



**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 N ₂ O Abatement Project II	
UNFCCC reference number of the project activity	6083	
Version number of the PDD applicable to this monitoring report	03	
Version number of this monitoring report	01	
Completion date of this monitoring report	24/08/2018	
Monitoring period number	6	
Duration of this monitoring period	01/07/2017 – 31/07/2018	
Monitoring report number for this monitoring report	Not applicable	
Project participants	Omnia Fertilizer, Division of Omnia Group (Pty) Ltd Nordic Environment Finance Corporation Belektron d.o.o	
Host Party	South Africa	
Sectoral scopes	Sectoral Scope: 05	
Applied methodologies and standardized baselines	Applied Methodology: ACM0019 v01.0.0.	
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	246,187
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	370,854	

SECTION A. Description of project activity

A.1. General description of project activity

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a) The increasing demand for fertilizer in South Africa induces the development of new and additional facilities related to fertilizer manufacturing. Omnia Fertilizer, a division of Omnia Group (Pty) Ltd. (hereafter "Omnia") is a leading Nitrogen Fertilizer producer in South Africa. Omnia operates two nitric acid plants in Sasolburg, South Africa. The second nitric acid plant was commissioned second quarter 2012, designed by Uhde GmbH with a confirmed production capacity of 400,000 ton 100% concentrated nitric acid per year. The CDM project at this second plant was registered as "Omnia N₂O Abatement Project II".

Nitrous Oxide (N₂O) is an undesired by-product of the nitric acid (HNO₃) production process at the synthetic fertilizer production facility. However, N₂O emissions from nitric acid production are not regulated in South Africa. No N₂O abatement system was designed into the plant. Without the incentive of the proposed CDM project activity, approx. 800,000 tCO₂e per year¹ would be emitted at Omnia Nitric Acid Plant II. Therefore the baseline scenario without the CDM project would be the operation of the nitric acid plant without N₂O reduction catalyst.

The aim of the project activity is to reduce N₂O emissions in the tail gas by installing a tertiary catalyst after the absorption unit. It is expected that the N₂O abatement catalyst reduces 98 % of the N₂O². Against the standardized baseline emissions factor the project would generate an estimated 3,481,376 t CO₂e emission reductions during a 10 year crediting period.

b) The N₂O abatement system consists of a tertiary N₂O catalyst unit, which is installed downstream of the HNO₃ absorber and before the tail gas turbine. It was designed and constructed by Uhde (Germany) and is called the EnviNoxTM system. The tertiary catalyst consists of an additional catalysts containment facility that was erected at the plant.

A.2. Location of project activity

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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.

¹ An estimated business-as-usual emissions factor of 6.45kgN₂O/tHNO₃ (Average Baseline Emission factor of the first 5 monitoring periods of the first N₂O abatement project at Omnia's existing nitric acid plant) and annual confirmed capacity of 400,000tHNO₃/year was taken into account.

² While the calculations are based on this conservative assumption it should be noted that from experience from Omnia's first N₂O reduction project as well as from other similar projects with the same technology even higher abatement efficiencies of up to 99.9 % were observed.

Figure 1: Physical location of the Omnia II 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, Division of Omnia Group (Pty) Ltd	No

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

A.4. Reference to applied methodologies and standardized baselines

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1. (a) Applied methodology: ACM0019 Version 01.0.0: "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: Non-renewable 10 years and 0 months
- (b) Duration of the Crediting Period: 30/04/2012 – 29/04/2022

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

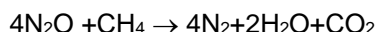
In the production process of nitric acid (HNO₃), NO₂ is produced as an intermediate material from ammonia (NH₃). The associated chemical reactions of oxidizing ammonia and simultaneous unwanted reactions are as follows:

- | | | | |
|---|---|---|--|
| 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 reaction³:

³ 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 Omnia's first N₂O reduction project as well as from other similar projects with the same technology even higher abatement efficiencies of up to 99.9 % were observed.



In the tertiary abatement system N_2O 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 HNO_3 production and a high expected N_2O reduction.

The expected lifetime of the N_2O 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.

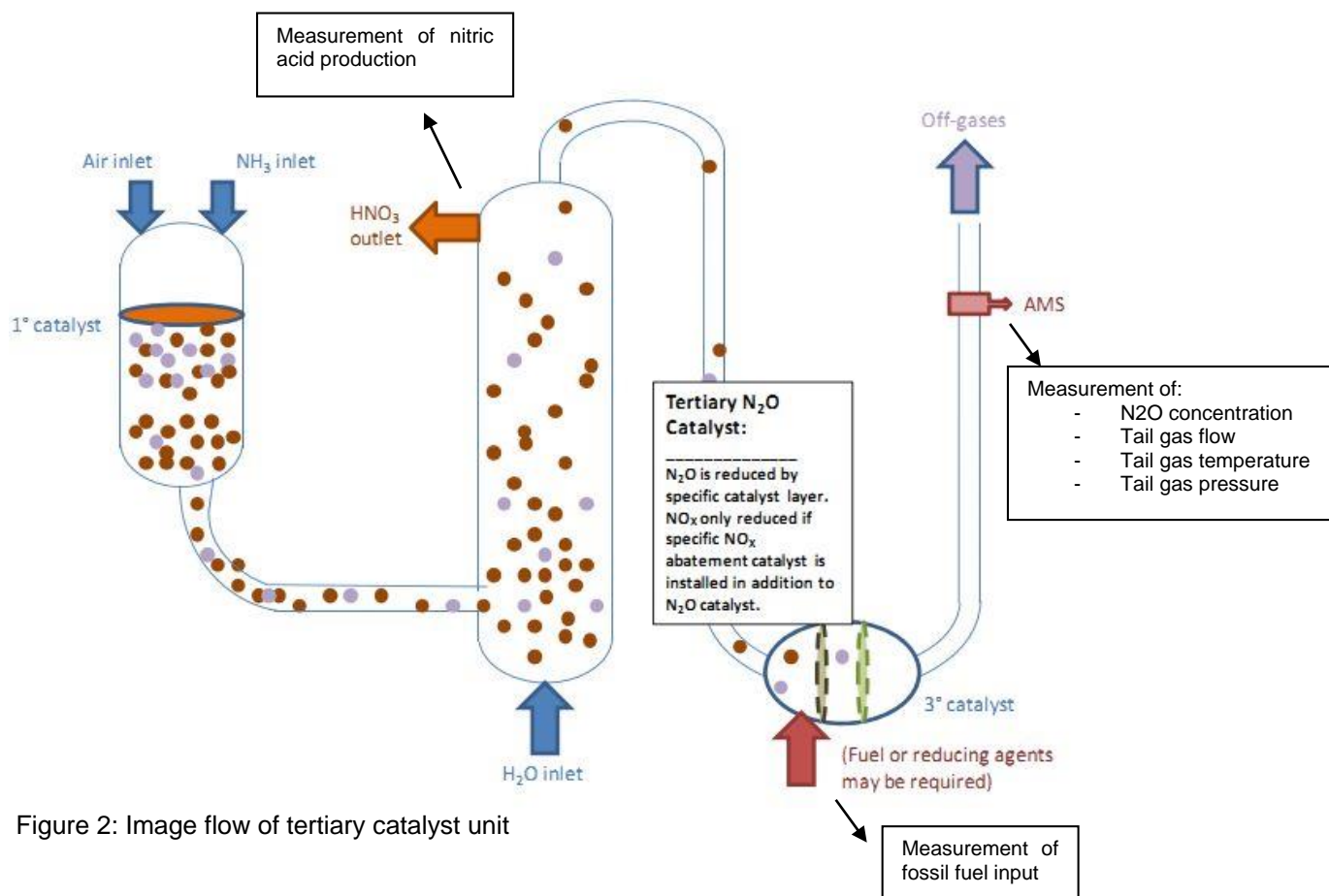


Figure 2: Image flow of tertiary catalyst unit

b) Relevant Dates for the Project Activity

Date	Event
14/09/2009	Basic Engineering Nitric Acid Plant
09/03/2010	Detailed engineering Design Nitric Acid Plant
04/06/2011	Approval of ACM0019 by UNFCCC
18/07/2011	Change Order UHDE from De-NO _x to EnviNox™
31/03/2012	Commission Nitric Acid Plant
31/03/2012	Commission Project
30/04/2012	Project registered at UNFCCC
30/04/2012	Start Crediting period
30/04/2012 – 30/11/2012	1 st Monitoring period – status: issued
01/12/2012 – 31/05/2014	2 nd Monitoring period – status: issued
01/06/2014 – 31/07/2015	3 rd Monitoring period – status: issued
01/08/2015 – 31/05/2016	4 th Monitoring period – status: issued
01/06/2016 – 30/06/2017	5 th Monitoring period – status: issued
01/07/2017 – 31/07/2018	6 th Monitoring period – status: this monitoring period

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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The following corrections were approved on 03/03/2017 prior to this monitoring period (PRC-6083-001).

Corrections are as follows:

1. Project participants:

Update of the list of project participants on the cover page, Chapter A.4 and Appendix 1 from Omnia Fertilizer, Division of Omnia Group (Pty) Ltd.

to

Omnia Fertilizer, Division of Omnia Group (Pty) Ltd,
Nordic Environment Finance Corporation,
Belektron d.o.o

2. PDD, Section B.6.2 and Section B.7.1

Information for "Purpose of data" added as this is a new requirement of the new PDD template.

Parameter " $w_{C,i,y}$ " removed from the section B.6.2 as this is a Parameter to be monitored and not fixed ex-ante

3. PDD, Section B.7.1

Information for "Monitoring frequency " added as this is a new requirement of the new PDD template

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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The following post registration changes were approved on 03/03/2017 prior to this monitoring period (PRC-6083-001).

Post registration changes are as follows:

PDD, Section B.7.1.; Parameter Pt:

Permanent change of the QA/QC calibration procedure of the monitoring parameter Pt (part of the stack gas flow meter) described in the PDD as "Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as

the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) must be calibrated monthly”,

to

“Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. According to EN 14181, the flow meter (including the parameter Pt) is 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.”

B.2.6. Changes to project design

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No

SECTION C. Description of monitoring system

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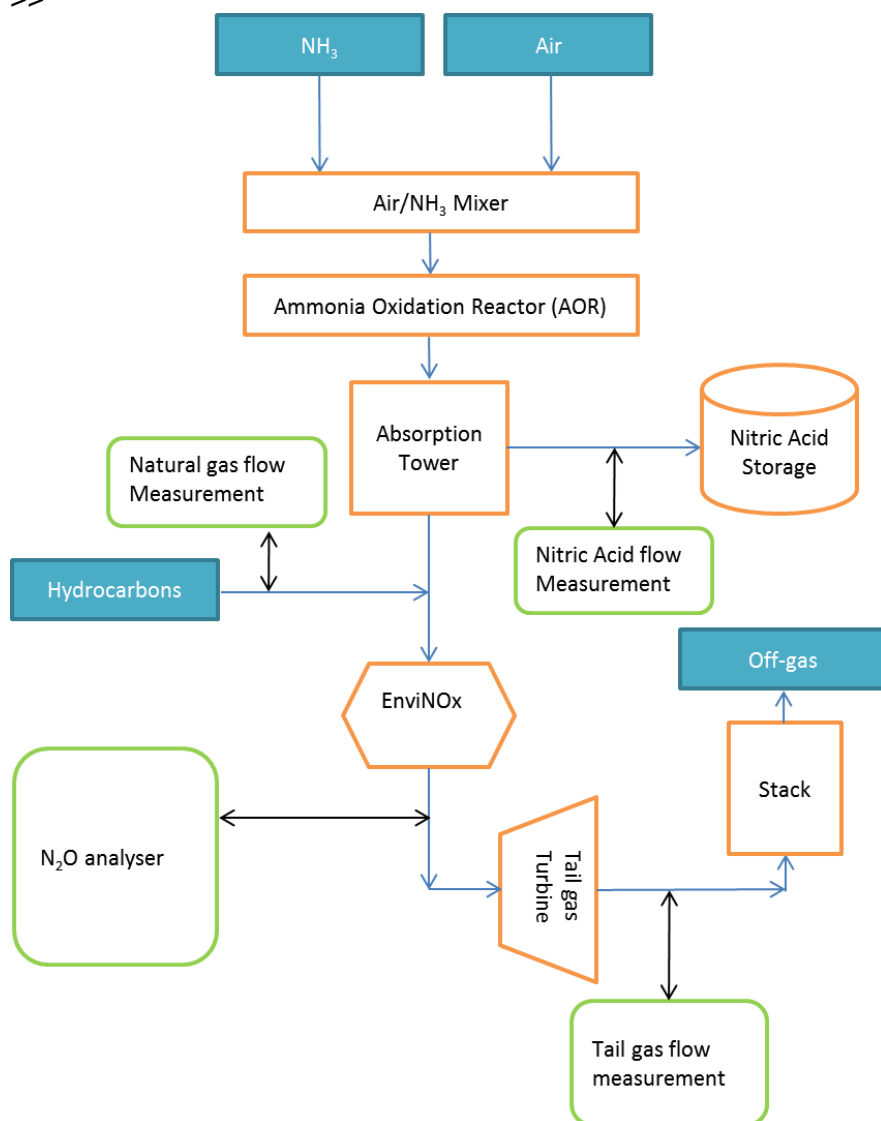


Figure 3: Schematic diagram of location of sample points

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 opto-pneumatic 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 such as, e.g. absolute pressure and temperature, the volume flow is converted from operating to standard conditions. This calculation is performed in the DURAG data system D-EMS 2000. The D-FL 100 is QAL1 tested according to EN 14181:2004 (see below).

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. These procedures can be found for each parameter in section D.2.

ACM0019 requires all key meters to be subject to a quality control regime that will include regular maintenance and calibration. For the N₂O and stack gas flow analyzer this includes the application of the European Norm EN 14181. 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).

Monitor ing equipm ent (Tag- No./ Descrip tion)	Serial Number	Description; Related monitoring parameter as per applicable registered monitoring plan	Type	Accuracy or accuracy class	Calibration frequency	Calibrations
FT- 95060	Transmitter: 3816752 Sensor:142 57727	Natural gas flow meter FC_{i,j,y}	Micro Motion Coriolis Massflow	+/- 0.5 % of the adjusted range	Annually	24/03/2015 07/09/2015 31/05/2016 23/03/2017
FT- 95023	Transmitter: 3811087 Sensor:142 06070	Nitric acid flow meter P_{NA,n}	Micro Motion Coriolis Massflow	+/- 0.2 % of the adjusted range	Annually	24/03/2015 07/09/2015 31/05/2016 25/03/2017
AI- 95005	991010305 5428	N ₂ O Outlet Analyser V_{i,t,db}	Emerson NGA 2000	QAL1: +/- 2.71 % QAL2: +/- 2.70 % AST: +/- 2.77 %.	QAL3 done automatically, zero every day, span every second day. AST done every year and QAL2 every 5 years.	QAL2/AST: 26/05/2015 - 29/05/2015 AST: 31/10/2016 – 02/11/2016 14/09/2017 – 15/09/2017
FT- 95015	1223797	Stackgas volume flow meter V_{t,db}	Durag Annubar measuring system D- FL 100	QAL1: +/- 2.37 % QAL 2: +/- 2.42 %.	AST done every year and QAL2 every 5 years	QAL2/AST: 26/05/2015 - 29/05/2015 QAL2/AST: 31/10/2016 – 02/11/2016 AST 14/09/2017 – 15/09/2017

Monitor ing equipm ent (Tag- No./ Descrip tion)	Serial Number	Description; Related monitoring parameter as per applicable registered monitoring plan	Type	Accuracy or accuracy class	Calibration frequency	Calibrations
PT 95043	1220831	Stackgas pressure measurement P_t	Durag Annubar measuring system D- FL 100	QAL1: not specified QAL 2: not specified	AST done every year and QAL2 every 5 years	QAL2/AST: 26/05/2015 - 29/05/2015 QAL2/AST: 31/10/2016 – 02/11/2016 AST 14/09/2017 – 15/09/2017
TT 95075	02389948/4 9490828	Stackgas temperature measurement T_t	Durag Annubar measuring system D- FL 100	QAL1: not specified QAL 2: not specified	AST done every year and QAL2 every 5 years	QAL2/AST: 26/05/2015 - 29/05/2015 QAL2/AST: 31/10/2016 – 02/11/2016 AST 14/09/2017 – 15/09/2017

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

QAL1

In accordance with EN 14181:2004, the monitoring system for N₂O concentration measurements are suitable for the measuring task (parameter and composition of the flue gas) by use of the QAL1 procedure as specified by EN ISO 15267 or equivalent standards. This standard's objective proves that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in the applicable regulations. Such suitability testing was carried out under specific conditions by an independent third-party on a specific testing site.

QAL2

QAL2 is a procedure for the determination of the calibration function and its variability. According to EN 14181:2004, the QAL2 test including the SRM is conducted by an independent testing house which is accredited to EN ISO/IEC 17025. The QAL2 tests are performed on suitable AMS that is correctly installed and commissioned on-site (as opposed to QAL1 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 was then evaluated by the independent qualified "testing house".

QAL2 tests are performed at least every 5 years according to EN 14181:2004.

AST

In addition, Annual Surveillance Tests (AST) were conducted in accordance with EN 14181:2004 and EN 14181:2014; these are a series of measurements with independent measurement equipment in parallel to the existing AMS. The AST tests were performed annually. If a full QAL2 test was performed (at least every 5 years), an additional AST test is not necessary in that same year.

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 was demonstrated that the AMS was 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 as outlined for the applicable parameter in section D.2.

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 was 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 were 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 was the responsibility of the operational personal. All relevant data was recorded automatically and stored on electronic media.

Data ProcessingArchiving of data

In accordance with the PDD, all of the data collected for the project activity was 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 Durag system and drives and the main server as follows:

- All data collected by the Delta V DCS is stored on its internal hard drive for 1 month.
- The EnviNoxTM data is stored on the plant Durag system and is designed to carry the full crediting period + 2 years. This system comprises of two hard disc drives, as a backup to the process.
- The EnviNoxTM 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.

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	EF _{default,y}
Unit	kgN ₂ O/tHNO ₃
Description	Default N ₂ O baseline emissions factor in the calendar year y of the monitoring period n

Source of data	According to ACM0019 Version 01.0.0, the default N ₂ O baseline emission factor 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	Emissions 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
	Year n	2.50
Value(s) applied	2017: 3.00 2018: 2.80	
Choice of data or measurement methods and procedures	Default value	
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals	
Additional comments	<ul style="list-style-type: none"> The decrease in the value for the baseline emission factor over time is to reflect the technological development. Please note that the factual business as usual emissions are estimated to be 6.45 kgN₂O/tHNO₃. 	

Data/Parameter	GWP _{N₂O}
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 removals and Calculation of project emissions or actual net GHG removals
Additional comments	-

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_2O)
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	-

Data/Parameter	$T_{open,n}$
Unit	%
Description	Fraction 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.
Source of data	ACM0019 v.01.0.0
Value(s) applied	0
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of baseline emissions or baseline net GHG removals
Additional comments	No by-pass is foreseen in the project design and therefore no by-pass valve will be installed from the beginning of the project activity. If necessary, plant will shut down.

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Data/Parameter	$P_{NA,n}$
Unit	tHNO ₃
Description	Nitric Acid Produced
Measured/calculated/default	Measured and Calculated
Source of data	The mass flow of HNO ₃ is continuously measured by a mass flow meter. HNO ₃ concentration is calculated on the DCS using density and temperature from DCS. The mass flow is then multiplied by the concentration to calculate the 100% HNO ₃ mass flow. Density & acid concentration are crosschecked by laboratory analysis.
Value(s) of monitored parameter	324,727

Monitoring equipment	<p>TAG number/ model specification of meter: FT 95023/ Micro Motion, Coriolis Mass flow Serial Number SN: 14206070 (Sensor) SN: 3811087 (Transmitter) Tag No. FT-95023 Overall measurement accuracy +/- 0.2% of the adjusted range Calibration frequency: annually Calibration dates: 31/05/2016; 25/03/2017</p> <p>Density & acid concentration are crosschecked by laboratory analysis.</p>
Measuring/reading/recording frequency	<p>HNO₃: Mass flow and concentration</p> <p>Continuously at 1 second intervals.</p> <p>Density & concentration analysis for crosschecks: approximately 12 samples per day are collected, which are sent to the plant laboratory for analysis. Another sample is taken daily to the central laboratory for analysis. This is for cross reference purposes.</p>
Calculation method (if applicable)	<p>Mass flow measurements (kg/h) are multiplied with acid concentration determined on the DCS to calculate $P_{NA,n}$ mass flow in tHNO₃/h. This method of calculation is used instead of manual inputs of lab data into the DCS to prevent finger mistakes and is also done on a continuous basis at 1 second intervals.</p>
QA/QC procedures	<p>Maintenance and calibration of the flow meter and density meter has been applied under the internal QA/QC procedures implemented for this project activity.</p> <p>Omnia is accredited with ISO9001, ISO 14001 and OHS 18001. All plant equipment and piping are designed as per ASME standards and their maintenance/QAQC is based on relevant API standards, vendor recommendations and prevailing practices in fertilizer industry.</p>
Purpose of data/parameter	Calculation of baseline emissions or baseline 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: 14.0626 applied for the determination of $Q_{N_2O, tailgas, n}$ and overall 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	Continuously / 1 second

Calculation method (if applicable)	<ul style="list-style-type: none"> The monitoring system provides separate hourly average values for the N₂O concentration and the volume or mass flow of the tail gas based on 1 second interval readings that are recorded and stored electronically. These N₂O data sets are 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 EN 14181 must be applied to both the N₂O concentration and the volume or mass flow of the tail gas. The QAL 2 calibration factors are applied in the data storage system at the plant. If the data for either the N₂O concentration or the volume or mass flow of the tail gas is 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. The hourly values are then aggregated as follows: $Q_{N_2O, tailgas, n} = \sum_{h=1}^{h=h_n} F_{N_2O, tailgas, h} * 10^{-3}$ <p> $Q_{N_2O, tailgas, n}$ = Amount of N₂O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN₂O) $F_{N_2O, tailgas, h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kgN₂O/h) h_n = Number of hours in monitoring period n during which the plant was in operation </p>
QA/QC procedures	<p>As per EN 14181:2004 and EN 14181:2014 standards, the flow meter and the analyser 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.</p> <p>QAL2 & 3 calibration schedules are performed according to plant internal procedures Refer to calibration overview table in Section C.</p>
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	-

Data/Parameter	h_n
Unit	Hours
Description	Number of hours in monitoring period n the plant was in operation
Measured/calculated/default	Measured
Source of data	Omnia production log and continuous monitoring according to operational parameters

Value(s) of monitored parameter	7,879		
Monitoring equipment	The total operating hours are logged continuously in the production log		
Measuring/reading/recording frequency	Continuously/ 1 second		
Calculation method (if applicable)	-		
QA/QC procedures	-		
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals		
Additional comments	The nitric acid plant was out of operation during 1,625 hours of this monitoring period:		
	Begin of downtime	End of downtime	Time duration (hours)
	05.07.2017 08:00	11.07.2017 12:00	149
	23.08.2017 03:00	24.08.2017 04:00	26
	05.09.2017 01:00	09.09.2017 12:00	108
	02.11.2017 01:00	03.11.2017 10:00	34
	03.11.2017 13:00	04.11.2017 11:00	23
	22.12.2017 06:00	06.01.2018 17:00	372
	24.02.2018 20:00	18.03.2018 14:00	523
	25.03.2018 08:00	25.03.2018 22:00	15
	13.04.2018 15:00	20.04.2018 15:00	169
	09.05.2018 09:00	09.05.2018 21:00	13
	16.05.2018 12:00	18.05.2018 14:00	51
	01.06.2018 12:00	01.06.2018 20:00	9
	14.06.2018 09:00	14.06.2018 19:00	11
	03.07.2018 08:00	06.07.2018 13:00	78
	23.07.2018 21:00	25.07.2018 04:00	32
	25.07.2018 06:00	25.07.2018 17:00	12
		total hours of plant downtime	1625

Data/Parameter	$T_{open,n}$
Unit	%
Description	Fraction of time in monitoring period n during which the by-pass valve on the line feeding the tertiary N_2O abatement facility was open to vent the gas directly to the atmosphere.
Measured/calculated/default	Measured
Source of data	N/A
Value(s) of monitored parameter	0
Monitoring equipment	N/A
Measuring/reading/recording frequency	N/A

Calculation method (if applicable)	N/A
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	No by-pass is foreseen in the project design and therefore no by-pass valve will be installed from the beginning of the project activity.

Data/Parameter	$PE_{FF,n}$
Unit	tCO ₂ e
Description	Project emissions related to fossil fuel input to the destruction facility and/or re-heater in monitoring period n (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 will be measured by a mass-flow meter
Value(s) of monitored parameter	1,307.29
Monitoring equipment	-
Measuring/reading/recording frequency	Continuously/ 1 second
Calculation method (if applicable)	<p>Calculated based on measurement of natural gas consumption according to the following formula, as provided in the applicable tool “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” (Version 02):</p> <p>2) $PE_{FF,n} = PE_{FC,i,j}$</p> <p>3) $PE_{FC,j,n} = \sum_i FC_{i,j,y} * COEF_{i,n}$</p> <p style="text-align: center;">$COEF_{i,n} = w_{C,i,y} * 44/12$</p> <p>Where:</p> <p>$PE_{FC,j,n}$ = CO₂ emissions from fossil fuel combustion in process j in monitoring period n (tCO₂/n)</p> <p>$FC_{i,j,y}$ = Quantity of fuel type i combusted in the process j during the monitoring period n (mass or volume unit/n)</p> <p>$COEF_{i,n}$ = CO₂ emission coefficient of fuel type i in monitoring period n (tCO₂/mass or volume unit)</p> <p>i = fuel types combusted in process j during monitoring period n</p> <p>$w_{C,i,y}$ = Weighted mass average fraction of carbon in fuel type i in year y</p>
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	Calibration procedures are performed according to plant internal procedure

Data/Parameter	$WC_{i,y}$						
Unit	tC/mass unit of fuel type natural gas						
Description	Weighted average mass fraction of carbon in fuel type i in year y						
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	-						

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 n
Measured/calculated/default	Measured
Source of data	The mass flow of natural gas is continuously measured by a mass flow meter.
Value(s) of monitored parameter	488.782 t

Monitoring equipment	TAG number/ model specification of meter: Micro Motion, Mass flow Serial Number SN:14257727 (Sensor) SN: 3816752 (Transmitter) Tag No. FT-95060 Overall measurement accuracy +/- 0.5% of the adjusted range Calibration frequency: annually Calibration dates: 31/05/2016; 25/03/2017
Measuring/reading/recording frequency	Continuously/ 1 second
Calculation method (if applicable)	-
QA/QC procedures	Calibration schedules are performed according to plant internal procedure.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	

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	Measurements from Durag Annubar flow meter
Value(s) of monitored parameter	Average Value: 134,173
Monitoring equipment	Durag Annubar Flow meter D-FL 100 Serial Number: 1223797 Tag No.: FT-95015 Calibration frequency: AST done every year and QAL2 every 5 years Calibration dates: QAL2/AST: 31/10/2016 – 02/11/2016 AST: 14/09/2017 – 15/09/2017
Measuring/reading/recording frequency	Continuously / 1 second
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. According to EN 14181, the flow meter will be 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	Calibration schedules are performed according to plant internal procedures. As the gaseous stream is assumed to be dry, Option A of the tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" 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 H ₂ O/m ³ dry gas. See parameter $C_{H_2O,t,db,n}$ below.

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	Continuously
Source of data	-
Value(s) of monitored parameter	Average value: 0.00005396
Monitoring equipment	<p>Emerson N₂O Analyser NGA 2000 Serial Number: 9910103055428 Tag No.: AI-95005 Accuracy: QAL1: +/- 2.71 % QAL2: +/- 2.70 % AST: +/- 2.77 %.</p> <p>Calibration frequency: AST done every year, QAL2 every 5 years, QAL3 done automatically, zero every day, span every second day</p> <p>Calibration dates: QAL2/AST: 26/05/2015 - 29/05/2015 AST: 31/10/2016 – 02/11/2016; 14/09/2017 – 15/09/2017</p>
Measuring/reading/recording frequency	Continuously/ 1 second
Calculation method (if applicable)	-
QA/QC procedures	Calibration includes zero verification with an inert gas (e.g. N ₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases have a certificate provided by the manufacturer and are under their validity period.
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals
Additional comments	<p>Calibration schedules are performed according to plant internal procedures. The N₂O concentration is measured in ppmv (= 10⁻⁶ m³ N₂O/ m³ dry gas) and automatically converted to mg N₂O / Nm³ dry gas (= 10⁻⁶ kg N₂O/ Nm³ dry gas) by multiplication with the density of N₂O within the data storage system at the plant. The QAL 2 calibration factor is also applied in the data storage system at the plant. The results from the data storage system in mg N₂O / Nm³ dry gas are used for further calculation in the data calculation spreadsheet.</p> <p>In total during 1,571 hours of the monitoring period the N₂O 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</p>

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	0.0043
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 14181:2004 or 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
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: 140.46
Monitoring equipment	<p>Thermocouples Part of Durag Annubar measuring system D-FL 100 Serial Number: 02389948/49490828 Tag No.: TT-95075 Accuracy: not specified</p> <p>Calibration frequency: AST done every year and QAL2 every 5 years Calibration dates: QAL2/AST: 31/10/2016 – 02/11/2016 AST: 14/09/2017 – 15/09/2017</p>
Measuring/reading/recording frequency	Continuously/ 1 second
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibration against a primary device is provided by an independent accredited laboratory is mandatory. According to EN 14181, the flow meter (including the parameter T_t) is 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	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 Part of Durag Annubar measuring system D-FL 100 Serial Number: 1220831 Tag No.: PT-95043 Accuracy: not specified Calibration frequency: AST done every year and QAL2 every 5 years Calibration dates: QAL2/AST: 31/10/2016 – 02/11/2016 AST: 14/09/2017 – 15/09/2017
Value(s) of monitored parameter	Average value 85,788
Monitoring equipment	Pressure probe
Measuring/reading/recording frequency	Continuously/ 1 second
Calculation method (if applicable)	-
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. According to EN 14181, the flow meter (including the parameter P_t) is 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	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	ER_n
Unit	tCO ₂ e
Description	Emission reduction in monitoring period
Measured/calculated/default	Calculated
Source of data	-
Value(s) of monitored parameter	246,187
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	4) $ER_n = BE_n - PE_n$
QA/QC procedures	-
Purpose of data/parameter	Calculation of project emissions or actual net GH removals
Additional comments	-

D.3. Implementation of sampling plan

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Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

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Baseline emissions:

The calculation of the baseline emissions or baseline net GHG removals sinks has been established in accordance with ACM0019 Version 01.0.0. The formulae are numbered according to the numbering in the registered PDD.

$$(1) \quad BE_n = P_{NA,n} * EF_{BL, N_2O,n} * GWP_{N_2O} * 10^{-3}$$

Where:

BE_n = Baseline emissions in monitoring period n (tCO₂e)

$P_{NA,n}$ = Nitric acid produced in the monitoring period n (tHNO₃)

$EF_{BL, N_2O,n}$ = Baseline N₂O emission factor for nitric acid production in the monitoring period n (kgN₂O/tHNO₃).

GWP_{N_2O} = Global Warming Potential of N₂O valid for the commitment period (298 tCO₂e)

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

Year	BE_n	P_{NA}	$EF_{BL,N_2O,n}$	GWP_{N_2O}	
2017	143,410.94	160,414.92	3.00	298	0.001
2018	137,102.06	164,312.15	2.80	298	0.001
Total	280,513.00				

Determination of the baseline N₂O emission factor ($EF_{BL,N_2O,n}$)

The baseline N₂O emission factor in the monitoring period n ($EF_{BL,N_2O,n}$) shall be determined as a default emission factor $EF_{default,y}$ given for each calendar year y for which BE_n is calculated (see monitoring table for $EF_{default,y}$), as follows:

$$(2) \quad EF_{BL, N_2O,n} = EF_{default, y}$$

Where:

$EF_{BL, N_2O,n}$ = Baseline N₂O emission factor for nitric acid production in the monitoring period n (kgN₂O/tHNO₃).

$EF_{default, y}$ = Default N₂O baseline emissions factor in the calendar year of the monitoring period n (kgN₂O/tHNO₃) (see list of $EF_{default, y}$ values under D.1.).

Year	$EF_{BL, N_2O,n}$	$EF_{default,n}$
2017	3.00	3.00
2018	2.80	2.80

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

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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 using the "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" (Version 02) referred to in ACM0019.

Project emissions are calculated as follows:

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

Where:

PE_n	= Project emissions in monitoring period n (tCO ₂ e)
$PE_{N_2O,n}$	= Project emissions of N ₂ O from the project plant in monitoring period n (tCO ₂ e)
$PE_{CO_2, \text{tertiary}, n}$	= Project emissions of CO ₂ from the operation of the tertiary N ₂ O abatement facility in monitoring period n (tCO ₂)

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

Year	PE_n	$PE_{N_2O,n}$	$PE_{CO_2, \text{tertiary}, n}$
2017	5,354.16	4,619.42	734.74
2018	28,971.22	28,398.67	572.55
Total	34,325.38		

The amount of N₂O emissions from the project activity includes two emission sources:

- The N₂O contained in the tail gas stream of the plant which is released to the atmosphere and;
- In the case of a tertiary N₂O abatement, the N₂O contained in any by-pass streams to the tertiary N₂O abatement facility.

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

Where:

$PE_{N_2O,n}$ = Project emissions of N₂O from the project plant in monitoring period (tCO₂e)

$Q_{N_2O, \text{tail gas}, n}$ = Amount of N₂O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN₂O)

$Q_{N_2O, \text{by-pass}, n}$ = Amount of N₂O released through the by-pass to a tertiary N₂O abatement system to the atmosphere in monitoring period n (tN₂O)

GWP_{N_2O} = Global warming potential of N₂O valid for the commitment period (310 tCO₂e)

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

Year	$PE_{N_2O,n}$	$Q_{N_2O, \text{tail gas}, n}$	$Q_{N_2O, \text{by-pass}, n}$	GWP_{N_2O}
2017	4,619.42	15.50	0	298
2018	28,398.67	95.30	0	298
Total	33,018.10			

According to the methodology and for keeping up flexibility in the event of a possible by-pass installation at a later point of time the parameter $T_{open,n}$ will be monitored throughout the crediting period and has been added to section D.2.

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

The amount of N₂O emissions from the tail gas stream of the project plant is 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 N₂O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;
- The monitoring system provides separate hourly average values for the N₂O concentration and the volume or mass flow of the tail gas based on 1 second interval readings that are recorded and stored electronically. These N₂O data sets are 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 EN 14181 are 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;
- 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 is 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 is applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down is excluded for the determination of the maximum values.

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

- The total volume flow or mass flow of the gas stream and
- The volumetric fraction of the gas in the gaseous stream and
- 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 ($CH_2O_{t,db,n}$) 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* ($F_{i,t}$), which is calculated as follows:

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

With

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

Where:

$F_{i,t}$	= mass flow of greenhouse gas N ₂ O in the gaseous stream in time interval <i>t</i> (kg gas /h)
$V_{t,db}$	= Volumetric flow of the gaseous stream in time interval <i>t</i> , on dry basis (m ³ dry gas/h)
$v_{i,t,db}$	= Volumetric fraction of greenhouse gas N ₂ O in the gaseous stream in a time interval <i>t</i> on a dry basis (m ³ gas N ₂ O/m ³ dry gas)
$\rho_{i,t}$	= Density of greenhouse gas N ₂ O in the gaseous stream in a time interval <i>t</i> (kg gas N ₂ O/m ³ gas N ₂ O)
P_t	= Absolute pressure of the gaseous stream in time interval <i>t</i> (Pa)
MM_i	= Molecular mass of greenhouse gas N ₂ O (kg/kmol)
R_u	= Universal ideal gases constant (Pa.m ³ /kmol.K)
T_t	= Temperature of the gaseous stream in time interval <i>t</i> (K)

Sample calculation for equation (5) applying average values for the monitoring period:

$F_{i,t}$	$V_{t,db}$	$v_{i,t,db}$	$\rho_{i,t}$
14.219	134,173	0.0000540	1.964

Calculation for equation (6) 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

The hourly values are then aggregated for the duration of the monitoring period n, as follows:

$$(7) \quad Q_{N_2O, tailgas, n} = \sum_{h=1}^{h=h_n} F_{N_2O, tailgas, h} * 10^{-3}$$

Where:

$Q_{N_2O, tailgas, n}$ = Amount of N₂O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN₂O)
 $F_{N_2O, tailgas, h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kgN₂O/h)
 h_n = Number of hours in monitoring period n during which the plant was in operation

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

Year	$Q_{N_2O, tail gas, n}$	$\sum F_{N_2O, tail gas, h}$	
2017	15.501	15,501.41	0.001
2018	95.298	95,297.56	0.001
Total	110.799		

During any periods in which a tertiary abatement system is by-passed, $F_{N_2O, tailgas, h}$ is set to zero in order to avoid double counting of project emissions.

$$(8) \quad Q_{N_2O, by-pass; n} = EF_{BL, N_2O, n} * P_{NA, n} * T_{open, n} * 10^{-3}$$

Where:

$Q_{N_2O, by-pass; n}$ = Amount of N₂O released through the by-pass to a tertiary N₂O abatement system to the atmosphere in monitoring period n (tN₂O)
 $EF_{BL, N_2O, n}$ = Default N₂O baseline emissions factor in the calendar year y of the monitoring period n (kgN₂O/t HNO₃)
 $P_{NA, n}$ = Nitric acid produced in the monitoring period n (tHNO₃)
 $T_{open, n}$ = Fraction of time in monitoring period n during which the by-pass valve on the line feeding the tertiary N₂O abatement facility was open to vent the gas directly to the atmosphere.

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

Year	$Q_{N_2O, by-pass, n}$	$EF_{BL, N_2O, n}$	P_{NA}	$T_{open, n}$	
2017	0.00	3.00	160,415	0	0.001
2018	0.00	2.80	164,312	0	0.001
Total	0.00				

The emissions related to the operation of the N₂O destruction facility include only on-site emissions due to the fossil fuel use as input to the N₂O destruction facility:

Project emissions from the operation of the tertiary N₂O abatement facility ($PE_{CO_2, tertiary, n}$)

The emissions related to the operation of the N₂O destruction facility include only on-site emissions due to the fossil fuel use as input to the N₂O destruction facility:

$$(9) \quad PE_{CO_2, tertiary, n} = PE_{FF, n}$$

Where:

$PE_{CO_2, tertiary, n}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in monitoring period n (tCO₂)
 $PE_{FF, n}$ = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in monitoring period n (t CO₂)

For the determination of the project emissions related to the operation of the tertiary abatement system in monitoring period n the project proponents are required to use the latest version of the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion.”

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 $PE_{FF,n}$ in the applied methodology:

$$(10) \quad PE_{FF,n} = PE_{FC,i,j}$$

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:

$$(11) \quad PE_{FC,j,n} = \sum_i FC_{i,j,y} * COEF_{i,n}$$

Where:

$PE_{FC,j,n}$ = CO₂ emissions from fossil fuel combustion in process j in monitoring period n (tCO₂/n)

$FC_{i,j,y}$ = Quantity of fuel type i combusted in the process j during the monitoring period n (mass or volume unit/n)

$COEF_{i,n}$ = CO₂ emission coefficient of fuel type i in monitoring period n (tCO₂/mass or volume unit)

i = fuel types combusted in process j during monitoring period n

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

Year	$PE_{CO_2,tertiary,n}$	$\sum FC_{i,j,y}$	$COEF_{i,n}$
2017	734.736	275.173	2.670
2018	572.550	213.609	2.680
Total	1,307.285		

As data about the chemical composition of the fuel type i is available $COEF_{i,n}$ 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):

$$(12) \quad COEF_{i,n} = w_{C,i,y} * 44/12$$

Where:

$COEF_{i,n}$ = CO₂ emission coefficient of fuel type i in monitoring period n (tCO₂/mass or volume unit)

$w_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type i in monitoring period n (tC/mass unit of the fuel)

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

Year	$COEF_{i,n}$	$w_{C,i,y}$	
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 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
2017	143,410.94	5354.16	0.00	0.00	138,056.78	138,056.78
2018	137,102.06	28971.22	0.00	0.00	108,130.84	108,130.84

	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	280,513.00	34325.38	0.00	0.00	246,187	246,187

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)
246,187	370,854

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.