

Draft consolidated baseline and monitoring methodology ACM00XX**“N₂O abatement from nitric acid production”****I. SOURCE, DEFINITIONS AND APPLICABILITY****Sources**

This consolidated baseline and monitoring methodology is based on elements from the following approved baseline and monitoring methodologies and proposed new methodologies:

- NM0339 “N₂O abatement in New Capacity nitric acid plants” prepared by N.serve Environmental Services GmbH;
- NM0340 “N₂O abatement in New Nitric Acid Plants” prepared by Carbon Climate Protection GmbH and Enaex S.A.;
- AM0028 “Catalytic N₂O destruction in the tail gas of Nitric Acid or Caprolactam Production Plants”, Version 5;
- AM0034 “Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants”, Version 4.

This methodology also refers to the latest approved versions of the following tools:

- “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”;
- “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”.

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

“Existing actual or historical emissions, as applicable”.

Definitions

For the purpose of this methodology, the following definitions apply:

Secondary N₂O abatement. Refers to the installation of a catalyst inside the ammonia burner unit with the sole purpose of removing N₂O emissions from the stream.

Tertiary N₂O abatement. Refers to the installation of an abatement system in the tail-gas leaving the absorption column of a nitric acid plant to destroy the N₂O generated in the ammonia burner unit.

Applicability

This methodology applies to project activities that introduce N₂O abatement measures in nitric acid plants.

The methodology is applicable under the following conditions:

- In case the nitric acid plant started commercial operation before the implementation of the CDM project activity, the project participants shall demonstrate that there was no secondary or tertiary abatement technology installed in the respective nitric acid plant;
- Continuous real-time measurements of the N₂O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N₂O emissions throughout the crediting period of the project activity;
- No law or regulation which mandate the complete or partial destruction of N₂O from nitric exist in the host country where the CDM project activity is implemented.

In addition, the applicability conditions included in the tools referred to above apply.

II. BASELINE METHODOLOGY PROCEDURE

Identification of the baseline scenario and demonstration of additionality

In the absence of regulations requiring the abatement of N₂O emissions, the operator of the nitric acid plant has no economic incentives to take any N₂O abatement measures because this entails capital and operating costs but no financial benefits. Therefore the CDM project activity is considered **additional** and the baseline scenario is the N₂O emitted to the atmosphere with no N₂O abatement measure implemented.

Project boundary

The **spatial extent** of the project boundary encompasses the facility and equipment for the nitric acid production process from the inlet of the ammonia burner to the outlet of the tail gas section.

If the project activity introduces only secondary and no tertiary N₂O abatement, then the only gas to be included as project emissions is the N₂O which is not destroyed and still present in the tail gas stream of the plant. The situation using a secondary abatement technology is illustrated below (Figure 1).

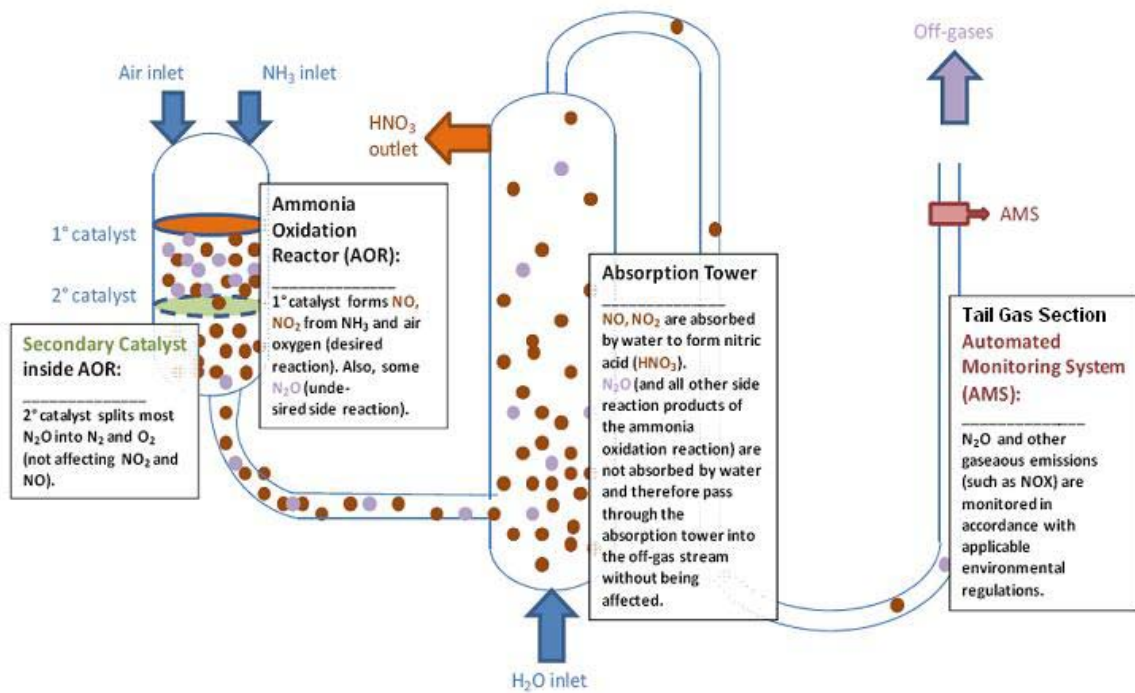


Figure 1: Project boundary if the Project Activity consists of the introduction of a secondary N₂O abatement measure (Simplified standard nitric plant layout displaying location of N₂O abatement catalyst, process sources of N₂O and sampling point location for Automated Monitoring System (AMS))

If the project activity introduces tertiary N₂O abatement, then any remaining N₂O emissions from the project plant and CO₂ emissions arising from the operation of the tertiary abatement system are included as project emissions in the project boundary. The situation using a tertiary abatement technology is illustrated below (Figure 2).

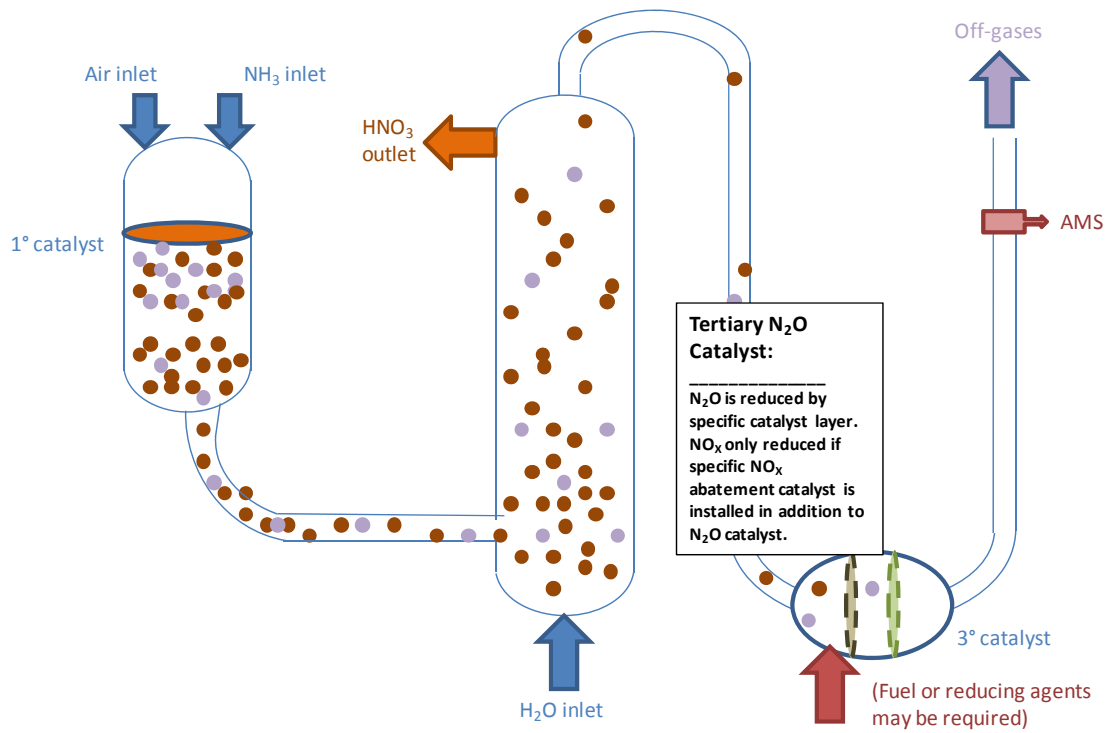


Figure 2: Project boundary if the Project Activity consists of the introduction of a tertiary N₂O abatement measure (Simplified standard nitric plant layout displaying location of N₂O abatement catalyst, process sources of N₂O and the sampling point location for Automated Monitoring System (AMS))

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

Table 1: Emissions sources included in or excluded from the project boundary

Source		Gas	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 ₂ O	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 ₂ O	Yes	Included, main emission source
	Operation of a tertiary N ₂ O 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 ₂ O 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 ₂ O	Yes	

Baseline emissions

Baseline emissions are calculated as follows:

$$BE_n = P_{NA,n} \times EF_{BL,N_2O,n} \times GWP_{N_2O} \times 10^{-3} \tag{1}$$

Where:

- BE_n = Baseline emissions in monitoring period n (tCO₂e)
- P_{NA,n} = Nitric acid produced in the monitoring period n (tHNO₃)
- EF_{BL,N₂O,n} = Baseline N₂O emission factor for nitric acid production in the monitoring period n (kg N₂O / t HNO₃)
- GWP_{N₂O} = Global Warming Potential of N₂O valid for the commitment period

Determination of the baseline N₂O emission factor (EF_{BL,N₂O,n})

The baseline N₂O emission factor in the monitoring period n (EF_{BL,N₂O,n}) shall be determined as a default emission factor EF_{default,y} given for each calendar year y in which BE_n is calculated (see monitoring tables for EF_{default,y}), as follows:

$$EF_{BL,N_2O,n} = EF_{default,y} \tag{2}$$

Where:

- $EF_{BL,N_2O,n}$ = Baseline N_2O emission factor for nitric acid production in the monitoring period n (kg N_2O / t HNO_3)
- $EF_{default,y}$ = Default N_2O baseline emissions factor in the calendar year of the monitoring period n (kg N_2O / t HNO_3)

If the monitoring period spans across two (or more) calendar years, the baseline emissions (BE_n) will have to be calculated separately for each calendar year, first establishing $EF_{BL,N_2O,n}$ and then applying this to the nitric acid production of that calendar year.

Project emissions

Project emissions include emissions of N_2O 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:

$$PE_n = PE_{N_2O,n} + PE_{CO_2,tertiary,n} \quad (3)$$

Where:

- PE_n = Project emissions in monitoring period n (t CO_2e)
- $PE_{N_2O,n}$ = Project emissions of N_2O from the project plant in monitoring period n (t CO_2e)
- $PE_{CO_2,tertiary,n}$ = Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in monitoring period n (t CO_2)

Project emissions of N_2O from the project plant

The amount of N_2O emissions from the project activity include two emission sources:

- The N_2O contained in the tail gas stream of the plant which is released to the atmosphere; and
- In the case of a tertiary N_2O abatement, the N_2O contained in any by-pass streams to the tertiary N_2O abatement facility.

Accordingly, $PE_{N_2O,n}$ is determined as follows:

$$PE_{N_2O,n} = (Q_{N_2O,tail\ gas,n} + Q_{N_2O,by-pass,n}) \times GWP_{N_2O} \quad (4)$$

Where:

- $PE_{N_2O,n}$ = Project emissions of N_2O from the project plant in monitoring period n (t CO_2e)
- $Q_{N_2O,tail\ gas,n}$ = Amount of N_2O released through the tail gas of the project plant to the atmosphere in monitoring period n (t N_2O)
- $Q_{N_2O,by-pass,n}$ = Amount of N_2O released through the by-pass to a tertiary N_2O abatement system to the atmosphere in monitoring period n (t N_2O)
- GWP_{N_2O} = Global warming potential of N_2O valid for the commitment period

Determination of $Q_{N_2O, tail\ gas, n}$

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:

- 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;
- 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 2 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;
- 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;
- If no data for either the N_2O concentration and 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 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 no data for both the N_2O concentration and 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;
- Formulae (1) and (2) of the tool can be ignored, if the volume or mass flow of the tail gas is reported as normalised values and if normalisation is processed automatically by the monitoring device.

The hourly values are then aggregated to yearly values, as follows:

$$Q_{N_2O, tail\ gas, n} = \sum_{h=1}^{h=h_n} F_{N_2O, tail\ gas, n} \cdot 10^{-3} \quad (5)$$

Where:

$Q_{N_2O, tail\ gas, n}$	=	Amount of N ₂ O released through the tail gas of the project plant to the atmosphere in monitoring period n (t N ₂ O)
$F_{N_2O, tail\ gas, h}$	=	Mass flow of N ₂ O in the gaseous stream of the tail gas in the hour h (kg N ₂ O/h)
h_n	=	Number of hours in monitoring period n during which the plant was in operation

If the tertiary abatement system is by-passed, $Q_{N_2O, tail\ gas, y}$ is set to zero in order to avoid double counting of project emissions.

Determination of $Q_{N_2O, by-pass, n}$

This emission source only needs to be estimated if a tertiary N₂O abatement facility is installed under the project activity. In some situations, the gas stream from the nitric acid plant may not be sent to the tertiary N₂O abatement facility but may be directly vented to the atmosphere through a by-pass.

In these situation, the project emissions are assumed to equal the baseline emissions and no emission reductions are claimed under the project activity. This means that during the time when the by pass is open the project emission factor will be equal to the baseline emission factor.

Accordingly, $Q_{N_2O, by-pass, b}$ is determined as follows:

$$Q_{N_2O, by-pass, n} = EF_{BL, N_2O, n} \cdot P_{NA, n} \cdot T_{open, n} \cdot 10^{-3} \quad (6)$$

Where:

$Q_{N_2O, by-pass, n}$	=	Amount of N ₂ O released through the by-pass to a tertiary N ₂ O abatement system to the atmosphere in monitoring period n (t N ₂ O)
$EF_{BL, N_2O, n}$	=	Baseline N ₂ O emission factor for nitric acid production in monitoring period n (kg N ₂ O / t HNO ₃)
$P_{NA, n}$	=	Nitric acid produced in the monitoring period n (tHNO ₃)
$T_{open, n}$	=	Percentage of time in monitoring period n during which the by-pass valve on the line feeding the tertiary N ₂ O abatement facility was open to vent the gas directly to the atmosphere

Project emissions from the operation of the tertiary N₂O abatement facility

The emissions related to the operation of the N₂O destruction facility are given by

- (1) On-site emissions due to the fossil fuel use as input to the N₂O destruction facility; and
- (2) Upstream emissions related to the production of ammonia used as input.

For the CDM project activity, only the emissions due to fossil fuel consumption are considered as project emissions.

$$PE_{CO_2, tertiary, n} = PE_{FF, n} \quad (7)$$

Where:

$PE_{CO_2, \text{tertiary}, n}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in monitoring period n (t CO₂e)

$PE_{FF, n}$ = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in monitoring period n (t CO₂e)

This emission source only needs to be estimated if a tertiary N₂O 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.

Project proponents shall use the latest version of the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” to calculate the project emissions related to fossil fuels used in monitoring period n..

Specific guidance on the use the tool:

- The parameter $PE_{FC, j, y}$ used in the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” corresponds to the parameter $PE_{CO_2, \text{tertiary}, n}$ in this methodology, and
- The element process j in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N₂O abatement facility and/or the re-heating of the tail gas.

Leakage

Any leakage emissions sources are deemed to be negligible.

Emission reductions

Emission reductions are calculated as follows:

$$ER_n = BE_n - PE_n \quad (8)$$

Where:

ER_n = Emission reductions in monitoring period n (t CO₂e)

BE_n = Baseline emissions in monitoring period n (t CO₂e)

PE_n = Project emissions in monitoring period n (t CO₂)

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter:	EF _{default,y}																																													
Data unit:	kgN ₂ O/tHNO ₃																																													
Description:	Default N ₂ O baseline emissions factor in year <i>y</i>																																													
Source of data:	<p>The baseline default emission factor will vary every year. In year 2005 the emission factor will be 5.1 and then it will decrease linearly every year until reach a final value of 2.5 in the year 2020. The value of 2.5 will remain constant after 2020.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Year</th> <th>Emission factor (kgN₂O/tHNO₃)</th> </tr> </thead> <tbody> <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> </tbody> </table>		Year	Emission factor (kgN ₂ O/tHNO ₃)	2005	5.10	2006	4.90	2007	4.70	2008	4.60	2009	4.40	2010	4.20	2011	4.10	2012	3.90	2013	3.70	2014	3.50	2015	3.40	2016	3.20	2017	3.00	2018	2.80	2019	2.70	2020	2.50	2021	2.50	2022	2.50	2023	2.50	⋮	⋮	Year n	2.50
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Measurement procedures (if any):	None																																													
Any comment:	The decrease in the value for the baseline emission factor over time is to reflect the technological development																																													

Data / Parameter:	GWP_{N_2O}
Data unit:	tCO ₂ e/tN ₂ O
Description:	Global warming potential of N ₂ O
Source of data:	IPCC
Measurement procedures (if any):	None
Any comment:	Default value 310, to be checked at the renewal of crediting period

III. MONITORING METHODOLOGY

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

In addition, the monitoring provisions in the tools referred to in this methodology apply.

Data and parameters monitored

Baseline emissions

Data / Parameter:	$P_{NA,n}$
Data unit:	tHNO ₃
Description:	Nitric acid produced in the monitoring period n
Source of data:	Measurements by project participants. Production reports
Measurement procedures (if any):	
Monitoring frequency:	Every monitoring period
QA/QC procedures:	Measurement devices such as weight scales shall follow QA/QC supplier recommendations
Any comment:	

Project emissions

Data / Parameter:	h_n
Data unit:	-
Description:	Number of hours of operation in a monitoring period n
Source of data:	Measured
Measurement procedures (if any):	
Monitoring frequency:	Every monitoring period
QA/QC procedures:	
Any comment:	Records to be maintained during project's lifetime

Data / Parameter:	T _{Open,n}
Data unit:	%
Description:	% of time the valve on the line feeding the decomposition facility is open during monitoring period n
Source of data:	Measured
Measurement procedures (if any):	Measured as a percentage by monitoring the period of opened condition and the total operating hours of the production facility during the monitoring period n
Monitoring frequency:	Every monitoring period
QA/QC procedures:	Metering instruments shall be calibrated regularly to industry standards
Any comment:	Records to be maintained during project’s lifetime.

IV. REFERENCES AND ANY OTHER INFORMATION

Methodology proposal “Standardized N2O baselines for new nitric acid plants” prepared by N.serve Environmental Services GmbH.

History of the document

Version	Date	Nature of revision(s)
01.0.0	EB 61, Annex # 3 June 2011	To be considered at EB 61.
Decision Class: Regulatory Document Type: Standard Business Function: Methodology		