



CDM Monitoring Report No. 1:

" Catalytic N₂O destruction project in the tail gas of three Nitric
Acid Plants at Hu-Chems Fine Chemical Corp."

UNFCCC 0765

Monitoring Period:

From: 22/01/2007

To: 31/03/2007

Version 1

May 15th 2007

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1 Introduction

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

This monitoring report covers the activity from **22/01/2007** to **31/03/2007** as the 1st 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 N₂O 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 N₂O destruction in the tail gas of Nitric Acid Plants”; submitted by Carbon Projektentwicklung GmbH.

Approved Monitoring methodology:

AM0028 Version 1: “Catalytic N₂O destruction in the tail gas of Nitric Acid Plants”; submitted by Carbon Projektentwicklung GmbH.

Project Design Document:

“Catalytic N₂O 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 N₂O 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 N₂O 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

Definition

- **y** : Monitoring period (in this report, January 22nd 2007 to March 31st 2007.)
- **PDD** : Project Design Document of this project “Catalytic N₂O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.” Version 2 on July 22nd 2006.

3 General Description of Project

3.1 Project Activity

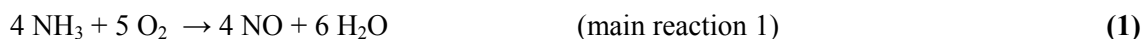
The Project Activity includes development, design, engineering, procurement, finance, construction, operation and maintenance of a system for catalytic reduction of N₂O in three Nitric Acid Plants (Hu-Chems II; Hu-Chems III; Hu-Chems IV) at Hu-Chems Fine Chemical Corp.

The EnviNOx® process used in the **Hu-Chems IV** nitric acid plant is based on the catalytic decomposition of nitrous oxide (N₂O) and the catalytic reduction of NO_x (NO and NO₂) with ammonia (NH₃). This process works very well at temperatures above about 425°C. The tail gas temperature at Hu-Chems IV nitric acid plant is about 435°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_x (NO and NO₂) with ammonia (NH₃) and of nitrous oxide (N₂O) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane (C₃H₈). The reactions take place over an iron zeolite catalyst bed.

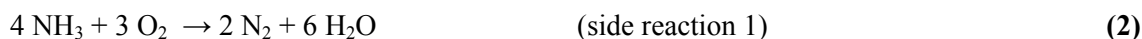
General Introduction:

Nitrous oxide (N₂O) 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:

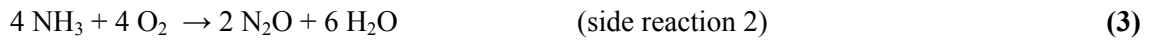
1. Ammonia (NH₃) combustion to form nitric oxide (NO)¹:



Simultaneously nitrous oxide (N₂O), nitrogen (N) and water (H₂O) are formed as well, in accordance with the following equations:

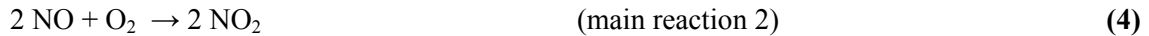


¹ Ammonia is reacted with air on noble metal catalyst in the oxidation section of nitric acid plants. Nitric oxide and water are formed in this process according to the above mentioned main equation.

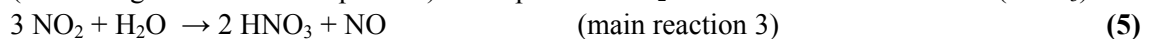


NO yield mainly depends on pressure and temperature in the ammonia oxidation process and is usually in a range of 95% to 97%.

2. NO is oxidised to nitrogen dioxide (NO₂):



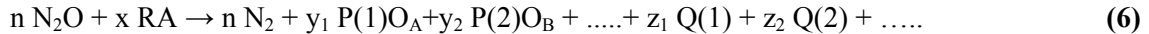
3. (According to the technical process) Absorption of NO₂ in water to form nitric acid (HNO₃):



(NO is oxidised to NO₂ 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 N₂O occurs when reactions take place between N₂O and other substances in contact with a catalyst, such that the oxygen is removed from the N₂O molecule and forms one or more compounds with other species. The substance or substances that react with N₂O to remove oxygen are termed reducing agent. A general reaction equation for the catalytic reduction of N₂O can be given as:



where RA is a molecule of the reducing agent, P(1)O_A, P(2)O_B are the compound formed by reaction with the oxygen of the N₂O and Q(1), Q(2) represent further products of the oxidation reaction, n, x, y₁, y₂, z₁, z₂ are the appropriate stoichiometric coefficients.

Equations reduction N₂O with propane:



or



The definition does not exclude the possibility of side reactions resulting in consumption of reducing agent without any reduction of N₂O, 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:

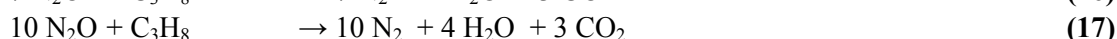
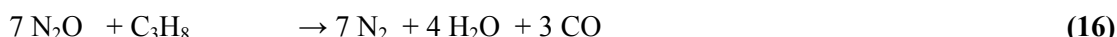
The EnviNOx® process used in the Hu-Chems II + III nitric acid plants is based on the catalytic reduction of NO_x (NO and NO_2) with ammonia (NH_3) and of nitrous oxide (N_2O) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane (C_3H_8). The reactions take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

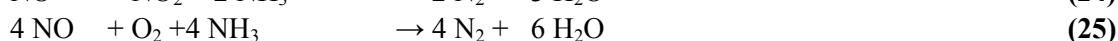
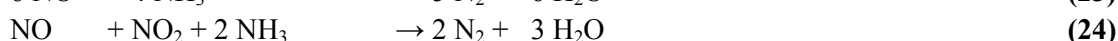
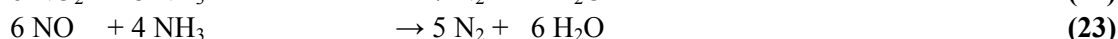
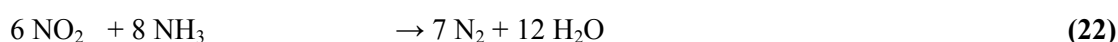
The EnviNOx® process used in the Hu-Chems IV nitric acid plant is based on the catalytic decomposition of nitrous oxide (N₂O) and the catalytic reduction of NO_x (NO and NO₂) with ammonia (NH₃). This process works very well at temperatures above about 425°C. The reactions take place over two iron zeolite catalyst beds.

In the first bed N₂O is catalytically decomposed into its elements:



This rate of this reaction is enhanced by high concentrations of NO_x.

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_x is reduced with ammonia according to such reactions as:



Some further destruction of N₂O 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_x and N₂O 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 N₂O destruction project at Hu-Chems II and Hu-Chems III involves that propane is employed as a reducing agent for N₂O removal.

The EnviNOx® system at Hu-Chems IV was installed in December 2006 and the catalytic reduction process of N₂O 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 N₂O 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) will be 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) will be 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) will be 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.

3.2 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 N₂O 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 9002 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 N₂O from nitric acid tail gas streams.

4 Baseline Methodology

The approved Baseline Methodology AM0028 Version 1 “Catalytic N₂O 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 N₂O 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 N₂O 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_x emission reductions that are at least as effective as the DeNO_x-units installed prior to the start of the project activity.
- The DeNO_x-units installed prior to the start of the project activity were SCR DeNO_x-units.
- The N₂O concentrations are measured in real time at the inlet and the outlet of the N₂O 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:

- N₂O emissions in the tail gas downstream the project activity (Hu-Chems II, III, IV);
- CO₂ emissions associated with the use of propane as reducing agent, converted C₃H₈ (Hu-Chems II, III).

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

- N₂O 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 1: Overview on emission sources included or excluded from the project boundary

Baseline Emissions

<i>Source</i>	<i>Gas</i>		<i>Justification/Explanation</i>
Emissions of N ₂ O as a result of side reaction to the nitric acid production process	N ₂ O	Included	Main emission source, taking national N ₂ O emission regulations into account.

Emissions related to the production of ammonia used for NO _x reduction (Attention: Ammonia used for NO _x -reduction does not cause GHG emissions, only the production of ammonia causes GHG emissions)	CO ₂ CH ₄ N ₂ O	Excluded according to AM0028	In case of Hu-Chems II, III and IV SCR DeNO _x 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 _x reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation.
N ₂ O emissions from SCR DeNO _x unit	N ₂ O	Excluded according to AM0028	The presence of a SCR DeNO _x unit tends to increase the N ₂ O emissions. Therefore the ex-post measurement of the baseline emissions at the inlet of the N ₂ O destruction facility represents a conservative determination of the baseline N ₂ O emissions.

Project Emissions

<i>Source</i>	<i>Gas</i>		<i>Justification/Explanation</i>
Emissions of N ₂ O as a result of side reaction to the nitric acid production process	N ₂ O	Included	Main emission source that remains in the tail gas after the N ₂ O destruction facility
Emissions related to the production of ammonia input used for NO _x reduction (Attention: Ammonia used for NO _x -reduction doesn't cause GHG emissions, only production causes GHG emissions)	CO ₂ CH ₄ N ₂ O	Excluded according to AM0028	In case of Hu-Chems II, III and IV SCR DeNO _x 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 _x -reduction. Baseline emissions and project emissions are similar and therefore not considered for calculation. In case no SCR DeNO _x unit is already installed prior to the project start: ammonia input for NO _x reduction is monitored and considered for project emissions.
In case of N ₂ O reduction process installed: Emissions at the project site resulting from hydrocarbons used as reducing agent	CO ₂	Included	At Hu-Chems II and III a N ₂ O reduction process will be installed and propane will be used as reducing agent. Propane is used to enhance the efficiency of a N ₂ O catalytic reduction facility. In this case hydrocarbons are mainly converted to CO ₂ , while some hydrocarbons may remain intact. In order to apply a conservative approach propane is assumed to be completely converted to CO ₂ .
Emissions from electricity demand	CO ₂ CH ₄	Excluded	GHG emissions related to the electricity consumption are insignificant (< 0.005%) and are excluded as

	N ₂ O		monitoring would lead to unreasonable costs.
Emissions related to the production of the hydrocarbons	CO ₂ CH ₄ N ₂ O	Excluded	GHG emissions related to the production of hydrocarbons used as reducing agent represent less than 0.001% of expected emission reductions and will not be taken into account due to unreasonable costs for monitoring.

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

Figure 1: Project boundary Hu-Chems II and Hu-Chems III

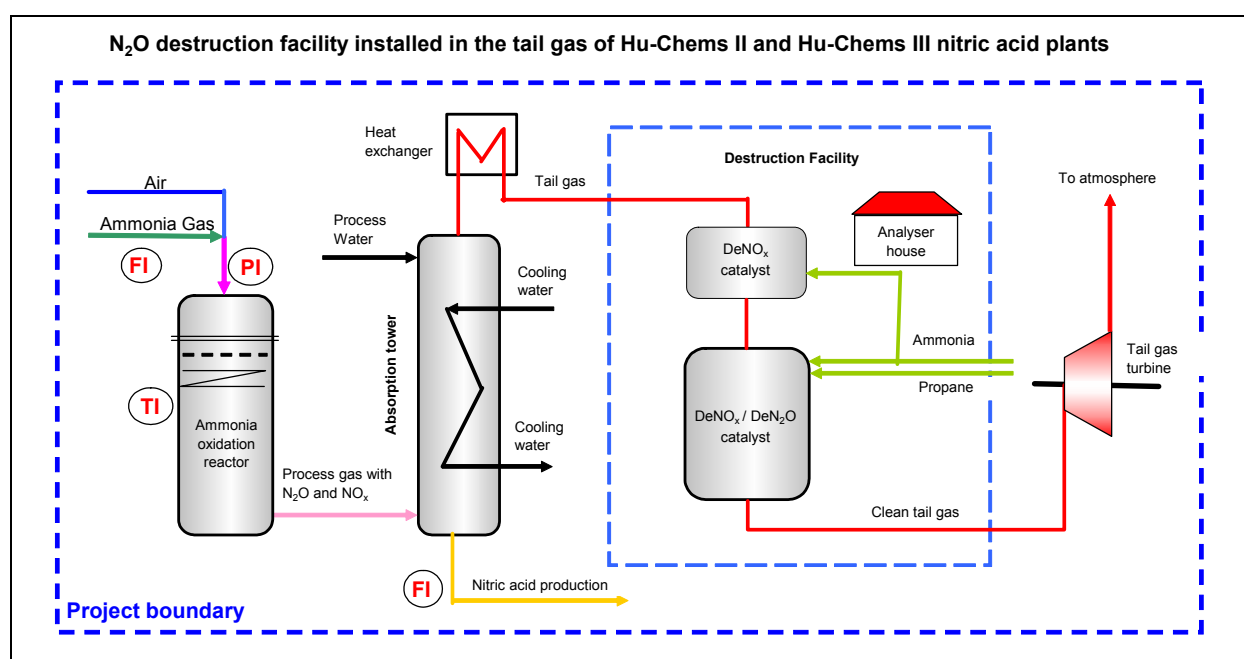
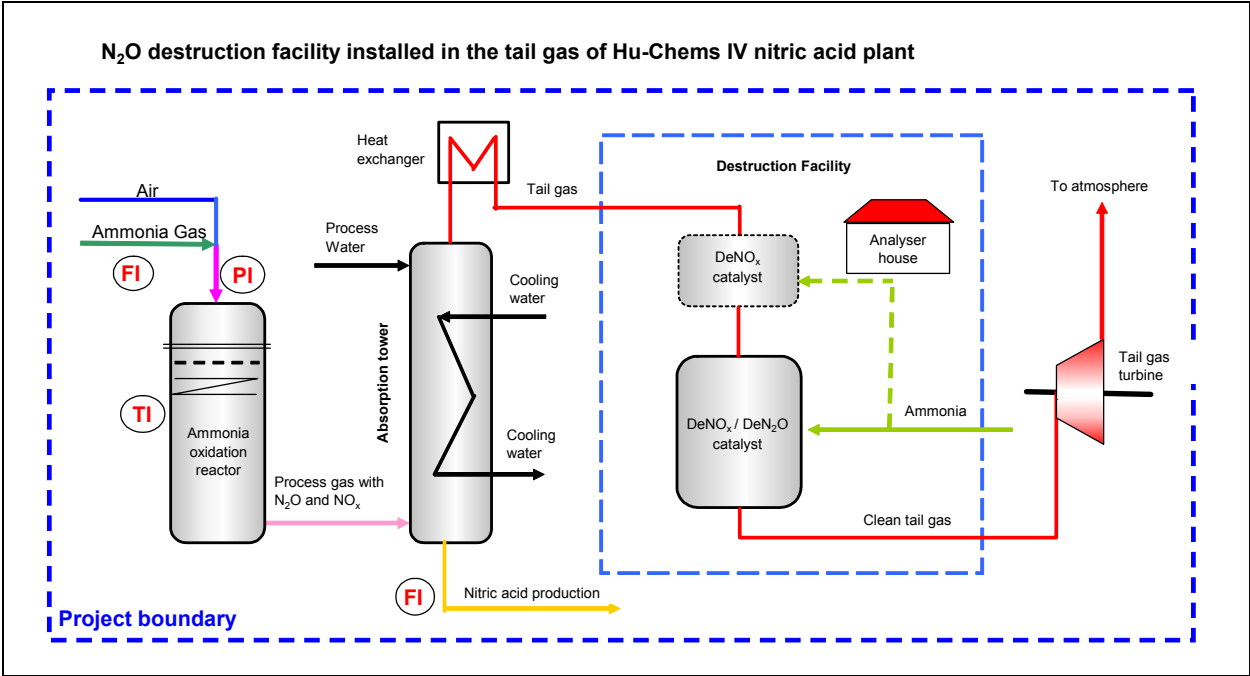


Figure 2: Project boundary Hu-Chems IV



5 Monitoring Methodology and Plan

The approved Monitoring Methodology AM0028 Version 1 “Catalytic N₂O 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 N₂O emissions either by catalytic decomposition or catalytic reduction of N₂O in the tail gas of nitric acid plants (i.e. tertiary destruction) This approved Monitoring Methodology was valid from March 3rd 2006 to October 5th 2006 (request for registration until November 30th 2006). The present project activity submitted the registration request form on November 16th 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 N₂O 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_x emission reductions that are at least as effective as the existing DeNO_x-unit.
- The DeNO_x-units installed at Hu-Chems II, III and IV nitric acid plants were SCR DeNO_x-units.
- The N₂O concentrations are measured in real time at the inlet and the outlet of the N₂O 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 N₂O 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.

Overall:

ID number	Data Variable	Source of data	Data unit	Recording frequency
P1	PE_y Project emissions	Monitoring system	tCO ₂ e	Annual
P2	PE_ND,y Project emissions from N ₂ O not destroyed	Monitoring system	tCO ₂ e	Annual
P3	PE_DF,y Project emissions from destruction facility	Monitoring system	tCO ₂ 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 ₂ e	Annual
P5	PE_ND,y,II Project emissions from N ₂ O not destroyed	Monitoring system	tCO ₂ e	Annual
P6	PE_DF,y,II Project emissions from destruction facility	Monitoring system	tCO ₂ e	Annual

P7	PE_N2O,y,II N ₂ O not destroyed by facility	Monitoring system	tN ₂ O	Daily
P8	F_TG,I,II Volume flow tail gas at N ₂ O destruction facility	Flow meter	m ³ /h	Daily
P9	CO_N2O,i,II N ₂ O concentration at destruction facility outlet	Monitoring system, measuring device	tN ₂ O/ Nm ³	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 ₂ e	Annual
P12	HCE_C,y,II Converted hydrocarbon emissions	Monitoring system	tCO ₂ e	Annual
P13	Q_HC,y,II Hydrocarbon input (reducing agent)	Measuring device	m ³	Daily
P14	ρ_HC,II Hydrocarbon density	Certificate hydrocarbon supplier or default value	t/m ³	Yearly
P15	EF_HC,II Hydrocarbon CO ₂ emission factor	IPCC	tCO ₂ /t	Once
P16	OXID_HC,II Hydrocarbon oxidation factor	Measuring device	%	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 ₂ e	Annual
P19	PE_ND,y,III Project emissions from N ₂ O not destroyed	Monitoring system	tCO ₂ e	Annual
P20	PE_DF,y,III Project emissions from destruction facility	Monitoring system	tCO ₂ e	Annual
P21	PE_N2O,y,III N ₂ O not destroyed by facility	Monitoring system	tN ₂ O	Daily
P22	F_TG,I,III Volume flow tail gas at N ₂ O destruction facility	Flow meter	m ³ /h	Daily
P23	CO_N2O,i,III N ₂ O concentration at destruction facility outlet	Monitoring system, measuring device	tN ₂ O/ Nm ³	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 ₂ e	Annual
P26	HCE_C,y,III Converted hydrocarbon emissions	Monitoring system	tCO ₂ e	Annual
P27	Q_HC,y,III Hydrocarbon input (reducing agent)	Measuring device	m ³	Daily
P28	ρ_HC,III Hydrocarbon density	Certificate hydrocarbon supplier or default value	t/m ³	Yearly
P29	EF_HC,III Hydrocarbon CO ₂ emission factor	IPCC	tCO ₂ /t	Once
P30	OXID_HC,III Hydrocarbon oxidation factor	Measuring device	%	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 ₂ e	Annual

P33	PE_ND,y,IV Project emissions from N ₂ O not destroyed	Monitoring system	tCO ₂ e	Annual
P34	PE_DF,y,IV Project emissions from destruction facility	Monitoring system	tCO ₂ e	Annual
P35	PE_N2O,y,IV N ₂ O not destroyed by facility	Monitoring system	tN ₂ O	Daily
P36	F_TG,I,IV Volume flow tail gas at N ₂ O destruction facility	Flow meter	m ³ /h	Daily
P37	CO_N2O,i,IV N ₂ O concentration at destruction facility outlet	Monitoring system, measuring device	tN ₂ O/ Nm ³	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 ₃ ,y,II Plant output of HNO ₃	Production reports	tHNO ₃	Daily

B2	QI_N2O,y,II Quantity of N ₂ O at inlet of destruction facility		tN ₂ O	Daily
B3	CI_N2O,I,II N ₂ O concentration at N ₂ O destruction facility inlet	Monitoring system, measuring device	tN ₂ O/Nm ³	Daily
B4	QR_N2O,y Regulation I: annual quantity N ₂ O limited	National legislation	tN ₂ O	Date of regulation
B5	RSE_N2O,y Regulation II: N ₂ O emissions per unit of nitric acid	National legislation	tN ₂ O/t HNO ₃	Date of regulation
B6	CR_N2O Regulation III: N ₂ O concentration in tail gas limited	National legislation	tN ₂ O/m ³	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 _x emissions	National regulations, Ministry of Environment	tNO _x /m ³	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 ₂ O emission rate per ton of nitric acid	Monitoring reports	tN ₂ O/t HNO ₃	Yearly
B18	A_OR,hist,II Max. historical ammonia flow rate to the ammonia oxidation reactor	Production reports / manufacturer's specifications / literature	tNH ₃ /day	Once
B19	A_OR,d,II Actual ammonia flow rate to the ammonia oxidation reactor	Measuring device	tNH ₃ /day	Continuous

Hu-Chems III:

ID number	Data Variable	Source of data	Data unit	Recording frequency
B20	P_HNO ₃ ,y,III Plant output of HNO ₃	Production reports	tHNO ₃	Daily
B21	QI_N ₂ O,y,III Quantity of N ₂ O at inlet of destruction facility		tN ₂ O	Daily
B22	CI_N ₂ O,I,III N ₂ O concentration at N ₂ O destruction facility inlet	Monitoring system, measuring device	tN ₂ O/Nm ³	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 ₂ O emission rate per ton of nitric acid	Monitoring reports	tN ₂ O/t HNO ₃	Yearly
B32	A_OR,hist,III Max. historical ammonia flow rate to the ammonia oxidation reactor	Production reports / manufacturer's specifications / literature	tNH ₃ /day	Once
B33	A_OR,d,III Actual ammonia flow rate to the ammonia oxidation reactor	Measuring device	tNH ₃ /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 ₃	Production reports	tHNO ₃	Daily
B35	QI_N2O,y,IV Quantity of N ₂ O at inlet of destruction facility		tN ₂ O	Daily
B36	CI_N2O,I,IV N ₂ O concentration at N ₂ O destruction facility inlet	Monitoring system, measuring device	tN ₂ O/Nm ³	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 ₂ O emission rate per ton of nitric acid	Monitoring reports	tN ₂ O/t HNO ₃	Yearly

B47	A_OR,hist,IV Max. historical ammonia flow rate to the ammonia oxidation reactor	Production reports / manufacturer's specifications / literature	tNH ₃ /day	Once
B48	A_OR,d,IV Actual ammonia flow rate to the ammonia oxidation reactor	Measuring device	tNH ₃ /day	Continuous

6 Quality Control (QC) and Quality Assurance (QA)

6.1 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 9002 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).

Carbon CDM Korea is responsible for reporting of data under the CDM Project.

6.2 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 9002 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.

6.3 Calibration and maintenance

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

The maintenance methods and procedures have been incorporated as part of the ISO 9001 procedures, and form an integral part of the systems and procedures of HU-CHEMS.

6.4 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_x emissions are measured at the outlet of the EnviNOx® systems. The continuous measurement of the NO_x concentration reports the following concentrations:

- Hu-Chems II: 14 ppm
- Hu-Chems III: 9 ppm
- Hu-Chems IV: 25 ppm

7 GHG Calculation

In terms of the Approved Methodology (AM0028 / Version 1), the emission reduction (ER_y) by the project activity during a given period y is the difference between the baseline emissions (BE_y), project emissions (PE_y) and leakage emissions (LE_y), as follows:

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

where:

ER _y	emissions reductions of the project activity during the year y (tCO ₂ e)
BE _y	baseline emissions during the year y (tCO ₂ e)
PE _y	project emissions during the year y (tCO ₂ e)
LE _y	leakage emissions in year y (tCO ₂ e)

Project Emissions:

The emissions due to the project activity are composed of (a) the emissions of not destroyed N₂O and (b) emissions from auxiliary hydrocarbons input resulting from the operation of the EnviNOx® systems at Hu-Chems II and III.

N₂O emissions not destroyed by the project activity are calculated based on the continuous measurement of the N₂O 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 N₂O destruction facility are given by on-site emissions due to the hydrocarbons used as input to the EnviNOx® systems (Hu-Chems II and III).

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

e.g.

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

where:

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

PE_DF,y,III Project emissions related to the operation of the destruction facility in year y Hu-Chems
III (tCO₂e)

PE_DF,y,IV Project emissions related to the operation of the destruction facility in year y Hu-Chems
IV (tCO₂e)

$$\begin{aligned}
 PE_{y,II} &= PE_{ND,y,II} + PE_{DF,y,II} = \\
 &= PE_{N_2O,y,II} \times GWP_{N_2O} + PE_{HC,y,II} = \\
 &= \sum_i^n F_{TG,i,II} \times CO_{N_2O,i,II} \times M_{i,II} \times GWP_{N_2O} + HCE_{C,y,II} = \\
 &= \sum_i^n F_{TG,i,II} \times CO_{N_2O,i,II} \times M_{i,II} \times GWP_{N_2O} + \rho_{HC,II} \times \\
 &\quad Q_{HC,y,II} \times EF_{HC,II} \times OXID_{HC,II}/100 = \\
 &= \mathbf{457 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 PE_{y,III} &= PE_{ND,y,III} + PE_{DF,y,III} = \\
 &= PE_{N_2O,y,III} \times GWP_{N_2O} + PE_{HC,y,III} = \\
 &= \sum_i^n F_{TG,i,III} \times CO_{N_2O,i,III} \times M_{i,III} \times GWP_{N_2O} + HCE_{C,y,III} = \\
 &= \sum_i^n F_{TG,i,III} \times CO_{N_2O,i,III} \times M_{i,III} \times GWP_{N_2O} + \rho_{HC,III} \times \\
 &\quad Q_{HC,y,III} \times EF_{HC,III} \times OXID_{HC,III}/100 = \\
 &= \mathbf{411 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 PE_{y,IV} &= PE_{ND,y,IV} + PE_{DF,y,IV} = \\
 &= PE_{N_2O,y,IV} \times GWP_{N_2O} + PE_{HC,y,IV} = \\
 &= \sum_i^n F_{TG,i,IV} \times CO_{N_2O,i,IV} \times M_{i,IV} \times GWP_{N_2O} + HCE_{C,y,IV} = \\
 &= \sum_i^n F_{TG,i,IV} \times CO_{N_2O,i,IV} \times M_{i,IV} \times GWP_{N_2O} + \rho_{HC,IV} \times \\
 &\quad Q_{HC,y,IV} \times EF_{HC,IV} \times OXID_{HC,IV}/100 = \\
 &= \mathbf{2,843 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 PE_y &= PE_{y,II} + PE_{y,III} + PE_{y,IV} \\
 &= \mathbf{3,711 \text{ tCO}_2\text{e}}
 \end{aligned}$$

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 regulation in place that would limit the quantity of N₂O 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 N₂O emitted in the baseline scenario, taking national regulations, production levels and operating conditions into consideration. The quantity of N₂O is determined based on the measurements of the N₂O at the inlet of the EnviNOx[®]-Systems, which results in a conservative estimation of baseline emissions.

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

e.g.

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

where:

BE _y	Baseline emissions in year y (tCO ₂ e)
BE _{y,II}	Baseline emissions Hu-Chems II in year y (tCO ₂ e)
BE _{y,III}	Baseline emissions Hu-Chems III in year y (tCO ₂ e)
BE _{y,IV}	Baseline emissions Hu-Chems IV in year y (tCO ₂ e)
BE _{N₂O,y}	Baseline emissions of N ₂ O in year y (tN ₂ O)
GWP _{N₂O}	Global warming potential of N ₂ O = 310
BE _{N₂O,II}	Baseline emissions of N ₂ O in year y at Hu-Chems II (tN ₂ O)
BE _{N₂O,III}	Baseline emissions of N ₂ O in year y at Hu-Chems III (tN ₂ O)
BE _{N₂O,IV}	Baseline emissions of N ₂ O in year y at Hu-Chems IV (tN ₂ O)

$$\begin{aligned}
 BE_{y,II} &= BE_{N_2O,y,II} \times GWP_{N_2O} \\
 &= \sum_i^n F_{TG,i,II} \times CI_{N_2O,i,II} \times M_{i,II} \times GWP_{N_2O} = \\
 &= \mathbf{5,979 \text{ tCO}_2\text{e}}
 \end{aligned}$$

$$\begin{aligned}
 BE_{y,III} &= BE_{N_2O,y,III} \times GWP_{N_2O} \\
 &= \sum_i^n F_{TG,i,III} \times CI_{N_2O,i,III} \times M_{i,III} \times GWP_{N_2O} = \\
 &= \mathbf{2,779tCO_2e}
 \end{aligned}$$

$$\begin{aligned}
 BE_{y,IV} &= BE_{N_2O,y,IV} \times GWP_{N_2O} \\
 &= \sum_i^n F_{TG,i,IV} \times CI_{N_2O,i,IV} \times M_{i,IV} \times GWP_{N_2O} = \\
 &= \mathbf{169,913tCO_2e}
 \end{aligned}$$

$$\begin{aligned}
 BE_y &= BE_{y,II} + BE_{y,III} + BE_{y,IV} = \\
 &= \mathbf{178,670tCO_2e}
 \end{aligned}$$

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 productions 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 first monitoring period is therefore:

$$\begin{aligned}
 ER_y &= BE_y - PE_y - LE_y \\
 &= \mathbf{174,959 \text{ tCO}_2e}
 \end{aligned} \quad . \quad (32)$$

The above emission reductions cover the monitoring period from January 22nd 2007 to March 31st 2007.

8 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 N₂O generation, thereby increasing the CERs, actual operating conditions have been checked against the baseline requirements. In case of downtime or malfunctions of the measuring instruments or Delta V system, calculations are based on statistical methods.

Operating temperature:

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

Operating pressure:

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

Composition of the ammonia oxidation catalyst:

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

Ammonia flow rate to the ammonia oxidation reactor:

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

Annex 1

Data and parameter monitored Hu-Chems:

Data and parameters monitored:	
Data / Parameter:	PE_y
Data unit:	tCO ₂ 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: 22 nd January 2007 to 31 st March 2007	3,711 tCO₂e

Data / Parameter:	PE_ND,y
Data unit:	tCO ₂ e
Description:	Project emissions from N ₂ O not destroyed
Source of data to be used:	Monitoring system
Description of measurement methods and procedures to be applied:	Calculation
Value monitoring period: 22 nd January 2007 to 31 st March 2007	3,695 tCO₂e

Data / Parameter:	PE_DF,y
Data unit:	tCO ₂ e
Description:	Project emissions from destruction facility
Source of data to be used:	Monitoring system
Description of measurement methods	Calculation

and procedures to be applied:	
Value monitoring period: 22 nd January 2007 to 31 st March 2007	16 tCO₂e

Data / Parameter:	BE_y
Data unit:	tCO ₂ e
Description:	Baseline emissions in year y
Source of data to be used:	
Description of measurement methods and procedures to be applied:	
Value monitoring period: 22 nd January 2007 to 31 st March 2007	178,670 tCO₂e

Data and parameter monitored Hu-Chems II:

Data and parameters monitored:	
Data / Parameter:	F_TG,II
Data unit:	Nm ³ /h
Description:	Volume flow tail gas at N ₂ 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: 22 nd January 2007 to 31 st March 2007	4,913,405 Nm³
Data / Parameter:	CO_N2O,II

Data unit:	tN ₂ O/ Nm ³
Description:	N ₂ O concentration at destruction facility outlet Hu-Chems II
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Description of measurement methods and procedures to be applied:	In the effluent of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O) is analysed continuously. Analysis is done by using non-dispersive infrared photometry for N ₂ O.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	2.93E-07 tN₂O/Nm³

Data / Parameter:	P_HNO3,II
Data unit:	tHNO ₃
Description:	Plant output of HNO ₃ 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 will be recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	1,556 tHNO₃

Data / Parameter:	SE_N2O,II
Data unit:	tN ₂ O/tHNO ₃
Description:	N ₂ 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 ₂ 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: 22 nd January 2007 to 31 st March 2007	0.0124 tN₂O/tHNO₃

Data / Parameter:	CI_N2O,II
Data unit:	tN ₂ O/ Nm ³
Description:	N ₂ O concentration at destruction facility inlet Hu-Chems II
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Description of measurement methods and procedures to be applied:	In the feed of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O), is analysed continuously. Analysis is done by using non-dispersive infrared photometry in a combined analyser device.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	3.93E-06 tN₂O/Nm³

Data / Parameter:	T_g, II
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.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	893.68 °C

Data / Parameter:	P_g, II
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: 22 nd January 2007 to 31 st March 2007	8.84 barg

Data / Parameter:	G_sup, II
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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: 22 nd January 2007 to 31 st March 2007	Johnson Matthey

Data / Parameter:	G_{com,II}
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:	Certificate catalyst supplier
Value monitoring period: 22 nd January 2007 to 31 st March 2007	90% Pt 5% Rh 5% Pd

Data / Parameter:	A_{OR,d,II}
Data unit:	tNH ₃ /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: 22 nd January 2007 to 31 st March 2007	460 tNH₃

Data / Parameter:	Q_{HC,II}
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Data unit:	Nm ³
Description:	Hydrocarbon input (natural gas as reducing agent) Hu-Chems II
Source of data to be used:	Flow meter
Description of measurement methods and procedures to be applied:	The natural gas used as reducing agent is measured by standard flow meters. Flow is converted to standard conditions based on temperature and pressure measurement.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	1,823 Nm³

Data / Parameter:	$\rho_{\text{HC, II}}$
Data unit:	t/m ³
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: 22 nd January 2007 to 31 st March 2007	1.98E-03 t/Nm³ Standard Normal Conditions: 1,013.25 hPa, 273.15K

Data / Parameter:	$\text{EF}_{\text{HC, II}}$
Data unit:	tCO ₂ e/t
Description:	Hydrocarbon CO ₂ 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 ₂ emission factor is given by the molecular weights and the chemical reaction when hydrocarbons are converted.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	3.0 tCO₂e/t

Data / Parameter:	HCE_C, II
Data unit:	tCO ₂ 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: 22 nd January 2007 to 31 st March 2007	10.8 tCO₂e

Data / Parameter:	HCE_NC,II
Data unit:	tCO ₂ e
Description:	Non converted hydrocarbon emissions Hu-Chems II
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	In order to apply a conservative baseline approach the fraction of unconverted hydrocarbons is zero.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	0 tCO₂e

Data / Parameter:	M_i,II
Data unit:	h
Description:	Measuring Interval
Source of data to be used:	Delta V System, Monitoring System
Description of measurement methods and procedures to be applied:	Analysers automatically take readings every 10 seconds. Based on raw data average hourly values are calculated and reported.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	10 sec

Data / Parameter:	Type_HC,II
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: 22 nd January 2007 to 31 st March 2007	Propane

Data / Parameter:	QR_N2O,y RSE_N2O,y CR_N2O
Data unit:	tN ₂ O tN ₂ O/t HNO ₃ tN ₂ O/m ³
Description:	National regulation on N ₂ O emissions
Source of data used:	Regional authorities
Description of measurement methods and procedures to be applied:	Actual no regulations on N ₂ O emissions are in place.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	Not applicable

Data and parameter monitored Hu-Chems III:

Data and parameters monitored:	
Data / Parameter:	F_TG,III
Data unit:	Nm ³ /h
Description:	Volume flow tail gas at N ₂ 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: 22 nd January 2007 to 31 st March 2007	2,239,402 Nm³

Data / Parameter:	CO_N2O,III
Data unit:	tN ₂ O/ Nm ³
Description:	N ₂ O concentration at destruction facility outlet Hu-Chems III
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Description of measurement methods and procedures to be applied:	In the effluent of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O) is analysed continuously. Analysis is done by using non-dispersive infrared photometry for N ₂ O.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	5.84E-07 tN₂O/Nm³

Data / Parameter:	P_HNO3,III
Data unit:	tHNO ₃
Description:	Plant output of HNO ₃ 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 measured according to the installed instruments. The instrument signals will be recorded in control rooms and used to determine whether the nitric acid production is within the historical designed

applied:	capacity.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	645 tHNO₃

Data / Parameter:	SE_N2O,III
Data unit:	tN ₂ O/tHNO ₃
Description:	N ₂ 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 ₂ 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: 22 nd January 2007 to 31 st March 2007	0.0139 tN₂O/tHNO₃

Data / Parameter:	CI N2O,III
Data unit:	tN ₂ O/ Nm ³
Description:	N ₂ O concentration at destruction facility inlet Hu-Chems III
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Description of measurement methods and procedures to be applied:	In the feed of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O), is analysed continuously. Analysis is done by using non-dispersive infrared photometry in a combined analyser device.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	4.00E-06 tN₂O/Nm³

Data / Parameter:	T_g, III
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.

applied:	
Value monitoring period: 22 nd January 2007 to 31 st March 2007	900.1 °C

Data / Parameter:	P_{g, III}
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: 22 nd January 2007 to 31 st March 2007	9.0 barg

Data / Parameter:	G_{sup, III}
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 and procedures to be applied:	Commercial Invoice
Value monitoring period: 22 nd January 2007 to 31 st March 2007	Johnson Matthey

Data / Parameter:	G_{com, III}
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: 22 nd January 2007 to 31 st March 2007	90% Pt 5% Rh 5% Pd
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Data / Parameter:	A_OR,d,III
Data unit:	tNH ₃ /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: 22 nd January 2007 to 31 st March 2007	201 tNH₃

Data / Parameter:	Q_HC,III
Data unit:	Nm ³
Description:	Hydrocarbon input (natural gas as reducing agent) Hu-Chems III
Source of data to be used:	Flow meter
Description of measurement methods and procedures to be applied:	The natural gas used as reducing agent is measured by standard flow meters. Flow is converted to standard conditions based on temperature and pressure measurement.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	855 Nm³

Data / Parameter:	$\rho_{\text{HC, III}}$
Data unit:	t/m ³
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: 22 nd January 2007 to 31 st March 2007	1.98E-03 t/Nm³ Standard Normal Conditions: 1,013.25 hPa, 273.15K

Data / Parameter:	EF_HC,III
Data unit:	tCO ₂ e/t
Description:	Hydrocarbon CO ₂ 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 ₂ emission factor is given by the molecular weights and the chemical reaction when hydrocarbons are converted.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	3.0 tCO₂e/t

Data / Parameter:	HCE_C, III
Data unit:	tCO ₂ 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: 22 nd January 2007 to	5.1 tCO₂e

31 st March 2007	
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Data / Parameter:	HCE_NC,III
Data unit:	tCO ₂ e
Description:	Non converted hydrocarbon emissions Hu-Chems III
Source of data to be used:	Monitoring System
Description of measurement methods and procedures to be applied:	In order to apply a conservative baseline approach the fraction of unconverted hydrocarbons is zero.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	0 tCO₂e

Data / Parameter:	M_i,III
Data unit:	h
Description:	Measuring Interval
Source of data to be used:	Delta V System, Monitoring System
Description of measurement methods and procedures to be applied:	Analysers automatically take readings every 10 seconds. Based on raw data average hourly values are calculated and reported.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	10 sec

Data / Parameter:	Type_HC,III
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:	Propane

22 nd January 2007 to 31 st March 2007	
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Data / Parameter:	QR_N2O,y RSE_N2O,y CR_N2O
Data unit:	tN ₂ O tN ₂ O/t HNO ₃ tN ₂ O/m ³
Description:	National regulation on N ₂ O emissions
Source of data used:	Regional authorities
Description of measurement methods and procedures to be applied:	Actual no regulations on N ₂ O emissions are in place.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	Not applicable

Data and parameter monitored Hu-Chems IV:

Data and parameters monitored:	
Data / Parameter:	F_TG,IV
Data unit:	Nm ³ /h
Description:	Volume flow tail gas at N ₂ 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: 22 nd January 2007 to 31 st March 2007	259,882,599 Nm³

Data / Parameter:	CO_N2O,IV
Data unit:	tN ₂ O/ Nm ³
Description:	N ₂ O concentration at destruction facility outlet Hu-Chems IV
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Description of measurement methods and procedures to be applied:	In the effluent of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O) is analysed continuously. Analysis is done by using non-dispersive infrared photometry for N ₂ O.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	3.53E-08 tN₂O/Nm³

Data / Parameter:	P_HNO3,IV
Data unit:	tHNO ₃
Description:	Plant output of HNO ₃ 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 will be recorded in control rooms and used to determine whether the nitric acid production is within the historical designed capacity.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	81,660 tHNO₃

Data / Parameter:	SE_N2O,IV
Data unit:	tN ₂ O/tHNO ₃
Description:	N ₂ 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 ₂ 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: 22 nd January 2007 to 31 st March 2007	0.0067 tN₂O/tHNO₃

Data / Parameter:	CI N₂O,IV
Data unit:	tN ₂ O/ Nm ³
Description:	N ₂ O concentration at destruction facility inlet Hu-Chems IV
Source of data to be used:	Non-dispersive infrared photometry for N ₂ O
Description of measurement methods and procedures to be applied:	In the feed of the EnviNOx®- system, the concentrations of nitrous oxide (N ₂ O), is analysed continuously. Analysis is done by using non-dispersive infrared photometry in a combined analyser device.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	2.11E-06 tN₂O/Nm³

Data / Parameter:	T_g, IV
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: 22 nd January 2007 to 31 st March 2007	896.6 °C

Data / Parameter:	P_g, IV
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: 22 nd January 2007 to 31 st March 2007	3.5 barg

Data / Parameter:	G_{sup, IV}
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: 22 nd January 2007 to 31 st March 2007	Johnson Matthey

Data / Parameter:	G_{com, IV}
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: 22 nd January 2007 to 31 st March 2007	95% Pt 5% Rh 92% Pt 8% Rh

Data / Parameter:	A_{OR,d, IV}
Data unit:	tNH ₃ /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: 22 nd January 2007 to	23,108 tNH₃

31 st March 2007	
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Data / Parameter:	M_{i,IV}
Data unit:	h
Description:	Measuring Interval
Source of data to be used:	Delta V System, Monitoring System
Description of measurement methods and procedures to be applied:	Analysers automatically take readings every 10 seconds. Based on raw data average hourly values are calculated and reported.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	10 sec

Data / Parameter:	QR_{N2O,y} RSE_{N2O,y} CR_{N2O}
Data unit:	tN ₂ O tN ₂ O/t HNO ₃ tN ₂ O/m ³
Description:	National regulation on N ₂ O emissions
Source of data used:	Regional authorities
Description of measurement methods and procedures to be applied:	Actual no regulations on N ₂ O emissions are in place.
Value monitoring period: 22 nd January 2007 to 31 st March 2007	Not applicable