

**CDM  
MONITORING REPORT #16  
of  
“N2O Emission Reduction in Paulinia,  
SP, Brazil”  
UNFCCC 0116**

**From: August 01, 2008  
To: August 31, 2008**

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Date: September 4<sup>th</sup>, 2008

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Pascal Siegwart, Rhodia Energy SAS

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## 1 Introduction

The purpose of this monitoring report is to calculate and clarify GHG emission reduction quantity achieved by this project for periodic verification.

This monitoring report covers the activity from August 1<sup>st</sup>, 2008 to August 31<sup>st</sup>, 2008 as the 16<sup>th</sup> period.

Duration of the project activity period

The starting date of the project is defined as 11/19/2006.

Note: In the PDD the original starting date of the project activity is 01/01/2007. A demand to the UNFCCC for anticipating the actual start up of the project activity to 11/19/2006 was made and approved. The new starting date of the project activity has been updated on the UNFCCC website.

## 2. Reference

### **Approved Baseline methodology :**

Baseline Methodology for decomposition of N<sub>2</sub>O from existing adipic acid production plants (AM0021/version 1)

### **Approved Monitoring methodology :**

Monitoring Methodology for decomposition of N<sub>2</sub>O from existing adipic acid production plants (AM0021/version 1)

### **Project Design Document :**

N<sub>2</sub>O Emission Reduction in Paulinia, SP, Brazil.

Version number of the document : 4

Date : October 12<sup>th</sup>, 2005

### **CDM registration number :**

“N<sub>2</sub>O Emission Reduction in Paulinia, SP, Brazil” – UNFCCC ref number 0116

## 3. Definition

y : Monitoring period (in this report, see dates § 1)

PDD : Project Design Document of this project “N<sub>2</sub>O Emission Reduction in Paulinia, SP, Brazil.” Version number of the document: 4, issued on October, 12<sup>th</sup>, 2005

#### 4. General description of project

##### Project activity

Nitrous oxide (N<sub>2</sub>O) is a by-product of adipic acid production. It is of low toxicity but is a greenhouse gas (GHG), whose GWP is large (GWP=310 in the IPCC 2nd Assessment Report). Emissions of N<sub>2</sub>O will be controlled under the Kyoto Protocol. As far as we are aware, there are however no national or regional regulations or restrictions on the emission of N<sub>2</sub>O 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, Rhodia Poliamida e Especialidades Ltda. additionally installed N<sub>2</sub>O collection and a thermal decomposition process equipment to the currently operating adipic acid manufacturing plant. This installation reduces the GHG emissions, which would otherwise be released to the atmosphere if the project were not implemented.

The decomposition facility was installed in the factory site of Paulinia Rhodia Poliamida e Especialidades Ltda. in October 2006 and destruction of N<sub>2</sub>O was started in November 2006. The starting date of the project as well as the starting date of the first crediting period is defined as November 19<sup>th</sup>, 2006. It should be noted that the original starting date of the project activity is 01/01/2007 according to the PDD. However the start up of the project activity was anticipated to 11/19/2006, as formalized to and approved by the UNFCCC.

This project activity was registered at UNFCCC on December 25<sup>th</sup>, 2005 with the number 0116.

##### Technical description of the project

##### **Location of the project activity**

The decomposition facilities were installed in the factory site Rhodia Poliamida e Especialidades Ltda in Paulinia, SP, Brazil in October, 2006.

##### **Technology employed by the project activity**

A thermal oxidizer with 2 chambers is the technology used to decompose N<sub>2</sub>O.

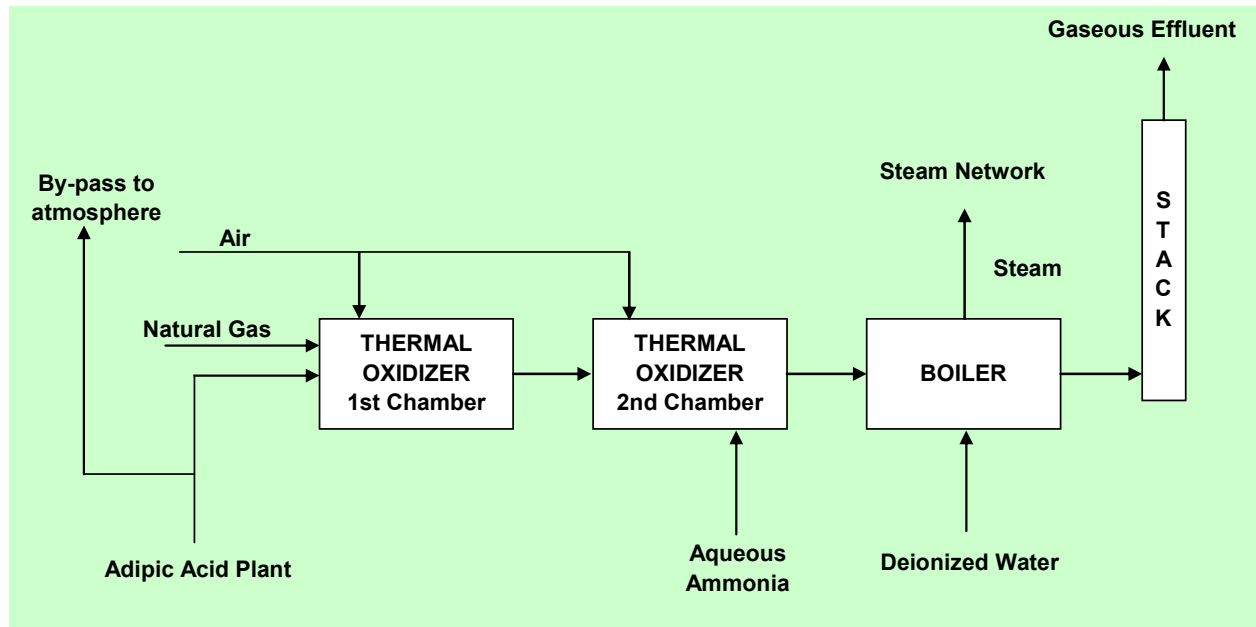
Natural gas is fed with the off gas adipic acid production containing N<sub>2</sub>O and some air in a reduction chamber, where it burns (oxidizes) to carbon dioxide CO<sub>2</sub> and water vapour. N<sub>2</sub>O is used as an oxidizer. Being oxygen deficient, the oxidation is not complete and carbon monoxide and hydrogen are present.



The temperature in the furnace is kept at about 1300°C and under fuel rich conditions, so as to promote the complete decomposition of N<sub>2</sub>O while minimizing the formation of unwanted combustion by-products such as NO and NO<sub>2</sub>.

The gas is then quenched with air to complete the combustion of carbon monoxide and hydrogen at a temperature of about 950°C in a second chamber. Aqueous ammonia is injected to control the emission of NO and NO<sub>2</sub>.

Before release to the stack, the flue gas coming from the thermal oxidizer is used to produce superheated steam, which is fed into the existing on-site steam network.

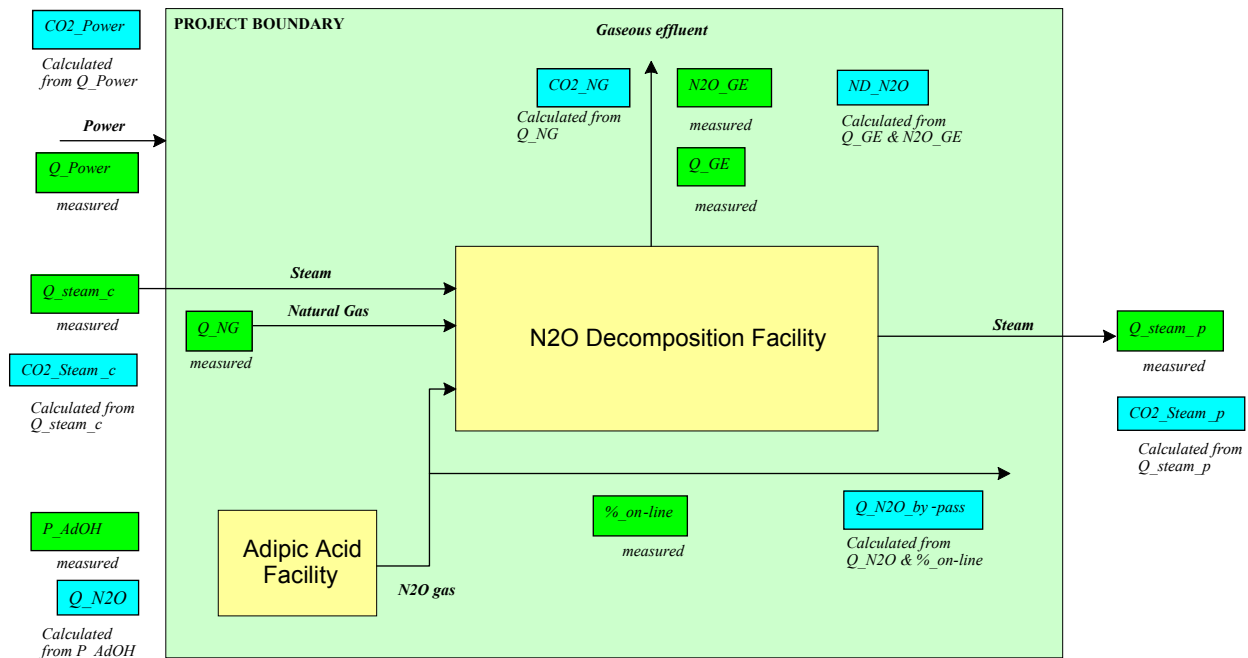


## 5. Baseline methodology

Approved baseline methodology AM 0021 / version 1: “Baseline methodology for decomposition of N<sub>2</sub>O from existing adipic acid production plants” is applied to this project.

The project boundary related to the baseline methodology is shown below and this project boundary is used and explained in the PDD.

Potential sources of anthropogenic emissions by sources of GHG within the project boundary and emissions which are not included in the project boundary are also shown in below.



## 6. Applicability of the methodology

Approved monitoring methodology AM 0021 / version 1 is applied to this project.

This methodology is applicable to projects which decompose N<sub>2</sub>O from an adipic acid production plant under the following conditions:

- either catalytic or thermal decomposition of the N<sub>2</sub>O by-product of adipic acid production at existing production plants
- The methodology is spatially generic, being applicable across regions where the data (both related and project activity as well) exist to undertake the assessment
- The methodology is applicable only for installed capacity (measured in tonnes of adipic acid per year) that exists by the end of the year 2004.

The present project satisfies these conditions as:

- Thermal decomposition of the N<sub>2</sub>O by-product of adipic acid production was implemented in an existing production plant
- All required data (see following paragraph) are available and used
- The production of adipic acid within the current year is below the installed capacity that exists by the end of the year 2004 as defined in the PDD.

For the sake of clarity, the amount of Emission Reductions can exceed the amount calculated in a year period in the PDD in "SECTION E. Estimation of GHG emissions by sources" as all data in the PDD were conservative, in particular the performance of the N<sub>2</sub>O abatement unit (in fact, the actual efficiency has been > 85%, and the destruction rate > 99%).

## 7. Monitored Parameters

According to the methodology AM 0021/version 1 and the Monitoring Plan, the data being collected to monitor the GHG reduction are given in the table below:

ID	Data variable	Source of data	Data unit	Recording frequency	Reference
Q_GE	Volume of effluent gas leaving the stack	Flow meter	Nm <sup>3</sup>	Monthly	Appendix 1
N <sub>2</sub> O_GE	Concentration of N <sub>2</sub> O in the effluent gas	Laser diode online analyzer	ppm	Monthly	Appendix 2
ND_N <sub>2</sub> O	Quantity of N <sub>2</sub> O in the effluent gas leaving the stack	Calculated from Q_GE and N <sub>2</sub> O_GE	kg	Monthly	Appendix 3
Q_NG	Amount of natural gas burned	Natural gas meter	Nm <sup>3</sup>	Monthly	Appendix 4
NGC	Natural gas composition required for calculation of E_NG	Gas supplier	-	Monthly	Appendix 5
%_on-line	% of production time the position switch on the by-pass valve is closed	Position switches on bypass valve	% of production time	Monthly	Appendix 6
Q_N <sub>2</sub> O_by-pass	N <sub>2</sub> O by passing the decomposition facility	Calculated from Q_N <sub>2</sub> O and %_on-line	kg	Monthly	Appendix 7

ID	Data variable	Source of data	Data unit	Recording frequency	Reference
P_AdOH	Amount of adipic acid production	Excel workbook for calculation of nylon salt production, AA slurry production and dry AA production	ton	Monthly	Appendix 8
Nitric acid consumption (HNO <sub>3</sub> _consumption) & physical losses in the adipic acid production process (HNO <sub>3</sub> _physical)	All data required for calculation of HNO <sub>3</sub> chemical and the N <sub>2</sub> O emission factor N <sub>2</sub> O_AdOH	Excel workbook based on the raw material consumption, DCS data and Lab data	ton	Monthly	Appendix 9
Q N <sub>2</sub> O reg	Per Brazilian regulation allowed N <sub>2</sub> O emissions	Brazilian regulation	kg/a	Date when relevant legislation is in place	Appendix 10
N <sub>2</sub> O reg/AdOH	Per Brazilian regulation allowed N <sub>2</sub> O emissions per kg of adipic acid produced	Brazilian regulation	kg/kg	Date when relevant legislation is in place	Appendix 10
r <sub>y</sub>	Per Brazilian regulation required share of N <sub>2</sub> O emissions to be destroyed	Brazilian regulation	%	Date when relevant legislation is in place	Appendix 10
P N <sub>2</sub> O	Market price of N <sub>2</sub> O	Estimated	€/t	Yearly	Appendix 11
Q_Steam_p	Amount of steam produced by the decomposition process	Steam meter	kg	Monthly	Appendix 12



ID	Data variable	Source of data	Data unit	Recording frequency	Reference
Steam supplier data	All data required for calculation of E_Steam	Rhodia Industrial Platform of Paulínia	-	Yearly	Appendix 13
Q_Power	Electric consumption of the decomposition facility	Electricity meter	kWh	Monthly	Appendix 14
Electricity grid data	All data required for calculation of E_Power according to ACM0002 version 2	Brazilian ONS (Operador Nacional do Sistema Elétrico)	-	Yearly	Appendix 15
Q_Steam_c	Amount of steam consumed by the decomposition facility	Steam meter	kg	Monthly	Appendix 16
Steam suppliers data	All data required for calculation of E_Steam_c	Rhodia Industrial Platform of Paulínia	-	Yearly	Appendix 17

## 8. Quality Control (QC) and Quality Assurance (QA)

### 8.1. Quality Management System

The thermal oxidation plant is operated by Rhodia operating personnel. Rhodia has assigned the responsibility for operating, monitoring and reporting to the Adipic Acid Plant Manager.

The operation, data transfer and reporting procedures are incorporated into the ISO 9001 procedures of the Paulínia Adipic Acid plant

The personnel have been trained by Rhodia engineers who have been trained by the technology supplier i.e. John Zink Company LLC, USA.

### 8.2. Quality control (QC) and quality assurance (QA) procedures that are being undertaken for data monitored

The Paulínia adipic acid plant is certified according to ISO9001 and applies appropriate QA & QC procedures.



The equipment and analytical methods given by the technology supplier John Zink Company LLC, USA as well as those supplied by Rhodia are done according to internationally accepted standards.

The QA & QC procedures are set and implemented in order to:

1. Secure a good consistency through planning to implementation of this CDM project and,
2. Stipulate who has responsibility for what and,
3. Avoid any misunderstanding between people and organization involved.

Data (Indicate table and ID number e.g. 3.-1.; 3.2.)	Uncertainty level of data (High/Medium/ Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
2a.1. (D.2.1.1) Q GE	Low	<i>This flow rate is measured with an Averaging Pitot tube. This instrument is a critical instrument in the QA/QC procedure.</i>
2a.2. (D.2.1.1) N <sub>2</sub> O_GE	Low	<i>Measured using Laser Diode technology Specific procedures are applied to this analyzer for QA &amp; QC following the manufacturer's recommendation.</i>
2a.4. (D.2.1.1) Q NG	Low	<i>Is measured using natural gas meter from the supplier and as such is part of a regular procedure control between the Natural Gas supplier and Rhodia.</i>
2b.1. (D.2.1.3) P_AdOH	Low	<i>Is obtained from production records of the Paulinia Adipic Acid plant where the N<sub>2</sub>O waste originates. A QA/QC procedure is implemented. Production quantity is based on the packaged product plus slurry production used for the Nylon Salt production. Both dry adipic acid and nylon salt are weighed.</i>
2a.5. (D.2.1.1) %_on-line	Low	<i>Use high integrity performance by-pass valve to limit leaks. Procedures currently in place in Chalampé for monitoring N<sub>2</sub>O emissions have been implemented in Paulinia to periodically check their tightness and assure their good operation. They have been added to the QA/QC existing procedures.</i>
2b.7. (D.2.1.3) Q Steam p	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures</i>
3.1. (D.2.3.1) Q Power	Low	<i>Electricity meter. Standard procedures are used. No QA/QC procedures implemented as this flow represents less than 0.01% of the baseline emissions.</i>
3.4. (D.2.3.1) Q Steam c	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures.</i>

### 8.3. Calibration/Maintenance of Measuring and Analytical Instruments

All measuring and analytical instruments are being calibrated as per the methodology AM0021/version 1 and the PDD using either existing or specifically created protocols in Paulínia's Quality Management System procedures.

The maintenance methods and procedures have been incorporated as part of the ISO 9001 procedures and form an integral part of the systems and procedures for the organization.

### 8.4. Environmental Impact

After commissioning the thermal oxidation plant, online analysis of the NO<sub>x</sub> content in the gaseous effluents is carried out to verify such discharge from the plant. Monitoring of the NO<sub>x</sub> content in the waste gas is required by local environmental legislation stated in the Commitment Agreement (TAC) signed with the Public Attorney of the State of São Paulo. NO<sub>x</sub> in the gaseous effluent can be randomly checked by the environmental agency Cetesb through sampling and analysis by an external laboratory. Analytical data show that the plant complies with the established environmental standard.

Table showing analysis of Gaseous Emission for Thermal Oxidation plant

Parameter		Value as per applicable standard	Actual analysis
NO <sub>x</sub>	ppm	300 max	Less than 300

## 9. GHG Calculations

Statement of GHG emission reduction in this monitoring period.

As suggested by the methodology (AM0021/version 1), the GHG emission reduction, (ER<sub>y</sub>), achieved by the project activity for the period is  
$$ER_y = BE_y - PE_y - L_y$$

### 9.1. Calculation of Q<sub>N2Oy</sub>

It has been checked that there are no Brazilian regulation into place that would limit the quantity of N<sub>2</sub>O emitted that can be taken into account for the calculation of the baseline emissions (see D.2.1.4. in the PDD).

The quantity Q<sub>N2Oy</sub> of N<sub>2</sub>O emitted over the period can then be calculated by:

$$Q_{N2Oy} = P_{AdOH} \times N2O_{AdOH}$$

Over the period of reference the emission factor from the adipic acid plant was above the capped value of 0.27 kg N<sub>2</sub>O/kg AdOH (see Appendix 9). So the capped value is being used according to AM 0021/version 1.

Parameter	Value	Reference
Q_N2O <sub>y</sub>	2 160 291	Calculated
P_AdOH	8 001 t	Appendix 8
N2O /AdOH	0.27 kg N2O/kg AdOH	Appendix 9
Q_N2O reg	No limit	Appendix 10
N2O_reg / AdOH	No limit	Appendix 10
r <sub>y</sub>	NA	Appendix 10

As the total production of adipic acid over the year ending with the last day of this period is below the nameplate capacity of the adipic acid plant (information available in the Excel Workbook “ER Paulinia”, sheet AM, submitted to UNFCCC), the total production of this period can be used as such.

The Executive Board has confirmed on EB36 the application of a yearly Adipic acid production cap as required by the methodology.

## 9.2. Calculation of baseline emissions

The amount of baseline emissions in the given period y (measured in t CO<sub>2</sub> eq.) is calculated by

$$BE_y = Q_{N_2O_y} \times GWP_{N_2O} + Q_{Steam\_p_y} \times E_{Steam_y}$$

and rounded down in t CO<sub>2</sub> eq. to get conservative consistency of final calculation of emission reductions formula.

Parameter	Value	Reference
<b>BE<sub>y</sub></b>	<b>671 101 t CO<sub>2</sub> eq.</b>	Calculated
Q_N2O <sub>y</sub>	2 160 291 kg	Calculated in 9.1
GWP_N2O	310 kg CO <sub>2</sub> eq./ kg N <sub>2</sub> O	Kyoto Protocol Rule. Decision 2/CP.3
Q_Steam_p <sub>y</sub>	9 733 600 kg of steam	Appendix 12
E_Steam <sub>y</sub>	0.145 kg-CO <sub>2</sub> /kg of steam	Appendix 13

## 9.3. Calculation of (Q\_N2O x (1-%\_on-line))<sub>y</sub>

The quantity of N<sub>2</sub>O that has by-passed the decomposition facility is calculated from the adipic acid production made while by-passing the decomposition facility.

The quantity of adipic acid produced while by-passing the destruction facility is monitored and the quantity of N<sub>2</sub>O that by-pass the decomposition facility is registered daily:

$$Q_{N_2O\_by-pass} = P_{AdOH} \times (1-\%_{on-line}) \times N_2O_{/AdOH}$$

This value is a value by excess as during each connection/ disconnection phases the production is counted as completely by-passed.

The quantity of N<sub>2</sub>O that by-passed the decomposition facility over the period is:

$$(Q_{N_2O} \times (1 - \%_{on-line}))_y = Q_{N_2O\_by-pass}_y$$

The  $\%_{on-line}_y$  equivalent over the period is calculated as:

$$\%_{on-line}_y = 1 - (Q_{N_2O\_by-pass}_y / Q_{N_2O}_y)$$

Parameter	Value	Reference
$Q_{N_2O\_by-pass}_y$	42 736 kg	Appendix 7
$P_{AdOH}$	8 001 t	Appendix 8
$N_2O_{/AdOH}$	0.27 kg N <sub>2</sub> O/kg AdOH	Appendix 9
$\%_{on-line}_y$	98.022 %	Appendix 6

#### 9.4. Calculation of project emissions

The emissions due to the decomposition process  $PE_y$  are the emissions due to the N<sub>2</sub>O that has not been sent to the decomposition process, the N<sub>2</sub>O non destroyed by the decomposition process and the emissions due to the use of natural gas.

$$PE_y = ((Q_{N_2O} \times (1 - \%_{on-line}))_y + (Q_{GE} \times N_2O_{GE} \times Specific\_gravity\_of\_N_2O)_y) \times GWP_{N_2O} + Q_{NG}_y \times E_{NG}_y$$

$$PE_y = (Q_{N_2O\_by-pass}_y + (Q_{GE} \times N_2O_{GE} \times Specific\_gravity\_of\_N_2O)_y) \times GWP_{N_2O} + Q_{NG}_y \times E_{NG}_y$$

The non-destroyed N<sub>2</sub>O ( $ND_{N_2O}_y$ ) is constantly monitored and obtained from the constant monitoring of the flow ( $Q_{GE}$ ) and the concentration of N<sub>2</sub>O ( $N_2O_{GE}$ ) of the effluent gas:

$$ND_{N_2O} = Q_{GE} \times N_2O_{GE} \times Specific\_gravity\_of\_N_2O$$

$$PE_y = (Q_{N_2O\_by-pass}_y + ND_{N_2O}_y) \times GWP_{N_2O} + Q_{NG}_y \times E_{NG}_y$$

$PE_y$  is rounded up in t CO<sub>2</sub> eq. to get conservative consistency in final calculation of emission reductions formula.

Parameter	Value	Reference
<b><math>PE_y</math></b>	<b>15 102 t CO<sub>2</sub> eq.</b>	Calculated
$Q_{N_2O\_by-pass}_y$	42 736 kg	Appendix 7
$Q_{GE}$	11 934 361 Nm <sup>3</sup>	Appendix 1
$N_2O_{GE}$	34.1 vppm	Appendix 2
Specific gravity of N <sub>2</sub> O	$1.963 \times 10^{-6}$	Appendix 2 and 3
$ND_{N_2O}_y$	799 kg N <sub>2</sub> O	Appendix 3
$GWP_{N_2O}$	310 kg CO <sub>2</sub> eq./ kg N <sub>2</sub> O	Kyoto Protocol Rule. Decision 2/CP.3
$Q_{NG}_y$	722 568 Nm <sup>3</sup>	Appendix 4
$E_{NG}_y$	2.208 kg CO <sub>2</sub> eq./ Nm <sup>3</sup>	Appendix 5

Note:

- 1) The value of E\_NGy shown above is the yearly moving average of E\_NG as required by the PDD for calculation of E\_Steam. The project emissions are more accurately calculated using the monthly values of E\_NG shown in Appendix 5, following methodology AM0021/version 1 and the Monitoring Plan.
- 2) The value of ND\_N2Oy is calculated by the DCS using every 10 second data of Q\_GE and N2O\_GE (see Appendix 2 and 3) and is more accurate than the value calculated using total average values.

### 9.5. Calculation of leakage

Leak emissions comprise the emissions associated with the energy sources used to generate any steam and electricity used by the decomposition plant.

Leakage amounts to:

$$L_y = Q\_Power \times E\_Power + Q\_steam\_c_y \times E\_steam\_c_y$$

$L_y$  is rounded up in tCO<sub>2</sub> eq. to get conservative consistency in final calculation of emission reductions formula.

Parameter	Value	Reference
<b><math>L_y</math></b>	<b>59 t CO<sub>2</sub> eq.</b>	Calculated
Q_Power	52 238 kWh	Appendix 14
E_Power	0.979 kg CO <sub>2</sub> /kWh	Appendix 15
Q_Steam_c <sub>y</sub>	36 200 kg	Appendix 16
E_Steam_c <sub>y</sub>	0.214 kg CO <sub>2</sub> / kg of steam	Appendix 17

### 9.6. Calculation of emission reduction

The total emission reduction achieved by this project activity during this monitoring period is therefore,

$$ER_y = BE_y - PE_y - L_y$$

Or,

$$ER_y = 671\,101\, \text{t CO}_2 \text{ eq.} - 15\,102\, \text{t CO}_2 \text{ eq.} - 59\, \text{t CO}_2 \text{ eq.}$$

Or,

$$ER_y = 655\,940\, \text{t CO}_2 \text{ eq.}$$

The above emission reduction covers the generation of N<sub>2</sub>O during this monitoring period.

## Appendix 1

Name of item	Q_GE
Description	Volume of effluent gas leaving the stack
Value in period	11 934 361 Nm <sup>3</sup>
Method of monitoring	Annubar flow meter
Recording frequency	Monthly
Background data	Log sheet record / flowmeter

Period	Quantity of gaseous effluent Nm <sup>3</sup>
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	11 934 361

## Appendix 2

Name of item	N2O_GE
Description	Concentration of N <sub>2</sub> O in the effluent gas
Value in period	34.1 vppm
Method of monitoring	Laser diode online analyzer
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	<p>The instant values of the on-line analyzer are used to calculate the quantity of ND_N2O every 10 sec:</p> $ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$ <p>The specific_gravity_of_N2O = <math>44/22.414 \times 10^{-6}</math></p> <p>The analyzer has a range of 0-500 ppm with a detection limit of 5 ppm (1% of range). We use 5 ppm as a default value when the measured value is below the detection limit.</p> <p>Cumulated value for ND_N2O is recorded (see appendix 3).</p> <p>At the end of the month/period based upon the flow Q_GE, and ND_N2O the concentration of N2O equivalent for the month/period is calculated.</p> <p>This value is for information as the constant calculation of ND_N2O is more accurate.</p>

Period	ND_N2O kg	Quantity of gaseous effluent Nm <sup>3</sup>	Average concentration of N <sub>2</sub> O_GE vppm
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	799	11 934 361	34.1



### Appendix 3

Name of item	ND_N2O
Description	Quantity of non-destroyed N2O emitted by the decomposition facility
Value in period	799 kg N <sub>2</sub> O
Method of monitoring	On-line DCS calculation
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	Actual quantity of non destroyed N2O is calculated on-line in the DCS from the concentration of N2O and the flow rate of the gaseous effluent: $ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$ The specific_gravity_of_N2O = $44/22.414 \times 10^{-6}$

Period	ND_N2O kg
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	799



## Appendix 5

Name of item	E_NGy with NGC
Description	Emissions coefficient for natural gas combustion Natural gas composition (NGC) is informed by the natural gas supplier
Value in period for E_NGy	2.208 kg CO <sub>2</sub> /Nm <sup>3</sup>
Method of monitoring	Natural Gas Composition (NGC)
Recording frequency	Monthly
Background data	Composition data received from COMGAS, the natural gas supplier
Calculation method	The average number of C in a mole of NG is calculated from the composition = $\sum$ (number of C in each mole) x (volume ratio) Following monthly data are used to calculate monthly project emissions due to the consumption of Natural Gas. Data for the month of August has been used for this monitoring period.  The yearly value (E_NGy) is calculated with the data available for the year prior to the beginning of the period and is used for the calculation of E_Steam.

Component	August Natural Gas Composition	Number of C
CH <sub>4</sub> (Methane)	88,30	1
C <sub>2</sub> H <sub>6</sub> (Ethane)	6.35	2
C <sub>3</sub> H <sub>8</sub> (Propane)	1.99	3
I-C <sub>4</sub> H <sub>10</sub> (I-Butane)	0.29	4
N-C <sub>4</sub> H <sub>10</sub> (N-Butane)	0.42	4
I-C <sub>5</sub> H <sub>12</sub> (I-Pentane)	0.12	5
N-C <sub>5</sub> H <sub>12</sub> (N-Pentane)	0.08	5
C <sub>6</sub> H <sub>14</sub> + (Hexane)	0.10	6
N <sub>2</sub> (Nitrogen)	0.76	0
CO <sub>2</sub> (Carbon dioxide)	1.58	1
Average number of C	1.131	
E_NG (month)	<b>2.222</b>	

The CO<sub>2</sub> specific gravity in standard state is 1.965  
 $E\_NG = 1.965 \times (\text{average number of C in a mole of NG})$

## Appendix 6

Name of item

%\_on-line

Description

% of production time that the N<sub>2</sub>O is sent to the decomposition facility

Value in period

98.022 %

Method of monitoring

Position of limit switch on the valve allowing to by-pass the decomposition facility

Recording frequency

Monthly

Background data

Log sheet record

Calculation method

Based upon the position of the limit switch on the valve by-passing the decomposition facility, the % of time that the production is connected to the facility is continuously counted and used to calculate Q\_ N<sub>2</sub>O\_by-pass (See Appendix 7).

At the end of the period, %\_on-line for the period is calculated as:

$$\%_{\text{on-line}_y} = 1 - (Q_{\text{N}_2\text{O\_by-pass}_y} / (P_{\text{AdOH}_y} \times \text{N}_2\text{O\_AdOH}))$$

Period	Q_N <sub>2</sub> O_by-pass <sub>y</sub> kg	P_AdOH <sub>y</sub> t	%_on-line <sub>y</sub> %
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	42 736	8 001	98.022

## Appendix 7

Name of item	Q_N2O_by-pass
Description	N2O by-passing the decomposition facility
Value in period	42 736 kg
Method of monitoring	Production record and %_on-line DCS monitoring
Recording frequency	Monthly
Background data	Production & %_on-line log sheet record
Calculation method	<p>The quantity of adipic acid produced while by-passing the destruction facility is first calculated:</p> $\text{AdOH}_{\text{by-pass}} = \text{P}_{\text{AdOH}} \times (1 - \%_{\text{on-line}})$ <p>The quantity of N2O that by-pass the facility is then recorded daily.</p> $\text{Q}_{\text{N2O\_by-pass}_d} = \text{P}_{\text{AdOH}_d} \times \text{N2O}_{\text{AdOH}} \times (1 - \%_{\text{on-line}})$ <p>At the end of the period the quantity of N2O that by-passed the facility is :</p> $\text{Q}_{\text{N2O\_by-pass}_y} = \Sigma (\text{Q}_{\text{N2O\_by-pass}_d})$

Period	Q_N2O_by-pass <sub>y</sub> kg
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	42 736

## Appendix 8

Name of item	P_AdOH
Description	Adipic acid production
Value in period	8 001 t
Method of monitoring	Packaged production and slurry used to nylon salt production
Recording frequency	Monthly
Background data	Log sheet record The Executive Board has confirmed on EB36 the application of a yearly Adipic acid production cap as required by the methodology The production of adipic acid over the year ending with the last day of this period is below the capped value defined in the PDD. The quantity of adipic acid produced during this period can then be fully used as such.

Month - year	Adipic acid production t
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	8 001

The details of the calculation of the production amount are as follows:

The adipic acid production in Paulínia is determined in accordance with the PDD, based on the production of adipic acid both as a dry product and as a slurry. The total daily adipic acid made by the nitric oxidation reaction is the sum of two terms (Equation (1)):

Total Production [P_AdOH] = [Finished Product] + [Variation of the In-Process Product]	(1)
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The finished adipic acid production is obtained by adding the production of dry and slurry adipic acid, according to Equation (2).

[Finished Product] = [Dry Adipic Acid] + [Slurry Adipic Acid]	(2)
---	-----

Only the product that has actually left the plant is considered as finished product. In this case:

- Dry adipic acid: is the product which was actually packaged (determined by weigh scales).
- Slurry Adipic Acid: is the product actually used to react with HMD and make nylon salt. Nylon salt truck loads are very accurately weighed, analyzed and its

inventory variation is taken into account to determine the adipic acid consumed by means of stoichiometric equivalence.

The in-process adipic acid is obtained by adding the amount of adipic acid contained in all process equipment where adipic acid is present at different concentrations.

The variation of the In-Process Product inventory of day N is obtained by subtracting the total In-Process Product of day N minus In-Process Product of day (N-1) as in Equation (3):

$[\text{Variation of the In-Process Product}] = [\text{In-process Product of day N}] - [\text{In-process Product of day (N-1)}]$	(3)
--	-----

Therefore, according to described in the sections above, the total production of adipic acid is the sum of the following terms described in Equation (4), after rewriting Equation (1) using Equation (2):

$\text{Total Production [P\_AdOH]} = [\text{Dry Adipic Acid}] + [\text{Slurry Adipic Acid}] + [\text{Variation of the In-Process Product}]$	(4)
---	-----

The total production is normally different from the finished product on a daily basis since the in-process product is always varying. The total production can be higher or lower than the finished product. On a long term basis however those differences compensate each other and the accumulated total production will of course approach the sum of dry + slurry.

For the purpose of determining the daily amount of N<sub>2</sub>O generated by the nitric oxydation of the raw materials, it must be used the total production, not the finished adipic acid production, since N<sub>2</sub>O is generated by the reaction and is independent of the finished production for a limited time (up to 1 or 2 days). In fact during such limited time the adipic acid made at the reaction can be accumulated in the process equipments awaiting to be processed through purification and drying.

## Appendix 9

Name of item	N2O_AdOH
Description	N2O emission factor for adipic acid production
Value in period	0.270 kg N <sub>2</sub> O/kg AdOH
Method of monitoring	Adipic acid production, nitric acid consumption and physical losses
Recording frequency	Yearly
Background data	Log sheet records
Calculation method	Nitric acid physical losses (HNO <sub>3</sub> _physical) in the aqueous wastes, the off gases, the adipic acid and the by-product are monitored. Those losses are deducted from the nitric acid consumption, (HNO <sub>3</sub> _consumption) to get the chemical consumption, (HNO <sub>3</sub> _chemical).

The N2O emission factor is then calculated over the period on one year using the last rolling year data:

$$\text{N2O\_AdOH} = \text{HNO3\_chemical} / \text{P\_AdOH} / 63 / 2 \times 0.96 \times 44$$

The calculated value for this period is above 0.270 and is then capped by the value of KE\_N2O = 0.27, as specified in the PDD table D.2.1.3 and required by the methodology AM0021/version 1. The calculated value is in the Excel Workbook of this period which is a confidential document communicated to the DOE and to the CDM Executive Board.

Year ending	Value calculated kg N2O/kg AdOH	KE_N2O kg N2O/kg AdOH	N2O_AdOH kg N2O/kg AdOH
Aug 31 <sup>st</sup> , 2008	> 0.270	0.270	0.270



## Appendix 10

Name of item  
Description

$Q_{N_2O \text{ reg}}$ ,  $N_2O_{\text{reg}} / AdOH$  and  $r_y$   
Evolution of Brazilian legislation that may require limitation of  $N_2O$  emissions using one of the following criteria:

- $Q_{N_2O \text{ reg}}$  : allowed  $N_2O$  emissions
- $N_2O_{\text{reg}} / AdOH$  : allowed  $N_2O$  emissions per kg of adipic acid produced
- $r_y$  : share of  $N_2O$  emissions required to be destroyed

Value in period

not applicable

Method of monitoring

Survey

Recording frequency

When relevant

Background data

Brazilian legislation

No evolution of legislation since PDD emission.

Period	$Q_{N_2O \text{ reg}}$ kg	$N_2O_{\text{reg}} / AdOH$ kg	$r_y$ %
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	No limit	No limit	0

Note: Rhodia follows the evolution of Brazilian legislation about  $N_2O$  emissions that could affect the project Emission Reduction through the parameters  $N_2O_{\text{reg}} / AdOH$ ,  $Q_{N_2O \text{ reg}}$ , or  $r_y$  as part of the ISO 14000 requirements.

Rhodia has hired an external company specialized in regulations. It sends to GSIMAP (Rhodia Industrial Platform) all the changes in regulations that may impact Rhodia. GSIMAP team evaluates the changes and discusses the applicability to the Rhodia operations in a steering committee. The conclusions from this steering committee are then presented to the Quality representatives of all plant units in a formal meeting that happens every three months.

Furthermore GSIMAP experts on environmental issues participate on meetings held on external organizations (such as ABIQUIM - Brazilian Association of Chemical Industries, CETESB - local environmental agency) that discuss draft regulations. Those experts know in advance what comes next in terms of environmental laws.

## Appendix 11

Name of item

P\_N<sub>2</sub>O

Description

Market price of N<sub>2</sub>O in waste gas

Value in period

0 €/t
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Method of monitoring

Market survey

Recording frequency

Yearly

Background data

No market for this low level of N<sub>2</sub>O concentration

Beside the very high investment cost in a purification-concentration-liquefaction unit to extract the N<sub>2</sub>O from the exhaust flow of the adipic acid plant, neither the process as the product will get the necessary certifications for the pharmaceutical and food markets.

As pharmaceutical and food markets are the largest of the N<sub>2</sub>O usages we can conclude that there is no N<sub>2</sub>O market for the N<sub>2</sub>O produced as by-product of adipic acid.

Year	P_N <sub>2</sub> O
2008	0

## **Appendix 12**

Name of item	Q_Steam_p
Description	Amount of steam produced by the decomposition facility
Value in period	9 733 600 kg
Method of monitoring	Flowmeter
Recording frequency	Monthly
Background data	Log sheet record

Period	Q_Steam_p Kg
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	9 733 600

### Appendix 13

Name of item	E_Steam
Description	CO <sub>2</sub> emission factor for steam produced by the facility
Value in period	0.145 kg CO <sub>2</sub> /kg of steam
Method of monitoring	Supplier data
Recording frequency	Yearly
Background data	Data supplied by the Rhodia Paulínia Industrial Platform
Calculation method	<p>The calculation is made according to the monitoring plan.</p> <p>We first calculate the amount of natural gas required to generate steam in Nm<sup>3</sup>/t of steam in a very efficient boiler</p> $QNG\_steam = \Delta H \text{ (kJ/t)} / (\text{LHV (kJ/Nm}^3\text{)} \times \eta \text{ (\%)})$ <p>The LHV data is the yearly average value for the gas supplied by COMGAS.</p> <p>E_NG<sub>y</sub> is the yearly average value for the gas supplied by COMGAS (see appendix 5).</p> <p>The yearly value of E_Steam is calculated with the data available for the year prior to the beginning of the period in order to assure to have the data.</p>
Comment	LHV data is supplied by COMGAS in kcal/m <sup>3</sup> at 20 °C. Data were converted to kJ/Nm <sup>3</sup> .

Year ending	LHV kJ/Nm <sup>3</sup>	$\Delta H$ kJ/t	$\eta$ %	QNG_tsteam Nm <sup>3</sup> /t of steam	E_NG <sub>y</sub> kg- CO <sub>2</sub> /Nm <sup>3</sup>	E_Steam kg-CO <sub>2</sub> / kg of steam
Jul 31 <sup>st</sup> , 2008	38 728	2624000	97	65.72	2.208	0.145

## **Appendix 14**

Name of item	Q_Power
Description	Electricity consumption by the decomposition facility
Value in period	52 238 kWh
Method of monitoring	Power consumption data
Recording frequency	Monthly
Background data	Log sheet record / counter

Period	Q_Power kWh
Aug 1 <sup>st</sup> – Aug 31 <sup>st</sup> , 2008	52 238

## **Appendix 15**

Name of item	E_Power
Description	CO <sub>2</sub> intensity for electric generation
Value in period	0.979 kg CO <sub>2</sub> /kWh
Method of monitoring	Survey of data publication
Recording frequency	Yearly
Background data	Latest data made publicly available by the Brazilian Operador Nacional do Sistema Elétrico, ONS, are for 2006.
Calculation method	Calculated according to the PDD monitoring plan based on ACM0002 version2, conservative value used. The detailed calculation is available in the Excel file “Workbook ER Paulínia” of this period (in the worksheet “E_Power”) which is a confidential document communicated to the DOE and to the CDM Executive Board. The data and the calculations were verified by the DOE prior to their utilization.

Date (year)	E_Power kg CO <sub>2</sub> /kWh
2008	0.979



## Appendix 17

Name of item	E_Steam_c
Description	CO <sub>2</sub> intensity for steam consumed in the facility
Value in period	0.214 kg CO <sub>2</sub> /kg of steam
Method of monitoring	Calculated from steam supplier data
Recording frequency	Yearly
Background data	Data supplied by the Rhodia Paulínia Industrial Platform
Calculation method	<p>This steam is supplied by existing boilers on site. Steam production, natural gas, fuel oil and by-products consumptions are monitored. From the monthly consumption of all fuels, the monthly value of E_NG and of the carbon content of each liquid fuel, monthly emissions of CO<sub>2</sub> for steam production are calculated and cumulated over the year. E_Steam_c is obtained from the ratio of yearly CO<sub>2</sub> emission over the yearly steam production.</p> <p>According to the PDD we calculate E_steam_c as a weighted average of the coefficients E_steam_c_NG (emission factor of steam produced by the boilers running on natural gas) and E_steam_c_chem&amp;oil (emission factor of the steam produced by the boilers running on by-products and fuel oil) with the real share of the steam generated with each type of fuel.</p> $E\_steam\_c = E\_steam\_c\_NG \times \%\_gen\_NG + E\_steam\_c\_chem\&oil \times \%\_gen\_chem\&oil$ <p>where <math>\%\_gen\_chem\&amp;oil = 100\% - \%gen\_NG</math></p> <p>The yearly value of E_Steam_c is calculated with the data available for the year prior to the beginning of the period in order to assure to have the data.</p>

Year ending	E_Steam_c_NG kg CO <sub>2</sub> /kg of steam	E_Steam_c_chem&oil kg CO <sub>2</sub> /kg of steam	%_gen_NG Share of steam generated using natural gas	E_Steam_c kg CO <sub>2</sub> / kg of steam
Jul 31 <sup>st</sup> , 2008	0.210	0.242	88.8	0.214