



**Monitoring report form for CDM project activity
(Version 06.0)**

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

MONITORING REPORT

Title of the project activity	Omnia Fertilizer Limited Nitrous Oxide (N ₂ O) Reduction Project	
UNFCCC reference number of the project activity	0752	
Version number of the PDD applicable to this monitoring report	2	
Version number of this monitoring report	01	
Completion date of this monitoring report	24/08/20118	
Monitoring period number	4	
Duration of this monitoring period	01/07/2017 – 30/06/2018 Duration (365 days)	
Monitoring report number for this monitoring report	Not applicable	
Project participants	Omnia Fertilizer Limited, Belektron d.o.o., Nordic Environment Finance Corporation	
Host Party	South Africa	
Sectoral scopes	Sectoral Scope: 05	
Applied methodologies and standardized baselines	Applied Methodology: ACM0019 Version 02.0.	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	209,511
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	421,913	

SECTION A. Description of project activity

A.1. General description of project activity

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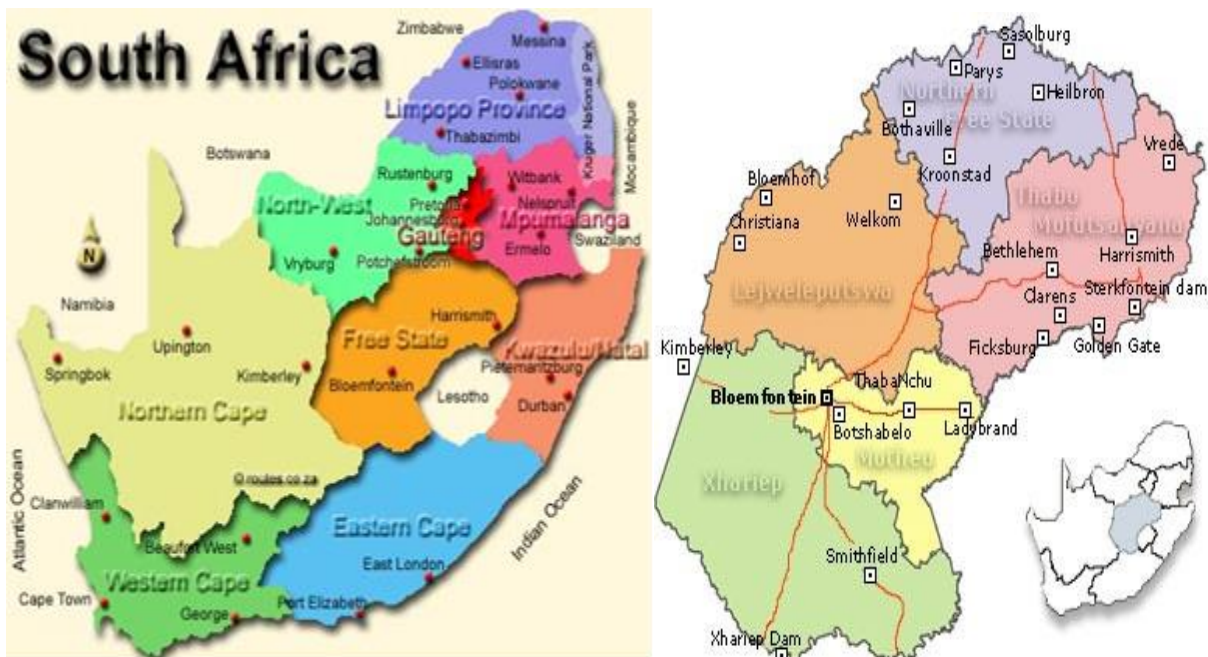
a). Omnia Fertilizer Limited has implemented a project activity aimed at reducing the N_2O emissions from its Nitric Acid plant in Sasolburg, South Africa. The project activity is under the category large scale, Sectoral scope 5 "Chemical Industry".

b). The project activity involves the installation of an N_2O catalytic Destruction Facility, EnviNox in the tail gas section of the process downstream of the absorption column at Omnia Fertilizer nitric acid plant in Sasolburg, South Africa. Catalytic reduction of N_2O occurs when the N_2O in the tail gas reacts, in the presence of the iron zeolite catalyst, with the reducing agent in the Destruction Facility. The reaction removes the oxygen from the N_2O molecules and forms one or more compounds. In this case the reducing agent is natural gas, comprised mostly of methane (CH_4).

A.2. Location of project activity

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- a) Host Party: Republic of South Africa
- b) Free State Province, Sasolburg, Metsimaholo Municipality
- c) Omnia's plant is located at latitude of approximately 26°48'48" South and a longitude of 27°51'23" East.



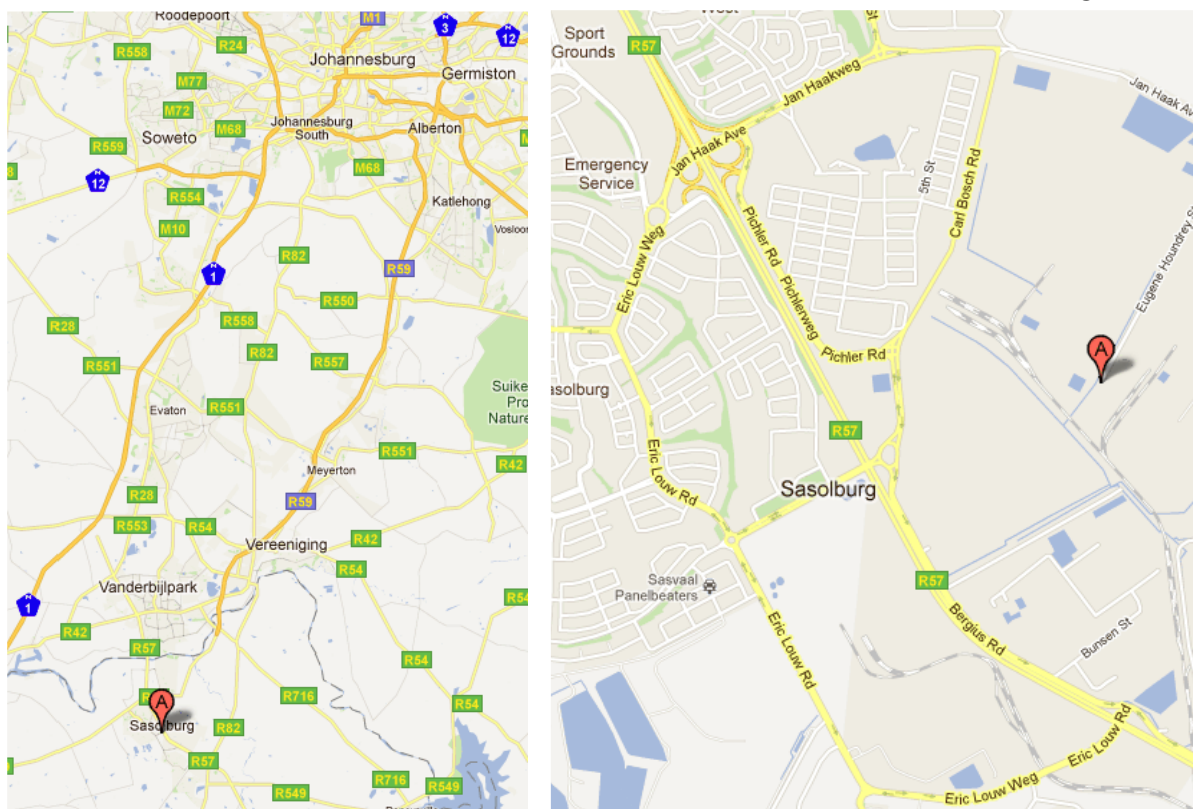


Figure 1: Physical location of the Omnia I nitric acid plant in Sasolburg, South Africa

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
South Africa (host Party)	Omnia Fertilizer Limited	No
United Kingdom of Great Britain and Northern Ireland	Belektron d.o.o.	No
Norway	Nordic Environment Finance Corporation	No

A.4. Reference to applied methodologies and standardized baselines

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1. (a) Applied methodology: ACM0019 Version 02.0: "N₂O abatement from nitric acid production"
- (b) Applied tools:
 - i. "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" (Version 02)
 - ii. "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)

A.5. Crediting period type and duration

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- (a) Type of Crediting Period: Renewable: 7 years and 0 months
- (b) Duration of 1st Crediting Period: 26/02/2008 - 25/02/2015
- Duration of 2nd Crediting Period: 26/02/2015 - 25/02/2022

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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- a) The project activity entails the installation of:
- Tertiary N₂O abatement technology,
 - Specialized monitoring equipment that is installed at the tail gas stream after the abatement of N₂O emissions.

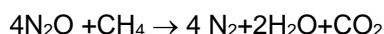
Catalyst Technology

In the production process of nitric acid (HNO₃), NO₂ is produced as an intermediate material from ammonia (NH₃). The associated chemical reactions of oxidizing ammonia and simultaneous unwanted reactions are as follows:

- | | | | |
|---|---|---|--|
| 1. NH ₃ + 2 O ₂ | → | HNO ₃ + H ₂ O | (overall desirable reaction) |
| 2. 4 NH ₃ + 5 O ₂ | → | 4 NO + 6 H ₂ O | (desirable in the NH ₃ oxidization process) |
| 3. 2 NO + O ₂ | → | 2 NO ₂ | (desirable in the NO oxidization process) |
| 4. 3 NO ₂ + H ₂ O | → | 2 HNO ₃ + NO | (desirable in the NO ₂ absorption process) |
| 5. 4 NH ₃ + 3 O ₂ | → | 2 N ₂ + 6 H ₂ O | (undesirable) |
| 6. 4 NH ₃ + 4 O ₂ | → | 2 N ₂ O + 6 H ₂ O | (undesirable) |
| 7. 2 NH ₃ + 8 NO | → | 5 N ₂ O + 3 H ₂ O | (undesirable) |

Through the sixth and seventh reactions, some N₂O is generated in the process.

The N₂O abatement technology is installed in the tail gas downstream after the HNO₃ absorber and before the tail gas turbine. A tertiary catalyst reduces N₂O that is formed in the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have been shown to be of varied efficiency in N₂O abatement catalysts. The abatement efficiency of this pelleted catalyst has been shown to be up to 99.9% in the following reaction¹:



In the tertiary abatement system N₂O is removed by catalytic reduction with a hydrocarbon, such as methane from natural gas.

The applied technology is chosen because it has negligible risk of decreasing HNO₃ production and a high expected N₂O reduction.

The expected remaining lifetime of the N₂O reduction unit is at least 10 years. It is expected to be in the range of 25 years. However the installed catalyst itself may need to be replaced after a few years, depending on the achieved abatement performance.

In addition NO_x is reduced in a separate catalyst bed by reduction with ammonia.

¹ While the calculations of estimated emission reductions are based on the conservative estimation of an abatement efficiency of 98 %, it should be noted that from experience from the first crediting period of this project as well as from other similar projects with the same technology even higher abatement efficiencies of up to 99.9 % were observed.

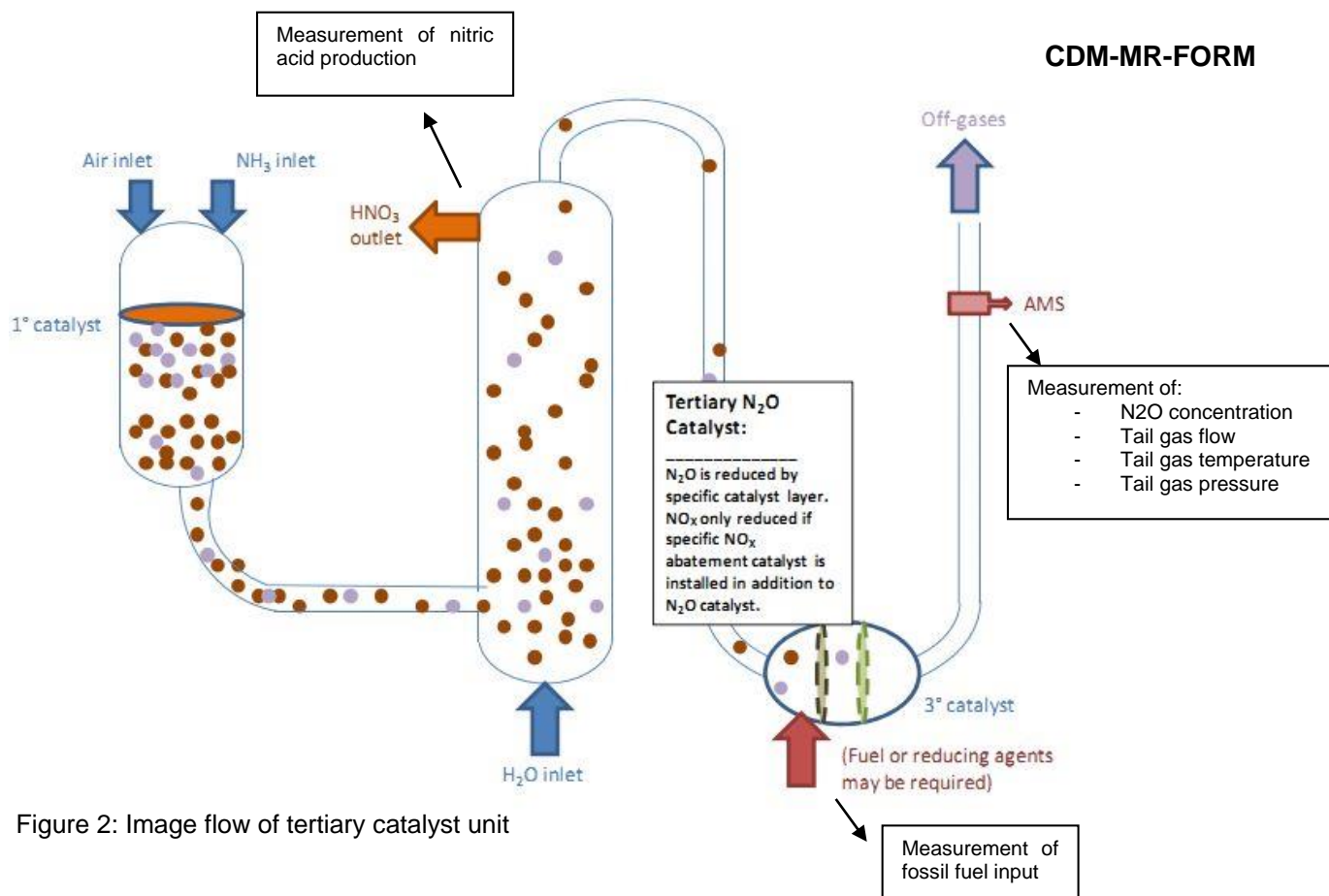


Figure 2: Image flow of tertiary catalyst unit

b) Relevant Dates for the Project Activity

Registration date: 03/05/2007

1st Crediting period: 26/02/2008 to 25/02/2015 (Renewable)

2nd Crediting period: 26/02/2015 to 25/02/2022 (Renewable)

The starting date of operation of the project activity is 26/02/2008.

The EnviNox installation was completed and commissioned in January 2008.

Omnia erected and commissioned the Nitric Acid Plant in 1983.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

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No

B.2.2. Corrections

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No

B.2.3. Changes to the start date of the crediting period

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No

B.2.4. Inclusion of monitoring plan

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No

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

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No

B.2.6. Changes to project design

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No

SECTION C. Description of monitoring system

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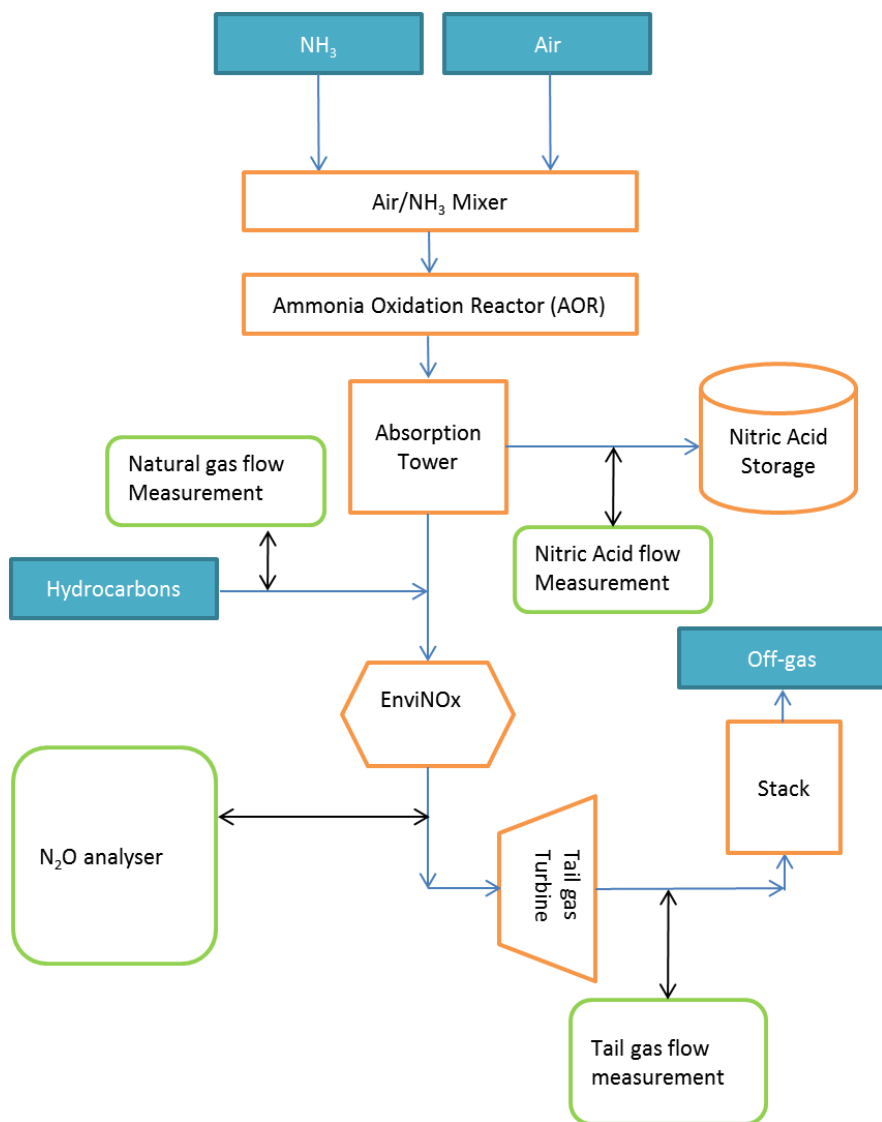


Figure 3: Schematic diagram of location of sample points

Sample points

The sample points were chosen in accordance with the AMS requirements, EN 14181:2004 requirements and the plant design specifications to allow an optimum of data collecting quality.

The location of the sample point was selected to provide ease of access and a location close to the analyser. The most suitable position is in the horizontal section of the exit stack. At this point, the gas is still hot and well mixed. The graph above shows the location of the sample point schematically.

Analyser

The Emerson NGA 2000 is capable of analysing N₂O concentration in gas mixtures. The continuous NDIR industrial photometer can selectively measure concentrations of up to four sample components. In this case it is equipped for the measurement of N₂O and NO. The analyser features gas-filled optopneumatic detectors. The detector provides optimum sensitivity and high selectivity compared with the other gas components in the sample. The Analyser is QAL1 tested according to EN 14181:2004 for the measurement of N₂O.

Sample Conditioning System

The gas sample is extracted at the sampling point particles are removed with a heated filter unit and the clean sampling gas is delivered through a heated sampling line to the analyser cabinet. Before being fed to the analyser, traces of moisture are removed by a sample conditioning system that is installed in the analyser cabinet. The minimum flow rate to the analyser is controlled and connected to an alarm.

Stack gas flow meter

The Durag annubar measuring system D-FL 100 operates according to the differential pressure principle. The probe has two separate chambers, between which the flow builds up a differential pressure. Taking into account the other flow parameters absolute pressure and temperature, the volume flow is converted from operating to standard conditions. The D-FL 100 is QAL1 tested according to EN 14181:2004 and EN ISO 15267.

Accuracy and Calibration of Instruments

All meters are maintained to ensure a high level of accuracy. The exact specifications of each meter have been included in procedures to maintain those levels of accuracy.

All key monitoring instruments are calibrated in regular intervals. A record is being maintained showing the location and unique identification number of each meter, the calibration status of that meter (when last calibrated, when next due for calibration).

Monitoring equipment (Tag-No./ Description)	Serial Number	Description; Related monitoring parameter as per applicable registered monitoring plan	Type	Accuracy or accuracy class	Calibration frequency	Calibrations
FT 7672	Transmitter: 3845068 Sensor: 14459566	Natural gas flow meter FC_{i,j,n}	Micro Motion Coriolis Massflow	+/- 0.5 % of the adjusted range	3 years	25/02/2015 13/08/2015 03/08/2017
FT-76010	Transmitter: 3765698 Sensor: 14163265	Nitric acid flow meter P_{production,y}	Micro Motion Coriolis Massflow	+/- 0.2 % of the adjusted range	Annually	14/03/2015 13/08/2015 06/05/2016 24/02/2017 09/06/2017
TT 76009/6	02395244	Gauze Temperature (used to indicate plant operational status) h_y	Thermocouple/ Temperature Transmitter 248HA11N0NS	+/- 0.125%	Once per year or shorter, according to gauze change	15/02/2015 14/01/2016 03/08/2017
FT/PT/TT 7681	1243952	Stack gas flow, pressure and temp V_{t,db}, P_t, T_t	Durag annubar measuring system D-FL 100	QAL1: +/- 2.37 % QAL 2: +/- 2.94 %.	AST done every year and QAL2 every 5 years	QAL2 (including AST): 31/08/2016 – 02/09/2016 AST: 13.09.2017 – 15.09.2017

Monitoring equipment (Tag-No./ Description)	Serial Number	Description; Related monitoring parameter as per applicable registered monitoring plan	Type	Accuracy or accuracy class	Calibration frequency	Calibrations
AT 7639	9904717054 99	N ₂ O Outlet Analyser V _{i,t,db}	Emerson NGA 2000 MLT2 IR U	QAL1: +/- 2.71 % QAL 2: +/- 2.97 %.	QAL3 done automatically, zero every day, span every second day. AST done every year and QAL2 every 5 years.	QAL2 (including AST): 31/08/2016 – 02/09/2016 AST: 13.09.2017 – 15.09.2017

In the following, it is described how the procedures given in EN 14181:2004 and EN 14181:2014 for QAL1-3 have been applied at the plant.

QAL1

In accordance with EN14181:2004, the monitoring system for N₂O concentration measurements has been proven suitable for its measuring task (parameter and composition of the flue gas) by use of the QAL1 procedure as specified by EN ISO 15267 or equivalent standards. Monitoring equipment for N₂O concentration measurement and Stack gas flow measurement was installed at suitable sampling points in the tail gas of the nitric acid plant.

QAL2

QAL2 is a procedure for the determination of the calibration function and its variability. According to EN 14181:2004 and EN 14181:2014, the QAL2 test was conducted by an independent “testing house” or laboratory which is accredited according to EN ISO/IEC 17025. The QAL2 tests are performed on suitable AMS that have been correctly installed and commissioned on-site (as opposed to QAL 1 which is conducted off-site).

A calibration function was established from the results of a number of parallel measurements performed with a Standard Reference Method (SRM). The variability of the measured values obtained with the AMS is then evaluated by the independent qualified “testing house”. QAL2 tests are to be performed at least every 5 years according to EN 14181:2004 and EN 14181:2014.

AST

In addition, Annual Surveillance Tests (AST) are conducted in accordance with EN 14181:2014; these are a series of measurements with independent measurement equipment in parallel to the existing AMS. The AST tests are performed annually. If a full QAL2 test is performed (at least every 5 years), an additional AST test is not necessary in that same year.

Calibration delay:

The AST was due 02/09/2017 (one year after the previous AST). The AST was postponed due to several shutdowns of the Nitric Acid plant and it was finally performed 13/09/2017 – 15/09/2017. For the period between the end of the validity of the AST test and the next AST the monitoring results were corrected according to EB 52, Annex 60 “GUIDELINES FOR ASSESSING COMPLIANCE WITH THE CALIBRATION FREQUENCY REQUIREMENTS”. The maximum permissible error of the instruments for N₂O concentration and Stack Gas Flow were applied. The value was determined as stipulated in the decision EB 52 annex 60 paragraph 4. (a).

For the N₂O concentration the maximum error as determined during the QAL1 test is +/- 2.71 % (expressed as standard uncertainty) and +/- 5.31 % (expressed as expanded uncertainty). The error as determined during the calibration (QAL2) was +/- 2.97 % (expressed as standard uncertainty) and +/- 5.82 % (expressed as expanded uncertainty). Therefore, the error of 5.82 % was applied in a conservative manner for the period between the end of the validity of the AST and the actual date of the AST. The error was applied for the period from 03/09/2017 – 15/09/2017.

For the stack gas flow the maximum error as determined during the QAL1 is +/- 2.37 % (expressed as standard uncertainty) and +/- 4.65 % (expressed as expanded uncertainty). The error as determined during the calibration (QAL2) was +/- 2.94 % (expressed as standard uncertainty) and +/- 5.76 % (expressed as expanded uncertainty). Therefore, the error of 5.76 % was applied in a conservative manner for the period between the end of the validity of the AST and the actual date of the AST. The correction was applied for the period from 03/09/2017 – 15/09/2017.

The calibration of the Gauze Temperature measurement (used to indicate plant operational status h_y) was due 14/01/2017. The calibration was delayed and finally performed 03/08/2017. For the period between the end of the validity of the calibration and the next calibration the monitoring results were corrected according to EB 52, Annex 60 "GUIDELINES FOR ASSESSING COMPLIANCE WITH THE CALIBRATION FREQUENCY REQUIREMENTS". The maximum permissible error of the instrument for gauze temperature measurement was applied. The value was determined as stipulated in the decision EB 52 annex 60 paragraph 4. (a).

For the Gauze Temperature measurement (used to indicate plant operational status h_y) the maximum error as specified by the manufacturer is +/- 0,125 %. The maximum error as determined during the calibration was + 0,5 %. Therefore, the error of 0,5 % was applied in a conservative manner for the period between the end of the validity of the calibration and the actual date of the calibration. The correction was applied for the period from 01/08/2017 (as the beginning of the monitoring period) – 03/08/2017. However, this had no impact on the result for the number of operating hours or the amount of emission reductions calculated.

QAL3

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

In essence, the instrumentation personnel performed QAL3 procedures through the established calibration procedures.

N₂O-Analyser Zero Calibration

Nitrogen gas was used as reference gas for zero calibration. The zero calibration was conducted automatically every 24 hours.

N₂O-Analyser Span calibration

Span calibrations were performed every second day by means of a certified calibration gas and were automatically triggered. Manual initiation of the span calibration can also be performed if required. The calibration results and subsequent actions were all documented as part of the CDM procedure. In addition, the analyser room and equipment was visually inspected on a regular basis.

Flow meter calibration procedures

The flow meter itself does not need to be calibrated since it is a physical device which does not have drift. Therefore, it is sufficient to regularly inspect its physical condition by means of visual and electric checks of the probe. In addition the flow meter was checked during the QAL2 and AST tests by an independent laboratory by comparison to a standard reference method (SRM) as stated above.

Organization Structure with Management & Operation Process

As an operator of nitric acid plants since many years, the plant's staff in general and its instrument department in particular have been accustomed to operating technical equipment adhering to high quality standards.

Omnia has trained the staff selected for the operation of the relevant monitoring systems and ensures that the operational standards required for the appropriate handling of the equipment is maintained throughout the crediting period. Measuring instruments are calibrated by the instrumentation engineer in accordance with the requirements of the instrument suppliers. The operations and equipment engineers of the nitric acid plant are responsible for the daily operation and maintenance of the systems.

The monitoring of the parameters for the determination of the mass flow of the N₂O is the responsibility of the operational personal. All relevant data is recorded automatically and stored on electronic media.

Data Processing

Archiving of data

In accordance with the PDD, all of the data collected for the project activity is stored in electronic format for the duration of the crediting period + 2 years. To meet these criteria, Omnia provides an extensive data storage system covering both the raw data received by the Delta V DCS as well as the output reports from the Delta V DCS as follows:

- All data collected by the Delta V DCS is stored on its internal hard drive for 1 month.

- The Envinox™ data on the server is also backed up to an external USB HDD which is kept at the instrumentation department and also retained there for the duration of the crediting period + 2 years.
- The monitoring team will periodically archive data to a secure and retrievable storage format. Calibration records may be archived by scanning and storage in an accessible electronic format. These data will be stored until 2 years after the end of the crediting period or the last issuance of CER's whichever occur later.

Audit function and management review

Internal audits are performed regularly in accordance with implemented quality and environmental management systems.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

(Copy this table for each data or parameter.)

Data/Parameter	Operating pressure
Unit	kPa
Description	Operating pressure of the ammonia burner
Source of data	Manufacturer specifications
Value(s) applied	300
Choice of data or measurement methods and procedures	lowest design operation limit of the ammonia burner
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals
Additional comments	The design operational range is indicated by the manufacturer as 300 – 450 kPa

Data/Parameter	EF _{historical}
Unit	kgN ₂ O/tHNO ₃
Description	Historical baseline emission factor of the nitric acid plant
Source of data	Historical information from issuance reports of CDM-Project documents
Value(s) applied	5.54
Choice of data or measurement methods and procedures	For plants that used AM0028 in the first crediting period: use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period;
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG
Additional comments	This value will remain constant over the second and third crediting period

Data/Parameter	EF _{default,y}
Unit	kg N ₂ O/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	<p>This default N₂O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N₂O/t HNO₃ for low, medium and high pressure ammonia burners. For each subsequent year, the emission factors will decrease by 0.2 kg N₂O/t HNO₃ 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:</p>																																																																												
	<table border="1"> <thead> <tr> <th>Year</th> <th>Low pressure (0 – 200 kPa)</th> <th>Medium pressure (200 – 600kPa)</th> <th>High pressure (Over 600 kPa)</th> </tr> </thead> <tbody> <tr><td>2013</td><td>5.5</td><td>8.4</td><td>12.6</td></tr> <tr><td>2014</td><td>5.3</td><td>8.2</td><td>12.4</td></tr> <tr><td>2015</td><td>5.1</td><td>8.0</td><td>12.2</td></tr> <tr><td>2016</td><td>4.9</td><td>7.8</td><td>12</td></tr> <tr><td>2017</td><td>4.7</td><td>7.6</td><td>11.8</td></tr> <tr><td>2018</td><td>4.5</td><td>7.4</td><td>11.6</td></tr> <tr><td>2019</td><td>4.3</td><td>7.2</td><td>11.4</td></tr> <tr><td>2020</td><td>4.1</td><td>7</td><td>11.2</td></tr> <tr><td>2021</td><td>3.9</td><td>6.8</td><td>11</td></tr> <tr><td>2022</td><td>3.7</td><td>6.6</td><td>10.8</td></tr> <tr><td>2023</td><td>3.5</td><td>6.4</td><td>10.6</td></tr> <tr><td>2024</td><td>3.3</td><td>6.2</td><td>10.4</td></tr> <tr><td>2025</td><td>3.1</td><td>6</td><td>10.2</td></tr> <tr><td>2026</td><td>2.9</td><td>5.8</td><td>10</td></tr> <tr><td>2027</td><td>2.7</td><td>5.6</td><td>9.8</td></tr> <tr><td>2028</td><td>2.5</td><td>5.4</td><td>9.6</td></tr> <tr><td>2029</td><td>2.5</td><td>5.2</td><td>9.4</td></tr> <tr><td>2030</td><td>2.5</td><td>5.0</td><td>9.2</td></tr> </tbody> </table>	Year	Low pressure (0 – 200 kPa)	Medium pressure (200 – 600kPa)	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	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	11.2	2021	3.9	6.8	11	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	10.2	2026	2.9	5.8	10	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
	Year	Low pressure (0 – 200 kPa)	Medium pressure (200 – 600kPa)	High pressure (Over 600 kPa)																																																																									
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Value(s) applied	2017: 7.6 2018: 7.4																																																																												
Choice of data or measurement methods and procedures	-																																																																												
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals																																																																												
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development																																																																												

Data/Parameter	EF _{new,y}
Unit	kg N ₂ O/t HNO ₃
Description	Baseline N ₂ O emission factor for nitric acid production in year y (related to 100 per cent pure acid)

Source of data	The baseline N ₂ O 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 until it reaches a final value of 2.5 in the year 2020. The value of 2.5 will remain constant after 2020, as provided in the following table:	
	Year	Emission factor (kgN₂O/t HNO₃)
	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
Value(s) applied	2017: 3.00 2018: 2.80	
Choice of data or measurement methods and procedures	-	
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals	
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development	

Data/Parameter	P _{product,max}
Unit	t Product
Description	Design capacity of nitric acid production during the first crediting period
Source of data	Project operator and/or technology provider
Value(s) applied	273,020 t HNO ₃ /year
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals
Additional comments	This parameter is only for project activities applying case 1

Data/Parameter	GWP_{N_2O}
Unit	tCO ₂ e/tN ₂ O
Description	Global warming potential of the nitrous oxide
Source of data	Relevant decisions by the CMP
Value(s) applied	298
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of Baseline emissions or baseline net GHG removal, and Calculation of project emissions or actual net GHG removals
Additional comments	-

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0):

Data/Parameter	R_u
Unit	Pa*m ³ /kmol*K
Description	Universal ideal gas constant
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	-

Data/Parameter	MM_i
Unit	kg/mol
Description	Molecular mass of greenhouse gas i (N ₂ O)
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	44.02
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	-

Data/Parameter	P_n
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" (Version 02.0.0)
Value(s) applied	101,325

Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	-

Data/Parameter	T_n
Unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	273.15
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	-

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Data/Parameter	$P_{\text{production},y}$
Unit	t HNO ₃
Description	Nitric acid produced in year y
Measured/calculated/default	Measured and Calculated
Source of data	Measurements by project participants and production reports
Value(s) of monitored parameter	2017: 99,017 2018: 46,637
Monitoring equipment	Type: Micro Motion Coriolis Massflow Tag No: FT-76010 Serial Number: Transmitter SN 3765698, Sensor SN 14163265 Accuracy: +/- 0.2 % of the adjusted range Calibration frequency: Annually Calibration dates: 24/02/2017, 09/06/2017 Density & acid concentration are crosschecked by laboratory analysis.
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	Mass flow measurements (kg/h) are multiplied with acid concentration determined on the DCS to calculate $P_{\text{production},y}$ mass flow in tHNO ₃ /h.
QA/QC procedures	Periodic calibration
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals
Additional comments	During 5 hours the HNO ₃ measurement delivered negative results (usually for short periods during plant startup). The negative results were replaced by 0 as the most conservative approach. These hours are automatically excluded from the calculation of emission reductions and counted as $h_{r,y}$: "abatement system is by-passed, underperforming or failed"

Data/Parameter	h_y
-----------------------	-------

Unit	h																																																																		
Description	Number of hours of operation in year y																																																																		
Measured/calculated/default	Measured																																																																		
Source of data	Omnia production log and continuous monitoring according to operational parameter (operational temperature of the ammonia oxidation reactor)																																																																		
Value(s) of monitored parameter	2017: 3,687 2018: 1,884																																																																		
Monitoring equipment	<p>The total operating hours are logged continuously in the production log</p> <p>Type: Thermocouple/ Temperature Transmitter 248HAI1N0NS</p> <p>Tag No: TT 76009/6</p> <p>Serial Number: 02395244</p> <p>Accuracy: +/- 0.125%</p> <p>Calibration frequency: Once per year or shorter, according to gauge change</p> <p>Calibration dates: 14/01/2016, 03/08/2017</p>																																																																		
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings																																																																		
Calculation method (if applicable)	-																																																																		
QA/QC procedures	Operating hours are cross checked against other operational parameters of the plant according to internal QA/QC procedures.																																																																		
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals																																																																		
Additional comments	<p>The nitric acid plant was out of operation during 3189 hours of this monitoring period:</p> <table border="1"> <thead> <tr> <th>Begin of downtime</th><th>End of downtime</th><th>Time duration (hours)</th></tr> </thead> <tbody> <tr><td>01.07.2017 01:00</td><td>07.07.2017 19:00</td><td>163</td></tr> <tr><td>28.07.2017 23:00</td><td>09.08.2017 06:00</td><td>272</td></tr> <tr><td>18.08.2017 05:00</td><td>18.08.2017 14:00</td><td>10</td></tr> <tr><td>18.08.2017 18:00</td><td>18.08.2017 23:00</td><td>6</td></tr> <tr><td>28.08.2017 04:00</td><td>29.08.2017 17:00</td><td>38</td></tr> <tr><td>16.09.2017 10:00</td><td>17.09.2017 10:00</td><td>25</td></tr> <tr><td>14.12.2017 14:00</td><td>23.12.2017 12:00</td><td>215</td></tr> <tr><td>09.01.2018 11:00</td><td>09.01.2018 16:00</td><td>6</td></tr> <tr><td>14.01.2018 19:00</td><td>15.01.2018 01:00</td><td>7</td></tr> <tr><td>18.01.2018 14:00</td><td>21.02.2018 20:00</td><td>823</td></tr> <tr><td>23.02.2018 14:00</td><td>25.02.2018 15:00</td><td>50</td></tr> <tr><td>01.03.2018 21:00</td><td>02.03.2018 12:00</td><td>16</td></tr> <tr><td>02.03.2018 18:00</td><td>02.03.2018 19:00</td><td>2</td></tr> <tr><td>03.03.2018 11:00</td><td>04.03.2018 12:00</td><td>26</td></tr> <tr><td>09.03.2018 23:00</td><td>11.03.2018 04:00</td><td>30</td></tr> <tr><td>19.03.2018 19:00</td><td>27.03.2018 11:00</td><td>185</td></tr> <tr><td>27.03.2018 13:00</td><td>23.04.2018 03:00</td><td>639</td></tr> <tr><td>23.04.2018 05:00</td><td>23.04.2018 06:00</td><td>2</td></tr> <tr><td>03.05.2018 18:00</td><td>07.05.2018 21:00</td><td>100</td></tr> <tr><td>11.05.2018 01:00</td><td>29.05.2018 09:00</td><td>441</td></tr> <tr><td>11.06.2018 12:00</td><td>17.06.2018 00:00</td><td>133</td></tr> </tbody> </table>	Begin of downtime	End of downtime	Time duration (hours)	01.07.2017 01:00	07.07.2017 19:00	163	28.07.2017 23:00	09.08.2017 06:00	272	18.08.2017 05:00	18.08.2017 14:00	10	18.08.2017 18:00	18.08.2017 23:00	6	28.08.2017 04:00	29.08.2017 17:00	38	16.09.2017 10:00	17.09.2017 10:00	25	14.12.2017 14:00	23.12.2017 12:00	215	09.01.2018 11:00	09.01.2018 16:00	6	14.01.2018 19:00	15.01.2018 01:00	7	18.01.2018 14:00	21.02.2018 20:00	823	23.02.2018 14:00	25.02.2018 15:00	50	01.03.2018 21:00	02.03.2018 12:00	16	02.03.2018 18:00	02.03.2018 19:00	2	03.03.2018 11:00	04.03.2018 12:00	26	09.03.2018 23:00	11.03.2018 04:00	30	19.03.2018 19:00	27.03.2018 11:00	185	27.03.2018 13:00	23.04.2018 03:00	639	23.04.2018 05:00	23.04.2018 06:00	2	03.05.2018 18:00	07.05.2018 21:00	100	11.05.2018 01:00	29.05.2018 09:00	441	11.06.2018 12:00	17.06.2018 00:00	133
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		total hours of plant downtime	3189	
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Data/Parameter	$h_{r,y}$
Unit	h
Description	Number of hours (h) in year y where the abatement system is by-passed, underperforming or failed
Measured/calculated/default	Measured
Source of data	Omnia production log and continuous monitoring according to AMS results
Value(s) of monitored parameter	2017: 46 2018: 16
Monitoring equipment	Omnia production log and continuous monitoring according to AMS results
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	Periods where the abatement system is by-passed are logged in the production log. Periods where the abatement system is underperforming or failed are calculated continuously based on AMS results
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals, and Calculation of project emissions or actual net GHG removals
Additional comments	-

Data/Parameter	$F_{N_2O, Tailgas, h}$
Unit	kgN ₂ O/h
Description	Mass Flow of N ₂ O in the gaseous stream of the tail gas in hours h
Measured/calculated/default	Measured and Calculated
Source of data	N ₂ O concentration: Emerson N ₂ O Analyzer Stack gas volume flow: Durag Annubar D-FL 100 flow meter
Value(s) of monitored parameter	Average value for this monitoring period: 15.89 Applied for the determination of Project Emissions. See calculation sheet and sample calculation of section E.2.
Monitoring equipment	N ₂ O concentration: Emerson N ₂ O Analyzer Stack gas volume flow: Durag Annubar D-FL 100 flow meter
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings

Calculation method (if applicable)	<p>(a) Throughout the crediting periods of the project activity, the N₂O 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;</p> <p>(b) The monitoring system should provide separate hourly average values for the N₂O 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 N₂O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;</p> <p>(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 N₂O 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;</p> <p>(d) If data for either the N₂O 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 N₂O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N₂O 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 N₂O 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;</p> <p>(e) In the case that the N₂O 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 Pt and Tt do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.</p>
QA/QC procedures	According to EN 14181:2004 and EN 14181:2014, the flow meter and the analyzer was tested and calibrated by an external laboratory with EN ISO IEC 17025 Accreditation. The QAL2 test is conducted once every 5 years; the AST test is conducted once per year. Every 5 years the AST test is part of the QAL2 test.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	

Data/Parameter	PE _{FF,y} (corresponding to PE _{CO₂,tertiary,y})
Unit	tCO ₂ e
Description	Project emissions related to fossil fuel input to the destruction facility and/or re-heater in monitoring period y (tCO ₂)
Measured/calculated/default	Calculated

Source of data	The emissions related to the operation of the N ₂ O destruction facility include only on-site emissions due to fossil fuel use as input to the N ₂ O destruction facility. Natural gas consumption is measured by a mass-flow meter
Value(s) of monitored parameter	2017: 2,818.20 2018: 1,120.34
Monitoring equipment	-
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	Calculated based on measurement of natural gas consumption and $w_{C,i,y}$
QA/QC procedures	Maintenance and calibration of the mass flow meter is applied under the internal QA/QC procedures.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	

Data/Parameter	$w_{C,i,y}$						
Unit	tC/mass unit of fuel type natural gas						
Description	Weighted average mass fraction of carbon in fuel type <i>i</i> in year <i>y</i>						
Measured/calculated/default	Measured						
Source of data	<p>The following data source may be used if the relevant conditions apply:</p> <table border="1"> <tr> <th>Data Source</th><th>Conditions for using the data source</th></tr> <tr> <td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr> <tr> <td>b) Measurements by the project participants</td><td>If a) is not available</td></tr> </table> <p>Option a) Not received from Invoices but by request from supplier.</p>	Data Source	Conditions for using the data source	a) Values provided by the fuel supplier in invoices	This is the preferred source	b) Measurements by the project participants	If a) is not available
Data Source	Conditions for using the data source						
a) Values provided by the fuel supplier in invoices	This is the preferred source						
b) Measurements by the project participants	If a) is not available						
Value(s) of monitored parameter	2017: 0.728 2018: 0.731						
Monitoring equipment	-						
Measuring/reading/recording frequency	The mass fraction of carbon is obtained by request from supplier.						
Calculation method (if applicable)	The mass fraction is calculated by using the composition obtained from the supplier.						
QA/QC procedures	Verify if the values under a) and b) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in b) should have ISO17025 accreditation or justify that they can comply with similar quality standards.						
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals						
Additional comments	The gas supplier provided a report for the average gas composition for every 6 month. The weighted average mass fraction of carbon was then calculated based on the carbon content of the fractions of the different components.						

Data/Parameter	$FC_{i,j,y}$
Unit	Mass unit per monitoring period (ton)

Description	Quantity of fuel type i combusted in process j during the monitoring period y
Measured/calculated/default	Measured
Source of data	Measured by mass flow meter
Value(s) of monitored parameter	2017: 1,055.47 2018: 417.98
Monitoring equipment	Type: Micro Motion Coriolis Massflow Meter TAG No: FT 7672 Serial Number: SN: 3845068, Sensor SN: 14459566 Accuracy: +/- 0.5 % of the adjusted range Calibration frequency: 3 years Calibration dates: 13/08/2015, 03/08/2017
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibrations
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	During 11 hours the flowmeter delivered negative results (for short periods during plant startup). The negative results were replaced by the maximum value measured during the complete monitoring period as the most conservative approach.

Data/Parameter	$V_{t,db}$
Unit	Nm ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Measured/calculated/default	Measured
Source of data	Tail gas volume flow meter
Value(s) of monitored parameter	Average Value: 91,458
Monitoring equipment	Type: Durag annubar measuring system D-FL 100 Serial Number: 1243952 Tag No: FT/PT/TT 7681 Accuracy: QAL1: +/- 2.37 %, QAL 2: +/- 2.94 % Calibration frequency: AST done every year and QAL2 every 5 years Calibration dates: QAL2 (including AST): 31/08/2016 – 02/09/2016 AST: 13/09/2017 – 15/09/2017
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	Calculation of normalized flow with measurement of temperature (T_t) and pressure (P_t)
QA/QC procedures	According to EN 14181:2014, the flow meter was tested and calibrated by an external laboratory with EN ISO IEC 17025 Accreditation. The QAL2 test is conducted once every 5 years; the AST test is conducted once per year. Every 5 years the AST test is part of the QAL2 test.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	In total during 4 hours of the monitoring period the stack gas flow meter was out of operation or in maintenance for more than 1/3 of an hour. The results were replaced by the maximum value that was recorded during the monitoring period

Data/Parameter	$V_{i,t,db}$
Unit	m ³ gas i/m ³ dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Measured/calculated/default	measured
Source of data	N ₂ O gas analyzer
Value(s) of monitored parameter	Average value: 0.00009007
Monitoring equipment	Type: Emerson NGA 2000 MLT2 IR U Serial Number: 990471705499 Tag No: AT 7639 Accuracy: QAL1: +/- 2.71 %, QAL 2: +/- 2.97 %. Calibration frequency: QAL3 done automatically, zero every day, span every second day. AST done every year and QAL2 every 5 years Calibration dates: QAL2 (including AST): 31/08/2016 – 02/09/2016 AST: 13/09/2017 – 15/09/2017
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	-
QA/QC procedures	According to EN 14181:2004, the analyzer was tested and calibrated by an external laboratory with EN ISO IEC 17025 Accreditation. The QAL2 test is conducted once every 5 years; the AST test is conducted once per year. Every 5 years the AST test is part of the QAL2 test. Additional QAL3 procedures are performed regularly
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
Additional comments	In total during 63 hours of the monitoring period the N ₂ O analyser was out of operation or in maintenance for more than 1/3 of an hour. The results were replaced by the maximum value that was recorded during the monitoring period

Data/Parameter	$C_{H_2O,t,db,n}$
Unit	kg H ₂ O/m ³ drygas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t
Measured/calculated/default	Measured
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) of monitored parameter	0.004
Monitoring equipment	Manual sampling by external laboratory or testing house.
Measuring/reading/recording frequency	Annually, Measurements should coincide with the Annual Surveillance Test (associated with requirements of the EN 14181:2014 standard) or the calibration of the flow meter for the gaseous stream.
Calculation method (if applicable)	-
QA/QC procedures	According to the USEPA CF42 method 4
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
Additional comments	Required for proving that the gaseous stream is dry.

Data/Parameter	T_t
Unit	°C
Description	Temperature in the gaseous stream in time interval t
Measured/calculated/default	Measured
Source of data	Tail Gas temperature measurement
Value(s) of monitored parameter	Average value: 117
Monitoring equipment	PT 100 - Part of the Durag annubar measuring system D-FL 100 Refer to the parameter $V_{t,db}$ above for details
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	-
QA/QC procedures	According to EN 14181:2014, the instrument was tested together with the flowmeter by an external laboratory with EN ISO IEC 17025 Accreditation. The QAL2 test is conducted once every 5 years; the AST test is conducted once per year. Every 5 years the AST test is part of the QAL2 test.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
Additional comments	As parameters are converted to normal conditions during the monitoring process, this parameter is not needed. Calibration schedules are performed according to plant internal procedures

Data/Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Measured/calculated/default	Measured
Source of data	Pressure probe
Value(s) of monitored parameter	Average value 85,602
Monitoring equipment	Pressure probe: Part of the Durag annubar measuring system D-FL 100 Refer to the parameter $V_{t,db}$ above for details
Measuring/reading/recording frequency	1 h average based on two seconds (or shorter) interval readings
Calculation method (if applicable)	-
QA/QC procedures	According to EN 14181:2014, the instrument was tested together with the flowmeter by an external laboratory with EN ISO IEC 17025 Accreditation. The QAL2 test is conducted once every 5 years; the AST test is conducted once per year. Every 5 years the AST test is part of the QAL2 test.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
Additional comments	As parameters are converted to normal conditions during the monitoring process, this parameter is not needed. Calibration schedules are performed according to plant internal procedures.

D.3. Implementation of sampling plan

>>

Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

>>

Baseline emissions:

ACM0019, Version 02.0, is the methodology chosen for the implementation of this project activity.

In the following, the explanation of the calculation of baseline and project emissions, as required under the ACM0019, Version 02.0, is presented.

In this case the nitric acid plant used AM0028 during the first crediting period therefore 5.3.1 – Case 1 of the methodology applies.

Case 1: For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

For nitric acid plants that have used AM0028 or AM0034 in the first crediting period and apply this methodology in their second or third crediting period, the baseline emissions are calculated as follows:

$$BE_y = \left(\frac{\min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y} + \max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y}}{h_y} \right) \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N_2O} \times 10^{-3} \quad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year y (t CO ₂ e)
$P_{product,max}$	=	Design capacity (t HNO ₃)
$P_{production,y}$	=	Production of nitric acid in year y (t HNO ₃)
$EF_{existing,y}$	=	N ₂ O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N ₂ O/t HNO ₃)
$EF_{new,y}$	=	Baseline N ₂ O emission factor for nitric acid production in year y (kg N ₂ O/t HNO ₃)
GWP_{N_2O}	=	Global Warming Potential of N ₂ O 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 ₂ O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N ₂ O abatement: the abatement system is bypassed, underperforming or failed

Sample calculation applying summed-up values of the whole monitoring period

Year	BE _n	P _{production,y}	P _{product,max}	EF _{existing,y}	EF _{new,y}	h _y	h _{r,y}	GWP
2017	161,352.5	99,016.7	137,632.0	5.537	3.0	3,687	46	298
2018	76,303.4	46,636.8	135,388.0	5.537	2.8	1,884	16	298

The N₂O emission factor for nitric acid plants that have used AM0028 and AM0034 in the first crediting period ($EF_{existing,y}$) will be calculated as follows:

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

Where:

- $EF_{existing,y}$ = N₂O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N₂O/t HNO₃)
- $EF_{historical}$ = Historical baseline emission factor of the nitric acid plant (kg N₂O/t HNO₃)
- $EF_{default,y}$ = Default emission factor according to the operating pressure of the ammonia burner in year y (kg N₂O/t HNO₃)

Sample calculation applying summed-up values of the whole monitoring period

Year	$EF_{existing,y}$	$EF_{historical}$	$EF_{default}$
2017	5.537	5.537	7.600
2018	5.537	5.537	7.400

Calculation of $h_{r,y}$

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

Case 1: For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

$$F_{N2O,tail\ gas,h} > EF_{existing\ y} \times P_{NA,h} \quad \text{Equation (3)}$$

Where:

- $P_{NA,h}$ = Nitric acid produced in the hour h (t HNO₃)
- $EF_{existing\ y}$ = Default N₂O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N₂O/t HNO₃)
- $F_{N2O,tail\ gas,h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/h)

E.2. Calculation of project emissions or actual net removals

>>

Project emissions include emissions of N₂O which have not been destroyed by the project activity and, in case of the installation of a tertiary N₂O abatement facility, CO₂ emissions resulting from the operation of the N₂O abatement facility.

Project emissions are calculated as follows:

$$PE_y = PE_{N2O,y} + PE_{CO2,tertiary,y} \quad \text{Equation (4)}$$

Where:

- PE_y = Project emissions in year y (t CO₂e)
 $PE_{N2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
 $PE_{CO2,tertiary,y}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in year y (t CO₂)

Sample calculation applying summed-up values of the whole monitoring period:

Year	PE _y	PE _{N2O,y}	PE _{CO2,tertiary,y}
2017	17,246.5	14,428.3	2,818.2
2018	10,898.3	9,777.9	1,120.3

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

The amount of N₂O emissions from the project activity are the emissions from the N₂O contained in the tail gas stream of the plant which is released to the atmosphere.

Accordingly, $PE_{N2O,y}$ is determined as follows:

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tail\ gas,h} \times GWP_{N2O} \times 10^{-3} \quad \text{Equation (5)}$$

Where:

- $PE_{N2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
 GWP_{N2O} = Global warming potential of N₂O valid for the commitment period
 $F_{N2O,tail\ gas,h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/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: For tertiary N₂O abatement. The abatement system is by-passed, underperforming or failed

Sample calculation applying summed-up values of the whole monitoring period:

Year	PE _{N2O,y}	F _{N2O,tailgas,h}	GWP
2017	14,428.3	48,417.1	298
2018	9,777.9	32,811.9	298

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

The amount of N₂O 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:

- (f) Throughout the crediting periods of the project activity, the N₂O 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;

- (g) The monitoring system should provide separate hourly average values for the N₂O 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 N₂O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;
- (h) 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 N₂O 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;
- (i) If data for either the N₂O 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 N₂O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N₂O 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 N₂O 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;
- (j) In the case that the N₂O 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 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0) 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 flow or mass flow of the gas stream and
- (b) the volumetric fraction of the gas in the gaseous stream and
- (c) the water content and gas composition.

The tool covers possible measurement options, providing six different calculation options to determine the volume or mass flow of a particular greenhouse gas (A-F).

Furthermore, the tool provides several options for the determination of the moisture content of the gaseous stream. As the gaseous stream is assumed to be dry, Option A is applied. In order to apply this option, it shall be demonstrated that the gaseous stream is dry. As described in part (a) of Option A, the moisture content of the gaseous stream ($C_{H_2O,t,db,n}$) will be measured and it shall be demonstrated that it is less or equal to 0.05 kg H₂O/m³ dry gas.

The moisture measurement shall coincide with the Annual Surveillance Test or the calibration of the flow meter for the gaseous stream.

In accordance with Option A of the tool, the mass flow of greenhouse gas i ($F_{i,t}$) is calculated as follows:

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

Equation (6)

With:

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

Equation (7)

Where:

- $F_{i,t}$ = mass flow of greenhouse gas N_2O 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 dry basis (m^3 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 (m^3 gas i / m^3 dry gas)
 $\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in a time interval t (kg gas i / m^3 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)

Sample calculation for equation (6) applying average values for the monitoring period:

$F_{i,t}$	$V_{t,db}$	$V_{i,t,db}$	$\rho_{i,t}$
16.179	91,458	0.0000901	1.964

Calculation for equation (7) applying standard condition values:

$\rho_{i,t}$	P_t	MM_{N_2O}	R_u	T_t
1.964	101.33	44.02	8.31	273.150

Project emissions from the operation of the tertiary N_2O abatement facility ($PE_{CO_2,tertiary,y}$)

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. Therefore it needs only to be estimated for this nitric acid plant as fossil fuel is used for operation of the tertiary N_2O abatement facility.

The emissions related to the operation of the N_2O destruction facility include only on-site emissions due to the fossil fuel use as input to the N_2O destruction facility:

$$PE_{CO_2,tertiary,y} = PE_{FF,y}$$

Equation (8)

Where:

- $PE_{CO_2,tertiary,y}$ = 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 Project proponents shall use the latest version of 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:

- (a) 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 $PE_{FF,y}$ in this methodology; and
- (b) 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.

CO₂ emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO₂ emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad \text{Equation (9)}$$

Where:

$PE_{FC,j,y}$ = CO₂ emissions from fossil fuel combustion in process j in year y (tCO₂/yr)
 $FC_{i,j,y}$ = Quantity of fuel type i combusted in the process j during year y (mass or volume unit/yr)
 $COEF_{i,y}$ = CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)
 i = fuel types combusted in process j during year y

Sample calculation applying summed-up values of the whole monitoring period:

Year	$PE_{CO_2, \text{tertiary}, y}$	$PE_{FF, y}$
2017	2,818.2	2,818.2
2018	1,120.3	1,120.3

Year	$PE_{FC,j,y}$	$\sum FC_{i,j,y}$	$COEF_{i,y}$
2017	2,818.2	1,055.5	2.670
2018	1,120.3	418.0	2.680

As data about the chemical composition of the fuel type i is available $COEF_{i,y}$ is calculated based on its chemical composition of the fossil fuel type i using Option A of the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” (Version 02). As $FC_{i,j,y}$ is measured in a mass unit, the following equation applies:

$$COEF_{i,y} = w_{C,i,y} \times 44/12 \quad \text{Equation (10)}$$

Where:

$COEF_{i,y}$ = CO₂ emission coefficient of fuel type i in year y (tCO₂/volume unit)
 $w_{C,i,y}$ = weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)
 i = fuel types combusted in process j during the year y

Sample calculation applying summed-up values of the whole monitoring period:

Year	COEF _{i,y}	w _{C,i,y}	
2017	2.670	0.728	44/12
2018	2.680	0.731	44/12

w_{C,i,y} is calculated according to a mass fraction calculation of carbon in the fuel type applied

2017	Natural Gas properties					
Component	Atoms Carbon per molecule	Molar weight	mol Fraction	Molar weight - weighted	Carbon content Molar weight - weighted	mass fraction of carbon in fuel = w _{C,i,y}
		g/mol	%	g/mol	g/mol	
Carbon		12.011				
Nitrogen	0	28.013	2.211	0.619	0.000	
Carbon dioxide	1	44.010	0.002	0.001	0.000	
Methane	1	16.043	93.736	15.038	11.259	
Ethane	2	30.070	2.205	0.663	0.530	
Propane	3	44.096	0.979	0.432	0.353	
i Butane	4	58.120	0.252	0.146	0.121	
n Butane	4	58.120	0.298	0.173	0.143	
i pentane	5	72.150	0.090	0.065	0.054	
n pentane	5	72.150	0.073	0.053	0.044	
Hexane	6	86.180	0.157	0.135	0.113	
			Total	17.326	12.617	0.728

2018	Natural Gas properties					
Component	Atoms Carbon per molecule	Molar weight	mol Fraction	Molar weight - weighted	Carbon content Molar weight - weighted	mass fraction of carbon in fuel = w _{C,i,y}
		g/mol	%	g/mol	g/mol	
Carbon		12.011				
Nitrogen	0	28.013	1.966	0.551	0.000	
Carbon dioxide	1	44.010	0.005	0.002	0.001	
Methane	1	16.043	94.059	15.090	11.297	
Ethane	2	30.070	2.152	0.647	0.517	
Propane	3	44.096	0.947	0.418	0.341	
i Butane	4	58.120	0.251	0.146	0.121	
n Butane	4	58.120	0.287	0.167	0.138	
i pentane	5	72.150	0.087	0.063	0.052	
n pentane	5	72.150	0.072	0.052	0.043	
Hexane	6	86.180	0.172	0.148	0.124	
			Total	17.283	12.634	0.731

E.3. Calculation of leakage emissions

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According to the methodology ACM0019 Any leakage emissions sources are deemed to be negligible.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	237,656	28,145	0	0	209,511	209,511

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante (t CO ₂ e)
209,511	421,913

E.6. Remarks on increase in achieved emission reductions

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Due to the lower nitric acid production during the monitoring period, the achieved emission reductions were below the expected value.