



**CDM  
MONITORING REPORT #28  
of  
“N2O Emission Reduction in Onsan,  
Republic of Korea”  
UNFCCC 0099**

**Revision 1**

**From: July. 10<sup>th</sup>, 2009  
To: August. 31<sup>st</sup>, 2009**

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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 July 10<sup>th</sup>, 2009 to August 31<sup>st</sup>, 2009 as the 28<sup>th</sup> crediting period.

Duration of the project activity period  
The starting date of the project is defined as 01/09/2006.

## 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 Onsan, Republic of Korea.

Version number of the document : 8

Date : September, 1<sup>st</sup> 2005

### **CDM registration number :**

“N<sub>2</sub>O Emission Reduction in Onsan, Republic of Korea” – UNFCCC ref number 0099

### **Directly related EB guidance:**

EB45 Annex13 “Guidance to calculate adipic acid production in cases where it cannot be measured directly” version 1, February 13th 2009

## 3. Definition

y : Monitoring period (period as defined in the first paragraph)

PDD : Project Design Document of this project “N<sub>2</sub>O Emission Reduction in Onsan, Republic of Korea.” Version number of the document: 8, issued on September, 1st 2005



## **4. General description of project**

### **4.1 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 South Korea. There are in fact no governmental regulations with quantified emission limits in any non-Annex I countries at this point.

In this project, Rhodia Polyamide Co. Ltd 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 was not implemented.

The decomposition facilities was installed in the factory site of Onsan Rhodia Polyamide Co., Ltd. in May 2006 and destruction of N<sub>2</sub>O was started in September 2006.

The starting date of the project is defined as 01/09/2006.

This project activity was registered at UNFCCC on November 27<sup>th</sup> 2005 with the number 0099.

### **4.2 Technical description of the project**

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

The decomposition facilities were installed in the factory site of Onsan Rhodia Polyamide Co. Ltd, in May 2006. The surrounding area is the Onsan industrial complex area.

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

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

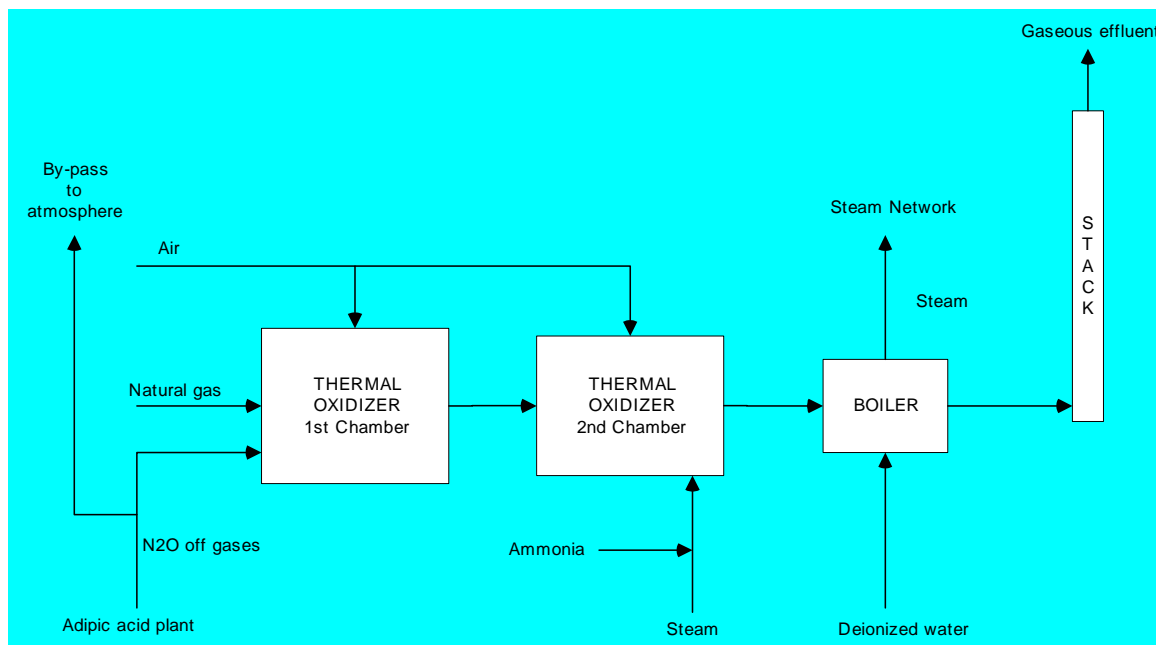
Natural gas is fed with the off gas adipic acid production containing N<sub>2</sub>O and some air in a reduction chamber, where it burns (oxidizes) to carbon dioxide CO<sub>2</sub> and water vapour. N<sub>2</sub>O is used as an oxidizer. Being oxygen deficient, the oxidation is not complete and carbon 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. Steam and ammonia are 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 saturated steam, which is fed into the existing on-site steam network.



#### 4.3 Implementation of the project

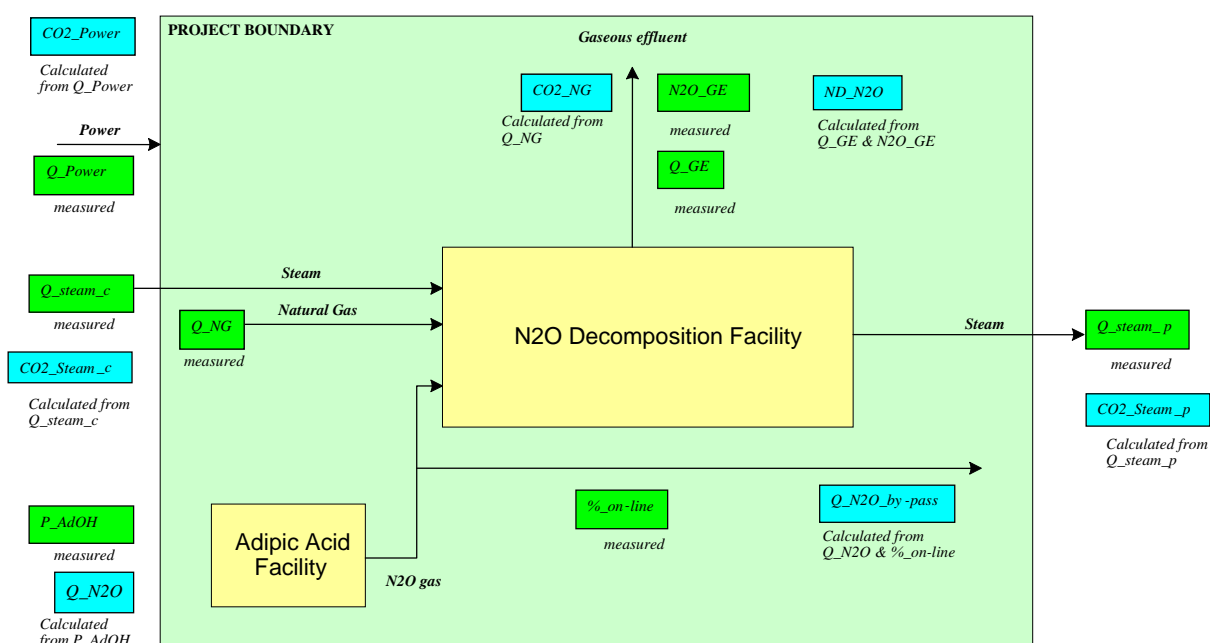
The project is fully implemented according to the description presented in the PDD. The project activity is completely operational.

## 5. Baseline methodology

Approved baseline methodology AM0021 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 AM0021 version 1 is applied to this project

This methodology is applicable to projects which decomposes 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 and 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 were conservative, in particular the performance of the N<sub>2</sub>O abatement unit (in fact, %\_on-line (unit efficiency) > 85%, and destruction rate > 99%)

## 7. Monitored Parameters

According to the methodology AM0021 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 on wet basis converted to standard conditions by temperature and pressure correction	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 on wet basis, in volume fraction	Laser diode online analyzer	vppm	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- N <sub>2</sub> O	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 switches on the by-pass valves are closed	Position switches on by-pass valves	% 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	Log sheet for packaged product and DCS for silo inventory	tonne AdOH	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	-	Monthly	Appendix 9
Q N <sub>2</sub> O reg	Per Korean regulation allowed N <sub>2</sub> O emissions	South Korean regulation	kg	Date when relevant legislation is in place	Appendix 10
N <sub>2</sub> O reg/AdOH	Per Korean regulation allowed N <sub>2</sub> O emissions per kg of adipic acid produced	South Korean regulation	kg	Date when relevant legislation is in place	Appendix 10
r <sub>y</sub>	Per Korean regulation required share of N <sub>2</sub> O emissions to be destroyed	South Korean 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
Steam supplier data	All data required for calculation of E_Steam	External steam supplier and steam properties	-	Yearly	Appendix 13



ID	Data variable	Source of data	Data unit	Recording frequency	Reference
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	Korean Energy Economics Institute	-	Yearly	Appendix 15
Q_Steam_c	Amount of steam consumed by the decomposition facility	Steam meter	kg-steam	Monthly	Appendix 16
Steam suppliers data	All data required for calculation of E_Steam_c	Internal & External steam suppliers	-	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 ISO9001:2000 procedures of the Onsan Adipic Acid plant

The personnel have been trained by the technology supplier i.e. M/s John Zink International Luxembourg.

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

The Onsan plant is certified according to ISO9001:2000 and applies appropriate QA & QC procedures covering also the adipic acid plant and the N<sub>2</sub>O decomposition unit. The Quality Management System includes as part of the standard the Management Responsibility, the Resource Management, the Product Realization, and the Measurement, analysis and improvement.

The equipment and analytical methods given by the technology supplier M/s John Zink International Luxembourg 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) <i>Q_GE</i>	Low	<i>This flow meter is measured with an Averaging Pitot tube. This instrument is considered as a critical instrument in the QA/QC procedure.</i>
2a.2. (D.2.1.1) <i>N<sub>2</sub>O_GE</i>	Low	<i>Existing procedures are applied to this analyzer for QA &amp; QC.</i>
2a.4. (D.2.1.1) <i>Q_NG</i>	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) <i>P_AdOH</i>	Low	<i>Is obtained from production records of the ONSAN 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 silo volume.</i>
2a.5. (D.2.1.1) <i>%_on-line</i>	Low	<i>Use opening of high integrity performance connecting valves to limit leaks. Procedures currently in place in Chalampé for monitoring N<sub>2</sub>O emissions have be implemented in ONSAN 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) <i>Q_Steam_p</i>	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures</i>
3.1. (D.2.3.1) <i>Q_Power</i>	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) <i>Q_Steam_c</i>	Low	<i>Steam meter placed on the list of critical instrument data in the QA/QC procedures.</i>

#### Main QC and QA procedures specific to the project activity:

706-30 Data handling protocol PR(Korean English).doc

706-31 Data review protocol.doc

### 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 created as a protocol in Onsan's Quality management system procedures.

Calibration frequency requirements for the measuring equipments are described in the Excel Workbook ER ONSAN, "Cal\_Maint" worksheet.

The maintenance methods and procedures have been incorporated as part of the ISO9001: 2000 procedures and form an integral part of the systems and procedures for the organization.

During this period, we made Calibration/Maintenance of Measuring and analytical instruments according to PDD.

The Monitoring Equipment Calibration and Maintenance status is presented on Appendix 18.

#### 8.4. Environmental Impact

The Thermal oxidation plant has been installed with on line analyzers to monitor constantly some parameters that are required by Korean legislation.

According to local government environmental law, NO<sub>x</sub> value is continually transmitted to local government agency as a part of the TeleMonitoring System (TMS) from July 1<sup>st</sup> 2007.

To make sure of the on-line analysis value, KumHo Environmental Co, Ltd had carried out the analysis of the gas discharged from the N<sub>2</sub>O stack during this monitoring period. The analysis values were under the control specification limit of the Korea environmental regulation and the average values of those results are shown in the table below.

(KumHo Company has an analysis license for air emission which is permitted by the Korean environmental government)

Table showing analysis Gaseous Emission for Thermal Oxidation plant

Parameter	Unit	Value as per applicable standard	On-line analysis value of the period	Average value in monitoring period by KumHo
CO	ppm	50 max	< 5 ppm	Not measured
NH <sub>3</sub>	ppm	50 max	-	< 3 ppm
NO <sub>x</sub>	ppm	200 max	82 ppm	90.2 ppm

The project was compliant with all environmental Korean regulation.

### 9. GHG Calculations

A spreadsheet Excel file "ER ONSAN" containing all the values of the monitoring parameters and the emission reduction calculation according to the methodology (AM0021/version 1) and the PDD is submitted to the DOE and to the UNFCCC for the request of issuance.

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 Korean 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  $Q_{N_2O_y}$  of  $N_2O$  emitted over the period can then be calculated by (AM0021/version 1 equation (2)):

$$Q_{N_2O_y} = P_{AdOH} \times N_2O_{/AdOH}$$

Over the period of reference the emission factor from the adipic acid plant was above the capped value of 0.27 kg  $N_2O$ /kg AdOH (see appendix 9). So the capped value is being used according to AM0021 version 1.

Parameter	value	Reference
$Q_{N_2O_y}$	3 067 108 kg	Calculated
$P_{AdOH}$ (eligible)	11 359.661 ton	Appendix 8
$N_2O_{/AdOH}$	0.27 kg $N_2O$ /kg AdOH	Appendix 9
$Q_{N_2O \text{ reg}}$	No limit	Appendix 10
$N_2O_{\text{reg}} / AdOH$	No limit	Appendix 10
$r_y$	NA	Appendix 10

As the total production of adipic acid over the year ending with the last day of this period (01/09/2008 to 31/08/2009) is higher than the capped capacity of the adipic acid plant (see details in Appendix 8) the eligible production of adipic acid has been capped for this period. Therefore, the capped production of adipic acid produced during this period is used to calculate the baseline emission according to the methodology.

## 9.2. Calculation of baseline emissions

The amount of baseline emissions in the given period  $y$  (measured in t  $CO_2$  eq.) is calculated by (AM0021/version 1 equation (1)):

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

and rounded down in t  $CO_2$  eq. to get conservative consistency of final calculation of Emission Reductions formula.

Parameter	value	Reference
<b><math>BE_y</math></b>	<b>954 686 t <math>CO_2</math> eq.</b>	Calculated
$Q_{N_2O_y}$	3 067 108 kg	Calculated in 9.1
$GWP_{N_2O}$	310	Kyoto Protocol Rule. Decision 2/CP.3
$Q_{\text{Steam}_p_y}$	31 823 391 kg of steam	Appendix 12
$E_{\text{Steam}_y}$	0.122 kg- $CO_2$ /kg of steam	Appendix 13

## 9.3. Calculation of $(Q_{N_2O} \times (1 - \%_{\text{on-line}}))_y$

The quantity of  $N_2O$  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:

$$Q\_N2O\_by-pass = P\_AdOH \times (1 - \%\_on-line) \times N2O\_/AdOH$$

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:

$$(Q\_N2O \times (1 - \%\_on-line))_y = Q\_N2O\_by-pass_y$$

The  $\%\_on-line_y$  equivalent over the period is calculated as:

$$\%\_on-line_y = 1 - (Q\_N2O\_by-pass_y / Q\_N2O_y)$$

Parameter	Value	Reference
Q_N2O_by-pass <sub>y</sub>	86 361.6 kg	Appendix 7
P_AdOH_period	22 537 ton	Appendix 8
N2O_/AdOH	0.27 kg N2O/kg AdOH	Appendix 9
$\%\_on-line_y$	98.58 %	Appendix 6

#### 9.4. Calculation of project emissions

The emissions due to the decomposition process PE<sub>y</sub> 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.

$$PE_y = ((Q\_N2O \times (1 - \%\_on-line))_y + (Q\_GE \times N2O\_GE \times Specific\_gravity\_of\_N2O)_y) \times GWP\_N2O + Q\_NG_y \times E\_NG_y \quad (AM0021/version 1 equation (6))$$

(The specific gravity of N<sub>2</sub>O is used to transform vppm in kg/ Nm<sup>3</sup>)

$$PE_y = (Q\_N2O\_by-pass_y + (Q\_GE \times N2O\_GE \times Specific\_gravity\_of\_N2O)_y) \times GWP\_N2O + Q\_NG_y \times E\_NG_y$$

The non-destroyed N<sub>2</sub>O (ND\_ N<sub>2</sub>O<sub>y</sub>) is constantly monitored and obtained from the constant monitoring of the flow (Q\_GE) and the concentration of N<sub>2</sub>O (N<sub>2</sub>O\_GE) of the effluent gas:

$$ND\_N2O = Q\_GE \times N2O\_GE \times Specific\_gravity\_of\_N2O$$

$$PE_y = (Q\_N2O\_by-pass_y + ND\_N2O_y) \times GWP\_N2O + Q\_NG_y \times E\_NG_y \quad (AM0021/version 1 equation (5))$$

PE<sub>y</sub> 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>PE<sub>y</sub></b>	<b>30 844 t CO<sub>2</sub> eq.</b>	Calculated
Q_N <sub>2</sub> O_by-pass <sub>y</sub>	86 361.6 kg	Appendix 7
Q_GE	27 017 758 Nm <sup>3</sup>	Appendix 1
N <sub>2</sub> O_GE	5 vppm	Appendix 2
Specific gravity of N <sub>2</sub> O	1.963 x 10 <sup>-6</sup>	Appendix 2 or 3
ND_N <sub>2</sub> O <sub>y</sub>	274 kg N <sub>2</sub> O	Appendix 3
GWP_N <sub>2</sub> O	310 kg CO <sub>2</sub> eq./ kg N <sub>2</sub> O	Kyoto Protocol Rule. Decision 2/CP.3 and IPCC
Q_NG <sub>y</sub>	1 805 908 Nm <sup>3</sup>	Appendix 4
E_NG <sub>y</sub>	2.210 kg CO <sub>2</sub> eq./ Nm <sup>3</sup>	Appendix 5

**Note :**

- 1) The value of E\_NG<sub>y</sub> 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 monthly values of E\_NG shown in Appendix 5, following the methodology AM0021 version 1 and the Monitoring Plan.
- 2) The value of ND\_N<sub>2</sub>O<sub>y</sub> is calculated by the DCS using every 10 second data of Q\_GE and N<sub>2</sub>O\_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 (AM0021/version 1 equation (7) ):

$$L_y = Q_{\text{Power}} \times E_{\text{Power}} + Q_{\text{steam}_c} \times E_{\text{steam}_c}$$

L<sub>y</sub> is rounded up in tCO<sub>2</sub> eq. to get conservative consistency in final calculation of emission reduction formula.

Parameter	Value	Reference
<b>L<sub>y</sub></b>	<b>163 t CO<sub>2</sub> eq.</b>	Calculated
Q_Power	202 774 kWh	Appendix 14
E_Power	0.685 kg-CO <sub>2</sub> /kWh	Appendix 15
Q_Steam_c <sub>y</sub>	175 049 kg	Appendix 16
E_Steam_c <sub>y</sub>	0.132 kg-CO <sub>2</sub> / kg of steam	Appendix 17



#### 9.6. Calculation of emission reduction

Following the PDD section D.2.4, the total emission reduction achieved by this project activity during this monitoring period is therefore,

$$ER_y = BE_y - PE_y - L_y$$

Or,

$$ER_y = 954\,686 \text{ t CO}_2 \text{ eq.} - 30\,844 \text{ t CO}_2 \text{ eq.} - 163 \text{ t CO}_2 \text{ eq.}$$

Or,

$$ER_y = 923\,679 \text{ t CO}_2 \text{ eq.}$$

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

#### 9.7. Comparison of the emission reduction with the PDD estimates

In the PDD section E, the annual emission reduction is estimated to be 9 147 301 tCO<sub>2</sub>eq. So the PDD estimated emission reduction relative to the monitoring period of 53 days is 1 328 238 tCO<sub>2</sub>eq.

Despite of the good performance of the N<sub>2</sub>O abatement unit (%\_online of 98.58% instead of the conservative value of 85% in the PDD) the actual emission reduction claimed for this period is lower than the PDD estimate, because the adipic acid production for the year ending on August 31<sup>st</sup> 2009 has been capped for the base line calculation. The eligible production for the baseline emission has been limited to 11 359.661 t while the actual production for the period was 22 537 t. Project emissions and leakage have been taken into account over the full production of the crediting period.



### **Appendix 1**

Name of item	Q_GE
Description	Volume of effluent gas leaving the stack
Value in period	27 017 758 Nm <sup>3</sup>
Method of monitoring	Annubar flow meter on wet gas basis
Recording frequency	Monthly
Background data	Log sheet record / flowmeter

Period	Quantity of gaseous effluent Nm <sup>3</sup>
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	14 325 257
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	12 692 501





## Appendix 2

Name of item	N2O_GE
Description	Concentration of N <sub>2</sub> O in the effluent gas
Value in period	5 vppm
Method of monitoring	Laser diode online analyzer on wet gas basis
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	<p>According to AM0021/version1, the actual quantity of non destroyed N2O is calculated on-line in the DCS every 10 sec from the concentration of N2O and the flow rate of the gaseous effluent:</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> is used to transform vppm in kg/ Nm<sup>3</sup></p> <p>The analyzer has a range of 0-200 vppm with a detection limit of 5 vppm, which is used 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> $N2O\_GE = ND\_N2O / (Q\_GE \times N2O\_GE \times Specific\_gravity\_of\_N2O)$ <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
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	142	14 325 257	5
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	132	12 692 501	5



### Appendix 3

Name of item	ND_N2O
Description	Quantity of non-destroyed N2O emitted by the decomposition facility
Value in period	274 kg N <sub>2</sub> O
Method of monitoring	On-line DCS calculation
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	According to AM0021/version1, the 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 both measured on a wet basis (Equivalent to method D of EB47 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"): $ND\_N2O = Q\_GE * N2O\_GE * Specific\_gravity\_of\_N2O$ The specific_gravity_of_N2O = $44/22.414 \times 10^{-6}$ is used to transform vppm in kg/ Nm <sup>3</sup>

Period	ND_N2O kg
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	142
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	132



#### **Appendix 4**

Name of item	Q_NG
Description	Amount of natural gas used by the decomposition process
Value in period	1 805 908 Nm3
Method of monitoring	Natural gas consumption data
Recording frequency	Monthly
Background data	Log sheet record / flowmeter

Period	Q_NG Nm <sup>3</sup>
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	794 472
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	1 011 436

## Appendix 5

Name of item	E_NGy with NGC
Description	Emission coefficients for natural gas combustion Natural Gas Composition (NGC) from Supplier for natural gas
Value in period for E_NGy	2.210 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 Kyung Dong City Gas Ltd, the natural gas supplier
Calculation method	Following the PDD Monitoring Plan 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) As LNG composition data in July is not yet available, the previous monthly data are used to calculate monthly project emissions as required by the data handling protocol, document requested by the monitoring plan.

Component	July Natural Gas Composition	Number of C
CH <sub>4</sub> (Methane)	91.44	1
C <sub>2</sub> H <sub>6</sub> (Ethane)	5.26	2
C <sub>3</sub> H <sub>8</sub> (Propane)	2.26	3
I-C <sub>4</sub> H <sub>10</sub> (I-Butane)	0.46	4
N-C <sub>4</sub> H <sub>10</sub> (N-Butane)	0.43	4
I-C <sub>5</sub> H <sub>12</sub> (I-Pentane)	0.01	5
N-C <sub>5</sub> H <sub>12</sub> (N-Pentane)	0.00	5
N <sub>2</sub> (Nitrogen)	0.14	0
CO <sub>2</sub> (Carbon dioxide)	0.00	1
Average number of C	1.124	
<b>E_NG<sub>m</sub></b>	2.207	

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 N2O is sent to the decomposition facility
Value in period	98.58 %
Method of monitoring	Position of limit switches on the valves allowing to by-pass the decomposition facility
Recording frequency	Monthly
Background data	Log sheet record
Calculation method	<p>%_on-line is determined following the PDD. Based upon the position of the limit switches on the valves by-passing the decomposition facility, the % of time that the production is connected to the facility is continuously counted and used to calculate the daily value of Q_N2O_by-pass (See Appendix 7). The daily values of Q_N2O_by-pass are added to determine the monthly values of Q_N2O_by-pass, as required by the PDD</p> <p>At the end of the period, %_on-line for the period is calculated as:</p> $\%_{\text{on-line}} = 1 - (Q_{\text{N2O\_by-pass}} / (P_{\text{AdOH}} \times \text{N2O\_}/\text{AdOH}))$ <p>The by-pass emissions are calculated with the adipic acid production for the entire crediting period.</p>

Period	Q_N2O_by-pass <sub>y</sub> kg	P_AdOH <sub>y</sub> t	%_on-line <sub>y</sub> %
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	44 576.6	10 058	98.36
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	41 785	12 479	98.76



## Appendix 7

Name of item	Q_N2O_by-pass
Description	N2O by-passing the decomposition facility
Value in period	86 361.6 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:  <math>AdOH\_by-pass = P\_AdOH \times (1 - \%\_on-line)</math>  The quantity of N2O that by-pass the facility is then recorded daily and calculated following AM0021/version1.  <math>Q\_N2O\_by-pass_d = Q\_N2O_d \times (1 - \%\_on-line)</math> or  <math>Q\_N2O\_by-pass_d = P\_AdOH_d \times N2O\_/AdOH \times (1 - \%\_on-line)</math>  At the end of the period the quantity of N2O that by-passed the facility is :  <math>Q\_N2O\_by-pass_y = \Sigma (Q\_N2O\_by-pass_d)</math></p>

Period	Q_N2O_by-pass <sub>y</sub> kg
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	44 576.6
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	41 785

## Appendix 8

Name of item	P_AdOH (eligible)
Description	Adipic acid production after cap application
Value in period	11 359.661 t
Method of monitoring	Packaged production and silo inventory
Recording frequency	Monthly
Background data	Log sheet records and DCS data for silo weight

The daily Adipic Acid production is measured directly by the weight of packed finished product and the silo weight difference between two consecutive days. The EB45 guidance Annex 13 in reference does not apply to such cases.

The Executive Board has confirmed on EB36 the application of a yearly Adipic acid production cap as required by the methodologies (issue 1 of the Requests of review for the Monitoring Period #9 Aug 8<sup>th</sup>, 2007 ~ Aug 31<sup>st</sup>, 2007).

The cumulated production of Adipic acid over the current year (starting last September 1<sup>st</sup> and ending with the last day of this period) is 153 728 t. This production is above the cap clarified in the EB48. Following EB48 clarification, the cap is 142 551 t/y calculated as 415 t/d x 365 x 94,109 % (information available in the Excel Workbook “ER ONSAN”, sheet BE, submitted to UNFCCC).

The quantity of adipic acid produced during this period and the eligible production for the baseline emission calculation are given below:

	Adipic acid production after cap application P_AdOH (eligible) t	Adipic acid production P_AdOH t
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	10 058	10 058
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	1 301.661	12 479
Total	11 359.661	22 537

## Appendix 9

Name of item HNO<sub>3</sub>\_consumption & HNO<sub>3</sub>\_physical  
Description Nitric acid consumption and losses in the adipic acid process  
Value in period (see table below)  
Method of monitoring Excel workbook based on monitoring data and analysis  
Recording frequency Monthly

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) (AM0021/version 1 equation (3) ).

Period	HNO <sub>3</sub> _consumption t	HNO <sub>3</sub> _physical t	HNO <sub>3</sub> _chemical t
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	8 639	168	8 471
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	10 640	219	10 421
Rolling year Aug. 31 <sup>st</sup> , 2009	131 458	2 570	128 888

Name of item N<sub>2</sub>O\_AdOH  
Description N<sub>2</sub>O 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

Calculation method The N<sub>2</sub>O emission factor is then calculated over the period on one year using the last rolling year data (AM0021/version 1 equation (4) ):

$$N_2O\_AdOH = HNO_3\_chemical / P\_AdOH / 63 / 2 \times 0.96 \times 44$$

The calculated value for this period is above 0.270 and is then capped by the value of KE\_N<sub>2</sub>O = 0.27, as specified in the PDD table D.2.1.3 and required by the methodology AM0021/version 1 referring to the IPCC Good Practice Guidance.

Period	Value N <sub>2</sub> O_AdOH calculated kg N <sub>2</sub> O/kg AdOH	KE_N <sub>2</sub> O kg N <sub>2</sub> O/kg AdOH	N <sub>2</sub> O_AdOH kg N <sub>2</sub> O/kg AdOH
Rolling year Aug. 31 <sup>st</sup> , 2009	0.281	0.270	0.270



## Appendix 10

Name of item	Q_N <sub>2</sub> O reg , N <sub>2</sub> O_reg / AdOH and r <sub>y</sub>
Description	<p>Evolution of Korean legislation that may require limitation of N<sub>2</sub>O emissions using one of the following criteria:</p> <ul style="list-style-type: none"> <li>- Q_N<sub>2</sub>O reg : allowed N<sub>2</sub>O emissions</li> <li>- N<sub>2</sub>O_reg / AdOH : allowed N<sub>2</sub>O emissions per kg of adipic acid produced</li> <li>- r<sub>y</sub> : share of N<sub>2</sub>O emissions required to be destroyed</li> </ul>
Value in period	not applicable
Method of monitoring	Survey
Recording frequency	When relevant
Background data	<p>South Korean legislation</p> <p>Rhodia follows the evolution of Korean legislation part of its SIMSER+ procedures (System Integrating Management for Safety and Environment). SIMSER+ is covering ISO 14001 standard which requires to follow any updates on environmental regulations. For the monitoring of the new HSE (Hygiene, Safety and Environment) local and national regulations, Rhodia Korea has joined two committees: “Onsan Environment Management Society” and “Korea Environmental Engineers Federation”.</p> <p>No evolution of legislation since PDD emission</p>

Period	Q_N <sub>2</sub> O reg kg	N <sub>2</sub> O_reg / AdOH kg	r <sub>y</sub> %
Aug. 31 <sup>st</sup> 2009	No limit	No limit	0.



## **Appendix 11**

Name of item

Description

Value in period

Method of monitoring

Recording frequency

Background data

P\_ N<sub>2</sub>O

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

0 €/t
-------

Market survey

Yearly

Refers to study

Background data Refers to study “N<sub>2</sub>O market study NITROUS OXIDE Korea” –update September 2008

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 nor the product will get the necessary certifications for the pharmaceutical (80% share), food and semiconductor markets.

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
2009	0



## **Appendix 12**

Name of item	Q_Steam_py
Description	Amount of steam produced by the decomposition facility
Value in period	<div>31 823 391 kg</div>
Method of monitoring	Flowmeter
Recording frequency	Monthly
Background data	Log sheet record

Period	Q_Steam_py kg
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	14 044 035
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	17 779 356



### **Appendix 13**

Name of item	E_Steam
Description	CO <sub>2</sub> emission factor for steam produced by the facility
Value in period	0.122 kg-CO <sub>2</sub> /kg of steam
Method of monitoring	Supplier data
Recording frequency	Yearly
Background data	Monthly external natural gas data from supplier
Calculation method	<p>As we cannot get the data from the supplier, 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> $QNG\_tsteam = \Delta H \text{ (kcal/t)} / (\text{HHV (kcal/Nm}^3\text{)} \times \eta \text{ (\%)})$ <p>The HHV data is the yearly average value for the gas supplied by Kyung Dong City Gas Co, Ltd</p> <p>This leads to a conservative value of E_Steam as the steam from the external supplier is produced from coal.</p>

Year ending	HHV kcal/Nm <sup>3</sup>	$\Delta H$ kcal/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
Aug. 31 <sup>st</sup> 2009	10 413	557 960	97	55. 240	2.210	0.122



#### **Appendix 14**

Name of item	Q_Power
Description	Electricity consumption by the decomposition facility
Value in period	<div>202 774 kWh</div>
Method of monitoring	Power consumption data
Recording frequency	Monthly
Background data	Log sheet record / counter

Period	Q_Power kWh
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	97 125
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	105 649

## Appendix 15

Name of item	E_Power
Description	CO <sub>2</sub> intensity for electric generation
Value in period	0.685 kg-CO <sub>2</sub> /kWh
Method of monitoring	Survey of data publication
Recording frequency	Yearly
Background data	KEPCO data made publicly available by the Korean Energy Economics Institute (KEEI) for 2008.
Calculation method	Calculated using the combined margin (CM) approach according to ACM0002 version 2 in file <sup>1</sup> (Grid_EF_SouthKorea 2008 rev1.xls).

Date (year)	E_Power kg-CO <sub>2</sub> /kWh
2009	0.685

<sup>1</sup> AM00021 version 1 requires calculation of E\_Power as “the highest of the operating margin and the build margin according to ACM0002 version 2 for the grid connected to the facility”. The way the emission factor is calculated follows exactly the requirement of the methodology for the following reasons:

- (i) “according to ACM0002” means among other things to follow the combined margin CM approach (CM is the weighted average of OM and BM, with default weights of 50%/50%),
- (ii) “the highest of the operating margin” means the simple OM as it is the highest operating margin of all alternatives listed in ACM0002 for calculation of the OM since the simple OM excludes all low-operating costs and must-run power plants which are nuclear power plants, hydro power plants and all renewable energy power plants, and
- (iii) “the build margin” means the build margin (option 2 updated annually ex post) as required to be calculated following ACM0002 version 2.



## **Appendix 16**

Name of item	Q_Steam_c
Description	Amount of steam consumed by the decomposition facility
Value in period	175 049 kg
Method of monitoring	Mass flowmeter
Recording frequency	Monthly
Background data	Log sheet record

Period	Q_Steam_c Kg
July 10 <sup>th</sup> ~ July 31 <sup>st</sup>	72 791
Aug. 1 <sup>st</sup> ~ Aug 31 <sup>st</sup>	102 258



## **Appendix 17**

Name of item	E_Steam_c
Description	CO2 intensity for steam consumed in the facility
Value in period	0.132 kg-CO <sub>2</sub> /kg of steam
Method of monitoring	Calculated from steam supplier data
Recording frequency	Yearly
Background data	Log sheet records / Composition from Kyung Dong City Gas Ltd, the natural gas supplier
Calculation method	<p>This steam is supplied by existing boilers on site. Steam production and natural gas consumption are monitored. From the monthly natural gas consumption and the monthly value of E_NG, monthly emissions of CO2 for steam production are calculated and cumulated over the year.</p> <p>Q_NG_tsteam in Nm3/t of steam is obtained from the ratio of annual natural gas consumption over the annual steam production.</p> <p>The E_Steam_c is obtained from:</p> $E\_Steam\_c = E\_NG_y \times Q\_NG\_tsteam$

Year ending	Q_NG_tsteam Nm3/t of steam	E_NG <sub>y</sub> kg-CO <sub>2</sub> /Nm3	E_Steam_c kg-CO <sub>2</sub> / kg of steam
Aug. 31 <sup>st</sup> 2009	59.502	2.210	0.132



# **Appendix 18 INSTRUMENT CALIBRATION & MAINTENANCE STATUS** (see remarks in the Workbook ER Onsan, sheet Cal\_Maint)

Related PDD parameter	Instrument / equipment	Tag number	Periodicity	Done by	2008												2009											
					1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
%_online	By-pass Valves Integrity Check	HV-57001	Annually	Rhodia							•								•									
%_online	By-pass Valves Integrity Check	HV-57003	Annually	Rhodia							•								•									
P_AdOH	Small bags and bags Balance	W42811	Annually	Rhodia					•											•								
P_AdOH	Big bags and bags Balance	W43741	Annually	Rhodia					•											•								
P_AdOH	Big bags and bags Balance	W43742	Annually	Rhodia					•											•								
Q_steam_c	Steam import to N2O system	FIQ-58082	Annually	Third party							•								•									
Q_steam_p	Steam production by N2O system	FIQ-58213	Annually	Third party							•								•									
Q_steam_P	Boiler feed water to N2O system	FIQ58204	Annually	Third party															•									
Q_steam_p	Boiler continuous purge flow rate	FIQ58303	Annually	Rhodia															•									
N2O_GE	Stack N2O analyzer (in-situ, laser diode)	AIT-58408	2 / year	Rhodia					•						•				•									
N2O_GE	Stack N2O analyzer (extractive infrared)	AI58418	Weekly	Rhodia	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Q_NG	Natural Gas burning	FQ91485A	Annually	Third party					•										•									
Q_NG	Natural Gas burning (Back up flow meter)	FQ91485B	Annually	Third party								•											•					
Q_GE	Effluent Gas	FIQ-58407	Annually	Third party					•										•									
Q_Power	Electricity meter	LV22WH	Every 7 years	Third party												•												
Nitric Cons	Potentiometric titrator	Lab analyzer	weekly	Rhodia	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Nitric Cons	HPLC	Lab analyzer	Daily	Rhodia	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Nitric Cons	Truck Scale	W-90000	Annually	Third party											•													
Nitric Cons	FRESH NIITRIC ACID HANWHA	FT6C069	Annually	Third party					•										•									
Nitric Cons	FRESH NIITRIC ACID HANWHA	FT760CD	Annually	Third party											•													
Nitric Cons	FRESH NIITRIC ACID TANK R92000	LT-92005	Annually	Rhodia						•										•								
Nitric Cons	FRESH NIITRIC ACID TANK R92010	LT-92015	Annually	Rhodia						•											•							
Nitric Cons	NOX GAS DCN INLET	AYA-51526	4 / year	Rhodia	•				•		•			•		•		•		•		•		•				
Nitric Cons	LNOX E56010 TO A56020	AYA-56026	4 / year	Rhodia	•				•		•			•		•		•		•		•		•				
Nitric Cons	KAOP TO OXIDATION	FT-12701	Annually	Third party						•						•			•									
Nitric Cons	LNOX D51500 TO E55030	FQ-51525	Annually	Rhodia						•						•												
Nitric Cons	LNOX D52400 TO E56030	FQ-52428	Annually	Rhodia						•						•												
Nitric Cons	HPCE R61380 TO K83160	FQ-61782	Annually	Third party						•									•									
Nitric Cons	DBA TO F81200	FQ-81115	Annually	Third party						•									•									
Nitric Cons	DBA R81100 TO K83300	FQ-82351	Annually	Third party						•									•									
Nitric Cons	Waste water to R83200	FQ-83401	Annually	Third party						•									•									
Reference	KA OIL TANK R92100	LT-92106	Annually	Rhodia						•											•							
Reference	KA OIL TANK R92200	LT-92206	Annually	Rhodia						•											•							
P_AdOH	SILO R42500	W-42505	Annually	Rhodia						•						•			•									