Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT		
Title of the project activity	Fatima N_2O Abatement Project	
UNFCCC reference number of the project activity	5461	
Version number of the monitoring report	1	
Completion date of the monitoring report	04/05/2017	
Monitoring period number and duration of this monitoring period	Monitoring Period Number: 4 From 01/05/2016 to 30/04/2017 Duration (days): 365	
Project participant(s)	- Fatima Fertilizer Company Limited - N.serve Environmental Services GmbH - Norwegian Ministry of Climate and Environment	
Host Party	Islamic Republic of Pakistan	
Sectoral scope(s)	5	
Selected methodology(ies)	ACM0019 v.01.0.0.	
Selected standardized baseline(s)	N/A	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	458,254 tCO_2e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	0	426,012 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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(a)

The aim of the project activity is to reduce nitrous oxide (N_2O) 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. N_2O is an undesired by-product in the production process of nitric acid, which was normally released to the atmosphere, as no abatement N_2O-abatement system was foreseen in the original plant design. Therefore, the original plant (which did not foresee any N_2O-abatement system) has been equipped with a tertiary N_2O abatement unit in the tail gas stream right after the absorption tower.

(b)

The tertiary N_2O abatement technology is installed downstream of the HNO_3 absorber and before the tail gas turbine. The tertiary system has been designed and constructed by Uhde. A tertiary catalyst reduces N_2O that is formed in the primary ammonia oxidation reaction. In the tertiary abatement system N_2O is removed by a catalytic reduction with a hydro carbon, such as natural gas. Within the De-N_2O catalyst layer the decomposition of N_2O is carried out at full load of NO_x, because the NO_x additionally promotes the decomposition of N_2O. The applied technology is chosen because it has negligible risk to decrease HNO_3 production and a high expected N_2O decomposition rate of above 98% of the N_2O.

(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_2O 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_2O abatement system) in Fatima's nitric acid plant (Tertiary N_2O abatement system)
11/02/2012	Installation of ABB EL 3020 Uras 26 analyser (AMS for N_2O monitoring)
01/04/2012	Registration to the UNFCCC
01/04/2012	Start of Crediting Period
01/04/2012	Start of 1st Monitoring Period
31/07/2012	End of 1st Monitoring Period
01/08/2012	Start of 2nd Monitoring Period
16/07/2013	Installation of new ABB EL 3020 Uras 26 analyser (AMS for N_2O monitoring) due to malfunctioning of the former item
31/03/2014	End of 2nd Monitoring Period
01/04/2014	Start of 3rd Monitoring Period
30/04/2016	End of 3rd Monitoring Period
01/05/2016	Start of 4th Monitoring Period
30/04/2017	End of 4th Monitoring Period

(d)

Total GHG emission reductions achieved in this monitoring period: 426,012 tCO_2e.

A.2. Location of project activity

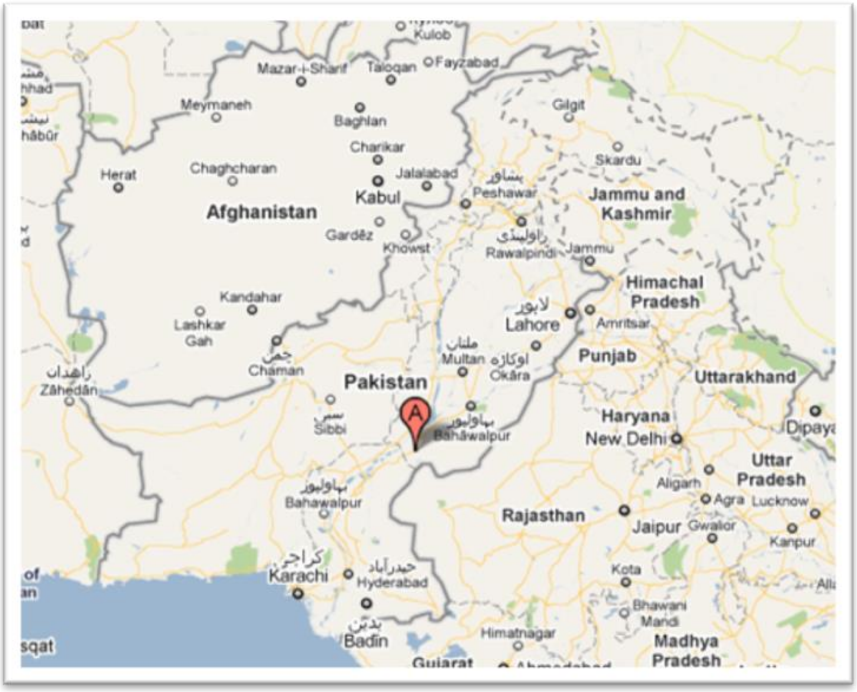
>>

(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 participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Pakistan (host)	- Fatima Fertilizer Company Limited - N.serve Environmental Services GmbH	No
United Kingdom of Great Britain and Northern Ireland	- N.serve Environmental Services GmbH - Fatima Fertilizer Company Limited	No
Norway	- Norwegian Ministry of Climate and Environment	Yes

A.4. Reference of applied methodology and standardized baseline

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(a) Applied methodology: ACM0019 Version 01.0.0: “N_2O abatement from nitric acid production”

(https://cdm.unfccc.int/UserManagement/FileStorage/CDM_ACMHXKPX0GBQMNS4MA745SZQ2NX6OE672)

(b) Applied tools:

i. “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 02)

https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

ii. "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)

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

A.5. Crediting period of project activity

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

(b) Start date of Crediting Period: 01/04/2012

(c) Start of this Monitoring Period: 01/05/2016

(d) End date of this Monitoring Period: 30/04/2017

Length of this Monitoring Period: 365 days

A.6. Contact information of responsible persons/entities

>>

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for completing the CDM-MR-FORM
Organization name	N.serve Environmental Services GmbH
Street/P.O. Box	Große Theaterstraße
Building	14
City	Hamburg
State/Region	
Postcode	20354
Country	Germany
Telephone	+49 40 3099786-0
Fax	+49 40 3099786-10
E-mail	contact@nserve.net
Website	www.nserve.net
Contact person	Nikolaus Gutknecht-Stoehr
Title	
Salutation	Mr.
Last name	Gutknecht-Stoehr
Middle name	
First name	Nikolaus
Department	Portfolio Management
Mobile	+49 163 364 2825
Direct fax	+49 40 3099786-10
Direct tel.	+49 40 3099786-15
Personal e-mail	gutknecht@nserve.net

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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(a)

The N_2O abatement system consists of a tertiary N_2O catalyst unit, which is installed downstream of the HNO_3 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 N_2O 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 N_2O abatement. Within the De-N_2O catalyst layer the decomposition of N_2O is carried out at full load of NO_x, because the NO_x additionally promotes the decomposition of N_2O.

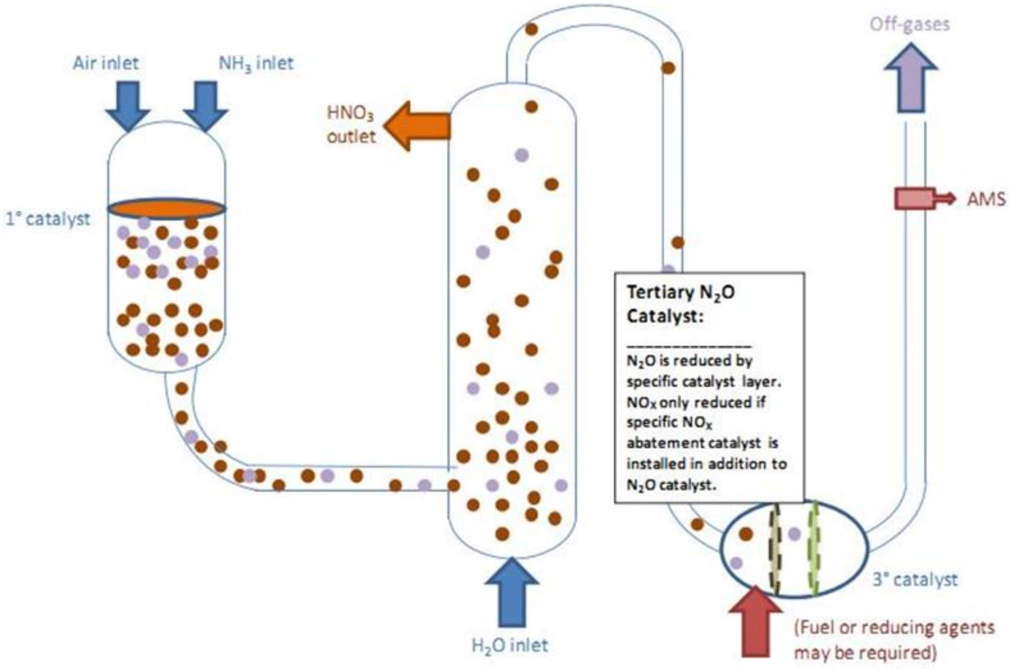
The technology has negligible impact on the HNO_3 production and is guaranteed to have a minimum abatement efficiency of 94%, an expected abatement efficiency of around 98% and a factual abatement efficiency of more than 99% of N_2O.

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_2O
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_2O concentration	2,000 ppm
Abatement efficiency	
Expected abatement efficiency	98 %
Guaranteed abatement efficiency	94 %

Fehler! Verweisquelle konnte nicht gefunden werden. 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
01/06/2016 17:00	01/06/2016 20:00	Safe shutdown of NA Plant	Plant shutdown due to ammonia gas low temperature caused by malfunction of secondary air valve HCV-6282.
15/06/2016 01:00	17/06/2016 13:00	Safe shutdown of NA Plant	Ammonia oxidation reactor catalyst replacement.
04/08/2016 10:00	04/08/2016 14:00	Safe shutdown of NA Plant	Plant shutdown for relay replacement of Ammonia gas control valve (FFCV-6172).
16/08/2016 02:00	17/08/2016 18:00	Safe shutdown of NA Plant	Plant shutdown for Ammonia gas control valve (FFCV-6172) replacement.
26/08/2016 01:00	26/08/2016 18:00	Safe shutdown of NA Plant	Plant shutdown due to turbo-log card failure and oil leakage from barring gear supply line connector.
28/11/2016 16:00	01/12/2016 04:00	Safe shutdown of NA Plant	Plant shutdown for metal stitching job of Lamont boiler (H-105A) shell.
23/12/2016 21:00	26/12/2016 19:00	Safe shutdown of NA Plant	Plant shutdown by actuating IS-1 due to tripping of liquid ammonia delivery pump. Shutdown extended as per planned outage.
12/02/2017 10:00	12/02/2017 15:00	Safe shutdown of NA Plant	Plant shutdown due to malfunction of Ammonia vaporizer (H-101) level switch (LSZH-6106).

29/03/2017 15:00	18/04/2017 12:00	Safe shutdown of NA Plant	Plant shutdown due to annual turn-around 2017.
18/04/2017 16:00	21/04/2017 11:00	Safe shutdown of NA Plant	Plant shutdown due to Lamont Boiler Shell (H-105B) lip seal leakage.
21/04/2017 14:00	21/04/2017 19:00	Safe shutdown of NA Plant	Plant shutdown due to actuation of IS-01 caused by NODE 5 Slot 1 Channel 3 Card Failure.

No AMS downtimes occured during this Monitoring Period while the plant was operating.

(b)

Table 3: 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
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_2O abatement system)
11/02/2012	Installation of ABB EL 3020 Uras 26 analyser (AMS for N_2O monitoring)
01/04/2012	Registration to the UNFCCC
01/04/2012	Start of Crediting Period
01/04/2012	Start of 1st Monitoring Period
31/07/2012	End of 1st Monitoring Period
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16/07/2013	Installation of new ABB EL 3020 Uras 26 analyser (AMS for N_2O monitoring) due to malfunctioning of the former item
31/03/2014	End of 2nd Monitoring Period
01/04/2014	Start of 3rd Monitoring Period
30/04/2016	End of 3rd Monitoring Period
01/05/2016	Start of 4th Monitoring Period
30/04/2017	End of 4th Monitoring Period

(c) Description of:

i. Events or situations that may have impacted the applicability of the applied methodology:

No.

ii. The following describes how these events or situations have been addressed:

Not applicable.

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

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Have there been any temporary deviations from the Monitoring plan during this monitoring period?

No.

B.2.2. Corrections

>>
Are there any corrections to project information or parameters fixed at validation approved during this monitoring period or submitted in this monitoring report?
No.

B.2.3. Changes to start date of crediting period

>>
No.

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>>
No.

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>>
No.

B.2.6. Changes to project design of registered project activity

>>
No.

B.2.7. Types of changes specific to afforestation or reforestation project activity

>>
Not applicable

SECTION C. Description of monitoring system

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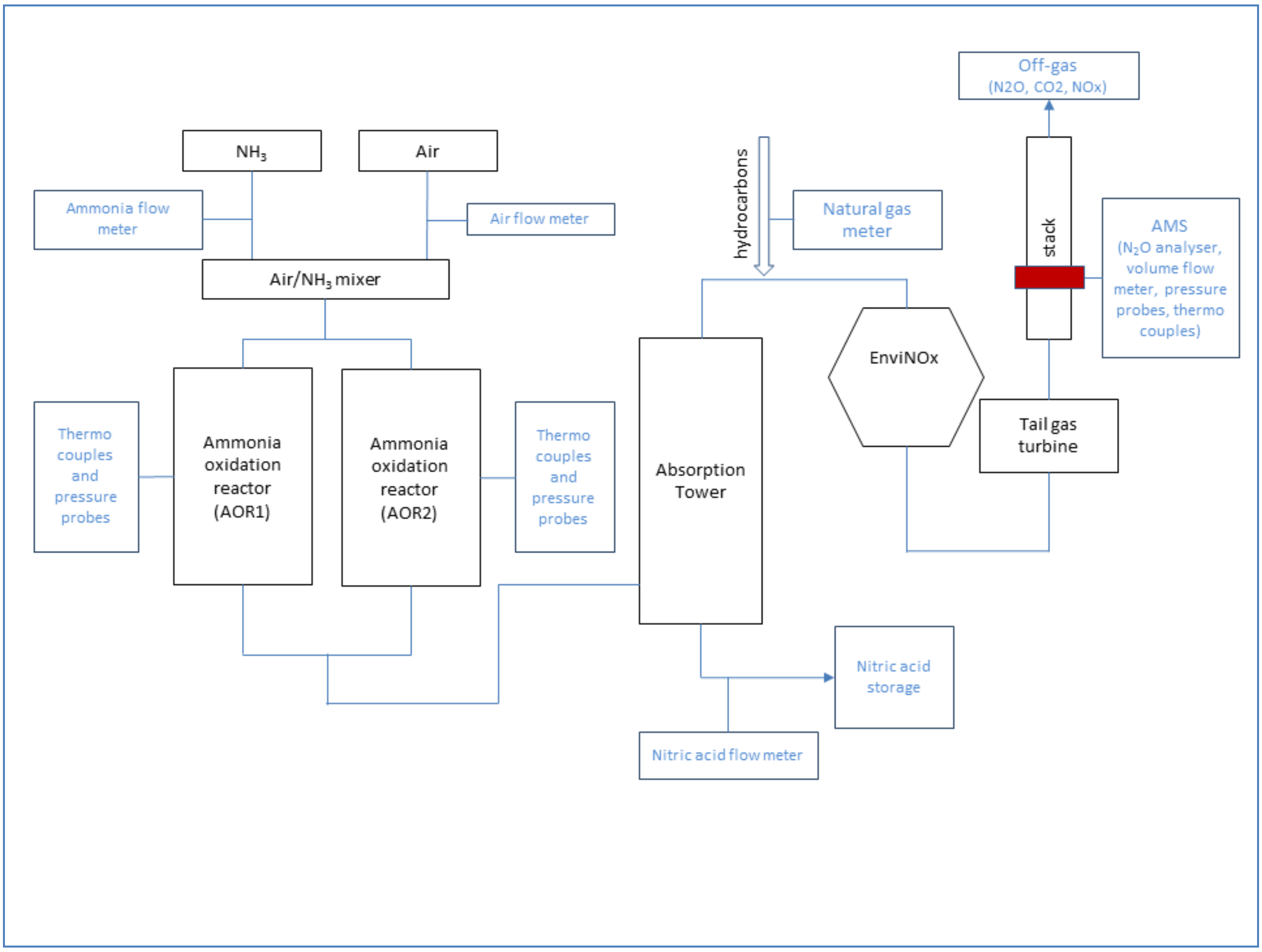
Installed Measurement Equipment

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 N_2O 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-ts[1]

Durag D-FL 100: Tüv Rheinland Immissionsschutz und Energiesysteme GmbH, Test Report: 128 CU11650 Tüv Nord 1996-03-29[2]

QAL2

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[1] Download: http://www.qal1.de/15267/1669640ts_00_abb_EL3000_de.pdf.
[2] The certificate has been provided to the DOE.

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.

N_2O-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.

N_2O-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.

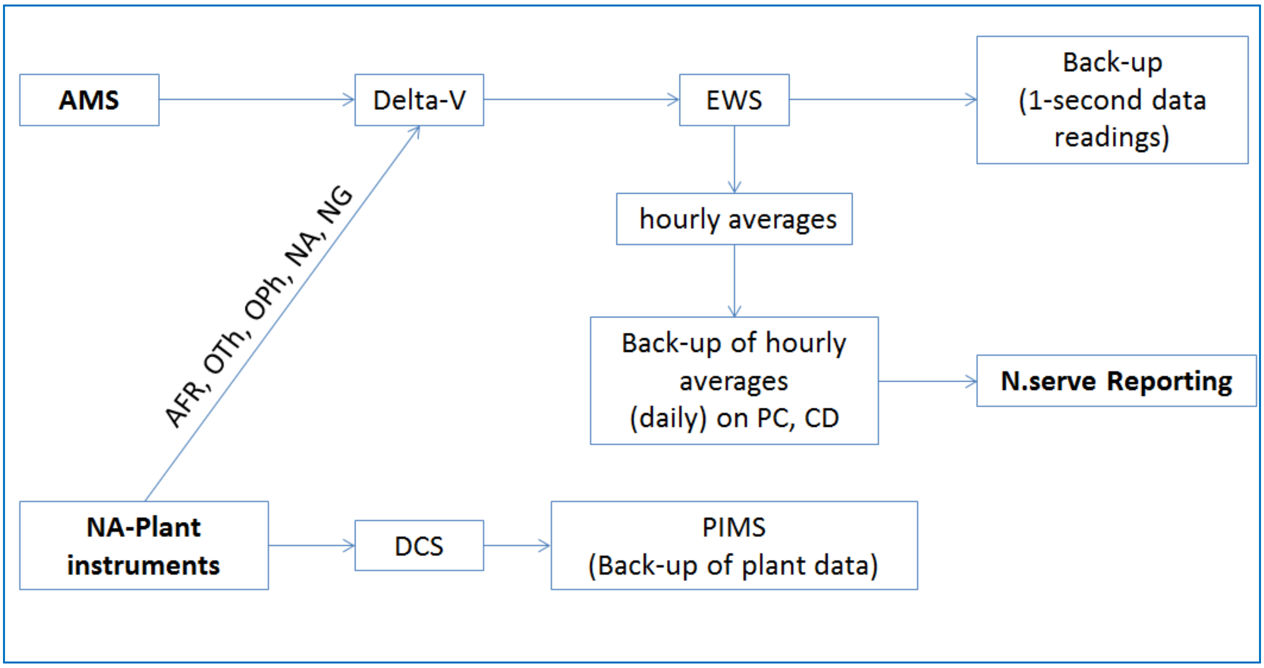
The monitoring of the parameters for the determination of the mass flow of the N_2O will be the responsibility of the monitoring department. All relevant data will be recorded automatically and stored on electronic media.

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

Similar provision may apply for the CH_4 inflow and the nitric acid produced. If data for the CH_4 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 CH_4 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 or at renewal of crediting period

Data / Parameter:	**$EF_{default,y}$**
Unit:	$kgN_2O/tHNO_3$
Description:	Default N_2O baseline emissions factor in the calendar year y of the monitoring period *n*
Source of data:	ACM0019 Version 01.0.0
Value(s) applied):	Year / Emissions factor ($kgN_2O/tHNO_3$): 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:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	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 $kgN_2O/tHNO_3$.

Year	Emissions factor ($kgN_2O/tHNO_3$)
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

Data / Parameter:	**GWP_{N2O}**
Unit:	tCO_2e/tN_2O
Description:	Global warming potential of N_2O
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:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	-

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:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	-

Data / Parameter:	MM_i
Unit:	kg/kmol
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:	N/A
Purpose of data:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	-

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:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	-

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:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	-

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:	Calculation of baseline emissions or baseline net GHG removals by sinks
Additional comment:	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

Data/parameter:	$\mathbf{P_{NA,n}}$
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	469,622
Monitoring equipment	Magnetic flow meter Optiflux 5000 W, manufactured by Krohne Germany 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 05/04/2017: TAG number/ model specification of meter: F 6291/ Optiflux 5000 KROHNE Overall measurement uncertainty: *+/- 0.02%* Serial Number: *A12022699* Calibration frequency: *Once per 5 years* Date of last calibration: *10/04/2012* Valid until: *09/04/2017* 2. Installed from 05/04/2017: TAG number/ model specification of meter: F 6291/ Optiflux 5000 KROHNE 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* TAG number/ model specification of meter: DMA 4500 Density meter /Anton Paar: Overall measurement accuracy: *$0.000011g/cm^3$* Serial Number: *80374589* Calibration frequency: *Once per year* Date of last calibration: *09/06/2015, 07/06/2016* Valid until: *06/06/2017*
Purpose of data:	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_2O/h
Description	Mass flow of N_2O in the gaseous stream of the tail gas in the hour *h*
Measured/calculated/default	Measured & calculated
Source of data	N_2O concentration: ABB EL3020 URAS 26 N_2O Analyser Stack gas volume flow: Durag Annubar D-FL 100 flow meter
Value(s) of monitored parameter	Average value for this monitoring period: 5.34 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_2O concentration: ABB EL3020 URAS 26 N_2O Analyser Stack gas volume flow: Durag Annubar D-FL 100 flow meter
Measuring/reading/recording frequency:	Continuously
Calculation method (if applicable):	• The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on 2 seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be identified by means of a unique time / date key indicating when exactly the values were observed; • The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN 14181 must be applied to both the N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions (as done in present project). If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values. The hourly values are then aggregated as follows: (1) $Q_{N2O,tailgas,n} = \sum_{h=1}^{h=h_n} F_{N2O,tailgas,h} * 10^{-3}$ $Q_{N2O,tailgas,n}$ = Amount of N_2O released through the tail gas of the project plant to the atmosphere in monitoring period *n* (tN_2O) $F_{N2O,tailgas,h}$ = 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

<table>
<tr><td>QA/QC procedures:</td><td>
TAG number/ model specification of meter: AT-7640 / ABB EL3020 URAS 26 N_2O Analyzers

Measurement accuracy (for N_2O)	*< 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:*** 27/01/2014 – 29/01/2014 ***2. AST:*** 04/03/2015 – 05/03/2015 ***3. AST:*** 19/05/2016 – 20/05/2016 **4. QAL2:** 14/03/2017 – 16/03/2017
valid until	*13/03/2018 (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:*** *27/01/2014 – 29/01/2014* ***2. AST:*** 04/03/2015 – 05/03/2015 ***3. AST:*** 19/05/2016 – 20/05/2016 **4. QAL2:** 14/03/2017 – 16/03/2017
valid until	*13/03/2018 (next AST),* *13/03/2022 (next QAL2)*

QAL2 correction factors:

	<=13/03/2017	>=14/03/2017
Analyzer	1.0686	1.1840
Stack Gas Flow meter	1.059	1.058
</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of project emissions or actual net GHG removals by sinks</td></tr>
<tr><td>Additional comments:</td><td>
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)

The 2015 AST (number 2. above) was due on 27/01/2015 but was conducted on 04/03/2015 (period not part of this monitoring period).

The 2016 AST (number 3. above) was due on 03/03/2016 but was conducted on 19/05/2016.

Therefore, all measurements during the period from 01/05/2016 (beginning of the monitoring period) until 18/05/2016 have been multiplied with the maximum uncertainty as of the then valid QAL2 report (number 1 above, 1.0686 for N2O, 1.059 for Stack gas flow).
</td></tr>
</table>

Data/parameter:	**h_n**
Unit	Hours
Description	Number of hours in monitoring period *n* 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	7,936
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 excessing the trip values OT < 800 – 920< and ammonia to air ratio >11.5) are considered as plant downtimes.
QA/QC procedures:	-
Purpose of data:	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 *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:	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_2e
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_2O destruction facility include only on-site emissions due to fossil fuel use as input to the N_2O destruction facility. Natural gas consumption is measured by a mass-flow meter
Value(s) of monitored parameter	1,008

Monitoring equipment	-
Measuring/reading/recording frequency:	Continuously
Calculation method (if applicable):	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 CO_2 emissions from fossil fuel combustion" (Version 02): (2) $PE_{FF,n} = PE_{FC,j,y}$ (3) $PE_{FC,j,n} = \sum_i FC_{i,j,n} * COEF_{i,n}$ (4) $COEF_{i,n} = w_{C,i,y} * 44/12$ Where: $PE_{FC,j,n}$ = CO_2 emissions from fossil fuel combustion in process *j* in monitoring period *n* (tCO_2/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) $COEF_{i,n}$ = CO_2 emission coefficient of fuel type *i* in monitoring period *n* (tCO_2/mass or volume unit) i = Fuel types combusted in process *j* during monitoring period *n* $w_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type *i* in year *y* (tC/mass unit of the fuel)
QA/QC procedures:	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 Until 30/11/2016 1. Overall measurement accuracy: *+/- 0.03% of mass flow* Serial Number: *14275263* Calibration frequency: *at least once every 5 years* Date of last calibration: *27/02/2012* Valid until: *26/02/2017* From 30/11/2016 2. 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:	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	The following data source may be used if the relevant conditions apply: **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 **Option b)** has been applied since values from the supplier have not been available.
Value(s) of monitored parameter	0.565
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:	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: 43,06 TJ/Gg (range: 46.5 TJ/Gg – 50.4 TJ/Gg) The value falls below the uncertainty range of the IPCC default values because of the low methane content and high CO_2- concentration of the natural gas during this monitoring period: Methane: 71.34% CO2: 11.11%
Purpose of data:	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:	**$FC_{i,j,y}$**
Unit	Mass unit per year (ton/yr)
Description	Quantity of fuel type *i* combusted in process *j* during the year y
Measured/calculated/default	Measured
Source of data	Measurements from mass flow meter
Value(s) of monitored parameter	**Year** / **ton/yr** 2016 / 313.50 2017 / 173.08 **Total** / **486.57**
Monitoring equipment	Coriolis mass flow meter
Measuring/reading/recording frequency:	Continuously.
Calculation method (if applicable):	-

<table>
<tr><td>QA/QC procedures:</td><td>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

Until 30/11/2016
1.
<table>
<tr><td>Overall measurement accuracy</td><td>+/- 0.03% of mass flow</td></tr>
<tr><td>Serial Number</td><td>14275263</td></tr>
<tr><td>Calibration frequency</td><td>at least once every 5 years</td></tr>
<tr><td>Date of last calibration</td><td>27/02/2012</td></tr>
<tr><td>Valid until</td><td>26/02/2017</td></tr>
</table>
From 30/11/2016
2.
<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>
</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of project emissions or actual net GHG removals by sinks</td></tr>
<tr><td>Additional comments:</td><td>Calibration schedules are performed according to plant internal procedure: SOP No. 11</td></tr>
</table>

<table>
<tr><td>Data/parameter:</td><td>$V_{t,wb}$</td></tr>
<tr><td>Unit</td><td>Nm^3 wet gas/h</td></tr>
<tr><td>Description</td><td>Volumetric flow of the gaseous stream in time interval t on a wet basis</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Measurements from Durag Annubar D-FL 100 flow meter</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>weighted average value: 186,819</td></tr>
<tr><td>Monitoring equipment</td><td>Durag Annubar D-FL 100 flow meter</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Continuously</td></tr>
<tr><td>Calculation method
(if applicable):</td><td>Average value has been weighted reflecting different numbers of operating hours during Monitoring period in years 2016 and 2017.</td></tr>
<tr><td>QA/QC procedures:</td><td>TAG number / model specification of meter: FT 7681/D-FL 100:
<table>
<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: 27/01/2014 – 29/01/2014
2. AST: 04/03/2015 – 05/03/2015
3. AST: 19/05/2016 – 20/05/2016
4. QAL2: 14/03/2017 – 16/03/2017</td></tr>
<tr><td>valid until</td><td>13/03/2018 (next AST),
13/03/2022 (next QAL2)</td></tr>
</table>
QAL2 correction factors:
<table>
<tr><td></td><td><=13/03/2017</td><td>>=14/03/2017</td></tr>
<tr><td>Analyzer</td><td>1.0686</td><td>1.1840</td></tr>
<tr><td>Stack Gas Flow meter</td><td>1.059</td><td>1.058</td></tr>
</table>
</td></tr>
</table>

Purpose of data:	Calculation of project emissions or actual net GHG removals by sinks
Additional comments:	QAL2&3 test schedules are performed according to plant internal procedures: SOP No. 14 (stack gas flow meter) The 2015 AST (number 2. above) was due on 27/01/2015 but was conducted on 04/03/2015 (period not part of this monitoring period). The 2016 AST (number 3. above) was due on 03/03/2016 but was conducted on 19/05/2016. Therefore, all measurements during the period from 01/05/2016 (beginning of the monitoring period) until 18/05/2016 have been multiplied with the maximum uncertainty as of the then valid QAL2 report (number 1 above, 1.0686 for N2O, 1.059 for Stack gas flow).

Data/parameter:	$\mathbf{v_{i,t,db}}$
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	Measurements from ABB EL3020 URAS 26 N_2O Analyser
Value(s) of monitored parameter	Weighted average value: 0.0000143
Monitoring equipment	ABB EL3020 URAS 26 N_2O 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 2016 and 2017.

<table>
<tr><td>QA/QC procedures:</td><td><u>N_2O-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.
<u>N_2O-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.

Dates of manual calibrations:
04/05/2016, 18/05/2016, 28/05/2016, 13/06/2016, 28/06/2016, 13/07/2016, 25/07/2016, 08/08/2016, 25/08/2016, 22/09/2016, 27/09/2016, 25/10/2016, 11/11/2016, 05/12/2016, 20/12/2016, 02/01/2017, 16/01/2017, 30/01/2017, 15/02/2017, 06/03/2017, 21/03/2017, 24/04/2017

TAG number / model specification of meter: AT-7640 / EL3020 N_2O Analyser

<table>
<tr><td>Measurement accuracy (for N_2O)</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: 27/01/2014 – 29/01/2014
2. AST: 04/03/2015 – 05/03/2015
3. AST: 19/05/2016 – 20/05/2016
4. QAL2: 14/03/2017 – 16/03/2017</td></tr>
<tr><td>valid until</td><td>13/03/2018 (next AST),
13/03/2022 (next QAL2)</td></tr>
</table>

QAL2 correction factors:
<table>
<tr><td></td><td><=13/03/2017</td><td>>=14/03/2017</td></tr>
<tr><td>Analyzer</td><td>1.0686</td><td>1.1840</td></tr>
<tr><td>Stack Gas Flow meter</td><td>1.059</td><td>1.058</td></tr>
</table>
</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of project emissions or actual net GHG removals by sinks</td></tr>
<tr><td>Additional comments:</td><td>QAL2&3 calibration schedules are performed according to plant internal procedures:
SOP No. 10

The 2015 AST (number 2. above) was due on 27/01/2015 but was conducted on 04/03/2015 (period not part of this monitoring period).

The 2016 AST (number 3. above) was due on 03/03/2016 but was conducted on 19/05/2016.

Therefore, all measurements during the period from 01/05/2016 (beginning of the monitoring period) until 18/05/2016 have been multiplied with the maximum uncertainty as of the then valid QAL2 report (number 1 above, 1.0686 for N2O, 1.059 for Stack gas flow).</td></tr>
</table>

Data/parameter:	**T_t**
Unit	°C

<table>
<tr><td>Description</td><td>Temperature in the gaseous stream in time interval t</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Tail gas temperature measurement</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>N/A</td></tr>
<tr><td>Monitoring equipment</td><td>Thermocouples (integral parts of flow meter)</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Continuously</td></tr>
<tr><td>Calculation method
(if applicable):</td><td>-</td></tr>
<tr><td>QA/QC procedures:</td><td>TAG number / model specification of transmitter: TT-6160 / D-XT 400 H-L100-E-D09-G1/2
<table>
<tr><td>Measurement accuracy</td><td>Δt ±(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: 27/01/2014 – 29/01/2014
2. AST: 04/03/2015 – 05/03/2015
3. AST: 19/05/2016 – 20/05/2016
4. QAL2: 14/03/2017 – 16/03/2017</td></tr>
<tr><td>valid until</td><td>13/03/2018 (next AST),
13/03/2022 (next QAL2)</td></tr>
</table>

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.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of project emissions or actual net GHG removals by sinks</td></tr>
<tr><td>Additional comments:</td><td>As parameters are converted to normal conditions during the monitoring process, this parameter is not needed.

The 2015 AST (number 2. above) was due on 27/01/2015 but was conducted on 04/03/2015 (period not part of this monitoring period).

The 2016 AST (number 3. above) was due on 03/03/2016 but was conducted on 19/05/2016.

Therefore, all measurements during the period from 01/05/2016 (beginning of the monitoring period) until 18/05/2016 have been multiplied with the maximum uncertainty as of the then valid QAL2 report (number 1 above, 1.0686 for N2O, 1.059 for Stack gas flow).</td></tr>
</table>

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: *± 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:** 27/01/2014 – 29/01/2014* **2. AST:** 04/03/2015 – 05/03/2015 **3. AST:** 19/05/2016 – 20/05/2016 **4. QAL2:** 14/03/2017 – 16/03/2017 *valid until*: *13/03/2018 (next AST), 13/03/2022 (next QAL2)* 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.
Purpose of data:	Calculation of project emissions or actual net GHG removals by sinks
Additional comments:	As parameters are converted to normal conditions during the monitoring process, this parameter is not needed and therefore not reported. The 2015 AST (number 2. above) was due on 27/01/2015 but was conducted on 04/03/2015 (period not part of this monitoring period). The 2016 AST (number 3. above) was due on 03/03/2016 but was conducted on 19/05/2016. Therefore, all measurements during the period from 01/05/2016 (beginning of the monitoring period) until 18/05/2016 have been multiplied with the maximum uncertainty as of the then valid QAL2 report (number 1 above, 1.0686 for N2O, 1.059 for Stack gas flow).

Data/parameter:	**ER_n**
Unit	tCO_2e
Description	Emission reductions in monitoring period
Measured/calculated/default	Calculated
Source of data	-
Value(s) of monitored parameter	426,012
Monitoring equipment	-
Measuring/reading/recording frequency:	-
Calculation method (if applicable):	$ER_n = BE_n - PE_n$
QA/QC procedures:	-
Purpose of data:	Calculation of project emissions or actual net GHG removals by sinks
Additional comments:	-

D.3. Implementation of sampling plan

>>

Not applicable

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>>

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) $BE_n = P_{NA,n} * EF_{BL,\ N2O,n} * GWP_{N2O} * 10^{-3}$

Where:

BE_n	= Baseline emissions in monitoring period *n* (tCO_2e)
$P_{NA,n}$	= Nitric acid produced in the monitoring period *n* ($tHNO_3$)
$EF_{BL,\ N2O,n}$	= Baseline N_2O emission factor for nitric acid production in the monitoring period *n* ($kgN_2O/tHNO_3$).
GWP_{N2O}	= Global Warming Potential of N_2O valid for the commitment period (310 tCO_2e until 31/12/2012 and 298 tCO_2e thereafter)

Sample calculations:

Year (n)	BE_n	$P_{NA,n}$	$EF_{BL,N2O,n}$	GWP_{N2O}	10^{-3}
2016	**314,207**	329,497	3.20	298	0.001
2017	**125,271**	140,125	3.00	298	0.001

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

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

(2) $EF_{BL,\ N2O,n} = EF_{default,\ y}$

Where:

$EF_{BL,N2O,n}$	= Baseline N_2O emission factor for nitric acid production in the monitoring period *n* ($kgN_2O/tHNO_3$).
$EF_{default,y}$	= Default N_2O baseline emissions factor in the calendar year *y* of the monitoring period *n* ($kgN_2O/tHNO_3$) (see list of $EF_{default,y}$ values under D.1).

Year (y)	$EF_{BL,\ N2O,y}$	$EF_{default,y}$
2016	3.20	3.20
2017	3.00	3.00

E.2. Calculation of project emissions or actual net GHG removals by sinks

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Project emissions include emissions of N_2O which have not been destroyed by the project activity and, in case of the installation of a tertiary N_2O abatement facility, CO_2 emissions resulting from the operation of the N_2O abatement facility. 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 CO_2 emissions from fossil fuel combustion" (Version 02) referred to in ACM0019.
Project emissions are calculated as follows:

(3) $PE_n = PE_{N2O,n} + PE_{CO2,tertiary,n}$

Where:

PE_n	= Project emissions in monitoring period *n* (tCO_2e)
$PE_{N2O,n}$	= Project emissions of N_2O from the project plant in monitoring period *n* (tCO_2e)
$PE_{CO2,tertiary,n}$	= Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in monitoring period *n* (tCO_2)

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

PE_n	$PE_{N2O,n}$	$PE_{CO2,tertiary,n}$
13,466	12,456	1,008

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

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

(4) $PE_{N2O,n} = (Q_{N2O,tail\ gas,n} + Q_{N2O,by\text{-}pass,n}) * GWP_{N2O}$

Where:

$PE_{N2O,n}$	= Project emissions of N_2O from the project plant in monitoring period *n* (tCO_2e)
$Q_{N2O,tail\ gas,n}$	= Amount of N_2O released through the tail gas of the project plant to the atmosphere in monitoring period *n* (tN_2O)
$Q_{N2O,\ by\text{-}pass,n}$	= 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)[3]
GWP_{N2O}	= Global warming potential of N_2O valid for the commitment period (298 tCO_2e)

Sample calculations:

Year (n)	$PE_{N2O,n}$	$Q_{N2O,tail\ gas,n}$	$Q_{N2O,by\text{-}pass,n}$	GWP_{N2O}
2016	**8,647.56**	29.02	0	298
2017	**3,808.41**	12.78	0	298

Determination of $Q_{N2O,tail\ gas,n}$

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

- Throughout the crediting periods of the project activity, the N_2O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Standard EN 14181 (2004), or any more recent update of that standard;
- The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on 2 seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be

[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 B.7.1.

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 N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;
- If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values.

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

With:

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

Where:

$F_{i,t}$ = mass flow of greenhouse gas N_2O in the gaseous stream in time interval *t* (kg gas /h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on dry basis (m^3 dry gas/h)[4]
$v_{i,t,db}$ = Volumetric fraction of greenhouse gas N_2O in the gaseous stream in a time interval *t* on a dry basis (m^3 gas N_2O/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas N_2O in the gaseous stream in a time interval *t* (kg gas N_2O/m^3 gas N_2O)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas N_2O (kg/kmol)
R_u = Universal ideal gases constant (Pa.m^3/kmol.K)
T_t = Temperature of the gaseous stream in time interval *t* (K)

[4] Please note that units are presented according to the applied methodology and tools. Here and forthcoming all m^3 units are referring to m^3.in standard conditions.

Sample calculation for equation (5) applying values for 2016:

$F_{i,t}$	$V_{t,db}$	$v_{i,t,db}$	$\rho_{i,t}$
5.129	184,137	0.0000142	1.964

Sample calculation for equation (6)*:*

$\rho_{i,t}$	P_t	MM_{N2O}	Ru	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 **($m_{H2O,t,db}$)** 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:

$$V_{t,db} = V_{t,wb}/\left(1 + V_{H2O,t,db}\right) = V_{t,wb} \quad (7)$$

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)
$v_{H2O,t,db}$ = 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 from 30/08/2016 17:00:

$V_{t,db}$	$V_{t,wb}$	**1 + $v_{H2O,t,db}$**
1887,548	187,548	1

The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to equation (8):

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}} \quad (8)$$

Where:

$v_{H2O,t,db}$ = 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)
$m_{H2O,t,db}$ = 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_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O)

As stated above, $m_{H2O,t,db}$ is assumed to be 0. Accordingly $v_{H2O,t,db}$ 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:

$$Q_{N2O,tailgas,n} = \sum_{h=1}^{h=h_n} F_{N2O,tailgas,h} * 10^{-3} \quad (9)$$

Where:

$Q_{N2O,tailgas,n}$ = Amount of N_2O released through the tail gas of the project plant to the atmosphere in monitoring period *n* (tN_2O)
$F_{N2O,tailgas,h}$ = 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)	$Q_{N2O,tail gas,n}$	$\sum F_{N2O,tail gas,h}$	10^{-3}
2016	**29.02**	29,018.67	0.001
2017	**12.78**	12,779.90	0.001

During any periods in which a tertiary abatement system is by-passed, $F_{N2O,tailgas,h}$ 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) $Q_{N2O, by-pass;n} = EF_{BL, N2O,n} * P_{NA.n} * T_{open,n} * 10^{-3}$

Where:

$Q_{N2O, by-pass;n}$ = 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)
$EF_{BL, N2O,n}$ = 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)	$Q_{N2O,by-pass,n}$	$EF_{BL,N2O,n}$	P_{NA}	$T_{open,n}$	10^{-3}
2016	**0.00**	3.20	329,497	0	0.001
2017	**0.00**	3.00	140,125	0	0.001

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

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) $PE_{CO2,tertiary,n} = PE_{FF,n}$

Where:

$PE_{CO2\ ,tertiary,n}$ = 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) $PE_{FF,n}= PE_{FC,j,y}$

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

Where:

$PE_{FC,j,n}$	= CO_2 emissions from fossil fuel combustion in process *j* in monitoring period *n* (tCO_2/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)
$COEF_{i,n}$	= CO_2 emission coefficient of fuel type *i* in monitoring period *n* (tCO_2/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)	$PE_{CO2,tertiary,n}$	$\sum FC_{i,j,n}$	$COEF_{i,n}$
2016	**649.52**	313.50	2.072
2017	**358.60**	173.08	2.072

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 CO_2 emissions from fossil fuel combustion" (Version 02):

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

Where:

$COEF_{i,n}$	= CO_2 emission coefficient of fuel type *i* in monitoring period *n* (tCO_2/mass or volume unit)
$w_{C,i,y}$	= Is the weighted average mass fraction of carbon in fuel type *i* in year *y* (tC/mass unit of the fuel)

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

$COEF_{i,n}$	$w_{C,i,y}$	
2.072	0.565	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	71.34
M_{C2H6}	30.07	g/mol	0.20
M_{CO2}	44.01	g/mol	11.11
M_{N2}	28.0134	g/mol	17.34

E.3. Calculation of leakage

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Any leakage emissions sources are deemed to be negligible.

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

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
2016	314,207	9,298	0	0	304,909	304,909
2017	125,271	4,168	0	0	121,103	121,103
Total	439,478	13,466	0	0	426,012	426,012

E.4. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	458,254*	426,012

* The monitoring period covers parts of 2016 (245 days) and parts of 2017 (120 days). The value above is calculated as follows:

ER_{MR} (PDD) = ER_{2016} (PDD) / 365 days * 245 days + ER_{2017} (PDD) / 365 days * 120 days

458,254 = 468,344 / 365 * 245 + 437,654 / 365 * 120

E.5. Remarks on difference from estimated value in registered PDD

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Not applicable.

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for completing the CDM-MR-FORM
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