



CDM Monitoring Report No.10:

"Catalytic N<sub>2</sub>O destruction project in the tail gas of three Nitric  
Acid Plants at Hu-Chems Fine Chemical Corp."

UNFCCC 0765

Monitoring Period:

From: 01/07/2009

To: 30/09/2009

Version 1

08/10/2009

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## Table of Contents:

1	Introduction.....	4
2	Reference .....	4
3	Definition.....	5
4	General Description of Project .....	5
4.1	Project Activity.....	5
4.2	Project Participants .....	9
5	Baseline Methodology .....	11
6	Monitoring Methodology and Plan.....	15
7	Quality Control (QC) and Quality Assurance (QA) .....	27
7.1	Quality Management System.....	27
7.2	Quality Control and Quality Assurance procedures .....	27
7.2.1	Periodical observation of the automated monitoring system and Back Up Plans for measuring systems.....	27
7.2.2	Systematic measures for QA for monitoring data during AMS down times .....	29
7.3	Calibration and maintenance .....	29
7.4	Environmental Impacts .....	31
7.5	Social Fund .....	32
8	GHG Calculation .....	33
9	Check against baseline requirements .....	40
10	Downtimes & observations during the monitoring period .....	43
10.1	Downtimes of Nitric Acid Plants.....	43
10.2	Downtimes of EnviNOx® Systems .....	43
10.3	Relevant observations during the monitoring period.....	44

## Tables:

Table 1: Project Participants .....	9
Table 2: Overview on emission sources included or excluded from the project boundary .....	11
Table 3: Description of Monitoring Data.....	16
Table 4: Periodical observation of the AMS.....	29
Table 5: Instrument overview – Hu-Chems II.....	30
Table 6: Instrument overview – Hu-Chems III.....	31
Table 7: Instrument overview – Hu-Chems IV .....	31
Table 8: Comparison of emission reductions with PDD values – Hu-Chems II.....	38
Table 9: Comparison of emission reductions with PDD values – Hu-Chems III .....	38
Table 10: Comparison of emission reductions with PDD values – Hu-Chems IV .....	39
Table 11: Summary of Nitric Acid Production in 2009 .....	42
Table 12: Summary on installed catalyst gauzes .....	42
Table 13 - Downtimes of the nitric acid plants .....	43
Table 14 - Downtimes of the EnviNOx® Systems .....	43
Table 16: Overview on monitoring parameters Hu-Chems II.....	73
Table 17: Overview on monitoring parameters Hu-Chems III.....	74
Table 18: Overview on monitoring parameters Hu-Chems IV .....	75

## Figures:

Figure 1: Project boundary Hu-Chems II and Hu-Chems III .....	13
Figure 2: Project boundary Hu-Chems IV .....	14



## 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 **01/07/2009** to **30/09/2009** as the **10th** monitoring period.

The starting date of the project activity is the:	22/12/2005
The project was registered at UNFCCC on:	22/01/2007 with number 0765
The starting data of the crediting period is:	22/01/2007

Carbon CDM Korea has implemented a project for GHG emission reduction by catalytic N<sub>2</sub>O destruction in Yeosu, Republic of Korea. 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 Korea.

## 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 three Nitric Acid Plants at Hu-Chems Fine Chemical Corp."

Version: 2

Date of Completion: 22/07/2006

### **Validation Report:**

Validation of the CDM Project: "Catalytic N<sub>2</sub>O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp."

REPORT NO. 775390

Date: 05/08/2006 by TÜV SÜD Industrie Service GmbH

### **CDM Registration:**

"Catalytic N<sub>2</sub>O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp."

UNFCCC Ref. Number 0765

Date of registration: 22/01/2007

### 3 Definition

- **y** : Monitoring period (in this report, **01/07/2009** to **30/09/2009**)
- **PDD** : Project Design Document of this project “Catalytic N<sub>2</sub>O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.” Version 2 on July 22<sup>nd</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 in three Nitric Acid Plants (Hu-Chems II; Hu-Chems III; Hu-Chems IV) at Hu-Chems Fine Chemical Corp.

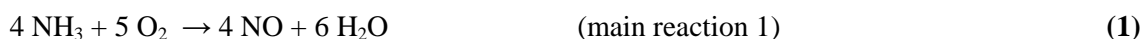
The EnviNOx® process used in the **Hu-Chems IV** nitric acid plant is based on the catalytic decomposition of nitrous oxide (N<sub>2</sub>O) and the catalytic reduction of NO<sub>x</sub> (NO and NO<sub>2</sub>) with ammonia (NH<sub>3</sub>). This process works very well at temperatures above about 425°C. The reactions take place over two iron zeolite catalyst beds.

The EnviNOx® process used in the **Hu-Chems II + III** nitric acid plants 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 propane gas of which the main constituent is propane (C<sub>3</sub>H<sub>8</sub>). The reactions take place over an iron zeolite catalyst bed.

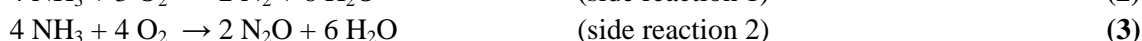
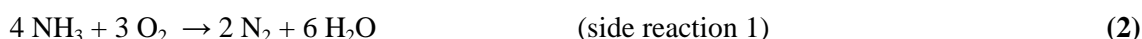
#### General Introduction:

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>:



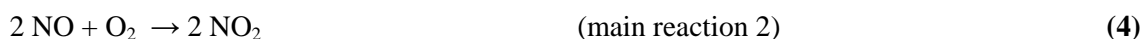
Simultaneously nitrous oxide (N<sub>2</sub>O), nitrogen (N) and water (H<sub>2</sub>O) are formed as well, in accordance with the following equations:



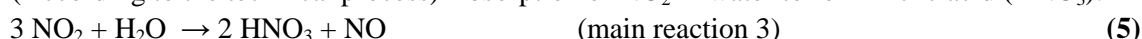
<sup>1</sup> Ammonia is reacted with air on noble metal catalyst in the oxidation section of nitric acid plants. Nitric oxide and water are formed in this process according to the above mentioned main equation.

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>):



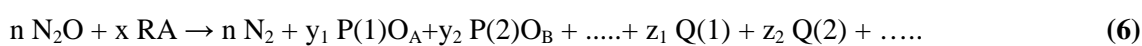
3. (According to the technical process) Absorption of NO<sub>2</sub> in water to form nitric acid (HNO<sub>3</sub>):



(NO is oxidised to NO<sub>2</sub> 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 N<sub>2</sub>O occurs when reactions take place between N<sub>2</sub>O and other substances in contact with a catalyst, such that the oxygen is removed from the N<sub>2</sub>O molecule and forms one or more compounds with other species. The substance or substances that react with N<sub>2</sub>O to remove oxygen are termed reducing agent. A general reaction equation for the catalytic reduction of N<sub>2</sub>O can be given as:



where RA is a molecule of the reducing agent, P(1)O<sub>A</sub>, P(2)O<sub>B</sub> are the compound formed by reaction with the oxygen of the N<sub>2</sub>O and Q(1), Q(2) represent further products of the oxidation reaction, n, x, y<sub>1</sub>, y<sub>2</sub>, z<sub>1</sub>, z<sub>2</sub> are the appropriate stoichiometric coefficients.

Equations reduction N<sub>2</sub>O with propane:



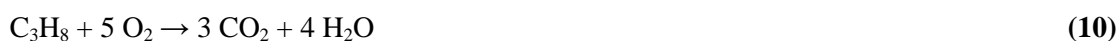
or



The definition does not exclude the possibility of side reactions resulting in consumption of reducing agent without any reduction of N<sub>2</sub>O, for example with propane:



or



#### Description of catalytic decomposition process:

Catalytic decomposition of  $N_2O$  occurs when the  $N_2O$  is split into its constituent elements by contact with a catalyst. A catalyst is a material which accelerates the speed of the reaction without itself being transformed or consumed by the reaction.

Overall reaction:



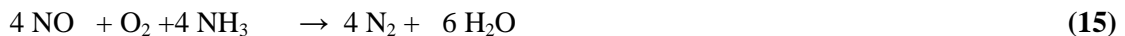
The products of  $N_2O$  decomposition are the substances that result from decomposition reaction ( $N_2$  and  $O_2$ )

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

##### Principles of the EnviNOx® process Hu-Chems II + III:

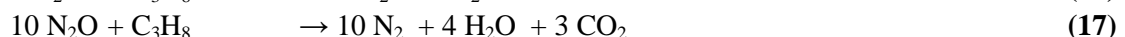
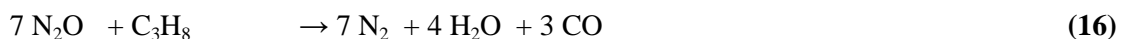
The EnviNOx® process used in the Hu-Chems II + III nitric acid plants is based on the catalytic reduction of  $NO_x$  ( $NO$  and  $NO_2$ ) with ammonia ( $NH_3$ ) and of nitrous oxide ( $N_2O$ ) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane ( $C_3H_8$ ). The reactions take place over an iron zeolite catalyst bed.

First the  $NO_x$  is reduced with ammonia according to such reactions as:



Effectively all the  $NO_x$  is removed. Some destruction of  $N_2O$  also occurs.

Secondly the nitrous oxide is reduced with hydrocarbons over the iron zeolite according to such reactions as:



Similar reactions take place between nitrous oxide and the small quantities of other hydrocarbons such as butane ( $C_4H_{10}$ ) that are present in the commercial propane used.  $N_2O$  reduction by these reactions is much more effective when  $NO_x$  is absent.

A large proportion of the carbon monoxide that is formed is further oxidised to carbon dioxide over a second EnviCat®-CO / CH catalyst installed in the EnviNOx® reactor downstream of the first catalyst:



All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor.

Compared with the reduction in greenhouse gas emission achieved by the destruction of  $N_2O$  the additional greenhouse gas emissions ( $CO_2$ ) caused by the use of hydrocarbons in the process are insignificant but are monitored.

#### Principles of the EnviNOx® process Hu-Chems IV:

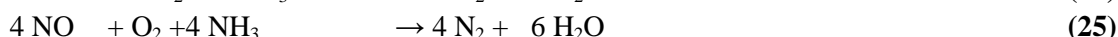
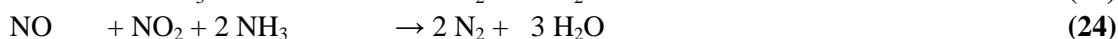
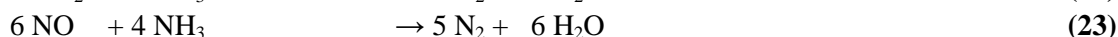
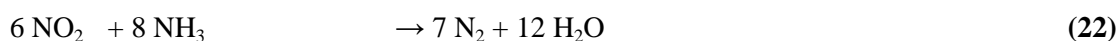
The EnviNOx® process used in the Hu-Chems IV nitric acid plant is based on the catalytic decomposition of nitrous oxide (N<sub>2</sub>O) and the catalytic reduction of NO<sub>x</sub> (NO and NO<sub>2</sub>) with ammonia (NH<sub>3</sub>). This process works very well at temperatures above about 425°C. The reactions take place over two iron zeolite catalyst beds.

In the first bed N<sub>2</sub>O is catalytically decomposed into its elements:



This rate of this reaction is enhanced by high concentrations of NO<sub>x</sub>.

Before the tail gas enters the second catalyst bed, a small quantity of ammonia vapour is added. In the second bed a large part of the NO<sub>x</sub> is reduced with ammonia according to such reactions as:



Some further destruction of N<sub>2</sub>O also occurs. All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor. The consumption of ammonia corresponds to the stoichiometric ratio given in the reaction equations above and does not differ significantly from the consumption of a conventional DeNOx unit.

#### Technology employed by the project activity:

In this project, CARBON CDM Korea installed three EnviNOx® systems for catalytic reduction and decomposition of NO<sub>x</sub> and N<sub>2</sub>O additionally to the equipment at the three nitric acid manufacturing plants. 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 Hu-Chems II and Hu-Chems III involves that propane is employed as a reducing agent for N<sub>2</sub>O removal.

The EnviNOx® system at Hu-Chems IV was installed in December 2006 and the catalytic reduction process of N<sub>2</sub>O started in the beginning of January 2007.

The EnviNOx® system at Hu-Chems II and Hu-Chems III was installed in February and March 2007 and the catalytic reduction process of N<sub>2</sub>O started in the end of March 2007.

#### Location of the project activity:

The three EnviNOx® systems were installed at the nitric acid plants Hu-Chems II, III and IV on site of Hu-Chems Fine Chemical Corp.” furthermore called “HU-CHEMS”.

#### Location of the EnviNOx®-Systems:

Hu-Chems II: The new EnviNOx® reactor (322-R-202) is located between the existing SCR DeNOx reactor (37-R-201) and the tail gas turbine (37-C-201 T2) which is the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems II.





Hu-Chems III: The new EnviNOx® reactor (323-R-302) is located between the existing SCR DeNOx reactor and the tail gas turbine of Hu-Chems III which is the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems III.

Hu-Chems IV: The new EnviNOx® reactor (324-R-402) is located upstream of the tail gas turbine (324-C-401 T2) at the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems IV.

## 4.2 Project Participants

**Table 1:** Project Participants

Name of Party involved	Project participants (as applicable)	Party involved considered as project participant
Republic of Korea (Host)	CARBON CDM Korea Ltd.	No
Federal Republic Germany	RWE Power AG	No

Host Country is the Republic of Korea. The Republic of Korea ratified the Kyoto Protocol in November 2002. 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 CDM Korea Ltd. serves as focal point of communication with the Executive Board and the UNFCCC Secretariat.

**Project applicant, developer and sponsor is CARBON CDM Korea Ltd.** (furthermore called “CARBON”). CARBON CDM KOREA Ltd. is registered under the laws of the Republic of Korea. The company is a 100% daughter company of CARBON Projektentwicklung GmbH, Austria, and represents a foreign direct investment under the Foreign Investment Promotion Act (FIPA) of Korea. 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.

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 **Hu-Chems Fine Chemical Corp.** HU-CHEMS was established by separating from Nam-Hae chemical corporation in 2002. HU-CHEMS operates 14 production units which produce fine chemical products in its Yeosu, Jeonnam, industrial complex and provides excellent job conditions to its 254 employees. The company's headquarter is in Seoul.

HU-CHEMS is active in two major business areas, which are fine chemicals and biotechnology. The products are provided to major-chemicals companies in Korea as well as to world-wide major-chemical companies like Dupont and BASF on long term offtake contract basis. Nitric Acid is sold mainly to BASF, Rhodia Polyamide, Keumho Mitsui, POSCO and Hanhwa. The company is listed on the Korean Stock Exchange, KOSPI200, item code 069260, since September 17, 2002, with an aggregate value of stocks of KRW 85,377 million (end of 2005). Major shareholder is NACF with 56%. The rest of the shares are floating.

HU-CHEMS is ISO 9001 and 14001 certified and received the Korean safety and health management system certificate (KGS18001 & OHSAS18001). The company has received the Grand Prize of Korea Valuable Management Award in 2005, the President of Korea's medal in an Energy Saving Promote Contest as well as the Korean Marketing Best Award (KMAC) in 2004 as well as other awards.

**Project Technology Provider** is UHDE GmbH a 100% subsidiary of ThyssenKrupp. UHDE is world market leader in the field of fertilizer technology engineering and construction. Consequently, UHDE has constructed many modern fertilizer plants including nitric acid plants. Among these plants are the three Hu-Chems plants. 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 three HU-CHEMS nitric acid plants have *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 Hu-Chems II, III and IV.
- 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>-units installed prior to the start of the project activity.
- The DeNO<sub>x</sub>-units installed prior to the start of the project activity were SCR DeNO<sub>x</sub>-units.
- 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 facilities at Hu-Chems II, III and IV.

### Project boundary

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

- N<sub>2</sub>O emissions in the tail gas downstream the project activity (Hu-Chems II, III, IV);
- CO<sub>2</sub> emissions associated with the use of propane as reducing agent, converted C<sub>3</sub>H<sub>8</sub> (Hu-Chems II, III).

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

- N<sub>2</sub>O emissions in the tail gas upstream the project activity (Hu-Chems II, III, IV).

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 2:** 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  (Attention: Ammonia used for NO <sub>x</sub> -reduction does not cause GHG emissions, only the production of ammonia causes GHG emissions)	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	Excluded according to AM0028	In case of Hu-Chems II, III and IV SCR DeNO <sub>x</sub> units are 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.

### 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  (Attention: Ammonia used for NO <sub>x</sub> -reduction doesn't cause GHG emissions, only production causes GHG emissions)	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	Excluded according to AM0028	In case of Hu-Chems II, III and IV SCR DeNO <sub>x</sub> units are 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 no SCR DeNO <sub>x</sub> unit is already installed prior to the project start: ammonia input for NO <sub>x</sub> reduction is monitored and considered for project emissions.
In case of N <sub>2</sub> O reduction process installed: Emissions at the project site resulting from hydrocarbons used as reducing agent	CO <sub>2</sub>	Included	At Hu-Chems II and III a N <sub>2</sub> O reduction process is installed and propane is used as reducing agent. Propane is used to enhance the efficiency of a N <sub>2</sub> O catalytic reduction facility.  In this case hydrocarbons are mainly converted to CO <sub>2</sub> , while some hydrocarbons may remain intact.  In order to apply a conservative approach propane is assumed to be completely converted to CO <sub>2</sub> .
Emissions from Electricity demand	CO <sub>2</sub> CH <sub>4</sub>	Excluded	GHG emissions related to the electricity consumption are insignificant (< 0.005%) and are excluded as

	N <sub>2</sub> O		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 are 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 Hu-Chems II and Hu-Chems III

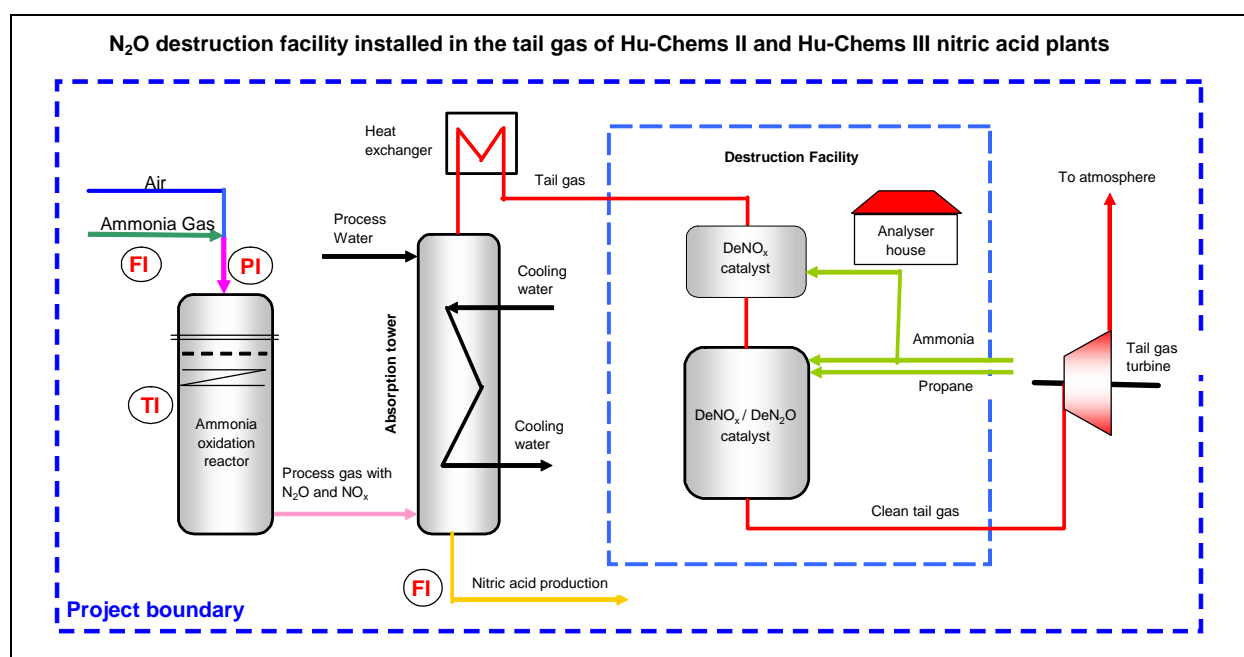
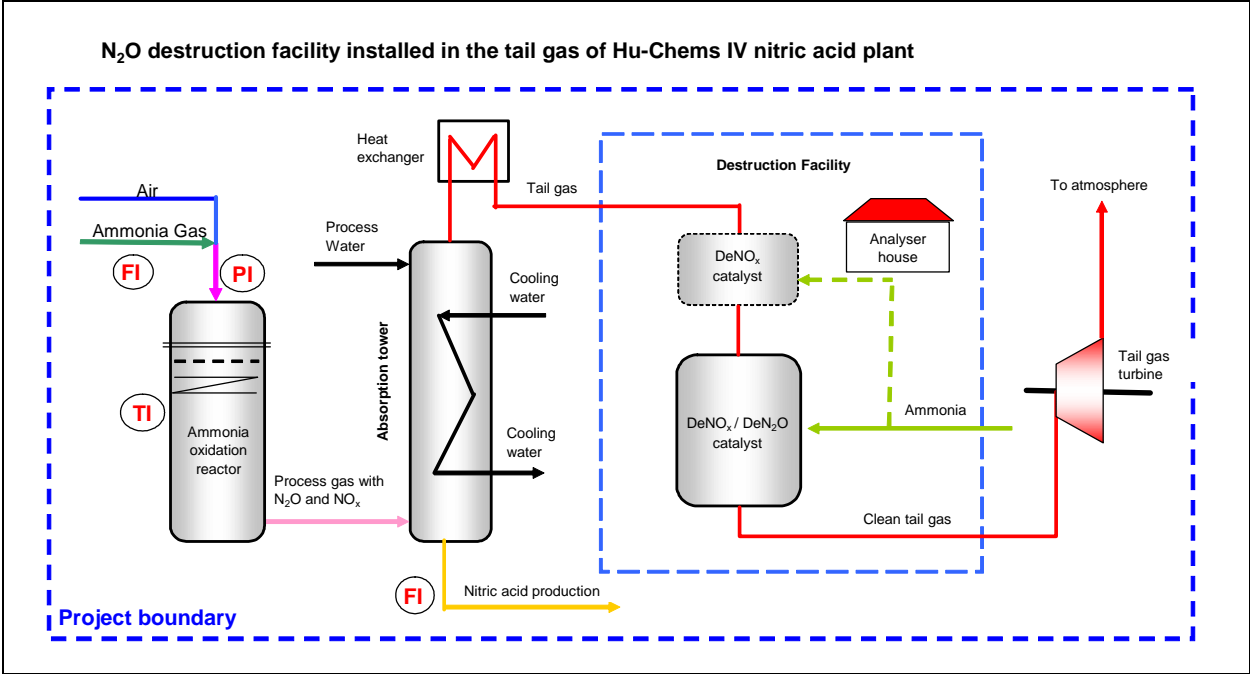


Figure 2: Project boundary Hu-Chems IV



## 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 submitted the registration request form on November 16<sup>th</sup> 2006 and 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 three nitric acid plants Hu-Chems II, III and IV have 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.
- 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>-units installed at Hu-Chems II, III and IV nitric acid plants were SCR DeNO<sub>x</sub>-units.
- 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 facilities at Hu-Chems II, III and IV.
- 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.

**Table 3:** Description of Monitoring Data

**Overall:**

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

**Hu-Chems II:**

ID number	Data Variable	Source of data	Data unit	Recording Frequency
P4	PE_y,II Project emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P5	PE_ND,y,II Project emissions from N <sub>2</sub> O not destroyed	Monitoring system	tCO <sub>2</sub> e	Annual
P6	PE_DF,y,II Project emissions from destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual



P7	PE_N2O,y,II N <sub>2</sub> O not destroyed by facility	Monitoring system	tN <sub>2</sub> O	Daily
P8	F_TG,I,II Volume flow tail gas at N <sub>2</sub> O destruction facility	Flow meter	m <sup>3</sup> /h	Daily
P9	CO_N2O,i,II N <sub>2</sub> O concentration at destruction facility outlet	Monitoring system, measuring device	tN <sub>2</sub> O/ Nm <sup>3</sup>	Daily
P10	M_i,II Measuring Interval	Measuring device, data management system	H	Daily
P11	PE_HC,y,II Emissions from hydrocarbon use in destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual
P12	HCE_C,y,II Converted hydrocarbon emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P13	Q_HC,y,II Hydrocarbon input (reducing agent)	Measuring device	m <sup>3</sup>	Daily
P14	ρ_HC,II Hydrocarbon density	Certificate hydrocarbon supplier or default value	t/m <sup>3</sup>	Yearly
P15	EF_HC,II Hydrocarbon CO <sub>2</sub> emission factor	IPCC	tCO <sub>2</sub> /t	Once
P16	OXID_HC,II Hydrocarbon oxidation factor	According to AM0028 OXID_HC_II is 100% (conservative approach)	%	Daily

P17	Type_HC,II Type of hydrocarbon	Hydrocarbon supplier	-	Once
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**Hu-Chems III:**

ID number	Data Variable	Source of data	Data unit	Recording Frequency
P18	PE_y,III Project emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P19	PE_ND,y,III Project emissions from N <sub>2</sub> O not destroyed	Monitoring system	tCO <sub>2</sub> e	Annual
P20	PE_DF,y,III Project emissions from destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual
P21	PE_N2O,y,III N <sub>2</sub> O not destroyed by facility	Monitoring system	tN <sub>2</sub> O	Daily
P22	F_TG,I,III Volume flow tail gas at N <sub>2</sub> O destruction facility	Flow meter	m <sup>3</sup> /h	Daily
P23	CO_N2O,i,III N <sub>2</sub> O concentration at destruction facility outlet	Monitoring system, measuring device	tN <sub>2</sub> O/ Nm <sup>3</sup>	Daily
P24	M_i,III Measuring Interval	Measuring device, data management system	H	Daily

P25	PE_HC,y,III Emissions from hydrocarbon use in destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual
P26	HCE_C,y,III Converted hydrocarbon emissions	Monitoring system	tCO <sub>2</sub> e	Annual
P27	Q_HC,y,III Hydrocarbon input (reducing agent)	Measuring device	m <sup>3</sup>	Daily
P28	ρ_HC,III Hydrocarbon density	Certificate hydrocarbon supplier or default value	t/m <sup>3</sup>	Yearly
P29	EF_HC,III Hydrocarbon CO <sub>2</sub> emission factor	IPCC	tCO <sub>2</sub> /t	Once
P30	OXID_HC,III Hydrocarbon oxidation factor	According to AM0028 OXID_HC_III is 100% (conservative approach)	%	Daily
P31	Type_HC,III Type of hydrocarbon	Hydrocarbon supplier	-	Once

#### **Hu-Chems IV:**

ID number	Data Variable	Source of data	Data unit	Recording Frequency
P32	PE_y,IV Project emissions	Monitoring system	tCO <sub>2</sub> e	Annual

P33	PE_ND,y,IV Project emissions from N <sub>2</sub> O not destroyed	Monitoring system	tCO <sub>2</sub> e	Annual
P34	PE_DF,y,IV Project emissions from destruction facility	Monitoring system	tCO <sub>2</sub> e	Annual
P35	PE_N2O,y,IV N <sub>2</sub> O not destroyed by facility	Monitoring system	tN <sub>2</sub> O	Daily
P36	F_TG,I,IV Volume flow tail gas at N <sub>2</sub> O destruction facility	Flow meter	m <sup>3</sup> /h	Daily
P37	CO_N2O,i,IV N <sub>2</sub> O concentration at destruction facility outlet	Monitoring system, measuring device	tN <sub>2</sub> O/ Nm <sup>3</sup>	Daily
P38	M_i,IV Measuring Interval	Measuring device, data management system	H	Daily

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

### **Hu-Chems II:**

ID number	Data Variable	Source of data	Data unit	Recording Frequency
B1	P_HNO <sub>3</sub> ,y,II Plant output of HNO <sub>3</sub>	Production reports	tHNO <sub>3</sub>	Daily

B2	QI_N2O,y,II  Quantity of N <sub>2</sub> O at inlet of destruction facility		tN <sub>2</sub> O	Daily
B3	CI_N2O,I,II  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_N2O,y  Regulation I: annual quantity N <sub>2</sub> O limited	National legislation	tN <sub>2</sub> O	Date of regulation
B5	RSE_N2O,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,II  Design capacity	Manufacturer's specifications	T	Once
B8	T_g,hist,II  Historical operating temperature range of the ammonia oxidation reactor	Production reports / manufacturer's Specification	°C	Once
B9	P_g,hist,II  Historical operating pressure range of the ammonia oxidation reactor	Production reports / manufacturer's specifications	Pa	Once
B10	T_g,II  Actual operating temperature ammonia oxidation reactor	Measuring device	°C	Continuous
B11	P_g,II  Actual operating pressure ammonia oxidation reactor	Measuring device	Pa	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,II  Supplier of the ammonia oxidation catalyst	Supplier's information	-	
B14	G_com,II  Composition of the ammonia oxidation catalyst	Annual reports, supplier's information	%	Date of changing gauze composition
B15	G_sup,hist,II  Historical supplier of ammonia oxidation catalyst	Annual reports, supplier's information	-	Once
B16	G_com,hist,II  Historical composition of the ammonia oxidation catalyst	Supplier's information	%	Date of start of use of catalyst
B17	SE_N2O,II  N <sub>2</sub> O emission rate per ton of nitric acid	Monitoring reports	tN <sub>2</sub> O/t HNO <sub>3</sub>	Yearly
B18	A_OR,hist,II  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,II  Actual ammonia flow rate to the ammonia oxidation reactor	Measuring device	tNH <sub>3</sub> /day	Continuous

**Hu-Chems III:**

ID number	Data Variable	Source of data	Data unit	Recording Frequency
B20	P_HNO <sub>3</sub> ,y,III Plant output of HNO <sub>3</sub>	Production reports	tHNO <sub>3</sub>	Daily
B21	QI_N <sub>2</sub> O,y,III Quantity of N <sub>2</sub> O at inlet of destruction facility		tN <sub>2</sub> O	Daily
B22	CI_N <sub>2</sub> O,I,III 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
B23	T_g,hist,III Historical operating temperature range of the ammonia oxidation reactor	Production reports / manufacturer's Specification	°C	Once
B24	P_g,hist,III Historical operating pressure range of the ammonia oxidation reactor	Production reports / manufacturer's specifications	Pa	Once
B25	T_g,III Actual operating temperature ammonia oxidation reactor	Measuring device	°C	Continuous
B26	P_g,III Actual operating pressure ammonia oxidation reactor	Measuring device	Pa	Continuous
B27	G_sup,III Supplier of the ammonia oxidation catalyst	Supplier's information	-	
B28	G_com,III Composition of the ammonia oxidation catalyst	Annual reports, supplier's information	%	Date of changing gauze composition

B29	G_sup,hist,III Historical supplier of ammonia oxidation catalyst	Annual reports, supplier's information	-	Once
B30	G_com,hist,III Historical composition of the ammonia oxidation catalyst	Supplier's information	%	Date of start of use of catalyst
B31	SE_N2O,III N <sub>2</sub> O emission rate per ton of nitric acid	Monitoring reports	tN <sub>2</sub> O/t HNO <sub>3</sub>	Yearly
B32	A_OR,hist,III Max. historical ammonia flow rate to the ammonia oxidation reactor	Production reports / manufacturer's specifications / literature	tNH <sub>3</sub> /day	Once
B33	A_OR,d,III Actual ammonia flow rate to the ammonia oxidation reactor	Measuring device	tNH <sub>3</sub> /day	Continuous

#### **Hu-Chems IV:**

ID number	Data Variable	Source of data	Data unit	Recording Frequency
B34	P_HNO3,y,IV Plant output of HNO <sub>3</sub>	Production reports	tHNO <sub>3</sub>	Daily
B35	QI_N2O,y,IV Quantity of N <sub>2</sub> O at inlet of destruction facility		tN <sub>2</sub> O	Daily
B36	CI_N2O,I,IV 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



B37	P_HNO3,hist,IV Design capacity	Manufacturer's specifications	T	Once
B38	T_g,hist,IV Historical operating temperature range of the ammonia oxidation reactor	Production reports / manufacturer's Specification	°C	Once
B39	P_g,hist,IV Historical operating pressure range of the ammonia oxidation reactor	Production reports / manufacturer's specifications	Pa	Once
B40	T_g,IV Actual operating temperature ammonia oxidation reactor	Measuring device	°C	Continuous
B41	P_g,IV Actual operating pressure ammonia oxidation reactor	Measuring device	Pa	Continuous
B42	G_sup,IV Supplier of the ammonia oxidation catalyst	Supplier's information	-	
B43	G_com,IV Composition of the ammonia oxidation catalyst	Annual reports, supplier's information	%	Date of changing gauze composition
B44	G_sup,hist,IV Historical supplier of ammonia oxidation catalyst	Annual reports, supplier's information	-	Once
B45	G_com,hist,IV Historical composition of the ammonia oxidation catalyst	Supplier's information	%	Date of start of use of catalyst
B46	SE_N2O,IV N <sub>2</sub> O emission rate per ton of nitric acid	Monitoring reports	tN <sub>2</sub> O/t HNO <sub>3</sub>	Yearly

B47	A_OR,hist,IV  Max. historical ammonia flow rate to the ammonia oxidation reactor	Production reports / manufacturer's specifications / literature	tNH <sub>3</sub> /day	Once
B48	A_OR,d,IV  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 Hu-Chems Fine Chemical Corp. (HU-CHEMS). HU-CHEMS operates 14 production units which produce fine chemical products. HU-CHEMS is ISO 9001 and 14001 certified and received the Korean safety and health management system certificate (KGS18001 & OHSAS18001). The company has received the Grand Prize of Korea Valuable Management Award in 2005, the President of Korea's medal in an Energy Saving Promote Contest as well as the Korean Marketing Best Award (KMAC) in 2004 as well as other awards.

The operating and maintenance 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), further Hu-Chems has established internal training plans on the CDM procedures, operation of the EnviNOx® system and the monitoring system to train staffs who are assigned to the project during the crediting period. Training records are available and submitted to the DOE for verification.

Carbon CDM Korea is responsible for 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. HU-CHEMS is certified under ISO 9001 and 14001 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 Periodical observation of the automated monitoring system and Back Up Plans for measuring systems

##### EnviNOx® – Automatic DCS system:

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

Malfunction of system components is indicated on the operator 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 Hu-Chems instrument department and Carbon CDM Korea. It is then deciding whether the problem can be fixed immediately by themselves, or whether external support from Emerson Korea/Emerson Germany/Uhde is required.

Back Up – Regular on-site inspection:

The project operator Hu-Chems is carrying out visual **on-site inspections** on a daily basis. Relevant data are logged on the ISO Document HCSEF-448-1 “CDM Analyzer/Reactor Check List” once per shift. Actions are defined in case of abnormal observations.

Back Up – EnviNOx® support:

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

Carbon CDM Korea has contracted Emerson Process Management Korea to execute monthly on-site **Health Checks** and 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 monitoring equipment required for the CDM project and the automated monitoring system. The system components, measurement devices and the automated monitoring system required for the monitoring of the CDM project are covered by the contracts. The contract was coming into force after the start-up period of the project activity. Health check reports and inspection visit reports are available.

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

Back Up – On-site spare part stock:

As further important contribution to the availability of the monitoring system (e.g. in the event of failure of the measuring equipment), Hu-Chems stores a comprehensive range of spare parts at the project site. The types and amount of stored spare parts meet the recommendations of the supplier. The majority of spare part types are re-purchased after consumption, some other spare part types are re-purchased after their stock has reached a defined reorder level, in both cases Hu-Chems is following the recommendation of the supplier.

The spare part stock includes inter alia filter elements, valves and pressure controllers for the sample handling system and filter elements, analysis cells (crucial part for analyzers), flow sensors and several electrical parts for the analyzers.

Back Up – Certified test gases

Pressure levels of test gases used for the regular, automatic calibration of the inlet and outlet analysers are constantly monitored during the regular on-site inspection. Spare bottles of test gases are purchased in proper time. Specifications and certification of test gases are available and submitted to the DOE for verification.

### Back Up – Procedures:

In addition to the quality control and quality assurance procedures according to the Hu-Chems quality management system and in order to avoid possible failures of the automated monitoring system, procedures are implemented for the project activity. The approach by Carbon CDM Korea was to ensure immediate response to such special events in the system.

The following table summarizes the periodical observations of the AMS.

**Table 4:** Periodical observation of the AMS

Organization	Action	Frequency	Output
Delta V	Events & Alarm List	Continuously	Txt-files, Excel files
Hu-Chems	Shift inspection	3 times per day	Protocol, Check List
Emerson Process Management Korea	Health check: AMS System and instruments	Monthly	Health Check Report
Emerson Process Management Korea	Inspection visit: AMS System, all diagnostics and calibration work	Quarterly	Inspection Report
UHDE	Supervision	Continuously	Plausibility Check

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

### 7.2.2 Systematic measures for QA for monitoring data during AMS down times

In order to ensure data quality, back up plans (refer to 7.2.1) are in place. In case of AMS down times, demonstration of normal plant operation and estimation of emission reductions are conducted according to the PDD.

### 7.3 Calibration and maintenance

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 HU-CHEMS.

Records of conducted maintenance activities by Hu-Chems are available and submitted to the DOE for verification.

As pointed out in section 7.2, Carbon CDM Korea has contracted Emerson Process Management Korea to execute monthly on-site **Health Checks** and quarterly on-site **Inspection Visits**. The system

components, measurement devices and the automated monitoring system required for the monitoring of the CDM project are covered by these contracts. Service reports of conducted health checks, inspection visits and further maintenance activities and checks, respectively are available and submitted to the DOE for verification.

The sampling system is inspected regularly by Emerson Process Management Korea. Additionally, the most recent sample line check by applying test at the beginning of the sample line has been performed for all analysers of all three plants on the 29<sup>th</sup> June 2009 and showed positive results. Reports of these checks are made available to the DOE.

All measuring and analytical instruments are being calibrated as defined in the Approved Methodology AM0028. Calibration procedures have been incorporated in HU-CHEMS Quality Management System and Procedures. All relevant instruments have been calibrated accordingly.

Carbon CDM Korea has mandated Emerson Process Management Korea to execute additional calibration & health check services to ensure accuracy of all monitoring instruments related to the CDM Project. These additional services consist of calibration verification, diagnostic tests, zero and span status checks as well as check of the electrical connections and component status.

Service reports of conducted additional calibration & health check services are made available to the DOE.

**Table 5:** Instrument overview – Hu-Chems II

Instrument overview: Hu-Chems II		
Instrument	TAG Number	Latest service applied
EnviNOx® Inlet Analyser	322-AI-2-0125	29/09/2009
EnviNOx® Outlet Analyser	322-AI-2-0127	29/09/2009
Tail Gas Flow	322-FT-2-5130B	19/03/2009
Tail Gas Flow	322-FT-2-5184B	19/03/2009
Propane Flow to EnviNOx®	322-FT-2-5121	18/03/2009
Ammonia Flow to AOR	322-FT-2-503	09/09/2009
Pressure in AOR	322-PT-2-304	12/05/2009
Temperature in AOR	322-TT-2-115	10/06/2009
Temperature in AOR	322-TT-2-116	10/06/2009
Nitric Acid Flow	322-FT-2-512	09/09/2009

**Table 6:** Instrument overview – Hu-Chems III

Instrument overview: Hu-Chems III		
Instrument	TAG Number	Latest service applied
EnviNOx® Inlet Analyser	323-AI-3-0125	29/09/2009
EnviNOx® Outlet Analyser	323-AI-3-0127	29/09/2009
Tail Gas Flow	323-FT-3-5130B	29/12/2008
Tail Gas Flow	323-FT-3-5184B	29/12/2008
Propane Flow to EnviNOx®	323-FT-3-5121	07/05/2009
Ammonia Flow to AOR	323-FT-3-503	13/08/2009
Pressure in AOR	323-PT-3-304	09/05/2009
Temperature in AOR	323-TT-3-115	13/08/2009
Temperature in AOR	323-TT-3-116	13/08/2009
HNO3 Flow	323-FT-3-512	13/08/2009

**Table 7:** Instrument overview – Hu-Chems IV

Instrument overview: Hu-Chems IV		
Instrument	TAG Number	Latest service applied
EnviNOx® Inlet Analyser	324-AI-4-0108	29/09/2009
EnviNOx® Outlet Analyser	324-AI-4-0107	29/09/2009
Tail Gas Flow	324-FT-4-4115B	29/01/2009
Tail Gas Flow	324-FT-4-4116B	29/01/2009
Ammonia Flow to AOR	324-FT-4-5020	29/01/2009
Pressure in AOR	324-PT-4-305A	29/01/2009
Pressure in AOR	324-PT-4-305B	29/01/2009
Temperature in AOR	324-TT-4-106A	19/05/2009
Temperature in AOR	324-TT-4-106B	25/06/2009
Temperature in AOR	324-TT-4-106C	19/05/2009
HNO3 Flow	324-FT-4-609	29/01/2009

#### 7.4 Environmental Impacts

According to Article 4 of the Korean Environmental Impact Assessment Law and the item 3 of the Article 2 of its Enforcement Ordinance, no EIA was required for the project activity. NO<sub>x</sub> emissions are measured at the outlet of the EnviNOx® systems.

The continuous measurement of the NO<sub>x</sub> concentration reports the following concentrations:

- Hu-Chems II: 4.0 ppm
- Hu-Chems III: 2.7 ppm
- Hu-Chems IV: 23.7 ppm

## 7.5 Social Fund

As described in the PDD a social fund was established by the project developer and the project operator. This fund will contribute to the social benefit of the people living in the area of the project activity by financing projects and social activities. The contribution to the Social Fund in 2008 was about 855,000,000 Million Won, equivalent to about 530,000 Euro. Projects and Organizations supported by the CDM Social Fund are the Yeodo Academy, the Endowment of In-Company welfare fund and the Sang am village fund. The Yeodo Academy intends to improve the basic elementary and secondary education and the objective of the Welfare Fund is to contribute to working employees' life stabilization and welfare improvement.

- Social Fund 2007: 250,931,278 WON (~ 150,000 Euro)
- Social Fund 2008: 854,902,652 WON (~ 530,000 Euro)



## 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>), project emissions (PE<sub>y</sub>) and leakage emissions (LE<sub>y</sub>), as follows:

$$ER_y = BE_y - PE_y - LE_y \quad . \quad (26)$$

where:

ER <sub>y</sub>	Emissions reductions of the project activity during the year y (tCO <sub>2</sub> e)
BE <sub>y</sub>	Baseline emissions during the year y (tCO <sub>2</sub> e)
PE <sub>y</sub>	Project emissions during the year y (tCO <sub>2</sub> e)
LE <sub>y</sub>	Leakage emissions in year y (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® systems at Hu-Chems II and III.

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® systems and the volume flow rates of the tail gas streams. 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® systems (Hydrocarbons are used in plant Hu-Chems II and Hu-Chems III only. No hydrocarbons are used in plant Hu-Chems IV).

$$PE_y = PE_{y,II} + PE_{y,III} + PE_{y,IV} \quad (27)$$

e.g.

$$PE_{y,II} = PE_{ND,y,II} + PE_{DF,y,II} \quad (28)$$

where:

PE <sub>y</sub>	Project emissions in year y (tCO <sub>2</sub> e)
PE <sub>y,II</sub>	Project emissions Hu-Chems II in year y (tCO <sub>2</sub> e)
PE <sub>y,III</sub>	Project emissions Hu-Chems III in year y (tCO <sub>2</sub> e)
PE <sub>y,IV</sub>	Project emissions Hu-Chems IV in year y (tCO <sub>2</sub> e)
PE <sub>ND,y</sub>	Project emissions from N <sub>2</sub> O not destroyed in year y (tCO <sub>2</sub> e)
PE <sub>DF,y</sub>	Project emissions related to the operation of the destruction facility in year y (tCO <sub>2</sub> e)
PE <sub>ND,y,II</sub>	Project emissions from N <sub>2</sub> O not destroyed in year y Hu-Chems II (tCO <sub>2</sub> e)
PE <sub>ND,y,III</sub>	Project emissions from N <sub>2</sub> O not destroyed in year y Hu-Chems III (tCO <sub>2</sub> e)
PE <sub>ND,y,IV</sub>	Project emissions from N <sub>2</sub> O not destroyed in year y Hu-Chems IV (tCO <sub>2</sub> e)
PE <sub>DF,y,II</sub>	Project emissions from the operation of the destruction facility in year y Hu-Chems II (tCO <sub>2</sub> e)
PE <sub>DF,y,III</sub>	Project emissions from the operation of the destruction facility in year y Hu-Chems III (tCO <sub>2</sub> e)
PE <sub>DF,y,IV</sub>	Project emissions from the operation of the destruction facility in year y Hu-Chems IV (tCO <sub>2</sub> e)

$$\begin{aligned}
 PE_{y,II} &= PE_{ND,y,II} + PE_{DF,y,II} = [2,626 + 243 = 2,869 \text{ tCO}_2\text{e}] \\
 &= PE_{N_2O,y,II} \times GWP_{N_2O} + PE_{HC,y,II} = \\
 &= \sum_i^n F_{TG,i,II} \times CO_{N_2O,i,II} \times M_{i,II} \times GWP_{N_2O} + HCE_{C,y,II} = \\
 &= \sum_i^n F_{TG,i,II} \times CO_{N_2O,i,II} \times M_{i,II} \times GWP_{N_2O} + \\
 &\quad \rho_{HC,II} \times Q_{HC,y,II} \times EF_{HC,II} \times OXID_{HC,II}/100 = \\
 &= \mathbf{2,869 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 PE_{y,III} &= PE_{ND,y,III} + PE_{DF,y,III} = [1,747 + 240 = 1,987 \text{ tCO}_2\text{e}] \\
 &= PE_{N_2O,y,III} \times GWP_{N_2O} + PE_{HC,y,III} = \\
 &= \sum_i^n F_{TG,i,III} \times CO_{N_2O,i,III} \times M_{i,III} \times GWP_{N_2O} + HCE_{C,y,III} = \\
 &= \sum_i^n F_{TG,i,III} \times CO_{N_2O,i,III} \times M_{i,III} \times GWP_{N_2O} + \\
 &\quad \rho_{HC,III} \times Q_{HC,y,III} \times EF_{HC,III} \times OXID_{HC,III}/100 = \\
 &= \mathbf{1,987 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 PE_{y,IV} &= PE_{ND,y,IV} + PE_{DF,y,IV} = [4,732 + 0 = 4,732 \text{ tCO}_2\text{e}] \\
 &= PE_{N_2O,y,IV} \times GWP_{N_2O} = \\
 &= \sum_i^n F_{TG,i,IV} \times CO_{N_2O,i,IV} \times M_{i,IV} \times GWP_{N_2O} = \\
 &= \mathbf{4,732 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 PE_y &= PE_{y,II} + PE_{y,III} + PE_{y,IV} = [2,869 + 1,987 + 4,732 = 13,383 \text{ tCO}_2\text{e}] \\
 &= \mathbf{9,588 \text{ tCO}_2\text{e}}
 \end{aligned}$$

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 Korean regulations 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 measurements of the N<sub>2</sub>O at the inlet of the EnviNOx<sup>®</sup>-Systems.

$$BE_y = BE_{y,II} + BE_{y,III} + BE_{y,IV} = BE_{N_2O,y} \times GWP_{N_2O} \quad (29)$$

e.g.

$$BE_{y,II} = BE_{N_2O,II} \times GWP_{N_2O} \quad (30)$$

where:

BE <sub>y</sub>	Baseline emissions in year y (tCO <sub>2</sub> e)
BE <sub>y,II</sub>	Baseline emissions Hu-Chems II in year y (tCO <sub>2</sub> e)
BE <sub>y,III</sub>	Baseline emissions Hu-Chems III in year y (tCO <sub>2</sub> e)
BE <sub>y,IV</sub>	Baseline emissions Hu-Chems IV in year y (tCO <sub>2</sub> e)
BE <sub>N<sub>2</sub>O,y</sub>	Baseline emissions of N <sub>2</sub> O in year y (tN <sub>2</sub> O)
GWP <sub>N<sub>2</sub>O</sub>	Global warming potential of N <sub>2</sub> O = 310
BE <sub>N<sub>2</sub>O,II</sub>	Baseline emissions of N <sub>2</sub> O in year y at Hu-Chems II (tN <sub>2</sub> O)
BE <sub>N<sub>2</sub>O,III</sub>	Baseline emissions of N <sub>2</sub> O in year y at Hu-Chems III (tN <sub>2</sub> O)
BE <sub>N<sub>2</sub>O,IV</sub>	Baseline emissions of N <sub>2</sub> O in year y at Hu-Chems IV (tN <sub>2</sub> O)

$$\begin{aligned}
 BE_{y,II} &= BE_{N_2O,y,II} \times GWP_{N_2O} = [336.48 \times 310 = 104,309 \text{ tCO}_2\text{e}] \\
 &= \sum_i^n F_{TG,i,II} \times CI_{N_2O,i,II} \times M_{i,II} \times GWP_{N_2O} = \\
 &= \mathbf{104,309 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 BE_{y,III} &= BE_{N_2O,y,III} \times GWP_{N_2O} = [317.48 \times 310 = 98,418 \text{ tCO}_2\text{e}] \\
 &= \sum_i^n F_{TG,i,III} \times CI_{N_2O,i,III} \times M_{i,III} \times GWP_{N_2O} = \\
 &= \mathbf{98,418 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 BE_{y,IV} &= BE_{N_2O,y,IV} \times GWP_{N_2O} = [726.40 \times 310 = 225,184 \text{ tCO}_2\text{e}] \\
 &= \sum_i^n F_{TG,i,IV} \times CI_{N_2O,i,IV} \times M_{i,IV} \times GWP_{N_2O} = \\
 &= \mathbf{225,184 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned} BE_y &= BE_{y,II} + BE_{y,III} + BE_{y,IV} = [104,309 + 98,418 + 225,184 = 427,911 \text{ tCO}_2\text{e}] \\ &= \mathbf{427,911 \text{ tCO}_2\text{e}} \end{aligned}$$

Baseline emissions are limited to the design capacities of the nitric acid plants. 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:

$$LE_y = 0 \quad . \quad (31)$$

### **Emission Reduction:**

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

$$\begin{aligned} ER_y &= BE_y - PE_y - LE_y \quad . \quad (32) \\ &= 427,911 - 9,588 - 0 = \\ &= \mathbf{418,323 \text{ tCO}_2\text{e}} \end{aligned}$$

The above emission reductions cover the monitoring period from **01/07/2009** to **30/09/2009**.

### **Calculation of Project and Baseline Emission parameters (valid for all three EniNOx® systems)**

#### *Applied Steps*

1. The “DeltaV” automatic measuring system (AMS) used for plant operation & CDM Monitoring was designed by the company Emerson, the overall supplier of components related to the monitoring system.
2. The DeltaV System automatically takes average concentrations from the continuously measuring analysers every 10 seconds.
3. Based on these concentrations and corresponding flows, relevant Project and Baseline Emission Parameters are calculated by the DeltaV System every 10 seconds.
4. The DeltaV Continuous Historian captures and stores the time-series parameter values from the run-time DeltaV system.

5. The DeltaV System generates daily DeltaV Reports, where averages (concentrations) and totals (Flows, Project/Baseline emission parameters) of the collected values over one day are contained, as required by the PDD.
6. Finally, based on these daily DeltaV Reports, calculation of Emission Reductions is conducted. A comprehensive overview overview on monitoring data and calculation of Emission Redutions is made available to the DOE for verification.

Due to the calculation at a very early stage (10 seconds basis), a highly representative and accurate calculation is achieved, since calculations which are based on concentrations and volume flows are not adulterated due to big calculation intervals.

This approach and all implemented formulas in the Delta V system fully comply with the approved Monitoring Methodology AM0028 Version 1 “Catalytic N<sub>2</sub>O destruction in the tail gas of Nitric Acid Plants” and the respective, registered PDD.

#### *Plausibility Check*

In order to assess the automatic calculation of Project and Baseline Emission Parameters in the DeltaV system, a plausibility check was performed. For that purpose, the calculation of Project and Baseline Emission Parameters has been conducted manually, based on daily average and total values and using the same formulas implemented in the DeltaV system. The result clearly shows plausible data with only slight variations (Hu-Chems II: 0.002%; Hu-Chems III 0.001%; Hu-Chems IV: 0.005%) in the Emission Reduction calculation. Anyway, calculations with average concentrations on a daily basis compared to calculations on a 10 second basis do not represent the most accurate way to calculate Emission Reductions.

#### *Conclusion*

Applied ER calculations on a 10 seconds basis guarantee a highly representative and accurate (almost real time) approach. The applied approach is in full compliance with methodology AM0028 Version 1 and respective, registered PDD. Plausibility Check is to prove correct and transparent application of formulas and clearly shows plausible data.

### **Comparison of actual emission reductions with ex-ante emission reduction estimation according to PDD:**

**Table 8:** Comparison of emission reductions with PDD values – Hu-Chems II

<b>Comparison of ER with PDD values: Hu-Chems II</b>	
<b>Source</b>	<b>Value</b>
Emission reduction estimation according to PDD (one year)	329,397 tCO <sub>2</sub> e
Corresponding PDD estimation (over 92 days)	83,026 tCO <sub>2</sub> e
Actual calculation of emission reduction in monitoring period (over 92 days)	101,440 tCO <sub>2</sub> e

The excess of the actual emission reduction during the monitoring period compared to the corresponding ex-ante estimation according to the PDD in nitric acid plant II is caused by following reasons:

- For the PDD calculation, a destruction rate of [94.00%] was used, the actual destruction rate reaches an average level of about [97.48%];
- Due to the absence of actual values, an inlet concentration of [3.5E-06 tN<sub>2</sub>O / Nm<sup>3</sup>] for baseline emission estimation in the PDD was used. Actual concentrations measured reach an average level of [4.4E-06 tN<sub>2</sub>O / Nm<sup>3</sup>] and therefore lead to higher baseline emissions;

It should be noted that the ex-ante estimation of emissions reductions in the PDD was generally based on conservative assumptions.

**Table 9:** Comparison of emission reductions with PDD values – Hu-Chems III

<b>Comparison of ER with PDD values: Hu-Chems III</b>	
<b>Source</b>	<b>Value</b>
Emission reduction estimation according to PDD (one year)	329,397 tCO <sub>2</sub> e
Corresponding PDD estimation (over 92 days)	83,026 tCO <sub>2</sub> e
Actual calculation of emission reduction in monitoring period (over 92 days)	96,431 tCO <sub>2</sub> e

The excess of the actual emission reduction during the monitoring period compared to the corresponding ex-ante estimation according to the PDD in nitric acid plant II is caused by following reasons:

- For the PDD calculation, a destruction rate of [94.00%] was used, the actual destruction rate reaches an average level of about [98.23%];
- Due to the absence of actual values, an inlet concentration of [3.5E-06 tN<sub>2</sub>O / Nm<sup>3</sup>] for baseline emission estimation in the PDD was used. Actual concentrations measured reach an average level of [3.8E-06 tN<sub>2</sub>O / Nm<sup>3</sup>] and therefore lead to higher baseline emissions;

It should be noted that the ex-ante estimation of emissions reductions in the PDD was generally based on conservative assumptions.

It should be noted that the ex-ante estimation of emissions reductions in the PDD was generally based on conservative assumptions.

**Table 10:** Comparison of emission reductions with PDD values – Hu-Chems IV

<b>Comparison of ER with PDD values: Hu-Chems IV</b>	
<b>Source</b>	<b>Value</b>
Emission reduction estimation according to PDD (one year)	621,634 tCO <sub>2</sub> e
Corresponding PDD estimation (over 92 days)	156,685 tCO <sub>2</sub> e
Actual calculation of emission reduction in monitoring period (over 92 days)	220,452 tCO <sub>2</sub> e

The excess of the actual emission reduction during the monitoring period compared to the corresponding ex-ante estimation according to the PDD in nitric acid plant IV is caused by following reasons:

- For the PDD calculation, a destruction rate of [94.00%] was used, the actual destruction rate reaches an average level of about [97.90%];
- Due to the absence of actual values, an inlet concentration of [1.7E-06 tN<sub>2</sub>O / Nm<sup>3</sup>] for baseline emission estimation in the PDD was used. Actual concentrations measured reach an average level of [2.0E-06 tN<sub>2</sub>O / Nm<sup>3</sup>] and therefore lead to higher baseline emissions;
- Due to the absence of tail gas flow measurement, the tail gas flow used for emission reduction determination in the PDD was estimated with [149,675 Nm<sup>3</sup> / h]. Actual flows measured reach an average level of [161,338 Nm<sup>3</sup> / h] and therefore contribute to a higher emission reduction than estimated.

It should be noted that the ex-ante estimation of emissions reductions in the PDD was generally based on conservative assumptions.

## 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<sub>2</sub>O generation, thereby increasing the CERs, actual operating conditions have been checked against the baseline requirements.

### Operating temperature:

In each nitric acid plant, the temperature in the ammonia oxidation reactor (AOR) is monitored by three thermocouples, whereas in each case two thermocouples are used for the CDM project. The operating temperatures in the AOR are automatically collected by HuChems Fine Chemical distributed control system (DCS) and then automatically transferred to the Delta-V distributed control system (Delta-V system) serving the CDM project. Based on these two thermocouples, the Delta-V system automatically calculates and reports the daily average temperature. Subsequently, the Delta-V system generates daily reports including the daily average AOR temperature.

The data from the daily reports generated by the Delta-V system are transferred to excel sheets (one for each nitric acid plant) in order to present all parameters as required by AM0028 in an overall format. These files also include the daily average values of the ammonia oxidation temperatures and an automatic check of each daily average value in order to see if the operation has been within the permitted operating ranges.

The actual average daily operating temperatures in the three ammonia oxidation reactors are within the permitted ranges for all days covered by this monitoring report.

### Operating pressure:

The operating pressure representing the pressure in the ammonia oxidation reactors (AOR) are measured in the primary air supply lines of the three nitric acid plants. The operating pressures are automatically collected by the Hu-Chems Fine Chemical distributed control system (DCS) and then automatically transferred to the Delta-V distributed control system (Delta-V system), serving the CDM project.. Subsequently, the Delta-V system generates daily reports including the daily average AOR pressure.

The data from the daily reports generated by the Delta-V system are transferred to excel sheets (one for each nitric acid plant) in order to present all parameters as required by AM0028 in an overall format. These files also include the daily average values of the ammonia oxidation pressures and an automatic check of each daily average value in order to see if the operation has been within the permitted operating ranges.

The actual average daily operating pressures in the three ammonia oxidation reactors are within the permitted ranges for all days covered by this monitoring period.



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

The ammonia inlet flows to the ammonia oxidation reactors (AOR) are monitored by flow meters and automatically collected by Hu-Chems Fine Chemical distributed control system (DCS) and then automatically transferred to the Delta-V distributed control system (Delta-V system) serving the CDM project. The Delta-V system generates daily reports including daily ammonia input to the AOR.

The data from the daily reports generated by the Delta-V system are transferred to excel sheets (one for each nitric acid plant) in order to present all parameters as required by AM0028 in an overall format. These files also include the total daily ammonia inlet flows and an automatic check of each daily value in order to see if the operation has been within the permitted operating ranges.

The daily ammonia input to the three ammonia oxidation reactors are within the permitted ranges for all days covered by this monitoring report.

#### HNO<sub>3</sub> production:

The nitric acid produced (recorded as 100% nitric acid) is determined from the volume flow measured with flow meters. The hourly volume flow rate is available from the Hu-Chems Fine Chemical distributed control system (DCS).

The concentration and density of the acid is determined by laboratory analysis three times daily. The daily average of the nitric acid concentration and density are calculated and used for the specific day.

The nitric acid production in tons 100% concentration is manually calculated from the volume flow, density and concentration of the acid and manually transferred to the DCS and serving the CDM project. The DCS generates daily reports including the daily nitric acid production.

The data from the daily reports generated by the DCS are transferred to excel sheets (one for each nitric acid plant) in order to present all parameters as required by AM0028 in an overall format. These files also include the daily 100% nitric acid production.

The plausibility of HNO<sub>3</sub> production data is regularly checked for all three nitric acid plant. During the actual monitoring period, the conversion rates of ammonia nitrogen to nitric acid are within plausible ranges in all three nitric acid plants.

The nitric acid production in all three nitric acid plants is within the permitted range.

**Table 11:** Summary of Nitric Acid Production in 2009

Nitric Acid plant	Hu-Chems II	Hu-Chems III	Hu-Chems IV
Data unit	tHNO <sub>3</sub>	tHNO <sub>3</sub>	tHNO <sub>3</sub>
Nitric Acid produced in 2009 (until 30 <sup>th</sup> September 2009)	<b>51,334</b>	<b>58,756</b>	<b>304,840</b>
Limit of annual Nitric Acid Production according to PDD	<b>116,800</b>	<b>116,800</b>	<b>467,200</b>

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. Evidence on compliance of supplier and composition with historical data is made available to the DOE during verification.

**Table 12:** Summary on installed catalyst gauzes

Nitric Acid plant	Hu-Chems II	Hu-Chems III	Hu-Chems IV
Installation date	09/06/2009 09/09/2009 29/09/2009	07/05/2009 13/08/2009	25/06/2009
Supplier of currently installed gauzes	Johnson Matthey	Johnson Matthey	Johnson Matthey
Composition of currently installed gauzes	90%Pt, 5%Rh, 5%Pd	90%Pt, 5%Rh, 5%Pd	95%Pt, 5%Rh
Historical supplier of gauzes	Johnson Matthey and/or Umicore	Johnson Matthey and/or Umicore	Johnson Matthey and/or Umicore
Historical composition of gauzes	90%Pt, 5%Rh, 5%Pd	90%Pt, 5%Rh, 5%Pd	95%Pt, 5%Rh and/or 92%Pt, 8%Rh

## 10 Downtimes & observations during the monitoring period

### 10.1 Downtimes of Nitric Acid Plants

During the below mentioned periods, the Nitric Acid Plants were out of operation due to the given reasons.

**Table 13 - Downtimes of the nitric acid plants**

Nitric Acid Plant downtimes					
Plant	Downtime - Start		Downtime - End		Downtime Reason
Plant 2	Date	Time	Date	Time	Description
2	07.09.2009	02:00	09.09.2009	03:00	Shutdown due to exchange of catalyst gauzes in Ammonia Oxidation Reactor
2	09.09.2009	12:00	10.09.2009	23:00	Shutdown of NA Plant due to problems with the air compressor
2	11.09.2009	22:00	13.09.2009	07:00	Shutdown of NA Plant due to problems with a waste heat boiler.
2	28.09.2009	19:00	30.09.2009	10:00	Shutdown due to exchange of catalyst gauzes in Ammonia Oxidation Reactor
Plant 3	Date	Time	Date	Time	Description
3	22.07.2009	11:00	25.07.2009	13:00	Emergency shutdown of NA Plant due to a process leakage
3	12.08.2009	20:00	14.08.2009	05:00	Shutdown due to exchange of catalyst gauzes in Ammonia Oxidation Reactor
Plant 4	Date	Time	Date	Time	Description
4	-	-	-	-	No downtimes of nitric acid plant #4 occurred during MP

### 10.2 Downtimes of EnviNOx® Systems

During the below mentioned periods, the EnviNOx® Systems were out of operation due to the given reasons. No Emission Reduction is claimed during these downtimes.

**Table 14 - Downtimes of the EnviNOx® Systems**

EnviNOx® System downtimes					
Plant	Downtime - Start		Downtime - End		Downtime Reason
Plant 2	Date	Time	Date	Time	Description
2	07.09.2009	20:00	13.09.2009	13:00	EnviNOx® system has been stopped due to nitric acid plant shut down and again started full operation after final startup of nitric acid plant (13/09/2009)
2	28.09.2009	14:00	30.09.2009	12:00	EnviNOx® system has been stopped due to nitric acid plant shut down
Plant 3	Date	Time	Date	Time	Description
3	22.07.2009	11:00	25.07.2009	13:00	EnviNOx® system has been stopped due to nitric acid plant shut down
3	12.08.2009	20:00	14.08.2009	05:00	EnviNOx® system has been stopped due to nitric acid plant shut down
Plant 4	Date	Time	Date	Time	Description
4	-	-	-	-	No downtimes of EnviNOx® system in plant#4 occurred during MP



### 10.3 Relevant observations during the monitoring period

During the below mentioned periods, observations related to the operation of the EnviNOx® system and the AMS have been made.

#### **EnviNOx® System at Nitric acid plant #2:**

On the 20<sup>th</sup> of August 2009 between 13:00 and 19:00, a check of the inlet and the outlet analyser has been performed which influenced the recorded values. In order to apply a conservative approach, no emission reduction is claimed during this period.

#### **EnviNOx® System at Nitric acid plant #3:**

On the 19<sup>th</sup> of August 2009 between 09:00 and 20:00, a check of the inlet and the outlet analyser has been performed which influenced the recorded values. In order to apply a conservative approach, no emission reduction is claimed during this period.

#### **EnviNOx® System at Nitric acid plant #4:**

On the 18<sup>th</sup> of August 2009 between 11:00 and 22:00, a check of the inlet and the outlet analyser has been performed which influenced the recorded values. In order to apply a conservative approach, no emission reduction is claimed during this period.

## Annex 1

### Data and parameter monitored Hu-Chems:

<b>Data / Parameter:</b>	<b>PE_y</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculation
Value monitoring period:	<b>9,588 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_ND,y</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from N <sub>2</sub> O not destroyed
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculation
Value monitoring period:	<b>9,105 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_DF,y</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from destruction facility
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculation
Value monitoring period:	<b>483 tCO<sub>2</sub>e</b>

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<b>Data / Parameter:</b>	<b>BE_y</b>
Data unit:	tCO <sub>2</sub> e
Description:	Baseline emissions
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculation
Value monitoring period:	<b>427,911 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>REG_NOx</b>
Data unit:	tNO <sub>x</sub> /m <sup>3</sup>
Description:	National regulation on NO <sub>x</sub> emissions
Source of data to be used:	Regional authorities
Description of measurement methods and procedures to be applied:	Official notification local authorities
Value monitoring period:	<b>200 ppmv</b>

**Data and parameter monitored Hu-Chems II:**

<b>Data / Parameter:</b>	<b>PE_y,II</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions Hu-Chems II
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>2,869 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_ND,II</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from N <sub>2</sub> O not destroyed Hu-Chems II
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>2,626 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_DF,II</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from destruction facility Hu-Chems II
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>243 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_N<sub>2</sub>O,II</b>
Data unit:	tN <sub>2</sub> O

Description:	N <sub>2</sub> O not destroyed by facility Hu-Chems II
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>8.47 tN<sub>2</sub>O</b>

<b>Data / Parameter:</b>	<b>F_TG,II</b>
Data unit:	Nm <sup>3</sup> /h
Description:	Volume flow tail gas at N <sub>2</sub> O destruction facility interval i Hu-Chems II
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:	<b>77,258,979 Nm<sup>3</sup></b> <b>(38,266 Nm<sup>3</sup>/h)</b>

<b>Data / Parameter:</b>	<b>CO_N2O,II</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility outlet Hu-Chems II
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:	<b>1.10E-07 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>M_i,II</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:	The DeltaV System automatically takes average readings from the continuously measuring analysers every 10 seconds. Based on raw data, the Monitoring System calculates Project and Baseline Emission Parameters every 10 seconds. The DeltaV System generates daily DeltaV Reports, where averages (concentrations) and totals (Flows, Project/Baseline emission parameters) of the collected values over one day are contained, as required by the PDD.
Value monitoring period:	<b>10 seconds</b>

<b>Data / Parameter:</b>	<b>PE_HC,II</b>
Data unit:	tCO <sub>2</sub> e
Description:	Emissions from hydrocarbon use in destruction facility Hu-Chems II
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>243 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>HCE_C, II</b>
Data unit:	tCO <sub>2</sub> e
Description:	Converted hydrocarbon emissions Hu-Chems II
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>243 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>Q_HC,II</b>
Data unit:	Nm <sup>3</sup>
Description:	Hydrocarbon input (propane as reducing agent) Hu-Chems II
Source of data to be	Flow meter

used:	
Description of measurement methods and procedures to be applied:	The propane 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:	<b>40,431 Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b><math>\rho_{\text{HC, II}}</math></b>
Data unit:	t/m <sup>3</sup>
Description:	Hydrocarbon density Hu-Chems II
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:	<b>2.00E-03 t/Nm<sup>3</sup></b>
	Standard Normal Conditions: 1,013.25 hPa, 273.15K

<b>Data / Parameter:</b>	<b><math>\text{EF}_{\text{HC,II}}</math></b>
Data unit:	tCO <sub>2</sub> e/t
Description:	Hydrocarbon CO <sub>2</sub> emission factor Hu-Chems II
Source of data to be used:	Hydrocarbon supplier or default value
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.
Value monitoring period:	<b>3.0 tCO<sub>2</sub>e/t</b>

<b>Data / Parameter:</b>	<b><math>\text{OXID}_{\text{HC,II}}</math></b>
Data unit:	%
Description:	Hydrocarbon oxidation factor Hu-Chems II
Source of data to be	

used:	
Description of measurement methods and procedures to be applied:	According to AM0028 OXID_HC_II is 100% (conservative approach)
Value monitoring period:	<b>100%</b>

<b>Data / Parameter:</b>	<b>Type_HC,II</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:	<b>Propane</b>

<b>Data / Parameter:</b>	<b>P_HNO3,II</b>
Data unit:	tHNO <sub>3</sub>
Description:	Plant output of HNO <sub>3</sub> Hu-Chems II
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 are recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity.
Value monitoring period:	<b>25,267 tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>QI_N2O,II</b>
Data unit:	tN2O
Description:	Quantity of N2O at inlet of destruction facility Hu-Chems II
Source of data to be used:	Monitoring system

Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>336.48 tN<sub>2</sub>O</b>

<b>Data / Parameter:</b>	<b>CI_N2O,II</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility inlet Hu-Chems II
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:	<b>4.36E-06 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>QR_N2O,y RSE_N2O,y CR_N2O</b>
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.
Value monitoring period:	Not applicable

<b>Data / Parameter:</b>	<b>P_HNO3,hist,II</b>
Data unit:	tHNO <sub>3</sub>
Description:	Design capacity

Source of data used:	PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>116,800 tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>T<sub>g,hist,II</sub></b>
Data unit:	°C
Description:	Historical operating temperature of the ammonia oxidation reactor Hu-Chems II
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>880 – 910 °C</b>

<b>Data / Parameter:</b>	<b>P<sub>g,hist,II</sub></b>
Data unit:	barg
Description:	Historical operating pressure of the ammonia oxidation reactor Hu-Chems II
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>5.0 – 9.8 barg</b>

<b>Data / Parameter:</b>	<b>T<sub>g,II</sub></b>
Data unit:	°C
Description:	Actual operating temperature ammonia oxidation reactor Hu-Chems II
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 installed measuring devices. Actual daily temperatures are reported in the Delta V Daily reports.

applied:	
Value monitoring period:	<b>897.5 °C</b>

<b>Data / Parameter:</b>	<b>P<sub>g,II</sub></b>
Data unit:	Barg
Description:	Actual operating pressure ammonia oxidation reactor Hu-Chems II
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:	<b>8.69 barg</b>

<b>Data / Parameter:</b>	<b>G<sub>sup,II</sub></b>
Data unit:	-
Description:	Supplier of the ammonia oxidation catalyst Hu-Chems II
Source of data to be used:	Ammonia oxidation catalyst supplier
Description of measurement methods and procedures to be applied:	Commercial Invoice
Value monitoring period:	<b>Johnson Matthey</b>

<b>Data / Parameter:</b>	<b>G<sub>com,II</sub></b>
Data unit:	%
Description:	Composition of the ammonia oxidation catalyst Hu-Chems II
Source of data to be used:	Ammonia oxidation catalyst supplier
Description of measurement methods and procedures to be applied:	Supplier's information
Value monitoring period:	<b>90% Pt 5% Rh 5% Pd</b>

<b>Data / Parameter:</b>	<b>G<sub>sup,hist,II</sub></b>
Data unit:	-
Description:	Historical supplier of the ammonia oxidation catalyst Hu-Chems II
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>Johnson Matthey and/or Umicore</b>

<b>Data / Parameter:</b>	<b>G<sub>com,hist,II</sub></b>
Data unit:	%
Description:	Historical composition of the ammonia oxidation catalyst Hu-Chems II
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>90% Pt 5% Rh 5% Pd</b>

<b>Data / Parameter:</b>	<b>SE<sub>N2O,II</sub></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 Hu-Chems II
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:	<b>0.013 tN<sub>2</sub>O/tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>A_OR,hist,II</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Max. historical ammonia flow rate to the ammonia oxidation reactor Hu-Chems II
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>91.82 tNH<sub>3</sub>/d</b>

<b>Data / Parameter:</b>	<b>A_OR,d,II</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Actual ammonia flow rate to the ammonia oxidation reactor Hu-Chems II
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:	<b>81.74 tNH<sub>3</sub>/d</b>



**Data and parameter monitored Hu-Chems III:**

<b>Data / Parameter:</b>	<b>PE_y,III</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project Emissions Hu-Chems III
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>1,987 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_ND,III</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from N <sub>2</sub> O not destroyed Hu-Chems III
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>1,747 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_DF,III</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from destruction facility Hu-Chems III
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>240 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_N2O,III</b>
Data unit:	tN <sub>2</sub> O
Description:	N <sub>2</sub> O not destroyed by facility Hu-Chems III
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>5.63 tN<sub>2</sub>O</b>

<b>Data / Parameter:</b>	<b>F_TG,III</b>
Data unit:	Nm <sup>3</sup> /h
Description:	Volume flow tail gas at N <sub>2</sub> O destruction facility interval i Hu-Chems III
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:	<b>83,907,480 Nm<sup>3</sup></b> <b>(40,147 Nm<sup>3</sup>/h)</b>

<b>Data / Parameter:</b>	<b>CO_N2O,III</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility outlet Hu-Chems III
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:	<b>6.71E-08 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>M_i,III</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:	The DeltaV System automatically takes average readings from the continuously measuring analysers every 10 seconds. Based on raw data, the Monitoring System calculates Project and Baseline Emission Parameters every 10 seconds. The DeltaV System generates daily DeltaV Reports, where averages (concentrations) and totals (Flows, Project/Baseline emission parameters) of the collected values over one day are contained, as required by the PDD.
Value monitoring period:	<b>10 seconds</b>

<b>Data / Parameter:</b>	<b>PE_HC,III</b>
Data unit:	tCO <sub>2</sub> e
Description:	Emissions from hydrocarbon use in destruction facility Hu-Chems III
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>240 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>HCE_C, III</b>
Data unit:	tCO <sub>2</sub> e
Description:	Converted hydrocarbon emissions Hu-Chems III
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>240 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>Q_HC,III</b>
Data unit:	Nm <sup>3</sup>
Description:	Hydrocarbon input (propane as reducing agent) Hu-Chems III

Source of data to be used:	Flow meter
Description of measurement methods and procedures to be applied:	The propane 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:	<b>39,882 Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b><math>\rho_{\text{HC, III}}</math></b>
Data unit:	t/m <sup>3</sup>
Description:	Hydrocarbon density Hu-Chems III
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:	<b>2.00E-03 t/Nm<sup>3</sup></b>  Standard Normal Conditions: 1,013.25 hPa, 273.15K

<b>Data / Parameter:</b>	<b>EF<sub>HC,III</sub></b>
Data unit:	tCO <sub>2</sub> e/t
Description:	Hydrocarbon CO <sub>2</sub> emission factor Hu-Chems III
Source of data to be used:	Hydrocarbon supplier or default value
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.
Value monitoring period:	<b>3.0 tCO<sub>2</sub>e/t</b>

<b>Data / Parameter:</b>	<b>OXID<sub>HC,III</sub></b>
Data unit:	%

Description:	Hydrocarbon oxidation factor Hu-Chems III
Source of data to be used:	
Description of measurement methods and procedures to be applied:	According to AM0028 OXID_HC_III is 100% (conservative approach)
Value monitoring period:	<b>100%</b>

<b>Data / Parameter:</b>	<b>Type_HC,III</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:	<b>Propane</b>

<b>Data / Parameter:</b>	<b>P_HNO3,III</b>
Data unit:	tHNO <sub>3</sub>
Description:	Plant output of HNO <sub>3</sub> Hu-Chems III
Source of data to be used:	Production reports
Description of measurement methods and procedures to be applied:	The actual nitric acid production is determined based on flow measurement according to the installed instruments and on laboratory concentration and density determination according to a respective procedure. The instrument signals are recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity.
Value monitoring period:	<b>27,028 tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>QI_N2O,III</b>
Data unit:	tN <sub>2</sub> O

Description:	Quantity of N <sub>2</sub> O at inlet of destruction facility Hu-Chems III
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>317.48 tN<sub>2</sub>O</b>

<b>Data / Parameter:</b>	<b>CI_N2O,III</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility inlet Hu-Chems III
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:	<b>3.78 E-06 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>T_g,hist,III</b>
Data unit:	°C
Description:	Historical operating temperature range of the ammonia oxidation reactor Hu-Chems III
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>880 – 910 °C</b>

<b>Data / Parameter:</b>	<b>P_g,hist,III</b>
Data unit:	barg
Description:	Historical operating pressure range of the ammonia oxidation reactor Hu-Chems III

Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>5.0 – 9.8 barg</b>

<b>Data / Parameter:</b>	<b>T<sub>g</sub>, III</b>
Data unit:	°C
Description:	Actual operating temperature ammonia oxidation reactor Hu-Chems III
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 installed measuring devices. Actual daily temperatures are reported in the Delta V Daily reports.
Value monitoring period:	<b>900.8 °C</b>

<b>Data / Parameter:</b>	<b>P<sub>g</sub>, III</b>
Data unit:	Barg
Description:	Actual operating pressure ammonia oxidation reactor Hu-Chems III
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:	<b>8.93 barg</b>

<b>Data / Parameter:</b>	<b>G<sub>sup</sub>, III</b>
Data unit:	-
Description:	Supplier of the ammonia oxidation catalyst Hu-Chems III
Source of data to be used:	Ammonia oxidation catalyst supplier
Description of measurement methods	Commercial Invoice

and procedures to be applied:	
Value monitoring period:	<b>Johnson Matthey</b>

<b>Data / Parameter:</b>	<b>G_com,III</b>
Data unit:	%
Description:	Composition of the ammonia oxidation catalyst Hu-Chems III
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:	<b>90% Pt</b> <b>5% Rh</b> <b>5% Pd</b>

<b>Data / Parameter:</b>	<b>G_sup,hist,III</b>
Data unit:	-
Description:	Historical supplier of ammonia oxidation catalyst Hu-Chems III
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>Johnson Matthey</b> <b>and/or</b> <b>Umicore</b>

<b>Data / Parameter:</b>	<b>G_com,hist,III</b>
Data unit:	%
Description:	Historical composition of the ammonia oxidation catalyst Hu-Chems III
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>90% Pt</b> <b>5% Rh</b>



	<b>5% Pd</b>
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<b>Data / Parameter:</b>	<b>SE_N2O,III</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 Hu-Chems III
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:	<b>0.012 tN<sub>2</sub>O/tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>A_OR,hist,III</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Max. historical ammonia flow rate to the ammonia oxidation reactor Hu-Chems III
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>92.57 tNH<sub>3</sub>/d</b>

<b>Data / Parameter:</b>	<b>A_OR,d,III</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Actual ammonia flow rate to the ammonia oxidation reactor Hu-Chems III
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:	<b>84.72 tNH<sub>3</sub>/d</b>

**Data and parameter monitored Hu-Chems IV:**

<b>Data / Parameter:</b>	<b>PE_y,IV</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions Hu-Chems IV
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>4,732 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_ND,IV</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from N <sub>2</sub> O not destroyed Hu-Chems IV
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>4,732 tCO<sub>2</sub>e</b>

<b>Data / Parameter:</b>	<b>PE_DF,IV</b>
Data unit:	tCO <sub>2</sub> e
Description:	Project emissions from destruction facility Hu-Chems IV
Source of data to be used:	
Description of measurement methods and procedures to be applied:	Not applicable
Value monitoring period:	<b>Not applicable</b>

<b>Data / Parameter:</b>	<b>PE_N<sub>2</sub>O,IV</b>
Data unit:	tN <sub>2</sub> O
Description:	N <sub>2</sub> O not destroyed by facility Hu-Chems IV

Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>15.26 tN<sub>2</sub>O</b>

<b>Data / Parameter:</b>	<b>F_TG,IV</b>
Data unit:	Nm <sup>3</sup> /h
Description:	Volume flow tail gas at N <sub>2</sub> O destruction facility interval i Hu-Chems IV
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:	<b>354,459,540 Nm<sup>3</sup></b> <b>(161,338 Nm<sup>3</sup>/h)</b>

<b>Data / Parameter:</b>	<b>CO_N2O,IV</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility outlet Hu-Chems IV
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:	<b>4.31E-08 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>M_i,IV</b>
Data unit:	h
Description:	Measuring Interval
Source of data to be	Delta V System, Monitoring System

used:	
Description of measurement methods and procedures to be applied:	The DeltaV System automatically takes average readings from the continuously measuring analysers every 10 seconds. Based on raw data, the Monitoring System calculates Project and Baseline Emission Parameters every 10 seconds. The DeltaV System generates daily DeltaV Reports, where averages (concentrations) and totals (Flows, Project/Baseline emission parameters) of the collected values over one day are contained, as required by the PDD.
Value monitoring period:	<b>10 seconds</b>

<b>Data / Parameter:</b>	<b>P_HNO3,IV</b>
Data unit:	tHNO <sub>3</sub>
Description:	Plant output of HNO <sub>3</sub> Hu-Chems IV
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 are recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity.
Value monitoring period:	<b>113,820 tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>QI_N2O,IV</b>
Data unit:	tN <sub>2</sub> O
Description:	Quantity of N <sub>2</sub> O at inlet of destruction facility Hu-Chems IV
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculated
Value monitoring period:	<b>726.40 tN<sub>2</sub>O</b>

<b>Data / Parameter:</b>	<b>CI_N2O,IV</b>
Data unit:	tN <sub>2</sub> O/ Nm <sup>3</sup>
Description:	N <sub>2</sub> O concentration at destruction facility inlet Hu-Chems IV

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:	<b>2.05E-06 tN<sub>2</sub>O/Nm<sup>3</sup></b>

<b>Data / Parameter:</b>	<b>P_HNO3,hist,IV</b>
Data unit:	tHNO <sub>3</sub>
Description:	Design capacity Hu-Chems IV
Source of data used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>467,200 tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>T_g,hist,IV</b>
Data unit:	°C
Description:	Historical operating temperature of ammonia oxidation reactor Hu-Chems IV
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>860 – 910 °C</b>

<b>Data / Parameter:</b>	<b>P_g,hist,IV</b>
Data unit:	barg
Description:	Historical operating pressure of the ammonia oxidation reactor Hu-Chems IV
Source of data to be used:	According to PDD
Description of measurement methods	

and procedures to be applied:	
Value monitoring period:	<b>2.2 – 4.4 barg</b>

<b>Data / Parameter:</b>	<b>T<sub>g, IV</sub></b>
Data unit:	°C
Description:	Actual operating temperature ammonia oxidation reactor Hu-Chems IV
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 installed measuring devices. Actual daily temperatures are reported in the Delta V Daily reports.
Value monitoring period:	<b>891.4 °C</b>

<b>Data / Parameter:</b>	<b>P<sub>g, IV</sub></b>
Data unit:	Barg
Description:	Actual operating pressure ammonia oxidation reactor Hu-Chems IV
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:	<b>3.73 barg</b>

<b>Data / Parameter:</b>	<b>G<sub>sup, IV</sub></b>
Data unit:	-
Description:	Supplier of the ammonia oxidation catalyst Hu-Chems IV
Source of data to be used:	Ammonia oxidation catalyst supplier
Description of measurement methods and procedures to be applied:	Commercial Invoice
Value monitoring period:	<b>Johnson Matthey</b>

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<b>Data / Parameter:</b>	<b>G_com,IV</b>
Data unit:	%
Description:	Composition of the ammonia oxidation catalyst Hu-Chems IV
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:	<b>95% Pt</b> <b>5% Rh</b>

<b>Data / Parameter:</b>	<b>G_sup,hist,IV</b>
Data unit:	-
Description:	Historical supplier of the ammonia oxidation catalyst Hu-Chems IV
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>Johnson Matthey</b> <b>and/or</b> <b>Umicore</b>

<b>Data / Parameter:</b>	<b>G_com,hist,IV</b>
Data unit:	%
Description:	Historical composition of the ammonia oxidation catalyst Hu-Chems IV
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>95% Pt</b> <b>5% Rh</b>  <b>and/or</b>  <b>92% Pt</b>

	<b>8% Rh</b>
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<b>Data / Parameter:</b>	<b>SE_N2O,IV</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 Hu-Chems IV
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:	<b>0.006 tN<sub>2</sub>O/tHNO<sub>3</sub></b>

<b>Data / Parameter:</b>	<b>A_OR,hist,IV</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Max. historical ammonia flow rate to the ammonia oxidation reactor
Source of data to be used:	According to PDD
Description of measurement methods and procedures to be applied:	
Value monitoring period:	<b>355.50 tNH<sub>3</sub>/d</b>

<b>Data / Parameter:</b>	<b>A_OR,d,IV</b>
Data unit:	tNH <sub>3</sub> /d
Description:	Actual ammonia flow rate to the ammonia oxidation reactor Hu-Chems IV
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:	<b>348.77 tNH<sub>3</sub>/d</b>



## Annex 2

**Table 15:** Overview on monitoring parameters Hu-Chems II

ER Calculation Parameters					
Parameter Name	Value in	Unit	Description		
BE_y,II	104,309	tCO <sub>2</sub> e	Baseline Emissions		
PE_y,II	2,869	tCO <sub>2</sub> e	Project Emissions		
LE_y,II	0	tCO <sub>2</sub> e	Leakage Emissions		
ER_y,II	101,440	tCO <sub>2</sub> e	Emission Reduction		

Project Emission Parameters - Plant Hu-Chems II					
ID in AM0028 v1	ID in PDD	Parameter Name	Value	Unit	Description
P1	P4	PE_y,II	2,869	tCO <sub>2</sub> e	Project Emissions
P2	P5	PE_ND,y,II	2,626	tCO <sub>2</sub> e	Project Emissions from N <sub>2</sub> O not destroyed
P3	P6	PE_DF,y,II	243	tCO <sub>2</sub> e	Project Emissions from destruction facility
P4	P7	PE_N <sub>2</sub> O,y,II	8.47	tN <sub>2</sub> O	N <sub>2</sub> O not destroyed by facility
P5	P8	F_TG,i,II	77,258,979	Nm <sup>3</sup>	Volume flow tail gas at N <sub>2</sub> O destruction facility
			38,266	Nm <sup>3</sup> /h	
P6	P9	CO_N <sub>2</sub> O,i,II	1.10E-07	tN <sub>2</sub> O/m <sup>3</sup>	N <sub>2</sub> O concentration at destruction facility outlet
P7	P10	M_i,II	10	sec	Measuring Interval
P8	-	PE_NH <sub>3</sub> ,y,II	Not Applicable	tCO <sub>2</sub> e	Emissions from ammonia use in destruction facility
P9	P11	PE_HC,y,II	243	tCO <sub>2</sub> e	Emissions from hydrocarbon use in destruction facility
P10	-	Q_NH <sub>3</sub> , y,II	Not Applicable	tNH <sub>3</sub>	N <sub>2</sub> O destruction facility: Project Ammonia input
P11	-	EF_NH <sub>3</sub>	Not Applicable	tCO <sub>2</sub> e/tNH <sub>3</sub>	Ammonia production GHG Emission Factor
P12	P12	HCE_C,y,II	243	tCO <sub>2</sub> e	Converted hydrocarbon emissions
P13	-	HCE_NC, y,II	Not Applicable	tCO <sub>2</sub> e	Non Converted Methane Emissions
P14	P13	Q_HC,y,II	40,431	m <sup>3</sup> Propane	Hydrocarbon input (reducing agent)
P15	P14	p_HC,II	2.00E-03	tPropane/m <sup>3</sup>	Hydrocarbon density
P16	P15	EF_HC,II	3.0	tCO <sub>2</sub> /tPropane	Hydrocarbon CO <sub>2</sub> Emission Factor
P17	P16	OXID_HC,II	100	%	Hydrocarbon Oxidation Factor
P18	P17	Type_HC,II	Propane	-	Type of Hydrocarbon

Baseline Emission Parameters - Plant Hu-Chems II					
ID in AM0028 v1	ID in PDD	Parameter Name	Value	Unit	Description
B1	B1	P_HNO <sub>3</sub> ,y,II	25,267	tHNO <sub>3</sub>	Plant output of HNO <sub>3</sub>
B2	B2	QI_N <sub>2</sub> O,y,II	336.48	tN <sub>2</sub> O	Quantity of N <sub>2</sub> O at inlet of destruction facility
B3	B3	CI_N <sub>2</sub> O,i,II	4.36E-06	tN <sub>2</sub> O/m <sup>3</sup>	N <sub>2</sub> O concentration at N <sub>2</sub> O destruction facility inlet
B4	B4	QR_N <sub>2</sub> O,y	Not Applicable	tN <sub>2</sub> O	Regulation I: annual quantity N <sub>2</sub> O limited
B5	B5	RSE_N <sub>2</sub> O,y	Not Applicable	tN <sub>2</sub> O/tHNO <sub>3</sub>	Regulation II: N <sub>2</sub> O emissions per unit of nitric acid
B6	B6	CR_N <sub>2</sub> O	Not Applicable	tN <sub>2</sub> O/m <sup>3</sup>	Regulation III: N <sub>2</sub> O concentration in tail gas limited
B7	B7	P_HNO <sub>3</sub> ,hist,II	116,800	t	Design capacity
B8	B8	T_g,hist,II	low	880	Historical operating temperature range of the ammonia oxidation reactor
			high	910	
B9	B9	P_g,hist,II	low	5.0	Historical operating pressure range of the ammonia oxidation reactor
			high	9.8	
B10	B10	T_g,II	897.5	°C	Actual operating temperature ammonia oxidation reactor
B11	B11	P_g,II	8.69	barg	Actual operating pressure ammonia oxidation reactor
B12	B12	Reg_Nox	200	ppmv	National Regulation on Nox emissions
B13	B13	G_sup,II	Johnson Matthey	-	Supplier of the ammonia oxidation catalyst
B14	B14	G_com,II	90%Pt, 5%Rh, 5%Pd	%	Composition of the ammonia oxidation catalyst
B15	B15	G_sup,hist,II	Umicore and/or Johnson Matthey	-	Historical supplier of ammonia oxidation catalyst
B16	B16	G_com,hist,II	90%Pt, 5%Rh, 5%Pd	%	Historical composition of the ammonia oxidation catalyst
B17	B17	SE_N <sub>2</sub> O,II	0.013	tN <sub>2</sub> O/tHNO <sub>3</sub>	N <sub>2</sub> O emission rate per ton of nitric acid
B18	B18	A_OR,hist,II	91.82	tNH <sub>3</sub> /day	Max. historical ammonia flow rate to the ammonia oxidation reactor
B19	B19	A_OR,d,II	81.74	tNH <sub>3</sub> /day	Actual ammonia flow rate to the ammonia oxidation reactor

**Table 16:** Overview on monitoring parameters Hu-Chems III

			ER Calculation Parameters			
			Parameter Name	Value in	Unit	Description
			BE_y,III	98,418	tCO <sub>2</sub> e	Baseline Emissions
			PE_y,III	1,987	tCO <sub>2</sub> e	Project Emissions
			LE_y,III	0	tCO <sub>2</sub> e	Leakage Emissions
ER_y,III	96,431	tCO <sub>2</sub> e	Emission Reduction			

Project Emission Parameters - Plant Hu-Chems III					
ID in AM0028 v1	ID in PDD	Parameter Name	Value	Unit	Description
P1	P18	PE_y,III	1,987	tCO <sub>2</sub> e	Project Emissions
P2	P19	PE_ND,y,III	1,747	tCO <sub>2</sub> e	Project Emissions from N2O not destroyed
P3	P20	PE_DF,y,III	240	tCO <sub>2</sub> e	Project Emissions from destruction facility
P4	P21	PE_N2O,y,III	5.63	tN <sub>2</sub> O	N2O not destroyed by facility
P5	P22	F_TG,i,III	83,907,480	Nm³	Volume flow tail gas at N2O destruction facility
			40,147	Nm³/h	
P6	P23	CO_N2O,i,III	6.71E-08	tN <sub>2</sub> O/m³	N2O concentration at destruction facility outlet
P7	P24	M_i,III	10	sec	Measuring Interval
P8	-	PE_NH3,y,III	Not Applicable	tCO <sub>2</sub> e	Emissions from ammonia use in destruction facility
P9	P25	PE_HC,y,III	240	tCO <sub>2</sub> e	Emissions from hydrocarbon use in destruction facility
P10	-	Q_NH3, y,III	Not Applicable	tNH <sub>3</sub>	N2O destruction facility: Project Ammonia input
P11	-	EF_NH3	Not Applicable	tCO <sub>2</sub> e/tNH <sub>3</sub>	Ammonia production GHG Emission Factor
P12	P26	HCE_C,y,III	240	tCO <sub>2</sub> e	Converted hydrocarbon emissions
P13	-	HCE_NC, y,III	Not Applicable	tCO <sub>2</sub> e	Non Converted Methane Emissions
P14	P27	Q_HC,y,III	39,882	m³ Propane	Hydrocarbon input (reducing agent)
P15	P28	ρ_HC,III	2.00E-03	tPropane/m³	Hydrocarbon density
P16	P29	EF_HC,III	3.0	tCO <sub>2</sub> /tPropane	Hydrocarbon CO2 Emission Factor
P17	P30	OXID_HC,III	100	%	Hydrocarbon Oxidation Factor
P18	P31	Type_HC,III	Propane	-	Type of Hydrocarbon

Baseline Emission Parameters - Plant Hu-Chems III						
ID in AM0028 v1	ID in PDD	Parameter Name	Value	Unit	Description	
B1	B20	P_HNO3,y,III	27,028	tHNO <sub>3</sub>	Plant output of HNO3	
B2	B21	QI_N2O,y,III	317.48	tN <sub>2</sub> O	Quantity of N2O at inlet of destruction facility	
B3	B22	CI_N2O,i,III	3.78E-06	tN <sub>2</sub> O/m³	N <sub>2</sub> O concentration at N <sub>2</sub> O destruction facility inlet	
B4	B4	QR_N2O,y	Not Applicable	tN <sub>2</sub> O	Regulation I: annual quantity N2O limited	
B5	B5	RSE_N2O,y	Not Applicable	tN <sub>2</sub> O/tHNO <sub>3</sub>	Regulation II: N2O emissions per unit of nitric acid	
B6	B6	CR_N2O	Not Applicable	tN <sub>2</sub> O/m³	Regulation III: N2O concentration in tail gas limited	
B7	-	P_HNO3,hist,III	116,800	t	Design capacity	
B8	B23	T_g,hist,III	low	880	°C	Historical operating temperature range of the ammonia oxidation reactor
			high	910		
B9	B24	P_g,hist,III	low	5.0	barg	Historical operating pressure range of the ammonia oxidation reactor
			high	9.8		
B10	B25	T_g,III	900.8	°C	Actual operating temperature ammonia oxidation reactor	
B11	B26	P_g,III	8.93	barg	Actual operating pressure ammonia oxidation reactor	
B12	B12	Reg_Nox	200	ppmv	National Regulation on Nox emissions	
B13	B27	G_sup,III	Johnson Matthey	-	Supplier of the ammonia oxidation catalyst	
B14	B28	G_com,III	90%Pt, 5%Rh, 5%Pd	%	Composition of the ammonia oxidation catalyst	
B15	B29	G_sup,hist,III	Umicore and/or Johnson Matthey	-	Historical supplier of ammonia oxidation catalyst	
B16	B30	G_com,hist,III	90%Pt, 5%Rh, 5%Pd	%	Historical composition of the ammonia oxidation catalyst	
B17	B31	SE_N2O,III	0.012	tN <sub>2</sub> O/tHNO <sub>3</sub>	N2O emission rate per ton of nitric acid	
B18	B32	A_OR,hist,III	92.57	tNH <sub>3</sub> /day	Max. historical ammonia flow rate to the ammonia oxidation reactor	
B19	B33	A_OR,d,III	84.72	tNH <sub>3</sub> /day	Actual ammonia flow rate to the ammonia oxidation reactor	

**Table 17:** Overview on monitoring parameters Hu-Chems IV

ER Calculation Parameters					
Parameter Name	Value in	Unit	Description		
BE_y,IV	225,184	tCO <sub>2</sub> e	Baseline Emissions		
PE_y,IV	4,732	tCO <sub>2</sub> e	Project Emissions		
LE_y,IV	0	tCO <sub>2</sub> e	Leakage Emissions		
ER_y,IV	220,452	tCO <sub>2</sub> e	Emission Reduction		

Project Emission Parameters - Plant Hu-Chems IV					
ID in AM0028 v1	ID in PDD	Parameter Name	Value	Unit	Description
P1	P32	PE_y,IV	4,732	tCO <sub>2</sub> e	Project Emissions
P2	P33	PE_ND,y,IV	4,732	tCO <sub>2</sub> e	Project Emissions from N <sub>2</sub> O not destroyed
P3	P34	PE_DF,y,IV	0	tCO <sub>2</sub> e	Project Emissions from destruction facility
P4	P35	PE_N <sub>2</sub> O,y,IV	15.26	tN <sub>2</sub> O	N <sub>2</sub> O not destroyed by facility
P5	P36	F_TG,i,IV	354,459,540	Nm <sup>3</sup>	Volume flow tail gas at N <sub>2</sub> O destruction facility
			161,338	Nm <sup>3</sup> /h	
P6	P37	CO_N <sub>2</sub> O,i,IV	4.31 E-08	tN <sub>2</sub> O/m <sup>3</sup>	N <sub>2</sub> O concentration at destruction facility outlet
P7	P38	M_i,IV	10	sec	Measuring Interval
P8	-	PE_NH <sub>3</sub> ,y,IV	Not Applicable	tCO <sub>2</sub> e	Emissions from ammonia use in destruction facility
P9	-	PE_HC,y,IV	Not Applicable	tCO <sub>2</sub> e	Emissions from hydrocarbon use in destruction facility
P10	-	Q_NH <sub>3</sub> ,y,IV	Not Applicable	tNH <sub>3</sub>	N <sub>2</sub> O destruction facility: Project Ammonia input
P11	-	EF_NH <sub>3</sub>	Not Applicable	tCO <sub>2</sub> e/tNH <sub>3</sub>	Ammonia production GHG Emission Factor
P12	-	HCE_C,y,IV	Not Applicable	tCO <sub>2</sub> e	Converted hydrocarbon emissions
P13	-	HCE_NC,y,IV	Not Applicable	tCO <sub>2</sub> e	Non Converted Methane Emissions
P14	-	Q_HC,y,IV	Not Applicable	m <sup>3</sup> Propane	Hydrocarbon input (reducing agent)
P15	-	ρ_HC,IV	Not Applicable	tPropane/m <sup>3</sup>	Hydrocarbon density
P16	-	EF_HC,IV	Not Applicable	tCO <sub>2</sub> /tPropane	Hydrocarbon CO <sub>2</sub> Emission Factor
P17	-	OXID_HC,IV	Not Applicable	%	Hydrocarbon Oxidation Factor
P18	-	Type_HC,IV	Not Applicable	-	Type of Hydrocarbon

Baseline Emission Parameters - Plant Hu-Chems IV					
ID in AM0028 v1	ID in PDD	Parameter Name	Value	Unit	Description
B1	B34	P_HNO <sub>3</sub> ,y,IV	113,820	tHNO <sub>3</sub>	Plant output of HNO <sub>3</sub>
B2	B35	QI_N <sub>2</sub> O,y,IV	726.40	tN <sub>2</sub> O	Quantity of N <sub>2</sub> O at inlet of destruction facility
B3	B36	CI_N <sub>2</sub> O,i,IV	2.05E-06	tN <sub>2</sub> O/m <sup>3</sup>	N <sub>2</sub> O concentration at N <sub>2</sub> O destruction facility inlet
B4	B4	QR_N <sub>2</sub> O,y	Not Applicable	tN <sub>2</sub> O	Regulation I: annual quantity N <sub>2</sub> O limited
B5	B5	RSE_N <sub>2</sub> O,y	Not Applicable	tN <sub>2</sub> O/tHNO <sub>3</sub>	Regulation II: N <sub>2</sub> O emissions per unit of nitric acid
B6	B6	CR_N <sub>2</sub> O	Not Applicable	tN <sub>2</sub> O/m <sup>3</sup>	Regulation III: N <sub>2</sub> O concentration in tail gas limited
B7	B37	P_HNO <sub>3</sub> ,hist,IV	467,200	t	Design capacity
B8	B38	T_g,hist,IV	low 860 high 910	°C	Historical operating temperature range of the ammonia oxidation reactor
B9	B39	P_g,hist,IV	low 2.2 high 4.4	barg	
B10	B40	T_g,IV	891.4	°C	Actual operating temperature ammonia oxidation reactor
B11	B41	P_g,IV	3.73	barg	Actual operating pressure ammonia oxidation reactor
B12	B12	Reg_Nox	200	ppmv	National Regulation on Nox emissions
B13	B42	G_sup,IV	Johnson Matthey	-	Supplier of the ammonia oxidation catalyst
B14	B43	G_com,IV	95%Pt, 5%Rh	%	Composition of the ammonia oxidation catalyst
B15	B44	G_sup,hist,IV	Umicore and/or Johnson Matthey	-	Historical supplier of ammonia oxidation catalyst
B16	B45	G_com,hist,IV	95%Pt, 5%Rh and/or 92%Pt, 8%Rh	%	Historical composition of the ammonia oxidation catalyst
B17	B46	SE_N <sub>2</sub> O,IV	0.006	tN <sub>2</sub> O/tHNO <sub>3</sub>	N <sub>2</sub> O emission rate per ton of nitric acid
B18	B47	A_OR,hist,IV	355.50	tNH <sub>3</sub> /day	Max. historical ammonia flow rate to the ammonia oxidation reactor
B19	B48	A_OR,d,IV	348.77	tNH <sub>3</sub> /day	Actual ammonia flow rate to the ammonia oxidation reactor