



CDM Monitoring Report No. 3:

"Catalytic N<sub>2</sub>O destruction project in the tail gas of the Nitric Acid  
Plant of Abu Qir Fertilizer Co"

UNFCCC 0490

Monitoring Period:

From: 01/04/2007

To: 30/06/2007

Version 1

July 20<sup>th</sup> 2007

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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 activity for periodic verification.

This monitoring report covers the activity from **01/04/2007 to 30/06/2007** as the 3<sup>rd</sup> monitoring period.

Duration of the project activity period:

The starting date of the project activity is the: 09/10/2004

The project was registered at UNFCCC on: 07/10/2006 with number 0490

The starting date of the crediting period is: 15/09/2006

Carbon Egypt has implemented a project for GHG emission reduction by catalytic N<sub>2</sub>O destruction in Abu Qir, Egypt. The project is categorized as large scale project under sectoral scope 5: “Chemical Industry”. The Host Party for the project activity is the Republic of Egypt.

## 2 Reference

### **Approved Baseline methodology:**

AM0028 Version 1: “Catalytic N<sub>2</sub>O destruction in the tail gas of Nitric Acid Plants”; submitted by Carbon Projektentwicklung GmbH.

### **Approved Monitoring methodology:**

AM0028 Version 1: “Catalytic N<sub>2</sub>O destruction in the tail gas of Nitric Acid Plants”; submitted by Carbon Projektentwicklung GmbH.

### **Project Design Document:**

“Catalytic N<sub>2</sub>O destruction project in the tail gas of the Nitric Acid Plant of Abu Qir Fertilizer Co”

Version: 2 (b)

Date of Completion: June 20th 2006

### **Validation Report:**

Validation of the CDM Project: “Catalytic N<sub>2</sub>O Destruction project in the tail gas of the Nitric Acid Plant of Abu Qir Fertilizer Co.”

REPORT NO. 611173

July 03<sup>rd</sup> 2006 by TÜV SÜD Industry Service GmbH

### **CDM Registration:**

“Catalytic N<sub>2</sub>O destruction project in the tail gas of the Nitric Acid Plant of Abu Qir Fertilizer Co” – UNFCCC ref. Number 0490

Date of registration: October 07<sup>th</sup> 2006

### 3 Definition

- y : Monitoring period (in this report, April 1<sup>st</sup> 2007 to June 30<sup>th</sup> 2007)
- **PDD** : Project Design Document of this project “Catalytic N<sub>2</sub>O destruction project in the tail gas of the Nitric Acid Plant of Abu Qir Fertilizer Co” Version 2 (b) on June 20<sup>th</sup> 2006.

## 4 General Description of Project

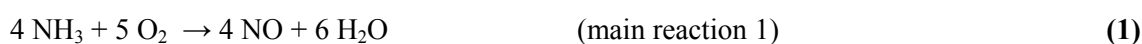
### 4.1 Project Activity

The Project Activity includes development, design, engineering, procurement, finance, construction, operation and maintenance of a system for catalytic reduction of N<sub>2</sub>O. The EnviNOx® process used in the Abu Qir II nitric acid plant is based on the catalytic reduction of NO<sub>x</sub> (NO and NO<sub>2</sub>) with ammonia (NH<sub>3</sub>) and of nitrous oxide (N<sub>2</sub>O) with a hydrocarbon. The hydrocarbon used is natural gas of which the main constituent is methane (CH<sub>4</sub>). The reactions take place over two iron zeolite catalyst beds.

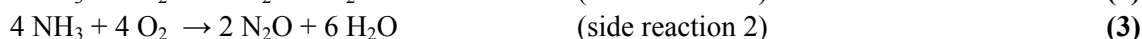
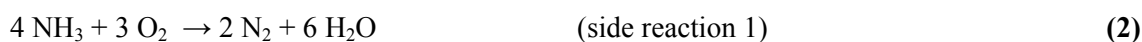
#### General Introduction:

Nitrous oxide (N<sub>2</sub>O) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. The production of nitric acid takes place in three main process steps as indicated by the following reactions:

1. Ammonia (NH<sub>3</sub>) combustion to form nitric oxide (NO)<sup>1</sup>:



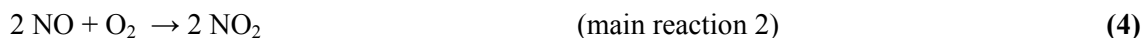
Simultaneously nitrous oxide (N<sub>2</sub>O), nitrogen (N) and water (H<sub>2</sub>O) are formed as well, in accordance with the following equations:



NO yield mainly depends on pressure and temperature in the ammonia oxidation process and is usually in a range of 95% to 97%.

2. NO is oxidised to nitrogen dioxide (NO<sub>2</sub>):

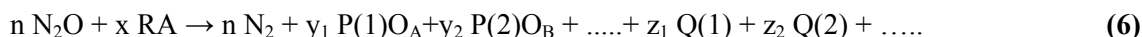
<sup>1</sup> Ammonia is reacted with air on noble metal catalyst in the oxidation section of nitric acid plants. Nitric oxide and water are formed in this process according to the above mentioned main equation.



3. (According to the technical process) Absorption of  $\text{NO}_2$  in water to form nitric acid ( $\text{HNO}_3$ ):
- $$3 \text{ NO}_2 + \text{H}_2\text{O} \rightarrow 2 \text{ HNO}_3 + \text{NO} \quad (\text{main reaction 3}) \quad (5)$$
- (NO is oxidised to  $\text{NO}_2$  according to main reaction 2)

#### Description of catalytic reduction process:

Although the term catalytic reduction nowadays has a more general definition in terms of the transfer of electrons, the following definition is sufficient for present purposes: catalytic reduction of  $\text{N}_2\text{O}$  occurs when reactions take place between  $\text{N}_2\text{O}$  and other substances in contact with a catalyst, such that the oxygen is removed from the  $\text{N}_2\text{O}$  molecule and forms one or more compounds with other species. The substance or substances that react with  $\text{N}_2\text{O}$  to remove oxygen are termed reducing agent. A general reaction equation for the catalytic reduction of  $\text{N}_2\text{O}$  can be given as:



where RA is a molecule of the reducing agent,  $\text{P(1)O}_A$ ,  $\text{P(2)O}_B$  are the compound formed by reaction with the oxygen of the  $\text{N}_2\text{O}$  and Q(1), Q(2) represent further products of the oxidation reaction, n, x,  $y_1$ ,  $y_2$ ,  $z_1$ ,  $z_2$  are the appropriate stoichiometric coefficients.

#### **Project Specific description:**

##### Principles of the EnviNOx® process

The reactions take place over two iron zeolite catalyst beds. The first bed contains an iron zeolite that is especially effective in catalysing the reduction of  $\text{NO}_x$  with ammonia according to such reactions as:



Effectively all the  $\text{NO}_x$  is removed. Furthermore some destruction of  $\text{N}_2\text{O}$  occurs.

##### Equations showing reduction $\text{N}_2\text{O}$ with methane:

The second and main bed contains an iron zeolite that is particularly efficient in catalysing the reduction of nitrous oxide with methane.





Technology employed by the project activity:

In this project, CARBON Egypt installed the EnviNOx® system for catalytic reduction of NO<sub>x</sub> and N<sub>2</sub>O additionally to the equipment at the nitric acid manufacturing plant. The project activity reduces the GHG emissions, which would otherwise be released to the atmosphere, if the project was not implemented. The implementation of the N<sub>2</sub>O destruction project at AFC involves that natural gas, a mixture of hydrocarbons of which the main constituent is methane (CH<sub>4</sub>), is employed as a reducing agent for N<sub>2</sub>O removal.

The EnviNOx® system was installed in September 2006 and the catalytic reduction process of N<sub>2</sub>O started in the end of September 2006.

The starting date of the second crediting period is defined as January 1<sup>st</sup> 2007.

Location of the project activity:

The EnviNOx® system was installed at the nitric acid plant on site of Abu Qir Fertilizer Co. S.A.E. furthermore called "AFC".

Location of the EnviNOx®-System:

The EnviNOx®-Reactor (21R004) is located between tail gas heater IV (21E013) and the tail gas turbine (21MT022) which is the position with the highest tail gas temperature in the nitric acid production process at AFC.

#### 4.2 Project Participants

Name of Party involved	Project participants (as applicable)	Party involved considered as project participant
Arab Republic of Egypt (Host)	CARBON Egypt Ltd.	No
Republic of Austria	KOMMUNALKREDIT PUBLIC CONSULTING GmbH	No
Federal Republic Germany	RWE Power AG	No

Host Country is the Arab Republic of Egypt. The Arab Republic of Egypt ratified the Kyoto Protocol in January 2005. The other Party involved in the Project at the time of registration is the Republic of Austria. Subsequent to the registration of the Project, Federal Republic Germany has been added as a Party involved in the Project.

**Focal point:**

The project participants agreed that CARBON Projektentwicklung GmbH, Austria serves as focal point of communication with the Executive Board and the UNFCCC Secretariat.



**Project applicant, developer and sponsor** is **CARBON Egypt Ltd.** (furthermore called “CARBON”). CARBON Egypt Ltd. is registered under the laws of the Arab Republic of Egypt. The company is a 100% subsidiary of CARBON Projektentwicklung GmbH, Austria.

CARBON Projektentwicklung GmbH was founded as a limited liability company located and registered in Austria under Austrian law in order to develop, finance and operate high quality JI/CDM Projects. CARBON Projektentwicklung GmbH has vast experience with CDM-Project development in Africa, Latin America and Asia and is specialized on the catalytic N<sub>2</sub>O destruction in the tail gas of nitric acid plants.

**Kommunalkredit Public Consulting (KPC)** was appointed for the Programme Management on behalf of the Austrian Ministry of Agriculture and Forestry, Environment & Water Management. The Programme is operational since August 2003.

The RWE Group is one of Europe’s leading integrated electricity and gas companies. **RWE Power AG** is the continental power generation company within the RWE Group and Germany’s biggest power producer. RWE Power has a diverse generation portfolio including lignite, hard coal, nuclear energy, gas and renewable sources such as hydro, wind and biomass. RWE invests and participates actively in projects under the Clean Development Mechanism and Joint Implementation. The RWE team combines a track record in global commodities and emissions trading as well as risk management with broad experience and a deep understanding of specific risks inherent in CDM and JI projects.

**Project Operator** is **Abu Qir Fertilizer Co. S.A.E.** (furthermore called “AFC”), the biggest Fertilizer Company in Africa. AFC was founded as a joint stock company located and registered in the Alexandria Province under Egyptian law in 1976 and is the market leader with a market share of close to 70% of the local Egyptian fertilizer market. With closely to 3000 employees AFC is among the major job providers in Alexandria area. The company is ISO 9001/2000 and ISO 14001 certified and one of the most important companies of the Egyptian industry. Owners of AFC are Egyptian banks, petroleum corporations, other industrial shareholders, insurance companies and the labour union as well as individual shareholders.

In the light of huge reserves of natural gas in Egypt, the recent major agricultural projects (irrigation) and the increasing over-population in Egypt, the fertilizer industry is considered to be one of the most important industries in Egypt, both today and in the future.

The nitric acid plant ABU QIR II was constructed by UHDE GmbH, Germany in July 1991. With a capacity of 1,830 t of nitric acid per day, ABU QIR II is one of the largest nitric acid plants in the world.

**Project Technology Provider** is UHDE GmbH (furthermore called “UHDE”), a 100% subsidiary of ThyssenKrupp. UHDE is world market leader in the field of fertilizer technology engineering and construction. Consequently, UHDE has constructed numerous modern fertilizer plants including nitric acid plants. Among these plants is AFC’s nitric acid plant. In response to increasing concerns surrounding climate change and the destruction of the ozone layer, UHDE has developed catalyst-based processes for removing N<sub>2</sub>O from nitric acid tail gas streams.



## 5 Baseline Methodology

The approved Baseline Methodology AM0028 Version 1 “Catalytic N<sub>2</sub>O destruction in the tail gas of Nitric Acid Plants”; submitted by Carbon Projektentwicklung GmbH is applied to this project activity.

The use of the methodology is justified because the following statements are true:

- The methodology is applied to the existing production capacity installed no later than 31 December 2005.
- The Abu Qir II nitric acid plant has *not* installed any N<sub>2</sub>O destruction or abatement technology prior to the start of the project activity. The project activity will not result in any shut down of an existing N<sub>2</sub>O destruction or abatement facility at Abu Qir II.
- The project activity does not cause a nitric acid production increase.
- The project activity results in NO<sub>x</sub> emission reductions that are at least as effective as the DeNO<sub>x</sub>-unit installed prior to the start of the project activity.
- The DeNO<sub>x</sub>-unit installed prior to the start of the project activity at Abu Qir II was a SCR DeNO<sub>x</sub>-unit.
- The N<sub>2</sub>O concentrations are measured in real time at the inlet and the outlet of the N<sub>2</sub>O destruction facility.

### Project boundary

For the purpose of determining project activity emissions, the following emission sources are included:

- N<sub>2</sub>O concentration in the flow stream of the tail gas;
- Hydrocarbons as a reducing agent to enhance the efficiency of a N<sub>2</sub>O catalytic reduction facility.

For the purpose of determining baseline emissions, the following emission sources are included:

- N<sub>2</sub>O concentration in the flow stream of the tail gas.

The following table illustrates, which emission sources are included and which are excluded from the project boundary for determination of both, baseline and project emissions.

**Table 1: Overview on emission sources included or excluded from the project boundary**

### Baseline Emissions:

<i>Source</i>	<i>Gas</i>		<i>Justification/Explanation</i>
Emissions of N <sub>2</sub> O as a result of side reaction to the nitric acid Production process	N <sub>2</sub> O	Included	Main emission source, taking national N <sub>2</sub> O emission regulations into account.
Emissions related to the production of ammonia used for NO <sub>x</sub> reduction	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	Excluded according to AM0028	In case of Abu Qir II a SCR DeNO <sub>x</sub> unit was already installed prior to the project start: ammonia input for SCR is considered to be of the same magnitude to project related ammonia input for NO <sub>x</sub> reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.

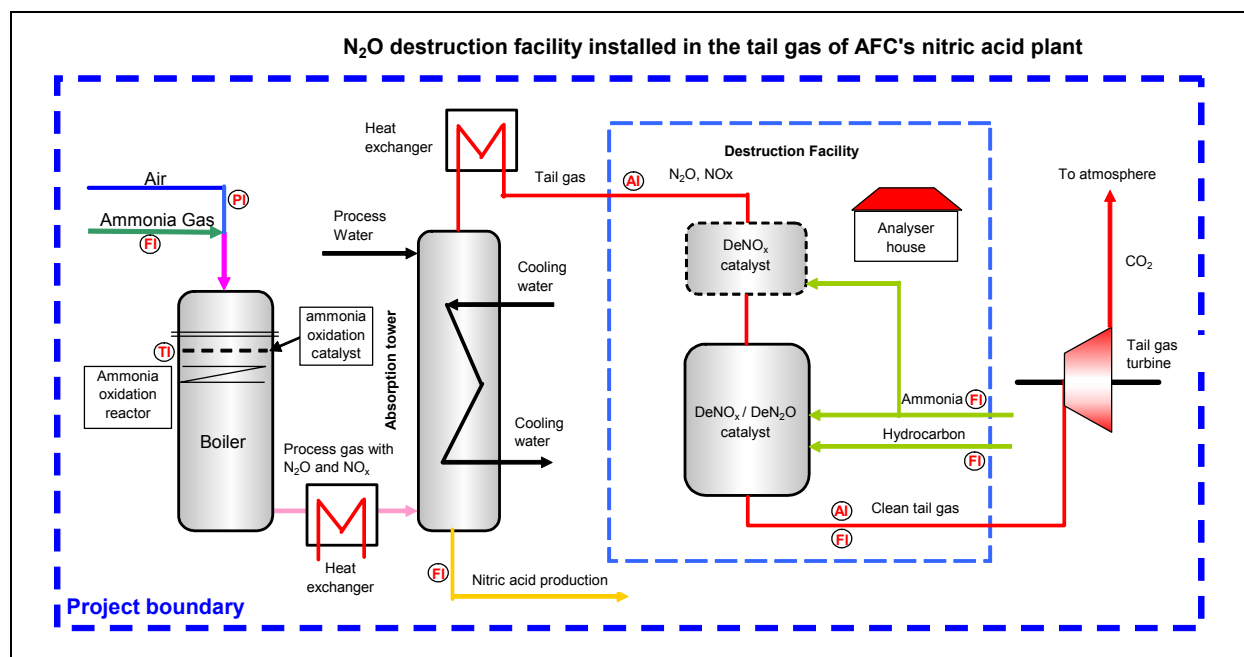
N <sub>2</sub> O emissions from SCR DeNO <sub>x</sub> unit	N <sub>2</sub> O	Excluded according to AM0028	The presence of a SCR DeNO <sub>x</sub> unit tends to increase the N <sub>2</sub> O emissions. Therefore the ex-post measurement of the baseline emissions at the inlet of the N <sub>2</sub> O destruction facility represents a conservative determination of the baseline N <sub>2</sub> O emissions.
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**Project Emissions:**

<i>Source</i>	<i>Gas</i>		<i>Justification/Explanation</i>
Emissions of N <sub>2</sub> O as a result of side reaction to the nitric acid production process	N <sub>2</sub> O	Included	Main emission source that remains in the tail gas after the N <sub>2</sub> O destruction facility
Emissions related to the production of ammonia input used for NO <sub>x</sub> reduction	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	Excluded according to AM0028	In case of Abu Qir II a SCR DeNO <sub>x</sub> unit was already installed prior to the project start: ammonia input for SCR is considered of the same order as project related ammonia input for NO <sub>x</sub> -reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.
In case of N <sub>2</sub> O reduction process installed: Emissions at the project site resulting from hydrocarbons used as reducing agent	CH <sub>4</sub> and/or CO <sub>2</sub>	Included	At Abu Qir II a N <sub>2</sub> O reduction process was installed and natural gas is used as reducing agent. Natural gas is used to enhance the efficiency of a N <sub>2</sub> O catalytic reduction facility.  Hydrocarbons are mainly converted to CO <sub>2</sub> , while some hydrocarbons may remain intact.  Fractions of unconverted methane are measured (monitored online). All other hydrocarbons are assumed to be completely converted to CO <sub>2</sub> .
Emissions from electricity demand	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	Excluded	GHG emissions related to the electricity consumption are insignificant (< 0.005%) and are excluded as monitoring would lead to unreasonable costs.
Emissions related to the production of the hydrocarbons	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	Excluded	GHG emissions related to the production of hydrocarbons used as reducing agent represent less than 0.001% of expected emission reductions and will not be taken into account due to unreasonable costs for monitoring.

The following figure shows the spatial extend of the project boundary.

**Figure 1: Project boundary Abu Qir II**



At Abu Qir II nitric acid plant, the EnviNOx<sup>®</sup>-Systems is installed between the tail gas heaters and the tail gas turbine. The DeNO<sub>x</sub>-unit was removed.

## 6 Monitoring Methodology and Plan

The approved Monitoring Methodology AM0028 Version 1 “Catalytic N<sub>2</sub>O destruction in the tail gas of Nitric Acid Plants”; submitted by Carbon Projektentwicklung GmbH is applied to this project activity.

This approved Monitoring Methodology is applicable to project activities that destroy N<sub>2</sub>O emissions either by catalytic decomposition or catalytic reduction of N<sub>2</sub>O in the tail gas of nitric acid plants (i.e. tertiary destruction) This approved Monitoring Methodology was valid from March 3<sup>rd</sup> 2006 to October 5<sup>th</sup> 2006 (request for registration until November 30<sup>th</sup> 2006). The present project activity, which has been registered on October 7<sup>th</sup> 2006, satisfies these applicability conditions.

Furthermore the use of the methodology is justified because the following statements are true:

- The methodology is applied to the existing production capacity installed no later than 31 December 2005.
- The Abu Qir II nitric acid plant has not installed any N<sub>2</sub>O destruction or abatement technology prior to the starting data of the project activity.
- The project activity did not cause a nitric acid production increase.
- A DeNO<sub>x</sub>-unit was already installed at Abu Qir II nitric acid plant prior to the starting date of the project activity. The project activity results in NO<sub>x</sub> emission reductions that are at least as effective as the existing DeNO<sub>x</sub>-unit.
- The DeNO<sub>x</sub>-unit installed at Abu Qir II nitric acid plant was a SCR DeNO<sub>x</sub>-unit.
- The N<sub>2</sub>O concentrations are measured in real time at the inlet and the outlet of the N<sub>2</sub>O destruction facility.
- Relevant historical data and manufacturer information were available.
- The monitoring methodology is used in conjunction with the “Baseline Methodology for Catalytic N<sub>2</sub>O destruction in the tail gas of Nitric Acid Plants”.

The data being collected in order to monitor GHG emissions from the project activity are described below and detailed in Annex 1 of the Monitoring Report.

ID number	Data Variable	Source of data	Data unit	Recording frequency
P1	PE_y Project emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P2	PE_ND,y Project emissions from N <sub>2</sub> O not destroyed	Monitoring system	tCO <sub>2</sub> e	Annual

P3	PE_DF,y Project emissions from destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual
P4	PE_N2O,y N <sub>2</sub> O not destroyed by facility	Monitoring system	tN <sub>2</sub> O	Daily
P5	F_TG,i Volume flow tail gas at N <sub>2</sub> O destruction facility	Flow meter	m <sup>3</sup> /h	Daily
P6	CO_N2O,i N <sub>2</sub> O concentration at destruction facility outlet	Monitoring system, measuring device	tN <sub>2</sub> O/ Nm <sup>3</sup>	Daily
P7	M_i Measuring Interval	Measuring device, data management system	h	Daily
P8	PE_HC,y Emissions from hydrocarbon use in destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual
P9	HCE_C,y Converted hydrocarbon emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P10	HCE_NC,y Non-converted hydrocarbon emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P11	Q_HC,y Hydrocarbon input (reducing agent)	Measuring device	m <sup>3</sup>	Daily
P12	ρ_HC Hydrocarbon density	Hydrocarbon supplier or default value	t/m <sup>3</sup>	Annual

P13	EF_HC Hydrocarbon CO <sub>2</sub> emission factor	IPCC	tCO <sub>2</sub> /t	Once
P14	OXID_HC Hydrocarbon oxidation factor	Measuring device	%	Daily
P15	Type_HC Type of hydrocarbon	Hydrocarbon supplier	-	Once

The data being collected in order to monitor baseline emissions are described below and detailed in Annex 1 of the Monitoring Report.

ID number	Data Variable	Source of data	Data unit	Recording Frequency
B1	P_HNO <sub>3</sub> ,y Plant output of HNO <sub>3</sub>	Production reports	tHNO <sub>3</sub>	Daily
B2	QI_N <sub>2</sub> O,y Quantity of N <sub>2</sub> O at inlet of destruction facility	Monitoring system	tN <sub>2</sub> O	Daily
B3	CI_N <sub>2</sub> O,I N <sub>2</sub> O concentration at N <sub>2</sub> O destruction facility inlet	Monitoring system, measuring device	tN <sub>2</sub> O/Nm <sup>3</sup>	Daily
B4	QR_N <sub>2</sub> O,y Regulation I: annual quantity N <sub>2</sub> O limited	National legislation	tN <sub>2</sub> O	Date of regulation
B5	RSE_N <sub>2</sub> O,y Regulation II: N <sub>2</sub> O emissions per unit of nitric acid	National legislation	tN <sub>2</sub> O/t HNO <sub>3</sub>	Date of regulation

B6	CR_N2O  Regulation III: N <sub>2</sub> O concentration in tail gas limited	National legislation	tN <sub>2</sub> O/m <sup>3</sup>	Date of regulation
B7	P_HNO3,hist  Design capacity	Manufacturer's specifications / production reports	t	Once
B8	T_g,hist  Historical operating temperature range of the ammonia oxidation reactor	Production reports / manufacturer's Specification	°C	Once
B9	P_g,hist  Historical operating pressure range of the ammonia oxidation reactor	Production reports / manufacturer's specifications	Barg	Once
B10	T_g  Actual operating temperature ammonia oxidation reactor	Measuring device	°C	Continuous
B11	P_g  Actual operating pressure ammonia oxidation reactor	Measuring device	Barg	Continuous
B12	Reg_NOx  National regulation on NO <sub>x</sub> emissions	National regulations, Ministry of Environment	tNO <sub>x</sub> /m <sup>3</sup>	Date of regulation
B13	G_sup  Supplier of the ammonia oxidation catalyst	Supplier's information	-	Date of changing gauze composition
B14	G_com  Composition of the ammonia oxidation catalyst	Annual reports, supplier's information	%	Date of changing gauze composition
B15	G_sup,hist  Historical supplier of ammonia oxidation catalyst	Annual reports, supplier's information	-	Once

B16	G_com,hist  Historical composition of the ammonia oxidation catalyst	Supplier's information	%	Date of start of usage of catalyst
B17	SE_N2O  N <sub>2</sub> O emission rate per ton of nitric acid	Monitoring reports	tN <sub>2</sub> O/tHNO <sub>3</sub>	Yearly
B18	A_OR,hist  Max. historical ammonia flow rate to the ammonia oxidation reactor	Production reports / manufacturer's specifications / literature	tNH <sub>3</sub> /day	Once
B19	A_OR,d  Actual ammonia flow rate to the ammonia oxidation reactor	Measuring device	tNH <sub>3</sub> /day	Continuous



## 7 Quality Control (QC) and Quality Assurance (QA)

### 7.1 Quality Management System

Project Operator is Abu Qir Fertilizer Co. S.A.E. ("AFC"), the biggest Fertilizer Company in Africa with closely to 3000 employees. AFC is ISO 9001:2000 and ISO 14001:2004 certified.

The EnviNOx® system is incorporated into AFC's ISO 9001:2000 and ISO 14001:2004 standards.

The operating personal of the EnviNOx® system have been trained by the technology provider UHDE and the supplier of the digital process control system (Delta V, M/s. process management). Carbon Egypt is responsible for monitoring and reporting of data under the CDM Project.

### 7.2 Quality Control and Quality assurance procedures

The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been defined based on applicable international standards, as well as standards provided by technology provider. AFC is certified under the ISO 9001:2000 and ISO 14001:2004 and applies appropriate QA & QC procedures.

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

1. secure a good consistency through planning to implementation of the CDM project and,
2. stipulate the responsibilities for operation and monitoring and,
3. avoid any misunderstanding between people and organizations involved.

#### 7.2.1 Periodically observation of the automated monitoring system

The EnviNOx® system is designed for automatic operation, so that activities by the operation personnel are not required for during normal operation. However, all alarms and any action taken by the operating personnel (events) are automatically logged at the engineering and the operation station (Alarm & Event List) of the DCS system. All log sheets for **Alarm & Events** are exported and therefore digital available (Excel Files) and can easily be analysed and evaluated.

Malfunction of system components is indicated on the operator (AFC) console in the control room as an alarm. Occurrence of such an alarm requires the operator to immediately take measures to remedy the problem. This is done by informing AFC instrument department and Carbon Egypt. Carbon Egypt is then deciding whether the problem can be fixed immediately by themselves, or whether external support from Entrag/Emerson/Uhde is required.

In addition to the quality control and quality assurance procedures according to AFC quality management system and in order to avoid possible failures of the automated monitoring system several procedures are implemented for the project activity.



Carbon Egypt has contracted the Egyptian ENTRAG Group – the Agent for EMERSON Process Management in Egypt - to execute (1) monthly on-site **Health Checks** and (2) quarterly on-site **Inspection Visits**. Furthermore a **24 hours emergency service** and the **Delta V Guardian Support** are covered by the contract.

The monthly health checks and the quarterly inspection visits are to conduct observation of the EnviNOx® system, the monitoring equipment required for the CDM project and the automated monitoring system. The system components, measurement devices, calibration works and the automated monitoring system required for the monitoring of the CDM project are covered by the contracts. Health check reports and inspection visit reports are available.

The responsible project managers of Carbon Egypt are carrying out **on-site inspections** on a daily basis and AFC is carrying out a site check of the EnviNOx system three times a day on shift basis.....

Furthermore AFC maintenance department is performing **weekly inspection** including an on-site check of the EnviNOx® system.

**Supervision** is done based on the daily reports by the technology provider Uhde and Emerson.

The following table summarizes the periodically observations of the AMS.

Organization	Action	Frequency	Output
Delta V	Events & Alarm List	Continuously	Txt-files, Excel files
AFC	Shift inspection	3 times a day	Plant check
CARBON Egypt	Inspection	Daily	EnviNOx Journal
AFC	Inspection	Weekly	AFC Report
ENTRAG	Health check, System diagnostic	Monthly	Health Check Report on AMS and EnviNOx
ENTRAG	Inspection visit	Quarterly	Inspection Report on AMS and EnviNOx
UHDE	Supervision	Continuously	Plausibility Check
EMERSON Germany	Supervision	Continuously	Plausibility Check

All resulting documents are analysed and evaluated by Carbon Egypt. In case of any upcoming problem or failure of the EnviNOx® system and/or the automated monitoring system Carbon Egypt immediately take measure to remedy the problem. The provider of the automated monitoring system is available 24 hours a day via Hotline. Furthermore Entrag is committed to be onsite within 24 hours.

### 7.3 Calibration and maintenance

All measuring and analytical instruments are being calibrated as defined in the Approved Methodology AM0028. Calibration procedures have been incorporated in AFC's Quality Management System and 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 of AFC.

During the regular shut down in May 2007 relevant measuring devices were maintained and calibrated.

#### 7.4 Environmental Impacts

According to the national Environment Law number 4 of Egypt (year 1994) the NO<sub>x</sub> emissions at nitric acid plants are limited to 3000 mg/m<sup>3</sup> for existing nitric acid plants (AFC). Continuous measurement of the NO<sub>x</sub> concentration at the outlet of the EnviNOx® system reports a concentration of 1.85 ppm.

The above shows that the CDM Project operation is in compliance of the environmental standards.

## 8 GHG Calculation

In terms of the Approved Methodology (AM0028 / Version 1), the emission reduction (ER<sub>y</sub>) by the project activity during a given period *y* is the difference between the baseline emissions (BE<sub>y</sub>) and project emissions (PE<sub>y</sub>), as follows:

$$ER_y = BE_y - PE_y - LE_y \quad (13)$$

where:

ER <sub>y</sub>	emissions reductions of the project activity during the year <i>y</i> (tCO <sub>2</sub> e)
BE <sub>y</sub>	baseline emissions during the year <i>y</i> (tCO <sub>2</sub> e)
PE <sub>y</sub>	project emissions during the year <i>y</i> (tCO <sub>2</sub> e)
LE <sub>y</sub>	leakage emissions in year <i>y</i> (tCO <sub>2</sub> e)

### Project Emissions:

The emissions due to the project activity are composed of (a) the emissions of not destroyed N<sub>2</sub>O and (b) emissions from auxiliary hydrocarbons input resulting from the operation of the EnviNOx® system. N<sub>2</sub>O emissions not destroyed by the project activity are calculated based on the continuous measurement of the N<sub>2</sub>O concentration in the tail gas of the EnviNOx® system and the volume flow rate of the tail gas stream. The emissions related to the operation of the N<sub>2</sub>O destruction facility are given by on-site emissions due to the hydrocarbons used as input to the EnviNOx® system.

$$\begin{aligned}
 PE_y &= PE_{ND,y} + PE_{DF,y} = [2,213.7 + 452.6 = 2,666 \text{ tCO}_2\text{e}] \\
 &= PE_{N_2O,y} \times GWP_{N_2O} + PE_{HC,y} = \\
 &= \sum_i^n F_{TG,i} \times CO_{N_2O,i} \times M_i \times GWP_{N_2O} + HCE_{C,y} = \\
 &= \sum_i^n F_{TG,i} \times CO_{N_2O,i} \times M_i \times GWP_{N_2O} + \rho_{HC} \times Q_{HC,y} \times EF_{HC} \times \\
 &\quad OXID_{HC}/100 = \\
 &= \mathbf{2,666 \text{ tCO}_2\text{e}}
 \end{aligned}$$

Project emissions are limited to the design capacity of the nitric acid plant. According to AM0028 the design capacity is measured in tons of nitric acid per year. The actual nitric acid production in the covered monitoring period does not exceed the design capacity.

### **Baseline Emissions:**

It has been checked that there are no Egyptian regulation in place that would limit the quantity of N<sub>2</sub>O that can be taken into account for the calculation of baseline emissions.

Baseline emissions of the project activity are determined based on the quantity of N<sub>2</sub>O emitted in the baseline scenario, taking national regulations, production levels and operating conditions into consideration. The quantity of N<sub>2</sub>O is determined based on the measurement of the N<sub>2</sub>O at the inlet of the EnviNOx<sup>®</sup>-System, which results in a conservative estimation of baseline emissions.

$$\begin{aligned}
 BE_y &= BE_{N_2O,y} \times GWP_{N_2O} = [1,236 \times 310 = 383,256 \text{ tCO}_2\text{e}] \\
 &= \sum_i^n F_{TG,i} \times CI_{N_2O,i} \times M_i \times GWP_{N_2O} = \\
 &= \mathbf{383,256 \text{ tCO}_2\text{e}}
 \end{aligned}$$

Baseline emissions are limited to the design capacity of the nitric acid plant. According to AM0028 the design capacity is measured in tons of nitric acid per year. The actual nitric acid production in the covered monitoring period does not exceed the design capacity.

### **Leakage Emissions:**

As described the project activity does not result in any relevant leakage emission, therefore:

$$LE_y = 0$$

### **Emission Reduction:**

The total emission reduction achieved by this project activity during the first monitoring period is therefore:

$$\begin{aligned}
 ER_y &= BE_y - PE_y - LE_y \\
 &= 383,256 - 2,666 - 0 = \\
 &= \mathbf{380,590 \text{ tCO}_2\text{e}}
 \end{aligned} \tag{14}$$

The above emission reductions cover the monitoring period from April 1<sup>st</sup> 2007 to June 30<sup>th</sup> 2007.

## 9 Check against baseline requirements

In order to avoid that the operation of the nitric acid production plant is manipulated in a way to increase the  $N_2O$  generation, actual operating conditions have been checked against the baseline requirements. In case of downtime or malfunctions calculations are based on statistical methods.

The plants were operating within the permitted operating ranges for the whole monitoring period. Please note the following regular shut down period for the nitric acid plant:

Shut down: 02/05/2007 – 03/05/2007

### Operating temperature:

The actual average daily operating temperature in the ammonia oxidation reactor is within the permitted range for all operating days covered by this monitoring report.

### Operating pressure:

The actual average daily operating pressure in the ammonia oxidation reactor is within the permitted range for all operating days covered by this monitoring report.

### Composition of the ammonia oxidation catalyst:

The composition of the ammonia oxidation catalyst is the same kind of catalyst composition already in operation prior to the start of the project activity.

### Ammonia flow rate to the ammonia oxidation reactor:

The daily ammonia input to the ammonia oxidation reactor is within the permitted range with for all operating days covered by this monitoring report.

## Annex 1

### Data and parameter monitored:

Data and parameters monitored:	
<b>Data / Parameter:</b>	<b>F_TG</b>
Data unit:	Nm <sup>3</sup> /h
Description:	Volume flow tail gas at N <sub>2</sub> O destruction facility interval i
Source of data to be used:	Venturi tube, designed and manufactured in accordance with ISO 5167-4:2003 Standard Normal Conditions: 1,013.25 hPa, 273.15K)
Description of measurement methods and procedures to be applied:	Flow metering system automatically record volume flow adjusted to standard temperature and pressure.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>503,574,406 Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>CO_N2O</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility outlet
Source of data to be used:	Non-dispersive infrared photometry for N <sub>2</sub> O
Description of measurement methods and procedures to be applied:	In the effluent of the EnviNOx®- system, the concentrations of nitrous oxide (N <sub>2</sub> O) is analysed continuously. Analysis is done by using non-dispersive infrared photometry for N <sub>2</sub> O.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>1.42E-08 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>P_HNO3</b>
Data unit:	tHNO <sub>3</sub>
Description:	Plant output of HNO <sub>3</sub>
Source of data to be used:	Production reports
Description of measurement methods and procedures to be applied:	The actual nitric acid production is measured according to the installed instruments. The instrument signals will be recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>161,654 tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>SE_N2O</b>
Data unit:	tN <sub>2</sub> O/tHNO <sub>3</sub>
Description:	N <sub>2</sub> O emission rate per ton of nitric acid
Source of data to be used:	Production reports
Description of measurement methods and procedures to be applied:	The quantity of N <sub>2</sub> O at the inlet of the destruction facility is calculated based on the concentration at the inlet and the volume flow. The actual nitric acid production is measured according to the installed instruments.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>0.0076 tN<sub>2</sub>O/tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>CI_N2O</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility inlet
Source of data to be used:	Non-dispersive infrared photometry for N <sub>2</sub> O
Description of measurement methods and procedures to be applied:	In the feed of the EnviNOx®- system, the concentrations of nitrous oxide (N <sub>2</sub> O), is analysed continuously. Analysis is done by using non-dispersive infrared photometry in a combined analyser device.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>2.46E-06 tN<sub>2</sub>O/Nm<sup>3</sup></b>



<b>Data / Parameter:</b>	<b>T<sub>g</sub></b>
Data unit:	°C
Description:	Actual operating temperature ammonia oxidation reactor
Source of data to be used:	Thermocouple
Description of measurement methods and procedures to be applied:	The actual temperature at the ammonia oxidation catalyst is measured with the exchanged measuring devices. Actual daily temperatures are reported in the Delta V Daily reports.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	Burner 1: <b>874.04 °C</b>  Burner 2: <b>891.50 °C</b>

<b>Data / Parameter:</b>	<b>P<sub>g</sub></b>
Data unit:	Barg
Description:	Actual operating pressure ammonia oxidation reactor
Source of data to be used:	Pressure transmitter
Description of measurement methods and procedures to be applied:	The actual pressure at the ammonia oxidation catalyst is measured with the installed measuring devices.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>3.7 barg</b>

<b>Data / Parameter:</b>	<b>G<sub>sup</sub></b>
Data unit:	-
Description:	Supplier of the ammonia oxidation catalyst
Source of data to be used:	Ammonia oxidation catalyst supplier
Description of measurement methods and procedures to be applied:	Commercial Invoice
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>Umicore</b>

<b>Data / Parameter:</b>	<b>G_com</b>
Data unit:	%
Description:	Composition of the ammonia oxidation catalyst
Source of data to be used:	Ammonia oxidation catalyst supplier
Description of measurement methods and procedures to be applied:	Certificate catalyst supplier
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>90% Pt</b> <b>10% Rh</b>

<b>Data / Parameter:</b>	<b>A_OR,d</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Actual ammonia flow rate to the ammonia oxidation reactor
Source of data to be used:	Flow meter
Description of measurement methods and procedures to be applied:	The actual ammonia flow to the ammonia oxidation reactor is measured with the already installed measuring devices. Actual daily ammonia flow is reported in the Delta V Daily reports.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>46,370 tNH<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>Q_HC</b>
Data unit:	Nm <sup>3</sup>
Description:	Hydrocarbon input (natural gas as reducing agent)
Source of data to be used:	Flow meter
Description of measurement methods and procedures to be applied:	The natural gas used as reducing agent is measured by standard flow meters. Flow is converted to standard conditions based on temperature and pressure measurement.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>154,358 Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b><math>\rho_{HC}</math></b>
Data unit:	t/m <sup>3</sup>
Description:	Hydrocarbon density
Source of data to be used:	Hydrocarbon supplier
Description of measurement methods and procedures to be applied:	Hydrocarbon supplier or default value
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>7.3E-04 t/Nm<sup>3</sup></b>  Standard Normal Conditions: 1,013.25 hPa, 273.15K

<b>Data / Parameter:</b>	<b>M<sub>i</sub></b>
Data unit:	H
Description:	Measuring Interval
Source of data to be used:	Delta V System, Monitoring System
Description of measurement methods and procedures to be applied:	Analysers automatically take readings every 10 seconds. Based on raw data average hourly values are calculated and reported.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	10 sec

<b>Data / Parameter:</b>	<b>Type<sub>HC</sub></b>
Data unit:	-
Description:	Type of hydrocarbon
Source of data to be used:	Hydrocarbon supplier
Description of measurement methods and procedures to be applied:	As per certificate of supplier.

Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	Natural Gas
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<b>Data / Parameter:</b>	<b>EF_HC</b>
Data unit:	tCO <sub>2</sub> e/t
Description:	Hydrocarbon CO <sub>2</sub> emission factor
Source of data to be used:	Hydrocarbon supplier or IPCC
Description of measurement methods and procedures to be applied:	The hydrocarbon CO <sub>2</sub> emission factor is given by the molecular weights and the chemical reaction when hydrocarbons are converted. In order to apply a conservative approach the HC emission factor for natural gas as reducing agent is set at 3.0 tCO <sub>2</sub> /t.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>3.0 tCO<sub>2</sub>e/t</b>

<b>Data / Parameter:</b>	<b>HCE_C</b>
Data unit:	tCO <sub>2</sub> e
Description:	Converted hydrocarbon emissions
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>319 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>HCE_NC</b>
Data unit:	tCO <sub>2</sub> e
Description:	Non converted hydrocarbon emissions (methane)
Source of data to be used:	Monitoring System

Description of measurement methods and procedures to be applied:	Analysis is done by using non-dispersive infrared photometry for CH <sub>4</sub>
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	<b>134 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	QR_N <sub>2</sub> O,y RSE_N <sub>2</sub> O,y CR_N <sub>2</sub> O
Data unit:	tN <sub>2</sub> O tN <sub>2</sub> O/t HNO <sub>3</sub> tN <sub>2</sub> O/m <sup>3</sup>
Description:	National regulation on N <sub>2</sub> O emissions
Source of data used:	Regional authorities
Description of measurement methods and procedures to be applied:	Actual no regulations on N <sub>2</sub> O emissions are in place, confirmed by the Arab Republic of Egypt, Ministry of State for Environmental Affairs.
Value monitoring period: 1 <sup>st</sup> April to 30 <sup>th</sup> June 2007	Not applicable