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	"N2O Emission Reduction in Nitric Acid Plant Paulínia, SP, Brazil"	
UNFCCC reference number of the project activity	UNFCCC 1011	
Version number of the PDD applicable to this monitoring report	8	
Version number of this monitoring report	1.0	
Completion date of this monitoring report	24/08/2020	
Monitoring period number	Monitoring period #15	
Duration of this monitoring period	28/07/2019 to 27/07/2020 (365 days)	
Monitoring report number for this monitoring period	1	
Project participants	1. Rhodia Energy Brazil Ltda. 2. Rhodia Energy GHG 3. Rhodia Energy GHG SAS 4. Nordic Environment Finance Corporation	
Host Party	Brazil	
Applied methodologies and standardized baselines	Category 5: Chemical Industry	
Sectoral scopes	Large-scale Consolidated Methodology - N2O abatement from nitric acid production (ACM0019 - Version 02.0)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	65,863 tCO2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	71,364 tCO2e	

SECTION A. Description of project activity

A.1. General description of project activity

Nitrous oxide (N_2O) is a by-product of nitric acid production. It is of low toxicity but is a greenhouse gas (GHG), whose GWP is large (GWP=298 considering EB69/Annex3). Emissions of N_2O are controlled under the Kyoto Protocol. There are no national or regional regulations or restrictions on the emission of N_2O in Brazil. There are in fact no governmental regulations with quantified emission limits in any non-Annex I countries at this point.

In this project, a secondary catalyst was installed inside the ammonia burner of the nitric acid plant of Paulínia for the reduction of N_2O emissions which would otherwise be released to the atmosphere if the project were not implemented.
The N_2O reduction catalyst was installed in the factory site of Paulínia Rhodia Poliamida e Especialidades Ltda. in July 2007 and the first project campaign started on 28/07/2007.

The unit operates continuously but needs to be stopped periodically (typically every 6 to 9 months) in order to replace the primary catalyst Pt gauzes. The period between two technical shutdowns is referred to as a "campaign".

The baseline campaign took place from 15/09/2006 to 13/04/2007 before the installation of the secondary catalyst.

This monitoring report covers the 15th monitoring period from 28/07/2019 to 27/07/2020. The emission reductions achieved during this period are: 65,863 tCO2e

Regarding the technical aspects of this project follows below a brief description of the process used for N_2O abatement and of the installed technology and equipment:

The basic Ostwald process involves 3 chemical steps:

A) Catalytic oxidation of ammonia with atmospheric oxygen, to yield Nitrogen Monoxide (or Nitric Oxide).
(1) $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$

B) Oxidation of the Nitrogen Monoxide to Nitrogen Dioxide or Dinitrogen Tetroxide
(2) $2\ NO + O_2 \rightarrow 2\ NO_2 \leftrightarrow N_2O_4$

C) Absorption of the Nitrogen Oxides with water to yield Nitric Acid
(3) $3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$

Reaction 1 is favored by lower pressure and higher temperature. Nevertheless, at too high temperature, secondary reactions take place that lower the yield (affecting the nitric acid production); then, an optimal temperature is found at 850-950 ºC, affected by other process conditions and catalyst chemical composition.

Reactions 2 and 3 are favored by higher pressure and lower temperatures.
The way in which these three steps are implemented, characterizes the various Nitric Acid processes found throughout the industry. In single pressure processes (the case of the Paulínia plant) ammonia combustion and nitrogen oxide absorption take place at the same working pressure. In dual pressure or split pressure plants the absorption pressure is higher than the ammonia combustion pressure.

Nitrous Oxide formation

Nitrous oxide is formed during the catalytic oxidation of Ammonia. Over a suitable catalyst, typically 90-99% of the fed Ammonia is converted to Nitric Oxide (NO) according to reaction (1) above. The remainder participates in undesirable side reactions that lead to Nitrous Oxide (N_2O), among other compounds.

Possible side reactions during oxidation of Ammonia:
(4) $4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$ (Nitrous Oxide formation).
(5) $4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$
(6) $2\ NO \rightarrow N_2 + O_2$
(7) $4\ NH_3 + 6\ NO \rightarrow 5\ N_2 + 6\ H_2O$

N_2O abatement technology classification

The potential technologies (proven and under development) to treat N_2O emissions at Nitric acid plants have been classified as follows, based on the location of the treatment device:

- Primary: N_2O is prevented from forming in the ammonia oxidation gauzes.
- Secondary: N_2O once formed, is eliminated anywhere between the outlet of the ammonia oxidation gauzes and the inlet of the absorption tower.
- Tertiary: N_2O is removed at the tail gas, after the absorption tower and before the expansion turbine.
- Quaternary: N_2O is reduced after the expansion turbine, and before the stack.

Selected technology for the project

The technology applied at Paulínia nitric acid plant involves the addition of a new catalyst inside the ammonia burner (“secondary catalyst”), located just below (downstream) the oxidation gauzes with the purpose of decomposing N_2O.

This choice has several advantages:

- The secondary catalyst does not consume any electricity, steam, fuels or reducing agents (all sources of leakage) to eliminate N_2O emissions. Therefore, operating costs are limited to the cost of the catalyst itself.
- The installation is simple and does not require the addition of new process equipment or the re-design of existing ones. The main investment is the measuring equipment needed to monitor the emissions (analyzer, flow meter, etc.).
- The installation of the secondary catalyst can be done during the periodic shutdown needed to change the primary gauze thus avoiding an additional downtime of the unit.
- This “secondary catalyst” decomposes N_2O without affecting the Nitric Acid production. Typically the secondary catalyst has a very high activity for N_2O decomposition in a typical medium pressure plant with more than 80% of N_2O reduction achieved. No additional greenhouse gases or other emissions are generated by the reactions on the N_2O abatement catalyst.

The Nitric Acid Plant at Paulínia uses a basket structure supporting the primary catalytic Pt gauzes used for the ammonia oxidation. In order to make room for the new catalyst, a few layers of inert rings were removed from the basket and replaced by the active secondary catalyst pellets. Once the secondary catalyst is installed, the primary gauzes are placed on top of the basket as usual. The secondary catalyst acts then like a support just downstream of the primary gauzes.
The N_2O abatement catalyst supplier is obliged by contract to take back the used catalyst at the end of its lifetime and to recycle it after regeneration.

A.2. Location of project activity

Host Party: Brazil
State: São Paulo
City: Paulínia
GPS coordinates: -22.753611 -47.158889

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Private entity : Rhodia Energy Brazil Ltda.	No
France	Private entity: Rhodia Energy GHG SAS	No

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Switzerland	Private entity: Rhodia Energy GHG SAS	No
Norway	Private entity : Nordic Environment Finance Corporation	No

A.4. References to applied methodologies and standardized baselines

- Large-scale Consolidated Methodology "N2O abatement from nitric acid production" (ACM0019, V 02.0)
- Methodological Tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (V 03.0.1 / EB 66 Annex 47)
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (V 02)
- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (V 02)
- Project Design Document:
- N2O Emission Reduction in nitric acid plant Paulínia, SP, Brazil Version 8 dated 13/01/2014

A.5. Crediting period type and duration

The length of the crediting period is 21 years (renewable 3*7 years).
The second crediting period (on-going) is from 28/07/2014 to 27/07/2021

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The baseline campaign took place from 15/09/2006 to 13/04/2007 before the installation of the secondary catalyst to reduce N2O and the first project campaign started on 28/07/2007.

The 15th monitoring period began on 28/07/2019 and ended on 27/07/2020.

During this monitoring period the project activity has been in normal operation and no special event occurred which may have impacted the applicability of the methodology.

Find below the relevant events for the period:

Event	Period	
	Beginning	End
Beginning of monitoring period #15	27/07/2019 at 17:00	
Nitric acid shutdown caused by safety trip	29/07/2019 at 20:07	30/07/2019 at 05:14
Nitric acid shutdown due to catalyst replacement	04/08/2019 at 04:59	10/08/2019 at 10:40
Nitric acid plant shutdown for maintenance	15/08/2019 at 09:37	15/08/2019 at 18:46
Nitric acid shutdown due to water leakage	27/08/2019 at 13:59	27/08/2019 at 19:02
Nitric acid shutdown caused by safety trip	07/09/2019 at 18:36	09/09/2019 at 18:44
Nitric acid plant shutdown for maintenance	01/10/2019 at 07:43	02/10/2019 at 05:27
Nitric acid shutdown caused by safety trip	09/10/2019 at 12:43	10/10/2019 at 06:07
Nitric acid plant shutdown for maintenance	14/10/2019 at 17:31	15/10/2019 at 04:46
Nitric acid shutdown caused by safety trip	17/11/2019 at 14:30	18/11/2019 at 15:06

Nitric acid shutdown caused by planned general maintenance	29/11/2019 at 13:19	20/12/2019 at 16:21
Nitric acid shutdown caused by safety trip	27/12/2019 at 15:40	27/12/2019 at 17:57
Nitric acid shutdown caused by safety trip	14/01/2020 at 14:30	14/01/2020 at 19:46
Nitric acid shutdown caused by safety trip	15/01/2020 at 16:54	17/01/2020 at 18:52
Nitric acid shutdown caused by safety trip	22/03/2020 at 05:25	23/03/2020 at 19:11
Nitric acid shutdown due to catalyst replacement	12/04/2020 at 17:30	17/04/2020 at 18:46
Nitric acid shutdown due to leakage	24/04/2020 at 03:54	24/04/2020 at 18:31
Nitric acid shutdown caused by safety trip	28/04/2020 at 14:54	03/05/2020 at 19:22
Nitric acid shutdown caused by safety trip	20/05/2020 at 01:55	20/05/2020 at 19:31
Nitric acid shutdown caused by planned general maintenance	26/05/2020 at 03:25	02/07/2020 at 13:07
Nitric acid shutdown due to water leakage	03/07/2020 at 08:10	04/07/2020 at 18:42
Nitric acid shutdown caused by safety trip	16/07/2020 at 14:30	17/07/2020 at 06:07
End of monitoring period #15		27/07/2020 at 17:00

B.2. Post-registration changes

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

No request for temporary deviation from registered monitoring plan or applied methodology was applied to this monitoring period.

B.2.2. Corrections

No correction related to project information or parameters fixed at validation was approved during this monitoring period or submitted with this monitoring report.

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

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

B.2.4. Inclusion of monitoring plan

No inclusion of monitoring plan was approved during this monitoring period or submitted with this monitoring report

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

No permanent changes to the registered monitoring plan or permanent deviation of monitoring from the applied methodology, standardized baseline or other applied standards or tools was approved during this monitoring period or submitted with this monitoring report.

B.2.6. Changes to project design

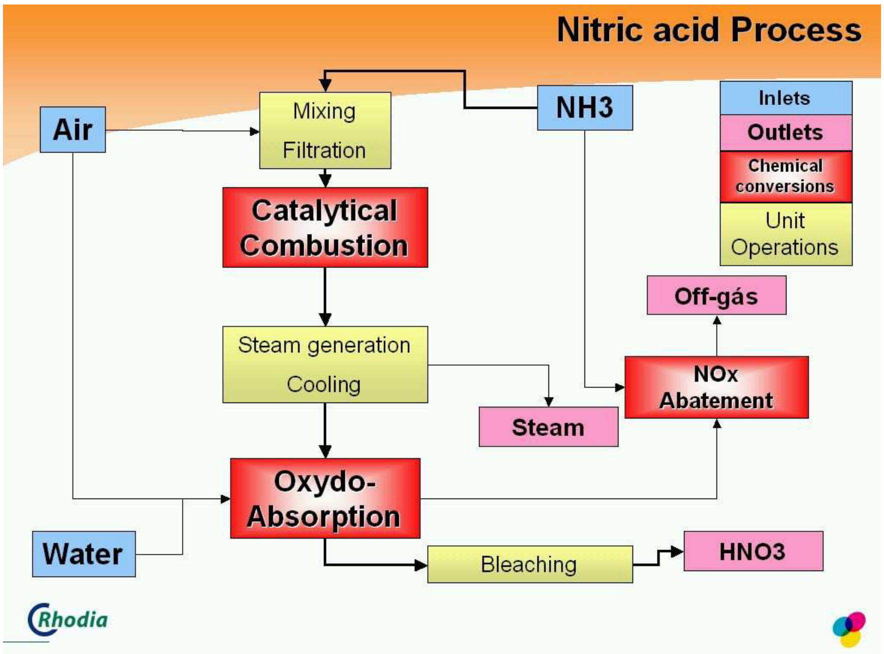
No changes to the project design was approved during this monitoring period or submitted with this monitoring report.

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

Not applicable to this project.

SECTION C. Description of monitoring system

The project boundary encompasses the complete process equipment for the nitric acid production as it can be seen in the simplified scheme of the nitric acid plant presented below.



The only GHG emission important to the project activity is N2O contained in the waste stream exiting the stack.

An overview of all emission sources inside the project boundary can be verified below:

	Source	Gas	Included?	Justification/Explanation
Baseline	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 and CH_4 emissions
		CH_4	No	
		N_2O	Yes	
Project Activity	Nitric Acid Plant (Burner Inlet to Stack)	CO_2	No	The process does not lead to any CO_2 and CH_4 emissions
		CH_4	No	
		N_2O	Yes	
	Leakage emissions from production, transport, operation and decommissioning of the catalyst	CO_2	No	No leakage emissions are expected
		CH_4	No	
		N_2O	No	

All data collection procedures, the organizational structure, the rules and responsibilities and procedures for dealing with abnormal situations are described in detail in the Data Handling Protocol and Data Review Protocol which are documents of Rhodia Quality System and are available to audit.
Taking into account the good monitoring practice and performance characteristics, the nitric acid plant on Rhodia site at Paulínia is ISO9001 and ISO14000 certified.

The overall responsibility, including the publication of the monitoring report, is with Rhodia Poliamidas e Especialidades represented by the Industrial Director of Paulínia Site.

The monitoring process is under the responsibility of the Nitric Acid Plant Manager. The description of these activities is made in the Data Handling Protocol.

The operation, data transfer and reporting procedures are incorporated into the ISO9001:2008 procedures of the Nitric Acid plant.

The monitoring procedures for baseline and project campaigns are described below.

The data collection is done by the production supervisor and/or plant operations technician who are responsible by data collection during plant operation.

The data are processed, validated, adjusted if necessary, and recorded. The nitric acid plant Process Engineer or the Production Engineer or the Production Coordinator is in charge of programming all formulae in the spreadsheets. The plant operations technician processes the data, checks the data for consistency, validates them, and records them every day as an electronic file. In case of failure of an instrument, or inconsistency of the data, he/she adjusts the data according to the Data Handling Protocol. In case the failure is not covered by the procedure, the nitric acid plant Manager makes the decision to correct the figures or to abandon the data.

The data archiving is done by nitric acid plant Production Engineer or Process Engineer or Production Coordinator. Once validated, the data are input into an electronic file (Workbook) and protected against any modification. The data are stored on the PIMS server, which is submitted to the back-up policy in the Rhodia's corporate network. Both original documents and the backup file are kept for the project crediting period. The Workbook is saved both electronically and on paper.

The calculation of emission reductions is done after each campaign by the nitric acid plant Production Engineer or Process Engineer or Production Coordinator, based on the campaign data, and validated by the nitric acid Plant Manager. This last one is responsible also for validating the Emission Reductions calculation.

As the Paulínia nitric acid plant is certified in ISO 9001:2015, the competence, awareness and training stated in the ISO 9001:2015 is met. There is a training procedure for the nitric acid plant (UQP-3-INT-TR-002) and the changes introduced due to this project were done according to that procedure for the operation team. For the lab team, which is responsible for the adjustments, calibration and operation of the N2O analyzer, the corresponding training was done according to the procedure UQP-2-DCA-RH-013.

All measured variables to be collected for the baseline and the project activity campaigns are considered critical process variables. The critical variables instruments calibration plan follows the critical variables procedures, and is included in the scope of the yearly ISO9001 audit.
The European Norm EN 14181:2004 is recommended as guidance regarding the selection, installation and operation of the Automatic Measuring System (AMS) for the GHG concentration in the off-gas under Monitoring Methodology ACM0019 - Version 02.0, and stipulates three levels of Quality Assurance Levels (QAL) and an Annual Surveillance Test (AST):

- QAL1: Suitability of the AMS for the specific measuring task.

The EN 14181: 2004 QAL1 report was provided by the equipment manufacturer considering the performance characteristics as measured by a qualified Technical Inspection Authority. The QAL1 report confirmed that the N2O analyzer (an AO 2000- URAS 14 NDIR supplied by ABB GmbH) is suitable to perform the indicated analysis (N2O concentration). The equipment manufacturer report was handed to the DOE for verification.

- QAL2: Validation of the AMS following the installation.

QAL2 describes a procedure for the determination of the calibration function and its variability, by means of certain number of parallel measurements, performed with a Standard Reference Method (SRM). The testing

performing the measurements with the SRM shall have an accredited quality assurance system according to EN ISO/IEC 17025 or relevant (national) standards.
The last QAL2 test was performed for N2O Analyzer on April 2019, during monitoring period #14, by SGS Environmental Services. The QAL2 report was made available for verification of DOE.

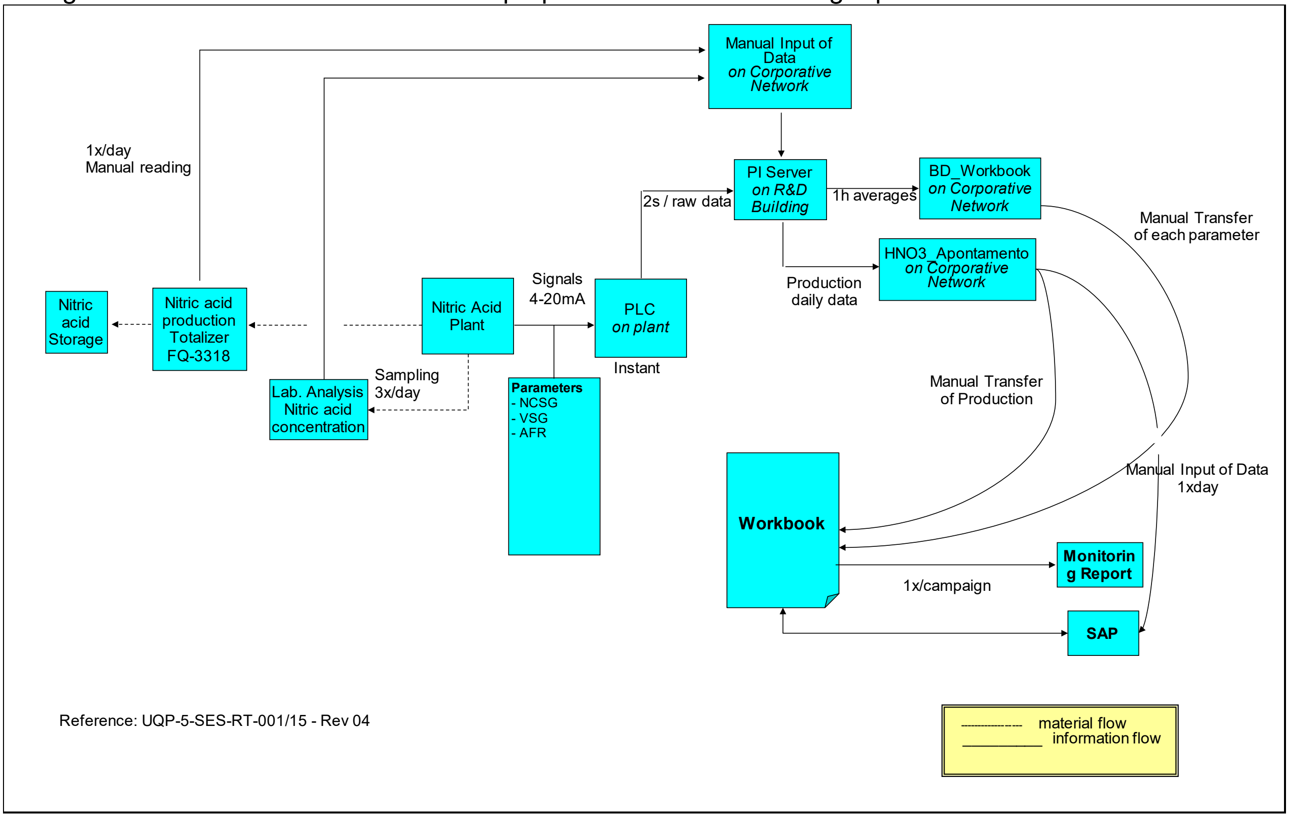
- QAL3: Ongoing quality assurance during operation.

According to EN 14181: 2004 drift and precision are checked in order to demonstrate that the AMS is in control during its operations so that it continues to function within the required specification for uncertainty. This is achieved by conducting periodic zero and span checks on the AMS, and evaluating results obtained using CUSUM (Cumulative Sum) control charts as recommended in Annex C of EN 14181:2004.

- AST: Annual validation of AMS

Taking into account EN 14181:2004 this test is to be done in order to evaluate that: (i) it functions correctly and its performance remains valid and (ii) its calibration function and variability remain as previously determined.
The Annual Surveillance Test (AST) has been performed in July 2012, July 2013, March 2015, March/April 2016, March 2017, June 2018, April 2019 and March 2020 by SGS Environmental Services. The documents from each work are made available for verification of DOE.

Considering the data management the following diagram illustrates the entire process of data acquisition, storage and transfer to the Workbook and preparation of the monitoring report:



SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

(Copy this table for each data or parameter.)

Data/Parameter	**Operating pressure**
Unit	kPa
Description	Operating pressure of the ammonia burner

Source of data	Manufacturer specifications
Value(s) applied	Between 359 and 385 kPa
Choice of data or measurement methods and procedures	Manufacturer specifications
Purpose of data/parameter	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure
Additional comments	-

Data/Parameter	**$EF_{historical}$**
Unit	kg N_2O/t HNO_3
Description	Historical baseline emission factor of the nitric acid plant
Source of data	Historical information from issuance reports of CDM-PDD documents
Value(s) applied	5.7603
Choice of data or measurement methods and procedures	Determined during the baseline campaign previous to the project implementation
Purpose of data/parameter	Calculation of Baseline emissions
Additional comments	This value will remain constant over the second and third crediting period

Data/Parameter	**$EF_{default}$**
Unit	kg N_2O/t HNO_3
Description	Default emission factor according to the operating pressure of the ammonia burner in year *y* (related to 100 per cent pure acid)
Source of data	This default N2O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N2O/t HNO3 for low, medium and high pressure ammonia burners. For each subsequent year, the emission factors will decrease by 0.2 kg N2O/t HNO3 until they reach a value of 2.5 or 2.4. After reaching the values of 2.5 or 2.4 the emission factor will remain constant over time:
Value(s) applied	7

Year	**Low pressure**	**Medium pressure**	**High pressure**
	(0 – 200 kPa)	**(200 – 600kPa)**	**(Over 600 kPa)**
2013	5.5	8.4	12.6
2014	5.3	8.2	12.4
2015	5.1	8	12.2
2016	4.9	7.8	12
2017	4.7	7.6	11.8
2018	4.5	7.4	11.6
2019	4.3	7.2	11.4
2020	4.1	7	11.2
2021	3.9	6.8	11
2022	3.7	6.6	10.8
2023	3.5	6.4	10.6
2024	3.3	6.2	10.4
2025	3.1	6	10.2
2026	2.9	5.8	10
2027	2.7	5.6	9.8
2028	2.5	5.4	9.6
2029	2.5	5.2	9.4
2030	2.5	5	9.2

Choice of data or measurement methods and procedures	Default value provided by the methodology
Purpose of data/parameter	Calculation of Baseline emissions
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development

Data/Parameter	**EF_{new}**
Unit	kg N_2O/t HNO_3
Description	Baseline N_2O emission factor for nitric acid production in year *y* (related to 100 per cent pure acid)
Source of data	The baseline N2O emission factor for nitric acid production will vary every year. In year 2005 the emission factor will be 5.1 and then it will decrease every year until it reaches a final value of 2.5 in the year 2020. The value of 2.5 will remain constant after 2020, as provided in the following table: (see table below)
Value(s) applied	2.5
Choice of data or measurement methods and procedures	Default value provided by the methodology
Purpose of data/parameter	Calculation of Baseline emissions
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development

Year	**Emission factor (kgN2O/t HNO3)**
2005	5.1
2006	4.9
2007	4.7
2008	4.6
2009	4.4
2010	4.2
2011	4.1
2012	3.9
2013	3.7
2014	3.5
2015	3.4
2016	3.2
2017	3
2018	2.8
2019	2.7
2020	2.5
2021	2.5
2022	2.5
2023	2.5
...	...
Year n	2.5

Data/Parameter	**$P_{product,max}$**
Unit	t HNO_3
Description	Design capacity of nitric acid production during the first crediting period
Source of data	Project operator and/or technology provider
Value(s) applied	55,900

Choice of data or measurement methods and procedures	Design capacity of nitric acid production
Purpose of data/parameter	Calculation of Baseline emissions
Additional comments	This parameter is only for project activities that have used AM0034 or AM0028 in the first crediting period

Data/Parameter	**GWP_{N2O}**
Unit	tCO_2e/tN_2O
Description	Global warming potential of the N_2O during the crediting period
Source of data	IPCC http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 “Standard for application of the global warming potentials to CDM project activities and PoAs for the second commitment period of the Kyoto Protocol (version 01.0)”
Value(s) applied	298
Choice of data or measurement methods and procedures	
Purpose of data/parameter	Calculation of Baseline and Project emissions
Additional comments	-

D.2. Data and parameters monitored

Data / Parameter	**$P_{production,y}$**
Unit	$t\ HNO_3$
Description	Nitric acid produced in the period
Measured /Calculated /Default:	Measured
Source of data	Flow meter (totalizer). Plant accounting
Value(s) of monitored parameter:	43,882.6
Monitoring equipment	Flow meter (totalizer). Plant accounting

Equipment	**Type**	**Accuracy Class**	**Calibration frequency**	**Calibration information**
Nitric acid mass flow meter (FQ-2179) Serial number 12014009 / 12000364 25775842 / 25984986	Mass flow meter	+/- 0.1 %	Yearly	Last Calibration 06/12/2019 Valid until 04/12/2020
Fresh nitric acid conc. analyzer (AI-2179) Serial number	Device integrated to mass flow meter FQ-2179	+/- 0.5 %	Yearly	Last Calibration 06/12/2019

	12014009 / 12000364 25775842 / 25984986				Valid until 04/12/2020
	Level of nitric acid storage tank F-1769 (LI-3350) Serial number U123502	Air bubble gauge (back-up for FQ-2179)	+/- 0.07 %	Yearly	Last Calibration 02/10/2019 Valid until 30/09/2020
	Flow meter of fresh nitric acid to storage (FQ-3318) Serial number (Flowmeter and Transmitter) 14642759/ 12138651	Magnetic Flow Meter Replaced by Mass Flow Meter on 23/08/2017	+/- 0.1 %	Yearly	Last Calibration 06/12/2019 Valid until 04/12/2020
	Truck weigh scale (BB-0090) Serial Number 7597	Load cell 80,000 kg	+/- 15 kg	2/year	Last Calibration 08/02/2020 Valid until 08/08/2020
	Truck weigh scale (BB-0335) Serial Number 28812	Load cell	+/- 15 kg	2/year	Last Calibration 15/02/2020 Valid until 15/08/2020
	Titrando 836 (BR006-TP-TI3-01) Serial Number 1836001011152	Potenciomet. Titrator to analyze the nitric acid concentration	+/- 0.2 mV	2/year	Last Calibration 08/06/2020 Valid until 07/12/2020
	Titrando 905 Lab equipment Serial Number 1905001029306	Potenciomet. Titrator to analyse the nitric acid concentration (backup for Titrando 836)	+/- 0.2 mV	2/year	Last Calibration 08/06/2020 Valid until 07/12/2020
Measuring/ Reading/ Recording frequency:	Measured continuously/Recorded daily				
Calculation method (if applicable):	Not applicable				

QA/QC procedures	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Purpose of data	Baseline emissions
Additional comment	Records to be maintained during project's lifetime

Data / Parameter	**h_y**
Unit	h
Description	Number of hours of operation in the period
Measured /Calculated /Default:	Measured / Calculated
Source of data	Production log
Value(s) of monitored parameter:	6688.8
Monitoring equipment	Flow meter (totalizer). Plant accounting

Equipment	Type	Accuracy Class	Calibration frequency	Calibration information
NH3 flow meter (Venturi) to oxidation reactor (FQCS-3122)	FT-3122 NH3 flow transmitter SN B1P700499 430 7	+/- 1.70%	Yearly	Last Calibration 06/08/2019 Valid until 04/08/2020
	PT-3122 NH3 pressure transmitter SN U578202		Yearly	Last Calibration 06/08/2019 Valid until 04/08/2020
	TT-3122 NH3 temperature transmitter 49256-05		Yearly	Last Calibration 06/08/2019 Valid until 04/08/2020

Measuring/ Reading/ Recording frequency:	Measured continuously/Recorded daily
Calculation method (if applicable):	The number of hours of operation is daily calculated subtracting the hours when the ammonia feed on the reactor is below of 0.8 t/h. This calculation is done by PIMS considering the value of ammonia feed provided by flowmeter.
QA/QC procedures	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Purpose of data	Baseline emissions
Additional comment	Records to be maintained during project's lifetime

Data / Parameter	$h_{r,y}$
Unit	h
Description	Number of hours in year y where, for secondary N2O abatement, abatement system was not installed, underperforming or failed
Measured /Calculated /Default:	Calculated
Source of data	Production log
Value(s) of monitored parameter:	0
Monitoring equipment	
Measuring/ Reading/ Recording frequency:	Calculated hourly
Calculation method (if applicable):	$h_{r,y}$ is determined by comparison of $F_{N2O,tail\ gas,h}$ and $EF_{existing,y}$ x $P_{NA,h}$ This comparison is done on an hourly basis.
QA/QC procedures	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Purpose of data	Baseline emissions
Additional comment	Records to be maintained during project's lifetime

Data / Parameter	**NCSG**
Unit	mg/Nm^3
Description	N_2O concentration in the stack gas
Measured /Calculated /Default:	Measured
Source of data	The data are automatically acquired continuously by DCS and stored in the PIMS.
Value(s) of monitored parameter:	For this second credit period, methodology defines usage of hourly average value for calculation during the monitoring period. Due to the volume of data, these values are provided to DOE auditors at Workbook for evaluation.
Monitoring equipment	ABB Infrared analyzer series 2000/URAS 14 – model AO2040. The Measurement Principle is a non-dispersive infrared absorption in the λ = 2.5–8 μm wavelength range. Because of analyzer technology, water has to be removed. So, this is a dry-basis measurement. For the project campaigns, Rhodia keeps the dry basis data as a conservative approach (the value for water content in the waste gas is considered to be zero)

Equipment	**Type**	**Accuracy Class**	**Calibration frequency**	**Calibration information**
N_2O concentration analyzer in the stack (AIC-3500C)	N_2O concentration analyzer	+/- 0.5 %	Each 2 weeks (Rhodia calibration)	Last Calibration
				22/07/2020
				Valid until
				Following 15 days

	Serial Number 3345914.6			2x/year (third party calibration)	Last Calibration 09/07/2020 Valid until 07/01/2021
Measuring/ Reading/ Recording frequency:	Measured continuously/Recorded daily				
Calculation method (if applicable):	Not applicable				
QA/QC procedures	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system				
Purpose of data	Baseline and project emissions				
Additional comment	Records to be maintained during project's lifetime				

Data / Parameter	**VSG**				
Unit	Nm^3/h				
Description	Volume flow rate of stack gas				
Measured /Calculated /Default:	Measured				
Source of data	The data are automatically acquired continuously by DCS and stored in the PIMS.				
Value(s) of monitored parameter:	For this second credit period, methodology defines usage of hourly average value for calculation during the monitoring period. Due to the volume of data, these values are provided to DOE auditors at Workbook for evaluation.				
Monitoring equipment	Venturi flow meter built according standard ISO 5167 - 2003 Edition. The same multi-variable transmitter provides also the temperature and pressure at the stack where the gas flow is measured. Those are considered as critical variables, so they are included in the ISO-9001 Nitric Acid Plant procedures.				
	Equipment	**Type**	**Accuracy Class**	**Calibration frequency**	**Calibration information**
	Gas flow (FI-3212) Serial Number 91F404443-612	Venturi – Multi variable transmitter	+/- 2.0 %	Yearly	Last Calibration 08/08/2019 Valid until 06/08/2020
	Gas pressure (PI-3212) Serial Number 91F404443-612			Yearly	Last Calibration 08/08/2019 Valid until 06/08/2020
	Gas temperature (TE-3212) Serial Number 91F404443-612			Yearly	Last Calibration 08/08/2019 Valid until 06/08/2020

Measuring/ Reading/ Recording frequency:	Measured continuously/Recorded daily
Calculation method (if applicable):	Not applicable
QA/QC procedures	Paulínia nitric acid plant is ISO 9001 certified. This measurement is considered as a critical measurement on the ISO 9001, so calibration routines and periodic check-up is follow-up by the quality system
Purpose of data	Baseline and project emissions
Additional comment	Records to be maintained during project's lifetime

Calibrations during current Monitoring Period

Monitoring Period #14

Tag number	Description		Parameter in PDD	Reference	Period	Done by	Previous calibration dates	Last calibration date	Remarks
FI-3212	Stack gas flow meter (Venturi)	FI-3212 Stack gas flow transmitter	VSG	Manufacturer Specifications	Yearly	Rhodia	09/08/2018	08/08/2019	
		PI-3212 Stack gas pressure transmitter	PSG	Manufacturer Specifications	Yearly	Rhodia			
		TE-3212 Stack gas temperature transmitter	TSG	Manufacturer Specifications	Yearly	Rhodia			
AIC-3500C	N2O concentration analyzer in the stack		NCSG	Manufacturer Specifications	each 2 weeks	Rhodia	24/07/2019	22/07/2020	Previous calibration dates: 07/08/2019; 21/08/2019; 04/09/2019; 18/09/2019; 02/10/2019; 16/10/2019; 30/10/2019; 13/11/2019; 27/11/2019; 08/01/2020; 22/01/2020; 05/02/2020; 19/02/2020; 04/03/2020; 09/03/2020; 18/03/2020; 01/04/2020; 15/04/2020; 29/04/2020; 13/05/2020; 27/05/2020; 10/06/2020; 24/06/2020; 08/07/2020; 22/07/2020
				Manufacturer Specifications	2/year	Third party	18/07/2019 13/01/2020	09/07/2020	
FQCS-3122	NH3 flow meter (Venturi) to oxidation reactor (AFR)	FT-3122 NH3 flow transmitter	hy	Manufacturer Specifications	Yearly	Rhodia	22/08/2017 09/08/2018	06/08/2019	
		PT-3122 NH3 pressure transmitter		Manufacturer Specifications	Yearly	Rhodia	22/08/2017 09/08/2018	06/08/2019	
		TT-3122 NH3 temperature transmitter		Manufacturer Specifications	Yearly	Rhodia	22/08/2017 09/08/2018	06/08/2019	

Lab Equipment Titrando 905	Potenciometric Titrator to analyze the nitric acid concentration (backup for Titrando 836)	HNO3_production	Manufacturer Specifications	2/year	Third party	25/07/2018 04/07/2019	08/06/2020	Planned calibrations on: 16/12/2019 and 08/06/2020
Titrando 836 (BR006-TP-TI3-01)	Potenciometric Titrator to analyze the nitric acid concentration	HNO3_production	Manufacturer Specifications	2/year	Third party	25/07/2018 04/07/2019	08/06/2020	Planned calibrations on: 16/12/2019 and 08/06/2020
FQ-3318	Nitric acid totalizer to storage tank F-1769	HNO3_production	Manufacturer Specifications	Yearly	Third party	28/11/2018	06/12/2019	
FQ-2179	Nitric acid mass flowmeter	HNO3_production	Manufacturer Specifications	Yearly	Third party	09/01/2019	06/12/2019	
AI-2179	Fresh nitric acid conc analyzer	HNO3_production	Manufacturer Specifications	Yearly	Third party	01/03/2018	06/12/2019	
LI-3350	Level of nitric acid storage tank F-1769	HNO3_production	Manufacturer Specifications	Yearly	Rhodia	22/10/2018	02/10/2019	
BB-0090	Truck Balance to control purchased Nitric Acid	HNO3_production	INMETRO - Brazil Standard Portaria no. 236 (22December1994)	2/year	Third party	17/03/2018 02/03/2019	08/02/2020	Planned calibration on: 16/08/2019 and 08/02/2020
BB-0335	Truck Balance to control purchased Nitric Acid	HNO3_production	INMETRO - Brazil Standard Portaria no. 236 (22December1994)	2/year	Third party	24/03/2018 09/03/2019	15/02/2020	Planned calibration on: 23/08/2019 and 15/02/2020
AICY-3500	NOx concentration analyzer in the stack	NOx emission control	Manufacturer Specifications	each 28 days	Rhodia	03/07/2019	01/07/2020	Previous calibration dates: 31/07/2019; 28/08/2019; 25/09/2019; 23/10/2019; 20/11/2019; 12/02/2020; 11/03/2020; 08/04/2020; 06/05/2020; 03/06/2020; 01/07/2020;
			Manufacturer Specifications	2/year	Third party	24/01/2019 18/07/2019	16/07/2020	Planned calibration: 14/01/2020 and 16/07/2020

AIRS-3001	NOx concentration analyzer in the stack (back-up of AICY-3500)	NOx emission control	Manufacturer Specifications	each 28 days	Rhodia	03/07/2019	01/07/2020	Previous calibration dates: 31/07/2019; 28/08/2019; 25/09/2019; 23/10/2019; 20/11/2019; 15/01/2020; 12/02/2020; 11/03/2020; 08/04/2020; 06/05/2020; 03/06/2020; 01/07/2020;
			Manufacturer Specifications	2/year	Third party	24/01/2019 18/07/2019	17/07/2020	Planned calibration: 14/01/2020 and 17/07/2020

* Source of data: Quality Management System and SAP

Legend:

IS - International Standard

NS - National Standard

MS - Manufacturer Specifications or Recomendations

INMETRO - Instituto Nacional de Metrologia www.inmetro.gov.br

ONS - Operador Nacional do Sistema Elétrico www.ons.org.br

D.3. Implementation of sampling plan

Not applicable: ACM0019, V 02.0 does not specify any requirement on sampling

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

The N_2O emission factor for nitric acid plant in the first crediting period in year y ($EF_{existing,y}$) is :

$$EF_{existing,y} = min\{EF_{historical}; EF_{default,y}\}$$

$EF_{default,y}$	=	7	kg N_2O/t HNO_3
$EF_{historical,y}$	=	5.7603	kg N_2O/t HNO_3
$EF_{existing,y}$	=	5.7603	kg N_2O/t HNO_3

The baseline emissions are:

$$BE_y = \begin{pmatrix} min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y} + \\ max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y} \end{pmatrix} \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N2O} \times 10^{-3}$$

$\mathbf{P_{product,max}}$	=	55,900	t HNO_3
$\mathbf{P_{production,y}}$	=	43,882.6	t HNO_3
$\mathbf{EF_{existing,y}}$	=	5.7603	kg N_2O/t HNO_3
$\mathbf{EF_{new,y}}$	=	2.5	kg N_2O/t HNO_3
$\mathbf{GWP_{N2O}}$	=	298	tCO_2e/tN_2O
$\mathbf{h_y}$	=	6,688.8	h
$\mathbf{h_{r,y}}$	=	0.0	h
BE_y	**=**	**75,327**	**t CO_2e**

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

PE_y = $PE_{N2O,y}$

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tail\ gas,h} \times GWP_{N20} \times 10^{-3}$$

$\Sigma F_{N2O,tailgas,h}$	=	31,758.1	kg N_2O
GWP_{N2O}	=	298	tCO_2e/tN_2O
PE_y	**=**	**9,464**	**t CO_2e**

E.3. Calculation of leakage emissions

As defined in ACM0019, V 02.0, any leakage emissions sources are deemed to be negligible.

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

	Baseline GHG emissions or baseline net GHG removals ($t\ CO_2e$)	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 01/01/2013	Total amount
Total	**75,327**	**9,464**	**0**	**0**	**65,863**	**65,863**

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 ($t\ CO_2e$)
65,863	**71,364**

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

The nitric acid unit data used for ex-ante calculations of emission reductions are data from 26/11/2011 until 25/11/2012. The emission factors ($EF_{default,y}$, $EF_{new,y}$) used correspond to the first crediting period after the completion date of the PDD (2015).

The N_2O emission factor for nitric acid plant in the first crediting period in year y ($EF_{existing,y}$) is :

$$EF_{existing,y} = min\{EF_{historical}; EF_{default,y}\}$$

$EF_{default,y}$	=	8.0	kg N_2O/t HNO_3
$EF_{historical,y}$	=	5.7603	kg N_2O/t HNO_3
$EF_{existing,y}$	=	5.7603	kg N_2O/t HNO_3

The baseline emissions are:

$$BE_y = \begin{pmatrix} min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y} + \\ max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y} \end{pmatrix} \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N2O} \times 10^{-3}$$

$\mathbf{P_{product,max}}$	=	55,900	t HNO_3
$\mathbf{P_{production,y}}$	=	45,982	t HNO_3
$\mathbf{EF_{existing,y}}$	=	5.7603	kg N_2O/t HNO_3
$\mathbf{EF_{new,y}}$	=	3.4	kg N_2O/t HNO_3
$\mathbf{GWP_{N2O}}$	=	298	tCO_2e/tN_2O
$\mathbf{h_y}$	=	6860.8	h
$\mathbf{h_{r,y}}$	=	0	h
$\mathbf{BE_y}$	**=**	**78,931**	**t CO_2e**

Calculation of project emissions or actual net removals

$PE_y = PE_{N2O,y}$

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tail\ gas,h} \times GWP_{N20} \times 10^{-3}$$

$\Sigma F_{N2O,tailgas,h}$	=	25,392.4	kg N_2O
GWP_{N2O}	=	298	tCO_2e/tN_2O
PE_y	**=**	**7,567**	**t CO_2e**

Emission reductions:

$$ER_y = BE_y - PE_y$$

BE_y	=	78,931	t CO_2e
PE_y	=	7,567	t CO_2e
ER_y	**=**	**71,364**	**t CO_2e**

E.6. Remarks on increase in achieved emission reductions

For this monitoring period, it was observed slightly lower emission reductions (65,863 tCO2e) when compared with the estimated value (71,364 tCO2e) by PDD.
This emission reductions decrease (-5,501 tCO2e) is linked to a lower nitric acid production (43,882.6 t compared to 45,982 t).

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

Not applicable to this project.

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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