



**Monitoring report form**  
**(Version 05.0)**

*Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.*

**MONITORING REPORT**

<b>Title of the project activity</b>	Catalytic N <sub>2</sub> O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.	
<b>UNFCCC reference number of the project activity</b>	0765	
<b>Version number of the monitoring report</b>	Version 1	
<b>Completion date of the monitoring report</b>	10/04/2015	
<b>Monitoring period number and duration of this monitoring period</b>	Monitoring period number: 27 (Monitoring period 1 in the 2 <sup>nd</sup> crediting period) Duration: 22/01/2014 – 11/06/2014 (141 days)	
<b>Project participant(s)</b>	CARBON CDM Korea Ltd. Hu-Chems Fine Chemical Corp. RWE Power AG Carbon Climate Protection GmbH	
<b>Host Party</b>	Republic of Korea	
<b>Sectoral scope(s)</b>	Sectoral scope 5: Chemical industries	
<b>Selected methodology(ies)</b>	ACM0019 Version 02.0 (N <sub>2</sub> O abatement from nitric acid production)	
<b>Selected standardized baseline(s)</b>	No standardized baseline(s) applicable	
<b>Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD</b>	Amount estimated in PDD for 2014: 1,172,010 tCO <sub>2</sub> e → Corresponding estimated amount for the duration of the monitoring period (141 days): 480,388 tCO <sub>2</sub> e	
<b>Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period</b>	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	Not applicable (Start of this monitoring period is after 31 December 2012)	205,728 tCO <sub>2</sub> e

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

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- a) The project participants have 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. 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.
- b) In this project, 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 were installed. The project activity reduces the GHG emissions, which would otherwise be released to the atmosphere, if the project was not implemented.  
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 LPG 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.  
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 and do not involve hydrocarbons.
- c) 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.
- d) Throughout the 1<sup>st</sup> crediting period of the CDM Project Activity had been implemented as well as operated & monitored continuously according to the approved CDM methodology AM0028 (Version 1). A Request for Renewal of Crediting Period with a new PDD under the methodology ACM0019 (Version 2) was submitted by the Project Participants and the crediting period was renewed on February 5<sup>th</sup> 2014.
- e) Total emission reductions achieved in this monitoring period: **205,728 tCO<sub>2</sub>e**

### A.2. Location of project activity

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Country (Host): Republic of Korea // Province: Jeollanam-do // Town: Yeosu, 7-6, Wollae-dong  
Unique geographic coordinates: Longitude: 127.743198 E // Latitude: 34.848686 N



Address : Zip code : 595-380 7-6 Wollae-dong, Yeosu City, Jeollanam-do  
Phone : 62-41-666-4500  
FAX : 62-41-666-4539



**A.3. Parties and project participant(s)**

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Republic of Korea (Host)	CARBON CDM Korea Ltd.  Hu-Chems Fine Chemical Corp.	No
Federal Republic Germany	RWE Power AG	No
Austria	Carbon Climate Protection GmbH	No

**Carbon CDM Korea Ltd.** is registered under the laws of the Republic of Korea. **CARBON Climate Protection GmbH** is registered under the laws of Austria. Both companies, jointly referred to as CARBON, are subsidiaries of CARBON Projektentwicklung GmbH, Austria, and RWE Power AG, Germany. 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. It has initially developed the methodology for destruction of N<sub>2</sub>O in the tail gas of nitric acid plants (AM0028) and has implemented such projects in Egypt, the Republic of Korea and the Republic of Chile. Furthermore, it has contributed to the consolidated methodology for N<sub>2</sub>O abatement in from nitric acid production (ACM0019).

**Hu-Chems Fine Chemical Corp.** (furthermore called "Hu-Chems"), an entity registered under the laws of the Republic of Korea. Hu-Chems was established by separating from Nam-Hae chemical corporation in 2002 and is listed on the Korean Stock Exchange, KOSPI200, item code 069260, since September 17, 2002. Hu-Chems operates several production units which produce fine chemical products in it industrial complex in Yeosu whereas the company's headquarter is in Seoul. Hu-Chems is active in major business areas, which are fine chemical products (Nitric acid, Dinitrotoluene, Mononitrobenzene, Ammonium nitrate, etc.). The products are provided to major-chemical companies in the Republic of Korea as well as to world-wide major chemical companies like BASF and Rhodia on long term off-take contract basis.

Hu-Chems is ISO 9002 and ISO 14001 certified and received the Korean safety and health management system certificate (KGS18001 & OHSHAS18001). The company has received the Grand Prize of Korea Valuable Management Award in 2005, the President of Korea's medal in Energy Saving Promote Contest as well as the Korean Marketing Best Award (KMAC) in 2004, as well as other awards.

The project activity has been implemented in the nitric acid plants Hu-Chems II, Hu-Chems III and Hu-Chems IV, along with the CDM monitoring equipment it has been included in the established quality management system.

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.

**Host Country is the Republic of Korea.** The Republic of Korea ratified the Kyoto Protocol in November 2002.

**A.4. Reference of applied methodology and standardized baseline**

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Applied methodology: ACM0019 "N<sub>2</sub>O abatement from nitric acid production" (Version 02.0)<sup>1</sup>

The methodology also refers to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" in its latest version, thus the tool is applied in this project activity (Version 02.0.0)<sup>2</sup>

Furthermore, the applied methodology refers to the "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion" in its latest version, thus the tool is applied in this project activity (Version 02)<sup>3</sup>

No standardized baselines are used.

**A.5. Crediting period of project activity**

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The project is currently in its second crediting period.

Type of the crediting period:	Renewable (3 x 7 years)
Starting date of the second crediting period:	22/01/2014
End date of the second crediting period:	21/01/2021
Length of the second crediting period:	7 years (renewable)

Already before the second crediting period, dates regarding the first crediting period were changed from/to:

Expected starting date of first crediting period:	From 15/12/2006 to 22/01/2007
Expected end date of first crediting period:	From 14/12/2013 to 21/01/2014

**A.6. Contact information of responsible persons/entities**

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Andreas Moser-Rammelmüller  
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Austria

Tel.: +43 2734 32 270 60

Email: [rammelmueller@carbon-austria.com](mailto:rammelmueller@carbon-austria.com)

Carbon Climate Protection GmbH is a project participant. For further information please refer to Appendix 1

<sup>1</sup> <http://cdm.unfccc.int/methodologies/DB/MNMFNF10VUEOJACEIRX3EHYC9QXGDC>

<sup>2</sup> <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/>

<sup>3</sup> <http://cdm.unfccc.int/methodologies/PAmethodologies/tools/>

## SECTION B. Implementation of project activity

### B.1. Description of implemented registered project activity

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#### (a) Information on the implementation status of the project activity

The project covers three nitric acid plants (three EnviNOx® systems, respectively). The EnviNOx® system at Hu-Chems IV was installed in December 2006, the EnviNOx® systems at Hu-Chems II and Hu-Chems III were installed in February and March 2007. The starting dates of operation of the project activity for each of the plant were as follows (first crediting period of CDM project activity):

- Hu-Chems nitric acid plant II: 26 March 2007
- Hu-Chems nitric acid plant III: 29 March 2007
- Hu-Chems nitric acid plant IV: 9 January 2007

The project has been implemented and is operated as per the registered PDD with all physical features (technology, project equipment, and monitoring and metering equipment) in place, besides the equipment for which a temporary deviation from 22 January 2014 until 11 June 2014 applies (for details please see section B.2.1 *Temporary deviation* of this document). Monitoring is done according to the applied methodology (ACM0019 v02.0) and the registered monitoring plan, unless affected by the temporary deviation.

*Specifically in the monitoring period covered by this monitoring report, it shall be considered that the nitric acid plants Hu-Chems II and Hu-Chems III and thus also their EnviNOx® Systems were permanently shut down due to nitric acid inventory control. For these two plants, no Emission Reductions are claimed during the monitoring period covered in this monitoring period.*

#### (b) Description of the installed technology, technical processes and equipment

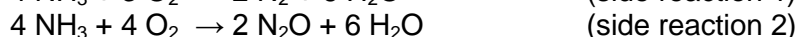
##### General Introduction

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>4</sup>:



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

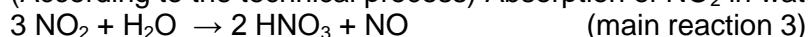


NO yield mainly depends on pressure and temperature in the ammonia oxidation process and is usually in a range of 95% to 97%.

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



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



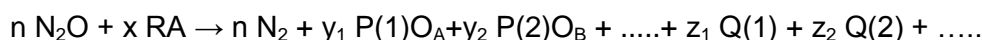

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<sup>4</sup> Ammonia is reacted with air on noble metal catalyst in the oxidation section of nitric acid plants. Nitric oxide and water are formed in this process according to the above mentioned main equation.

(NO 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:



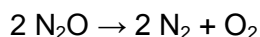
The definition does not exclude the possibility of side reactions resulting in consumption of reducing agent without any reduction of N<sub>2</sub>O, for example with propane:



#### Description of catalytic decomposition process:

Catalytic decomposition of N<sub>2</sub>O occurs when the N<sub>2</sub>O 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:

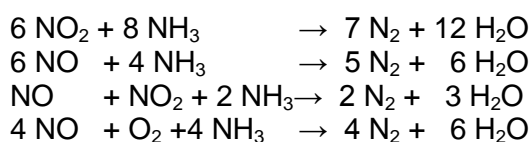


The products of N<sub>2</sub>O decomposition are the substances that result from the reaction (N<sub>2</sub> and O<sub>2</sub>).

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

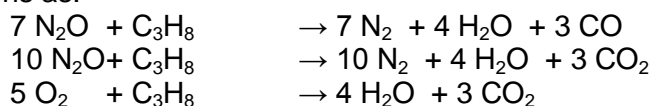
##### Principles of the EnviNOx® process in plants Hu-Chems II and Hu-Chems III:

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. First the NO<sub>x</sub> is reduced with ammonia according to such reactions as:



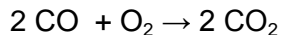
Effectively almost all the NO<sub>x</sub> is removed. Some destruction of N<sub>2</sub>O also occurs.

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





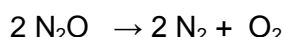
Similar reactions take place between nitrous oxide and the small quantities of other hydrocarbons such as butane ( $\text{C}_4\text{H}_{10}$ ) that are present in the commercial propane used.  $\text{N}_2\text{O}$  reduction by these reactions is much more effective when  $\text{NO}_x$  is absent. A 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:



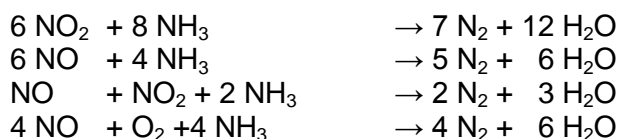
All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor. Compared with the reduction in greenhouse gas emission achieved by the destruction of  $\text{N}_2\text{O}$  the additional greenhouse gas emissions ( $\text{CO}_2$ ) caused by the use of hydrocarbons in the 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 ( $\text{N}_2\text{O}$ ) and the catalytic reduction of  $\text{NO}_x$  ( $\text{NO}$  and  $\text{NO}_2$ ) with ammonia ( $\text{NH}_3$ ). This process works well at temperatures above about  $425^\circ\text{C}$ . The reactions take place over two iron zeolite catalyst beds. In the first bed  $\text{N}_2\text{O}$  is catalytically decomposed:



This rate of this reaction is enhanced by high concentrations of  $\text{NO}_x$ . 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  $\text{NO}_x$  is reduced with ammonia according to such reactions as:



Some further destruction of  $\text{N}_2\text{O}$  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, three EnviNOx® systems for catalytic reduction and decomposition of  $\text{NO}_x$  and  $\text{N}_2\text{O}$  additionally to the equipment at the three nitric acid manufacturing plants were installed. 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  $\text{N}_2\text{O}$  destruction project at Hu-Chems II and III involves that propane is employed as a reducing agent for  $\text{N}_2\text{O}$  removal.

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

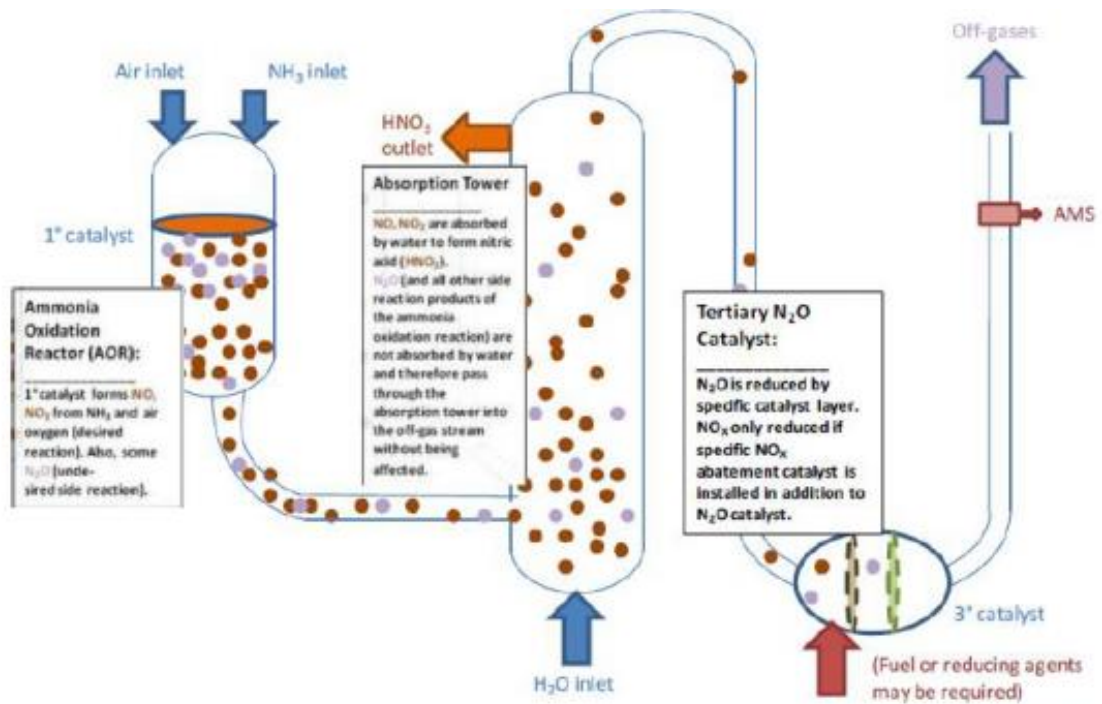
Hu-Chems II: The new EnviNOx® reactor (322-R-202) is located between the existing SCR DeNOx reactor (322-R-201) and the tail gas turbine (322-C-201-T2) which is the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems II.

Hu-Chems III: The new EnviNOx® reactor (323-R-302) is located between the existing SCR DeNOx reactor (323-R-301) and the tail gas turbine (323-C-301-T2) of Hu-Chems III which is the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems III.

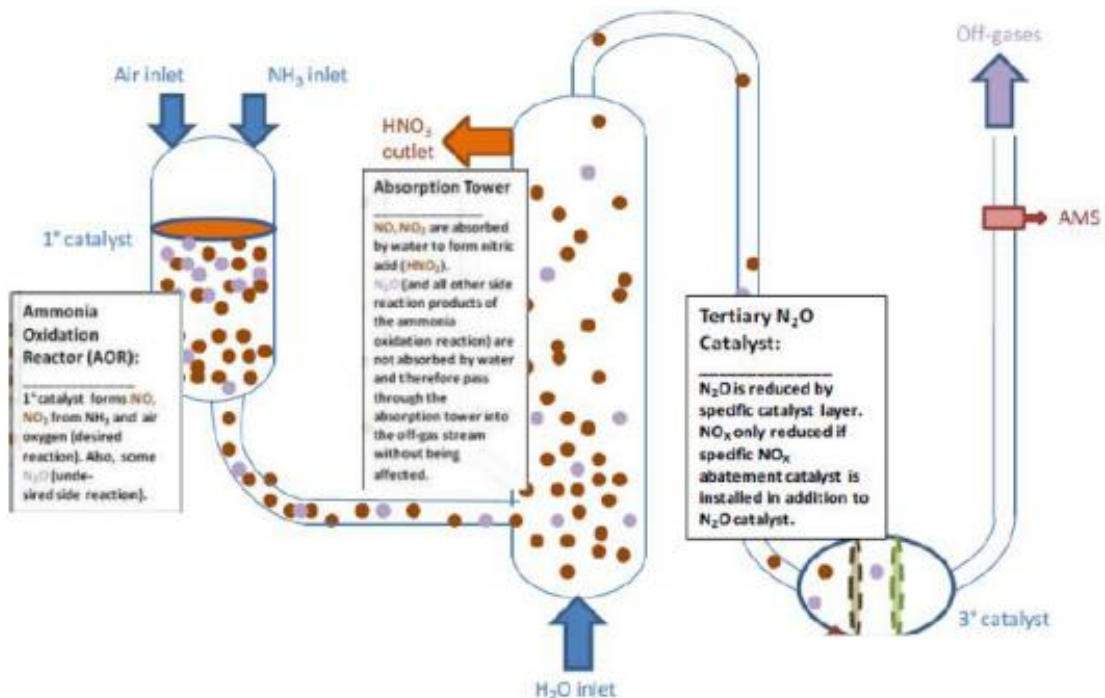
Hu-Chems IV: The new EnviNOx® reactor (324-R-402) is located upstream of the tail gas turbine (324-C-401-T2) at the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems IV. The priorly operational SCR DeNOx reactor has been de-commissioned.

The following figures show the spatial extent of the project boundary:

Project boundary Hu-Chems II and Hu-Chems III



Project boundary Hu-Chems IV





**(c) Actual operation of the Project Activity during the covered monitoring period**Downtimes of EnviNOx® Systems

During the below mentioned periods, Nitric Acid plants (and so, the EnviNOx® Systems) were out of operation due to the given reasons. No Emission Reduction is claimed during these downtimes.

Downtimes of the Nitric Acid plants &amp; EnviNOx® Systems

	Downtime - Start		Downtime - End		Downtime Reason
Plant	Date	Time	Date	Time	Description
II	Ongoing at the beginning of monitoring period		Ongoing at the end of monitoring period		Shutdown of the NA Plant (Inventory control)
	Downtime - Start		Downtime - End		Downtime Reason
Plant	Date	Time	Date	Time	Description
III	Ongoing at the beginning of monitoring period		Ongoing at the end of monitoring period		Shutdown of the NA Plant (Inventory control)
	Downtime - Start		Downtime - End		Downtime Reason
Plant	Date	Time	Date	Time	Description
IV	21/05/2014	01:00	Ongoing at the end of monitoring period		Annual general maintenance of the nitric acid plant & AOR Catalyst exchange

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 Hu-Chems II*

- No relevant observations due to permanent shutdown during the monitoring period

*EnviNOx® System at Nitric Acid Plant Hu-Chems III*

- No relevant observations due to permanent shutdown during the monitoring period

*EnviNOx® System at Nitric Acid Plant Hu-Chems IV*

- On 06/03/2014, between 10:00 and 18:00, the Korean Testing Laboratory (KTL) has performed the regular analyser certification as per Korean Standards. In the course of this procedure (which was part of a several different tests & checks that have been performed between 04/04/2014 and 11/03/2014), the N<sub>2</sub>O outlet analyser measurements (Parameter  $v_{i,t,db,IV}$ ) have been influenced.
- On 17/09/2013, between 11:00 and 15:00, engineers from Emerson Korea have performed maintenance activities (as part of regularly scheduled health check) in the analyser system. In the course of this service, the N<sub>2</sub>O outlet analyser measurements (Parameter  $v_{i,t,db,IV}$ ) have been influenced.

During the mentioned periods, the nitric acid plant IV as well as the respective EnviNOx® system were in normal operation and emission reductions have been conservatively determined as described in section C - 4 (Systematic Measures) of this Monitoring Report, fully in line with the applied methodology and the registered monitoring plan.

Calibration and Maintenance

The maintenance methods and procedures as well as the calibration scheme for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 procedures, and form an integral part of the systems and procedures of HU-CHEMS. QA/QC of monitoring equipment is in full compliance with the monitoring methodology and the monitoring plan of the registered PDD.

Details on exchange and/or calibration of instruments are mentioned under section D – 2.

All measuring and analytical instruments are being calibrated as defined in the approved Methodology ACM0019 (Version 2.0) as well as the registered monitoring plan and according to the supplier recommendations (i.e. Emerson Process Management), unless affected by the temporary deviation (for details please see section B.2.1 *Temporary deviation* of this document). As pointed out in section C – 3, Hu-Chems has mandated Emerson Process Management Korea to execute additional **regular calibration services** and **regular general maintenance services** to safeguard accuracy and availability of the monitoring instruments related to the CDM Project. Services are adapted to the annual shut-down schedule of the nitric acid plants, valid calibration records for all relevant monitoring instruments are available and submitted to the DOE for verification (Please also see details section D – 2).

As further pointed out in section C – 3, the project participants have contracted Emerson Process Management Korea to execute monthly on-site **Health Checks** and quarterly on-site **Inspection Visits**. System components, sampling system, analysers/measurement devices and the automated monitoring system required for the monitoring of the CDM project are covered by these contracts. Regular health check and inspection visit services, respectively, have been conducted by Emerson Process Management Korea in January 2014, February 2014, March 2014, April 2014, May 2014, and June 2014 and attest good condition and availability of the system (i.e. Sampling system, analyser as well as AMS hard- and software and total DeltaV DCS System).

Records of conducted maintenance activities and other performed services related to calibration and maintenance are available and submitted to the DOE for verification.

**(d) Situations with impact on the applicability of the methodology**

No such situations occurred during the covered monitoring period

**B.2. Post-registration changes****B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline**

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The following temporary deviation from monitoring plan applied for this monitoring period:

**(a) Reason for Deviation**

The present CDM Project was initially registered with renewable crediting periods (3 periods to 7 years) on 22 January 2007 under the methodology AM0028v1 and has since been operated & monitored accordingly throughout the first crediting period. That first crediting period ended on 21 January 2014 and in order to enable the direct continuation of crediting periods, the notification on the intention of renewal to the UNFCCC secretariat has been made in the respective time window prior to the expiration of the crediting period, as required in the CDM Project Cycle Procedure.

The initially following request for renewal of the crediting period under the methodology AM0028v5.1 (the latest version of the original methodology applied) has been submitted on 26 May 2013. However, after that submission date another methodology (ACM0019v2) became applicable for the project through decisions in the 73<sup>rd</sup> meeting of the CDM EB. Specifically, that methodology (ACM0019v2) has a dedicated section for projects requesting renewal of the crediting period and which were using AM0028 (among others) in the first crediting period. It consequently became unclear to the project participants which one of these methodologies is to be applied for the second crediting period. Eventually, the project participants decided to withdraw the request for renewal under the methodology AM0028v5.1 in order to re-submit it under the methodology ACM0019v2, which is the more modern and streamlined methodology for that purpose, as obvious from the CDM EB decision. The second request for renewal of the crediting period (under ACM0019v2) was finally submitted on 13 November 2013.

Due to those exceptional circumstances, the final approval of the renewal request (under ACM0019v2) was only granted by the CDM EB on 5 February 2014, i.e. some days after expiration of the first crediting period. As per the original intention of the project participants, an approval of the request for renewal of the crediting period through the CDM EB was desired to be obtained much earlier, substantiated by following facts:

- The notification on the intention of renewal of the crediting period to the UNFCCC was made at the earliest possible occasion, i.e. at the very beginning of the respective time window as per the CDM Project Cycle Procedure;
- Almost within one month after the notification, the request for renewal (under AM0028v5.1) has been submitted with the UNFCCC, a period which included a site visit to the Republic of Korea, settling of identified findings of the DOE as well as quality assurance of respective documentation and finally the compilation of respective documentation by the DOE.

Given that ambitious schedule and observing usual timeliness for such requests with the UNFCCC, a final approval of the request for renewal would have been expected in the early second half of 2013, some months prior to the expiration of the first crediting period. Contrary to that intention, as stated above, due to the lack of clarity regarding the methodology, the whole process has been extensively delayed, resulting in a final approval of the renewal request on 5 February 2014.

The project participants had to organize the technical preparations for the second crediting period in order to be consistent with all requirements of the finally applied methodology ACM0019v2. Please note that the installation of the new instruments according to ACM0019v2 requires a shutdown of the whole nitric acid production facilities. As soon as it was possible to implement the new instruments (next shut down of NA plant) all necessary technical modifications have been implemented without any further delay.

**(b) Duration of Deviation**

The implementation of the technical modifications in order to follow any and all provisions of ACM0019v2 in all three plants was performed on 12 June 2014, i.e. during the first scheduled nitric acid plant shutdown after the start of the 2<sup>nd</sup> crediting period and thus the first possible shutdown where the technical modifications to remedy the temporary deviation could be implemented.

*Consequently, the temporary deviation applies during the period **from 22 January 2014** (start date of the 2<sup>nd</sup> crediting period and thus start date of applicability of ACM0019v2 to the project activity) to **11 June 2014** (the last day before installation of the new equipment).*

**(c) Description of Deviation from Monitoring Plan**

As long as it was not possible to attune the monitoring system to the requirements of ACM0019v2 due to the reasons mentioned above, the following applied. It shall be mentioned, that due to the fact that plants Hu-Chems II and Hu-Chems III were permanently out of operation during the whole deviation period (which represents also this monitoring period) and no Emission Reductions are claimed in this period for these two plants, the temporary deviation effectively only affects plant Hu-Chems IV. As soon as Hu-Chems II and Hu-Chems III would resume operation, they will comply with all requirements as per ACM0019v2.

	Parameter as per PDD (second crediting period) and methodology ACM0019 (Version 2)	Applicable individual situation during deviation period & Alternative measures, where applicable
Data / Parameter	$V_{t,db,IV}$	No deviation (The parameter, which is equivalent to the same stream, was known as <b>F_TG,i,IV</b> under AM0028v1 in the first crediting period.)
Unit	m <sup>3</sup> dry gas/h	No deviation
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis	No deviation
Source of data	Measured	No deviation
Monitoring frequency:	Continuous monitoring	No deviation
Instrumentation	Anubar	Venturi Tube  Please note: 1) As long as it was not possible to fully attune the monitoring system to the requirements of ACM0019v2, the volumetric flow of the gaseous stream ( $V_{t,db,n}$ under ACM0019v2, which is equivalent to <b>F_TG,i</b> under AM0028v1) was measured and monitored using the tail gas flow instrumentation that was already installed during the 1 <sup>st</sup> crediting period. 2) The monitoring system was attuned as soon as possible, considering the nitric acid plant shutdown schedule, in order to fully comply with the requirement regarding the monitoring according to the European Norm 14181 (2004).
QA/QC procedures:	According to European Norm 14181.  The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated	<b>Deviation</b> During the deviation period, the provisions according to European Norm 14181 cannot be applied, due to the outstanding implementation of the physical requirements & equipments to do so.

	in the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant.	<p><b>Alternative measures</b></p> <p>The applied measurement (Venturi tube) is designed and manufactured in accordance with the standard ISO 5167-4:2003.</p> <p>The maintenance methods and procedures for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant. This QA/QC scheme has systematically and continuously been enforced during the first crediting period and is still ongoing. This means regular inspections, general maintenance and regular calibrations (valid calibration certificates are available for each instrument).</p> <p>Plausibility check of measured values is regularly done with recorded values of the redundantly installed instruments.</p> <p>These continuous efforts have been documented in the monitoring reports which were verified and credited with issuances of CERs during the first crediting period. The respective evidence is publicly available. The same quality level is kept during the deviation period.</p>
Purpose of data	Calculation of project emissions	No deviation

	Parameter as per PDD (second crediting period) and methodology ACM0019 (Version 2)	Applicable individual situation during deviation period & Alternative measures, where applicable
<b>Data / Parameter</b>	$V_{i,t,db,IV}$ Volumetric fraction of greenhouse gas i in a time interval t on a dry basis	No deviation (The parameter, which is equivalent to the same stream, was known as <b>CO<sub>2</sub>N<sub>2</sub>O<sub>i,IV</sub></b> under AM0028v1 in the first crediting period.)
Unit	m <sup>3</sup> gas i/m <sup>3</sup> dry gas	No deviation
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis	No deviation
Source of data	Measured	No deviation
Monitoring frequency:	Continuous monitoring	No deviation
Instrumentation	Non-dispersion infrared absorption analyser (NDIR)	No Deviation
QA/QC procedures:	According to European Norm 14181.	<p><b>Deviation</b></p> <p>During the deviation period, not all of the provisions according to European Norm 14181 can be applied, due to the outstanding implementation of the physical requirements to do so. However, it shall be noted that the used NDIR analyser (Emerson NGA2000) have valid QAL 1 certification in place throughout the whole deviation period.</p>

		<p><b>Alternative measures</b></p> <p>The maintenance methods and procedures for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant. This QA/QC scheme has been systematically and continuously been enforced during the first crediting period and is still ongoing. This means regular inspections and regular certifications of the analyser, as per national standards (valid certificates are available).</p> <p>Accuracy-safeguarding instructions from Emerson Process Management, the manufacturer of the equipment, related to regular self-calibration and quality of used standard gases, are followed. Zero calibration and span calibration with valid, certified standard gases are done daily (zero) and every two days (span) automatically.</p> <p>Sample line testing has been done annually by applying certified standard gas at the beginning of the sample line.</p> <p>Emerson Process Management Korea has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition. Additional extended general maintenance services by Emerson Process Management Germany have been conducted regularly.</p> <p>Plausibility check is regularly done with laboratory gas chromatography analysis.</p> <p>These continuous efforts have been documented in the monitoring reports which were verified and credited with issuances of CERs during the first crediting period. The respective evidence is publicly available. The same quality level is kept during the deviation period.</p>
Purpose of data	Calculation of project emissions	No deviation

	Parameter as per PDD (second crediting period) and methodology ACM0019 (Version 2)	Applicable individual situation during deviation period & Alternative measures, where applicable
Data / Parameter	$C_{H_2O,t,db,n,IV}$	<p><b>Deviation</b></p> <p>The parameter has not been measured, as the per definition coinciding calibration as per EN 14181 (i.e. QAL 2 reference measurement) was not performed during the monitoring period.</p> <p>This was due to the outstanding implementation of the physical requirements to do so.</p>
Unit	mg H <sub>2</sub> O/m <sup>3</sup> dry gas	
Description	Moisture content of the gaseous stream at normal conditions, in time interval t	
Source of data	Measured	

Measurement procedures (if any):	Discrete measurement procedure  The mean value among three consecutive measurements performed in the same day (at least 2 hours each) will be considered. Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream.	<b>Alternative measures</b> As also stated in the registered PDD and assessed during the validation (second crediting period) the ex-ante determination of the moisture content at the measuring point according to process parameters (plant design) shows values of 0.003 kg H <sub>2</sub> O/m <sup>3</sup> dry gas in plant Hu-Chems IV.  The alternatively determined values are significantly below the limit of 0.05 kg H <sub>2</sub> O/m <sup>3</sup> dry gas, consequently the gas is considered to be dry. Given this huge difference, it would be highly unlikely that measurements (which will be performed after the end of this monitoring period) would result in significantly different values.  This understanding has been confirmed by the moisture content measurements that were performed during 24 September 2014 (after this monitoring period), where respective measurements resulted in values of < 0.004 kg H <sub>2</sub> O/m <sup>3</sup> dry gas
Monitoring frequency:	Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream.	
QA/QC procedures:	According to the USEPA CF42 method 4	
Purpose of data	Calculation of project emissions	
Additional comment	Option A parameter for proving that the gaseous stream is dry.	

#### (d) Justification on the Conservativeness of the Approach

In fact, the temporary deviation affects exclusively parameters for the determination of the project emissions and although not having the same relevance to the overall emission reduction compared to the baseline emissions, the project emissions also form an integral part of the project monitoring and need to be monitored correctly and precisely. For the deviation period, the alternative measures taken seek to ensure a high quality as well as conservativeness and are considered reasonable and sufficient to establish trust in the obtained values of the monitoring parameters in the deviation period. This is also substantiated by the fact, that largely the same measures were clearly and conservatively applied in the first crediting period, verified and credited with issuance of CERs on many occasions.

Nevertheless, the project participants acknowledge that applicable QA/QC procedures between AM0028v1 and ACM0019v2 are different, especially considering the adoption of EN 14181 in ACM0019v2 as an integral part of the monitoring process, which basically ensures that uncertainties/inaccuracies of the monitoring equipment are duly taken into account. Corresponding to this requirement, as a further alternative measure during the deviation period, **a conservative correction factor is applied** on the determination of the project emissions. This correction factor is based on the maximum uncertainty of the monitoring equipment used, taking into account all relevant aspects, including the instruments and also standard gases used for regular analyser calibration. Consequently this chosen approach also reasonably & conservatively addresses potential uncertainties/inaccuracies of the monitoring equipment that may be present also in the case the scenario where equipment it is duly maintained & calibrated at any time.

**B.2.2. Corrections**

&gt;&gt;

No such corrections have been applied during this monitoring period, neither to any previous monitoring periods.

**B.2.3. Changes to start date of crediting period**

&gt;&gt;

No such changes have applied to this monitoring period neither to any previous monitoring periods in the second crediting period.

Already in the course of the expired first crediting period (end date was the 21/01/2014), the start date of that first crediting period has been changed from 15/12/2006 (indicated date in the PDD) to 22/01/2007 (start of regular operation of the EnviNOx® system in plant Hu-Chems IV). That change is neither related to the actual monitoring period nor to the currently ongoing second crediting period itself.

**B.2.4 Inclusion of a monitoring plan to the registered PDD that was not included at registration**

&gt;&gt;

No such inclusion has applied to this monitoring period.

**B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline**

&gt;&gt;

No such permanent changes have applied to this monitoring period.

With respect to the already expired, first crediting period only, upon a request by the CDM EB, a revision of the monitoring plan has been requested in November 2009 and has been approved by the CDM EB on the 18/03/2010 (i.e. before the start of this monitoring period) whereas monitoring of the project since then was done according to the monitoring plan in that latest approved version during the remaining first crediting period. For the regular CDM Project operation in the second crediting period, this revision of the monitoring plan has no further relevance.

**B.2.6. Changes to project design of registered project activity**

&gt;&gt;

No such changes have applied to this monitoring period neither to any previous monitoring periods.

**B.2.7. Types of changes specific to afforestation or reforestation project activity**

&gt;&gt;

Not applicable.



## SECTION C. Description of monitoring system

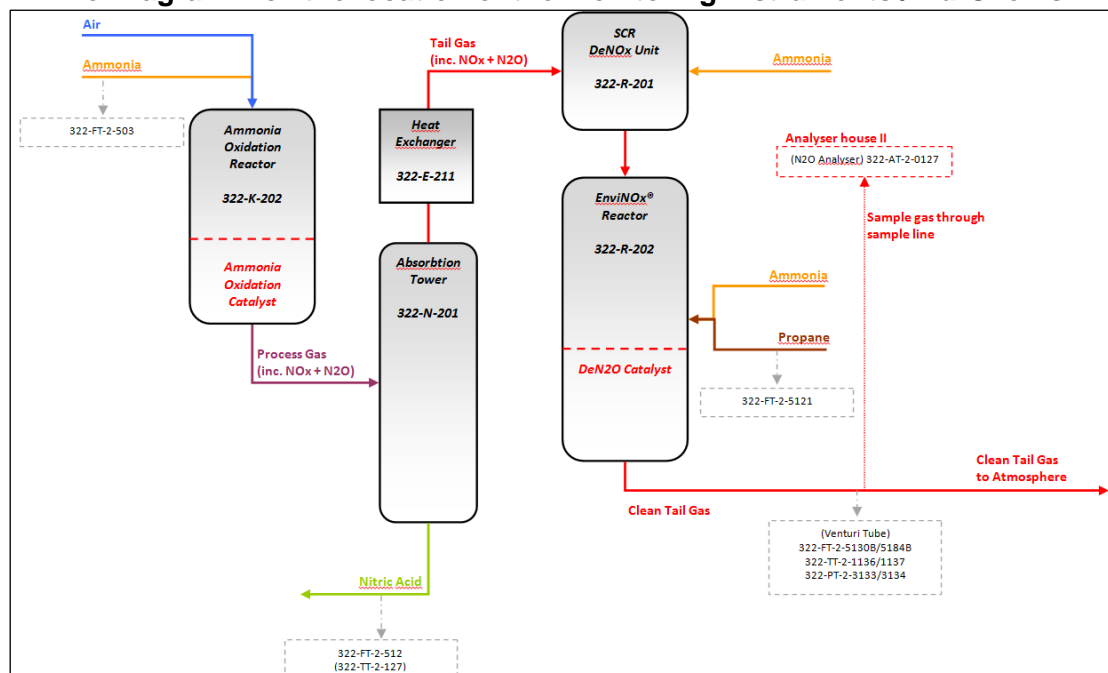
&gt;&gt;

### 1. Information Flow / Data collection procedures

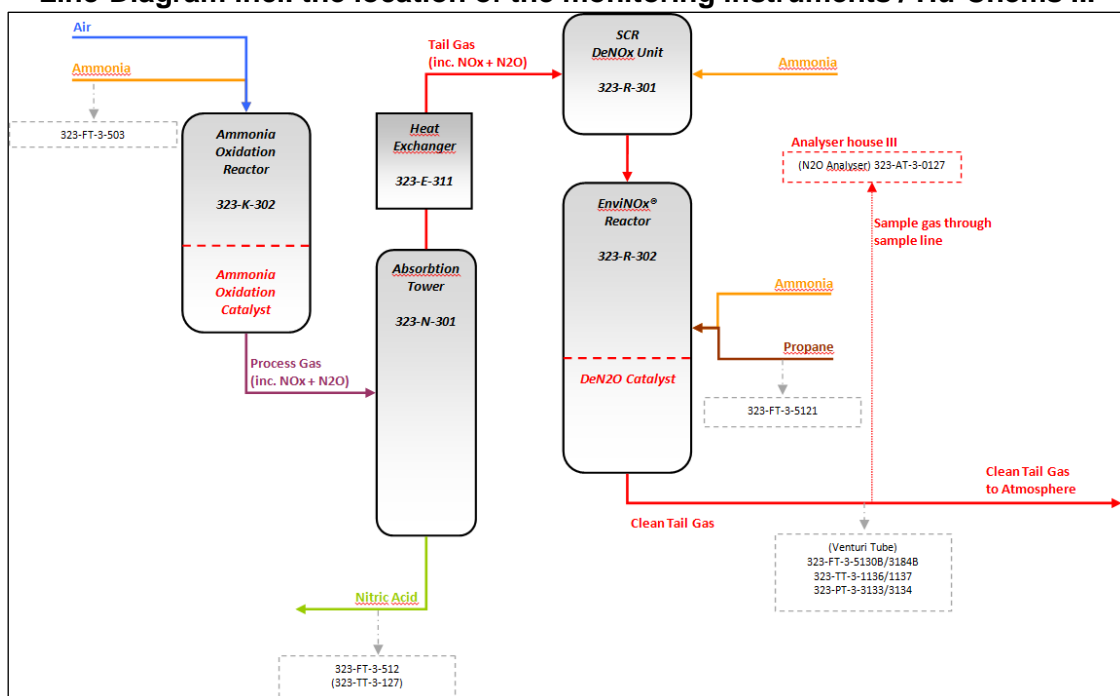
The instruments transmitters continuously provide a 4 - 20 mA analogue signal according to range and units configured. These signals are transmitted to I/O cards (analogue input/output cards) and collected by the DeltaV Processor. Resulting digital values are made available in the network to be further processed (e.g. in controller blocks, calculation of other variables) and are stored as raw data in the protected continuous historian server (CHS).

Modifications of the Delta V, which are protected by security levels by the supplier, are tracked by a Version Control Tool.

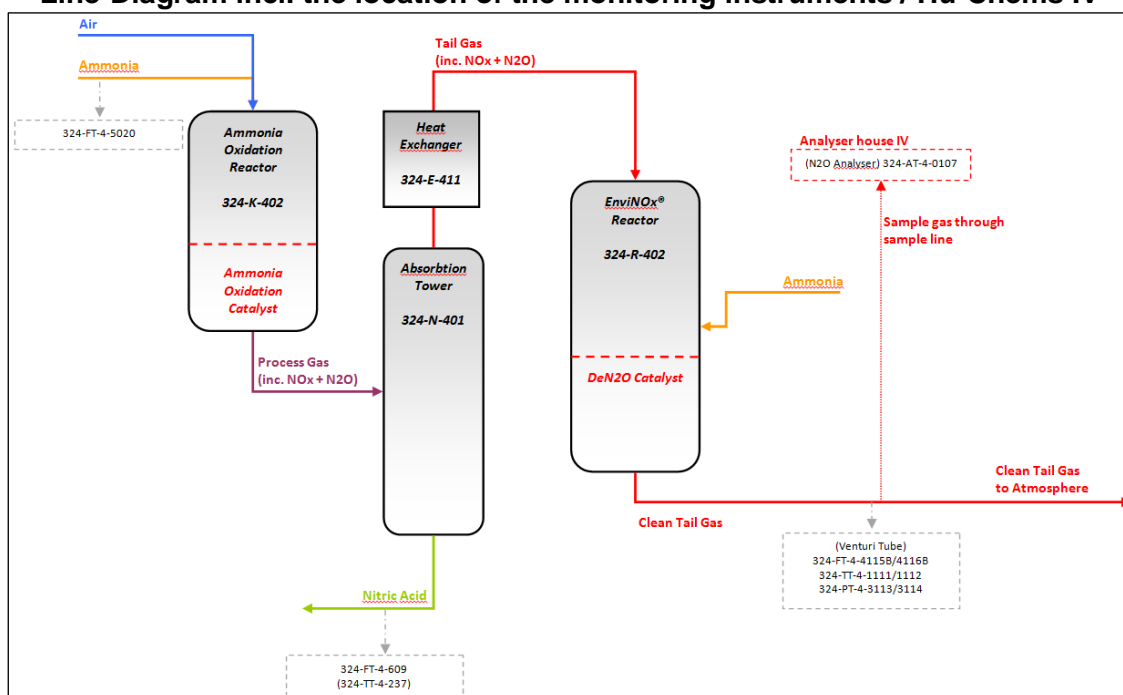
**Line-Diagram incl. the location of the monitoring instruments / Hu-Chems II**



## Line-Diagram incl. the location of the monitoring instruments / Hu-Chems III



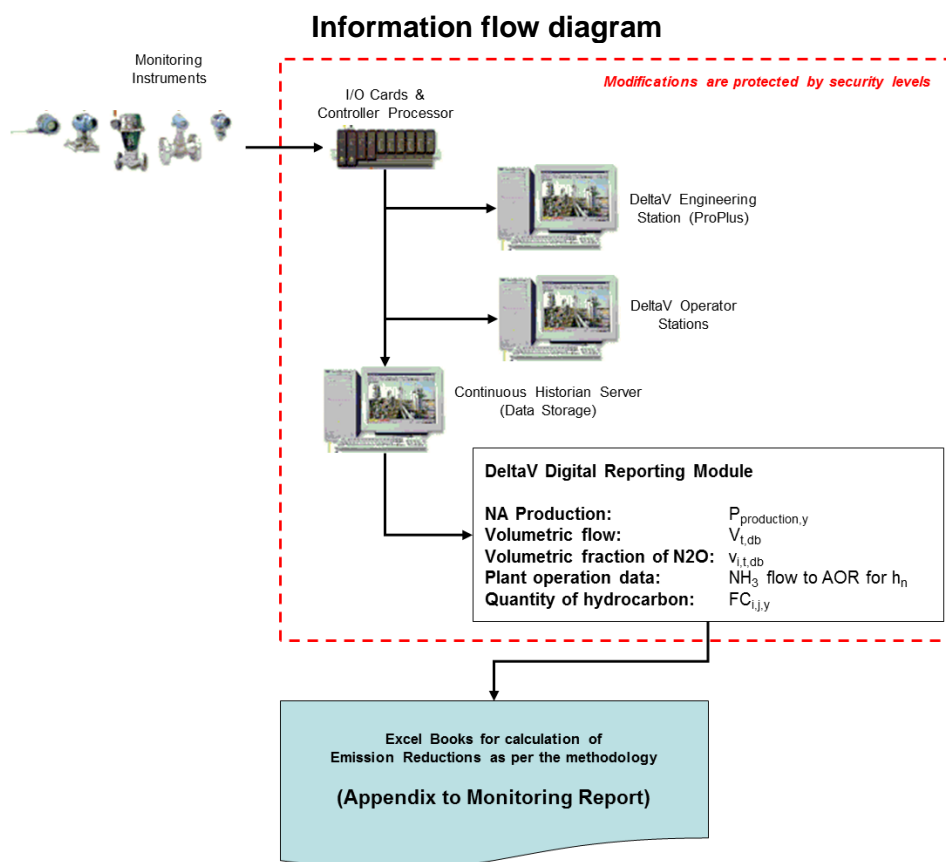
## Line-Diagram incl. the location of the monitoring instruments / Hu-Chems IV



The reporting module of the DeltaV system automatically generates aggregated daily reports (separately for plants Hu-Chems II, Hu-Chems III and Hu-Chems IV, as applicable) based on the stored raw data from the continuous historian server. Daily reports contain following kinds of data relevant for calculation of claimed emission reductions and at the required intervals:

- Nitric Acid Production ( $P_{\text{production},y}$ )
- Operating parameters of the nitric acid plants ( $\text{NH}_3$  flow to AOR for determining  $h_y$ )
- Volumetric flow of the gaseous stream ( $V_{t,db}$ )
- Volumetric fraction of  $\text{N}_2\text{O}$  in the gaseous stream ( $v_{i,t,db}$ )
- Quantity of hydrocarbon ( $\text{FC}_{i,j,y}$ ) – for plants Hu-Chems II and Hu-Chems III only

Relevant parameters as mentioned above are exported from the digitally available daily reports to an excel book (available as *Appendix 3* to this monitoring report) for presentation of required parameters and calculation of baseline emissions, project emissions and emission reductions according to formulae as required. Details on source of data of all relevant parameters can be found directly in the respective parameter tables in *Section D*.



The description of the information flow (including data generation, aggregation, recording, calculation and reporting) fully complies with the applied methodology (ACM0019, Version 2.0), the registered PDD and the Monitoring Plan.

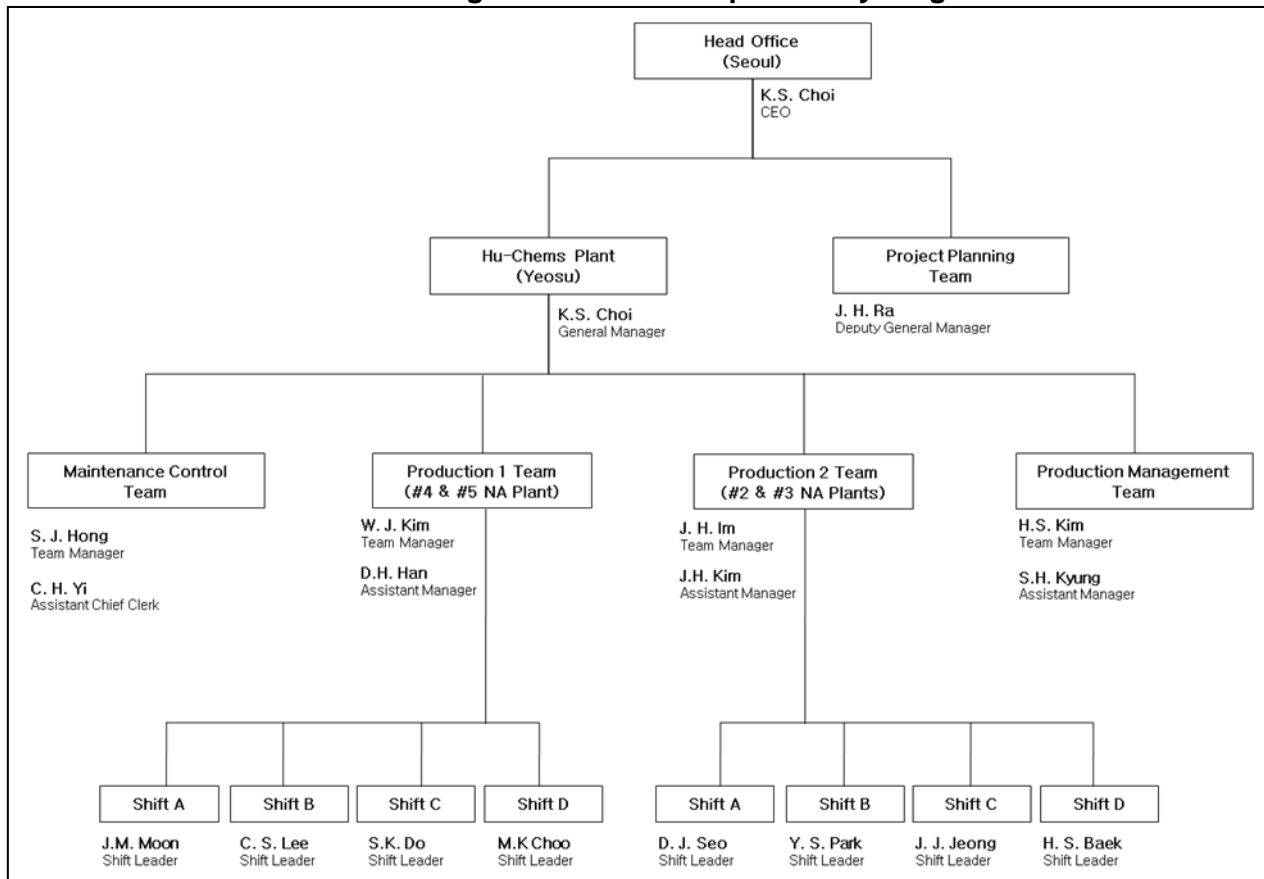
## 2. Roles and responsibilities of personnel

Project Operator is Hu-Chems Fine Chemical Corp. (HU-CHEMS). HU-CHEMS operates several 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.

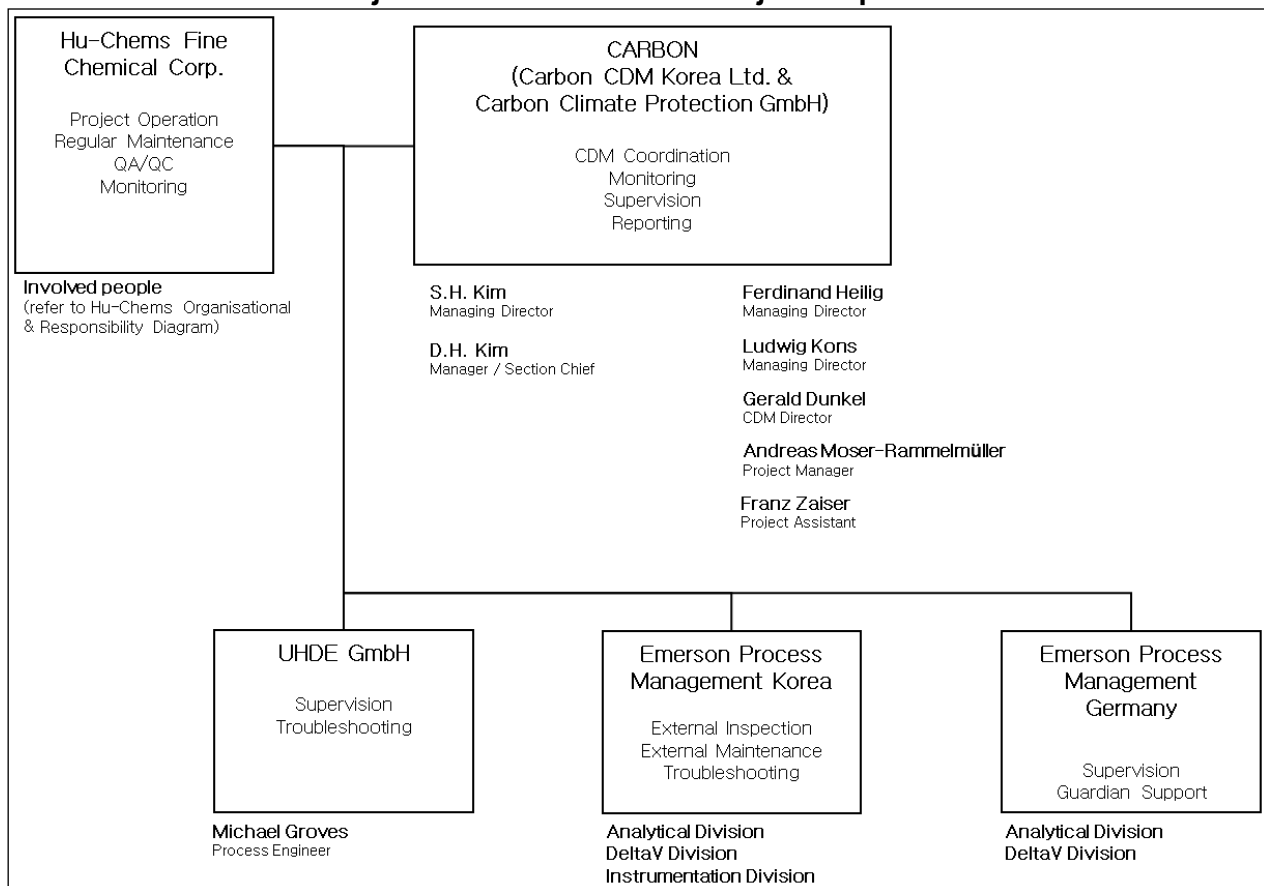
The operating and maintenance personal of the EnviNOx® system have been trained by the technology provider UHDE and the supplier of the digital process control system (Delta V, M/s. process management), further Hu-Chems has established internal training plans on the CDM procedures, operation of the EnviNOx® 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 is responsible for supervision and checks of monitoring and reporting data. Furthermore, CARBON prepares the CDM-MR and supporting documents and arranges additional double-checking of data and information. CARBON gives its approval on the supporting documents as well as the CDM-MR before submitting to the respective DOE for verification.

### Hu-Chems Organisational & Responsibility Diagram



### CDM Project: Involved entities & Project responsibilities



### 3. Back up plans / Emergency procedures for monitoring system

#### Back Up Plans for measuring systems / Periodic observations of the automated monitoring system

##### 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. 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:

In addition to the automatic error indication by the automatic DCS system, the project operator Hu-Chems is carrying out visual **on-site analyser cabinet inspections** as well as related installations on a shift basis (3 times daily). Relevant data related to the analyser and sampling system are logged on the ISO Document HCSEF-448-1 “CDM Analyzer/Reactor Check List”. Actions are defined in case of abnormal observations.

Further, Hu-Chems is carrying out a **visual on-site check of the EnviNOx® reactor and tail gas line** as well as related installations once per day. Relevant data are logged on the ISO Document HCSEF-448-1 “CDM Analyzer/Reactor Check List”. Actions are defined in case of abnormal observations.

##### Back Up – System support & Preventive maintenance: DeltaV

The DeltaV automatic measuring system (AMS) used for plant operation & CDM Monitoring was designed by the company Emerson, the main supplier of components related to the monitoring system.

In order to ensure maximum availability of the DeltaV automatic measuring system and to prevent deficient handling of data, Hu-Chems 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 **24 hours DeltaV Guardian Support** are covered by the contract. The contracted services comprise error diagnostics, measures for system stability, updates as well as preventive maintenance for the DeltaV System and related technical components. Health check reports and inspection visit reports are available and submitted to the DOE for verification.

##### Back Up – Support & Preventive maintenance: EnviNOx®-System/Analyser, Instruments

Main instruments for CDM Monitoring (i.e. Sampling system and the continuously measuring non-dispersive-infrared (NDIR) analyser used for N<sub>2</sub>O detection as well as further instruments) were designed and supplied by the company Emerson Process Management, the main supplier of components related to the monitoring system.

In order to enable high levels of availability and accuracy of instruments, Hu-Chems 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** is covered by the contract. The contracted regular services comprise error diagnostics of analysers, component updates of the analysers and the sampling system, in-depth inspections of analysers and the sampling system as well as preventive maintenance services for the analysers, the sampling system and technical components/instruments of the CDM Monitoring System. Exception handling for CDM Monitoring Instruments is covered by the 24 hours emergency service with guaranteed short-term on-site

availability of Emerson experts. Health check reports and inspection visit reports are available and submitted to the DOE for verification.

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

#### Back Up – Calibration and General Maintenance: Instruments

In order to safeguard availability and accuracy of instruments, the project participants have mandated Emerson Process Management Korea to execute **regular calibration services** and **regular general maintenance services** for all related monitoring instruments on a regular basis (adapted to the annual shut-down and maintenance schedule of the nitric acid plant). The service inter alia consists, besides calibrations, of hardware and connection maintenance as well as software checks and error diagnostics. Service reports of performed services and calibration records are submitted to the DOE for verification.

#### 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. An overview on available parts is made available to the DOE for verification.

#### Back Up – Certified standard gases

Pressure levels of standard gases used for the regular, automatic calibration of the 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 made available 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 was to ensure immediate response to such special events in the system.

The following table summarizes the periodical observations of the AMS.

Periodical observation of the AMS

Organization	Action	Frequency	Output
DeltaV	Events & Alarm List	Continuously	Txt-files, Excel files
Hu-Chems	Shift Inspection	3 times per day	Protocol/Check List
Hu-Chems	Daily Inspection	Daily	Protocol/Check List
UHDE	Supervision	Daily	Plausibility check of daily reporting
Emerson Process Management Korea (EPMK)	Health check of AMS System (Hardware & Software)	Monthly	Health Check Report
EPMK	Health Check of Sampling & Analyser system	Monthly	Health Check Report
EPMK	Inspection check of AMS System	Quarterly	Inspection Check Report

	(Hardware & Software)		
EPMK	Inspection check of Sampling & Analyser system	Quarterly	Inspection Check Report
EPMK & Suppliers	General Maintenance & Calibration Service of instruments	Regularly, adopted to annual shut-down schedule of plants	Service Reports & Calibration records

All resulting documents are analysed and evaluated by Hu-Chems under support of CARBON. In case of any upcoming problem or failure of the EnviNOx® system and/or the automated monitoring system Hu-Chems 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.

#### **4. Systematic measures for QA for monitoring data during analyser down times**

In order to ensure data quality, back up plans (see above) are in place. In case of (scheduled or unscheduled) AMS down times (or parts thereof, such as analyser, etc.), demonstration of normal plant operation and estimation of emission reductions are conservatively conducted according to the methodology and the monitoring plan. Related data and documents are provided to the DOE for verification, if applicable in the covered monitoring period.

Specifically, if data for either the N<sub>2</sub>O concentration or the volume flow of the stack gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour is replaced with the maximum value of N<sub>2</sub>O concentration or volume flow of the tail gas observed during the monitoring period. If data for neither the N<sub>2</sub>O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N<sub>2</sub>O calculated during the monitoring period is applied to any such hour. In such cases, values observed during five operating hours before and after a plant start-up and shut-down are not used for the determination of the maximum values.

**SECTION D. Data and parameters****D.1. Data and parameters fixed ex ante or at renewal of crediting period**

**Data and parameters fixed ex-ante and COMMONLY relevant for all three plants (Hu-Chems II, Hu-Chems III and Hu-Chems IV):**

<b>Data/parameter:</b>	<b>EF<sub>new,y</sub></b>																		
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>																		
Description	Baseline N <sub>2</sub> O emission factor for nitric acid production in year y (related to 100 per cent pure acid)																		
Source of data	According to PDD and methodology ACM0019 v02.0																		
Value(s) applied)	<table border="1"> <thead> <tr> <th>Year</th><th>Emission factor (kg N<sub>2</sub>O/t HNO<sub>3</sub>)</th></tr> </thead> <tbody> <tr><td>2014</td><td>3.50</td></tr> <tr><td>2015</td><td>3.40</td></tr> <tr><td>2016</td><td>3.20</td></tr> <tr><td>2017</td><td>3.00</td></tr> <tr><td>2018</td><td>2.80</td></tr> <tr><td>2019</td><td>2.70</td></tr> <tr><td>2020</td><td>2.50</td></tr> <tr><td>2021</td><td>2.50</td></tr> </tbody> </table>	Year	Emission factor (kg N <sub>2</sub> O/t HNO <sub>3</sub> )	2014	3.50	2015	3.40	2016	3.20	2017	3.00	2018	2.80	2019	2.70	2020	2.50	2021	2.50
Year	Emission factor (kg N <sub>2</sub> O/t HNO <sub>3</sub> )																		
2014	3.50																		
2015	3.40																		
2016	3.20																		
2017	3.00																		
2018	2.80																		
2019	2.70																		
2020	2.50																		
2021	2.50																		
Choice of data or measurement methods and procedures	N/A																		
Purpose of data	Calculation of baseline emissions																		
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development.																		

<b>Data/parameter:</b>	<b>GWP<sub>N2O</sub></b>
Unit	t CO <sub>2</sub> e/t N <sub>2</sub> O
Description	Global warming potential of N <sub>2</sub> O valid for the commitment period
Source of data	Relevant decisions by the CMP, according to PDD and methodology ACM0019 v02.0
Value(s) applied)	<b>298</b>
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline and project emissions
Additional comments	N/A



**Data and parameters fixed ex-ante and ONLY relevant for plant Hu-Chems II:**

<b>Data/parameter:</b>	<b>Operating pressure II</b>
Unit	kPa
Description	Operating pressure of the ammonia burner of Hu-Chems II
Source of data	Manufacturer's specifications
Value(s) applied)	<b>872 kPa</b> (equivalent to 8.72 barg)
Choice of data or measurement methods and procedures	N/A
Purpose of data	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure
Additional comments	N/A

<b>Data/parameter:</b>	<b>EF<sub>historical,II</sub></b>
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>
Description	Historical baseline emission factor of the nitric acid plant of Hu-Chems II
Source of data	Historical information from issuance reports of CDM-PDD documents
Value(s) applied)	<b>12.09 kg N<sub>2</sub>O / t HNO<sub>3</sub></b>
Choice of data or measurement methods and procedures	Plants that used AM0028 in the first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period.  Plant Hu-Chems II used AM0028 (Version 1) in the first crediting period, accordingly, the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period, is used.  The calculation of EF <sub>historical,II</sub> is based on actual data of overall historical baseline emission factors obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comments	This value will remain constant over the second and third crediting period.

<b>Data/parameter:</b>	<b>EF<sub>default,y,II</sub></b>																		
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>																		
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid) of Hu-Chems II																		
Source of data	According to PDD and methodology ACM0019 v02.0																		
Value(s) applied)	Since plant Hu-Chems II is a high pressure plant, corresponding values given in the methodology apply over the crediting period: <table border="1" data-bbox="778 1657 1193 2047"> <thead> <tr> <th>Year</th><th>High pressure (Over 600 kPa)</th></tr> </thead> <tbody> <tr><td>2014</td><td>12.40</td></tr> <tr><td>2015</td><td>12.20</td></tr> <tr><td>2016</td><td>12.00</td></tr> <tr><td>2017</td><td>11.80</td></tr> <tr><td>2018</td><td>11.60</td></tr> <tr><td>2019</td><td>11.40</td></tr> <tr><td>2020</td><td>11.20</td></tr> <tr><td>2021</td><td>11.00</td></tr> </tbody> </table>	Year	High pressure (Over 600 kPa)	2014	12.40	2015	12.20	2016	12.00	2017	11.80	2018	11.60	2019	11.40	2020	11.20	2021	11.00
Year	High pressure (Over 600 kPa)																		
2014	12.40																		
2015	12.20																		
2016	12.00																		
2017	11.80																		
2018	11.60																		
2019	11.40																		
2020	11.20																		
2021	11.00																		

Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development.

<b>Data/parameter:</b>	<b>P<sub>product,max,II</sub></b>
Unit	t product (→ t HNO <sub>3</sub> )
Description	Design capacity of nitric acid production during the first crediting period of Hu-Chems II
Source of data	Manufacturer's specifications
Value(s) applied)	<b>116,800 t product</b>
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	This parameter is only for project activities applying case 1 as per ACM0019 (Version 2), i.e. For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

**Data and parameters fixed ex-ante and ONLY relevant for plant Hu-Chems III:**

<b>Data/parameter:</b>	<b>Operating pressure III</b>
Unit	kPa
Description	Operating pressure of the ammonia burner of Hu-Chems III
Source of data	Manufacturer's specifications
Value(s) applied)	<b>872 kPa</b> (equivalent to 8.72 barg)
Choice of data or measurement methods and procedures	N/A
Purpose of data	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure
Additional comments	N/A

<b>Data/parameter:</b>	<b>EF<sub>historical,III</sub></b>
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>
Description	Historical baseline emission factor of the nitric acid plant of Hu-Chems III
Source of data	Historical information from issuance reports of CDM-PDD documents
Value(s) applied)	<b>11.26 kg N<sub>2</sub>O / t HNO<sub>3</sub></b>
Choice of data or measurement methods and procedures	<p>Plants that used AM0028 in the first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period.</p> <p>Plant Hu-Chems III used AM0028 (Version 1) in the first crediting period, accordingly, the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period, is used.</p> <p>The calculation of EF<sub>historical,III</sub> is based on actual data of overall historical baseline emission factors obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports.</p>

Purpose of data	Calculation of baseline emissions
Additional comments	This value will remain constant over the second and third crediting period.

<b>Data/parameter:</b>	<b>EF<sub>default,y,III</sub></b>																		
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>																		
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid) of Hu-Chems III																		
Source of data	According to PDD and methodology ACM0019 v02.0																		
Value(s) applied)	<p>Since plant Hu-Chems III is a high pressure plant, corresponding values given in the methodology apply over the crediting period:</p> <table border="1"> <thead> <tr> <th>Year</th><th>High pressure (Over 600 kPa)</th></tr> </thead> <tbody> <tr><td>2014</td><td>12.40</td></tr> <tr><td>2015</td><td>12.20</td></tr> <tr><td>2016</td><td>12.00</td></tr> <tr><td>2017</td><td>11.80</td></tr> <tr><td>2018</td><td>11.60</td></tr> <tr><td>2019</td><td>11.40</td></tr> <tr><td>2020</td><td>11.20</td></tr> <tr><td>2021</td><td>11.00</td></tr> </tbody> </table>	Year	High pressure (Over 600 kPa)	2014	12.40	2015	12.20	2016	12.00	2017	11.80	2018	11.60	2019	11.40	2020	11.20	2021	11.00
Year	High pressure (Over 600 kPa)																		
2014	12.40																		
2015	12.20																		
2016	12.00																		
2017	11.80																		
2018	11.60																		
2019	11.40																		
2020	11.20																		
2021	11.00																		
Choice of data or measurement methods and procedures	N/A																		
Purpose of data	Calculation of baseline emissions																		
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development.																		

<b>Data/parameter:</b>	<b>P<sub>product,max,III</sub></b>
Unit	t product (→ t HNO <sub>3</sub> )
Description	Design capacity of nitric acid production during the first crediting period of Hu-Chems III
Source of data	Manufacturer's specifications
Value(s) applied)	<b>116,800 t product</b>
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	This parameter is only for project activities applying case 1 as per ACM0019 (Version 2), i.e. For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

**Data and parameters fixed ex-ante and ONLY relevant for plant Hu-Chems IV:**

<b>Data/parameter:</b>	<b>Operating pressure IV</b>
Unit	kPa
Description	Operating pressure of the ammonia burner of Hu-Chems IV
Source of data	Manufacturer's specifications
Value(s) applied)	<b>335 kPa</b> (equivalent to 3.35 barg)
Choice of data or measurement methods and procedures	N/A
Purpose of data	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure
Additional comments	N/A

<b>Data/parameter:</b>	<b>EF<sub>historical,IV</sub></b>
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>
Description	Historical baseline emission factor of the nitric acid plant of Hu-Chems IV
Source of data	Historical information from issuance reports of CDM-PDD documents
Value(s) applied)	<b>5.70 kg N<sub>2</sub>O / t HNO<sub>3</sub></b>
Choice of data or measurement methods and procedures	Plants that used AM0028 in the first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period.  Plant Hu-Chems IV used AM0028 (Version 1) in the first crediting period, accordingly, the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period, is used.  The calculation of EF <sub>historical,IV</sub> is based on actual data of overall historical baseline emission factors obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comments	This value will remain constant over the second and third crediting period.

<b>Data/parameter:</b>	<b>EF<sub>default,y,IV</sub></b>																		
Unit	kg N <sub>2</sub> O/t HNO <sub>3</sub>																		
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid) of Hu-Chems IV																		
Source of data	According to PDD and methodology ACM0019 v02.0																		
Value(s) applied)	Since plant Hu-Chems III is a medium pressure plant, corresponding values given in the methodology apply over the crediting period: <table border="1" data-bbox="778 1659 1193 2047"> <thead> <tr> <th>Year</th><th>Medium pressure (200 – 600 Kpa)</th></tr> </thead> <tbody> <tr><td>2014</td><td>8.2</td></tr> <tr><td>2015</td><td>8.0</td></tr> <tr><td>2016</td><td>7.8</td></tr> <tr><td>2017</td><td>7.6</td></tr> <tr><td>2018</td><td>7.4</td></tr> <tr><td>2019</td><td>7.2</td></tr> <tr><td>2020</td><td>7.0</td></tr> <tr><td>2021</td><td>6.8</td></tr> </tbody> </table>	Year	Medium pressure (200 – 600 Kpa)	2014	8.2	2015	8.0	2016	7.8	2017	7.6	2018	7.4	2019	7.2	2020	7.0	2021	6.8
Year	Medium pressure (200 – 600 Kpa)																		
2014	8.2																		
2015	8.0																		
2016	7.8																		
2017	7.6																		
2018	7.4																		
2019	7.2																		
2020	7.0																		
2021	6.8																		

Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	The decrease in the value for the baseline emission factor over time is to reflect the technological development.

<b>Data/parameter:</b>	<b>P<sub>product,max,IV</sub></b>
Unit	t product (→ t HNO <sub>3</sub> )
Description	Design capacity of nitric acid production during the first crediting period of Hu-Chems IV
Source of data	Manufacturer's specifications
Value(s) applied)	<b>467,200 t product</b>
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comments	This parameter is only for project activities applying case 1 as per ACM0019 (Version 2), i.e. For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

**Parameters fixed ex-ante from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0) COMMONLY relevant for all three plants (Hu-Chems II, Hu-Chems III and Hu-Chems IV):**

<b>Data/parameter:</b>	<b>R<sub>u</sub></b>
Unit	Pa.m <sup>3</sup> /kmol.K
Description	Universal ideal gases constant
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0)
Value(s) applied)	<b>8,314 Pa.m<sup>3</sup>/kmol.K</b>
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comments	N/A

Data/parameter:	MM <sub>i</sub>								
Unit	kg/kmol								
Description	Molecular mass of greenhouse gas i								
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0)								
Value(s) applied)	<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Nitrous oxide</td><td>N<sub>2</sub>O</td><td>44.02</td></tr></table>			Compound	Structure	Molecular mass (kg/kmol)	Nitrous oxide	N <sub>2</sub> O	44.02
Compound	Structure	Molecular mass (kg/kmol)							
Nitrous oxide	N <sub>2</sub> O	44.02							
Choice of data or measurement methods and procedures	Specified in the tool								
Purpose of data	Calculation of project emissions								
Additional comments	N/A								

<b>Data/parameter:</b>	<b>P<sub>n</sub></b>
Unit	Pa
Description	Total pressure at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied)	<b>101,325 PA</b>
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comments	This parameter is used to determine the mass flow of the N <sub>2</sub> O in the tail gas

<b>Data/parameter:</b>	<b>T<sub>n</sub></b>
Unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied)	<b>273.15 K</b>
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comments	This parameter is used to determine the mass flow of the N <sub>2</sub> O in the tail gas

## D.2. Data and parameters monitored

In describing parameters, “Annual”, “Yearly” or “in year y” is sometimes mentioned, as it is defined in the methodology (ACM0019 version v02.0 and respective tools) and the Monitoring Plan and refers to the respective parameter during or related to a year “y”. It shall be considered, that “Annual”, “Yearly” and the year “y” is understood as the monitoring period covered by this report (22/01/2014 to 11/06/2014), unless otherwise described.

### **Data and parameters MONITORED during monitoring period which are specifically relevant for plant Hu-Chems II**

Data/parameter:	$P_{\text{production},y,\text{II}}$
Unit	tHNO <sub>3</sub>
Description	Nitric acid produced in year y of Hu-Chems II
Measured/calculated/default	Measured
Source of data	<p>Production reports (based on measurements from project participants)</p> <p>The nitric acid flow and density are measured with a coriolis flow meter, temperature with a temperature measurement and concentration is determined based on measured parameters. Values are sent to the DCS (control room), and the nitric acid production (as 100% HNO<sub>3</sub>) is calculated based on mass flow and HNO<sub>3</sub> concentration. Final production values are exported in production reports through the DeltaV System.</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>
Monitoring equipment	<p>Meter location: Located in the nitric acid line, downstream of the absorption tower (322-N-201). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>322-FT-2-512</b>            Type: Coriolis Flowmeter            Accuracy class: ± 0.35%            Serial number: 14266864            Calibration frequency: 60 months            Date of last calibration: 09/11/2012 (Validity: 08/11/2017)</p> <p><b>322-TI-2-127</b>            Type: Temperature Converter            Accuracy class: ± 0.15% of span            Serial Number: 51305907-175            Calibration frequency: 48 months            Date of last calibration: 14/05/2013 (Validity: 13/05/2017)</p>
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 Seconds Recording: Hourly
Calculation method (if applicable):	-

QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline emissions
Additional comments:	The parameter $P_{NA,h,II}$ (Nitric acid produced in the hour h of Hu-Chems II) represents the hourly value of $P_{production,y,II}$ and is used for determining $h_{r,y,II}$ as per the applied methodology.

Data/parameter:	$h_{y,II}$
Unit	h
Description	Number of hours of operation in year y of Hu-Chems II
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below)</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	<p>Meter location: Located in the ammonia supply line, upstream of the ammonia oxidation reactor (322-K-202). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>322-FT-2-503</b>  Type: Differential pressure transmitter  Accuracy class: <math>\pm 0.5\%</math> of span  Serial number: 2052133  Calibration frequency: 48 Months  Date of last calibration: 14/05/2013 (Validity: 13/05/2017)</p>
Measuring/reading/recording frequency:	<p>Measuring: Continuously  Reading: 10 Seconds  Recording: Hourly</p>
Calculation method (if applicable):	The flow of $NH_3$ to the ammonia oxidation reactor indicates the operational status. In case, the volume flow of $NH_3$ to the ammonia oxidation reactor lies above the threshold of 500 Nm <sup>3</sup> /h during an hour, the reactor is considered in operation during the hour.



QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime

Data/parameter:	$h_{r,y,II}$
Unit	h
Description	For tertiary N <sub>2</sub> O abatement, Number of hours ( <i>h</i> ) in year <i>y</i> where the abatement system is by-passed, underperforming or failed of Hu-Chems II
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below)</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>
Monitoring equipment	<p>HU-Chems II nitric acid plant has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour <i>h</i> in year <i>y</i> if:</p> $F_{N2O,tailgas,h,II} > EF_{existing,y,II} \times P_{NA,h,II}$ <p>The parameters mentioned above are determined and measured/monitored as explained in the respective sections of this monitoring report:</p> <ul style="list-style-type: none"> <li><math>P_{NA,h,II}</math> - determination is based on the monitored parameter <math>P_{production,y,II}</math> (refer to the respective parameter table in this monitoring report)</li> <li><math>F_{N2O,tailgas,h,II}</math> - determination is based on the monitored parameters <math>V_{t,db,n,IV}</math>, <math>V_{i,t,db,II}</math> and <math>C_{H2O,t,db,n,II}</math> (refer to the respective parameter tables in this monitoring report)</li> <li><math>EF_{existing,y,II}</math> – determination is based on the ex-ante determined parameters <math>EF_{historical,II}</math> and <math>EF_{default,y,II}</math> (refer to the respective parameter tables in this monitoring report)</li> </ul>
Measuring/reading/recording frequency:	<p>Measuring: Continuously</p> <p>Reading: Hourly</p> <p>Recording: Hourly</p>
Calculation method (if applicable):	(Refer to “Monitoring equipment” above)

QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	<p>Records to be maintained during project's lifetime.</p> <p>The parameter <math>P_{NA,h,II}</math> as used in the formula (Nitric acid produced in the hour h of Hu-Chems II) represents the hourly value of <math>P_{production,y,II}</math>.</p>

*Parameters from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0)*

Data/parameter:	$V_{t,db,II}$
Unit	m <sup>3</sup> dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis of Hu-Chems II
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below).</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>

Monitoring equipment	<p>Meter location: Located in the tail gas line, downstream of the EnviNO<sub>x</sub>® reactor (322-R-202). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p>Venturi tube, designed and manufactured in accordance with ISO 5167-4:2003</p> <p><b>322-FT-2-5130B/5184B</b>  Type: Differential pressure transmitters  Accuracy class: <math>\pm 0.1\%</math> of span  Serial numbers: 01990156/01990157  Calibration frequency: 24 months  Date of last calibrations: 14/05/2013 (Validity: 13/05/2015)</p> <p><b>322-TT-2-1136/1137</b>  Type: Temperature transmitters  Accuracy class: <math>\pm 0.15\%</math> of span  Serial numbers: 01990158/01990159  Calibration frequency: 24 months  Date of last calibrations: 14/05/2013 (Validity: 13/05/2015)</p> <p><b>322-PT-2-3133/3134</b>  Type: Pressure transmitters  Accuracy class: <math>\pm 0.1\%</math> of span  Serial numbers: 5435394/5435395  Calibration frequency: 24 months  Date of last calibrations: 14/05/2013 (Validity: 13/05/2015)</p>
Measuring/reading/recording frequency:	<p>Measuring: Continuously  Reading: Every 1 second  Recording: Hourly</p>
Calculation method (if applicable):	-
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p> <p>Plausibility check of measured values is regularly done with recorded values of the redundantly installed instruments.</p>
Purpose of data:	Calculation of project emissions

Additional comments:	<p>Option A parameter according to the applied “<i>Tool to determine the mass flow of a greenhouse gas in a gaseous stream.</i>” (Version 2)</p> <p>The volumetric flow is determined and expressed at normal conditions (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>) according to the applied methodology. Monitoring of actual conditions (<math>P_{t,II}</math>, <math>T_{t,II}</math>) is therefore not necessary, as per the applied methodology.</p> <p>Dry basis flow measurement, since gaseous stream is considered to be dry (refer to parameter <math>C_{H_2O,t,db,n,II}</math>)</p> <p>Please note, the information indicated in this parameter table refers to the period where the temporary deviation applied. For detailed information on the said temporary deviation, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i> of this Monitoring Report.</p>
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Data/parameter:	$V_{i,t,db,II}$
Unit	$\text{m}^3 \text{ gas i} / \text{m}^3 \text{ dry gas} \rightarrow \text{m}^3 \text{ N}_2\text{O} / \text{m}^3 \text{ dry gas}$
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis of Hu-Chems II
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below).</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	<p>Meter location: Sample take-off is located in the tail gas line, downstream of the EnviNOx® reactor (322-R-202), and leads (via sample gas line) to the locked analyser house II (located closely to the EnviNOx® reactor of Hu-Chems plant II), where the analyser is installed. Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>322-AT-2-0127</b>  Type: NDIR Analyzer  Accuracy class: <math>\pm 1\%</math> (zero/span)  Serial number: 990861497812  Calibration frequency: Zero calibration daily (automatically)  Span calibration every two days (automatically)  Third party analyser certification frequency by governmental Korean Testing Laboratory (KTL): 24 months  Date of penultimate certification: 27/03/2012 (Validity: 26/03/2014)  Date of last certification: 11/03/2014 (Validity: 10/03/2016)</p>
Measuring/reading/recording frequency:	<p>Measuring: Continuously  Reading: Every 1 second  Recording: Hourly</p>
Calculation method (if applicable):	-

QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p> <p>QAL 1 Certification pursuant to the standard EN 14181 is available for the monitoring equipment.</p> <p>Accuracy-safeguarding instructions from Emerson Process Management, the manufacturer of the equipment, related to regular self-calibration and quality of used standard gases, are followed.</p> <p>The analyzers need a calibration on a regular basis. This adjustment procedure is done automatically and can be triggered manually from the operating console or automatically on a time basis (Zero calibration: daily, span calibration: every two days).</p> <p>Certified (Certificates confirming stability of standard gas during monitoring period and 1% uncertainty) standard gases are used for self-calibration.</p> <p>Sample line testing is done annually by applying certified standard gas at the beginning of the sample line. Latest tests have been conducted in June 2013, with positive results.</p> <p>Emerson Process Management Korea has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition. Extended general maintenance service by Emerson Process Management Germany have been conducted in November 2012 and November 2013.</p> <p>Plausibility check is regularly done with laboratory gas chromatography analysis.</p>
Purpose of data:	Calculation of project emissions
Additional comments:	<p>The volumetric fraction of N<sub>2</sub>O is determined and expressed at normal conditions (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>) according to the applied methodology. Monitoring of actual conditions (<math>P_{t,II}</math>, <math>T_{t,II}</math>) is therefore not necessary, as per the applied methodology.</p> <p>Please note, the information indicated in this parameter table refers to the period where the temporary deviation applied. For detailed information on the said temporary deviation, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i> of this Monitoring Report.</p>

Data/parameter:	$C_{H_2O,t,db,n,II}$
Unit	mg H <sub>2</sub> O/m <sup>3</sup> dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems II
Measured/calculated/default	Measured

Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content (Measurement Report)
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>
Monitoring equipment	As per USEPA CF42 method 4 – Gravimetric determination of water content
Measuring/reading/recording frequency:	As per the PDD, measurements coincide with the first Annual Surveillance Test or the first calibration of the flow meter for the gaseous stream (QAL 2), both associated with requirements of the EN 14181 standard).
Calculation method (if applicable):	-
QA/QC procedures:	According to USEPA CF 42 method 4
Purpose of data:	Calculation of project emissions
Additional comments:	<p>As per the applied “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the flow and volumetric fraction may be measured on a dry basis or wet basis. The tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas (Option A to F).</p> <p>As described in the PDD, the option chosen for this project activity is Option A, requiring to demonstrate, that the gaseous stream is dry, whereas the tool suggests two ways to do this:</p> <ul style="list-style-type: none"> <li>(a) Measure the moisture content of the gaseous stream (<math>C_{H_2O,t,db,n}</math>) and demonstrate that this is less or equal to 0.05 kg H<sub>2</sub>O/m<sup>3</sup> dry gas; or</li> <li>(b) Demonstrate that the temperature of the gaseous stream (<math>T_t</math>) is less than 60°C (333.15 K) at the flow measurement point.</li> </ul> <p>In the case of this project activity, the first way (a) has been chosen.</p> <p>The value determined ex-ante for the estimation of Emission Reductions in the PDD was 0.007 kg H<sub>2</sub>O/m<sup>3</sup> dry gas (based on design values) and was hence clearly below the threshold value of 0.05 kg H<sub>2</sub>O/m<sup>3</sup> dry gas. As soon as the nitric acid plant will resume to operation, it is planned to perform the measurement of the moisture content coinciding with the first QAL2 calibration.</p>

Since the volumetric fraction of N<sub>2</sub>O and the volumetric flow of the gaseous stream are both determined and expressed at normal conditions ( $P_n = 101,325 \text{ Pa}$ ;  $T_n = 273.15 \text{ K}$ ), the actual conditions ( $P_{t,II}$ ,  $T_{t,II}$ ) are not required to be monitored, as per the applied methodology.

Parameters from the "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion" (Version 02) of Hu-Chems II

Data/parameter:	FC <sub>i,i,y,II</sub>
Unit	t/yr
Description	Quantity of fuel type i combusted in process j during the year y of Hu-Chems II
Measured/calculated/default	Measured
Source of data	Onsite measuring device (please refer to Monitoring equipment below).  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	Meter location: Located in the propane gas line, upstream of the EnviNOx® reactor (322-R-202). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.  <b>322-FT-2-5121</b> Type: Coriolis flowmeter Accuracy class: ± 0.35% Serial number: 14126211 Calibration frequency: 60 months Date of last calibration: 02/06/2011 (Validity: 01/06/2016)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 10 seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>As far as feasible, the consistency of metered fuel consumption quantities is cross-checked for plausibility by an annual energy balance that is based on purchased quantities and stock changes.</p> <p>Furthermore, as far as feasible, where the purchased fuel invoices can be identified specifically for the CDM project (and the specific plant, respectively), the metered fuel consumption quantities are cross-checked with available purchase invoices from the financial records.</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of project emissions
Additional comments:	The fuel (more exactly: hydrocarbon used as reducing agent) applied in the plant is LPG (Liquefied Petroleum Gas) with a major mass fraction (expected levels above 95%) of propane.

Data/parameter:	$W_{C,i,y,II}$
Unit	tC/t
Description	Weighted average mass fraction of carbon in fuel type i in year y of Hu-Chems II
Measured/calculated/default	Measured (by hydrocarbon supplier)
Source of data	Certificate of hydrocarbon supplier
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.
Measuring/reading/recording frequency:	Measuring: In order to assure conservativeness a certificate from the hydrocarbon supplier is requested at least on a yearly basis. This interval basically applies in case of operation of the EnviNOx® system, which was not the case during this monitoring period.
Calculation method (if applicable):	Composition of the delivered hydrocarbon is available on the specific certificates provided by the supplier. The mass fraction of carbon is obtained regularly (if feasible for each fuel delivery), from which weighted average annual values are calculated.
QA/QC procedures:	It is verified, if the applied value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
Purpose of data:	Calculation of project emissions
Additional comments:	Applicable where Option A of the "Tool to calculate project or leakage CO <sub>2</sub> emissions from fossil fuel combustion" (Version 02) is used.  The fuel (more exactly: hydrocarbon used as reducing agent) applied in the plant is LPG (Liquefied Petroleum Gas) with a major mass fraction of propane (about >95%).

**Data and parameters MONITORED during monitoring period which are specifically relevant for plant Hu-Chems III:**

Data/parameter:	$P_{\text{production},y,III}$
Unit	tHNO <sub>3</sub>
Description	Nitric acid produced in year y of Hu-Chems III
Measured/calculated/default	Measured
Source of data	Production reports (based on measurements from project participants)  The nitric acid flow and density are measured with a coriolis flow meter, temperature with a temperature measurement and concentration is determined based on measured parameters. Values are sent to the DCS (control room), and the nitric acid production (as 100% HNO <sub>3</sub> ) is calculated based on mass flow and HNO <sub>3</sub> concentration. Final production values are exported in production reports through the DeltaV System.  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>



Monitoring equipment	<p>Meter location: Located in the nitric acid line, downstream of the absorption tower (323-N-301). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>323-FT-3-512</b>  Type: Coriolis Flowmeter  Accuracy class: <math>\pm 0.35\%</math>  Serial number: 14325173  Calibration frequency: 60 months  Date of last calibration: 20/11/2012 (Validity: 19/11/2017)</p> <p><b>323-TI-3-127</b>  Type: Temperature Converter  Accuracy class: <math>\pm 0.15\%</math> of span  Serial Number: 51309204-125  Calibration frequency: 48 months  Date of last calibration: 15/05/2013 (Validity: 14/05/2017)</p>
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 Seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline emissions
Additional comments:	The parameter $P_{NA,h,III}$ (Nitric acid produced in the hour h of Hu-Chems III) represents the hourly value of $P_{production,y,III}$ and is used for determining $h_{r,y,III}$ as per the applied methodology.

<b>Data/parameter:</b>	<b><math>h_{y,III}</math></b>
Unit	h
Description	Number of hours of operation in year y of Hu-Chems III
Measured/calculated/default	Measured
Source of data	Measuring device (please refer to Monitoring equipment below)  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>

Monitoring equipment	<p>Meter location: Located in the ammonia supply line, upstream of the ammonia oxidation reactor (323-K-302). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>323-FT-3-503</b>  Type: Differential pressure transmitter  Accuracy class: <math>\pm 0.5\%</math> of span  Serial number: 2052134  Calibration frequency: 48 Months  Date of last calibration: 15/05/2013 (Validity: 14/05/2017)</p>
Measuring/reading/recording frequency:	<p>Measuring: Continuously  Reading: 10 Seconds  Recording: Hourly</p>
Calculation method (if applicable):	The flow of $\text{NH}_3$ to the ammonia oxidation reactor indicates the operational status. In case, the volume flow of $\text{NH}_3$ to the ammonia oxidation reactor lies above the threshold of $500 \text{ Nm}^3/\text{h}$ during an hour, the reactor is considered in operation during the hour.
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime

<b>Data/parameter:</b>	<b><math>h_{r,y,III}</math></b>
Unit	h
Description	For tertiary $\text{N}_2\text{O}$ abatement, Number of hours ( <i>h</i> ) in year <i>y</i> where the abatement system is by-passed, underperforming or failed of Hu-Chems III
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below)</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>

Monitoring equipment	<p>HU-Chems III nitric acid plant has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if:</p> $F_{N_2O, tailgas, h, III} > EF_{existing, y, III} \times P_{NA, h, III}$ <p>The parameters mentioned above are determined and measured/monitored as explained in the respective sections of this monitoring report:</p> <ul style="list-style-type: none"> <li>• <math>P_{NA, h, III}</math> - determination is based on the monitored parameter <math>P_{production, y, III}</math> (refer to the respective parameter table in this monitoring report)</li> <li>• <math>F_{N_2O, tail gas, h, III}</math> - determination is based on the monitored parameters <math>V_{t, db, n, III}</math>, <math>V_{i, t, db, III}</math> and <math>C_{H_2O, t, db, n, III}</math> (refer to the respective parameter tables in this monitoring report)</li> <li>• <math>EF_{existing, y, III}</math> – determination is based on the ex-ante determined parameters <math>EF_{historical, III}</math> and <math>EF_{default, y, III}</math> (refer to the respective parameter tables in this monitoring report)</li> </ul>
Measuring/reading/recording frequency:	<p>Measuring: Continuously Reading: Hourly Recording: Hourly</p>
Calculation method (if applicable):	(Refer to “Monitoring equipment” above)
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	<p>Records to be maintained during project's lifetime.</p> <p>The parameter <math>P_{NA, h, III}</math> as used in the formula (Nitric acid produced in the hour h of Hu-Chems III) represents the hourly value of <math>P_{production, y, III}</math>.</p>

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"  
(Version 02.0.0) of Hu-Chems III

Data/parameter:	$V_{t,db,III}$
Unit	m <sup>3</sup> dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis of Hu-Chems III
Measured/calculated/default	Measured
Source of data	Measuring device (please refer to Monitoring equipment below).  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	<p>Meter location: Located in the tail gas line, downstream of the EnviNOx® reactor (323-R-302). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p>Venturi tube, designed and manufactured in accordance with ISO 5167-4:2003</p> <p><b>323-FT-3-5130B/3184B</b>  Type: Differential pressure transmitters  Accuracy class: ± 0.1% of span  Serial numbers: 01885789 / 01885790  Calibration frequency: 24 months  Date of last calibrations: 15/05/2013 (Validity: 14/05/2015)</p> <p><b>323-TT-3-1136/1137</b>  Type: Temperature transmitters  Accuracy class: ± 0.15% of span  Serial numbers: 01885793 / 01885794  Calibration frequency: 24 months  Date of last calibrations: 15/05/2013 (Validity: 14/05/2015)</p> <p><b>323-PT-3-3133/3134</b>  Type: Pressure transmitters  Accuracy class: ± 0.1% of span  Serial numbers: 5389822 / 01993892  Calibration frequency: 24 months  Date of last calibrations: 15/05/2013 (Validity: 14/05/2015)</p>
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-

QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p> <p>With respect to requirements based on EN 14181, please refer to <i>Section B - 2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i></p> <p>Plausibility check of measured values is regularly done with recorded values of the redundantly installed instruments.</p>
Purpose of data:	Calculation of project emissions
Additional comments:	<p>Option A parameter according to the applied “<i>Tool to determine the mass flow of a greenhouse gas in a gaseous stream.</i>” (Version 2)</p> <p>The volumetric flow is determined and expressed at normal conditions (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>) according to the applied methodology. Monitoring of actual conditions (<math>P_{t,III}</math>, <math>T_{t,III}</math>) is therefore not necessary, as per the applied methodology.</p> <p>Dry basis flow measurement, since gaseous stream is considered to be dry (refer to parameter <math>C_{H_2O,t,db,n,III}</math>)</p> <p>Please note, the information indicated in this parameter table refers to the period where the temporary deviation applied. For detailed information on the said temporary deviation, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i> of this Monitoring Report.</p>

Data/parameter:	$V_{i,t,db,III}$
Unit	$\text{m}^3 \text{ gas i} / \text{m}^3 \text{ dry gas}$ ( $\rightarrow \text{m}^3 \text{ N}_2\text{O} / \text{m}^3 \text{ dry gas}$ )
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis of Hu-Chems III
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below).</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>

Monitoring equipment	<p>Meter location: Sample take-off is located in the tail gas line, downstream of the EnviNO<sub>x</sub>® reactor (323-R-302), and leads (via sample gas line) to the locked analyser house III (located closely to the EnviNO<sub>x</sub>® reactor of Hu-Chems plant III), where the analyser is installed. Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>323-AT-3-0127</b>  Type: NDIR Analyzer  Accuracy class: ±1% (zero/span)  Serial number: 990861497815  Calibration frequency: Zero calibration daily (automatically)  Span calibration every two days (automatically)  Third party analyser certification frequency by governmental Korean Testing Laboratory (KTL): 24 months  Date of penultimate certification: 27/03/2012 (Validity: 26/03/2014)  Date of last certification: 11/03/2014 (Validity: 10/03/2016)</p>
Measuring/reading/recording frequency:	<p>Measuring: Continuously  Reading: Every 1 second  Recording: Hourly</p>
Calculation method (if applicable):	-

QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p> <p>QAL 1 Certification pursuant to the standard EN 14181 is available for the monitoring equipment.</p> <p>With respect to other requirements based on EN 14181, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i></p> <p>Accuracy-safeguarding instructions from Emerson Process Management, the manufacturer of the equipment, related to regular self-calibration and quality of used standard gases, are followed.</p> <p>The analyzers need a calibration on a regular basis. This adjustment procedure is done automatically and can be triggered manually from the operating console or automatically on a time basis (Zero calibration: daily, span calibration: every two days).</p> <p>Certified (Certificates confirming stability of standard gas during monitoring period and 1% uncertainty) standard gases are used for self-calibration.</p> <p>Sample line testing is done annually by applying certified standard gas at the beginning of the sample line. Latest tests have been conducted in June 2013, with positive results.</p> <p>Emerson Process Management Korea has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition. Extended general maintenance service by Emerson Process Management Germany have been conducted in November 2012 and November 2013.</p> <p>Plausibility check is regularly done with laboratory gas chromatography analysis.</p>
Purpose of data:	Calculation of project emissions
Additional comments:	<p>The volumetric fraction of N<sub>2</sub>O is determined and expressed at normal conditions (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>) according to the applied methodology. Monitoring of actual conditions (<math>P_{t,III}</math>, <math>T_{t,III}</math>) is therefore not necessary, as per the applied methodology.</p> <p>Please note, the information indicated in this parameter table refers to the period where the temporary deviation applied. For detailed information on the said temporary deviation, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i> of this Monitoring Report.</p>

Data/parameter:	$C_{H_2O,t,db,n,III}$
Unit	mg H <sub>2</sub> O/m <sup>3</sup> dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems III

Measured/calculated/default	Measured
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content (Measurement Report)
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	As per USEPA CF42 method 4 – Gravimetric determination of water content
Measuring/reading/recording frequency:	As per the PDD, measurements coincide with the first Annual Surveillance Test or the first calibration of the flow meter for the gaseous stream (QAL 2), both associated with requirements of the EN 14181 standard).
Calculation method (if applicable):	-
QA/QC procedures:	According to USEPA CF 42 method 4
Purpose of data:	Calculation of project emissions
Additional comments:	<p>As per the applied “Tool to determine the mass flow of a greenhouse gas in a gaseous stream “, the flow and volumetric fraction may be measured on a dry basis or wet basis. The tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas (Option A to F).</p> <p>As described in the PDD, the option chosen for this project activity is Option A, requiring to demonstrate, that the gaseous stream is dry, whereas the tool suggests two ways to do this:</p> <ul style="list-style-type: none"> <li>(a) Measure the moisture content of the gaseous stream (<math>C_{H_2O,t,db,n}</math>) and demonstrate that this is less or equal to 0.05 kg H<sub>2</sub>O/m<sup>3</sup> dry gas; or</li> <li>(b) Demonstrate that the temperature of the gaseous stream (<math>T_t</math>) is less than 60°C (333.15 K) at the flow measurement point.</li> </ul> <p>In the case of this project activity, the first way (a) has been chosen.</p> <p>The value determined ex-ante for the estimation of Emission Reductions in the PDD was 0.007 kg H<sub>2</sub>O/m<sup>3</sup> dry gas (based on design values) and was hence clearly below the threshold value of 0.05 kg H<sub>2</sub>O/m<sup>3</sup> dry gas. As soon as the nitric acid plant will resume to operation, it is planned to perform the measurement of the moisture content coinciding with the first QAL2 calibration.</p>

Since the volumetric fraction of N<sub>2</sub>O and the volumetric flow of the gaseous stream are both determined and expressed at normal conditions ( $P_n = 101,325 \text{ Pa}$ ;  $T_n = 273.15 \text{ K}$ ), the actual conditions ( $P_{t,III}$ ,  $T_{t,III}$ ) are not required to be monitored, as per the applied methodology.



Parameters from the "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion" (Version 02) of Hu-Chems III

Data/parameter:	FC <sub>i,i,y,III</sub>
Unit	t/yr
Description	Quantity of fuel type i combusted in process j during the year y of Hu-Chems III
Measured/calculated/default	Measured
Source of data	Onsite measuring device (please refer to Monitoring equipment below).  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</b>
Monitoring equipment	Meter location: Located in the propane gas line, upstream of the EnviNOx® reactor (323-R-302). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.  <b>323-FT-3-5121</b> Type: Coriolis flow meter Accuracy class: ± 0.35% Serial number: 14125454 Calibration frequency: 60 months Date of last calibration: 02/06/2011 (Validity: 01/06/2016)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 10 seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>As far as feasible, the consistency of metered fuel consumption quantities is cross-checked for plausibility by an annual energy balance that is based on purchased quantities and stock changes.</p> <p>Furthermore, as far as feasible, where the purchased fuel invoices can be identified specifically for the CDM project (and the specific plant, respectively), the metered fuel consumption quantities are cross-checked with available purchase invoices from the financial records.</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of project emissions
Additional comments:	The fuel (more exactly: hydrocarbon used as reducing agent) applied in the plant is LPG (Liquefied Petroleum Gas) with a major mass fraction (expected levels above 95%) of propane.

Data/parameter:	$W_{C,i,y,III}$
Unit	tC/t
Description	Weighted average mass fraction of carbon in fuel type i in year y of Hu-Chems III
Measured/calculated/default	Measured (by hydrocarbon supplier)
Source of data	Certificate of hydrocarbon supplier
Value(s) of monitored parameter	<b><i>No values available in the monitoring period due to permanent shutdown of the EnviNOx® system and nitric acid plant during the monitoring period</i></b>
Monitoring equipment	Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.
Measuring/reading/recording frequency:	Measuring: In order to assure conservativeness a certificate from the hydrocarbon supplier is requested at least on a yearly basis. This interval basically applies in case of operation of the EnviNOx® system, which was not the case during this monitoring period.
Calculation method (if applicable):	Composition of the delivered hydrocarbon is available on the specific certificates provided by the supplier. The mass fraction of carbon is obtained regularly (if feasible for each fuel delivery), from which weighted average annual values are calculated.
QA/QC procedures:	It is verified, if the applied value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
Purpose of data:	Calculation of project emissions
Additional comments:	Applicable where Option A of the “Tool to calculate project or leakage CO <sub>2</sub> emissions from fossil fuel combustion” (Version 02) is used.  The fuel (more exactly: hydrocarbon used as reducing agent) applied in the plant is LPG (Liquefied Petroleum Gas) with a major mass fraction of propane (about >95%).

**Data and parameters MONITORED during monitoring period which are specifically relevant for plant Hu-Chems IV**

Data/parameter:	$P_{\text{production},y,IV}$
Unit	tHNO <sub>3</sub>
Description	Nitric acid produced in year y of Hu-Chems IV
Measured/calculated/default	Measured
Source of data	Production reports (based on measurements from project participants)  The nitric acid flow and density are measured with a coriolis flow meter, temperature with a temperature measurement and concentration is determined based on measured parameters. Values are sent to the DCS (control room), and the nitric acid production (as 100% HNO <sub>3</sub> ) is calculated based on mass flow and HNO <sub>3</sub> concentration. Final production values are exported in production reports through the DeltaV System.  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>138,204 tHNO<sub>3</sub></b>

Monitoring equipment	<p>Meter location: Located in the nitric acid line, downstream of the absorption tower (324-N-401). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>324-FT-4-609</b>  Type: Coriolis Flowmeter  Accuracy class: <math>\pm 0.35\%</math>  Serial number: 14326811  Calibration frequency: 60 months  Date of penultimate calibration: 02/12/2012 (Validity: 01/12/2017)  Date of last calibration: 27/05/2014 (Validity: 26/05/2019)</p> <p><b>324-TT-4-237</b>  Type: Temperature Transmitter  Accuracy class: <math>\pm 0.15\%</math> of span  Serial number: 966595  Calibration frequency: 48 months  Date of penultimate calibration: 07/05/2013 (Validity: 06/05/2017)  Date of last calibration: 02/06/2014 (Validity: 01/06/2018)</p>
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 Seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline emissions
Additional comments:	The parameter $P_{NA,h,IV}$ (Nitric acid produced in the hour h of Hu-Chems IV) represents the hourly value of $P_{production,y,IV}$ and is used for determining $h_{r,y,IV}$ as per the applied methodology.

<b>Data/parameter:</b>	<b><math>h_{y,IV}</math></b>
Unit	h
Description	Number of hours of operation in year y of Hu-Chems IV
Measured/calculated/default	Measured
Source of data	Measuring device (please refer to Monitoring equipment below)  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>2,857 h</b>

Monitoring equipment	<p>Meter location: Located in the ammonia supply line, upstream of the ammonia oxidation reactor (324-K-402). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>324-FT-4-5020</b>  Type: Coriolis flowmeter  Accuracy class: <math>\pm 0.35\%</math>  Serial number: 14137655  Calibration frequency: 60 Months  Date of penultimate calibration: 30/05/2011 (Validity: 29/05/2016)  Date of last calibration: 27/05/2014 (Validity: 26/05/2019)</p>
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 Seconds Recording: Hourly
Calculation method (if applicable):	The flow of $\text{NH}_3$ to the ammonia oxidation reactor indicates the operational status. In case, the volume flow of $\text{NH}_3$ to the ammonia oxidation reactor lies above the threshold of $500 \text{ Nm}^3/\text{h}$ during an hour, the reactor is considered in operation during the hour.
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime

<b>Data/parameter:</b>	<b><math>h_{r,y,IV}</math></b>
Unit	h
Description	For tertiary $\text{N}_2\text{O}$ abatement, Number of hours ( <i>h</i> ) in year <i>y</i> where the abatement system is by-passed, underperforming or failed of Hu-Chems IV
Measured/calculated/default	Measured
Source of data	Measuring device (please refer to Monitoring equipment below)  Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.
Value(s) of monitored parameter	<b>0 h</b>

Monitoring equipment	<p>HU-Chems IV nitric acid plant has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if:</p> $F_{N_2O, tailgas, h, IV} > EF_{existing, y, IV} \times P_{NA, h, IV}$ <p>The parameters mentioned in the formula are determined and measured as explained in the respective sections of this monitoring report:</p> <ul style="list-style-type: none"> <li>• <math>P_{NA, h, IV}</math> - determination is based on the monitored parameter <math>P_{production, y, IV}</math> (refer to the respective parameter table in this monitoring report)</li> <li>• <math>F_{N_2O, tail gas, h, IV}</math> - determination is based on the monitored parameters <math>V_{t, db, IV}</math>, <math>V_{i, t, db, IV}</math> and <math>C_{H_2O, t, db, n, IV}</math> (refer to the respective parameter tables in this monitoring report)</li> <li>• <math>EF_{existing, y, IV}</math> – determination is based on the ex-ante determined parameters <math>EF_{historical, IV}</math> and <math>EF_{default, y, IV}</math> (refer to the respective parameter tables in this monitoring report)</li> </ul>
Measuring/reading/recording frequency:	<p>Measuring: Continuously Reading: Hourly Recording: Hourly</p>
Calculation method (if applicable):	(Refer to “Monitoring equipment” above)
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p>
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	<p>Records to be maintained during project's lifetime. The parameter <math>P_{NA, h, IV}</math> as used in the formula (Nitric acid produced in the hour h of Hu-Chems IV) represents the hourly value of <math>P_{production, y, IV}</math>.</p>

*Parameters from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0) of Hu-Chems IV*

Data/parameter:	$V_{t, db, IV}$
Unit	m <sup>3</sup> dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis of Hu-Chems IV
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below).</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<p><b>146,986 m<sup>3</sup> dry gas / h</b></p> <p>The value represents an average over the monitoring period. An excel book containing recorded hourly values (covered by this monitoring period), is attached as Appendix 3 to this Monitoring Report.</p>

Monitoring equipment	<p>Meter location: Located in the tail gas line, downstream of the EnviNO<sub>x</sub>® reactor (324-R-402). Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p>Venturi tube, designed and manufactured in accordance with ISO 5167-4:2003</p> <p><b>324-FT-4-4115B/4116B</b>  Type: Differential pressure transmitters  Accuracy class: <math>\pm 0.1\%</math> of span  Serial numbers: 01885787 / 01885788  Calibration frequency: 24 months  Date of penultimate calibrations: 07/05/2013 (Validity: 06/05/2015)  Date of last calibrations: 02/06/2014 (Validity: 01/06/2016)</p> <p><b>324-TT-4-1111/1112</b>  Type: Temperature transmitters  Accuracy class: <math>\pm 0.15\%</math> of span  Serial numbers: 01885791 / 01885792  Calibration frequency: 24 months  Date of penultimate calibrations: 07/05/2013 (Validity: 06/05/2015)  Date of last calibrations: 02/06/2014 (Validity: 01/06/2016)</p> <p><b>324-PT-4-3113/3114</b>  Type: Pressure transmitters  Accuracy class: <math>\pm 0.1\%</math> of span  Serial numbers: 5389820 / 5389821  Calibration frequency: 24 months  Date of penultimate calibrations: 07/05/2013 (Validity: 06/05/2015)  Date of last calibrations: 02/06/2014 (Validity: 01/06/2016)</p>
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p> <p>Plausibility check of measured values is regularly done with recorded values of the redundantly installed instruments.</p>
Purpose of data:	Calculation of project emissions

Additional comments:	<p>Option A parameter according to the applied <i>“Tool to determine the mass flow of a greenhouse gas in a gaseous stream.” (Version 2)</i></p> <p>The volumetric flow is determined and expressed at normal conditions (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>) according to the applied methodology. Monitoring of actual conditions (<math>P_{t,IV}</math>, <math>T_{t,IV}</math>) is therefore not necessary, as per the applied methodology.</p> <p>Dry basis flow measurement, since gaseous stream is considered to be dry (refer to parameter <math>C_{H_2O,t,db,n,IV}</math>)</p> <p>Please note, the information indicated in this parameter table refers to the period where the temporary deviation applied. For detailed information on the said temporary deviation, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i> of this Monitoring Report.</p>
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Data/parameter:	$V_{i,t,db,IV}$
Unit	$\text{m}^3 \text{ gas i} / \text{m}^3 \text{ dry gas}$ ( $\rightarrow \text{m}^3 \text{ N}_2\text{O} / \text{m}^3 \text{ dry gas}$ )
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis of Hu-Chems IV
Measured/calculated/default	Measured
Source of data	<p>Measuring device (please refer to Monitoring equipment below).</p> <p>Please refer also to Section C – 1 (Information Flow) of this Monitoring Report.</p>
Value(s) of monitored parameter	<p><b><math>1.17 \cdot 10^{-4} \text{ m}^3 \text{ gas i} / \text{m}^3 \text{ dry gas}</math></b></p> <p>The value represents an average over the monitoring period. An excel book containing recorded hourly values (covered by this monitoring period), is attached as Appendix 3 to this Monitoring Report.</p>
Monitoring equipment	<p>Meter location: Sample take-off is located in the tail gas line, downstream of the EnviNOx® reactor (324-R-402), and leads (via sample gas line) to the locked analyser house IV (located closely to the EnviNOx® reactor of Hu-Chems plant IV), where the analyser is installed. Please refer also to <i>Section C – 1 (Line diagram)</i> of this Monitoring Report.</p> <p><b>324-AT-4-0107</b>  Type: NDIR Analyzer  Accuracy class: <math>\pm 1\%</math> (zero/span)  Serial number: 990861497818  Calibration frequency: Zero calibration daily (automatically)  Span calibration every two days (automatically)  Third party analyser certification frequency by governmental Korean Testing Laboratory (KTL): 24 months  Date of penultimate certification: 28/03/2012 (Validity: 27/03/2014)  Date of last certification: 11/03/2014 (Validity: 10/03/2016)</p>
Measuring/reading/recording frequency:	<p>Measuring: Continuously  Reading: Every 1 second  Recording: Hourly</p>
Calculation method (if applicable):	-

QA/QC procedures:	<p>The quality assurance and quality control procedures, in terms of equipment operation and maintenance for monitoring instruments used for CDM Monitoring have been incorporated as part of the ISO 9001 and ISO 14001 procedures of HU-CHEMS. Accordingly, calibration and maintenance are part of regular QA/QC of the nitric acid plant (please refer also to section C-3).</p> <p>Please refer also to <i>Section C – 3. Back Up plans / Emergency procedures for monitoring system</i> of this Monitoring Report and respective subitems <i>Back Up Plans for measuring systems / Periodic observation of the automated monitoring system</i> and <i>Systematic measures for QA for monitoring data during analyser down times</i>.</p> <p>QAL 1 Certification pursuant to the standard EN 14181 is available for the monitoring equipment.</p> <p>Accuracy-safeguarding instructions from Emerson Process Management, the manufacturer of the equipment, related to regular self-calibration and quality of used standard gases, are followed.</p> <p>The analyzers need a calibration on a regular basis. This adjustment procedure is done automatically and can be triggered manually from the operating console or automatically on a time basis (Zero calibration: daily, span calibration: every two days).</p> <p>Certified (Certificates confirming stability of standard gas during monitoring period and 1% uncertainty) standard gases are used for self-calibration.</p> <p>Sample line testing is done annually by applying certified standard gas at the beginning of the sample line. Latest tests have been conducted in June 2013, with positive results.</p> <p>Emerson Process Management Korea has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition. Extended general maintenance service by Emerson Process Management Germany have been conducted in November 2012 and November 2013.</p> <p>Plausibility check is regularly done with laboratory gas chromatography analysis.</p>
Purpose of data:	Calculation of project emissions
Additional comments:	<p>The volumetric fraction of N<sub>2</sub>O is determined and expressed at normal conditions (<math>P_n = 101,325 \text{ Pa}</math>; <math>T_n = 273.15 \text{ K}</math>) according to the applied methodology. Monitoring of actual conditions (<math>P_{t,IV}</math>, <math>T_{t,IV}</math>) is therefore not necessary, as per the applied methodology.</p> <p>Please note, the information indicated in this parameter table refers to the period where the temporary deviation applied. For detailed information on the said temporary deviation, please refer to <i>Section B -2.1 (Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline)</i> of this Monitoring Report.</p>

Data/parameter:	$C_{H_2O,t,db,n,IV}$
Unit	mg H <sub>2</sub> O/m <sup>3</sup> dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems IV
Measured/calculated/default	Measured



Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content (Measurement Report)
Value(s) of monitored parameter	<b><math>3.0 \cdot 10^3 \text{ mg H}_2\text{O/m}^3 \text{ dry gas}</math></b> <b>(refer also to comments below)</b>
Monitoring equipment	As per USEPA CF42 method 4 – Gravimetric determination of water content
Measuring/reading/recording frequency:	As per the PDD, measurements coincide with the first Annual Surveillance Test or the first calibration of the flow meter for the gaseous stream (QAL 2), both associated with requirements of the EN 14181 standard).
Calculation method (if applicable):	-
QA/QC procedures:	According to USEPA CF 42 method 4
Purpose of data:	Calculation of project emissions
Additional comments:	<p>As per the applied “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the flow and volumetric fraction may be measured on a dry basis or wet basis. The tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas (Option A to F).</p> <p>As described in the PDD, the option chosen for this project activity is Option A, requiring to demonstrate, that the gaseous stream is dry, whereas the tool suggests two ways to do this:</p> <ul style="list-style-type: none"> <li>(a) Measure the moisture content of the gaseous stream (<math>C_{\text{H}_2\text{O},t,\text{db},n}</math>) and demonstrate that this is less or equal to <math>0.05 \text{ kg H}_2\text{O/m}^3 \text{ dry gas}</math>; or</li> <li>(b) Demonstrate that the temperature of the gaseous stream (<math>T_t</math>) is less than <math>60^\circ\text{C}</math> (<math>333.15 \text{ K}</math>) at the flow measurement point.</li> </ul> <p>In the case of this project activity, the first way (a) has been chosen.</p> <p>As described in section B.2.1 – Temporary deviation of this Monitoring Report, it was not possible for the Project Participants from the beginning of the second crediting period to immediately measure the moisture content of the gaseous stream in plant Hu-Chems IV. As alternative measure, it was proposed to apply the value determined ex-ante for the estimation of Emission Reductions in the PDD. That value was <math>0.003 \text{ kgH}_2\text{O} / \text{m}^3 \text{ dry gas}</math> (based on design values) and was hence clearly below the threshold value of <math>0.05 \text{ kgH}_2\text{O} / \text{m}^3 \text{ dry gas}</math>. Therefore, Option A of the tool (measurement options: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis) was applied.</p> <p>Just for indicative purposes: Already <b>after</b> this monitoring period, repeated measurements of the moisture content in line with the USEPA CF42 method 4 were conducted by the company AIRTEC (which coincided with the QAL2 reference measurements) during 24/09/2013 and clearly showed, that the moisture content of the gaseous stream (<math>C_{\text{H}_2\text{O},t,\text{db},n,\text{IV}}</math>) is below <math>0.004 \text{ kgH}_2\text{O} / \text{m}^3 \text{ dry gas}</math>, which is <i>clearly</i> below the threshold value of <math>0.05 \text{ kg H}_2\text{O/m}^3 \text{ dry gas}</math>. Details on the measuring sequence:</p>

Since the volumetric fraction of  $\text{N}_2\text{O}$  and the volumetric flow of the gaseous stream are both determined and expressed at normal conditions ( $P_n = 101,325 \text{ Pa}$ ;  $T_n = 273.15 \text{ K}$ ), the actual conditions ( $P_{t,\text{IV}}$ ,  $T_{t,\text{IV}}$ ) are not required to be monitored, as per the applied methodology.

### D.3. Implementation of sampling plan

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Not applicable for the project activity.

## SECTION E. Calculation of emission reductions or GHG removals by sinks

All references to formulae and methods used are in compliance with ACM0019 (Version 2), applicable tools and the project documentation (PDD, monitoring plan) and are transparently shown in the excel books (Appendix 3 to this monitoring report). The excel books contain recorded monitored data, a comprehensive calculation of baseline emissions, project emissions and emission reductions with actual values (formulae of calculation are shown in the spreadsheet cells for ease of assessment).

### E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

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#### Overall baseline emissions:

Overall baseline emissions for the project activity are calculated as sum over the separately determined, plant specific baseline emissions, as per following equation:

$$BE_y = BE_{y,II} + BE_{y,III} + BE_{y,IV}$$

Where:

$BE_y$	=	Baseline emissions in year y (t CO <sub>2</sub> e)
$BE_{y,II}$	=	Baseline emissions of plant Hu-Chems II in year y (t CO <sub>2</sub> e)
$BE_{y,III}$	=	Baseline emissions of plant Hu-Chems III in year y (t CO <sub>2</sub> e)
$BE_{y,IV}$	=	Baseline emissions of plant Hu-Chems IV in year y (t CO <sub>2</sub> e)

$BE_y$	$BE_{y,II}$	$BE_{y,III}$	$BE_{y,IV}$
tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e
234,753	0	0	234,753

#### Plant specific baseline emissions:

Plant specific baseline emissions ( $BE_{y,II}$  //  $BE_{y,III}$  //  $BE_{y,IV}$ ) are calculated separately for each plant as per provisions of the methodology & PDD, using the same set of several equations for each plant, as shown below, unless described otherwise. Plant specific suffixes in parameter names have been neglected for all parameters in the following equations in order to prevent confusion and enhance readability.

$$BE_y = \left( \frac{\min\{P_{production,y}; P_{product,max}\} \times EF_{existing,y} + \max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y}}{\max\{P_{production,y}; P_{product,max}\}} \right) \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N_2O} \times 10^{-3}$$

Where:

$BE_y$	=	Baseline emissions in year y (t CO <sub>2</sub> e)
$P_{product,max}$	=	Design capacity (t HNO <sub>3</sub> )
$P_{production,y}$	=	Production of nitric acid in year y (t HNO <sub>3</sub> )
$EF_{existing,y}$	=	N <sub>2</sub> O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N <sub>2</sub> O/t HNO <sub>3</sub> )
$EF_{new,y}$	=	Baseline N <sub>2</sub> O emission factor for nitric acid production in year y (kg N <sub>2</sub> O/t HNO <sub>3</sub> )
$GWP_{N_2O}$	=	Global Warming Potential of N <sub>2</sub> O valid for the commitment period
$h_y$	=	Number of hours in year y during which the plant was in operation (h)

- $h_{r,y}$  = Number of hours ( $h$ ) in year  $y$  where:
- (a) For secondary N<sub>2</sub>O abatement: the abatement system was not installed, underperforming or failed;
  - (b) For tertiary N<sub>2</sub>O abatement: the abatement system is by-passed, underperforming or failed

Hu-Chems II values for the covered monitoring period

BE <sub>y</sub>	EF <sub>existing,y</sub>	EF <sub>new,y</sub>	P <sub>production,y</sub>	P <sub>product,max</sub>	h <sub>y</sub>	h <sub>r,y</sub>	GWP <sub>N2O</sub>
tCO <sub>2</sub> e	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	tHNO <sub>3</sub>	tHNO <sub>3</sub>	h	h	tCO <sub>2</sub> e / tN <sub>2</sub> O
0	12.09	3.50	0	45,120	0	0	298

Hu-Chems III values for the covered monitoring period

BE <sub>y</sub>	EF <sub>existing,y</sub>	EF <sub>new,y</sub>	P <sub>production,y</sub>	P <sub>product,max</sub>	h <sub>y</sub>	h <sub>r,y</sub>	GWP <sub>N2O</sub>
tCO <sub>2</sub> e	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	tHNO <sub>3</sub>	tHNO <sub>3</sub>	h	h	tCO <sub>2</sub> e / tN <sub>2</sub> O
0	11.26	3.50	0	45,120	0	0	298

Hu-Chems IV values for the covered monitoring period

*BE <sub>y</sub>	EF <sub>existing,y</sub>	EF <sub>new,y</sub>	P <sub>production,y</sub>	P <sub>product,max</sub>	h <sub>y</sub>	h <sub>r,y</sub>	GWP <sub>N2O</sub>
tCO <sub>2</sub> e	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	tHNO <sub>3</sub>	tHNO <sub>3</sub>	h	h	tCO <sub>2</sub> e / tN <sub>2</sub> O
234,753	5.70	3.50	138,204	180,480	2,944	0	298

\*Value is conservatively rounded DOWN

The plant specific N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period (EF<sub>existing,y</sub>) is calculated based on following equation:

$$EF_{existing,y} = \min\{EF_{historical}; EF_{default,y}\}$$

Where:

- EF<sub>existing,y</sub> = N<sub>2</sub>O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- EF<sub>historical</sub> = Historical baseline emission factor of the nitric acid plant (kg N<sub>2</sub>O/t HNO<sub>3</sub>)
- EF<sub>default,y</sub> = Default emission factor according to the operating pressure of the ammonia burner in year  $y$  (kg N<sub>2</sub>O/t HNO<sub>3</sub>)

Hu-Chems II values for the covered monitoring period

EF <sub>existing,y</sub>	EF <sub>historical</sub>	EF <sub>default,y</sub> (high pressure)
kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>
12.09	12.09	12.40

Hu-Chems III values for the covered monitoring period

$EF_{\text{existing},y}$	$EF_{\text{historical}}$	$EF_{\text{default},y}$ (high pressure)
kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>
11.26	11.26	12.40

Hu-Chems IV values for the covered monitoring period

$EF_{\text{existing},y}$	$EF_{\text{historical}}$	$EF_{\text{default},y}$ (medium pressure)
kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>	kgN <sub>2</sub> O / tHNO <sub>3</sub>
5.70	5.70	8.20

## E.2. Calculation of project emissions or actual net GHG removals by sinks

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### Overall project emissions:

Overall project emissions for the project activity are calculated as sum over the separately determined, plant specific project emissions, as per following equation:

$$PE_y = PE_{y,II} + PE_{y,III} + PE_{y,IV}$$

Where:

$PE_y$	=	Project emissions in year y (t CO <sub>2</sub> e)
$PE_{y,II}$	=	Project emissions of plant Hu-Chems II in year y (t CO <sub>2</sub> e)
$PE_{y,III}$	=	Project emissions of plant Hu-Chems III in year y (t CO <sub>2</sub> e)
$PE_{y,IV}$	=	Project emissions of plant Hu-Chems IV in year y (t CO <sub>2</sub> e)

$PE_y$	$PE_{y,II}$	$PE_{y,III}$	$PE_{y,IV}$
tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e
29,025	0	0	29,025

### Plant specific project emissions:

Plant specific baseline emissions ( $PE_{y,II}$  //  $PE_{y,III}$  //  $PE_{y,IV}$ ) are calculated separately for each plant as per provisions of the methodology & PDD, using the same set of several equations for each plant, as shown below, unless described otherwise. Plant specific suffixes in parameter names have been neglected for all parameters in the following equations in order to prevent confusion and enhance readability.

$$PE_y = PE_{N_2O,y} + PE_{CO_2,tertiary,y}$$

Where:

$PE_y$	=	Project emissions in year y (t CO <sub>2</sub> e)
$PE_{N_2O,y}$	=	Project emissions of N <sub>2</sub> O from the project plant in year y (t CO <sub>2</sub> e)
$PE_{CO_2,tertiary,y}$	=	Project emissions of CO <sub>2</sub> from the operation of the tertiary N <sub>2</sub> O abatement facility in year y (t CO <sub>2</sub> )

Hu-Chems II values for the covered monitoring period

$PE_y$	$PE_{N_2O,y}$	$PE_{CO_2,tertiary,y}$
t CO <sub>2</sub> e	t CO <sub>2</sub> e	t CO <sub>2</sub> e
0	0	0

Hu-Chems III values for the covered monitoring period

$PE_y$	$PE_{N_2O,y}$	$PE_{CO_2,tertiary,y}$
t CO <sub>2</sub> e	t CO <sub>2</sub> e	t CO <sub>2</sub> e
0	0	0

Hu-Chems IV values for the covered monitoring period

$PE_y$	$PE_{N_2O,y}$	$PE_{CO_2,tertiary,y}$
t CO <sub>2</sub> e	t CO <sub>2</sub> e	t CO <sub>2</sub> e
29,025	29,025	0

The project emissions of N<sub>2</sub>O from the project plant ( $PE_{N_2O,y}$ ) are the emissions from the N<sub>2</sub>O contained in the tail gas stream of the plant which is released to the atmosphere. Accordingly, the plant specific  $PE_{N_2O,y}$  is determined as follows:

$$PE_{N_2O,y} = \sum_1^{h_y-h_{r,y}} F_{N_2O,tail\ gas,h} \times GWP_{N_2O} \times 10^{-3}$$

Where:

- $PE_{N_2O,y}$  = Project emissions of N<sub>2</sub>O from the project plant in year  $y$  (t CO<sub>2</sub>e)
- $GWP_{N_2O}$  = Global warming potential of N<sub>2</sub>O valid for the commitment period
- $F_{N_2O,tail\ gas,h}$  = Mass flow of N<sub>2</sub>O in the gaseous stream of the tail gas in the hour  $h$  (kg N<sub>2</sub>O/h)
- $h_y$  = Number of hours in year  $y$  during which the plant was in operation ( $h$ )
- $h_{r,y}$  = Number of hours ( $h$ ) in year  $y$  where:
- For secondary N<sub>2</sub>O abatement. Abatement system was not installed, underperforming or failed;
  - For tertiary N<sub>2</sub>O abatement. The abatement system is by-passed, underperforming or failed

Hu-Chems II values for the covered monitoring period

$PE_{N_2O,y}$	$\sum_1^{h_y-h_{r,y}} F_{N_2O,tail\ gas,h}$	$h_y$	$h_{r,y}$	$GWP_{N_2O}$
tCO <sub>2</sub> e	tN <sub>2</sub> O	h	h	tCO <sub>2</sub> / tN <sub>2</sub> O
0	0	0	0	298

Hu-Chems III values for the covered monitoring period

$PE_{N_2O,y}$	$\sum_1^{h_y-h_{r,y}} F_{N_2O,tail\ gas,h}$	$h_y$	$h_{r,y}$	$GWP_{N_2O}$
tCO <sub>2</sub> e	tN <sub>2</sub> O	h	h	tCO <sub>2</sub> / tN <sub>2</sub> O
0	0	0	0	298

Hu-Chems IV values for the covered monitoring period

$*PE_{N_2O,y}$	$\sum_1^{h_y-h_{r,y}} F_{N_2O,tail\ gas,h}$	$h_y$	$h_{r,y}$	$GWP_{N_2O}$
tCO <sub>2</sub> e	tN <sub>2</sub> O	h	h	tCO <sub>2</sub> / tN <sub>2</sub> O
29,025	95,031	2,857	0	298

\*Value is conservatively rounded UP and includes conservative correction factor for the period of temporary deviation, as described in *Section B.2.1 – Temporary deviation* of this Monitoring Report

The amount of N<sub>2</sub>O emissions from the tail gas stream of the project plant (effectively, the parameter  $F_{N_2O,tailgas,h}$ ) is determined by using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. In applying the tool, the following provisions apply:

- Throughout the crediting periods of the project activity, the N<sub>2</sub>O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;  
 → *Project situation in this monitoring period: As described in section B.2.1 – Temporary deviation of this Monitoring Report, it was not possible for the Project Participants from the beginning of the second crediting period to fully follow EN 14181. Alternative actions have been defined in said section and have been applied fully and conservatively to the calculation of Project emissions throughout this monitoring period.*
- The monitoring system should provide separate hourly average values for the N<sub>2</sub>O concentration and the volume or mass flow of the tail gas based on two seconds (or shorter) interval readings that are recorded and stored electronically. These N<sub>2</sub>O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;  
 → *Project situation in this monitoring period: fulfilled, hourly data sets (based on two seconds or less interval readings) are available and included in the MS Excel books, which are part of this Monitoring Report as Appendix 3.*
- The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN14181 must be applied to both the N<sub>2</sub>O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;  
 → *Project situation in this monitoring period: As described in section B.2.1 – Temporary deviation of this Monitoring Report, it was not possible for the Project Participants from the beginning of the second crediting period to fully follow EN*

*14181. Alternative actions have been defined in said section and have been applied fully and conservatively to the calculation of Project emissions throughout this monitoring period.*

- (d) If data for either the  $N_2O$  concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of  $N_2O$  concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the  $N_2O$  concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of  $N_2O$  calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;  
*→ Project situation in this monitoring period: fulfilled, values in any such hours have been replaced by the maximum value observed during the monitoring period.*
- (e) In the case that the  $N_2O$  concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters  $P_t$  and  $T_t$  do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.  
*→ Project situation in this monitoring period:  $N_2O$  concentration and volume flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters  $P_t$  and  $T_t$  do thus not need to be monitored (as also described in the registered PDD).*

As described in the PDD according to the applied tool the mass flow of greenhouse gas  $i$  in the gaseous stream in time interval  $t$  ( $F_{i,t}$ ) is calculated based on measurements of

- (a) the total volume flow or mass flow of the gas stream; and
- (b) the volumetric fraction of the gas in the gaseous stream; and
- (c) the gas composition and water content.

The flow and volumetric fraction may be measured on a dry basis or wet basis. The tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas (Option A to F).

As stated in the PDD, the option chosen for this project activity is Option A, requiring to demonstrate, that the gaseous stream is dry, whereas the tool suggests two ways to do this:

- (a) Measure the moisture content of the gaseous stream ( $C_{H_2O,t,db,n}$ ) and demonstrate that this is less or equal to 0.05 kg  $H_2O/m^3$  dry gas; or
- (b) Demonstrate that the temperature of the gaseous stream ( $T_t$ ) is less than 60°C (333.15 K) at the flow measurement point.

*Specifically in this monitoring period, for plants Hu-Chems II and Hu-Chems III, this is not applicable as they were in permanent shutdown, i.e. no Emission Reductions are claimed out of these plants. Also, as described in section B.2.1 – Temporary deviation of this Monitoring Report, it was not possible for the Project Participants from the beginning of the second crediting period to immediately measure the moisture content of the gaseous stream in plant Hu-Chems IV ( $C_{H_2O,t,db,n,IV}$ ). As alternative measure, it was proposed to apply the value determined ex-ante for the estimation of Emission Reductions in the PDD. That value was 0.003 kg $H_2O / m^3$  dry gas (based on design values) and was hence clearly below the threshold value of 0.05 kg $H_2O / m^3$  dry gas. Therefore, Option A of the tool (measurement options: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis) was applied.*

Just for indicative purposes: Already **after** this monitoring period, repeated measurements of the moisture content in line with the USEPA CF42 method 4 were conducted by the company AIRTEC (which coincided with the QAL2 reference measurements) during 24/09/2013 and clearly showed,

that the moisture content of the gaseous stream ( $C_{H_2O,t,db,n,IV}$ ) is below 0.004 kgH<sub>2</sub>O / m<sup>3</sup> dry gas, which is *clearly* below the threshold value of 0.05 kg H<sub>2</sub>O/m<sup>3</sup> dry gas. Details on the measuring sequence:

The project emissions of N<sub>2</sub>O from the project plant ( $PE_{N_2O,y}$ ) are the emissions from the N<sub>2</sub>O contained in the tail gas stream of the plant which is released to the atmosphere. Accordingly, the plant specific  $PE_{N_2O,y}$  is determined as follows:

Therefore, the mass flow of greenhouse gas i ( $F_{i,t}$ )<sup>5</sup> is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$

With

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval t on a dry basis (m <sup>3</sup> dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m <sup>3</sup> gas i/m <sup>3</sup> dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m <sup>3</sup> gas i)
$P_t$	=	Absolute pressure of the gaseous stream in time interval t (Pa)
$MM_i$	=	Molecular mass of greenhouse gas i (kg/kmol)
$R_u$	=	Universal ideal gases constant (Pa.m <sup>3</sup> /kmol.K)
$T_t$	=	Temperature of the gaseous stream in time interval t (K)

When applying normal conditions and as described in section B.6.1 of the PDD, the density at normal conditions ( $P_t = P_n = 101,325$  Pa;  $T_t = T_n = 273.15$  K) was determined to be constantly 1.96 kg/m<sup>3</sup><sup>6</sup>. Respective parameters need not to be monitored according to the methodology.

For calculation of  $F_{N_2O,tailgas,h}$ , as well as application of calibration curves or corrections to data in case of observations & events (as described in section B.1. / (c)) on an hourly basis, please refer to the excel books which are available as Appendix 3 to this Monitoring Report.

<sup>5</sup>  $F_{i,t}$  corresponds to the parameter  $F_{N_2O,tail gas,h}$  of the methodology ACM0019 (Version 2).

<sup>6</sup>  $\rho_{i,t} = (P_n \times MM_i) / (T_n \times R_u) = 1.96$  kg/m<sup>3</sup>



The Project emissions from the operation of the tertiary N<sub>2</sub>O abatement facility ( $PE_{CO_2,tertiary,y}$ ) only need to be considered if a tertiary N<sub>2</sub>O abatement facility is installed under the project activity and if fossil fuels are used to operate the facility or re-heat the gas after the facility. Specifically to this project activity, this situation applies to plants Hu-Chems II and Hu-Chems III where propane (supplied as LPG) is used as reducing agent in the tertiary N<sub>2</sub>O abatement facilities. No fossil fuel is used in plant Hu-Chems IV. Hence, the following set of equations is applied exclusively for plants Hu-Chems II and Hu-Chems III, whereas the value for  $PE_{CO_2,tertiary,y}$  is **set to zero** due to inapplicability of this emission source in plant Hu-Chems IV (associated parameters are not monitored accordingly).

$$PE_{CO_2,tertiary,y} = PE_{FF,y}$$

Where:

- $PE_{CO_2,tertiary,y}$  = Project emissions of CO<sub>2</sub> from the operation of the tertiary N<sub>2</sub>O abatement facility in year y (t CO<sub>2</sub>)
- $PE_{FF,y}$  = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO<sub>2</sub>)

For determination of  $PE_{FF,y}$ , the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” shall be used to calculate the project emissions related to fossil fuels used in year y.

Specific guidance on the use of the tool are:

- The parameter  $PE_{FC,j,y}$  used in the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” corresponds to the parameter  $PE_{FF,y}$  in the methodology ACM0019 (Version 2), and
- The element process  $j$  in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N<sub>2</sub>O abatement facility and/or the re-heating of the tail gas.

According to the applied tool CO<sub>2</sub> emissions from fossil fuel combustion in process  $j$  are calculated based on the quantity of fuels combusted and the CO<sub>2</sub> emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:

- $PE_{FC,j,y}$  = Are the CO<sub>2</sub> emissions from fossil fuel combustion in process  $j$  during the year  $y$  (tCO<sub>2</sub>/yr)
- $FC_{i,j,y}$  = Is the quantity of fuel type  $i$  combusted in process  $j$  during the year  $y$  (t/yr)
- $COEF_{i,y}$  = Is the CO<sub>2</sub> emission coefficient of fuel type  $i$  in year  $y$  (tCO<sub>2</sub>/t)
- $i$  = Are the fuel types combusted in process  $j$  during the year  $y$

During this monitoring period, plant Hu-Chems II and plant Hu-Chems III were permanently out of operation and so were the respective tertiary abatement facilities (EnviNOx® systems). Thus, the calculation is not applicable due to non-use of fossil fuel (hydrocarbon). Instead, the value for  $PE_{FC,j,y}$  is **set to zero** for plant Hu-Chems II and plant Hu-Chems III instead. The underlying calculation of  $COEF_{i,y}$  is hence also not applicable.

Hu-Chems II values for the covered monitoring period

$PE_{CO2,tertiary,y} =$ $PE_{FF,y} = PE_{FC,j,y}$
tCO <sub>2</sub> /yr
0

Hu-Chems III values for the covered monitoring period

$PE_{CO2,tertiary,y} =$ $PE_{FF,y} = PE_{FC,j,y}$
tCO <sub>2</sub> /yr
0

Basically, Option A of the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion “ is applied, as the chemical composition of the used fossil fuel (i.e. LPG) is provided by the fuel supplier. According to Option A of said tool, the CO<sub>2</sub> emission coefficient  $COEF_{i,y}$  is calculated based on the chemical composition of the fossil fuel type  $i$ , using the following approach:

$$COEF_{i,y} = w_{C,i,y} \times 44/12$$

Where:

- $COEF_{i,y}$  = Is the CO<sub>2</sub> emission coefficient of fuel type  $i$  (t CO<sub>2</sub>/t)  
 $w_{C,i,y}$  = Is the weighted average mass fraction of carbon in fuel type  $i$  in year  $y$  (t C/t)  
 $i$  = Are the fuel types combusted in process  $j$  during the year  $y$

During this monitoring period, plant Hu-Chems II and plant Hu-Chems III were permanently out of operation and so were the respective tertiary abatement facilities (EnviNOx® systems). Thus, the calculation of  $COEF_{i,y}$  is not applicable due to non-use of fossil fuel (LPG).

### E.3. Calculation of leakage

>>

According to the applied methodology (ACM0019 v02.0) any leakage emissions sources are deemed to be negligible.

**E.4. Summary of calculation of emission reductions or net GHG removals by sinks**

Item	Baseline emissions or baseline net GHG removals by sinks (t CO <sub>2</sub> e)	Project emissions or actual net GHG removals by sinks (t CO <sub>2</sub> e)	Leakage (t CO <sub>2</sub> e)	GHG emission reductions or net GHG removals by sinks (t CO <sub>2</sub> e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
<b>Total</b>	234,753	29,025	0	0	205,728	205,728

**E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD**

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO <sub>2</sub> e)	<p><b>Amount estimated in PDD for 2014: 1,172,010</b></p> <p><b>→ Corresponding estimated amount for the duration of the monitoring period (141 days): 480,388</b></p>	<b>205,728</b>

Actual emission reductions achieved during this monitoring period are lower than values estimated in ex-ante calculation of registered PDD. Plant-by-plant assessment is done in section E.6. below.

**E.6. Remarks on difference from estimated value in registered PDD**

>>

## Comparison of emission reductions with PDD values – Hu-Chems II

Comparison of ER with PDD values: Hu-Chems II	
Source	Value
Emission reduction estimation according to PDD for 2014	262,749 tCO <sub>2</sub> e
Corresponding PDD estimation (over 141 days; rounded)	107,697 tCO <sub>2</sub> e
Actual calculation of emission reduction in monitoring period (over 141 days)	0 tCO <sub>2</sub> e

Actual emission reductions in plant Hu-Chems II were zero due to the permanent shutdown of the nitric acid plant and the respective EnviNOx® system during the monitoring period.

## Comparison of emission reductions with PDD values – Hu-Chems III

Comparison of ER with PDD values: Hu-Chems III	
Source	Value
Emission reduction estimation according to PDD for 2014	274,819 tCO <sub>2</sub> e
Corresponding PDD estimation (over 141 days; rounded)	112,644 tCO <sub>2</sub> e
Actual calculation of emission reduction in monitoring period (over 141 days)	0 tCO <sub>2</sub> e

Actual emission reductions in plant Hu-Chems III were zero due to the permanent shutdown of the nitric acid plant and the respective EnviNOx® system during the monitoring period.

## Comparison of emission reductions with PDD values – Hu-Chems IV

Comparison of ER with PDD values: Hu-Chems IV	
Source	Value
Emission reduction estimation according to PDD for 2014	634,443 tCO <sub>2</sub> e
Corresponding PDD estimation (over 141 days; rounded)	260,048 tCO <sub>2</sub> e
Actual calculation of emission reduction in monitoring period (over 141 days)	205,728 tCO <sub>2</sub> e

Actual emission reductions in plant Hu-Chems IV were below the ex-ante PDD estimation for this monitoring period.

- - - - -

## Appendix 1. Contact information of project participants and responsible persons/entities

<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Person/entity responsible for completing the CDM-MR-FORM
<b>Organization name</b>	Hu-Chems Fine Chemical Corp.
<b>Street/P.O. Box</b>	19 <sup>th</sup> Floor Kukdong Bldg., 60-1, Chungmuro 3ga. Jung-gu
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<b>State/region</b>	-
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<b>Country</b>	Republic of Korea
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<b>E-mail</b>	-
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<b>Title</b>	-
<b>Salutation</b>	-
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<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Person/entity responsible for completing the CDM-MR-FORM
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## Appendix 2. Social Fund

As described in the PDD a Social Fund was established by the project developer and the project operator. This fund contributes to the social benefit of the people living in the area of the project activity by financing projects and social activities. Projects and organizations that have been supported by the CDM Social Fund are the Yeo-do academy (improvement of basic elementary and secondary education), the In-Company welfare fund (contribution to working employee's life stabilization and welfare improvement) as well as the Sang-Am village fund. Furthermore, donations towards disabled people and people endangered from poverty as well as towards projects for environmental conservation have been made. Evidence / Documentation on contributions and donations is made available to the DOE for verification. Payments from the CDM Project to the Social Fund in the recent years were at follows:

- Social Fund 2007: 250,931,278 WON (~ 150,000 Euro)
- Social Fund 2008: 854,902,652 WON (~ 530,000 Euro)
- Social Fund 2009: 582,706,027 WON (~ 320,000 Euro)
- Social Fund 2010: 618,891,360 WON (~ 400,000 Euro)
- Social Fund 2011: 911,028,406 WON (~ 590,000 Euro)
- Social Fund 2012: 500,672,562 WON (~ 340,000 Euro)
- Social Fund 2013: 167,396,468 WON (~ 114,000 Euro)



## Appendix 3. Emission Reduction Calculation

Excel books containing monitored data and calculations of baseline emissions, project emissions and emission reductions and additional checks and information is attached:

HUC-0765\_II\_MP#27\_UNFCCC\_v1\_FINAL.xlsx  
HUC-0765\_III\_MP#27\_UNFCCC\_v1\_FINAL.xlsx  
HUC-0765\_IV\_MP#27\_UNFCCC\_v1\_FINAL.xlsx  
HUC-0765\_OVERALL\_MP#27\_UNFCCC\_v1\_FINAL.xlsx

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## Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> <li>• Include provisions related to delayed submission of a monitoring plan;</li> <li>• Provisions related to the Host Party;</li> <li>• Remove reference to programme of activities;</li> <li>• Overall editorial improvement.</li> </ul>
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>;</li> <li>• Editorial improvement.</li> </ul>
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Appendix 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		