are in the majority of cases part of a chemical complex and are built and operated to supply acid for the consumption in downstream process units. The most common use for NA is for fertilisers, with smaller quantities going into the manufacture of organic compounds and mining explosives.

Nitrous oxide (N_2O) is an unwanted, invisible and previously neglected by-product of the manufacture of NA. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. When leaving the ammonia oxidation reactor (hereinafter called "AOR"), there is no relevant loss of N_2O in the tail gas section unless a N_2O destruction facility is installed. N_2O that leaves the AOR is thus discharged to atmosphere in the tail gas and has no economic value. **The scenario existing prior to the start of the implementation of the project activity is that the N_2O is emitted to the atmosphere with no N_2O abatement measure being implemented.**

b. Baseline scenario

According to the applied methodology ACM0019 "N_2O abatement from nitric acid production" (Version 04.0) operators of NA plants have no economic incentives to take any N_2O abatement measures in the absence of regulations requiring the abatement of N_2O emissions, because this entails capital and operating costs, but no financial benefits. Since no laws or regulations exist at present, which mandate the complete or partial destruction of N_2O from NA plants in the Arab Republic of Egypt, AFC has no economic incentives as mentioned just before. Hence, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O abatement measure.

c. Project scenario

Under the project scenario, N_2O from NA production is removed from the tail gas downstream of the absorption tower by catalytic destruction in a tertiary N_2O abatement facility. This abatement facility contains a catalyst through which the tail gas flows and where the N_2O abatement occurs. This destruction process is described in detail in section A.4.3.

Annual average of GHG emission reductions during 3rd crediting period: 1,110,125 tCO_2e
Total GHG emission reductions over 3rd crediting period: 7,770,876 tCO_2e

(2) <u>Project's contribution to sustainable development</u>

Since the purpose of the project activity is to significantly reduce N_2O emissions from the production of NA at AFC´s NA plant II, it leads to environmental, economic and social benefits, and therefore contributes to improve the sustainable development in the Arab Republic of Egypt.

The catalytic N_2O destruction project activity reduces N_2O emissions that would be emitted in the absence of the CDM project activity. This leads to significant environmental benefits on a global level and helps to mitigate dangerous climate change. The technology transfer leads to improved understanding of high advanced air cleaning technologies in Egypt. Furthermore, plant personnel

benefits from training courses taking place for operation and maintenance purposes of the tertiary abatement facility.
Additionally, the project operator agreed on spending a share of the total income from selling of the CERs for a Social Fund for the area of Abu Qir. This fund contributes to the social benefit of the people living in the area of the CDM project activity by financing sustainable projects like projects in schools, hospitals and infrastructure.

A.2. Location of project activity

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Host Party(ies): Arab Republic of Egypt
Province: Al-Iskandariyah Province (Alexandria Province)
Town: Abu Qir
GPS coordinates: N31.272513° E30.09755°
Address: Abu Qir Fertilizer Co.
El-Tabya Plants
Rasheed Road
Postal Code: 21911
Alexandria, Egypt

SATELLITE IMAGE OF ALEXANDRIA

AFC, the largest fertilizer company in Egypt, is located about 15 km east of downtown Alexandria, in a rural area, approximately 5 km outside the small town of Abu Qir. Abu Qir is situated north-east of Alexandria, bordering the suburbs of Alexandria. AFC is located on the shores of the Mediterranean Sea. The company has road and rail access as well as a nearby ship loading terminal.

A.3. Technologies/measures

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(1) <u>Description of the installed technology and equipment</u>

The applied technology, the EnviNOx®-system, is a tertiary measure for the destruction of N_2O from NA plant´s tail gas streams based on the catalytic decomposition or catalytic reduction of N_2O. The EnviNOx®-system is located between tail gas heater IV and the tail gas turbine, which is the position with the highest tail gas temperature in the NA production process at AFC. The current tail gas temperature at design capacity is around 414°C and sufficient to permit very high rates of N_2O removal by virtue of the use of small quantities of methane (hydrocarbon) as a reducing agent. Hence, no modifications to the NA plant to increase the tail gas temperature is needed.
The implementation of the N_2O destruction project at AFC involves that natural gas, a mixture of hydrocarbons of which the main constituent is methane (CH_4), is employed as a reducing agent for N_2O removal. The EnviNOx®-system reactor also incorporates NOx reduction using ammonia in order to lower the NOx concentration to a very low level.

Decommissioning of existing DeNOx reactor

The NA plant was retrofitted with a DeNOx reactor in 1999. The reactor was installed upstream of the final tail gas heater. The existing SCR-DeNOx-unit reduces NOx (a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2) to nitrogen and water vapour with ammonia over a vanadium pentoxide V_2O_5-based catalyst. The implementation of the project activity involves the removal of the existing SCR DeNOx-unit (SCR = Selective Catalytic Reduction), whereas the new EnviNOx®-system takes over the function of the existing SCR DeNOx-unit as it too accomplishes the reduction of NOx with ammonia. As far as the amount of NOx-removal is concerned the performance of the EnviNOx®-system is at least as good as the existing SCR DeNOx-unit.

Ammonia feed

Liquid ammonia taken from downstream of the existing ammonia filter (liquid) is vaporised and superheated in the ammonia evaporator with low pressure steam. The superheated ammonia is supplied to the EnviNOx®-system under flow control. If for any reason the supply of ammonia to the EnviNOx® system must be interrupted, either due to a trip or operator intervention, an automatic double block and bleed system isolates the ammonia system from the tail gas side of the NA plant. In case of the project activity a SCR DeNOx unit was already installed prior to the starting date of the CDM project activity, therefore the project ammonia input will be considered equal to the ammonia input in the baseline scenario.

Natural gas feed

Natural gas at ambient temperature is let down from the supply pressure and then supplied to the EnviNOx®-system under flow control. As with the ammonia supply system, the natural gas is isolated from the tail gas side of the NA plant in case of an interruption of supply caused by operator actions or an interlock by means of a double block and bleed arrangement. The CDM project activity uses about 700,000 Nm^3/a natural gas. The natural gas (hydrocarbon) used at AFC´s NA plant II consists mainly of methane (CH_4) with small quantities of higher saturated hydrocarbons (ethane, propane, butane, etc.), nitrogen, carbon dioxide and ppm quantities of sulphur compounds. The higher hydrocarbons behave as reducing agents towards N_2O just as methane does. The CO_2 (<1% vol. in natural gas) and N_2 behave as inert in the EnviNOx®-system. The low levels of sulphur have no effect on the catalyst.

Mixer

Natural gas and ammonia vapour are supplied together to the lance of the tail gas / ammonia / natural gas static mixer. This inline device ensures that the reducing agents (ammonia and natural gas) are intimately mixed with the tail gas before the tail gas reaches the EnviNOx® reactor.

N_2O and NOx reduction

At the inlet of the EnviNOx® reactor the NOx concentration can reach 200 ppm and the N_2O concentration is typically at 1,250 ppm. The NOx concentration increases with the plant load and temperature in the absorption tower while increased absorption tower pressure reduces the NOx concentration. Thus, the NOx concentration is subject to short term fluctuations without any long-term trend.

While the tail gas N_2O concentration can increase with higher plant load, it also depends significantly on the state of the ammonia oxidation platinum-/rhodium gauzes in the ammonia burners. The state of the gauzes deteriorates over the length of a production campaign. So, the short-term fluctuations in N_2O concentration are generally – although not in every campaign – overlaid by a long-term trend to higher N_2O concentration as the campaign advances. The EnviNOx® reactor contains two catalyst beds arranged in series as described above. In the first bed the EnviCat-NOx catalyst reduces the concentration of NOx to a very low level by reaction with ammonia while in the second EnviCat®-N_2O-2 bed the reduction of N_2O with the hydrocarbons in the natural gas takes place.

A small quantity of methane leaves the reactor unreacted. This is measured by the online methane analyser downstream of the EnviNOx® reactor and electronically recorded. Compared with the reduction in greenhouse gas emission achieved by the destruction of N_2O the additional greenhouse gas emissions (CO_2 and CH_4) caused by the process are insignificant.

The installation of the EnviNOx®-system requires significant investment costs for the supply and installation of the equipment, as well as operating costs for the consumed natural gas, for the

replacement of the catalyst, and for the monitoring and maintenance of the facility. The CDM project activity also includes training courses for operation of the EnviNOx®-system and also for accurate monitoring. The implementation of the project activity does not increase the capacity or operating efficiency of AFC's NA plant II.

(2) Description of catalytic decomposition process (EnviNOx® process)

Catalytic decomposition of N_2O occurs when the N_2O is split into its constituent elements by contact with a catalyst. A catalyst is a material, which accelerates the speed of a reaction without being transformed or consumed by the reaction. The first bed contains an iron zeolite that is especially effective in catalysing the reduction of NOx with ammonia according to such reactions as:

$6\ NO_2 + 8\ NH_3 \rightarrow 7\ N_2 + 12\ H_2O$
$6\ NO + 4\ NH_3 \rightarrow 5\ N_2 + 6\ H_2O$
$NO + NO_2 + 2\ NH_3 \rightarrow 2\ N_2 + 3\ H_2O$
$4\ NO + O_2 + 4\ NH_3 \rightarrow 4\ N_2 + 6\ H_2O$

Effectively all the NOx is removed. Some destruction of N_2O also occurs.

The second and main bed contains an iron zeolite that is particularly efficient in catalysing the reduction of nitrous oxide with hydrocarbons:

$3\ N_2O + CH_4 \rightarrow 3\ N_2 + 2\ H_2O + CO$
$4\ N_2O + CH_4 \rightarrow 4\ N_2 + 2\ H_2O + CO_2$

Similar reactions take place between nitrous oxide and the small quantities of higher hydrocarbons such as ethane C_2H_6, propane C_3H_8 and butane C_4H_{10} that are present in natural gas. N_2O reduction by these reactions is much more effective when NOx is absent. A large proportion of the carbon monoxide that is formed is further oxidised to carbon dioxide:

$2\ CO + O_2 \rightarrow 2\ CO_2$

All the above reactions are exothermic, which leads to a temperature rise over the EnviNOx® reactor. A small quantity of methane leaves the reactor unreacted. This is measured by the online methane analyser downstream of the EnviNOx® reactor, and is recorded electronically.

The CDM project activity reduces the N_2O emissions from the NA plant of AFC by up to 94 % by installing the EnviNOx® process. It is important to emphasise that the purpose of the hydrocarbon and ammonia is not that of a fuel, increasing the temperature of the tail gas to a level at which high rates of N_2O decomposition can take place, but that they are used as genuine chemical reducing agents that take part in reactions with N_2O and NOx respectively on specific sites on the surface of catalysts specially developed for this purpose by ThyssenKrupp Industrial Solutions AG (formally known as Uhde). Thus, the consumption of hydrocarbons corresponds to the stoichiometric ratio given in the reaction equations above.

(3) Scenario existing prior to the implementation of the project activity

The NA plant was designed without any N_2O abatement measure. The production of NA takes place in three main process steps as indicated by the following reactions:

1. Ammonia (NH_3) combustion to form nitric oxide (NO):
   $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$ (main reaction 1)

   Simultaneously nitrous oxide (N_2O), nitrogen (N) and water (H_2O) are formed as well, in accordance with the following equations:
   $4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$ (side reaction 1)
   $4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$ (side reaction 2)

NO yield depends mainly on pressure and temperature in the ammonia oxidation process and usually is in a range of 95 – 97 %.

2. NO is oxidised to nitrogen dioxide (NO_2):
$2\ NO + O_2 \rightarrow 2\ NO_2$ (main reaction 2)

3. (According to the technical process) Absorption of NO_2 in water to form NA (HNO_3):
$3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$ (main reaction 3)
(NO is oxidised to NO_2 according to main reaction 2)

When leaving the AOR there is no relevant loss of N_2O in the tail gas section unless an N_2O destruction facility is installed. N_2O that leaves the AOR is thus discharged to the atmosphere in the tail gas and has no economic value.

According to the applied methodology ACM0019 "N_2O abatement from nitric acid production" (version 4.0) operators of NA plants have no economic incentives to take any N_2O abatement measures in the absence of regulations requiring the abatement of N_2O emissions, because this entails capital and operating costs, but no financial benefits. Since no laws or regulations exist at present, which mandate the complete or partial destruction of N_2O from NA plants in the Arab Republic of Egypt, AFC has no economic incentives as mentioned just before. Hence, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O abatement measure.

(4) Know-how transfer

The technology and know-how transfer will lead to an improved understanding of high advanced air cleaning technologies in Egypt. Furthermore, plant personnel will benefit from training courses taking place for operation and maintenance purposes of the N_2O tertiary abatement facilities.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Arab Republic of Egypt (Host)	CARBON Egypt Ltd.	No
Republic of Austria	CARBON Climate Protection GmbH	No
Federal Republic Germany	RWE Power AG	No

A.5. Public funding of project activity

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No public funds are or were available for the financing of the CDM project activity.

A.6. History of project activity

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The Project Participants confirm:
(a) The CDM project activity is already registered as a CDM project activity and with this PDD version a request for renewal of crediting period is submitted;
(b) The CDM project activity is not a project activity that has been deregistered.

The Project Participants declare:
(a) The CDM project activity was not a CPA that has been excluded from a registered CDM PoA;
(b) No other registered CDM project activity or a CPA under a registered CDM PoA exists in the same geographical location as the CDM project activity.

A.7. Debundling

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Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

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Selected methodology: ACM0019 “N2O abatement from nitric acid production” (version 4.0)[1]

Methodological tools:

- TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)[2]
- TOOL03 “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (version 03.0)[3]

No standardized baselines are used according to the applied methodology.

B.2. Applicability of methodologies and standardized baselines

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According to the used methodology, the project activity is applicable under following conditions:

(a) *The methodology applies to project activities that introduce N_2O abatement measures in NA plants;*
<u>Justification</u>: The project activity destroys N_2O emissions by the reduction of N_2O in the tail gas stream of the NA plant of AFC at Abu Qir (tertiary abatement technology).

(b) *In the case that the NA plant started commercial operation before the implementation of the CDM project activity, the project participants shall demonstrate that there was no secondary or tertiary N_2O abatement technology installed in the respective NA plant;*
<u>Justification</u>: Since the start of the commercial operation, no secondary or tertiary abatement technology was installed in AFC´s NA plant prior to the implementation of the CDM project in 2006 (1st crediting period). Evidence for this was demonstrated during 1st crediting period.

(c) *Continuous real-time measurements of the N_2O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N_2O emissions throughout the crediting period of the project activity;*
<u>Justification</u>: Continuous real-time measurements of the N_2O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N_2O emissions throughout the crediting period of the project activity. A dedicated Automated Monitoring System (hereinafter called “AMS”) was already installed in the plant prior to the beginning of the first crediting period of the project activity. If needed this AMS shall be adapted in order to meet the requirements of the applied monitoring methodology.

(d) *No law or regulation which mandates the complete or partial destruction of N_2O from NA plants exists in the host country where the CDM project activity is implemented.*
<u>Justification</u>: At present no laws or regulations exist, which mandate the complete or partial destruction of N_2O from NA plants in the host country, the Arab Republic of Egypt.

In addition, the following applicability condition included in TOOL08 applies and is met:

[1] https://cdm.unfccc.int/methodologies/PAmethodologies/approved
[2] https://cdm.unfccc.int/Reference/tools/index.html
[3] https://cdm.unfccc.int/Reference/tools/index.html

- *Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions.*
  Justification: In the applied methodology the flow and composition of residual or flared gases or exhaust gases need to be measured for the determination of project emissions.

No standardized baselines are used according to the applied methodology.

B.3. Project boundary, sources and greenhouse gases (GHGs)

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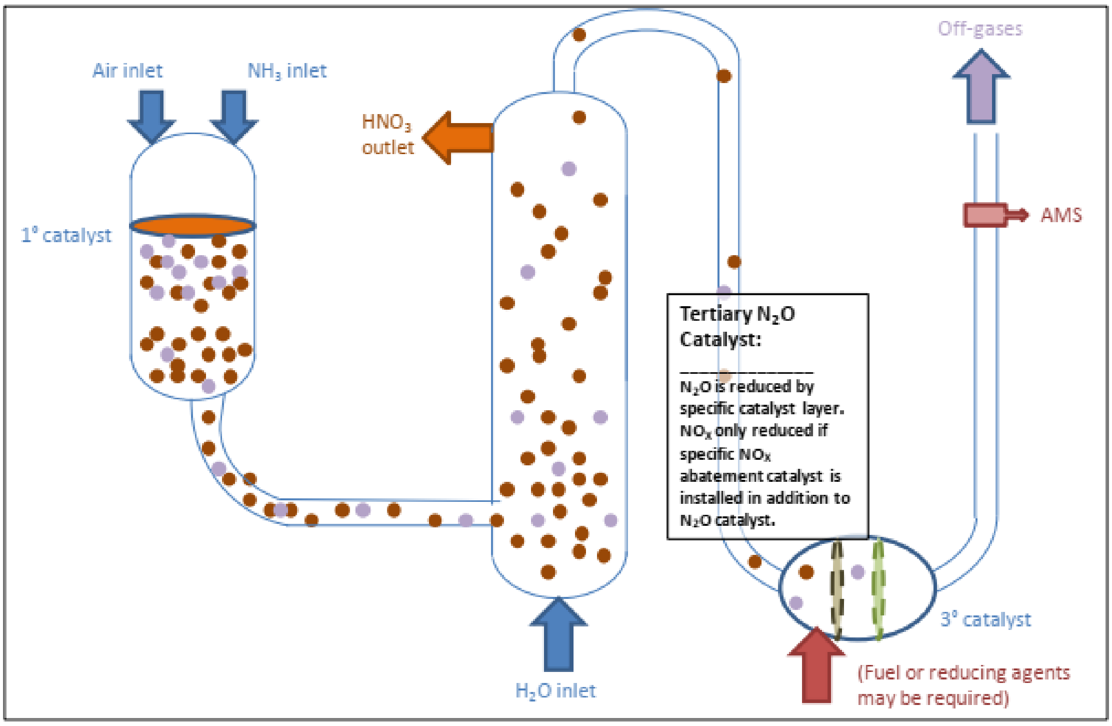
The following table illustrates in detail, which emissions sources are included or excluded from the project boundary for determination of both baseline and project emissions:

	Source	GHG	Included?	Justification/Explanation
Baseline	NH_3 oxidation at the primary catalyst gauze	CO_2	No	The project activity has no influence on these types of emissions, if present
		CH_4	No	
		N_2O	Yes	Included, main emission source
Project activity	NH_3 oxidation at the primary catalyst gauze	CO_2	No	The project activity has no influence on these types of emissions, if present
		CH_4	No	
		N_2O	Yes	Included, main emission source
	Operation of a tertiary N_2O Abatement facility	CO_2	Yes	In some cases, fossil fuels are used as reducing agent and/or for decomposing the tail gas as part of a tertiary N_2O abatement facility. In this case the fossil fuels are mainly converted to CO_2. CO_2 emissions arising from the production of ammonia are assumed to be small and not taken into account.
		CH_4	No	
		N_2O	Yes	Included



Project boundary if the project activity consists of the introduction of a tertiary N_2O abatement measure (simplified standard NA layout displaying the location of the N_2O abatement catalyst, process sources of N_2O and the sampling point location for the AMS)

As shown in the figure above, the only baseline emissions considered are the N_2O emissions formed in the AOR, a part of the NA plant. The project activity introduces a tertiary N_2O abatement facility, physically located in the tail gas stream of the NA plant. It is expected that the tertiary abatement facility will destroy N_2O emissions to a high extent. The remaining N_2O, which is not destroyed and still present after the abatement facility, is measured by the AMS downstream of the tertiary abatement measure and is considered as project emissions. Fossil fuels will be used when operating the abatement facility, for this reason emissions from this source are to be considered as well.

B.4. Establishment and description of baseline scenario

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At present, no laws or regulations exist, which mandate the complete or partial destruction of N_2O from NA plants in the host country, the Arab Republic of Egypt. This is attested by a letter of the Egyptian DNA (= Egyptian Environmental Affairs Agency (EEAA)).

In accordance with the methodology, AFC has no economic incentives to take any N_2O abatement measures in its NA plant in the absence of regulations requiring such measures, as this would entail capital and operating costs, but no financial benefits. Therefore, the CDM project is considered additional and the baseline scenario is that the N_2O emitted to the atmosphere with no N_2O abatement measure being implemented.

B.5. Demonstration of additionality

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According to the applied methodology ACM0019 version 4.0 the CDM project activity is considered additional in case of the absence of regulations requiring the abatement of N_2O emissions, as the operator of the NA plant has no economic incentives to take any N_2O abatement measures.

Since it was demonstrated in section B.4 above that in Egypt no regulations exist, which require the abatement of N_2O emissions in NA plants, the CDM project activity "Catalytic N_2O destruction project at AFC nitric acid plant" is considered additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline Emissions for Case 1: For NA plants that have used AM0028 or AM0034 in the 1st crediting period

AFC´s NA plant used AM0028 in the 1st CDM crediting period and used ACM0019 v.2.0 (substituting the methodologies AM0028 and AM0034 for their use in N_2O reduction projects in NA plants) in the 2nd CDM crediting period. Now, the methodology ACM0019 v.4.0 shall be applied for the 3rd crediting period of the CDM project and the baseline emissions are calculated as follows:

$$BE_y = \begin{pmatrix} min\{P_{production,y}\ ;\ P_{product,max}\} * EF_{existing,y} + \\ max\{P_{production,y} - P_{product,max}\ ; 0\} * EF_{new,y} \end{pmatrix} * \frac{(h_y - h_{r,y})}{h_y} * GWP_{N2O} * 10^{-3} \qquad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e)
$P_{product,max}$	=	Design capacity (t HNO_3)
$P_{production,y}$	=	Production of nitric acid in year *y* (t HNO_3)
$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year *y* (kg N_2O/t HNO_3)
$EF_{new,y}$	=	Baseline N_2O emission factor for nitric acid production in year *y* (kg N_2O/t HNO_3)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
h_y	=	Number of hours in year *y* during which the plant was in operation (*h*)
$h_{r,y}$	=	Number of hours (*h*) in year *y* where:

(a) For secondary N_2O abatement: the abatement system was not installed, underperforming or failed;
(b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

The N_2O emission factor for NA plants that used AM0028 or AM0034 in the 1st crediting period ($EF_{existing,y}$) shall be calculated as follows:

$$EF_{existing,y} = min\{EF_{historical} \, ; \, EF_{default,y}\}$$ Equation (2)

Where:

$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year *y* (kg N_2O/t HNO_3)
$EF_{historical,y}$	=	Historical baseline emission factor of the nitric acid plant (kg N_2O/t HNO_3)
$EF_{default,y}$	=	Default emission factor according to the operating pressure of the ammonia burner in year *y* (kg N_2O/t HNO_3)

Since the project activity used AM0028 in its 1st crediting period, Case 1 applies and Case 2 has not to be considered.

Calculation of $h_{r,y}$ for Case 1: For NA plants that have used AM0028 or AM0034 in the 1st crediting period

An abatement system is deemed to be bypassed, not working, underperform or failed in the hour h in year y if:

$$F_{N2O,tail\ gas,h} > EF_{existing,y} * P_{NA,h}$$ Equation (4)

Where:

$P_{NA,h}$	=	Nitric acid produced in the hour *h* (t HNO_3)
$EF_{existing,y}$	=	Default N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year *y* (kg N_2O/t HNO_3)
$F_{N2O,tailgas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour *h* (kg N_2O/h)

Since the project activity used AM0028 in its 1st crediting period, Case 1 applies and Case 2 has not to be considered.

<u>Project Emissions</u>

Project emissions include N_2O emissions, which have not been destroyed by the project activity and, in case of the installation of a tertiary N_2O abatement facility, CO_2 emissions resulting from the operation of the N_2O abatement facility. Project emissions are calculated as follows:

$$PE_y = PE_{N2O,y} + PE_{CO2,tertiary,y}$$ Equation (6)

Where:

PE_y	=	Project emissions in year *y* (t CO_2e)
$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year *y* (t CO_2e)
$PE_{CO2,tertiary,y}$	=	Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year *y* (t CO_2)

Project emissions of N_2O from the project plant ($PE_{N2O,y}$)

The amount of N_2O emissions from the project activity are the emissions from the N_2O contained in the tail gas stream of the plant, which is released to the atmosphere. Accordingly, $PE_{N2O,y}$ is determined as follows:

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tail\ gas,h} * GWP_{N2O} * 10^{-3} \quad \text{Equation (7)}$$

Where:

$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year y (t CO_2e)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
$F_{N2O,tail\ gas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N_2O abatement. Abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement. The abatement system is bypassed, underperforming or failed

Determination of $F_{N2O,tail\ gas,h}$

The amount of N_2O emissions from the tail gas stream of the project plant shall be determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. In applying the tool, the following provisions apply:

(a) Throughout the crediting periods of the project activity, the N_2O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;
(b) The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on two seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;
(c) The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN14181 must be applied to both the N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;
(d) If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;
(e) In the case that the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.

According to the applied tool the mass flow of greenhouse gas i in the gaseous stream in time interval t ($F_{i,t}$) is calculated based on measurements of (a) the total volume or mass flow of the gas stream, (b) the volumetric fraction of the gas in the gaseous stream, and (c) the gas composition and water content. The flow and volumetric fraction may be measured on a dry or wet basis. The tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas (Option A to F).

Based on the currently available information **Option A** of the tool will be applied (measurement options for option A: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis), which states two ways how to demonstrate that the gaseous stream is dry. These are:

a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or
b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

The mass flow of greenhouse gas i ($F_{i,t}$)[4] is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$ Equation (5) of tool

With:

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$ Equation (6) of tool

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval t on a dry basis (m³ dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m³ gas i/m³ dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ gas i)
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i	=	Molecular mass of greenhouse gas i (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m³/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval t (K)

Option A of the tool can be applied since results of all measurements, which were performed during the 2nd crediting period, show that the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) is less than 0.05 kg H_2O/m^3 dry gas and therefore the gas is considered to be dry. The moisture content of the gaseous stream will be measured according to the prevailing methodology and tool as well as to relevant current norms and standards.

According to the applied methodology the amount of N_2O emissions from the tail gas stream of the project plant shall be determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", but the parameters P_t and T_t do not need to be monitored – except, if applicable, for the purpose of determining the moisture content in the gaseous stream – if the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process.
Since the N_2O concentration and the volume flow of the tail gas and by-pass are automatically converted to normal conditions, the parameters P_t and T_t need not to be monitored. The term m³ used in the units for the volumetric flow ($V_{t,db}$) and the volumetric fraction ($v_{i,t,db}$) refer to m³ at these mentioned standard conditions throughout this document. Therefore, when applying equation (6) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (see above) the N_2O density in the gaseous stream at normal conditions was determined to be 1.96 kg/m³ ($P_t = P_n$ = 101,325 Pa; $T_t = T_n$ = 273.15 K).

Project emissions from the operation of the tertiary N_2O abatement facility ($PE_{CO2,tertiary,y}$)

This emission source only needs to be estimated if a tertiary N_2O abatement facility is installed under the project activity and if fossil fuels are used to operate the facility or re-heat the gas after the facility. Since a tertiary N_2O abatement facility was installed under the CDM project activity this applies to

[4] $F_{i,t}$ corresponds to the parameter $F_{N2O,tail\ gas,h}$ of the methodology ACM0019.

the project activity. The emissions related to the operation of the N_2O destruction facility include only onsite emissions due to the fossil fuel use as input to the N_2O destruction facility:

$$PE_{CO2,tertiary,y} = PE_{FF,y} \quad \text{Equation (8)}$$

Where:

$PE_{CO2,tertiary,y}$	=	Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year y (t CO_2)
$PE_{FF,y}$	=	Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO_2)

Project proponents shall use the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" to calculate the project emissions related to fossil fuels used in year y. Specific guidance on the use of the tool:

- The parameter $PE_{FC,j,y}$ used in the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" corresponds to the parameter $PE_{FF,y}$ in this methodology; and
- The element process *j* in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N_2O abatement facility and/or the re-heating of the tail gas.

It shall be considered that for synchronizing the applied tool with the methodology, "Annual", "Yearly", "yr" and "y" are understood to cover the same time period unless otherwise explained.

According to the applied tool CO_2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows.

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} * COEF_{i,y} \quad \text{Equation (1) of tool}$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr)
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process *j* during the year *y*

According to the applied tool the CO_2 emission coefficient $COEF_{i,y}$ can be calculated using one out of two options, depending on the availability of data on the fossil fuel type *i*. Option A should be the preferred approach, if the necessary data is available. Based on currently available information **Option A** of the tool can be applied as the necessary data such as chemical composition of the used fossil fuel (i.e. natural gas) will be provided by the natural gas supplier. According to Option A the CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type *i*, using the following approach:

If $FC_{i,j,y}$ is measured in a mass unit: $COEF_{i,y} = w_{C,i,y} * 44/12$ Equation (2) of tool

If $FC_{i,j,y}$ is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} * \rho_{i,y} * 44/12$ Equation (3) of tool

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i (tCO_2/mass or volume unit)
$w_{C,i,y}$	=	Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)
$\rho_{i,y}$	=	Is the weighted average density of fuel type i in year y (mass unit/volume unit of the fuel)
i	=	Are the fuel types combusted in process *j* during the year *y*

Since the amount of used fossil fuel will be measured in a volume unit, Equation (1) of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (see above) will be applied.

Leakage

According to the methodology any leakage emissions sources are deemed to be negligible.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (9)}$$

Where:

ER_y = Emission reductions in year y (t CO_2e)
BE_y = Baseline emissions in year y (t CO_2e)
PE_y = Project emissions in year y (t CO_2e)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	**Operating pressure**
Data unit	KPa
Description	Operating pressure of the ammonia burner
Source of data	Manufacturer's specifications
Value(s) applied	383 (equivalent to 3.83 barg)
Choice of data or measurement methods and procedures	N/A
Purpose of data	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure.
Additional comment	N/A

Data/Parameter	**$EF_{historical}$**
Data unit	kg N_2O/t HNO_3
Description	Historical baseline emission factor of the nitric acid plant
Source of data	Historical information from issuance reports of CDM-PDD documents
Value(s) applied	7.23
Choice of data or measurement methods and procedures	Plants that used AM0028 in the first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period; AFC plant used AM0028 in the first crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period is used. Calculation of $EF_{historical}$ is based on actual data of overall historical baseline emission factor of the nitric acid plant of the first crediting period from issuance reports of CDM-PDD.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the second and third crediting period.

Data/Parameter	**$EF_{default,y}$**
Data unit	kg N_2O/t HNO_3
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid)
Source of data	This default N_2O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N_2O/t HNO_3 for low, medium and high-pressure ammonia burners. For each subsequent year, the emission factors will decrease by 0.2 kg N_2O/t HNO_3 until they reach a value of 2.5 or 2.4. After reaching the values of 2.5 or 2.4 the emission factor will remain constant over time. (see table below)
Value(s) applied	(see table below)
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development.

Source of data:

Year	**Low pressure (0 – 200 kPa)**	**Medium pressure (200 – 600 kPa)**	**High pressure (Over 600 kPa)**
2013	5.5	8.4	12.6
2014	5.3	8.2	12.4
2015	5.1	8.0	12.2
2016	4.9	7.8	12.0
2017	4.7	7.6	11.8
2018	4.5	7.4	11.6
2019	4.3	7.2	11.4
2020	4.1	7.0	11.2
2021	3.9	6.8	11.0
2022	3.7	6.6	10.8
2023	3.5	6.4	10.6
2024	3.3	6.2	10.4
2025	3.1	6.0	10.2
2026	2.9	5.8	10.0
2027	2.7	5.6	9.8
2028	2.5	5.4	9.6
2029	2.5	5.2	9.4
2030	2.5	5.0	9.2

Value(s) applied:

Year	**Medium pressure (200 – 600 kPa)**
2020	7.0
2021	6.8
2022	6.6
2023	6.4
2024	6.2
2025	6.0
2026	5.8
2027	5.6

Data/Parameter	**$EF_{new,y}$**
Data unit	kg N_2O/t HNO_3
Description	Baseline N_2O emission factor for nitric acid production in year y (related to 100 per cent pure acid)
Source of data	The baselineN_2O emission factor for nitric acid production will vary every year. In year 2005 the emission factor will be 5.1 and then it will decrease every year

<table>
<tr><td></td><td>until it reaches a final value of 2.5 in the year 2020. The value of 2.5 will remain constant after 2020.
<table>
<tr><th>Year</th><th>Emission factor (kg N_2O/t HNO_3)</th></tr>
<tr><td>2005</td><td>5.10</td></tr>
<tr><td>2006</td><td>4.90</td></tr>
<tr><td>2007</td><td>4.70</td></tr>
<tr><td>2008</td><td>4.60</td></tr>
<tr><td>2009</td><td>4.40</td></tr>
<tr><td>2010</td><td>4.20</td></tr>
<tr><td>2011</td><td>4.10</td></tr>
<tr><td>2012</td><td>3.90</td></tr>
<tr><td>2013</td><td>3.70</td></tr>
<tr><td>2014</td><td>3.50</td></tr>
<tr><td>2015</td><td>3.40</td></tr>
<tr><td>2016</td><td>3.20</td></tr>
<tr><td>2017</td><td>3.00</td></tr>
<tr><td>2018</td><td>2.80</td></tr>
<tr><td>2019</td><td>2.70</td></tr>
<tr><td>2020</td><td>2.50</td></tr>
<tr><td>2021</td><td>2.50</td></tr>
<tr><td>2022</td><td>2.50</td></tr>
<tr><td>2023</td><td>2.50</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Year n</td><td>2.50</td></tr>
</table></td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Year</th><th>Emission factor (kg N_2O/t HNO_3)</th></tr>
<tr><td>2020</td><td>2.50</td></tr>
<tr><td>2021</td><td>2.50</td></tr>
<tr><td>2022</td><td>2.50</td></tr>
<tr><td>2023</td><td>2.50</td></tr>
<tr><td>2024</td><td>2.50</td></tr>
<tr><td>2025</td><td>2.50</td></tr>
<tr><td>2026</td><td>2.50</td></tr>
<tr><td>2027</td><td>2.50</td></tr>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>The decrease in the value for the baseline emission factor over time is to reflect the technological development.</td></tr>
</table>

Data/Parameter	$P_{product,max}$
Data unit	t product
Description	Design capacity of nitric acid production during the first crediting period
Source of data	Manufacture’s specifications
Value(s) applied	700,800
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is only for project activities applying case 1.

Data/Parameter	**GWP_{N2O}**
Data unit	t CO_2e/t N_2O
Description	Global warming potential of N_2O valid for the commitment period
Source of data	Relevant decisions by the CMP
Value(s) applied	298
Choice of data or measurement methods and procedures	None
Purpose of data	Calculation of baseline and project emissions
Additional comment	N/A

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data/Parameter	**R_u**
Data unit	Pa.m³/kmol.K
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	N/A

<table>
<tr><th>Data/Parameter</th><th>MM_i</th></tr>
<tr><td>Data unit</td><td>kg/kmol</td></tr>
<tr><td>Description</td><td>Molecular mass of greenhouse gas i</td></tr>
<tr><td>Source of data</td><td>Tool to determine the mass flow of a greenhouse gas in a gaseous stream</td></tr>
<tr><td>Value(s) applied</td><td><table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Nitrous oxide</td><td>N_2O</td><td>44.02</td></tr></table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Specified in the tool</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>N/A</td></tr>
</table>

Data/Parameter	**P_n**
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	101,325
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	This parameter is used to determine the mass flow of the N_2O in the tail gas.

Data/Parameter	**T_n**
Data unit	K
Description	Temperature at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	273.15
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	This parameter is used to determine the mass flow of the N_2O in the tail gas.

B.6.3. Ex ante calculation of emission reductions

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Baseline emissions

Since the CDM project activity used AM0028 in the first crediting period, Case 1 was applied and therefore baseline emissions are given by the following equation:

$$BE_y = \begin{pmatrix} min\{P_{production,y} \ ; \ P_{product,max}\} * \ EF_{existing,y} + \\ max\{P_{production,y} - \ P_{product,max} \ ; 0\} * \ EF_{new,y} \end{pmatrix} * \frac{(h_y - \ h_{r,y})}{h_y} * \ GWP_{N2O} * \ 10^{-3}$$

Where:

BE_y	=	Baseline emissions in year y (t CO_2e)
$P_{product,max}$	=	Design capacity (t HNO_3)
$P_{production,y}$	=	Production of nitric acid in year y (t HNO_3)
$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N_2O/t HNO_3)
$EF_{new,y}$	=	Baseline N_2O emission factor for nitric acid production in year y (kg N_2O/t HNO_3)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N_2O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

Year	**BE_y**	**$EF_{existing,y}$**	**$EF_{new,y}$**	**$P_{production,y}$**	**$P_{product,max}$**	**h_y**	**$h_{r,y}$**	**GWP_{N2O}**
	tCO_2e	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	$tHNO_3$	$tHNO_3$	h	h	-
15/09 – 31/12/2020	414,406	7.00	2.50	198,661	207,360	2,556	0	298
2021	1,360,525	6.80	2.50	671,400	700,800	8,640	0	298
2022	1,320,510	6.60	2.50	671,400	700,800	8,640	0	298
2023	1,280,494	6.40	2.50	671,400	700,800	8,640	0	298
2024	1,240,479	6.20	2.50	671,400	700,800	8,640	0	298
2025	1,200,463	6.00	2.50	671,400	700,800	8,640	0	298
2026	1,160,448	5.80	2.50	671,400	700,800	8,640	0	298
01/01 – 14/09/2027	788,907	5.60	2.50	472,739	493,440	6,084	0	298

$$EF_{existing,y} = min\{EF_{historical} \ ; \ EF_{default,y}\}$$

Where:

$EF_{existing,y}$ = N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year *y* (kg N_2O/t HNO_3)
$EF_{historical,y}$ = Historical baseline emission factor of the nitric acid plant (kg N_2O/t HNO_3)
$EF_{default,y}$ = Default emission factor according to the operating pressure of the ammonia burner in year *y* (kg N_2O/t HNO_3)

Year	$EF_{existing,y}$	$EF_{historical,y}$	$EF_{default,y}$ (for medium pressure)
	$kgN_2O/tHNO_3$	$kgN_2O/tHNO_3$	$kgN_2O/tHNO_3$
15/09 – 31/12/2020	7.00	7.23	7.00
2021	6.80	7.23	6.80
2022	6.60	7.23	6.60
2023	6.40	7.23	6.40
2024	6.20	7.23	6.20
2025	6.00	7.23	6.00
2026	5.80	7.23	5.80
01/01 – 14/09/2027	5.60	7.23	5.60

Project Emissions

$$PE_y = PE_{N2O,y} + PE_{CO2,tertiary,y}$$

Where:

PE_y = Project emissions in year *y* (t CO_2e)
$PE_{N2O,y}$ = Project emissions of N_2O from the project plant in year *y* (t CO_2e)
$PE_{CO2,tertiary,y}$ = Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year *y* (t CO_2)

Year	PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
	tCO_2e	tCO_2e	tCO_2
15/09 – 31/12/2020	42,074	41,642	432
2021	142,194	140,734	1,460
2022	142,194	140,734	1,460
2023	142,194	140,734	1,460
2024	142,194	140,734	1,460
2025	142,194	140,734	1,460
2026	142,194	140,734	1,460
01/01 – 14/09/2027	100,120	99,092	1,028

Project emissions of N_2O from the project plant ($PE_{N2O,y}$)

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tail\ gas,h} * GWP_{N2O} * 10^{-3}$$

Where:

$PE_{N2O,y}$ = Project emissions of N_2O from the project plant in year y (t CO_2e)
GWP_{N2O} = Global Warming Potential of N_2O valid for the commitment period
$F_{N2O,tail\ gas,h}$ = Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)
h_y = Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$ = Number of hours (h) in year y where:

(a) For secondary N_2O abatement. Abatement system was not installed, underperforming or failed;
(b) For tertiary N_2O abatement. The abatement system is bypassed, underperforming or failed

Year	$PE_{N2O,y}$	$F_{N2O,tailgas,h}$	h_y	$h_{r,y}$	GWP_{N2O}
	tCO_2e	kgN_2O/h	h	h	-
15/09 – 31/12/2020	41,642	54.66	2,556	0	298
2021	140,734	54.66	8,640	0	298
2022	140,734	54.66	8,640	0	298
2023	140,734	54.66	8,640	0	298
2024	140,734	54.66	8,640	0	298
2025	140,734	54.66	8,640	0	298
2026	140,734	54.66	8,640	0	298
01/01 – 14/09/2027	99,092	54.66	6,084	0	298

According to currently available information $F_{N2O,tailgas,h}$ was determined to 54.66 kg N_2O/h and was used for ex-ante determination.
Since the N_2O concentration and the volume flow of the tail gas and by-pass are automatically converted to normal conditions, the parameters P_t and T_t need not to be monitored. Therefore, Equation (5) & (6) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" were derived in order to determine a fixed value for the N_2O density at normal conditions ($P_t = P_n$ = 101,325 Pa; $T_t = T_n$ = 273.15 K). Accordingly, the N_2O density at normal conditions was determined to be 1.96 kg/m³.

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

With:

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval t on a dry basis (m³ dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m³ gas i/m³ dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ gas i)
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i	=	Molecular mass of greenhouse gas i (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m³/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval t (K)

The amount of N_2O emissions from the tail gas stream of the project plant shall be determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". → *Tool is used, exclusively formulae therein are applied.*

In the case that the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream. → *Reached through transformation of formulae → P_t and T_t need not to be monitored, since the N_2O concentration and the volume flow of the tail gas and by-pass are automatically converted to normal conditions.*

Year	$F_{N2O,tail\ gas,h} = F_{i,t}$	$V_{t,db}$	$v_{i,t,db}$	$\rho_{i,t}$
	kgN_2O/h	Nm^3 dry gas/h	m^3 gas i/ m^3 dry gas	kg gas i/m^3 gas i
15/09 – 31/12/2020	54.66	242,000	1.15E-04	1.96
2021	54.66	242,000	1.15E-04	1.96
2022	54.66	242,000	1.15E-04	1.96
2023	54.66	242,000	1.15E-04	1.96
2024	54.66	242,000	1.15E-04	1.96
2025	54.66	242,000	1.15E-04	1.96
2026	54.66	242,000	1.15E-04	1.96
01/01 – 14/09/2027	54.66	242,000	1.15E-04	1.96

Year	$\rho_{i,t}$	P_n	MM_i	R_u	T_n
	kg gas i/m^3 gas i	Pa	kg/kmol	$Pa.m^3/kmol.K$	K
15/09 – 31/12/2020	1.96	101,325	44.02	8,314	273.15
2021	1.96	101,325	44.02	8,314	273.15
2022	1.96	101,325	44.02	8,314	273.15
2023	1.96	101,325	44.02	8,314	273.15
2024	1.96	101,325	44.02	8,314	273.15
2025	1.96	101,325	44.02	8,314	273.15
2026	1.96	101,325	44.02	8,314	273.15
01/01 – 14/09/2027	1.96	101,325	44.02	8,314	273.15

Project emissions from the operation of the tertiary N_2O abatement facility ($PE_{CO2,tertiary,y}$)

$$PE_{CO2,tertiary,y} = PE_{FF,y}$$

Where:

$PE_{CO2,tertiary,y}$ = Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year y (t CO_2)

$PE_{FF,y}$ = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO_2)

- The parameter $PE_{FC,j,y}$ used in the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" corresponds to the parameter $PE_{FF,y}$ in this methodology, and
- The element process *j* in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N_2O abatement facility and/or the re-heating of the tail gas.

Year	$PE_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
	tCO_2/y
15/09 – 31/12/2020	432
2021	1,460
2022	1,460
2023	1,460
2024	1,460
2025	1,460
2026	1,460
01/01 – 14/09/2027	1,028

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} * COEF_{i,y}$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr)
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process *j* during the year *y*

Year	$PE_{FC,j,y}$	$FC_{i,j,y}$	$COEF_{j,y}$
	tCO_2/y	Nm^3/y	tCO_2/Nm^3
15/09 – 31/12/2020	432	207,123	2.09E-03
2021	1,460	700,000	2.09E-03
2022	1,460	700,000	2.09E-03
2023	1,460	700,000	2.09E-03
2024	1,460	700,000	2.09E-03
2025	1,460	700,000	2.09E-03
2026	1,460	700,000	2.09E-03
01/01 – 14/09/2027	1,028	492,877	2.09E-03

Based on the currently available information **Option A** of the tool will be applied, as the chemical composition of the used fossil fuel (i.e. natural gas) will be provided by the natural gas supplier.

The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type *i*, using the following approach:

$COEF_{i,y} = w_{C,i,y} * \rho_{i,y} * 44/12$ $FC_{i,j,y}$ is measured in a volume unit.

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i (tCO_2/mass or volume unit)
$w_{C,i,y}$	=	Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)
$\rho_{i,y}$	=	Is the weighted average density of fuel type i in year y (mass unit/volume unit of the fuel)
i	=	Are the fuel types combusted in process *j* during the year *y*

Year	$COEF_{i,y}$	$\rho_{i,y}$	$w_{C,i,y}$
	tCO_2/Nm^3	t/Nm^3	tC/t
15/09 – 31/12/2020	2.09E-03	7.60E-04	0.75
2021	2.09E-03	7.60E-04	0.75
2022	2.09E-03	7.60E-04	0.75
2023	2.09E-03	7.60E-04	0.75
2024	2.09E-03	7.60E-04	0.75
2025	2.09E-03	7.60E-04	0.75
2026	2.09E-03	7.60E-04	0.75
01/01 – 14/09/2027	2.09E-03	7.60E-04	0.75

Leakage

According to the methodology any leakage emissions sources are deemed to be negligible.

Emission reductions

$$ER_y = BE_y - PE_y$$

Where:

ER_y = Emission reductions in year y (t CO_2e)
BE_y = Baseline emissions in year y (t CO_2e)
PE_y = Project emissions in year y (t CO_2e)

Year	ER_y	BE_y	PE_y
	tCO_2e	tCO_2e	tCO_2e
15/09 – 31/12/2020	372,333	414,406	42,074
2021	1,218,331	1,360,525	142,194
2022	1,178,316	1,320,510	142,194
2023	1,138,300	1,280,494	142,194
2024	1,098,285	1,240,479	142,194
2025	1,058,270	1,200,463	142,194
2026	1,018,254	1,160,448	142,194
01/01 – 14/09/2027	688,787	788,907	100,120

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
15/09 – 31/12/2020	414,406	42,074	0	372,333
2021	1,360,525	142,194	0	1,218,331
2022	1,320,510	142,194	0	1,178,316
2023	1,280,494	142,194	0	1,138,300
2024	1,240,479	142,194	0	1,098,285
2025	1,200,463	142,194	0	1,058,270
2026	1,160,448	142,194	0	1,018,254
01/01 – 14/09/2027	788,907	100,120	0	688,787
Total	8,766,232	995,355	0	7,770,876
Total number of crediting years	**7 years**			
Annual average over the crediting period	**1,252,319**	**142,194**	**0**	**1,110,125**

Note that actual estimation of overall emission reductions as presented in chapters B.6.3 and B.6.4 has been done in an excel book. Conservative rounding has been made for final ER_y calculation only.

B.7. Monitoring plan

All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data will be monitored, if not indicated otherwise in the tables below. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards.

The accuracy of the N_2O emissions monitoring results will be ensured by using a monitoring system that has been certified to meet the requirements of the prevailing best industry practice or monitoring

standards in terms of operation, maintenance and calibration. Latest applicable European standards and norms (EN 14181) will be used as basis for selecting and operating the monitoring system.

B.7.1. Data and parameters to be monitored

The value(s) applied in the parameter tables below are an estimate of the data/parameters that will be monitored during the crediting period, but are used for the purpose of calculating estimated emission reductions. The value(s) applied are generally based on historic values from the 2nd crediting period.

Data/Parameter	$\mathbf{P_{production,y}}$
Data unit	t HNO_3
Description	Nitric acid produced in year *y*
Source of data	Production reports The actual NA production is measured according to the installed instruments. The instrument signals are recorded in the control room and are used to determine whether the NA production is within the historical designed capacity. The HNO_3 production data is derived from production reports, which are prepared in accordance with AFC´s quality management system ISO 9001. The cumulative volume of HNO_3 and the dedicated temperature in the HNO_3 line are recorded. The concentration of the NA is analysed and recorded as well. The daily HNO_3 production and the daily average concentration are recorded by AFC. This data is used for cross-check purpose.
Value(s) applied	671,400
Measurement methods and procedures	**FT 21411** Type: Magnetic flow meter Accuracy class: 0.25% Calibration frequency: at least 5 years (acc. to manufacturer´s recommendation) from commissioning or latest general maintenance (meter verification) **TE 21042** Type: Temperature Transmitter Accuracy class: ± 0.15°C digital accuracy in accordance with IEC 751 Calibration frequency: 2 years
Monitoring frequency	Recording frequency: daily
QA/QC procedures	In order to prove plausibility of HNO_3 production cross-checks will be performed (conversion efficiency). The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of AFC.
Purpose of data	Calculation of baseline emissions
Additional comment	The parameter $P_{NA,h}$ (Nitric acid produced in the hour h) represents the hourly value of $P_{production,y}$ and is used for determining $h_{r,y}$ as described in the applied methodology.

Data/Parameter	$\mathbf{h_y}$
Data unit	h
Description	Number of hours of operation in year y
Source of data	Measured
Value(s) applied	8,640

Measurement methods and procedures	The operation temperature of the two oxidation burners ranges from 850 – 910°C (as defined by the technology supplier) and this range corresponds to the real operation hours of the reactor. Therefore, the plant is considered to be in operation when the temperature is in a range from 850 – 910°C. The temperature is reported automatically by two independent measurement points for each burner measuring the temperature at the same time. The information will be stored in electronic records and paper during whole project´s lifetime. Instruments TAG numbers: • Burner I: **TE 21014** & **TE 21015** • Burner II: **TE 21020** & **TE 21021** The values of the instrument with the TAG numbers TE 21015 and TE 21021 were selected as main signals for monitoring the operation temperature; TE 21014 and TE 21020 are used as back-up signals in case of malfunction of the main signals.
Monitoring frequency	Every monitoring period
QA/QC procedures	Periodic calibration of relevant temperature transmitter as above mentioned will be performed according to supplier's recommendations. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of AFC.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime

Data/Parameter	$\mathbf{h_{r,y}}$
Data unit	h
Description	For tertiary N2O abatement, Number of hours (h) in year y where the abatement system is by-passed, underperforming or failed
Source of data	Measured
Value(s) applied	0
Measurement methods and procedures	AFC´s NA plant has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if: $F_{N2O,tailgas,h} > EF_{existing,y} \times P_{NA,h}$ The parameters mentioned above will be determined and monitored as explained in the respective sections/tables of this PDD ($EF_{existing,y}$ → needs not to be monitored, since it´s fixed for the crediting period).
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of AFC.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime. The parameter $P_{NA,h}$ (Nitric acid produced in the hour h) represents the hourly value of $P_{production,y}$ and is used for determining $h_{r,y}$ as described in the applied methodology.

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data/Parameter	$\mathbf{V_{t,db,n}}$
Data unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measured
Value(s) applied	242,000

Measurement methods and procedures	Volumetric flow measurement will refer to normal conditions. Calculated based on the dry basis flow measurement plus water concentration measurement (according to Option A of the tool).
Monitoring frequency	Continuous monitoring
QA/QC procedures	According to European Norm 14181.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool The volume flow is converted to normal conditions according to the applied methodology. Therefore, the respective parameters were determined at normal conditions ($P_t = P_n$ = 101,325 Pa; $T_t = T_n$ = 273.15 K).

Data/Parameter	$\mathbf{v_{i,t,db}}$
Data unit	m³ gas i/m³ dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Source of data	Measured
Value(s) applied	$1.15*10^{-4}$
Measurement methods and procedures	**AT 218002** Type: Non-dispersion infrared absorption analyser Calibration frequency: as per EN 14181 Continuous gas analyser operating in dry-basis. Volumetric fraction measurement refers to normal conditions.
Monitoring frequency	Continuous monitoring
QA/QC procedures	According to European Norm 14181. Calibration should include zero verification with an inert gas (N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). Certified (certificates confirming stability of standard) standard gases are used. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of AFC.
Purpose of data	Calculation of project emissions
Additional comment	The N_2O concentration is converted to normal conditions according to the applied methodology. Therefore, the respective parameters were determined at normal conditions ($P_t = P_n$ = 101,325 Pa; $T_t = T_n$ = 273.15 K).

Data/Parameter	$\mathbf{C_{H2O,t,db,n}}$
Data unit	mg H_2O/m³ dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) applied	Below 50,000
Measurement methods and procedures	Discrete measurement procedure
Monitoring frequency	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements will coincide with the Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the calibration of the flow meter for the gaseous stream.
QA/QC procedures	According to the USEPA CF42 method 4
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter for proving that the gaseous stream is dry.

Data/Parameter	**T_t**
Data unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	Needs not to be monitored, since the N_2O concentration and the volume flow are converted to normal conditions according to the applied methodology.

Data/Parameter	**P_t**
Data unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	N/A
Value(s) applied	N/A
Measurement methods and procedures	N/A
Monitoring frequency	N/A
QA/QC procedures	N/A
Purpose of data	N/A
Additional comment	Needs not to be monitored, since the N_2O concentration and the volume flow are converted to normal conditions according to the applied methodology.

Parameters from the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

Data/Parameter	**$FC_{i,j,y}$**
Data unit	Nm³/y
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements The natural gas used as reducing agent is measured by standard flowmeter. Flow is converted to standard conditions based on temperature and pressure measurement.
Value(s) applied	700,000
Measurement methods and procedures	**FT 218002** Type: Natural gas flow meter Accuracy class: + 1.6% in accordance with VDI/VDE 3513 Calibration frequency: 5 years **TE 218004** Type: Temperature transmitter Accuracy class: ±0.15 °C ± 0.03% of calibrated span in accordance with IEC 751 Calibration frequency: 5 years **PT 218004** Type: Pressure transmitter Accuracy class: ± 0.075% of calibrated span Calibration frequency: 5 years
Monitoring frequency	Continuous monitoring; daily recording

QA/QC procedures	As far as feasible the consistency of metered fuel consumption quantities should be cross-checked for plausibility by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should be cross-checked with available purchase invoices from the financial records. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of AFC.
Purpose of data	Calculation of project emissions
Additional comment	N/A

<table>
<tr><th>Data/Parameter</th><th>$w_{C,i,y}$</th></tr>
<tr><td>Data unit</td><td>tC/mass unit of the fuel type</td></tr>
<tr><td>Description</td><td>Weighted average mass fraction of carbon in fuel type i in year y</td></tr>
<tr><td>Source of data</td><td>Certificate of hydrocarbon supplier</td></tr>
<tr><td>Value(s) applied</td><td>0.75</td></tr>
<tr><td>Measurement methods and procedures</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using data source</th></tr>
<tr><td>a) Value provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurement by the project participants</td><td>If a) is not available</td></tr>
</table>
Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.</td></tr>
<tr><td>Monitoring frequency</td><td>Measuring; In order to assure conservativeness a certificate from the hydrocarbon supplier is requested at least on a yearly basis. The mass fraction of carbon should be obtained regularly, from which weighted average annual values should be calculated.</td></tr>
<tr><td>QA/QC procedures</td><td>It will be verified, if the applied value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>Applicable where Option A of the tool is used</td></tr>
</table>

<table>
<tr><th>Data/Parameter</th><th>$\rho_{i,y}$</th></tr>
<tr><td>Data unit</td><td>t/Nm^3</td></tr>
<tr><td>Description</td><td>Weighted average density of fuel type i in year y</td></tr>
<tr><td>Source of data</td><td>Certificate of hydrocarbon supplier</td></tr>
<tr><td>Value(s) applied</td><td>$7.60*10^{-4}$</td></tr>
<tr><td>Measurement methods and procedures</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using data source</th></tr>
<tr><td>a) Value provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurement by the project participants</td><td>If a) is not available</td></tr>
</table>
Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.</td></tr>
<tr><td>Monitoring frequency</td><td>Measuring; In order to assure conservativeness a certificate from the hydrocarbon supplier is requested at least on a yearly basis. The mass fraction of carbon should be obtained regularly, from which weighted average annual values should be calculated.</td></tr>
<tr><td>QA/QC procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
</table>

Additional comment	Applicable where Option A is used and where $FC_{i,j,y}$ is measured in a volume unit. Preferably the same data source should be used for $w_{C,i,y}$ and $\rho_{i,y}$.

B.7.2. Sampling plan

>>

Not applicable to this project activity.

B.7.3. Other elements of monitoring plan

>>

The emission reductions achieved by the project activity will be monitored using the requirements of the approved consolidated baseline and monitoring methodology ACM0019 "N_2O abatement from nitric acid production" (version 4.0) and of the relevant tools as mentioned above.

Measurement of the N_2O concentration and the total gas volume flow

The project employs the latest state of the art monitoring and control equipment that measures, records and reports all key parameters to determine the GHG emission reductions. The plant is equipped with an AMS in order to allow continuous real-time measurements of the N_2O concentration and the total gas volume flow, which is required by the methodology.

The amount of N_2O emissions from the tail gas stream of the project plant shall be determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". In applying the tool, the following provisions apply:

(a) Throughout the crediting periods of the project activity, the N_2O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;

(b) The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on two seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;

(c) The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN14181 must be applied to both the N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;

(d) If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;

(e) In the case that the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.

The EN 14181 stipulates three levels of quality assurance tests and one annual functional test for AMS, which are recommended to be used as guidance regarding the selection, installation and operation of the AMS under the applied monitoring methodology. The three quality assurance levels (QAL) are as follows:

1. Quality assurance of tested AMS; AMS will have performance certificate with calculation of uncertainty before installation. The specific performance characteristics of the monitoring system chosen by the project will be listed in the monitoring reports.
2. Quality assurance of installation and calibration of the AMS according to the Standard Reference Measurement Method (SRM) for concentration measurements, determination of the measurement uncertainty/variability of the AMS and inspection of the compliance with the prescribed measurement uncertainties; Such tests will be carried out by organisations that have an accredited quality assurance system.
3. Continuous quality assurance through the local operator/manager.
   a) Permanent quality assurance during the plant operation by the operating staff;
   b) Assurance of reliable and correct operation of the monitoring equipment (maintenance evidence);
   c) Regular controls as scheduled by the manufacturer (maintenance intervals);

In addition, annual functionality tests including SRM measurements to check for uncertainties in the data measured by the AMS are planned. Such tests will be carried out by organisations that have an accredited quality assurance system.

Operational and Management structure

The project operator, Abu Qir Fertilizer Co. S.A.E., was founded as a joint stock company and is located and registered in the Alexandria Province under Egyptian law in 1976. AFC is among the major job providers in Alexandria area. The company is ISO 9001 and ISO 14001 certified and one of the most important companies of the Egyptian industry. The EnviNOx® system is incorporated into AFC's ISO standards.

The operating personnel of the EnviNOx® system has been trained by the technology provider and the supplier of the digital process control system. CARBON Climate Protection GmbH (hereinafter called "CARBON") is responsible for monitoring and reporting of data under the CDM project, as well as for general supervision and cross-checks of monitoring and reporting data.

Data collection

The instruments transmitters continuously provide a 4 – 20 mA analogue signal according to range and units configured. These signals are transmitted to I/O cards (analogue input/output cards) and collected by the Delta V Processor. Resulting digital values are made available in the network to be further processed (e.g. in controller blocks, calculation of other variables) and are stored in the protected continuous historian server (CHS). The reporting module of the Delta V system automatically generates aggregated daily reports based on the stored raw data from the CHS. Relevant parameters are exported for presentation of required parameters and calculation of baseline emissions, project emissions and emission reductions according to the formulae as required. Daily production of the NA plant ($P_{production,y}$) is obtained from production reports for cross-checking.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

09/10/2004 (the date when the contract between AFC and CARBON was signed)

C.2. Expected operational lifetime of project activity

>>

25 years, 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable (3rd crediting period)

C.3.2. Start date of crediting period

>>
15/09/2020

C.3.3. Duration of crediting period

>>
7 years, 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The catalytic N_2O destruction project in the tail gas of the NA plant Abu Qir II is a sustainable project that contributes to the environmental, economic and social benefits in the Arab Republic of Egypt.

The ex-ante GHG emission reduction is estimated to be about 7.8 million tons of CO_2e in the 3rd crediting period. Additionally, the EnviNOx®-system takes over the function of the DeNOx-unit at Abu Qir II as it accomplishes the reduction of NOx with ammonia as well. No further environmental impacts are expected.
The Environmental Impact Assessment study was elaborated by an independent consultant and submitted to the Governorate of Alexandria. After the approval of the Governorate of Alexandria the study was submitted to the Egyptian Environmental Affair Agency (EEAA) for final approval.

EEAA final approval:	15/06/2006
EEAA approval letter No.:	02416 (Ministry of State for Environmental Affairs)

No transboundary impacts are expected.

According to the national Environment Law number 4 of Egypt (year 1994) and its latest revision by the prime minister resolution number 1963 for 2017, the NOx emissions at NA plants are limited to 400 mg/m³ for the AFC NA plant. Continuous measurement of the NOx concentration at the outlet of the EnviNOx® system during the 1st and 2nd crediting period reports that the CDM project operation is in compliance with the national environmental standards.

D.2. Environmental impact assessment

>>
In accordance with the Egyptian Environmental Law Number 4 (1994) a brief Environmental Impact Assessment study was prepared on the “Catalytic N_2O Destruction Project in the Tail Gas of the Nitric Acid Plant of Abu Qir Fertilizer Co.” and the project was approved by the Egyptian Environmental Affair Agency.
The Environmental Affairs Agency accepts, from the environmental side, the said project conditioned the liability to all the specifications and procedures mentioned in the submitted study as well as all the conditions mentioned in the environment law no. (4) for the year 1994 with its executive regulations and to be obliged to the following conditions:

- Take the necessary precautions to limit any negative effects on the surrounded environment, resulting from building and operational procedures.

- Liability to the environmental management plan mentioned in the study, taking into consideration the necessary precautions to limit the gas emissions resulting from the project.
- Liability to supervision plan and periodical observation as well as the necessity to report the measurements in the environmental register and make it available upon environmental inspection.
- Liability to return the consumed catalysts to the supplier as mentioned in the study.
- Take into consideration the working environment correctness and the labourer's security as well as the necessity of its conformity with Annex (9) of the executive regulations of law no. (4) for the year 1994.
- This acceptance is from the environmental side only without breach to any of the laws or decisions or other organizing rules to this activity.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

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A local stakeholder conference has been held by CARBON and AFC for stakeholders of the CDM project at the conference room of Hilton Green Plaza in Alexandria on March 26th, 2006. 49 participants attended the stakeholder conference, questionnaires were distributed and 32 had been returned.

Local public stakeholders were invited to the stakeholder meeting via personal invitation by AFC to the neighbours and companies around the area of Abu Qir. Furthermore, Egyptian governmental and non-governmental organizations and the DNA were invited. Moreover, to ensure that other interested parties were also invited, AFC published an announcement in the local newspaper. Lists of invited stakeholders and participants were presented to the DOE.

The contents of the stakeholder meeting are shown below:

- Welcoming address to the stakeholders by Mr. Mohammed Abdallah (Chairman of AFC)
- Welcoming address to the stakeholders by Mr. Ferdinand Heilig (Managing Director of CARBON)
- Welcoming address to the stakeholders by Dr. Sayed Mansour (Co-ordinator of Egyptian DNA)
- Presentation of AFC and the CDM project by Mr. Reda Kahlil (Vice President of AFC)
- Presentation of the CDM project and methodology by Mr. Ferdinand Heilig (Managing Director of CARBON)
- Discussion, questions and answers

Mr. Heilig was interviewed by the local Egyptian television, which was broadcasted in Egypt.

CARBON has carried out an investigation on the local stakeholder comments on the CDM project in the formats of issuing questionnaires to introduce the aims and characteristics of the CDM project and addressing in particular its potential environmental impacts.

E.2. Summary of comments received

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Translation of the minutes of environmental stakeholder consultation meeting:

Statistics of Stakeholder's Conference for CDM Project

1. Date : March 26, 2006.

2. Location : At the conference room of Hilton Green Plaza, Alexandria

3. Number of Questionnaires returned

Classification	*Number*
Local Governmental Organisations	4
Local Non-Governmental Organisations	2
Austrian Embassy	2
Private	3
Neighbouring companies	2
Promotrade	1
Abu Qir Fertilizer Co.	9
UHDE Engineering Egypt Ltd.	7
Carbon GmbH	1
Carbon Egypt Ltd.	1
Total	**32**

4. Content of conference

Welcoming address to the stakeholoders by Mr. Mohammed Abdallah (Chairman of Abu Qir Fertilizer Co.)

Welcoming address to the stakeholders by Mr. Ferdinand Heilig (Managing Director of Carbon)

Welcoming address to the stakeholders by Dr. Sayed Mansour (Co-ordinator of Egyptian D.N.A.)

Presentation of Abu Qir Fertilizer Co. & CDM project by Mr. Reda Kahlil (Vice President of Abu Qir Fertilizer Co.)

Presentation of CDM-Project & CARBON's Methodology AM0028 by Mr. Ferdinand Heilig (Managing Director of Carb

Questionnaires and Answers

5. Statistics of a survey of the stakeholders for the CDM project at Abu Qir Fertilizer Co.

- 32 stakeholders (out of 59 personal invited stakeholder) filled out the questionnaires

Questions to the Stakeholders	Yes	No
Do you think that the region and the Egyptian people living in the region will benefit from this CDM-Project?	32	0
Is your company or the organization you are working for / you are presenting influenced by this CDM-Project?	26	6
Will your company or the organization you are working for / you are presenting play a role in the implementation of this CDM-Project?	28	4
Do you think that the Egyptian government shall support this project?	31	1
Do you think that Egypt shall take efforts towards reducing greenhouse gas emissions within Egypt?	32	0
Do you consider that this CDM-Project will contribute to the sustainable development of Egypt?	32	0
Do you consider this CDM-Project as being "additional"?	30	2
Do you have any special remarks or questions the project participants shall answer to you? Which?		

Special remarks and questions discussed at the local stakeholder meeting:

- EEAA shall not hinder CDM project with too much "bureaucracy";
- Benefit for local residents;
- Such CDM projects are not "additional" as they are "essential" for mankind;
- Possible measures against global warming.

E.3. Consideration of comments received

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The main concern of the local stakeholders was the impact of the project on the local air quality. The project sponsor and the project operator have explained and illustrated the guidelines for CDM projects under the United Nations Framework Convention on Climate Change and the effect of the project activity on GHG emission reduction and NOx emission reduction.

Social Benefits: The project developer and the project operator agreed on spending a share of the total income from selling of the CERs for a Social Fund for the area of Abu Qir. This fund shall contribute to the social benefit of the people living in the area of the CDM project activity by financing sustainable projects like projects in schools, hospitals and infrastructure.

Economic Benefit: The project developer agreed to pay a share of the income of the CERs to the project operator, who is a major job provider in the region. Additionally, value and jobs were created in the region especially during the construction work of the EnviNOx®-system.

All remarks and questions were discussed at great length. No further comments were received during the stakeholder consultation process. The project owner will pay attention to the comments and questions of stakeholders and will make all conceivable effort to achieve environmental benefits, social benefits and economic benefits.

SECTION F. Approval and authorization

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The letters of approval of the following Parties are available at the time of submitting the PDD to the validating DOE for renewal of crediting period:

- Egypt (Host)
- Austria
- Germany

Appendix 1. Contact information of project participants

Organization name	CARBON EGYPT Ltd.
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Contact person	Mr. Hani Riskalla

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Website	-
Contact person	Ms. Sonja Bichler

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Fax	+49 201 12 24 132
E-mail	vlfocal-point@rwe.com
Website	
Contact person	Mr. Ludwig Kons

Appendix 2. Affirmation regarding public funding

No public funds are available for the financing of the project activity.

Appendix 3. Applicability of methodologies and standardized baselines

No additional information on the applicability of the methodology is to be mentioned.

Appendix 4. Further background information on ex ante calculation of emission reductions

No additional information on the ex-ante calculation of emission reductions is to be mentioned.

Appendix 5. Further background information on monitoring plan

Please refer to chapter B.7.3 (Other elements of monitoring plan).

Appendix 6. Summary report of comments received from local stakeholders

Please refer to chapter E.2.

Appendix 7. Summary of post-registration changes

In monitoring period 28 (15/09/2013 – 30/06/2014) a temporary deviation applied. Any reasons for that have been remedied by technical works during the NA plant shutdown on 01/04/2014. Since then, the project fully complies with the registered monitoring plan and applied methodology.
Reference number of PRC: PRC-0490-001
Date of approval by EB: August 19th, 2014

In the course of verification of monitoring period 30 a post-registration change (type "corrections") was submitted. The following corrections were done compared to the PDD v. 4.1:

- New version number and completion date of PDD;
- Update of information regarding project participants;
- Adding information to sections that were recently included to the PDD form;
- Correction and/or editorial changes of some information in the parameter tables.

Due to a delayed performance of AST a temporary deviation applied in monitoring period 36 and 37. Despite the fact that an AST is no calibration and does not influence the device calibration, PPs applied a recalculation in accordance with the CDM project standard for project activities 231 (a).

Additionally, in the course of verification of monitoring period 37 a post-registration change (type "corrections") was submitted. Following corrections were done compared to PDD v. 05.1:

- New version number and completion date of PDD;
- An editorial mistake on page 14 was corrected.

No other post registration changes have been applied.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).

Version	*Date*	*Description*
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document