



**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	Fatima N ₂ O Abatement Project	
UNFCCC reference number of the project activity	5461	
Version number of the PDD applicable to this monitoring report	2.2	
Version number of this monitoring report	01	
Completion date of this monitoring report	09/05/2018	
Monitoring period number	5	
Duration of this monitoring period	From 01/05/2017 to 30/04/2018 Duration (days): 365	
Monitoring report number for this monitoring report	N/A	
Project participants	<ul style="list-style-type: none"> - Fatima Fertilizer Company Limited - N.serve Environmental Services GmbH - Norwegian Ministry of Climate and Environment 	
Host Party	Islamic Republic of Pakistan	
Sectoral scopes	Chemical industries (5)	
Applied methodologies and standardized baselines	ACM0019 v.01.0.0.	
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 tCO ₂ e	419,785 tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	427,564 tCO ₂ e	

SECTION A. Description of project activity

A.1. General description of project activity

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(a)

The aim of the project activity is to reduce nitrous oxide (N₂O) emissions in the tail gas of the nitric acid plant of Fatima Fertilizer Company Ltd., Pakistan (hereafter: "Fatima"), which would normally be released to the atmosphere. N₂O is an undesired by-product in the production process of nitric acid, which was normally released to the atmosphere, as no abatement N₂O-abatement system was foreseen in the original plant design. Therefore, the original plant (which did not foresee any N₂O-abatement system) has been equipped with a tertiary N₂O abatement unit in the tail gas stream right after the absorption tower.

(b)

The tertiary N₂O abatement technology is installed downstream of the HNO₃ absorber and before the tail gas turbine. The tertiary system has been designed and constructed by Uhde. A tertiary catalyst reduces N₂O that is formed in the primary ammonia oxidation reaction. In the tertiary abatement system N₂O is removed by a catalytic reduction with a hydro carbon, such as natural gas. Within the De-N₂O catalyst layer the decomposition of N₂O is carried out at full load of NO_x, because the NO_x additionally promotes the decomposition of N₂O. The applied technology is chosen because it has negligible risk to decrease HNO₃ production and a high expected N₂O decomposition rate of above 98% of the N₂O.

(c)

Table 1: Implementation schedule of the project activity

Relevant dates for the project activity: Date	Event
12/2006	Relocation of nitric acid plant to Pakistan
26/10/2007	Project activity start date
04/2010	Commissioning of the nitric acid plant in Pakistan
30/09/2011	Construction start date of the ENVINOx unit (N ₂ O abatement system)
29/11/2011	Installation of Durag Annubar D-FL 100 (Stack gas flow meter)
01/12/2011	Commissioning of the ENVINOx unit (N ₂ O abatement system) in Fatima's nitric acid plant (Tertiary N ₂ O abatement system)
11/02/2012	Installation of ABB EL 3020 Uras 26 analyser (AMS for N ₂ O monitoring)
01/04/2012	Registration to the UNFCCC
01/04/2012	Start of Crediting Period
01/04/2012	Start of 1 st Monitoring Period
31/07/2012	End of 1 st Monitoring Period
01/08/2012	Start of 2 nd Monitoring Period
16/07/2013	Installation of new ABB EL 3020 Uras 26 analyser (AMS for N ₂ O monitoring) due to malfunctioning of the former item
31/03/2014	End of 2 nd Monitoring Period
01/04/2014	Start of 3 rd Monitoring Period
30/04/2016	End of 3 rd Monitoring Period
01/05/2016	Start of 4 th Monitoring Period
30/04/2017	End of 4 th Monitoring Period
01/05/2017	Start of 5 th Monitoring Period
30/04/2018	End of 5 th Monitoring Period

(d)

Total GHG emission reductions achieved in this monitoring period: 419,785 tCO₂e.

A.2. Location of project activity

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- (a) Host Party: Islamic Republic of Pakistan
- (b) Region/State/Province: Sadiqabad/District Rahim Yar Khan/Punjab
- (c) United Sugar Mill Road, Mukhtar Garh, Sadiqabad
- (d) Physical/ Geographical location: The Fatima Fertilizer complex is located at latitude of approximately N 28°15.749' and a longitude of E 70° 1.895'.

**A.3. Parties and project participants**

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Pakistan (host)	<ul style="list-style-type: none"> - Fatima Fertilizer Company Limited - N.serve Environmental Services GmbH 	No
United Kingdom of Great Britain and Northern Ireland	<ul style="list-style-type: none"> - N.serve Environmental Services GmbH - Fatima Fertilizer Company Limited 	No
Norway	<ul style="list-style-type: none"> - Norwegian Ministry of Climate and Environment 	Yes

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)

2.

a)

https://cdm.unfccc.int/UserManagement/FileStorage/CDM_ACMHXKPX0GBQMNS4MA745SZ_Q2NX6OE672

- b) i. <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf>

- ii. <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v2.0.0.pdf>

A.5. Crediting period type and duration

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Type of Crediting Period: Non-renewable 10 years and 0 month

Start date of Crediting Period: 01/04/2012

Start of this Monitoring Period: 01/05/2017

End date of this Monitoring Period: 30/04/2018

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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(a)

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. The tertiary catalyst consists of an additional catalysts containment facility that was erected at the plant. It is filled with a pelleted catalyst and utilizes a hydro - carbon, such as natural gas, to reduce the N₂O formed in the primary ammonia oxidation reaction. A wide range of metals (e.g. Cu, Fe, Mn, Co and Ni) have shown to be of varied efficiency in N₂O abatement. Within the De-N₂O catalyst layer the decomposition of N₂O is carried out at full load of NO_x, because the NO_x additionally promotes the decomposition of N₂O.

The technology has negligible impact on the HNO₃ production and is guaranteed to have a minimum abatement efficiency of 94% for the first 24 months of operation, an expected abatement efficiency of around 98% and an initial factual abatement efficiency of more than 99% of N₂O.

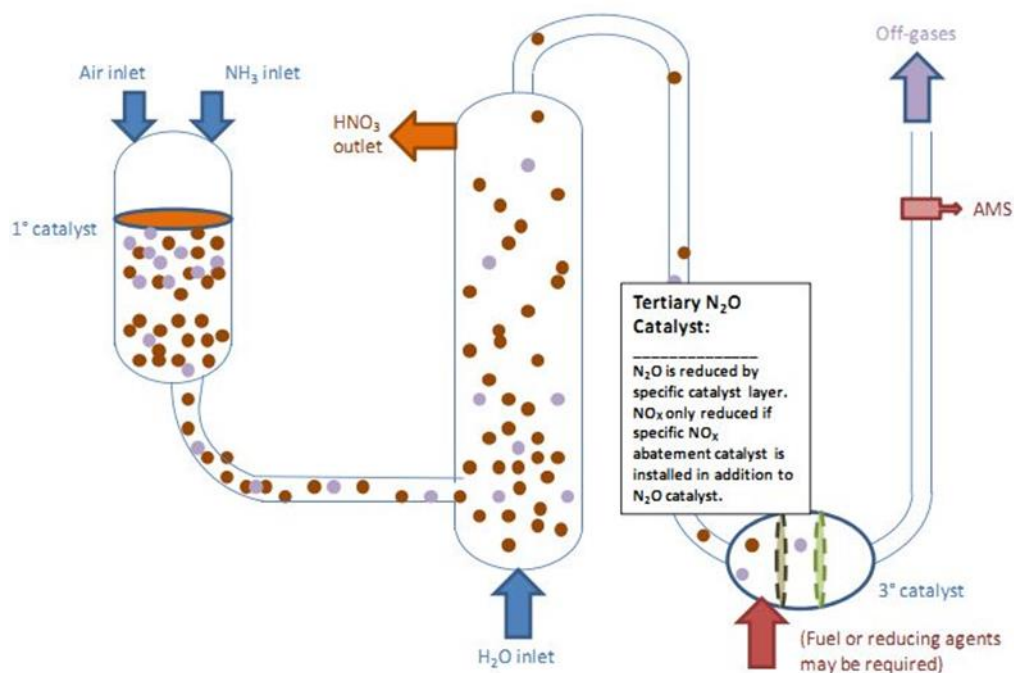
The tertiary abatement system to be implemented and the Fatima Nitric Acid Plant comprise the following technical core details:

Design parameter	
Plant capacity	1,500 t 100%HNO ₃ /day plant load
Tail gas flow	193,000 Nm ³ /h
Temperature	440°C
Pressure	9.5 bars
Natural gas consumption	0.45 mol CH ₄ / 1 mol N ₂ O
Operating conditions	
Min. Reactor inlet temperature	415 °C
Max. Reactor inlet temperature	450°C
Tailgas flow rate to reactor	200,000 Nm ³ /h

Max. Inlet N ₂ O concentration	2,000 ppm
Abatement efficiency	
Expected abatement efficiency	98 %
Guaranteed abatement efficiency (24 months)	94 %

The figure below depicts the flow system of the tertiary catalyst unit:

Figure 1: Image flow of tertiary catalyst unit



Production related events or situations that occurred during the monitoring period

As to the characteristics of this specific project type certain production related events and incidents may affect the performance of the project or influence the monitoring of emission reductions in addition to possible failure of the installed monitoring equipment. The below tables demonstrate all relevant events and incidents related to production and/or emission monitoring which have occurred during actual operation within this specific monitoring period, as well as the measures taken for addressing any resulting problems and issues:

Table 1: Production related plant events during Monitoring Period

From	To	Event	Explanation/Action
09/05/2017 17:00	10/05/2017 02:00	Safe shutdown of NA Plant	Plant tripped due to actuation of IS-02 caused by over-speed trip indication of steam turbine.
11/05/2017 18:00	13/05/2017 02:00	Safe shutdown of NA Plant	Plant tripped due to actuation of IS-02 caused by MAX-CNTRL speed indication of steam turbine.
15/05/2017 21:00	16/05/2017 02:00	Safe shutdown of NA Plant	Plant tripped due to opening of anti-surge valve (3HCV-6154) during probe swapping activity of compressor train.
20/07/2017 17:00	23/07/2017 00:00	Safe shutdown of NA Plant	Plant shutdown due to ammonia plant shutdown.
06/11/2017 14:00	09/11/2017 11:00	Safe shutdown of NA Plant	Plant shutdown due to dust ingress into air compressor & catalyst. Shutdown extended for catalyst campaign.
17/12/2017 21:00	20/12/2017 09:00	Safe shutdown of NA Plant	Plant shutdown for internal inspection & replacement of NH ₃ gas filter.

The following table lists the AMS downtimes during the Monitoring Period. The replacement value for NCSG is 104.12 ppm, for VSG is 217,402 Nm³/h for conservativeness. Downtimes while the plant wasn't operating are not listed.

Table 2: Monitoring related events during Monitoring Period

From	To	Event	Replacement Value
18/05/2017 11:00	18/05/2017 11:00	Analyzer downtime	104.12
18/05/2017 13:00	18/05/2017 15:00	Analyzer downtime	104.12
19/05/2017 12:00	19/05/2017 12:00	Analyzer downtime	104.12
20/05/2017 11:00	20/05/2017 15:00	Analyzer downtime	104.12
23/05/2017 17:00	23/05/2017 17:00	Analyzer downtime	104.12
12/06/2017 12:00	12/06/2017 12:00	Analyzer downtime	104.12
15/06/2017 10:00	15/06/2017 10:00	Analyzer downtime	104.12
16/06/2017 11:00	16/06/2017 12:00	Analyzer downtime	104.12
09/08/2017 11:00	09/08/2017 11:00	Analyzer downtime	104.12
21/10/2017 13:00	21/10/2017 19:00	Analyzer downtime	104.12
27/03/2018 13:00	27/03/2018 16:00	Analyzer downtime	104.12
30/04/2018 11:00	30/04/2018 11:00	Analyzer downtime	104.12

(b)

Table 3: Implementation schedule of the project activity

Relevant dates for the project activity: Date	Event
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12/2006	Relocation of nitric acid plant to Pakistan
26/10/2007	Project activity start date
04/2010	Commissioning of the nitric acid plant in Pakistan
29/11/2011	Installation of Durag Annubar D-FL 100(Stack gas flow meter)
01/12/2011	Commissioning of the ENVINOx unit in Fatima's nitric acid plant (Tertiary N ₂ O abatement system)
11/02/2012	Installation of ABB EL 3020 Uras 26 analyser (AMS for N ₂ O monitoring)
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01/05/2016	Start of 4 th Monitoring Period
30/04/2017	End of 4 th Monitoring Period
01/05/2017	Start of 5 th Monitoring Period
30/04/2018	End of 5 th Monitoring Period

No events or incidents of any relevance in regard to impacting the applicability of the methodology occurred during 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 temporary deviations from the registered monitoring plan or applied methodology have been applied during this monitoring period.

B.2.2. Corrections

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No corrections to project information or parameters fixed at validation have been approved during this monitoring period or submitted with this monitoring report.

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

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No changes to the start date of the crediting period have been approved during this monitoring period or submitted with this monitoring report.

B.2.4. Inclusion of monitoring plan

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The monitoring plan was already included in the registered PDD.

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 permanent changes from the registered monitoring plan or applied methodologies have been approved during this monitoring period or submitted with this monitoring report.

B.2.6. Changes to project design

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No changes to project design of the project activity have been approved during this monitoring period or submitted with this monitoring report.

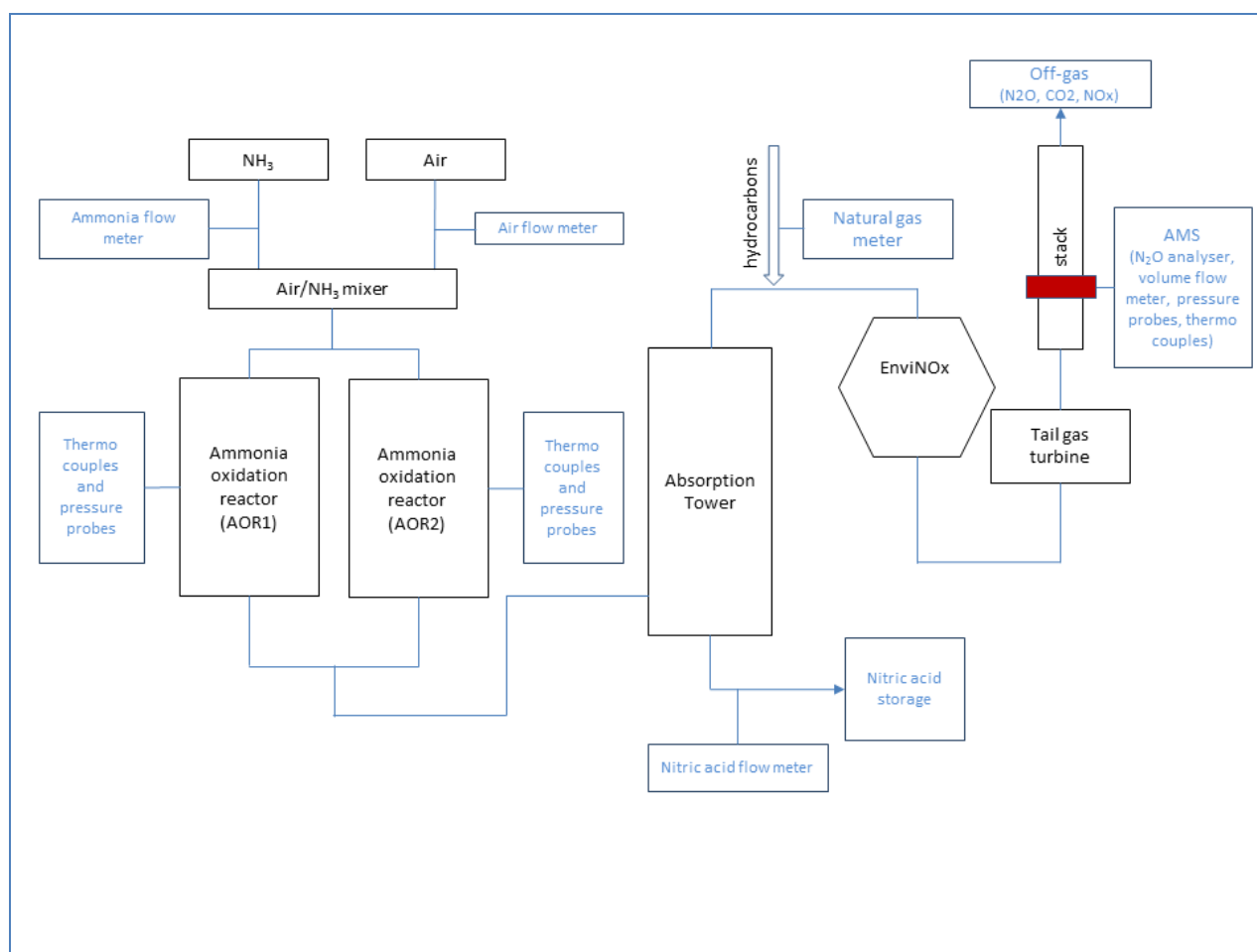
SECTION C. Description of monitoring system

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Installed Measurement Equipment

The following figure depicts the nitric acid plant including the tertiary abatement technology and all relevant installed meters. For specifications and details on the equipment, please see the respective information in the parameter tables of section D.2.

Figure 2: line diagram of nitric acid plant with tertiary abatement technology and positioning of measurement equipment



Sample points

The sample points were chosen in accordance with the AMS requirements, EN 14181 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 vertical section of the exit stack. At this point, the gas is still hot (above dew point) and well mixed. The graph above shows the location of the sample point schematically.

Analyser

The ABB EL3020 URAS 26 is capable of analysing N_2O 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 N_2O 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 and QAL2 tested (according to EN 14181) for the measurement of N_2O .

The plant is equipped with another two Emerson MLT N_2O analysers, one at the inlet of the EnviNOx and one at the outlet. The Emerson at the outlet is used to cross-check the measurement results of the ABB analyser and is also being QAL2/AST tested according to the annual schedule. Data have been submitted to N.serve but were not applied for the calculation of emission reductions.

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, moisture is removed by a sample conditioning system that is installed in the analyser cabinet. This gas cooler unit maintains a constant dew point of the sample gas of 3 °C and efficiently separates the moisture from the sampling gas. The minimum flow rate to the analyser is controlled and connected to an alarm. In case of moisture break through due to a failure of the cooler the sampling pump will be stopped automatically and an alarm is given to the data control system.

Stack gas flow meter

The D-FL 100 measuring system 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 with the help of the D-FL 100-10 microprocessor evaluation unit.

The D-FL 100 is type tested to the guidelines of the German Federal Ministry for the Environment, Nature Conservation and Reactor Safety on suitability testing of measuring equipment for continuous measuring of emissions and is therefore officially QAL1 approved (see below).

Additionally, a Venturi tube Kern VRB-420 transmitter is in operation. It is used to cross-check the D-FL 100 and is undergoing QAL2/AST tests according to the annual schedule. Data have been submitted to N.serve but were not applied for the calculation of emission reductions.

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 parts of the AMS to be subject to a quality control regime that will include regular maintenance and calibration according to the European Standard 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).

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, the monitoring system for N₂O concentration measurements shall have 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. This standard's objective is to prove that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in the applicable regulations. Such suitability testing has to be carried out under specific conditions by an independent third-party on a specific testing site.

ABB EL 3020 Uras 26: Tüv Süd Industrie Service GmbH, Certification Number 1669640-ts¹

Durag D-FL 100: Tüv Rheinland Immissionsschutz und Energiesysteme GmbH, Test Report: 128 CU11650 Tüv Nord 1996-03-29²

¹ Download: http://www.gal1.de/15267/1669640ts_00_abb_EL3000_de.pdf.

² [The certificate has been provided to the DOE.](#)

QAL2

QAL2 is a procedure for the determination of the calibration function and its variability. According to EN 14181, the QAL2 test including the SRM need to be conducted by an independent testing house or laboratory which has to be accredited 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 QAL1 which is conducted off-site).

A calibration function is 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.

Details on QAL2-tests can be found in the parameter section within D.2.

AST

In addition, Annual Surveillance Tests (AST) should be conducted in accordance with EN 14181; 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.

Details on AST-tests can be found in the parameter section within D.2.

QAL3

QAL3 describes the ongoing 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, staff performs QAL3 procedures through the established calibration procedures as outlined for the applicable parameter in section D.2.

N₂O-Analyser Zero Calibration

Manual zero calibration is undertaken according to plant internal requirements based on vendor suggestions. Certified gas is being used. Additional automatic zero calibration is undertaken on daily basis using ambient air.

N₂O-Analyser Span calibration

For automatic span calibrations the URAS 26 Analyser is equipped with a “Calibration Cuvette” (gas filled adjustment cells), which is installed as part of the analyser. The automatic calibration is done after every third day. Manual calibration checks are performed according to plant internal requirements and vendor suggestions with certified calibration gas. The calibration results and subsequent actions are all documented as part of the CDM procedure. In addition, the analyser room and equipment is visually inspected on a regular basis.

Flow meter calibration procedures

The flow meter is checked during the QAL2 and AST tests by an independent laboratory by comparison to a standard reference method (SRM) as stated above. It is a physical device which will not have drift. Therefore, it is sufficient to regularly inspect its physical condition by means of visual and electric checks of the probe. It shall be cleaned if deemed necessary.

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.

Fatima 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 will be maintained throughout the crediting period. Measuring instruments will be 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.

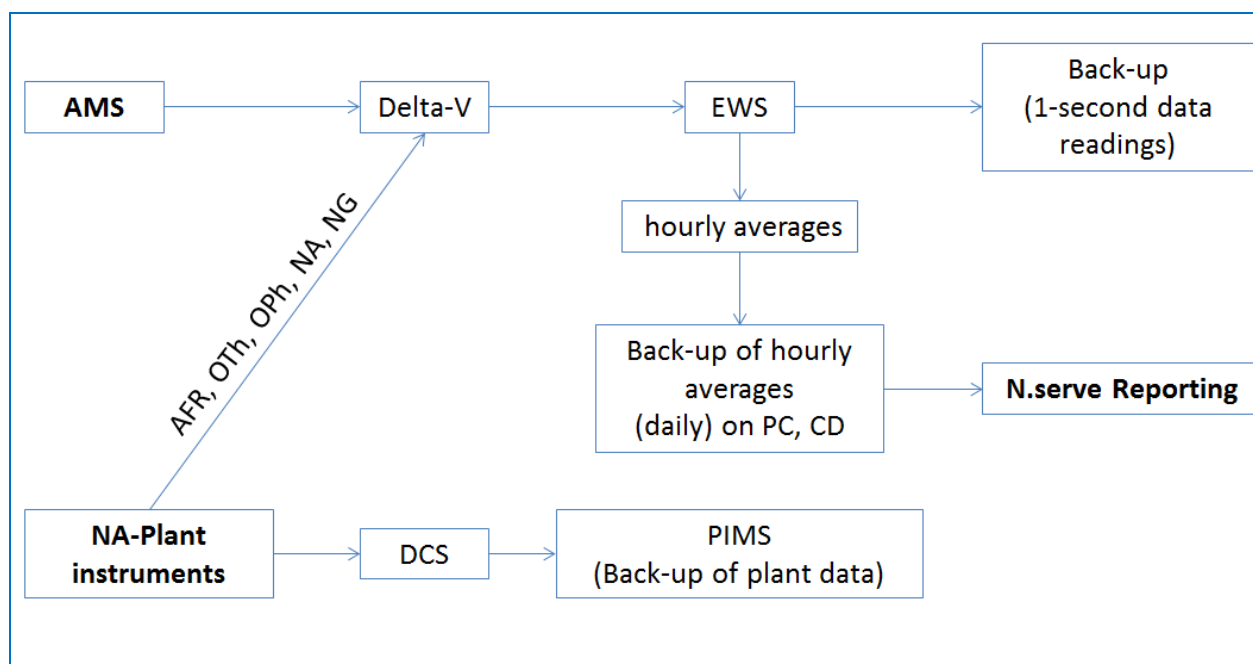
The monitoring of the parameters for the determination of the mass flow of the N_2O will be the responsibility of the monitoring department. All relevant data will be recorded automatically and stored on electronic media.

Data Processing

Information flow

The below Figure 3 depicts the information flow from the AMS readings until the reporting to N.serve. The instruments measurements are being transferred automatically to the Delta-V data management systems and thereof to the EWS (Engineering Work Station). Since some of the plant's production figures are being applied for the emission reduction calculation, a rational has been programmed to extract these data from the plant to the Delta-V and ultimately to the EWS as well. The EWS stores the 1-second readings and comprises a back-up capacity of 12 years from the start of the project activity. Furthermore, the responsible engineer is building hourly averages of the readings by applying automated Excel-based formula. These are then back-upped on a second PC as well as on CDs, which are being transferred to another room of the complex. As a last step, the hourly averages are provided to N.serve for further processing on a monthly basis.

Figure 3: Information flow at Fatima plant



Archiving of data

The monitoring team archives data to a secure and retrievable storage format on a periodic basis. This step of data archiving can also be implemented as an automated routine within the data collection unit. 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 CERs whichever occurs later.

Document Control

The Project Manager has implemented a document control system that ensures that the current versions of necessary documents are available at the point of use. All documents must be maintained in English with local translations (if necessary) because English is the formal language of the CDM.

Preparation of monitoring report

The archived / live data will be used to prepare a periodic monitoring report to be submitted to the UNFCCC secretariat for verification and issuance of CERs. Nserve is responsible for the preparation of the monitoring report and the calculation of achieved emission reductions according to ACM0019 based on the raw data submitted by the plant owner. An internal technical review process was conducted and documented before such a report will be submitted for verification.

Data recording system

The CDM Project Manager has implemented a data recording system for collection and archiving of the monitoring raw data. The data recording frequency for the continuously monitored parameters is 1 second. From these raw data hourly average values are calculated automatically.

Exclusion of data

Hours of plant downtime and hours of plant tripping (due to exceeding of security trip limits of the plant) have been excluded from the calculation of emission reductions as they do not represent normal operation of the plant.

Treatment of missing or corrupted data

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.

Similar provision may apply for the CH₄ inflow and the nitric acid produced. If data for the CH₄ inflow 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 CH₄ inflow observed during the monitoring period. In case of missing hourly data for the nitric acid produced in the monitoring period n ($P_{NA,n}$) the value will be replaced by a nitric acid production value from another source of data e. g. measurements of nitric acid storage tank levels in combination with a production – consumption mass balance. Only in the case that there should be no other reliable data source available the missing value should be replaced with the lowest measured value during plant operations of that monitoring period. 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 and minimum values.

Audit function and management review

The Project Manager arranges for an internal audit of the management system once per year. The auditor will not be involved in the daily operation of the plant and if necessary, may be sourced from a third party. The auditor will assess the implementation of the monitoring procedure, quality assurance steps and data collection and archiving. Audit findings, and steps taken to address findings will be recorded and reviewed in a Management Review meeting (convened at least annually) at which time the effectiveness of these procedures will be reviewed and necessary changes implemented.

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	ACM0019 Version 01.0.0																									
Value(s) applied	<table><tr><th>Year</th><th>Emissions factor (kgN₂O/tHNO₃)</th></tr><tr><td>2012</td><td>3.90</td></tr><tr><td>2013</td><td>3.70</td></tr><tr><td>2014</td><td>3.50</td></tr><tr><td>2015</td><td>3.40</td></tr><tr><td>2016</td><td>3.20</td></tr><tr><td>2017</td><td>3.00</td></tr><tr><td>2018</td><td>2.80</td></tr><tr><td>2019</td><td>2.70</td></tr><tr><td>2020</td><td>2.50</td></tr><tr><td>2021</td><td>2.50</td></tr><tr><td>Year n</td><td>2.50</td></tr></table>		Year	Emissions factor (kgN ₂ O/tHNO ₃)	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
Year	Emissions factor (kgN ₂ O/tHNO ₃)																									
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																									
Choice of data or measurement methods and procedures	No measurement procedures, specified in the methodology																									
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks																									
Additional comments	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 7.0 kgN ₂ O/tHNO ₃ .																									

Data / Parameter:	GWP_{N2O}	
Unit	tCO ₂ e/tN ₂ O	
Description	Global warming potential of N ₂ O	
Source of data	Decision 4/CMP.7	
Value(s) applied	298	
Choice of data or measurement methods and procedures	Specified in the methodology	
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks	
Additional comments	-	

Data / Parameter:	R_u	
Unit	Pa.m ³ /kmol.K	
Description	Universal ideal gases 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	N/A
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comments	-

Data / Parameter:	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas <i>i</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	N/A
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks
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	N/A
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comments	-

Data / Parameter:	T_n
Unit	K
Description	Temperature at standard 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	N/A
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks
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_2O 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	N/A
Purpose of data/parameters	Calculation of baseline emissions or baseline net GHG removals by sinks
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 in the monitoring period n
Measured/calculated/default	Measured & calculated
Source of data	Volume of HNO ₃ is continuously measured by a flow meter. Density & acid concentration are determined by laboratory analysis.
Value(s) of monitored parameter	520,128
Monitoring equipment	Magnetic flow meter Optiflux 5000 W, manufactured by Krohne Germany Magnetic flow meter 8732, manufactured by Emerson Density & acid concentration are determined by laboratory analysis.
Measuring/reading/recording frequency	HNO ₃ : continuously. Density & concentration analysis: 6 sample analyses per day are collected in one bottle, which is sent to the laboratory for analysis. From the result a daily average value is built.
Calculation method (if applicable)	Flow measurements (Nm ³ /h) are multiplied with density - and concentration readings to determine the $P_{NA,n}$ mass flow in tHNO ₃ /h

QA/QC procedures	Maintenance and calibration of the flow meter and density meter has been applied under the internal QA/QC procedures implemented for this project activity. Fatima prepares to acquire ISO9001 accreditation however at the time of writing this report the timeframe is not yet confirmed. 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.										
	1. Installed until 07/11/2017: TAG number/ model specification of meter: F 6291/ Optiflux 5000 KROHNE										
	<table><tr><td>Overall measurement uncertainty</td><td>+/- 0.02%</td></tr><tr><td>Serial Number</td><td>A13022599</td></tr><tr><td>Calibration frequency</td><td>Once per 5 years</td></tr><tr><td>Date of last calibration</td><td>25/01/2013</td></tr><tr><td>Valid until</td><td>24/01/2018</td></tr></table>	Overall measurement uncertainty	+/- 0.02%	Serial Number	A13022599	Calibration frequency	Once per 5 years	Date of last calibration	25/01/2013	Valid until	24/01/2018
	Overall measurement uncertainty	+/- 0.02%									
	Serial Number	A13022599									
	Calibration frequency	Once per 5 years									
	Date of last calibration	25/01/2013									
	Valid until	24/01/2018									
	2. Installed from 07/11/2017 TAG number/ model specification of meter: F 6291/ Emerson Magnetic 8732 Flowmeter										
	<table><tr><td>Overall measurement uncertainty</td><td>+/- 0.25%</td></tr><tr><td>Serial Number</td><td>6201307</td></tr><tr><td>Calibration frequency</td><td>Once per 5 years</td></tr><tr><td>Date of last calibration</td><td>28/04/2015</td></tr><tr><td>Valid until</td><td>27/04/2020</td></tr></table>	Overall measurement uncertainty	+/- 0.25%	Serial Number	6201307	Calibration frequency	Once per 5 years	Date of last calibration	28/04/2015	Valid until	27/04/2020
Overall measurement uncertainty	+/- 0.25%										
Serial Number	6201307										
Calibration frequency	Once per 5 years										
Date of last calibration	28/04/2015										
Valid until	27/04/2020										
TAG number/ model specification of meter: DMA 4500 Density meter /Anton Paar:											
<table><tr><td>Overall measurement accuracy</td><td>0.000011g/cm³</td></tr><tr><td>Serial Number</td><td>80374589</td></tr><tr><td>Calibration frequency</td><td>Once per year</td></tr><tr><td>Date of last calibration</td><td>07/06/2016, 06/06/2017</td></tr><tr><td>Valid until</td><td>05/06/2018</td></tr></table>	Overall measurement accuracy	0.000011g/cm ³	Serial Number	80374589	Calibration frequency	Once per year	Date of last calibration	07/06/2016, 06/06/2017	Valid until	05/06/2018	
Overall measurement accuracy	0.000011g/cm ³										
Serial Number	80374589										
Calibration frequency	Once per year										
Date of last calibration	07/06/2016, 06/06/2017										
Valid until	05/06/2018										
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks										
Additional comments	Calibration according to plant internal procedure SOP No. 12										

Data/Parameter	F_{N2O, tailgas,h}
Unit	kg N ₂ O/h
Description	Mass flow of N ₂ O in the gaseous stream of the tail gas in the hour <i>h</i>
Measured/calculated/default	Measured & calculated
Source of data	N ₂ O concentration: ABB EL3020 URAS 26 N ₂ O Analyser Stack gas volume flow: Durag Annubar D-FL 100 flow meter
Value(s) of monitored parameter	Average value for this monitoring period: 14.01 Applied for the determination of Q _{N2O,tailgas,n} and overall Project Emissions. See calculation sheet and sample calculation of section E.2.
Monitoring equipment	N ₂ O concentration: ABB EL3020 URAS 26 N ₂ O Analyser Stack gas volume flow: Durag Annubar D-FL 100 flow meter
Measuring/reading/recording frequency	Continuously

<p>Calculation method (if applicable)</p>	<ul style="list-style-type: none"> • 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 2 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; • 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. 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 (as done in present project). <p>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>The hourly values are then aggregated as follows:</p> <p>(1) $Q_{N2O,tailgas,n} = \sum_{h=1}^{h=h_n} F_{N2O,tailgas,h} * 10^{-3}$</p> <p>$Q_{N2O,tailgas,n}$ = Amount of N₂O released through the tail gas of the project plant to the atmosphere in monitoring period n (tN₂O)</p> <p>$F_{N2O,tailgas,h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kgN₂O/h)</p> <p>h_n = Number of hours in monitoring period n during which the plant was in operation</p>
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QA/QC procedures	TAG number/ model specification of meter: AT-7640 / ABB EL3020 URAS 26 N ₂ O Analyzers	
	Measurement accuracy (for N ₂ O)	< 1% of the span
	Serial Number	0030D60D2F15
	Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed as well as monthly calibration checks (with calibration gas cylinders)
	Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018
	valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)
	TAG number/ model specification of meter: FT7681 / Durag Annubar D-FL 100 flow meter	
	Measurement accuracy	< 2% of measurement range
	Serial Number	1223310
	Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.
Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018	
valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)	
QAL2 correction factor:		
	Factor	
Analyzer	1.1840	
Stack Gas Flow meter	1.058	
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks	
Additional comments	<p>According to EN 14181, the flow meter and the analyser will be tested and calibrated by an external laboratory with EN ISO/IEC 17025 accreditation. The QAL2 test is usually conducted once every 3 years (although requirement is every 5 years); the AST test is conducted once per year. The AST is part of the QAL2 test. QAL2&3 tests schedules are performed according to plant internal procedures: SOP No. 10 (analyser) SOP No. 14 (stack gas flow meter)</p> <p>The 2018 AST (number 2. above) was due on 14/03/2018 but was conducted on 27/03/2018. Therefore, all measurements during the period from 14/03/2018 until 26/03/2018 have been multiplied with the maximum uncertainty as of the QAL2 report as stated above.</p>	

Data/Parameter	h _n
Unit	Hours
Description	Number of hours in monitoring period <i>n</i> during which the plant was in operation
Measured/calculated/default	Measured
Source of data	Fatima production log and continuous monitoring according to operational parameters
Value(s) of monitored parameter	8,516

Monitoring equipment	The total operating hours are logged continuously in the production log.
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	Plant trips (plant exceeding the trip values OT (min (800) and max (920)) and ammonia to air ratio >11.5) are considered as plant downtimes.
QA/QC procedures	-
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
Additional comments	-

Data/Parameter	T_{open,n}
Unit	%
Description	Fraction of time in monitoring period <i>n</i> 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.
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 by sinks
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.

Data/Parameter	PE_{FF,n} (corresponding to PE_{CO2,tertiary,n})
Unit	tCO ₂ e
Description	Project emissions related to fossil fuel input to the destruction facility and/or re-heater in monitoring period <i>n</i> (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	1,639.50
Monitoring equipment	-
Measuring/reading/recording frequency	Continuously

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) $PE_{FF,n} = PE_{FC,j,y}$</p> <p>(3) $PE_{FC,j,n} = \sum_i FC_{i,j,n} * COEF_{i,n}$</p> <p>(4) $COEF_{i,n} = w_{C,i,y} * 44/12$</p> <p>Where:</p> <p>$PE_{FC,j,n}$ = CO₂ emissions from fossil fuel combustion in process j in monitoring period n (tCO₂/yr)</p> <p>$FC_{i,j,n}$ = Quantity of fuel type i combusted in the process j during the monitoring period n (mass or volume unit/yr)</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>$w_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)</p>										
QA/QC procedures	<p>Maintenance and calibration of the mass flow meter is applied under the internal QA/QC procedures. TAG number / model specification of meter: FT-7672 / 2700C</p> <table border="1"> <tr> <td>Overall measurement accuracy</td><td>+/- 0.03% of mass flow</td></tr> <tr> <td>Serial Number</td><td>14437222</td></tr> <tr> <td>Calibration frequency</td><td>at least once every 5 years</td></tr> <tr> <td>Date of last calibration</td><td>28/11/2014</td></tr> <tr> <td>Valid until</td><td>27/11/2019</td></tr> </table>	Overall measurement accuracy	+/- 0.03% of mass flow	Serial Number	14437222	Calibration frequency	at least once every 5 years	Date of last calibration	28/11/2014	Valid until	27/11/2019
Overall measurement accuracy	+/- 0.03% of mass flow										
Serial Number	14437222										
Calibration frequency	at least once every 5 years										
Date of last calibration	28/11/2014										
Valid until	27/11/2019										
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks										
Additional comments	Calibration schedules are performed according to plant internal procedure: SOP No. 11										

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 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 b) has been applied since values from the supplier have not been available.</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	0.563						

Monitoring equipment	-
Measuring/reading/recording frequency	The mass fraction of carbon should be obtained for each fuel delivery, from which weighted average annual values should be calculated. The exact chemical composition of the fuel is analyzed on a weekly basis in the Fatima laboratory.
Calculation method (if applicable)	-
QA/QC procedures	<p>The values under b) have been checked against the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. The laboratory of the project participant is equipped with state-of-the-art instruments and adheres to high level of quality. The outcome of the measurement provides the following average value: NCV: 42.83 TJ/Gg (range: 46.5 TJ/Gg – 50.4 TJ/Gg)</p> <p>The value falls below the uncertainty range of the IPCC default values because of the low methane content and high CO₂- concentration of the natural gas during this monitoring period: Methane: 70.97% CO₂: 11.30%</p>
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
Additional comments	The results of the analyses are being tracked in laboratory analysis sheets. Calibration schedules are performed according to plant internal procedure: LAB-123A

Data/Parameter	FC _{i,i,y}											
Unit	Mass unit per year (ton/yr)											
Description	Quantity of fuel type <i>i</i> combusted in process <i>j</i> during the year <i>y</i>											
Measured/calculated/default	Measured											
Source of data	Measurements from mass flow meter											
Value(s) of monitored parameter	<table><tr><td>Year</td><td>ton/yr</td></tr><tr><td>2017</td><td>429.30</td></tr><tr><td>2018</td><td>364.76</td></tr><tr><td>Total</td><td>794.06</td></tr></table>		Year	ton/yr	2017	429.30	2018	364.76	Total	794.06		
Year	ton/yr											
2017	429.30											
2018	364.76											
Total	794.06											
Monitoring equipment	Coriolis mass flow meter											
Measuring/reading/recording frequency	Continuously.											
Calculation method (if applicable)	-											
QA/QC procedures	<p>Maintenance and calibration of the mass flow meter is applied under the internal QA/QC procedures. TAG number / model specification of meter: FT-7672 / 2700C</p> <table><tr><td>Overall measurement accuracy</td><td>+/- 0.03% of mass flow</td></tr><tr><td>Serial Number</td><td>14437222</td></tr><tr><td>Calibration frequency</td><td>at least once every 5 years</td></tr><tr><td>Date of last calibration</td><td>28/11/2014</td></tr><tr><td>Valid until</td><td>27/11/2019</td></tr></table>		Overall measurement accuracy	+/- 0.03% of mass flow	Serial Number	14437222	Calibration frequency	at least once every 5 years	Date of last calibration	28/11/2014	Valid until	27/11/2019
Overall measurement accuracy	+/- 0.03% of mass flow											
Serial Number	14437222											
Calibration frequency	at least once every 5 years											
Date of last calibration	28/11/2014											
Valid until	27/11/2019											
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks											
Additional comments	Calibration schedules are performed according to plant internal procedure: SOP No. 11											

Data/Parameter	$V_{t,wb}$																
Unit	Nm ³ wet gas/h																
Description	Volumetric flow of the gaseous stream in time interval t on a wet basis																
Measured/calculated/default	Measured																
Source of data	Measurements from Durag Annubar D-FL 100 flow meter																
Value(s) of monitored parameter	weighted average value: 193,017																
Monitoring equipment	Durag Annubar D-FL 100 flow meter																
Measuring/reading/recording frequency	Continuously																
Calculation method (if applicable)	Average value has been weighted reflecting different numbers of operating hours during Monitoring period in years 2016 and 2017.																
QA/QC procedures	<p>TAG number / model specification of meter: FT 7681/D-FL 100:</p> <table border="1"> <tr> <td>Measurement accuracy</td><td>< 2% of measurement range</td></tr> <tr> <td>Serial Number</td><td>1223310</td></tr> <tr> <td>Calibration frequency</td><td>Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.</td></tr> <tr> <td>Date of last calibrations</td><td>1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018</td></tr> <tr> <td>valid until</td><td>26/03/2018 (next AST), 13/03/2022 (next QAL2)</td></tr> </table> <p>QAL2 correction factors:</p> <table border="1"> <tr> <td></td><td>Factor</td></tr> <tr> <td>Analyzer</td><td>1.1840</td></tr> <tr> <td>Stack Gas Flow meter</td><td>1.058</td></tr> </table>	Measurement accuracy	< 2% of measurement range	Serial Number	1223310	Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.	Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018	valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)		Factor	Analyzer	1.1840	Stack Gas Flow meter	1.058
Measurement accuracy	< 2% of measurement range																
Serial Number	1223310																
Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.																
Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018																
valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)																
	Factor																
Analyzer	1.1840																
Stack Gas Flow meter	1.058																
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks																
Additional comments	<p>QAL2&3 test schedules are performed according to plant internal procedures: SOP No. 14 (stack gas flow meter)</p> <p>The 2018 AST (number 2. above) was due on 14/03/2018 but was conducted on 27/03/2018. Therefore, all measurements during the period from 14/03/2018 until 26/03/2018 have been multiplied with the maximum uncertainty as of the QAL2 report as stated above.</p>																

Data/Parameter	$V_{i,t,db}$
Unit	m ³ gas /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	Measurements from ABB EL3020 URAS 26 N ₂ O Analyser
Value(s) of monitored parameter	Weighted average value: 0.0000339
Monitoring equipment	ABB EL3020 URAS 26 N ₂ O Analyser
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	Average value has been weighted reflecting different numbers of operating hours during Monitoring period in years 2017 and 2018.

QA/QC procedures	<p><u>N₂O-Analyser Zero Calibration</u> Manual zero calibration is undertaken every second week. Certified gas is being used. Additional automatic zero calibration is undertaken on daily basis using ambient air.</p> <p><u>N₂O-Analyser Span calibration</u> For automatic span calibrations the URAS 26 Analyser is equipped with a "Calibration Cuvette" (gas filled adjustment cells), which is installed as part of the analyser. The automatic calibration is done after every third day. Manual calibration checks are done with certified calibration gas at least every 2 weeks. The calibration results and subsequent actions are all documented as part of the CDM procedure. In addition, the analyser room and equipment is visually inspected on a regular basis. All calibration gases have a certificate provided by the manufacturer and are under their validity period.</p> <p>Dates of manual calibrations: 04/05/2017, 18/05/2017, 30/05/2017, 16/06/2017, 04/07/2017, 25/07/2017, 09/08/2017, 25/08/2017, 13/09/2017, 05/10/2017, 19/10/2017, 27/11/2017, 26/12/2017, 16/01/2018, 06/02/2018, 22/03/2018, 16/04/2018, 30/04/2018</p> <p>TAG number / model specification of meter: AT-7640 / EL3020 N₂O Analyser</p> <table border="1" data-bbox="523 831 1393 1144"> <tr> <td>Measurement accuracy (for N₂O)</td><td>< 1% of the span</td></tr> <tr> <td>Serial Number</td><td>0030D60D2F15</td></tr> <tr> <td>Calibration frequency</td><td>Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.</td></tr> <tr> <td>Date of last calibrations</td><td>1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018</td></tr> <tr> <td>valid until</td><td>26/03/2018 (next AST), 13/03/2022 (next QAL2)</td></tr> </table> <p>QAL2 correction factors:</p> <table border="1" data-bbox="523 1205 938 1332"> <tr> <td></td><td>Factor</td></tr> <tr> <td>Analyzer</td><td>1.1840</td></tr> <tr> <td>Stack Gas Flow meter</td><td>1.058</td></tr> </table>	Measurement accuracy (for N ₂ O)	< 1% of the span	Serial Number	0030D60D2F15	Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.	Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018	valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)		Factor	Analyzer	1.1840	Stack Gas Flow meter	1.058
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Serial Number	0030D60D2F15																
Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.																
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	Factor																
Analyzer	1.1840																
Stack Gas Flow meter	1.058																
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks																
Additional comments	<p>QAL2&3 calibration schedules are performed according to plant internal procedures: SOP No. 10</p> <p>The 2018 AST (number 2. above) was due on 14/03/2018 but was conducted on 27/03/2018. Therefore, all measurements during the period from 14/03/2018 until 26/03/2018 have been multiplied with the maximum uncertainty as of the QAL2 report as stated above.</p>																

Data/Parameter	T _t
Unit	°C
Description	Temperature in the gaseous stream in time interval <i>t</i>
Measured/calculated/default	Measured
Source of data	Tail gas temperature measurement
Value(s) of monitored parameter	N/A

Monitoring equipment	Thermocouples (integral parts of flow meter)																
Measuring/reading/recording frequency	Continuously																
Calculation method (if applicable)	-																
QA/QC procedures	<p>TAG number / model specification of transmitter: TT-6160 / D-XT 400 H-L100-E-D09-G1/2</p> <table border="1"> <tr> <td>Measurement accuracy</td><td>$\Delta t \pm (0.30 + 0.0050)$</td></tr> <tr> <td>Model Number</td><td>RTT-15-T1BNKNAE</td></tr> <tr> <td>Calibration frequency</td><td>Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.</td></tr> <tr> <td>Date of last calibrations</td><td>1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018</td></tr> <tr> <td>valid until</td><td>26/03/2018 (next AST), 13/03/2022 (next QAL2)</td></tr> </table> <p>Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications. The temperature transmitter is an integral part of the stack gas flow meter. Calibration is performed according to QAL2 and AST schedules once within 365 days together with the stack gas flow meter.</p> <p>QAL2 correction factor:</p> <table border="1"> <tr> <td></td><td>Factor</td></tr> <tr> <td>Analyzer</td><td>1.1840</td></tr> <tr> <td>Stack Gas Flow meter</td><td>1.058</td></tr> </table>	Measurement accuracy	$\Delta t \pm (0.30 + 0.0050)$	Model Number	RTT-15-T1BNKNAE	Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.	Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018	valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)		Factor	Analyzer	1.1840	Stack Gas Flow meter	1.058
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Stack Gas Flow meter	1.058																
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks																
Additional comments	<p>As parameters are converted to normal conditions during the monitoring process, this parameter is not needed.</p> <p>The 2018 AST (number 2. above) was due on 14/03/2018 but was conducted on 27/03/2018.</p> <p>This parameter is used to convert the stack gas flow to normal conditions. Therefore, the values of the parameter itself are not corrected due to the delayed AST, but all measurements during the period from 14/03/2018 until 26/03/2018 have been multiplied with the maximum uncertainty as of the QAL2 report as stated above. Refer to parameter $V_{t,wb}$ above.</p>																

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	-
Monitoring equipment	Pressure probe (integral part of flow meter)
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	-

QA/QC procedures	TAG number / model specification of transmitter: PT-7658/ D-FL 100 ADM-H							
	Measurement accuracy	$\pm 0.04\%$						
	Model Number	261ASLKBNTI						
	Calibration frequency	Annually by QAL2 /AST; Additional daily checks on operating conditions are performed.						
	Date of last calibrations	1. QAL2: 14/03/2017 – 16/03/2017 2. AST: 27/03/2018						
	valid until	26/03/2018 (next AST), 13/03/2022 (next QAL2)						
<p>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. The pressure transmitter is an integral part of the stack gas flow meter. Calibration is performed according to QAL2 and AST together with the stack gas flow meter.</p> <p>QAL2 correction factor:</p> <table border="1"> <tr> <td></td> <td>Factor</td> </tr> <tr> <td>Analyzer</td> <td>1.1840</td> </tr> <tr> <td>Stack Gas Flow meter</td> <td>1.058</td> </tr> </table>				Factor	Analyzer	1.1840	Stack Gas Flow meter	1.058
	Factor							
Analyzer	1.1840							
Stack Gas Flow meter	1.058							
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks							
Additional comments	<p>As parameters are converted to normal conditions during the monitoring process, this parameter is not needed and therefore not reported.</p> <p>The 2018 AST (number 2. above) was due on 14/03/2018 but was conducted on 27/03/2018.</p> <p>This parameter is used to convert the stack gas flow to normal conditions. Therefore, the values of the parameter itself are not corrected due to the delayed AST, but all measurements during the period from 14/03/2018 until 26/03/2018 have been multiplied with the maximum uncertainty as of the QAL2 report as stated above. Refer to parameter $V_{t,wb}$ above.</p>							

Data/Parameter	ER _n
Unit	tCO ₂ e
Description	Emission reductions in monitoring period
Measured/calculated/default	Calculated
Source of data	-
Value(s) of monitored parameter	419,785
Monitoring equipment	-
Measuring/reading/recording frequency	-
Calculation method (if applicable)	$ER_n = BE_n - PE_n$
QA/QC procedures	-
Purpose of data/parameter	Calculation of project emissions or actual net GHG removals by sinks
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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The calculation of the baseline emissions or baseline net GHG removals by sinks has been established in accordance with ACM0019 V.01.0.0. In the following a sample baseline calculation applying summed up figures will be presented. The formulae numbering is in line with the numbering in the registered PDD. All values are rounded while exact numbers have been used in the according Excel-calculation.

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

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 (310 tCO₂e until 31/12/2012 and 298 tCO₂e thereafter)

Sample calculations:

Year (n)	BE_n	$P_{NA,n}$	$EF_{BL, N_2O,n}$	GWP_{N_2O}	10^{-3}
2017	305,819	342,080	3.00	298	0.001
2018	148,563	178,048	2.80	298	0.001

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 tables 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 y of the monitoring period n (kgN₂O/tHNO₃) (see list of $EF_{default,y}$ values under D.1).

Year (y)	$EF_{BL, N_2O,y}$	$EF_{default,y}$
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. All values are rounded while exact numbers have been used in the according Excel-calculation.

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 (tCO₂e)

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

$PE_{CO_2,tertiary,n}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in monitoring period n (tCO₂)

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

PE_n	$PE_{N_2O,n}$	$PE_{CO_2,tertiary,n}$
34,597	32,956	1,639

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
- The N₂O contained in any by-pass streams to the tertiary N₂O abatement facility.

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

Where:

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

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

$Q_{N_2O, by-pass,n}$ = Amount of N₂O released through the by-pass to a tertiary N₂O abatement system to the atmosphere in monitoring period n (tN₂O)³

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

Sample calculations:

Year (n)	$PE_{N_2O,n}$	$Q_{N_2O,tail\ gas,n}$	$Q_{N_2O,by-pass,n}$	GWP_{N_2O}
2017	18,207.62	61.10	0	298
2018	14,748.11	49.49	0	298

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

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:

- 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 Standard EN 14181 (2004), or any more recent update of that standard;
- 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 2 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;

³ Please note that for the underlying project activity no by-pass option is foreseen in the current project design. Accordingly, no by-pass emissions will occur throughout the project activity. However, in order to comply with 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.

- 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. 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 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.

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 two options for the determination of the moisture content of the gaseous stream, while **Option 2** (simplified calculation without measurement of the moisture content) will be applied.

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. In order to follow a conservative approach for the determination of the project emissions the gaseous stream is assumed to have a moisture content of “0” and is therefore considered dry.

As the gaseous stream is assumed to be dry **Option B** is chosen for the calculation of 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 N₂O 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 (m³ dry gas/h)⁴
 $v_{i,t,db}$ = Volumetric fraction of greenhouse gas N₂O in the gaseous stream in a time interval *t* on a dry basis (m³ gas N₂O/m³ dry gas)
 $\rho_{i,t}$ = Density of greenhouse gas N₂O in the gaseous stream in a time interval *t* (kg gas N₂O/m³ gas N₂O)
 P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
 MM_i = Molecular mass of greenhouse gas N₂O (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 (5) applying values for 2017:

⁴ Please note that units are presented according to the applied methodology and tools. Here and forthcoming all m³ units are referring to m³ in standard conditions.

$F_{i,t}$	$V_{t,db}$	$V_{i,t,db}$	$p_{i,t}$
10.788	187,397	0.0000293	1.964

Sample calculation for equation (6):

$p_{i,t}$	P_t	MM_{N_2O}	R_u	T_t
1.96	101.325	44.02	8.314	273.150

The volumetric flow of the gaseous stream in time interval t on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis. The absolute humidity of the gaseous stream ($m_{H_2O,t,db}$) is determined using **Option 2** above and accordingly **set to be 0**. Consequently, equation (8) will result in 0 and thus equation (7) will result in:

$$(7) \quad V_{t,db} = V_{t,wb} / (1 + V_{H_2O,t,db}) = V_{t,wb}$$

Where:

$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on dry basis (m^3 dry gas/h)

$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis (m^3 dry gas/h)

$V_{H_2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval t on a dry basis ($m^3 H_2O/m^3$ dry gas)

Sample calculation applying values on date specified below:

30/08/2017 16:00

$V_{t,db}$	$V_{t,wb}$	$1 + V_{H_2O,t,db}$
171,835	171,835	1

The volumetric fraction of H_2O in time interval t on a dry basis ($v_{H_2O,t,db}$) is estimated according to equation (8):

$$(8) \quad v_{H_2O,t,db} = \frac{m_{H_2O,t,db} \cdot MM_{t,db}}{MM_{H_2O}}$$

Where:

$v_{H_2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval t on a dry basis ($m^3 H_2O/m^3$ dry gas)

$m_{H_2O,t,db}$ = Absolute humidity in the gaseous stream in time interval t on a dry basis (kg H_2O /kg dry gas)

$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval t on a dry basis (kg dry gas/kmol dry gas)

MM_{H_2O} = Molecular mass of H_2O (kg H_2O /kmol H_2O)

As stated above, $m_{H_2O,t,db}$ is assumed to be 0. Accordingly $v_{H_2O,t,db}$ results in 0 as applied in equation (7).

The hourly values are then aggregated for the duration of the monitoring period n , as provided in ACM0019:

$$(9) \quad Q_{N_2O,tailgas,n} = \sum_{h=1}^{h=h_n} F_{N_2O,tailgas,h} * 10^{-3}$$

Where:

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

$F_{N_2O, tailgas, h}$ = Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kgN_2O/h)
 h_n = Number of hours in monitoring period n during which the plant was in operation

Sample calculation applying values:

Year (n)	$Q_{N_2O, tail gas, n}$	$\sum F_{N_2O, tail gas, h}$	10^{-3}
2017	61.10	61,099.41	0.001
2018	49.49	49,490.30	0.001

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. However, no by-pass is installed in the present project activity.

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

Where:

$Q_{N_2O, by-pass, n}$ = Amount of N_2O released through the by-pass to a tertiary N_2O abatement system to the atmosphere in monitoring period n (tN_2O)

$EF_{BL, N_2O, n}$ = Default N_2O baseline emissions factor in the calendar year y of the monitoring period n ($kgN_2O/t HNO_3$)

$P_{NA, n}$ = Nitric acid produced in the monitoring period n ($tHNO_3$)

$T_{open, n}$ = 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.

Sample calculation applying values:

Year (n)	$Q_{N_2O, by-pass, n}$	$EF_{BL, N_2O, n}$	P_{NA}	$T_{open, n}$	10^{-3}
2017	0.00	3.00	342,080	0	0.001
2018	0.00	2.80	178,048	0	0.001

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

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:

$$(11) \quad PE_{CO_2, tertiary, n} = PE_{FF, n}$$

Where:

$PE_{CO_2, tertiary, n}$ = Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility I in monitoring period n (tCO_2)

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

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 CO_2 emissions from fossil fuel combustion."

The parameter $PE_{FC, j, y}$ used in the tool corresponds to the parameter $PE_{FF, n}$ in the applied methodology.

$$(12) \quad PE_{FF, n} = PE_{FC, j, y}$$

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

$$(13) \quad PE_{FC, j, n} = \sum_i FC_{i, j, n} * COEF_{i, n}$$

Where:

- $PE_{FC,j,n}$ = CO₂ emissions from fossil fuel combustion in process j in monitoring period n (tCO₂/yr)
- $FC_{i,j,n}$ = Quantity of fuel type i combusted in the process j during the monitoring period n (mass or volume unit/yr)
- $COEF_{i,n}$ = 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 values for each year (except $COEF_{i,n}$ which is for the whole monitoring period):

Year (n)	$PE_{CO2,tertiary,n}$	$\sum FC_{i,j,n}$	$COEF_{i,n}$
2017	886.38	429.30	2.065
2018	753.11	364.76	2.065

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):

$$(14) \quad COEF_{i,n} = w_{C,i,y} * 44/12$$

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 year y (tC/mass unit of the fuel)

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

$COEF_{i,n}$	$w_{C,i,y}$	
2.065	0.563	44/12

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

Name	Molar weight	Unit	Fraction in %
M_C	12.0107	g/mol	
M_{CH4}	16.043	g/mol	70.97
M_{C2H6}	30.07	g/mol	0.20
M_{CO2}	44.01	g/mol	11.30
M_{N2}	28.0134	g/mol	17.53

E.3. Calculation of leakage emissions

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Any leakage emissions sources are deemed to be negligible.

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

Emission reductions

Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	GHG emission reductions or net GHG removals by sinks (t CO ₂ e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
2017	305,819	19,095	0	0	286,724	286,724
2018	148,563	15,502	0	0	133,061	133,061
Total	454,382	34,597	0	0	419,785	419,785

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)
419,785	427,564*

* The monitoring period covers parts of 2017 (245 days) and parts of 2018 (120 days). The value above is calculated as follows:

$$ER_{MR} (PDD) = ER_{2017} (PDD) / 365 \text{ days} * 245 \text{ days} + ER_{2018} (PDD) / 365 \text{ days} * 120 \text{ days}$$

$$427,564 = 437,654 / 365 * 245 + 406,964 / 365 * 120$$

E.6. Remarks on increase in achieved emission reductions

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Not applicable as the actual GHG emission reductions achieved during this monitoring period are below the values estimated in ex-ante calculation of the registered PDD.