Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	Catalytic abatement of N2O in Nitric Acid Plant of Shiraz Petrochemical Company	
UNFCCC reference number of the project activity	8249	
Version number of the PDD applicable to this monitoring report	Version 11	
Version number of this monitoring report	Version 07.0	
Completion date of this monitoring report	31/07/2020	
Monitoring period number	3	
Duration of this monitoring period	23/09/2017-22/09/2018	
Monitoring report number for this monitoring report	1	
Project participants	1.Shiraz Petrochemical Company 2. Mehr Renewable Energies Company 3. Climate Protection Finance AG	
Host Party	Islamic Republic of Iran	
Sectoral scopes	Scope 5: Chemical industries	
Applied methodologies and standardized baselines	AM0028 / version 05.1.0 "Catalytic N2O destruction in the tail gas of nitric acid or caprolactam production plants"	
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
	NA	340,191
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	791,200 (731,361*357/330)	

SECTION A. Description of project activity

A.1. General description of project activity

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The objective of the project activity is to reduce the emission of N_2O from tail gas of Nitric Acid production process in the Nitric Acid Plant of Shiraz Petrochemical Company (herein after “SPC”) by installing a catalytic N_2O abatement system.

SPC is the only nitric acid producing commercial company in Iran, located in Shiraz which is the fourth biggest city in Iran. The company is in operation since 1963 to produce nitric acid, ammonia, ammonium nitrate, urea, and some other chemicals. Nitrous Oxide (N_2O) is an undesired by-product of ammonia oxidation reaction (to produce nitric acid).

The purpose of this project activity is to reduce N_2O emission of the tail gas of nitric acid plant by installation of a DeN_2O-$DeNO_X$ unit before releasing to atmosphere. The project activity includes installation of a DeN_2O-$DeNO_X$ unit at the tail gas of nitric acid plant, which is decomposing N_2O and NO_X by chemical reaction over a catalytic bed to N_2 and O_2. A new reactor carrying the catalyst with related aggregates as like a FD-fan, heat exchanger, burner and monitoring system has been installed in the project activity.

This abatement unit is utilizing a catalytic bed to decompose N_2O to its elements N_2 and O_2, thus is reducing N_2O (Greenhouse Gas) emission. The performance result of project equipments which granted by technology provider is 90%, while the installed abetment technology, now is decomposing the N2O with efficiency of around 97%, hence it is expected, its generated emission reduction is higher than ex-ante amount. Also the plant utilize Natural Gas as fuel for heating the tail gas, which has resulted in some emissions as a result of consumption of fossil fuels used for heating the tail gas to the required temperature of catalyst, also some ammonia used to decompose NO_X emissions.

Consequently, SPC decided to do required actions to secure CDM before starting the project activity. The project PDD has registered in UNFCCC on 31/12/2012. The start date of the project activity is 01/12/2012, the date of the purchase order for the DeN_2O/$DeNO_X$ unit and monitoring equipments such as N_2O analyzers. Also N_2O decomposition plant commissioning has been start on July-2016 and finished on end of November-2016.

This monitoring period is from 23/09/2017 to 22/09/2018. The total emission reductions achieved in this period is 340,191 tCO2e.

A.2. Location of project activity

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The project site is located at the facilities of Shiraz Petrochemical Company, km 5, Polkhan road, Shiraz, Iran. The coordinates of the project are: 29° 53' 21" N – 52° 44' 15" E.

Figure A-1 shows the project location.

Figure A-1: Project location

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Iran (host Party)	Shiraz Petrochemical Company Mehr Renewable Energies Company	**No**
Switzerland	Climate Protection Finance AG	**No**

A.4. Reference to applied methodologies and standardized baselines

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The project activity uses the approved large-scale methodology AM0028 "Catalytic N2O destruction in the tail gas of nitric acid or caprolactam production plants" (Version 05.1.0). Refer to: https://cdm.unfccc.int/methodologies/DB/Y0S50SAZFK4FJOMZH2T7EN1I3HI8T0

A.5. Crediting period type and duration

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The chosen crediting period: 7 years (Renewable)
The start date of crediting period: 01/10/2014.

Crediting period: 01/10/2014 – 30/09/2021 (Renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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General Introduction:

The industrial production of nitric acid (HNO_3) involves oxidizing ammonia (NH_3) with air over a platinum/rhodium gauze catalyst to produce nitrogen oxides in Ammonia Oxidization Reactor (AOR). This process yields nitrogen monoxide (NO), which then reacts with oxygen and water (in the Absorption Tower) to form nitric acid. However, it also produces nitrous oxide (N_2O) – a known Greenhouse Gas and Ozone killer – as an unintended by-product. Unlike NO, the nitrous oxide is not involved in the HNO_3 production process and is emitted into atmosphere with the tail gas.

Desired reaction:

$4\ NH_3 + 5\ O2 \rightarrow 4\ NO + 6\ H_2O$

Undesired reactions:

$4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$

$4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$

Up and downstream of the catalyst gauzes further nitrous oxide is formed through reactions between unconverted ammonia and nitric oxide:

$2\ NH_3 + 8\ NO \rightarrow 5\ N_2O + 3\ H_2O$

$4\ NH_3 + 4\ NO + 3\ O_2 \rightarrow 4\ N_2O + 6\ H_2O$

In the baseline scenario, above reactions occur in SPC Nitric Acid plant, which means that except nitric acid as the product of the plant, some undesired by-products are being produced and vented to atmosphere. One of these undesired by-products, Nitrous Oxide (N_2O), is known as a major Greenhouse Gas.

TableB- 1: Nitric Acid plant specification (baseline scenario)

Description	Unit	Design Value
Plant Capacity / Actual	*Mt/Y*	600 mtpd 100% HNO_3 Actual:198,000 Mt/Y (330 Working days/year)
Process	*GRANDE PAROISSE*	Medium Pressure Oxidation And High Pressure Absorption
Campaign Length	*Days*	180 days
NH3 Oxidizer Data	*Operating Pressure MpaA*	5.37 kg/cm^2 abs
	Temperature(˚C)	880
	Oxidation efficiency(%)	95.5
	NH_3 Flow Rate kg/h	7,057
	NH_3 Consumption Kg-NH_3 / t-HNO_3 100%	280
	NH_3 Content vol%	99.9
Oxidation Catalyst	*Pt, Rh, Rd Composition ratio(%)*	90% Pt , 10%Rh , 0%Pd
	Gauze Type	Woven/Knitted
	Number of Gauze	8
	Absorber Pressure MPaA	9.83 Kg/cm^2 abs
Tail Gas	*Temperature(˚C)*	153
	Flow rate(Nm^3/h)	88,200
	Comp. N_2 vol%	95.93
	H_2O vol%	0.46
	O_2 vol%	3.59
	NO_X mg/Nm^3	0.02
Existing DeNO_x Facility		None

Source: Plant design documents, SPC

Project Specific description:

The project includes installation of a catalytic bed and channelling the tail gas of the nitric acid plant through it. The catalytic bed is designed to decompose the N_2O to N_2 and O_2.

N_2O Decomposition Mechanism

$N_2O + * \rightarrow N_2 + O*$
$2O* \rightarrow O_2 + 2*$

In addition to the De-N_2O technology, the project also includes abatement of NO_X in the tail gas. There was no NO_X abatement/decomposition system in SPC before implementation of the project activity.

NO_X Decomposition Mechanism

$NO + O* \leftarrow\rightarrow NO_2 + *$
$2NO_2 \leftarrow\rightarrow 2NO + O_2 + *$
$6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$
*: Radical

List of Equipment which have installed through the project activity are;

- F.D. Fan: to blow the tail gas through abatement reactor (catalytic bed)
- Heat Exchanger: to recover heat from tail gas venting to atmosphere
- Combustor: to increase tail gas temperature to a value suitable for catalytic reaction
- Catalytic bed: to abate the N_2O and NO_X by chemical reaction over catalyst
- Piping & Connections: to connect above equipment together and to existing plant

The temperature of the tail gas over the installed catalyst should be about 500 ºC, thus some natural gas is used for re-heating the tail gas.
Heat recovery system is used to prevent excessive consumption of natural gas, hence project emissions is reduced accordingly.
As while the catalyst has installed out of the ammonia reactor near to the stack, it is an end-of-pipe technology similar to the well-established catalytic NO_X reduction processes, known as tertiary technology. This technology has almost no influence on nitric acid production and it has high N_2O decomposition rate.
The applied technology reduces the NO_X emissions distinctively by introducing a $DeNO_X$ unit although SPC has satisfied NO_X regulation in Iran without any $DeNO_X$ unit. Ammonia is consumed in the $DeNO_X$ process as the reducing agent.

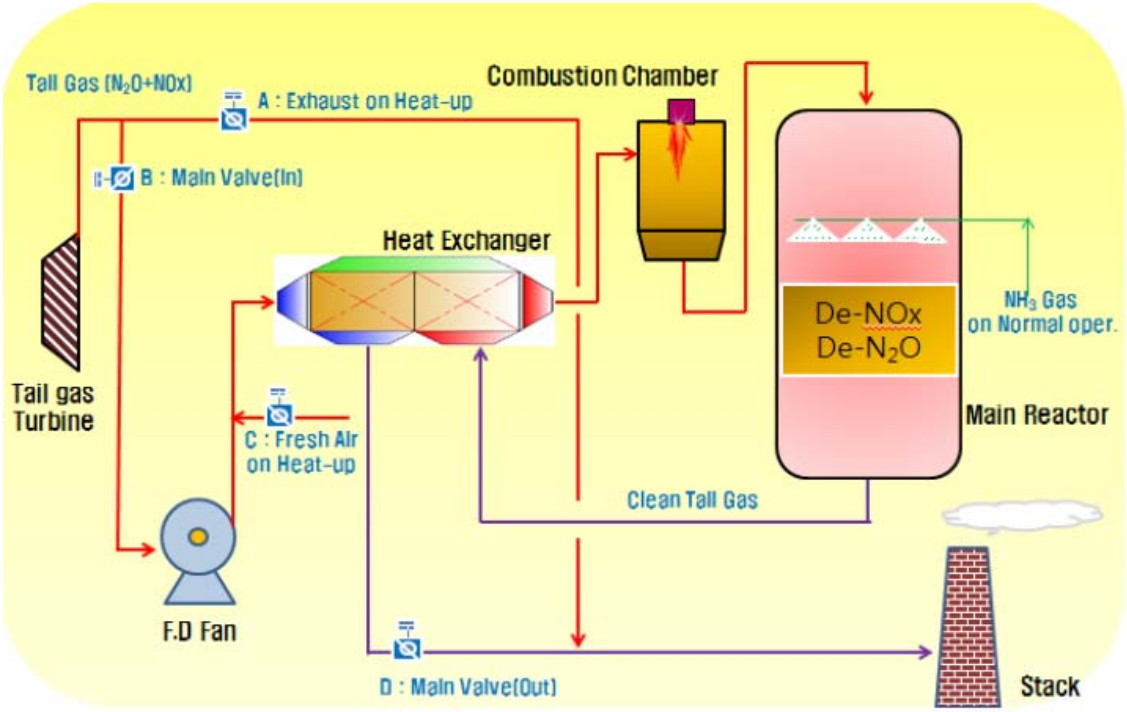

Figure B-1: Configuration of the N_2O/NO_X abatement system

The specification of the DeN2O system

The specification of the installed DeN2O system is shown in the following table.

TableB- 2: DeN_2O system specification

Item	Unit	Value	Note
Tail gas flow rate	m^3/h	88,200	Design value
Tail gas temperature	C	153	Exit of turbine
Tail gas pressure	Bar	0.89	
Natural gas flow rate	Nm^3/h	450	For re-heating of tail gas
Ammonia flow rate	Kg/hr	140	For NO_X decomposition
N_2O concentration of the entrance	Ppmv	2014.7	It is extracted from daily average monitored N2O concentration in tail gas of AOR for ex-ante emission calculation
N_2O concentration of the exit	Ppmv	201.47	It aims at 90% or more of DeN_2O
Catalyst Quantity	m^3	18	Ceramic type
Life time	Year	2.5	Based on manufacturer's document

Source: Design documents, SPC & Technology Provider

Whole N_2O abated by the project activity has been released to atmosphere in baseline scenario without any recovery or reduction.

B.2. Post-registration changes

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

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The temporary deviation has been applied to the monitoring plan during this monitoring period, because for the period 21/11/2017 to 28/04/2018 (including both days, 159 days), the CI N2O recording system did not record the continuously measured N_2O concentration in the inlet tail gas, properly.

In line with paragraph 231 (b) (i) of Project Standard for project activities, version 02, in the absence of any alternative monitoring arrangements, PP has applied zero baseline emissions for the entire non-conforming monitoring period which is the most conservative approach. Furthermore, being more conservative PP has considered the project emissions in the calculation of emission reductions for this period as per the monitored data.

B.2.2. Corrections

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No corrections have been submitted with this monitoring report or approved during this monitoring period.

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

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The request for changing the start date of the crediting period has requested and approved by EB.

B.2.4. Inclusion of monitoring plan

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No monitoring plan was included to the registered PDD that was not included at registration, during this monitoring period.

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

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No permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodology or other applied standards or tools has been included.

B.2.6. Changes to project design

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The following changes under PRC have been requested and approved by EB on 30 January 2020.

- Historical operating temperature range of the ammonia oxidation reactor($T_{g,hist}$) from 840 - 860 ^{0}C to 862-874 ^{0}C
- N_2O concentration at the inlet of the N_2O destruction facility (CI_{N2O}), It was changed from 1,120 ppm to 2014.7 ppm.
- Change the Gauze type of AOR catalyst, the type of catalyst has been changed from Woven to Knitted type in the mid of monitoring period (28/04/2018) with same composition (90% Pt., 10% Rh., 0% Pd.),
- Changes the GWP of Greenhouse Gases (GHGs), from IPCC Third Assessment Report (TAR) value to IPCC Fourth Assessment Report (AR4).

Please see the PRC request web-link as below:
https://cdm.unfccc.int/PRCContainer/DB/prcp538356995/view

B.2.7. Changes specific to afforestation or reforestation project activity

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Not applicable for the project activity

SECTION C. Description of monitoring system

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In order to ensure the successful operation of the project and the creditability and verifiability of the CERs achieved, a well-defined management and operational system has been designed and implemented.

Project Proponent monitors the emission reductions generated by the project activity. Project Proponent has formed an operational team, which is responsible for the monitoring of all the required data. This team is composed by the project manager who is the SPC Plant Manager, operation department managed by the Operation Manager of SPC, and maintenance department managed by Maintenance Manager of SPC. Company has been ISO 9001 certified, on which all the project quality management activities are based.

Figure C-1 outlines the operational and management structure for monitoring of the project activity.

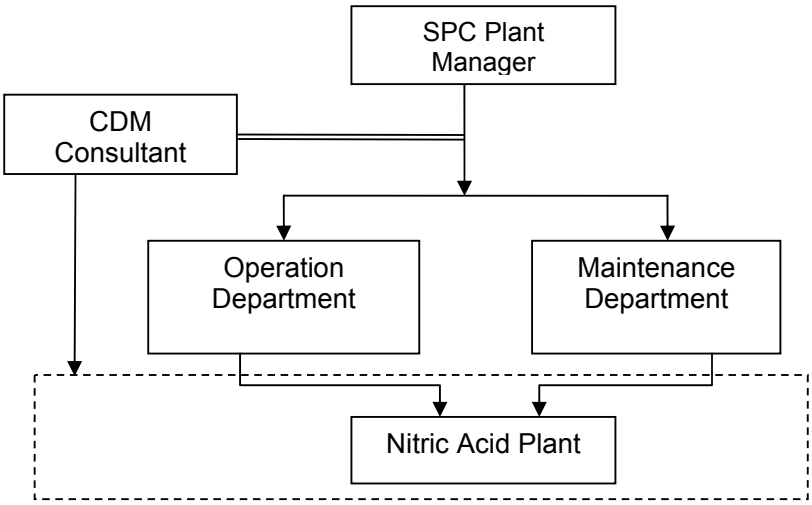

Figure C-1: Operational and management structure for monitoring the project activity

Responsibility of operation department:

SPC has been operating the nitric acid plant since the commissioning of the plant for number of years and has sufficient and well experienced staff to operate. In addition, the technology provider has provided an on-site training course for operation of the monitoring equipment according to the operating manuals of the monitoring equipment.

Responsibilities of the operation department are as follows:

1. Monitors continuously and records every two hours (aggregated daily) the different parameters mentioned in section D.2 below. Hence, the monitoring of the relevant data of DeN_2O-$DeNO_X$ unit is done automatically by new logging system and recorded onto the electronic media.
2. Records and archives data using paperwork and computer software. The computerized records will serve as back-up purpose and archived at Project site. All the data will be kept at least for 2 years after the end of crediting period.
3. Cross-checks the monitored data of nitric acid production ($P_{product,y}$) against ammonia consumption and sales (weighting) records of nitric acid.
4. Elaborates an estimate of emission reduction in an Emission Reduction Monitoring Report annually, based on the electronic data of Automated Measuring System.
5. Ensures that operators are appropriately trained and assigned for monitoring/checking the different parameters/meters with courses and an instruction manual.
6. Reviews the instruction manual for its effectiveness and improvement. This manual will be made available during verification.

Operation manager is responsible for the credibility and accuracy of the monitored data. In case deviation in the monitoring data is found, operation manager studies the operating parameters to identify the reason for the deviation and take remedial measures. If there are no changes in the operating parameters, the monitoring system will be examined. Once the fault is identified, the operation manager will introduce a correction to the fault. The operation manager reports such irregular event to project manager.

Responsibility of maintenance department:

All monitoring instruments are maintained, inspected and calibrated based on the manufacturers' requirement and SPC internal procedures, supported by an on-site training course for maintenance of the monitoring equipment by technology provider.

Responsibilities of the maintenance department are as follows:

1. Ensures that all meters installed at the plant are calibrated according to the company procedures and manufacturer's requirements.
2. Elaborates the Calibration Report annually. The Calibration Report is composed listing all CDM related instruments, their details, calibration status and expected error.

Responsibility of project manager:

Project manager has the entire responsibility of the CDM project and monitoring plan. SPC's Plant Manager is the project manager, and provides the annual monitoring report.

1. Manages and supervises all monitoring activities under the project.
2. Reviews and approves the Emission Reduction Monitoring Report with all its attachments.
3. Subjects the Calibration Report Status to internal audit and provides as an attachment in the annual Emission Reduction Monitoring Report, for verification.

Table C-1: Description of monitoring tasks and their responsible bodies

	Tasks description	Operator	Operation Manager	Maintenance Manager	Project Manager	CDM Consultant
Monitoring activity						
1	Recording of monitored data	✓				
Quality Assurance & Quality Control						
2	Verification of data monitored (consistency and completeness)		✓			
3	Ensuring adequate training of staff		✓			
4	Ensuring adequate maintenance			✓		
	Ensuring calibration of monitoring instruments			✓		
5	Data archiving: ensuring adequate storage of data monitored (integrity and backup): 2 years after the end of the crediting period		✓			
6.	Identification of non-conformance and corrective/preventive actions and monitoring plan improvement		✓			
7	Emergency procedures		✓			
8	External audit					✓
Calculation of GHG emission reductions and reporting						
9	Processing of data and calculation of emission reductions				✓	
10	Monitoring report: management review of monitoring report (internal audit)				✓	

Data monitoring

The following sections (D.1 and D.2) provide a detailed description of the application of the monitoring methodology and a description of the monitoring plan, including an identification of the data to be monitored and the procedures that are applied during monitoring.

Monitoring points for key parameters are shown in Figure C-2 below, and the list of parameters and related instruments are summarized in Table C-2 below.

Additionally measured data are recorded in paperwork through Daily Recording Forms, Monthly Reporting Form and Annual Reporting Form.

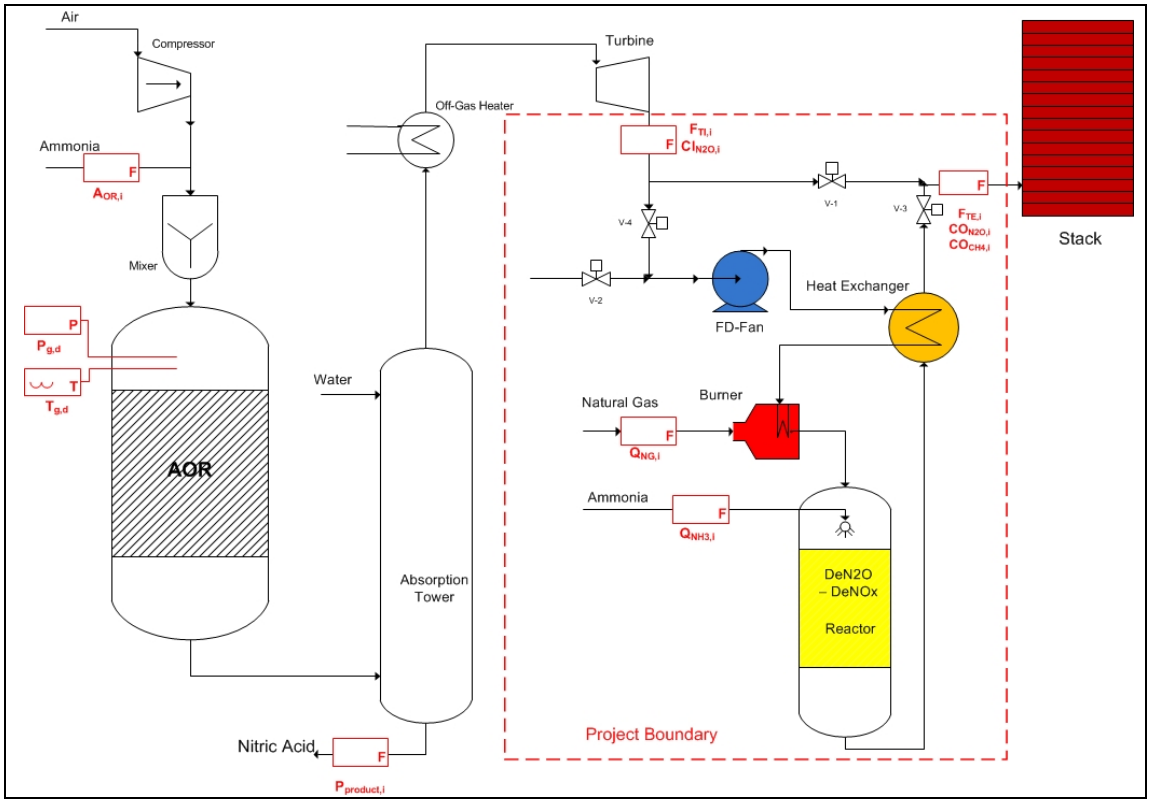

Figure C-2: Monitoring points for key parameters

Table C-2: List of monitoring parameters and instruments

Parameter	Description	Instrument
AOR	Actual ammonia flow rate to AOR	Flow meter
P_g	Actual operating pressure of the AOR	Pressure sensor
T_g	Actual operating temperature of the AOR	Temperature sensor
F_{TI}	Volume flow rate at the inlet of the destruction facility	Flow meter
F_{TE}	Volume flow rate at the exit of the destruction facility	Flow meter
CI_{N2O}	N2O concentration at the inlet of destruction facility	Fourier Transform Infrared Spectrometer
CO_{N2O}	N2O concentration at the outlet of destruction facility	Fourier Transform Infrared Spectrometer
Q_{NG}	Additional natural gas input for re-heating the tail gas	Flow meter
CO_{CH4}	CH4 concentration at destruction facility outlet	Methane concentration analyzer
$P_{product}$	Plant output of nitric acid	Flow meter
Q_{NH3}	Ammonia consumption as agent for NOx reduction in De-N2O/De-NOx facility	Flow meter

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	GWP_{N2O}
Unit	tCO_2e / tN_2O
Description	Global warming potential of nitrous oxide
Source of data	IPCC, The Fourth Assessment Report
Value(s) applied	298
Choice of data or measurement methods and procedures	Specified in the applied methodology
Purpose of data/parameter	Calculation of baseline and project emission
Additional comments	--

Data/Parameter	GWP_{CH4}
Unit	tCO_2e / tCH_4
Description	Global warming potential of nitrous oxide
Source of data	IPCC, The Fourth Assessment Report
Value(s) applied	25
Choice of data or measurement methods and procedures	Specified in the applied methodology
Purpose of data/parameter	Calculation of project emission
Additional comments	--

Data/Parameter	EF_{NH3}
Unit	tCO_2 / tNH_3
Description	Ammonia Production GHG Emission Factor
Source of data	IPCC
Value(s) applied	2.14
Choice of data or measurement methods and procedures	According to the applied methodology, a default factor of 2.14 tCO_2e/tNH_3 (Global Emission Model for Integrated Systems (GEMIS) Version 4.2) is suggested for this parameter.
Purpose of data/parameter	Calculation of project emission
Additional comments	--

Data/Parameter	$Type_{HC}$
Unit	--
Description	Type of hydrocarbon
Source of data	Fuel supplier
Value(s) applied	Type of hydrocarbon: Natural gas. Natural gas supplier's name: National Iranian Gas Company (NIGC)
Choice of data or measurement methods and procedures	Not Applicable.

Purpose of data/parameter	Calculation of project emissions
Additional comments	Please refer to SPC Monitoring Period 3_ ER Calculation Sheet for details of natural gas composition.

Data/Parameter	EF_{CH4}
Unit	tCO_2 / tCH_4
Description	Emission factor of methane
Source of data	Theoretical calculation
Value(s) applied	2.75
Choice of data or measurement methods and procedures	This value is theoretically calculated as follows; 44 gCO_2/16gCH_4
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	ρ_{CH4}
Unit	t / Nm_3
Description	Density of methane
Source of data	Tool to determine project emissions from flaring gases containing methane
Value(s) applied	0.000716
Choice of data or measurement methods and procedures	Tool to determine project emissions from flaring gases containing methane Here, this value is given at the normal condition (0°C, 1atm). For this project, the value converted into the normal condition is applied as this parameter. In case of the normal condition, this parameter can be given by theoretical value.
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	$OXID_{HC}$
Unit	%
Description	Oxidization factor of hydrocarbon (natural gas,) with two or more molecules of carbon
Source of data	AM0028 / Version05.1.0
Value(s) applied	100%
Choice of data or measurement methods and procedures	For this project, in conservative manner, 100% is applied for this parameter based on AM0028 / Version05.1.0 The value does not affect the final results significantly.
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	$P_{product, max}$
Unit	$tHNO_3$ / yr
Description	Design capacity of nitric acid production plant. Definition of "existing" production capacity is applied for the process with the existing ammonia oxidization reactor where N_2O is generated and not for the process with new ammonia oxidizer.
Source of data	Design documents
Value(s) applied	198,000
Choice of data or measurement methods and procedures	According to the applied methodology
Purpose of data/parameter	Calculation of baseline emission
Additional comments	The amount of emission reductions is capped by $P_{product,max}$

Data/Parameter	$A_{OR,hist}$
Unit	tNH_3/day
Description	Maximum of historical ammonia flow rate of the ammonia oxidization reactor (AOR)
Source of data	Plant records (Historical operating data in AOR)
Value(s) applied	194
Choice of data or measurement methods and procedures	These values has set based on maximum values of historical data. (21 Mar 2010－ 20 Mar 2011).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The data are measured by operation department of nitric acid plant of SPC, and all meters are under control of maintenance department.

Data/Parameter	$T_{g,hist}$
Unit	°C
Description	Historical operating temperature range of the ammonia oxidation reactor
Source of data	Plant records (Historical operating data in AOR. In absence of reliable historical data, the provided information by manufacture is used)
Value(s) applied	862 ~ 874
Choice of data or measurement methods and procedures	Operating temperature is measured by thermo-couple inside the AOR. The permitted range of operating temperatures is set based on historical data (21 Jan. 2017 －22 Sep. 2018). While the maximum of temperature was double-checked with technical data, which was provided by, AOR manufacture.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The data is used to check whether the ammonia oxidization reactor is operated normally. The data are measured by operation department of nitric acid plant of SPC, and all meters are under control of maintenance department.

Data/Parameter	$P_{g,hist}$
Unit	Pa
Description	Historical operating pressure range of the ammonia oxidation reactor

Source of data	Plant records (Historical operating data in AOR)
Value(s) applied	406,634 ~ 509,949 Pa (absolute) / 4.2 ~ 5.2 kg/cm^2-abs
Choice of data or measurement methods and procedures	The permitted range of operating pressures are set based on historical data (21 Mar 2010 －20 Mar 2011), while the maximum of pressure was double-checked with technical data, which was provided by, AOR manufacture. As while the pressure unit is measured as kg/cm^2 by the plant instrument, the value is converted from kg/cm^2 into Pa.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The data is used to check whether the ammonia oxidization reactor is operated normally. The data are measured by operation department of nitric acid plant of SPC, and all meters are under control of maintenance department

Data/Parameter	$G_{sup,his}$
Unit	--
Description	Historical supplier of the ammonia oxidization catalyst
Source of data	Purchase records
Value(s) applied	Name of the supplier: For the AOR, Hindustan Platinum
Choice of data or measurement methods and procedures	For the AOR, it consists of one woven/knitted type gauze (Pt gauze).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	--

Data/Parameter	$G_{com,hist}$
Unit	%
Description	Historical composition of the ammonia oxidization catalyst
Source of data	Purchase records and supplier's specification
Value(s) applied	For the AOR, Pt gauze Specification: Pt: 90.0 %, Rh:10%, Pd: 0%
Choice of data or measurement methods and procedures	For the AOR, it consists of one woven type gauze (one layer). It is Pt gauze.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	SPC has used above-mentioned catalysts.

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Data/Parameter	$F_{TE,i}$
Unit	m^3/hr
Description	Volume flow rate at the exit of destruction facility during interval *i*
Measured/calculated/ default	Measured
Source of data	Flow meter with normalizing functions
Value(s) of monitored parameter	Is provided in ER Calculation Sheet

Monitoring equipment	type: pitot tube type/ ABB accuracy class: ±2% serial number: 3K650000269898/1251111 calibration frequency: Annual date of last calibration before start of monitoring period: 04/08/2017 date of first calibration during the monitoring period: 04/07/2018 date of second calibration during the monitoring period (last calibration): Not Applicable validity: One year date of next calibration (due date): 04/07/2019
Measuring/reading/recording frequency	Measuring: Continuously Reading: every two hour Recording: every two hour
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Refer to QA / QC procedures cited in Appendix of PDD , Both of F_{TI} and F_{TE} parameters has cross-checked to ensure that no leak of N_2O is taking place. There is not observed any discrepancy.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Key parameter

Data/Parameter	$CO_{N2O,i}$
Unit	tN2O/m^3
Description	N_2O concentration at destruction facility outlet
Measured/calculated/ default	Measured
Source of data	Fourier Transform Infrared Spectrometer (FT-IR)
Value(s) of monitored parameter	Is provided in ER Calculation Sheet (this concentration is measured in ppmv and then converted to tN_2O/tNm^3 as follows: Concentration in ppmv: X Concentration in $tN_2O/Nm^3 = X * 10^{-6} * 44/22.4 / 1000$ (tN_2O/Nm^3)
Monitoring equipment	type: Fourier Transform Infrared Spectrometer / GASMET accuracy class: ±2% serial number: 153167 calibration frequency: Annual date of last calibration before start of monitoring period: 16/12/2016 date of first calibration during the monitoring period: 16/12/2017 and 04/07/2018 date of second calibration during the monitoring period (last calibration): NA validity: One year date of next calibration (due date): 04/07/2019
Measuring/reading/recording frequency	Measuring: Continuously Reading: every two hour Recording: every two hour
Calculation method (if applicable)	Not Applicable

QA/QC procedures	QA/QC for the analyzer is according to EN14181. For more details, please refer to Appendix 5 of PDD.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Key parameter

Data/Parameter	M_i
Unit	hr
Description	Measuring interval
Measured/calculated/ default	Measured
Source of data	Defined in the technical specifications of data logging system
Value(s) of monitored parameter	2
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Not Applicable
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	--

Data/Parameter	$Q_{NH3,y}$
Unit	tNH_3
Description	N_2O destruction facility: Project Ammonia Input (as gas or in solution)
Measured/calculated/ default	Measured
Source of data	Coriolis flow meter
Value(s) of monitored parameter	1,036
Monitoring equipment	type: Coriolis flow meter/ ABB accuracy class: ±1.5% serial number: 210004182520 calibration frequency: Once every three years date of last calibration before start of monitoring period: 04/08/2016 date of first calibration during the monitoring period: NA date of second calibration during the monitoring period (last calibration): NA validity: Three year date of next calibration (due date): 04/08/2019
Measuring/reading/recording frequency	Measuring: Continuously Reading: monthly Recording: monthly
Calculation method (if applicable)	Not Applicable
QA/QC procedures	QA/QC is maintained by usual maintenance, inspection and calibration by SPC based on SPC procedures.
Purpose of data/parameter	Calculation of project emissions

Additional comments	--

Data/Parameter	$Q_{NG,y}$
Unit	Nm^3
Description	Hydrocarbon (Natural Gas for this project) input for re-heating the tail gas
Measured/calculated/ default	Measured
Source of data	Turbine flow meter (with normalizing functions)
Value(s) of monitored parameter	2,685,714
Monitoring equipment	type: Turbine Flow meter / Elster accuracy class: ±0.5% serial number: 80115982/2015 calibration frequency: Once every three years date of last calibration before start of monitoring period: 04/08/2016 date of first calibration during the monitoring period: NA date of second calibration during the monitoring period (last calibration): NA validity: Three year date of next calibration (due date): 04/08/2019
Measuring/reading/recording frequency	Measuring: Continuously Reading: daily Recording: daily
Calculation method (if applicable)	Not Applicable
QA/QC procedures	QA/QC is maintained by usual maintenance, inspection and calibration by SPC based on SPC procedures
Purpose of data/parameter	Calculation of project emissions
Additional comments	In case of this project, this parameter includes a fraction of non hydrocarbon contents such as N_2 and CO_2, because the natural gas contains them.

Data/Parameter	ρ_{HC}
Unit	ton/m^3
Description	Density of hydrocarbon, with two or more molecules of carbon (in case of this project, this parameter include a fraction of non hydrocarbon contents such as N_2 and CO_2, because the natural gas contains them.)
Measured/calculated/ default	Calculated
Source of data	Composition table of the natural gas provided by the supplier (NIGC)
Value(s) of monitored parameter	0.001480
Monitoring equipment	Not Applicable (This value is set based on the data supplied by the NG supplier in Iran (National Iranian Gas Co.)
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	This parameter is calculated according to the composition of the natural gas, provided by NIGC as follow: $\rho_{HC} = (\rho_{NG} - (\rho_{CH4} * CF_{CH4}))/ (1- CF_{CH4})$
QA/QC procedures	Not Applicable

Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	CF_{CH4}
Unit	--
Description	Methane content of the hydrocarbon (natural gas for this project)
Measured/calculated/ default	Calculated
Source of data	Composition table of the natural gas provided by the NG supplier (NIGC)
Value(s) of monitored parameter	0.904
Monitoring equipment	Not Applicable (This value is set based on the data supplied by the NG supplier in Iran (National Iranian Gas Co.))
Measuring/reading/recording frequency	Monthly
Calculation method (if applicable)	This parameter is calculated according to the composition of the natural gas, provided by NIGC.
QA/QC procedures	--
Purpose of data/parameter	Calculation of $Q_{CH4,y}$ *and* $PE_{HC,y}$ for project emissions
Additional comments	This parameter is used to divide $Q_{NG,y}$ into $Q_{HC,y}$ and Q_{CH4} .

Data/Parameter	$Q_{CH4,y}$
Unit	m^3
Description	Consumed methane
Measured/calculated/ default	Calculated
Source of data	This parameter is calculated by measurement of natural gas input multiplied by the methane content of the natural gas provided by NIGC
Value(s) of monitored parameter	2,427,617
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Not Applicable
Calculation method (if applicable)	Calculated based on the amount of natural gas consumed and its methane content: $Q_{CH4} = Q_{NG,y} * CF_{CH4}$
QA/QC procedures	Not Applicable
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	$Q_{HC,y}$
Unit	m^3
Description	Hydrocarbon, with two or more molecules of carbon, used (For this project, this parameter includes a fraction of non hydrocarbon contents such as N_2 and CO_2, because the natural gas contains them.)
Measured/calculated/ default	Calculated

Source of data	This parameter is calculated by measurement of natural gas input multiplied by the methane content of the natural gas provided by NIGC
Value(s) of monitored parameter	258,097
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Not Applicable
Calculation method (if applicable)	Calculated based on the amount of natural gas consumed and its methane content: $Q_{HC,y} = Q_{NG,y} * (1-CF_{CH4})$
QA/QC procedures	Not Applicable
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	EF_{HC}
Unit	tCO_2/tHC
Description	Emission factor of hydrocarbon, with two or more molecules of carbon (For this project, this parameter includes a fraction of non hydrocarbon contents such as N_2 and CO_2, because the natural gas contains them)
Measured/calculated/ default	Calculated
Source of data	Composition table of the natural gas provided by the NG supplier (NIGC)
Value(s) of monitored parameter	1.702
Monitoring equipment	Not Applicable: This value is set based on the data supplied by the NG supplier in Iran (National Iranian Gas Co.)
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	This parameter is calculated according to the composition of the natural gas, provided by NIGC.
QA/QC procedures	Not Applicable
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	$CO_{CH4,i}$
Unit	$tCH4/m^3$
Description	Methane concentration at the outlet of the destruction facility
Measured/calculated/ default	Measured
Source of data	Methane analyzer
Value(s) of monitored parameter	Is provided in ER Calculation Sheet. In case of this project, methane fraction of the tail gas is monitored (case1 is applied) based on the applied methodology AM0028 ver. 5.1.0 In this project activity natural gas is not used as reducing agent but is used as additional fuel for re-heating the tail gas. Although this parameter is not specified in the methodology, it is needed to calculate $OXID_{CH4.}$

Monitoring equipment	Methane analyzer type: Fourier Transform Infrared Spectrometer/ GASMET accuracy class: ±2% serial number: 153167 calibration frequency: Annual date of last calibration before start of monitoring period: 16/12/2016 date of first calibration during the monitoring period: 16/12/2017 and 04/07/2018 date of second calibration during the monitoring period (last calibration): NA validity: One year date of next calibration (due date): 04/07/2019
Measuring/reading/recording frequency	Measuring: Continuously Reading: every two hours Recording: every two hours
Calculation method (if applicable)	Not Applicable
QA/QC procedures	QA/QC is maintained by usual maintenance, inspection and calibration by SPC based on the manufacturers' requirement and SPC procedures
Purpose of data/parameter	Calculation of $OXID_{CH4}$ and project emissions.
Additional comments	(see parameter $OXID_{CH4}$ below)

Data/Parameter	$OXID_{CH4}$
Unit	%
Description	Oxidization factor of methane
Measured/calculated/ default	Calculated
Source of data	Calculated by $CO_{CH4,i}$, $Q_{CH4,y}$ and $F_{TE,i}$
Value(s) of monitored parameter	Is provided in ER Calculation Sheet.
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Not Applicable
Calculation method (if applicable)	This parameter is calculated as follows; $OXID_{CH4} = (1- \sum_i [F_{TE,i} * CO_{CH4,i} * M_i] / \rho_{CH4} / Q_{CH4}) * 100$
QA/QC procedures	Not Applicable
Purpose of data/parameter	Calculation of project emissions
Additional comments	In case that the monitoring system would be down during measuring intervals, 0% will be applied to $OXID_{CH4}$ in conservative manner.

Data/Parameter	$P_{product,y}$
Unit	$tHNO_3$ / yr
Description	Plant output of nitric acid

Measured/calculated/ default	Measured
Source of data	Volume flow meter type: Coriolis flow meter/ PROMASSF EH/Hauser and Endress accuracy class: ±0.1% serial number: H7138002000 calibration frequency: Once every three years date of last calibration before start of monitoring period: 04/08/2016 date of first calibration during the monitoring period: NA date of second calibration during the monitoring period (last calibration): NA validity: Three year date of next calibration (due date): 04/08/2019
Value(s) of monitored parameter	224,830
Monitoring equipment	volume flow meters
Measuring/reading/recording frequency	Measuring: Continuously Reading: 3 times a day Recording: 3 times a day
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Cross –check of exported (sold) nitric acid records and/or ammonia input. Measurement devices such as flow meter with temperature sensor are subjected to QA / QC scheme consistent with the manufacturers' requirement and SPC internal procedures.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The flow meter directly measures volume, multiplies to density of weak acid, and automatically converts it to mass. In addition, it is converted to 100% acid by multiplying to acid concentration.

Data/Parameter	$CI_{N2O,i}$
Unit	tN_2O/m^3
Description	N_2O concentration at the inlet of the N_2O destruction facility
Measured/calculated/ default	Measured
Source of data	Fourier Transform Infrared Spectrometer (FT-IR)
Value(s) of monitored parameter	Is provided in ER Calculation Sheet The value in measured in ppmv and shall be converted to tN_2O/Nm^3 as bellow; X[ppmv] $=X * 44/22.4 / 1000 [tN_2O/Nm^3]$

<table>
<tr><td>Monitoring equipment</td><td>N_2O analyzer
<table>
<tr><td>type</td><td>Fourier Transform Infrared Spectrometer/ GASMET</td></tr>
<tr><td>accuracy class</td><td>±2%</td></tr>
<tr><td>serial number</td><td>153221</td></tr>
<tr><td>calibration frequency</td><td>Annual</td></tr>
<tr><td>date of last calibration before start of monitoring period</td><td>16/12/2016</td></tr>
<tr><td>date of first calibration during the monitoring period</td><td>16/12/2017 and 04/07/2018</td></tr>
<tr><td>date of second calibration during the monitoring period (last calibration)</td><td>NA</td></tr>
<tr><td>validity</td><td>One year</td></tr>
<tr><td>date of next calibration (due date)</td><td>04/07/2019</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measuring: Continuously
Reading: every two hour
Recording: every two hour</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not Applicable</td></tr>
<tr><td>QA/QC procedures</td><td>QA/QC for the analyzer is according toEN14181. For more details, please refer to Appendix 5 of PDD.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>Key parameter</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$F_{TI,i}$</td></tr>
<tr><td>Unit</td><td>m^3/hr</td></tr>
<tr><td>Description</td><td>Volume flow rate at the inlet of destruction facility during interval i</td></tr>
<tr><td>Measured/calculated/ default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Flow meter with normalizing functions</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Is provided in ER Calculation Sheet</td></tr>
<tr><td>Monitoring equipment</td><td>Flow meter
<table>
<tr><td>type</td><td>pitot tube type/ Siemens</td></tr>
<tr><td>accuracy class</td><td>±2%</td></tr>
<tr><td>serial number</td><td>W8189030502</td></tr>
<tr><td>calibration frequency</td><td>Annual</td></tr>
<tr><td>date of last calibration before start of monitoring period</td><td>04/08/2017</td></tr>
<tr><td>date of first calibration during the monitoring period</td><td>04/07/2018</td></tr>
<tr><td>date of second calibration during the
monitoring period (last calibration)</td><td>Not Applicable</td></tr>
<tr><td>validity</td><td>One year</td></tr>
<tr><td>date of next calibration (due date)</td><td>04/07/2019</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measuring: Continuously
Reading: every two hour
Recording: every two hour</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not Applicable</td></tr>
</table>

QA/QC procedures	Refer to QA / QC procedures cited in Appendix 5 of PDD. Both of F_{TI} and F_{TE} parameters has cross-checked to ensure that no leak of N_2O is taking place. There is not observed any discrepancy.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Key parameter

Data/Parameter	$A_{OR,i}$
Unit	m^3/h
Description	Actual ammonia input to oxidation reactor during interval *i*
Measured/calculated/ default	Measured
Source of data	Orifice flow meter and differential pressure transmitter (with normalizing functions)
Value(s) of monitored parameter	Is provided in ER Calculation Sheet
Monitoring equipment	Orifice flow meter type: Orifice flow meter / SIEMENS accuracy class: ±0.5% serial number: N1-N820-9344989 calibration frequency: Once every three years date of last calibration before start of monitoring period: 16/12/2016 date of first calibration during the monitoring period: NA date of second calibration during the monitoring period (last calibration): NA validity: Three year date of next calibration (due date): 16/12/2019 Existing orifice flow meter and differential pressure transmitter with thermocouple/ transmitter is used to monitor the ammonia consumption continuously, which has been recorded every two hour (aggregated daily). For this plant, the ammonia input to AOR is measured for volume flow rate which is automatically converted into the ton at 20°C/1atmosphere.
Measuring/reading/recording frequency	Measuring: Continuously Reading: every two hour Recording: every two hour
Calculation method (if applicable)	Not Applicable
QA/QC procedures	QA/QC is maintained by usual maintenance, inspection and calibration by SPC based on the manufacturers' requirement and SPC procedures
Purpose of data/parameter	For considering permit range of operation condition.. , If the daily ammonia consumption in AOR is greater than 194 ton/day, the conservative value for N2O emission factor is used (IPCC default emission factor of 4.5 Kg N2O/ton nitric acid).
Additional comments	To check whether "normal" operation is undertaken

Data/Parameter	$T_{g,d}$
Unit	°C
Description	Actual operating temperature ammonia oxidation reactors on day *d*
Measured/calculated/ default	Measured
Source of data	Thermo-couple with transmitter
Value(s) of monitored parameter	Is provided in ER Calculation Sheet
Monitoring equipment	Thermo-couple/JUMO/ Tag. No:TI-31015
Measuring/reading/recording frequency	Measuring: Continuously Reading: every two hour Recording: every two hour
Calculation method (if applicable)	Not Applicable
QA/QC procedures	QA/QC is maintained by usual maintenance, inspection and calibration by SPC based on the manufacturers' requirement and SPC procedures. It was calibrated on 17/12/2016.
Purpose of data/parameter	For considering permit range of operation condition. If the actual average daily operating temperature (Tg,d) is beyond the Tg,hist (permitted range i.e 862-874 ^{0}C) in the AOR, the baseline N2O emissions for that period are capped at 4.5kgN2O/ton of nitric acid conservatively applying the IPCC default value.
Additional comments	To check whether "normal" operation is undertaken.

Data/Parameter	$P_{g,d}$
Unit	Pa
Description	Actual operating pressure ammonia oxidation reactors on day
Measured/calculated/ default	Measured
Source of data	Pressure gauge with pressure transmitter
Value(s) of monitored parameter	Is provided in ER Calculation Sheet

<table>
<tr><td>Monitoring equipment</td><td>Pressure gauge

<table>
<tr><td>type</td><td>Capsule pressure gauge/ FOXBORO</td></tr>
<tr><td>accuracy class</td><td>±0.5%</td></tr>
<tr><td>serial number</td><td>V-617683</td></tr>
<tr><td>calibration frequency</td><td>Once every three years</td></tr>
<tr><td>date of last calibration before start of
monitoring period</td><td>17/12/2016</td></tr>
<tr><td>date of first calibration during the monitoring period</td><td>NA</td></tr>
<tr><td>date of second calibration during the
monitoring period (last calibration)</td><td>NA</td></tr>
<tr><td>validity</td><td>Three year</td></tr>
<tr><td>date of next calibration (due date)</td><td>17/12/2019</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measuring: Continuously
Reading: every two hour
Recording: every two hour</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>Not Applicable</td></tr>
<tr><td>QA/QC procedures</td><td>QA/QC is maintained by usual maintenance, inspection and calibration by SPC based on the manufacturers' requirement and SPC procedures.</td></tr>
<tr><td>Purpose of data/parameter</td><td>For considering permit range of operation condition. If the actual average daily operating pressure (Pg,d) is beyond the Pg,hist (permitted range-406,634 ~ 509,949 Pa) in the AOR, the baseline N2O emissions for that period are capped at 4.5kg N2O/ton of nitric acid conservatively applying the IPCC default value</td></tr>
<tr><td>Additional comments</td><td>To check whether "normal" operation is undertaken.</td></tr>
</table>

Data/Parameter	G_{sup}
Unit	--
Description	Supplier of the ammonia oxidation catalyst
Measured/calculated/ default	Not Applicable
Source of data	Ammonia oxidation catalyst purchase order record
Value(s) of monitored parameter	The catalyst suppliers used after the project starts will be checked and evaluated by the verifier. The catalyst supplier in monitoring period is same as before project registration, i.e Hindustan Platinum Pvt. Ltd. There are not any changes in catalyst composition and type as comparison to registered PDD in this mentoring period.
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Not Applicable
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable
Purpose of data/parameter	Baseline emission calculation
Additional comments	--

Data/Parameter	G_{com}
Unit	%

Description	Composition of the ammonia oxidation catalyst
Measured/calculated/ default	Measured
Source of data	Ammonia oxidation catalyst purchase order record
Value(s) of monitored parameter	The catalyst suppliers used after the project starts will be checked and evaluated by the verifier. The catalyst composition before and during monitoring period are same i.e. Pt. 90%, Rh: 10%, Pd: 0%, just catalyst type has changed from Woven to Knitted type on 28/04/2018.
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Not Applicable
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable
Purpose of data/parameter	Baseline emission calculation
Additional comments	--

Data/Parameter	**$SE_{N2O,y}$**
Unit	$tN_2O/t\ HNO_3$
Description	Specific N_2O emissions per ton of product of nitric acid in year *y*
Measured/calculated/ default	Calculated
Source of data	Calculated by the baseline N2O emission per ton of product of nitric acid in year *y*
Value(s) of monitored parameter	*0.01346*
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Recording frequency: Yearly
Calculation method (if applicable)	Because only N2O emissions stand for baseline emissions in this project, this parameter could be calculated as follows also; $SE_{N2O,y}=QI_{N2O,y}/P_{product,y}=3,022/224,830=0.01346\ tN_2O/tHNO_3$
QA/QC procedures	Not Applicable
Purpose of data/parameter	This value is to be used for cap of the baseline emission in case that N_2O regulation starts. No capping was applied, because there is not N2O emission regulation within the country.
Additional comments	

Data/Parameter	**$QR_{N2O,y}$**
Unit	tN_2O
Description	Regulation I: annual quantity N_2O limited
Measured/calculated/ default	Monitored
Source of data	National environmental regulation in Iran In case in future, any national regulation concerning N_2O emissions get implemented during the crediting period, the impact on baseline N_2O emissions will be considered without any delay by adjusting the measured N_2O emissions at the time the regulation get in operation.
Value(s) of monitored parameter	There is currently no regulation in Iran on N_2O emissions.

Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Recording frequency: every six months
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable
Purpose of data/parameter	Change in NO_X or N_2O regulations will automatically cause a re- assessment of the baseline scenario.
Additional comments	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario.

Data/Parameter	$RSE_{N2O,y}$
Unit	tN_2O/ $tHNO_3$
Description	Regulation II: N_2O emissions per unit of nitric acid
Measured/calculated/ default	Monitored
Source of data	National environmental regulation in Iran In case in future, any national regulation concerning N2O emissions get implemented during the crediting period, the impact on baseline N2O emissions will be considered without any delay by adjusting the measured N2O emissions at the time the regulation get in operation.
Value(s) of monitored parameter	There is currently no regulation in Iran on N_2O emissions.
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Recording frequency: every six months.
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable
Purpose of data/parameter	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario
Additional comments	--

Data/Parameter	$CR_{N2O,i}$
Unit	tN_2O/m^3
Description	Regulatory limit for specific N_2O concentration during interval *i*
Measured/calculated/ default	Monitored
Source of data	National environmental regulation in Iran In case in future, any national regulation concerning N_2O emissions get implemented during the crediting period, the impact on baseline N_2O emissions will be considered without any delay by adjusting the measured N_2O emissions at the time the regulation get in operation
Value(s) of monitored parameter	There is currently no regulation in Iran on N_2O emissions.
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	Recording frequency: every six months.
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable

Purpose of data/parameter	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario
Additional comments	Change in NO_X or N_2O regulations will automatically cause a re-assessment of the baseline scenario.

Data/Parameter	***Reg*$_{NOx}$**
Unit	tNOx/m¹
Description	National regulation on NO_X emissions
Measured/calculated/ default	Monitored
Source of data	National environmental regulation in Iran, NO_X limits for nitric acid plants
Value(s) of monitored parameter	500 ppmv- See Iran Environmental Regulation and Standard
Monitoring equipment	Not Applicable
Measuring/reading/recording frequency	The information for change of NO_X regulations will be monitored every six months.
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Not Applicable
Purpose of data/parameter	This is used to check whether SPC complies with the regulation.
Additional comments	--

The dates and summary of results of QAL1, QAL2, QAL3 and AST are shown in table below:

Item	Date	Agency	Parameters which tested during Quality Assurance	Test result
QAL1	04/07/2013 and 05/08/2015	SIRA Certification Co. with Certificate No.: Sira MC030014/07(for N2O analyzers $CI_{N2O\ and}$ CO_{N2O}) and Woori Environmental Technology TMS with certificate no. JW142(for flow meters for measuring $F_{TE,I}$ and $F_{TI,i}$)	• Response time • Repeatability of standard division at zero and reference points • Lack-of-fit • Influence of ambient temperature zero and reference points • Influence of sample gas flow for extractive CEMS • Influence of voltage variation 190-250 v • Cross sensitivity at zero and reference • Measurement uncertainty • Calibration function, response time and lack of fit in field • Zero and span drift requirement, changes in zero and reference point over maintenance interval (field)	It passed the test and measurement uncertainty is valid.
Plant procedure	04/08/2016	Behin Sanjesh Azma Co. with report no.	Regular calibration including functionality test, confirmation	Regular calibration was

based calibration		B6041/24, B6041/22 and B6041/23.	of calibration curve and control of zero and span drift.	done for instruments, which measuring Pproduct, Q_{NG} and Q_{NH3}. Calibration records show the parameter to be within the accuracy limit.
QAL3, AST and Plant procedure based calibration	17/12/2016	Behin Sanjesh Azma Co. with report no. B6041/12, B6041/97/13, B6041/20, B6041/21 and B6041/27.	For QAL3, The auditor checked the following parameters documentation/records in the plant. • Permanent quality assurance during the plant operation by the operating staff; • Assurance of reliable and correct operation of the monitoring equipment (maintenance evidence); • Regular controls: zero point, span, drift, meet schedule of manufacturer maintenance intervals; For AST, annual functionality tests including SRM measurements to check for uncertainties in the data measured by the AMS has been checked.	The QAL3 and AST were done for N2O Analyzers. Also regular calibration was done for measuring equipment Tg, A_{OR} and Pg.. Calibration records show the parameter to be within the accuracy limit. Also the QA/QC system of the plant meets the demands of EN14181 QAL3.
QAL3 and Annual Surveillance Test (AST)	04/08/2017	Behin Sanjesh Azma Co. with report no. B6041/25 and B6041/26	Same as above.	The QAL3 and AST were done for tail gas inlet and outlet flow meters. The QA/QC system of the plant meets the demands of EN14181 QAL3.
QAL3 and Annual Surveillance Test (AST)	16/12/2017	Behin Sanjesh Azma Co. with report no. B6041/08 and B6041/9	Same as above.	The QAL3 and AST were done for N2O Analyzers. The QA/QC system of the plant meet the demands of EN14181 QAL3.
QAL2 and Annual Surveillance Test (AST)	04/07/2018	SGS Netherland B.V. with reference number of EZN2O-2017-09-00004. (for N2O Analyzers and also inlet and outlet tail gas flow to destruction facility)	For the analysers and flow-meters, the following programme performed • Functional test including, control of installation of equipment, visual inspection of sampling system and analyser,	The N_2O and Flow measurement system comply with the demands stated in EN14181 and also analyzer and

			control of calibration(check of zero and span), leak test, determination of response time, check of documentation and records (log-book, service report, QAL3 documentation, maintenance schedule) • Additional test for calculation of uncertainty of analyzer and data acquisition system (complete measuring system) including ; determination of zero and span drift, check of the linearity of analyzer, check of correspondence of the analyzer with recorded value of data acquisition system • Determination of calibration function and calculation of variability including; comparative measurements with a SRM during minimal 15*30 minutes, calculation of calibration function, calculation of variability, check if the requirement of variability is met, estimation of total measurement uncertainty, moisture measurement in accordance EN14790 • AST suitability and variability test	flow-meter measurement uncertainty are valid. The used emission measurement equipment complies with QAL1 and QAL2 demands of EN14181. In addition, the QA/QC system of the plant meets the demands of EN14181 QAL3.

The result of QAL2 test shows an overall measurement uncertainty of N_2O emission (analyzer and flow meter) for inlet and outlet are 4.48% and 4.96%, respectively. Although the methodology AM0028 does not specify QAL2 correction factor and other two methodologies (AM0034 and ACM0019), clearly specified this correction. However, being conservative, PP decides to apply QAL2 correction factor.

D.3. Implementation of sampling plan

>>

Not applicable for the project activity

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

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According to the registered PDD, baseline emissions are calculated using equation below:

$BEy = \Sigma [F_{TI,i} * CI_{N2O,i} * M_i] * GWP_{N2O} * Minimum(_{Pproduct,max}, P_{product,y}) / P_{product,y}$

BEy = Baseline emissions in year y (tCO_2e)

GWP_{N2O} = Global warming potential of N_2O = 298

$F_{TI,i}$ = Volume flow rate at the inlet of the destruction facility during interval i (m^3/h)

$CI_{N2O,i}$ = N_2O concentration a destruction facility inlet during interval i (tN_2O/m^3)

M_i = Length of measuring interval i (h)

i = Interval

n = Number of intervals during the year

$P_{product,y}$ = Production of nitric acid in year y (t Product)

$P_{product,max}$ = Design capacity of nitric acid production (t Product)

It should be noted, There is currently no regulation in Iran on N_2O emissions.

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

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Project emissions are calculated using equation below:

$PEy = PE_{ND,y} + PE_{DF,y}$

$= PE_{N2O,y} * GWP_{N2O} + PE_{NH3,y} + HCE_{C,y} + HCE_{NC,y}$

$= \Sigma FT_{E,i} * CO_{N2O,i} * Mi * GWP_{N2O}$

$+ Q_{NH3,y} * EF_{NH3}$

$+ [\rho_{HC} * Q_{HC,y} * OXID_{HC}/100 * EF_{HC} + \rho_{CH4} * Q_{CH4,y} * * OXID_{CH4}/100]$

$+ [\rho_{CH4} * Q_{CH4},y * (1 - OXID_{CH4}/100) * GWP_{CH4}]$

Where:

PEy = Project emissions in year y (t CO_2e)

$PE_{ND,y}$ = Project emissions from N_2O not destroyed in year y (tCO_2e)

$PE_{DF,y}$ = Project emissions related to the operation of the destruction facility in year y (tCO_2e)

PEN_2O,y = Project emissions of N_2O in year y (tN_2O)

$GWPN_2O$ = Global warming potential of N_2O = 298

$PE_{NH3,y}$ = Project emissions related to ammonia input to destruction facility in year y (tCO2e)

$HCE_{C,y}$ = Converted hydrocarbon emissions in year y (tCO_2)

$HCE_{NC,y}$ = Methane emissions in year y (tCO_2e)

$FT_{E,i}$ = Volume flow rate at the exit of the destruction facility during interval i (m^3/h)

$CO_{N2O,i}$ = N_2O concentration in the tail gas of the N_2O destruction facility during interval I (tN_2O/m^3)

M_i = Length of measuring interval i (h)

i = Interval

n = Number of intervals during the year

$Q_{NH\ 3,\ y}$ = Ammonia input to the destruction facility in year y (tNH_3)
$EF_{NH\ 3}$ = GHG emissions factor for ammonia production (tCO_2e/tNH_3)
ρ_{HC} = Hydrocarbon density (t/m^3)
$Q_{HC,y}$ = Hydrocarbon, with two or more molecules of carbon, input in year y (m3)
$OXID_{HC}$ = Oxidation factor of hydrocarbon (%), with two or more molecules of carbon
EF_{HC} = Carbon emissions factor of hydrocarbon (tCO_2/t HC), with two or more molecules of Carbon
ρ_{CH4} = Methane density (t/m^3)
$Q_{CH4,y}$ = Methane used in year y (m^3)
GWP_{CH4} = Global warming potential of methane
$OXID_{CH4}$ = Oxidation factor of methane (%)

A default factor of 2.14 tCO_2e/tNH_3 is suggested (GEMIS 4.2) as EF_{NH3}. The detail of emission reduction calculation and also value of the parameters are shown in ER Calculation Sheet.

E.3. Calculation of leakage emissions

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The amount of leakages are calculated using equation below:

$$LE_y = LE_{S,\ y} + LE_{TGU,\ y} + LE_{TGH,\ y}$$

Where:

LE_y = Leakage emissions in year y (tCO_2e)
$LE_{s,y}$ = Emissions from net change steam export (tCO_2e)
$LE_{TGU,y}$ = Emissions from net change in tail gas utilization (tCO_2e)
$LE_{TGH,y}$ = Emissions from net change in tail gas heating (tCO_2e)

According to PDD, no leakage calculation is required. Because for this project activity, there is not any net change for steam export, tail gas utilization and tail gas heating activity at the tail gas duct line between the turbine and the $DeN_2O/DeNO_X$ unit. Therefore the installation of the N_2O destruction facility will not result in significant additional energy consumption at the nitric acid production plant. In conclusion, no leakage is expected at this project, thus no leakage calculation is required.

$LE_y = 0$

For example for day of 01/05/2018 the emission reduction calculation is as follow:

Baseline emission

$BEy = \Sigma [F_{TI,i} * CI_{N2O,i} * M_i] / P_{product,y} * Minimum(P_{product,max}, P_{product,y}) * GWP_{N2O}$

$BEy=0.01017* Minimum (554.62^{1}, 669.6) *298= 1681.48$ tCO_2e/day

Project emission

$PEy = PE_{ND,y} + PE_{DF,y}$
$= PE_{N2O,y} * GWP_{N2O} + PE_{NH3,y} + HCE_{C,y} + HCE_{NC,y}$
$= \Sigma FT_{E,i} * CO_{N2O,i} * Mi * GWP_{N2O}$
$+ Q_{NH3,y} * EF_{NH3}$
$+ [\rho_{HC} * Q_{HC,y} * OXID_{HC}/100 * EF_{HC} + \rho_{CH4} * Q_{CH4,y} * OXID_{CH4}/100]$
$+ [\rho_{CH4} * Q_{CH4},y * (1 - OXID_{CH4}/100) * GWP_{CH4}]$

$PEy=0.2650*298$
$+2.465*2.14$
$+ [1.480*10^{-3}*761.977*100/100 *1.702 +7.16*10^{-4}*7167.02*99.9906/100)$
$+ [7.16*10^{-4}*7167.02*(1-99.9906/100)*25] =78.99 +5.275 + 7.050+0.0120=91.33$ tCO_2e/day

leakage emissions

$LE_y = 0$

Emission reduction:

$ER = BEy - PEy - LE_y = 1681.48 - 91.33 - 0 = 1590.15$

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

	Baseline GHG emissions or baseline net GHG removals ($t CO_2e$)	Project GHG emissions or actual net GHG removals ($t CO_2e$)	Leakage GHG emissions ($t CO_2e$)	GHG emission reductions or net anthropogenic GHG removals ($t CO_2e$)		
				Before 01/01/2013	From 23/09/2017	Total amount
Total	380,586	40,395	0	0	340,191	340,191

[1] Considering maximum nitric acid production at the rate of 600 tpd for 330 days of operation in a calendar year of 365 days, the annual production stated in the PDD is 198,000 tonnes. For the current monitoring period of 365 days, the plant was in operation for 357 days. As the inlet N_2O emissions data are not monitored and available as per the registered monitoring plan for 159 days in this monitoring period, baseline emissions are being claimed for only 206 days (=365-159). Accordingly, PP has applied a daily cap of 554.62 ton/day (=198000 ton/357 operating days per annum) for nitric acid production in the calculation of baseline emissions. This approach takes care for the capping of daily as well as maximum annual Nitric Acid production of 198,000 ton.

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_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
340,191	791,200

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

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The length of the monitoring period was 365 days, which 8 days of them, the Nitric Acid plant was not in operation, so the total days which eligible for CER generation is 357 days, therefore the ex ante emission reduction is estimated as below:
357 days * 731,361 CER /330 days= 791,200 t CO_2e.

E.6. Remarks on increase in achieved emission reductions

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The emission reductions achieved in this monitoring period are 340,191 tonnes of CO2 equivalents (357 days). The yearly-expected emissions reductions for the relevant period according to the registered PDD are 731,361 tonnes of CO_2 equivalents (330 days). The expected ex-ante emission reductions for this monitoring period (357 days) are 791,200 tonnes of CO_2 equivalents. The result shows a decline in emission reduction in comparison to ex ante amount (57.%). The decrease in achieved emission reductions is mainly due to applying zero baseline emission, with respect to the Project Standard most conservative approach for 159 days, which the inlet N_2O Analyzer AT-3201 indicator is in downtime. In addition, some part of emission reduction has declined as result of applying QAL2 correction factor.

E.7. Remarks on scale of small-scale project activity

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Not applicable for the project activity.
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Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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