Monitoring report form

(Version 05.1)

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

MONITORING REPORT		
Title of the project activity	Catalytic N_2O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.	
UNFCCC reference number of the project activity	0765	
Version number of the monitoring report	Version 2	
Completion date of the monitoring report	16/11/2016	
Monitoring period number and duration of this monitoring period	Monitoring period number: 31 (Monitoring period 5 in the 2nd crediting period) Duration: 01/04/2016 – 30/09/2016	
Project participant(s)	CARBON CDM Korea Ltd. Hu-Chems Fine Chemical Corp. RWE Power AG Carbon Climate Protection GmbH	
Host Party	Republic of Korea	
Sectoral scope(s)	Sectoral scope 5: Chemical industries	
Selected methodology(ies)	ACM0019 Version 02.0 (N_2O abatement from nitric acid production)	
Selected standardized baseline(s)	No standardized baseline(s) applicable	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	Amount estimated in PDD for 2016: 1,241,313 tCO_2e → Corresponding estimated amount for the duration of the monitoring period (183 days): 620,657 tCO_2e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	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
	N/A	378,497 tCO_2e

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_2O 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_2O in three nitric acid (furthermore called "NA") 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_x and N_2O additionally to the equipment at the three NA 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** NA plants is based on the catalytic reduction of NO_x (NO and NO_2) with ammonia (NH_3) and of nitrous oxide (N_2O) with a hydrocarbon. The hydrocarbon used is LPG of which the main constituent is propane (C_3H_8). The reactions take place over an iron zeolite catalyst bed.
The EnviNOx® process used in the **Hu-Chems IV** NA plant is based on the catalytic decomposition of nitrous oxide (N_2O) and the catalytic reduction of NO_x (NO and NO_2) with ammonia (NH_3). 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_2O 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_2O started in the end of March 2007.

d) Throughout the 1st crediting period of the CDM project activity had been implemented as well as operated & monitored continuously according to the approved CDM methodology AM0028 v1. A Request for Renewal of Crediting Period with a new PDD under the methodology ACM0019 v2 was submitted by the Project Participants and the crediting period was renewed on February 5th 2014.

e) Total emission reductions achieved in this monitoring period: **378,497 tCO_2e**

A.2. Location of project activity

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

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** (furthermore called "CARBON") is registered under the laws of Austria. Both companies 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_2O destruction in the tail gas of NA plants. It has initially developed the methodology for destruction of N_2O in the tail gas of NA 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_2O abatement in from NA 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 (NA, 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 9001 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 NA 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 has a diverse generation portfolio including lignite, hard coal, nuclear energy, gas and renewable sources such as hydro and wind. RWE Power AG as part of the RWE Group is responsible for power generation units in Germany. RWE invests and participates actively in projects under the Clean Development Mechanism. 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 Joint Implementation 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_2O abatement from nitric acid production" (Version 02.0)[1]

The methodology 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[2].

Furthermore, the applied methodology refers to the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" in its latest version, thus the tool is applied in this project activity.[3]

No standardized baselines are used.

A.5. Crediting period of project activity

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The project is currently in its 2nd crediting period.

Type of the crediting period:	Renewable (3 x 7 years)
Starting date of the 2nd crediting period:	22/01/2014
End date of the 2nd crediting period:	21/01/2021
Length of the 2nd crediting period:	7 years (renewable)

Already before the 2nd crediting period, dates regarding the 1st crediting period were changed:

Expected starting date of 1st crediting period:	From 15/12/2006 to 22/01/2007
Expected end date of 1st crediting period:	From 14/12/2013 to 21/01/2014

A.6. Contact information of responsible persons/entities

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Carbon Climate Protection GmbH
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Tel.: +43 2734 32 270 70
Email: bichler@carbon-austria.com

1 http://cdm.unfccc.int/methodologies/DB/MNMFNF10VUEOJACEIRX3EHYC9QXGDC
2 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf
3 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

CARBON is a project participant. For further information please refer to Appendix 1.

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 NA 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 (1st crediting period of project activity):

- Hu-Chems NA plant II: 26 March 2007
- Hu-Chems NA plant III: 29 March 2007
- Hu-Chems NA 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, monitoring and metering equipment) in place. Monitoring is done according to the applied methodology (ACM0019 v2) and registered monitoring plan.

Specifically in the monitoring period covered by this monitoring report (MR), it shall be considered that the NA plant Hu-Chems II and thus also its EnviNOx® system was permanently shut down due to NA inventory control. For this plant, no emission reductions are claimed during the monitoring period covered by this MR.

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

General introduction

Nitrous oxide (N_2O) is an unwanted, invisible and previously neglected by-product of the manufacture of NA. 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 NA takes place in three main process steps as indicated by the following reactions:

1. Ammonia (NH_3) combustion to form nitric oxide (NO)[4]:

   $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$ (main reaction 1)

Simultaneously nitrous oxide (N_2O), nitrogen (N) and water (H_2O) are formed as well, in accordance with the following equations:

$4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$ (side reaction 1)
$4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$ (side reaction 2)

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_2):

   $2\ NO + O_2 \rightarrow 2\ NO_2$ (main reaction 2)

3. (According to the technical process) Absorption of NO_2 in water to form NA (HNO_3):

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

$3\ NO_2 + H_2O \rightarrow 2\ HNO_3 + NO$ (main reaction 3)
(NO is oxidised to NO_2 according to main reaction 2)

Description of catalytic reduction process:
Although the term catalytic reduction nowadays has a more general definition in terms of the transfer of electrons, the following definition is sufficient for present purposes: catalytic reduction of N_2O occurs when reactions take place between N_2O and other substances in contact with a catalyst, such that the oxygen is removed from the N_2O molecule and forms one or more compounds with other species. The substance or substances that react with N_2O to remove oxygen are termed reducing agent. A general reaction equation for the catalytic reduction of N_2O can be given as:

$$n\ N_2O + x\ RA \rightarrow n\ N_2 + y_1\ P(1)O_A + y_2\ P(2)O_B + ...+ z_1\ Q(1) + z_2\ Q(2) + ...$$

Where RA is a molecule of the reducing agent, $P(1)O_A$, $P(2)O_B$ are the compound formed by reaction with the oxygen of the N_2O and Q(1), Q(2) represent further products of the oxidation reaction, n, x, y_1, y_2, z_1, z_2 are the appropriate stoichiometric coefficients.

Equations reduction N_2O with propane:

$$C_3H_8 + 7\ N_2O \rightarrow 3\ CO + 4\ H_2O + 7\ N_2 \quad \text{or} \quad C_3H_8 + 10\ N_2O \rightarrow 3\ CO_2 + 4\ H_2O + 10\ N_2$$

The definition does not exclude the possibility of side reactions resulting in consumption of reducing agent without any reduction of N_2O, for example with propane:

$$2\ C_3H_8 + 7\ O_2 \rightarrow 6\ CO + 8\ H_2O \quad \text{or} \quad C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

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

Overall reaction:

$$2\ N_2O \rightarrow 2\ N_2 + O_2$$

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

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 NA plants is based on the catalytic reduction of NO_x (NO and NO_2) with ammonia (NH_3) and of nitrous oxide (N_2O) with a hydrocarbon. The hydrocarbon used is propane gas of which the main constituent is propane (C_3H_8). The reactions take place over an iron zeolite catalyst bed. First the NO_x is reduced with ammonia according to such reactions as:

$$6\ NO_2 + 8\ NH_3 \rightarrow 7\ N_2 + 12\ H_2O$$
$$6\ NO + 4\ NH_3 \rightarrow 5\ N_2 + 6\ H_2O$$
$$NO + NO_2 + 2\ NH_3 \rightarrow 2\ N_2 + 3\ H_2O$$
$$4\ NO + O_2 + 4\ NH_3 \rightarrow 4\ N_2 + 6\ H_2O$$

Effectively almost all the NO_x is removed. Some destruction of N_2O also occurs.
Second, the nitrous oxide is reduced with hydrocarbons over the iron zeolite according to such reactions as:

$$7\ N_2O + C_3H_8 \rightarrow 7\ N_2 + 4\ H_2O + 3\ CO$$
$$10\ N_2O + C_3H_8 \rightarrow 10\ N_2 + 4\ H_2O + 3\ CO_2$$
$$5\ O_2 + C_3H_8 \rightarrow 4\ H_2O + 3\ CO_2$$
$$7\ O_2 + 2\ C_3H_8 \rightarrow 8\ H_2O + 6\ CO$$

Similar reactions take place between nitrous oxide and the small quantities of other hydrocarbons such as butane (C_4H_{10}) that are present in the commercial propane used. N_2O reduction by these reactions is much more effective when NO_x is absent. A large proportion of the carbon monoxide that is formed is further oxidised to carbon dioxide over a second EnviCat®-CO / CH catalyst installed in the EnviNOx® reactor downstream of the first catalyst:

$$2\ CO + O_2 \rightarrow 2\ CO_2$$

All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor. Compared with the reduction in greenhouse gas emission achieved by the destruction of N_2O the additional greenhouse gas emissions (CO_2) caused by the use of hydrocarbons in the process are insignificant but are monitored.

Principles of the EnviNOx® process Hu-Chems IV:
The EnviNOx® process used in the Hu-Chems IV NA plant is based on the catalytic decomposition of nitrous oxide (N_2O) and the catalytic reduction of NO_x (NO and NO_2) with ammonia (NH_3). This process works well at temperatures above about 425°C. The reactions take place over two iron zeolite catalyst beds. In the first bed N_2O is catalytically decomposed:

$$2\ N_2O \rightarrow 2\ N_2 + O_2$$

This rate of this reaction is enhanced by high concentrations of NO_X. Before the tail gas enters the second catalyst bed, a small quantity of ammonia vapour is added. In the second bed a large part of the NO_x is reduced with ammonia according to such reactions as:

$$6\ NO_2 + 8\ NH_3 \rightarrow 7\ N_2 + 12\ H_2O$$
$$6\ NO + 4\ NH_3 \rightarrow 5\ N_2 + 6\ H_2O$$
$$NO + NO_2 + 2\ NH_3 \rightarrow 2\ N_2 + 3\ H_2O$$
$$4\ NO + O_2 + 4\ NH_3 \rightarrow 4\ N_2 + 6\ H_2O$$

Some further destruction of N_2O 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 NO_x and N_2O additionally to the equipment at the three NA 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 N_2O destruction project at Hu-Chems II and III involves that propane is employed as a reducing agent for N_2O removal.

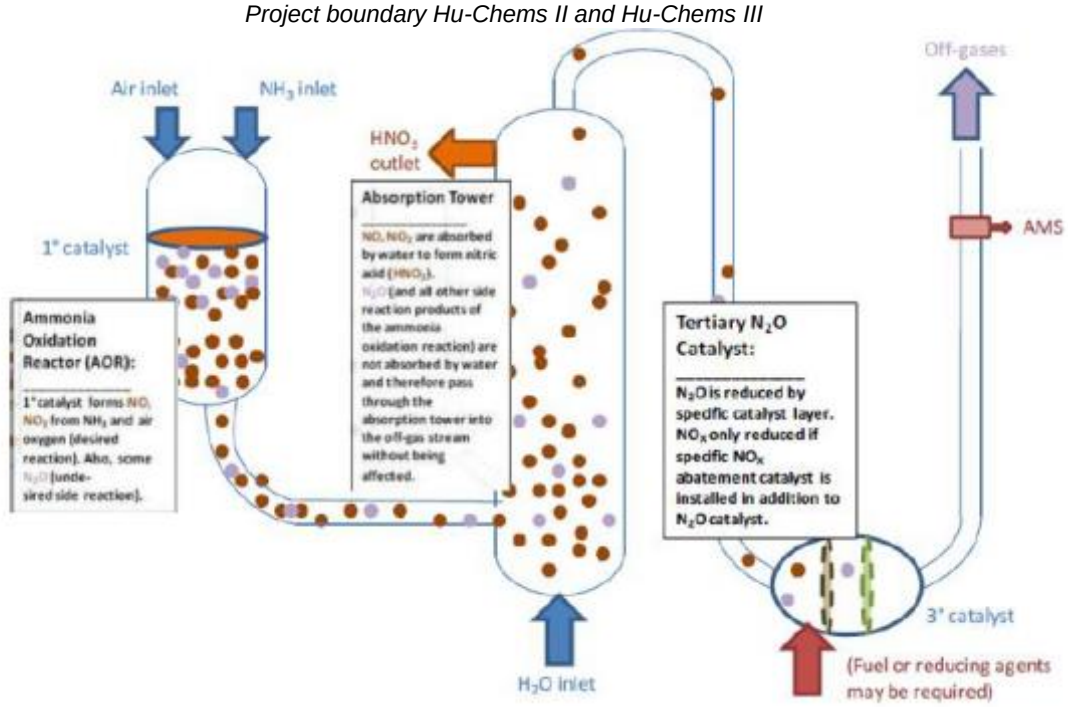
Location of the EnviNOx® systems:
Hu-Chems II: The new EnviNOx® reactor (322-R-202) is located between the existing SCR DeNOx reactor (322-R-201) and the tail gas turbine (322-C-201-T2), which is the position with the highest tail gas temperature in the NA production process at Hu-Chems II.

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), which is the position with the highest tail gas temperature in the NA production process at Hu-Chems III.

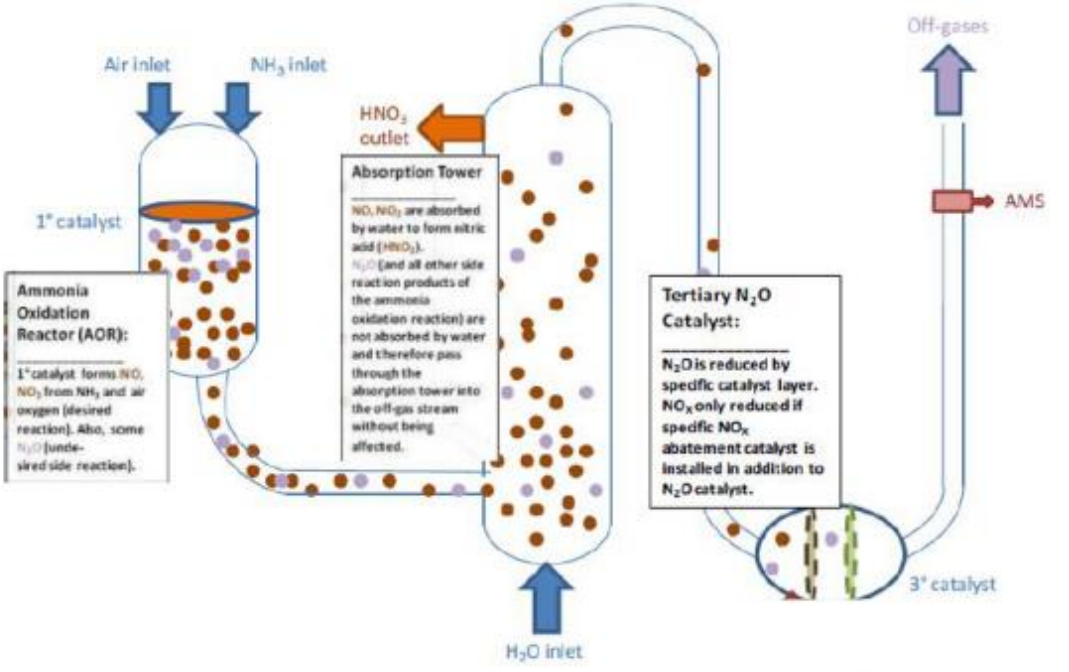
Hu-Chems IV: The new EnviNOx® reactor (324-R-402) is located upstream of the tail gas turbine (324-C-401-T2) at the position with the highest tail gas temperature in the NA production process at Hu-Chems IV. The SCR DeNOx reactor, which was in operation prior to the CDM project activity, has been de-commissioned.

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 NA plants & EnviNOx® systems:
During the below mentioned periods, NA plants (and so the EnviNOx® systems) were out of operation due to the given reasons. No emission reductions are claimed during these downtimes:

Plant	START		END		Description
	Date	Time	Date	Time	
II	Ongoing at the start of monitoring period		Ongoing at the end of monitoring period		NA plant shutdown (inventory control)
Plant	**START**		**END**		**Description**
	Date	**Time**	**Date**	**Time**	
III	Ongoing at the start of monitoring period		02/09/2016	19:00	NA plant shutdown (inventory control)
Plant	**START**		**END**		**Description**
	Date	**Time**	**Date**	**Time**	
IV	Ongoing at the start of monitoring period		04/04/2016	20:00	NA plant shutdown (Plant Turn Around & AOR catalyst replacement)
IV	04/04/2016	22:00	05/04/2016	19:00	NA plant shutdown (problem with boiler feed)
IV	21/09/2016	01:00	22/09/2016	22:00	NA plant shutdown (AOR catalyst replacement)

Relevant observations during the monitoring period:
During the below mentioned periods, observations related to the operation of the EnviNOx® systems and the AMS have been made.

Observations in NA plant & EnviNOx® system Hu-Chems II: No relevant observations due to permanent shutdown during the monitoring period.

Observations in NA plant & EnviNOx® system Hu-Chems III:

Date	Time	Date	Time	Observation, Reason & Conservative Action
06/09/2016	11:00	06/09/2016	13:00	Observation: Fluctuation of NA production Reason: Check of NA flowmeter Conservative action: Recalculation of NA production by applying min. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
07/09/2016	10:00	07/09/2016	16:00	Observation: Fluctuation of N_2O concentration Reason: QAL2 test by AIRTEC Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
09/09/2016	17:00	09/09/2016	21:00	Observation: Fluctuation of NA production Reason: Check of NA flowmeter Conservative action: Recalculation of NA production by applying min. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
19/09/2016	13:00	19/09/2016	15:00	Observation: Fluctuation of NA production Reason: Check of NA flowmeter Conservative action: Recalculation of NA production by applying min. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
22/09/2016	09:00	22/09/2016	10:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
23/09/2016	09:00	23/09/2016	14:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
24/09/2016	09:00	24/09/2016	10:00	Observation: Fluctuation of NA production Reason: Check of NA flowmeter

				Conservative action: Recalculation of NA production by applying min. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
26/09/2016	13:00	26/09/2016	17:00	Observation: Fluctuation of NA production Reason: Check of NA flowmeter Conservative action: Recalculation of NA production by applying min. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
28/09/2016	10:00	28/09/2016	12:00	Observation: Fluctuation of NA production Reason: Check of NA flowmeter Conservative action: Recalculation of NA production by applying min. value of monitoring period (in accordance with ACM0019 v2 & the PDD)

Observations in NA plant & EnviNOx® system Hu-Chems IV:

Date	Time	Date	Time	Observation, Reason & Conservative Action
05/04/2016	19:00	06/04/2016	14:00	Observation: Fluctuation of N_2O concentration Reason: Outlet analyser sample lines blockage Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
11/04/2016	10:00	11/04/2016	15:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check & quarterly inspection by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
12/04/2016	11:00	12/04/2016	14:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check & quarterly inspection by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
16/05/2016	10:00	16/05/2016	16:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
17/05/2016	11:00	17/05/2016	12:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
16/06/2016	14:00	16/06/2016	17:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
17/06/2016	11:00	17/06/2016	12:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
05/07/2016	11:00	05/07/2016	15:00	Observation: Fluctuation of N_2O concentration Reason: Outlet analyser error Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
18/07/2016	10:00	18/07/2016	17:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check & quarterly inspection by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
19/07/2016	11:00	19/07/2016	13:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check & quarterly inspection by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
15/08/2016	13:00	15/08/2016	16:00	Observation: Fluctuation of N_2O concentration Reason: Outlet analyser check Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)

18/08/2016	13:00	18/08/2016	16:00	Observation: Fluctuation of N_2O concentration Reason: Outlet analyser error Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
25/08/2016	10:00	25/08/2016	13:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
26/08/2016	11:00	26/08/2016	14:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
16/09/2016	09:00	16/09/2016	17:00	Observation: Fluctuation of N_2O concentration Reason: Outlet analyser check Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
18/09/2016	09:00	18/09/2016	14:00	Observation: Fluctuation of N_2O concentration Reason: Outlet analyser sample lines blockage Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)
23/09/2016	11:00	23/09/2016	12:00	Observation: Fluctuation of N_2O concentration Reason: Monthly health check by EMERSON Conservative action: Recalculation of N_2O concentration by applying max. value of monitoring period (in accordance with ACM0019 v2 & the PDD)

During the mentioned periods, the NA plant IV as well as the respective EnviNOx® system were in normal operation and emission reductions have been conservatively determined fully in line with the applied methodology and the registered monitoring plan – as described in section *C.4 Systematic Measures* of this MR.

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 v2 as well as the registered monitoring plan and according to the supplier recommendations (i.e. Emerson Process Management). As pointed out in section *C.3*, Hu-Chems has mandated Emerson Process Management Korea (furthermore called "EPMK") 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 shutdown schedule of the NA plants; valid calibration records for all relevant monitoring instruments are available and submitted to the DOE for verification (see details section *D.2*).

As further pointed out in section *C.3*, the project participants have contracted EPMK to execute monthly onsite **health checks** and/or quarterly onsite **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 EPMK in April 2016, May 2016, June 2016, July 2016, August 2016 and September 2016 and attest good condition and availability of the system (i.e. sampling system, analyser as well as AMS hard- and software and total Delta V DCS system). Extended general maintenance and calibration was performed by Emerson Korea in August 2016.

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

>>
No such temporary deviations applied to this monitoring period.

B.2.2. Corrections

>>
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

>>
No such changes have applied to this monitoring period neither to any previous monitoring periods in the 2nd crediting period.

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

>>
No such inclusion has applied to this monitoring period.

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

>>
No such permanent changes have applied to this monitoring period.

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

>>
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

>>
N/A

SECTION C. Description of monitoring system

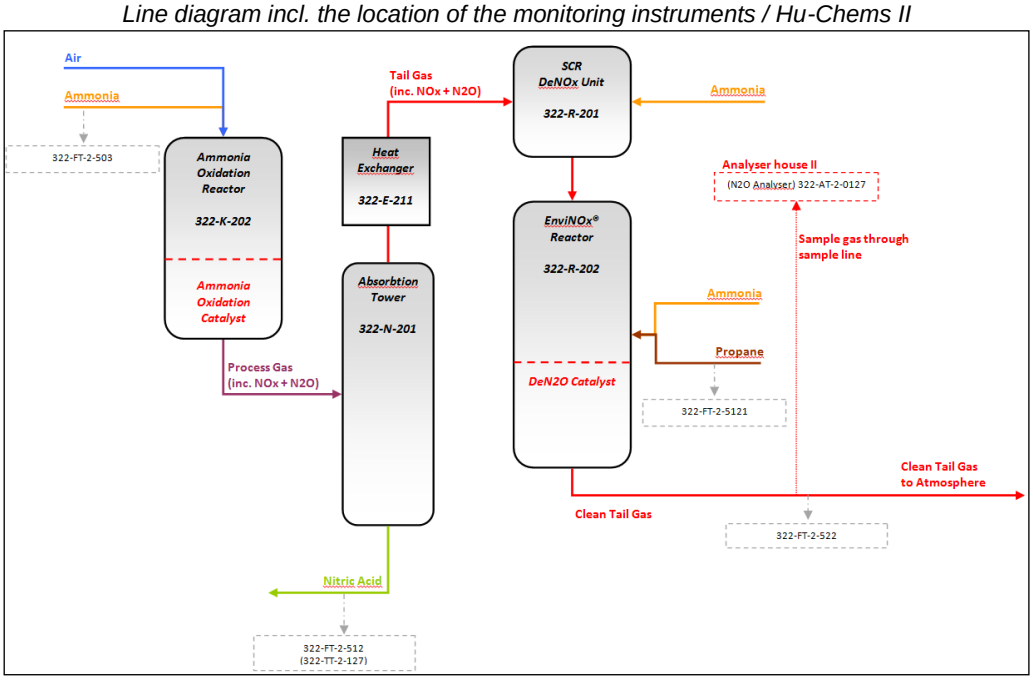
>>

a) Information flow / data collection procedures

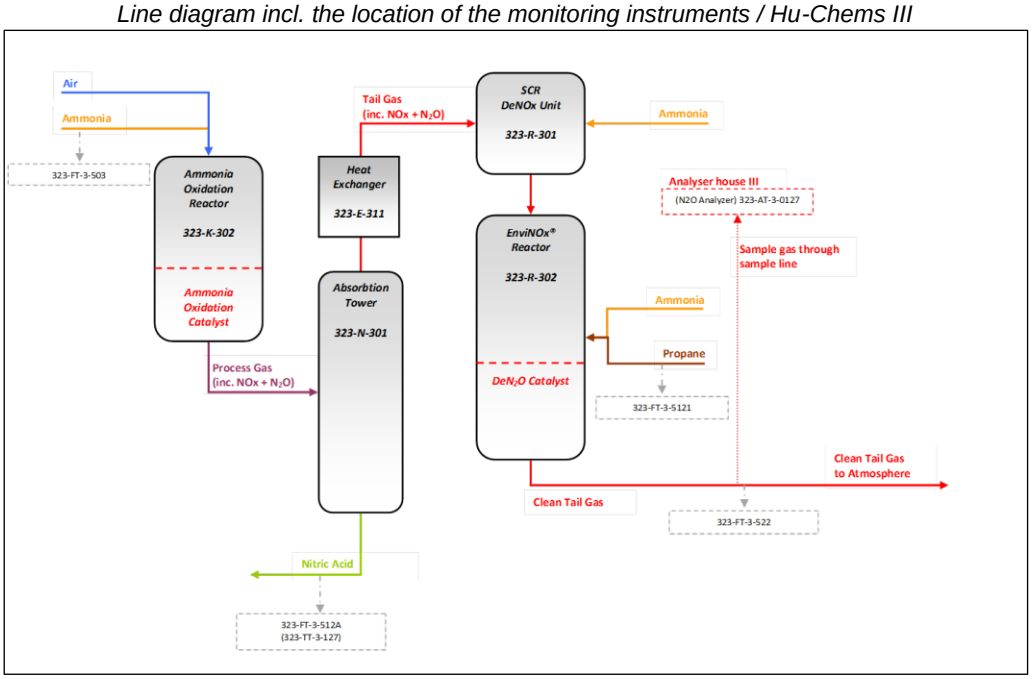
The instruments transmitters continuously provide a 4 – 20 mA analogue signal according to range and units configured. These signals are transmitted to I/O cards (analogue input/output cards) and collected by the Delta V processor. Resulting digital values are made available in the network to be further 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.

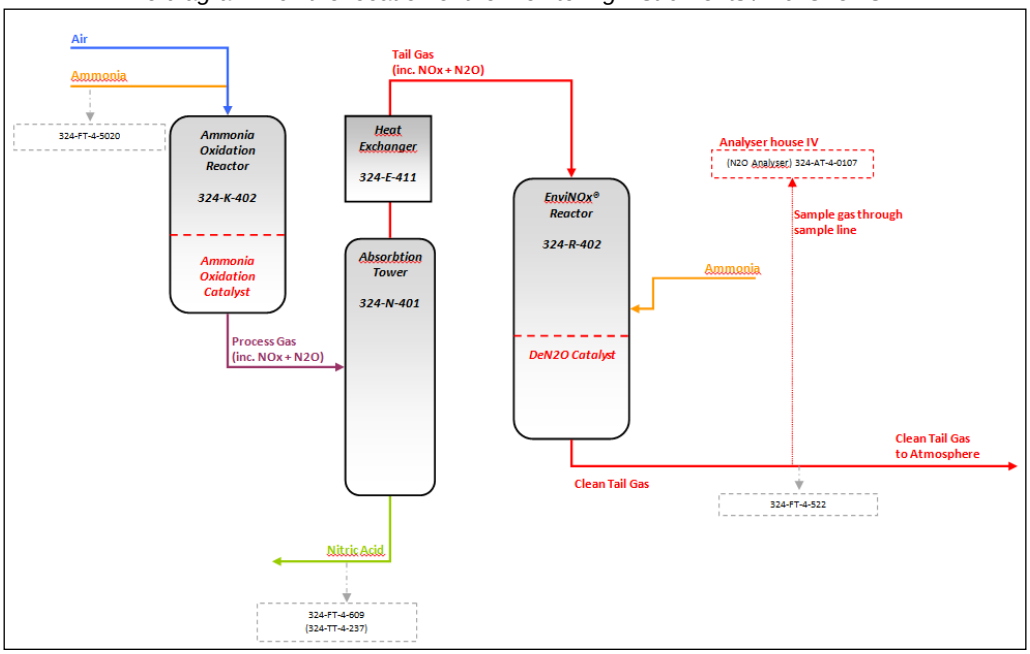
Line diagram incl. the location of the monitoring instruments / Hu-Chems II



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



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

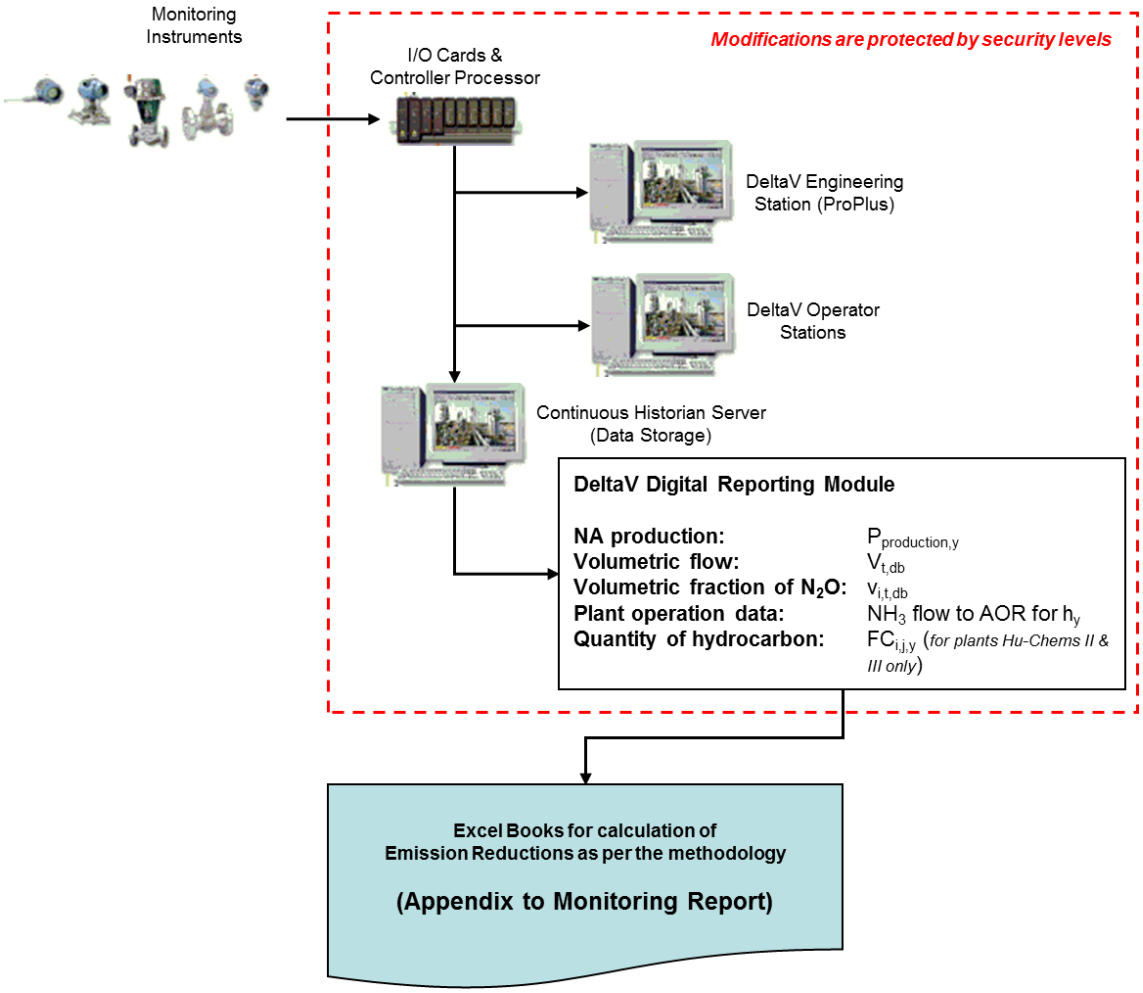


The reporting module of the Delta V system automatically generates aggregated daily reports (separately for plants Hu-Chems II, Hu-Chems III and Hu-Chems IV, as applicable) based on the stored raw data from the continuous historian server. Daily reports contain following kinds of data relevant for calculation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

- NA production ($P_{production,y}$)
- Operating parameters of the NA plants (NH_3 flow to AOR for determining h_y)
- Volumetric flow of the gaseous stream ($V_{t,db}$)
- Volumetric fraction of N_2O in the gaseous stream ($v_{i,t,db}$)
- Quantity of hydrocarbon ($FC_{i,j,y}$) – *for plants Hu-Chems II and Hu-Chems III only*

Relevant parameters as mentioned above are exported from the digital available daily reports to an excel book (available as *Appendix 3* of this MR) 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*.

Information flow diagram



The description of the information flow (including data generation, aggregation, recording, calculation and reporting) fully complies with the applied methodology (ACM0019 v2), the registered PDD and the monitoring plan.

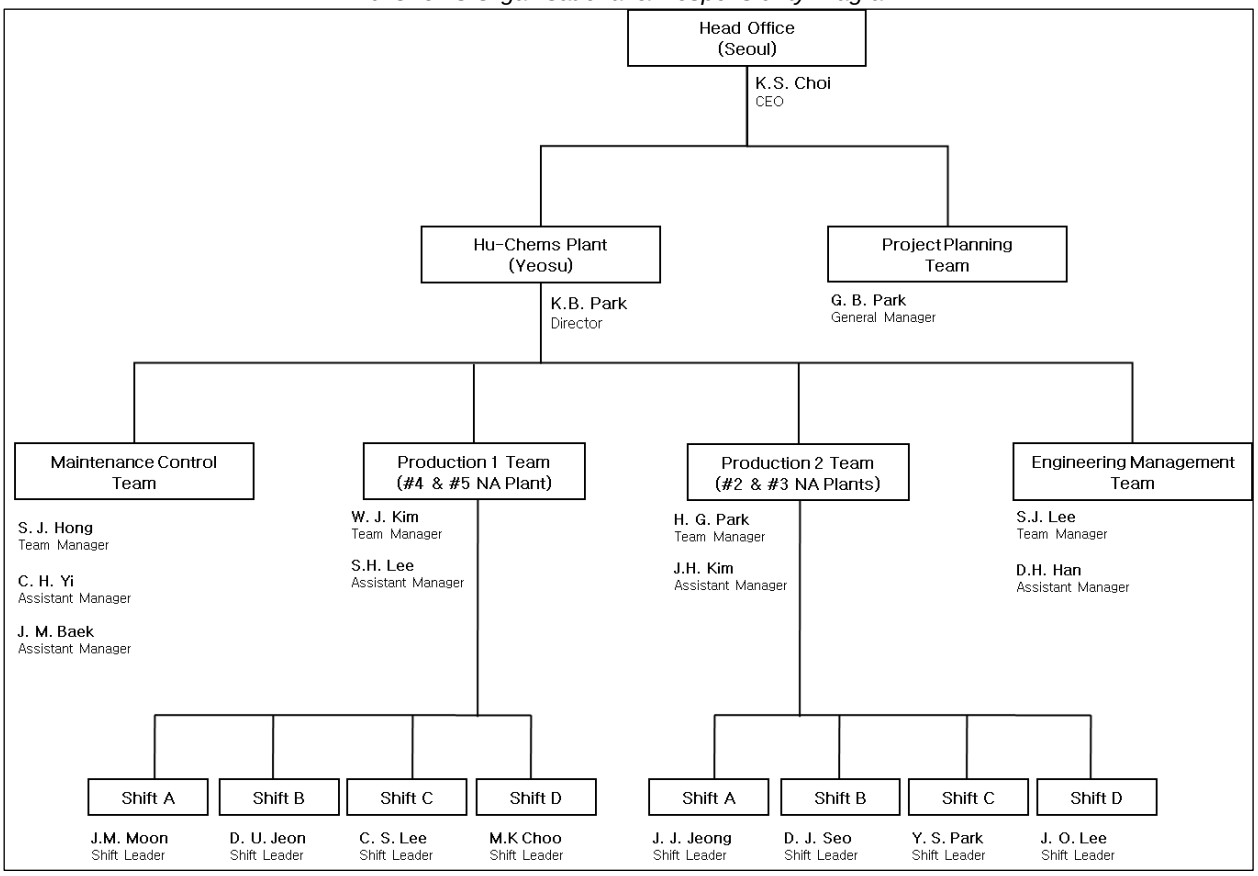
b) Roles and responsibilities of personnel

Project operator is Hu-Chems Fine Chemical Corp. 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 (KGS 18001 & OHSAS 18001). 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.

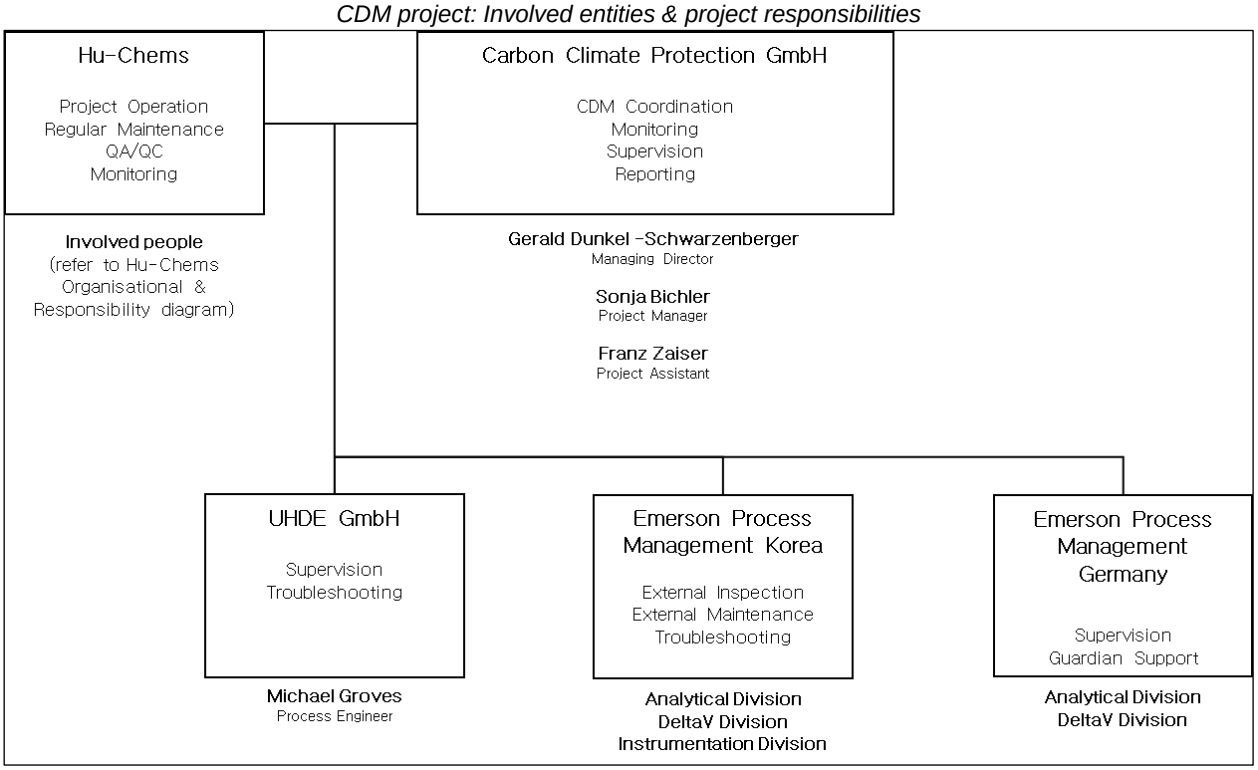
The operating and maintenance personal of the EnviNOx® system has been trained by the technology provider UHDE and the supplier of the digital process control system (Delta V, M/s. process management), further Hu-Chems has established internal training plans on the CDM procedures, operation of the EnviNOx® 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 MR before submitting to the respective DOE for verification.

Hu-Chems Organisational & Responsibility Diagram



CDM project: Involved entities & project responsibilities



c) Back up plans / Emergency procedures for monitoring system

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

EnviNO$_X$® – 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 and 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 decided whether the problem can be fixed immediately by them or whether external support from Emerson Korea/Emerson Germany/Uhde is required.

Back Up – Regular Onsite Inspection:
In addition to the automatic error indication by the automatic DCS system, the project operator Hu-Chems is carrying out visual onsite **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 Analyser/Reactor Check List”. Actions are defined in case of abnormal observations.
Further, Hu-Chems is carrying out a visual onsite **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 Analyser/Reactor Check List”. Actions are defined in case of abnormal observations.

Back Up – System Support & Preventive Maintenance → Delta V:
The Delta V automatic measuring system (AMS) used for plant operation and 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 Delta V AMS and to prevent deficient handling of data, Hu-Chems has contracted EPMK to execute monthly onsite **health checks** and/or quarterly onsite **inspection visits**. Furthermore a **24-hours emergency service** and the **24-hours Delta V 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 Delta V AMS 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_2O detection as well as further instruments – were designed and supplied by the company EMERSON, 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 EPMK to execute monthly onsite **health checks** and/or quarterly onsite **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 onsite 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 & General Maintenance → Instruments:
In order to safeguard availability and accuracy of instruments, the project participants have mandated EPMK 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 NA 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 – Onsite 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 analysers), flow sensors and several electrical parts for the analysers. 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 onsite 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:

Organization	Action	Frequency	Output
Delta V	Events & Alarm List	Continuously	Txt-files, Excel files
Hu-Chems	Shift Inspection	3 times per day	Protocol/Check List
Hu-Chems	Daily Inspection	Daily	Protocol/Check List
UHDE	Supervision	Daily	Plausibility check of daily reporting
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 (Hardware & Software)	Quarterly	Inspection Check Report
EPMK	Inspection check of Sampling & Analyser system	Quarterly	Inspection Check Report
EPMK & Suppliers	General Maintenance & Calibration Service of instruments	Regularly, adopted to annual shutdown 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, EPMK is committed to be onsite within 24 hours.

d) Systematic measures for QA for monitoring data during analyser down times

In order to ensure data quality back-up plans are in place (see above). 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_2O 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_2O concentration or volume 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 is applied to any such hour. In such cases, values observed during five operating hours before and after a plant start-up and shutdown 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

a) Data and parameters fixed ex-ante and COMMONLY relevant for all three plants

Data/parameter:	**$EF_{new,y}$**
Unit	kg N_2O/t HNO_3
Description	Baseline N_2O 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 v2
Value(s) applied)	**Year** / **Emission factor (kg N_2O/t HNO_3)**: 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.

Data/parameter:	**GWP_{N2O}**
Unit	t CO_2e/t N_2O
Description	Global warming potential of N_2O valid for the commitment period

Source of data	Relevant decisions by the CMP, according to PDD and methodology ACM0019 v2
Value(s) applied)	**298**
Choice of data or measurement methods and procedures	None
Purpose of data	Calculation of baseline and project emissions
Additional comments	N/A

b) Data and parameters fixed ex-ante and ONLY relevant for plant Hu-Chems II

Data/parameter:	**Operating pressure II**
Unit	kPa
Description	Operating pressure of the ammonia burner of Hu-Chems II
Source of data	Manufacturer's specifications
Value(s) applied)	**872** (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

Data/parameter:	**$EF_{historical,II}$**
Unit	kg N_2O/t HNO_3
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)	**12.09**
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 v1 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 $EF_{historical,II}$ 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.

Data/parameter:	**$EF_{default,y,II}$**
Unit	kg N_2O/t HNO_3
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 v2

Value(s) applied)	Since plant Hu-Chems II is a high pressure plant, corresponding values given in the methodology apply over the crediting period:

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.

Data/parameter:	**$P_{product,max,II}$**
Unit	t product ($\rightarrow$ t HNO_3)
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)	**116,800** (365 days) **58,560** (183 days)
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 v2, i.e. for NA plants that have used AM0028 or AM0034 in the first crediting period.

c) Data and parameters fixed ex-ante and ONLY relevant for plant Hu-Chems III

Data/parameter:	**Operating pressure III**
Unit	kPa
Description	Operating pressure of the ammonia burner of Hu-Chems III
Source of data	Manufacturer's specifications
Value(s) applied)	**872** (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 NA plant operates at a low, medium or high pressure.
Additional comments	N/A

Data/parameter:	**$EF_{historical,III}$**
Unit	kg N_2O/t HNO_3
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)	**11.26**
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 III used AM0028 v1 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 $EF_{historical,III}$ 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.

Data/parameter:	**$EF_{default,y,III}$**
Unit	kg N_2O/t HNO_3
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 v2
Value(s) applied)	Since plant Hu-Chems III is a high pressure plant, corresponding values given in the methodology apply over the crediting period:
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.

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

Data/parameter:	**$P_{product,max,III}$**
Unit	t product (→ t HNO_3)
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)	**116,800** (365 days) **58,560** (183 days)
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 v2, i.e. for NA plants that have used AM0028 or AM0034 in the first crediting period.

d) Data and parameters fixed ex-ante and ONLY relevant for plant Hu-Chems IV

Data/parameter:	**Operating pressure IV**
Unit	kPa
Description	Operating pressure of the ammonia burner of Hu-Chems IV
Source of data	Manufacturer's specifications
Value(s) applied)	**335** (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 NA plant operates at a low, medium or high pressure.
Additional comments	N/A

Data/parameter:	**$EF_{historical,IV}$**
Unit	kg N_2O/t HNO_3
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)	**5.70**
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 v1 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 $EF_{historical,IV}$ 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.

Data/parameter:	**$EF_{default,y,IV}$**
Unit	kg N_2O/t HNO_3
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 v2
Value(s) applied)	Since plant Hu-Chems IV is a medium pressure plant, corresponding values given in the methodology apply over the crediting period:

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.

Data/parameter:	**$P_{product,max,IV}$**
Unit	t product ($\rightarrow$ t HNO_3)
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)	**467,200** (365 days) **234,240** (183 days)
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 v2, i.e. for NA plants that have used AM0028 or AM0034 in the first crediting period.

e) Parameters fixed ex-ante from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" COMMONLY relevant for all three plants

Data/parameter:	**R_u**
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied)	**8,314**
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_i**
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
Value(s) applied)	**Compound** / **Structure** / **Molecular mass (kg/kmol)** Nitrous oxide / N_2O / 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

Data/parameter:	**P_n**
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
Value(s) applied)	**101,325**
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_2O in the tail gas.

Data/parameter:	**T_n**
Unit	K
Description	Temperature at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied)	**273.15**
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_2O in the tail gas.

D.2. Data and parameters monitored

Describing parameters sometimes mention “Annual”, “Yearly” or “in year y” as it is defined in the methodology ACM0019 v2, respective tools and the Monitoring Plan and it refers to the respective parameter during or related to a year “y”. It shall be considered that “Annual”, “Yearly” and “year y” is understood as the monitoring period covered by this report unless otherwise described.

a) Data and parameters monitored during monitoring period and ONLY relevant for plant Hu-Chems II

Data/parameter:	**$P_{production,y,II}$**
Unit	$tHNO_3$
Description	Nitric acid produced in year *y* of Hu-Chems II
Measured/calculated/default	Measured
Source of data	Production reports (based on measurements from project participants) The NA 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 NA production (as 100% HNO_3) is calculated based on mass flow and HNO_3 concentration. Final production values are exported in production reports through the Delta V system. Please refer to section *C.1 Information Flow* of this MR.
Value(s) of monitored parameter	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***

Monitoring equipment	Meter location: Located in the NA line, downstream of the absorption tower (322-N-201). Please refer to section *C.1 Line diagram* of this MR. **322-FT-2-512** Type: Coriolis Flowmeter Accuracy class: ± 0.35% Calibration frequency: 60 months Old instrument (beginning of monitoring period until 19/09/2016): Serial number: 14266864 Date of last calibration: 09/11/2012 (Validity: 08/11/2017) New instrument (ongoing since 19/09/2016): Serial number: 14325173 Date of penultimate calibration: 20/11/2012 (Validity: 19/11/2017) Date of last calibration: 12/08/2016 (Validity: 11/08/2021) **322-TT-2-127** 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)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system of this MR and respective subitems Back Up Plans for measuring systems / Periodic observation of the automated monitoring system and Systematic measures for QA for monitoring data during analyser down times.*
Purpose of data:	Calculation of baseline emissions
Additional comments:	The parameter $P_{NA,h,II}$ (NA 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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***

Monitoring equipment	Meter location: Located in the ammonia supply line, upstream of the ammonia oxidation reactor (322-K-202). Please refer to section *C.1 Line diagram* of this MR. **322-FT-2-503** Type: Differential pressure transmitter Accuracy class: ± 0.5% of span Serial number: 2052133 Calibration frequency: 48 Months Date of last calibration: 14/05/2013 (Validity: 13/05/2017) **322-TT-2-103** Type: Temperature transmitter Accuracy class: ± 0.15% of span Calibration frequency: 48 Months Serial number: 1784187 Date of last calibration: 14/05/2013 (Validity: 13/05/2017) **322-PT-2-303** Type: Pressure transmitter Accuracy class: ± 0.1% of span Serial number: 2052135 Calibration frequency: 48 Months Date of last calibration: 14/05/2013 (Validity: 13/05/2017)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 seconds Recording: Hourly
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^3/h during an hour, the reactor is considered in operation during the hour.
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
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_2O abatement, Number of hours (*h*) in year *y* where the abatement system is by-passed, underperforming or failed of Hu-Chems II
Measured/calculated/default	Measured
Source of data	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***

Monitoring equipment	HU-Chems II NA 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: $F_{N2O,tailgas,h,II} > EF_{existing,y,II} \times P_{NA,h,II}$ The parameters mentioned above are determined and measured/monitored as explained in the respective sections of this MR: • $P_{NA,h,II}$ – determination is based on the monitored parameter $P_{production,y,II}$ (refer to the respective parameter table in this MR) • $F_{N2O,tail\ gas,h,II}$ – determination is based on the monitored parameters $V_{t,db,n,II}$, $v_{i,t,db,II}$ and $C_{H2O,t,db,n,II}$ (refer to the respective parameter tables in this MR) • $EF_{existing,y,II}$ – determination is based on the ex-ante determined parameters $EF_{historical,II}$ and $EF_{default,y,II}$ (refer to the respective parameter tables in this MR)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Hourly Recording: Hourly
Calculation method (if applicable):	(Refer to "Monitoring equipment" above)
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime. The parameter $P_{NA,h,II}$ as used in the formula (NA produced in the hour h of Hu-Chems II) represents the hourly value of $P_{production,y,II}$.

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data/parameter:	**$V_{t,db,II}$**
Unit	m³ 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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***

Monitoring equipment	Meter location: Located in the stack at the end of the tail gas line. **322-FT-2-522** Type: Annubar / Differential pressure transmitter Accuracy class: ± 2% of span Serial number: 1240833 Calibration: The instrument requires QAL 2 calibration (per EN 14181; every 60 months). Since the date, this requirement applies (introduced in the 2nd crediting period of the project activity following the methodology ACM0019 v2), the NA plant was not in operation (and thus no Emission Reductions have been claimed). Due to the fact, that QAL 2 calibration requires the NA plant in an operational condition, it was not yet possible to perform it – however, this had no effects to any calculation of Emission Reductions and thus represents no deviation. As soon as the NA plant resumes to operation again, QAL 2 calibration will be performed.
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Calibration against a primary device provided by an independent accredited laboratory shall follow EN 14181 requirements (QAL 2 reference measurement). As described in "Monitoring equipment" above, such calibration will be performed as soon as the NA plant, which is currently in permanent shutdown, will resume top operation again. Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of project emissions
Additional comments:	Option A parameter according to the applied *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream".* The volumetric flow is determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K) according to applied methodology. Monitoring of actual conditions ($P_{t,II}$, $T_{t,II}$) is therefore not necessary, as per the applied methodology. Dry basis flow measurement, since gaseous stream is considered to be dry (refer to parameter $C_{H2O,t,db,n,II}$).

Data/parameter:	**$v_{i,t,db,II}$**
Unit	m³ gas i/m³ dry gas (→ m³ N2O / m³ 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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***

Monitoring equipment	Meter location: Sample take-off is located in the tail gas line, downstream of the EnviNO_X® 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 to section *C.1 Line diagram* of this MR. **322-AT-2-0127** Type: NDIR Analyser Accuracy class: ±1% (zero/span) Serial number: 990861497812 Calibration: The instrument requires QAL 2 calibration (per EN 14181; every 60 months). Since the date, this requirement applies (introduced in the 2nd crediting period of the project activity following methodology ACM0019 v2) the NA plant was not in operation (and no Emission Reductions have been claimed). Due to the fact that QAL 2 calibration requires the NA plant in operational conditions, it was not yet possible to perform it – however, this had no effects on Emission Reductions calculation and thus represents no deviation. As soon as the NA plant resumes to operation, QAL 2 calibration will be performed.
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Calibration against a primary device provided by an independent accredited laboratory shall follow EN 14181 requirements (QAL 2 reference measurement). As described in "Monitoring equipment" above, such calibration will be performed as soon as the NA plant, which is currently in permanent shutdown, will resume top operation again. Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*. EPMK has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition.
Purpose of data:	Calculation of project emissions
Additional comments:	The volumetric fraction of N_2O is determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K) according to the applied methodology. Monitoring of actual conditions ($P_{t,II}$, $T_{t,II}$) is therefore not necessary, as per the applied methodology.

Data/parameter:	**$C_{H2O,t,db,n,II}$**
Unit	mg H_2O/m^3 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	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***

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:	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). 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: (a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) 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. In the case of this project activity, the first option (a) has been chosen. The value determined ex-ante for the estimation of Emission Reductions in the PDD was 0.007 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. As soon as the NA plant will resume operation, the measurement of the moisture content coinciding with the first QAL2 calibration will be performed.

Since the volumetric fraction of N_2O and the volumetric flow of the gaseous stream are determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 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_2 emissions from fossil fuel combustion"

Data/parameter:	**$FC_{i,j,y,II}$**
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 and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***
Monitoring equipment	Meter location: Located in the propane gas line, upstream of the $EnviNO_X$® reactor (322-R-202). Please refer to section *C.1 Line diagram* of this MR. **322-FT-2-5121** 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:	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 NA plant (please refer to section *C.3*). 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. 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. Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
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	***No values available due to permanent shutdown of the EnviNOx® system and NA plant during the monitoring period***
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_2 emissions from fossil fuel combustion" 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%).

b) Data and parameters monitored during monitoring period and ONLY relevant for plant Hu-Chems III

Data/parameter:	**$P_{production,y,III}$**
Unit	$tHNO_3$
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 NA 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 NA production (as 100% HNO_3) is calculated based on mass flow and HNO_3 concentration. Final production values are exported in production reports through the Delta V system. Please refer to section *C.1 Information Flow* of this MR.
Value(s) of monitored parameter	**8,180**
Monitoring equipment	Meter location: Located in the NA line, downstream of the absorption tower (323-N-301). Please refer to section *C.1 Line diagram* of this MR. **323-FT-3-512A** Type: Coriolis Flowmeter Accuracy class: ± 0.35% Calibration frequency: 60 months Old instrument*) (beginning of monitoring period until 19/09/2016): Serial number: 14325173 Date of penultimate calibration: 20/11/2012 (Validity: 19/11/2017) Date of last calibration: 12/08/2016 (Validity: 11/08/2021) New instrument (ongoing since 19/09/2016): Serial number: 14266864 Date of last calibration: 09/11/2012 (Validity: 08/11/2017) **323-TT-3-127** Type: Temperature Converter Accuracy class: ± 0.15% of span Serial Number: 51309204-125 Calibration frequency: 48 months Date of penultimate calibration: 15/05/2013 (Validity: 14/05/2017) Date of last calibration: 17/08/2016 (Validity: 16/08/2020) *) *Instrument needed to be de-installed due to technical reasons*
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.

Purpose of data:	Calculation of baseline emissions
Additional comments:	The parameter $P_{NA,h,III}$ (NA 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.

Data/parameter:	**$h_{y,III}$**
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 and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**677**
Monitoring equipment	Meter location: Located in the ammonia supply line, upstream of the ammonia oxidation reactor (323-K-302). Please refer to section *C.1 Line diagram* of this MR. **323-FT-3-503** Type: Differential pressure transmitter Accuracy class: ± 0.5% of span Serial number: 2052134 Calibration frequency: 48 Months Date of penultimate calibration: 15/05/2013 (Validity: 14/05/2017) Date of last calibration: 17/08/2016 (Validity: 16/08/2020) **323-TT-3-103** Type: Temperature transmitter Accuracy class: ± 0.15% of span Serial number: 1809794 Calibration frequency: 48 Months Date of penultimate calibration: 15/05/2013 (Validity: 14/05/2017) Date of last calibration: 17/08/2016 (Validity: 16/08/2020) **323-PT-3-303** Type: Pressure transmitter Accuracy class: ± 0.1% of span Serial number: 2052136 Calibration frequency: 48 Months Date of penultimate calibration: 15/05/2013 (Validity: 14/05/2017) Date of last calibration: 17/08/2016 (Validity: 16/08/2020)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 Seconds Recording: Hourly
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^3/h during an hour, the reactor is considered in operation during the hour.
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of baseline and project emissions

Additional comments:	Records to be maintained during project's lifetime.

Data/parameter:	**$h_{r,y,III}$**
Unit	h
Description	For tertiary N_2O abatement, Number of hours (*h*) in year *y* where the abatement system is by-passed, underperforming or failed of Hu-Chems III
Measured/calculated/default	Measured
Source of data	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**11**
Monitoring equipment	Hu-Chems III NA 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: $$F_{N2O,tailgas,h,III} > EF_{existing,y,III} \times P_{NA,h,III}$$ The parameters mentioned above are determined and measured/monitored as explained in the respective sections of this MR: • $P_{NA,h,III}$ – determination is based on the monitored parameter $P_{production,y,III}$ (refer to the respective parameter table in this MR) • $F_{N2O,tail\ gas,h,III}$ – determination is based on the monitored parameters $V_{t,db,n,III}$, $v_{i,t,db,III}$ and $C_{H2O,t,db,n,III}$ (refer to the respective parameter tables in this MR) • $EF_{existing,y,III}$ – determination is based on the ex-ante determined parameters $EF_{historical,III}$ and $EF_{default,y,III}$ (refer to the respective parameter tables in this MR)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Hourly Recording: Hourly
Calculation method (if applicable):	(Refer to "Monitoring equipment" above)
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime. The parameter $P_{NA,h,III}$ as used in the formula (NA produced in the hour h of Hu-Chems III) represents the hourly value of $P_{production,y,III.}$

<u>Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"</u>

Data/parameter:	**$V_{t,db,III}$**
Unit	m^3 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 and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**47,479**
Monitoring equipment	Meter location: Located in the stack at the end of the tail gas line. **323-FT-3-522** Type: Annubar / Differential pressure transmitter Accuracy class: ± 2% of span Serial number: 1240832 Calibration frequency: 60 months (QAL 2 reference measurement) Date of initial QAL 2: 06/09/2016 – 08/09/2016*) (Validity: 05/09/2021) *) *Initial QAL 2 calibration was performed during the monitoring period and is valid since the date of the re-activation of the NA plant III. This is clearly traceable from the ER Calculation sheet attached to this MR as Appendix 3.*
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Calibration against a primary device provided by an independent accredited laboratory follows EN 14181 requirements (QAL 2 reference measurement). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of project emissions
Additional comments:	Option A parameter according to the applied *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*. The volumetric flow is determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K) according to the applied methodology. Monitoring of actual conditions ($P_{t,III}$, $T_{t,III}$) is therefore not necessary as per the applied methodology. Dry basis flow measurement, since gaseous stream is considered to be dry (refer to parameter $C_{H2O,t,db,n,III}$).

Data/parameter:	**$v_{i,t,db,III}$**
Unit	m³ gas i/m³ dry gas (→ m³ N_2O / m³ 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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**$7.16*10^{-5}$**

Monitoring equipment	Meter location: Sample take-off is located in the tail gas line, downstream of the EnviNO_X® reactor (323-R-302), and leads (via sample gas line) to the locked analyser house III (located closely to the EnviNOx® reactor of Hu-Chems plant III), where the analyser is installed. Please refer to *section C.1 Line diagram* of this MR. **323-AT-3-0127** Type: NDIR Analyser Accuracy class: ±1% (zero/span) Serial number: 990861497815 Calibration frequency: 60 months (QAL 2 reference measurement) Date of penultimate calibration: 11/03/2014 (Validity: 10/03/2016) Date of last calibration (initial QAL 2): 06/09/2016 – 08/09/2016*) (Validity: 05/09/2021) *) *Initial QAL 2 calibration was performed during the monitoring period and is valid since the date of the re-activation of NA plant III in September 2016. This is clearly traceable from the ER Calculation sheets attached to this MR as Appendix 3.*
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Calibration against a primary device provided by an independent accredited laboratory follows EN 14181 requirements (QAL 2 reference measurement). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*. EPMK has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition.
Purpose of data:	Calculation of project emissions
Additional comments:	The volumetric fraction of N_2O is determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K) according to the applied methodology. Monitoring of actual conditions ($P_{t,III}$, $T_{t,III}$) is therefore not necessary as per the applied methodology.

Data/parameter:	**$C_{H2O,t,db,n,III}$**
Unit	mg H_2O/m^3 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	**Below 5.0*10³** (equivalent to 0.005 kgH_2O/m^3 dry gas)

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). Repeated measurements were conducted by the company AIRTEC (which coincided with the initial QAL 2 reference measurement) in September 2016.
Calculation method (if applicable):	-
QA/QC procedures:	According to USEPA CF 42 method 4
Purpose of data:	Calculation of project emissions
Additional comments:	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). 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: (a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) 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. In the case of this project activity, the first option (a) has been chosen. The measured values as noted above show that the moisture content of the gaseous stream is significantly below the maximum threshold value of 0.05 kg H_2O/m^3 dry gas.

Since the volumetric fraction of N_2O and the volumetric flow of the gaseous stream are both determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 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_2 emissions from fossil fuel combustion"

Data/parameter:	**$FC_{i,j,y,III}$**
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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**30,861**

Monitoring equipment	Meter location: Located in the propane gas line, upstream of the EnviNO$_X$® reactor (323-R-302). Please refer to section *C.1 Line diagram* of this MR. **323-FT-3-5121** Type: Coriolis flow meter Accuracy class: ± 0.35% Serial number: 14125454 Calibration frequency: 60 months Date of penultimate calibration: 02/06/2011 (Validity: 01/06/2016)*) Date of last calibration: 12/08/2016 (Validity: 11/08/2021) *) *NA plant III was in permanent shutdown until September 1st, 2016 and hence the calibration was conducted in August 2016 well before the plant re-start.*
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 10 seconds Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). 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. Furthermore and 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. Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
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	**0.82**
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.
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_2 emissions from fossil fuel combustion" 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%).

c) Data and parameters monitored during monitoring period and ONLY relevant for plant Hu-Chems IV

Data/parameter:	**$P_{production,y,IV}$**
Unit	$tHNO_3$
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 NA 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 NA production (as 100% HNO_3) is calculated based on mass flow and HNO_3 concentration. Final production values are exported in production reports through the Delta V System. Please refer to section *C.1 Information Flow* of this MR.
Value(s) of monitored parameter	**218,782**
Monitoring equipment	Meter location: Located in the NA line, downstream of the absorption tower (324-N-401). Please refer to section *C.1 Line diagram* of this MR. **324-FT-4-609** Type: Coriolis Flowmeter Accuracy class: ± 0.35% Serial number: 14326811 Calibration frequency: 60 months Date of last calibration: 27/05/2014 (Validity: 26/05/2019) **324-TT-4-237** Type: Temperature Transmitter Accuracy class: ± 0.15% of span Serial number: 966595 Calibration frequency: 48 months Date of last calibration: 02/06/2014 (Validity: 01/06/2018)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 seconds Recording: Hourly
Calculation method (if applicable):	-

QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of baseline emissions
Additional comments:	The parameter $P_{NA,h,IV}$ (NA 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.

Data/parameter:	**$h_{y,IV}$**
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 and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**4,234**
Monitoring equipment	Meter location: Located in the ammonia supply line, upstream of the ammonia oxidation reactor (324-K-402). Please refer to section *C.1 Line diagram* of this MR. **324-FT-4-5020** Type: Coriolis flowmeter Accuracy class: ± 0.35% Serial number: 14137655 Calibration frequency: 60 Months Date of last calibration: 27/05/2014 (Validity: 26/05/2019)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: 10 seconds Recording: Hourly
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^3/h during an hour, the reactor is considered in operation during the hour.
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime.

Data/parameter:	**$h_{r,y,IV}$**
Unit	h

Description	For tertiary N_2O abatement, Number of hours (*h*) in year *y* 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 and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**0**
Monitoring equipment	HU-Chems IV NA 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: $F_{N2O,tailgas,h,IV} > EF_{existing,y,IV} \times P_{NA,h,IV}$ The parameters mentioned in the formula are determined and measured as explained in the respective sections of this MR: • $P_{NA,h,IV}$ – determination is based on the monitored parameter $P_{production,y,IV}$ (refer to the respective parameter table in this MR) • $F_{N2O,tail\ gas,h,IV}$ – determination is based on the monitored parameters $V_{t,db,IV}$, $v_{i,t,db,IV}$ and $C_{H2O,t,db,n,IV}$ (refer to the respective parameter tables in this MR) • $EF_{existing,y,IV}$ – determination is based on the ex-ante determined parameters $EF_{historical,IV}$ and $EF_{default,y,IV}$ (refer to the respective parameter tables in this MR)
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Hourly Recording: Hourly
Calculation method (if applicable):	(Refer to "Monitoring equipment" above)
QA/QC procedures:	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 NA plant (please refer to section *C.3*). Please to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	Records to be maintained during project's lifetime. The parameter $P_{NA,h,IV}$ as used in the formula (NA produced in the hour h of Hu-Chems IV) represents the hourly value of $P_{production,y,IV}$.

<u>Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" of Hu-Chems IV</u>

Data/parameter:	**$V_{t,db,IV}$**
Unit	m^3 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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)

Value(s) of monitored parameter	**174,693** 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 MR.
Monitoring equipment	Meter location: Located in the stack at the end of the tail gas line. **324-FT-4-522** Type: Annubar / Differential pressure transmitter Accuracy class: ± 2% of span Serial number: 1240834 Calibration frequency: 60 months (QAL 2 reference measurement) Date of last QAL 2: 23/09/2014 – 25/09/2014 (Validity: 24/09/2019) Date of penultimate AST test: 17/09/2015 – 18/09/2015 Date of last AST test: 08/09/2016 – 09/09/2016
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). QA/QC procedure consider requirements as per EN 14181 – Calibration against a primary device provided by an independent accredited laboratory follows EN 14181 requirements (QAL 2 reference measurement). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*.
Purpose of data:	Calculation of project emissions
Additional comments:	Option A parameter according to the applied *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*. The volumetric flow is determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K) according to the applied methodology. Monitoring of actual conditions ($P_{t,IV}$, $T_{t,IV}$) is therefore not necessary, as per the applied methodology. Dry basis flow measurement, since gaseous stream is considered to be dry (refer to parameter $C_{H2O,t,db,n,IV}$).

Data/parameter:	$v_{i,t,db,IV}$
Unit	m³ gas i/m³ dry gas (→ m³ N_2O / m³ 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	Measuring device (Please refer to monitoring equipment below and to section *C.1 Information Flow* of this MR.)
Value(s) of monitored parameter	**$4.32*10^{-5}$** 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 MR.

Monitoring equipment	Meter location: Sample take-off is located in the tail gas line, downstream of the EnviNO_X® 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 to section *C.1 Line diagram* of this MR. **324-AT-4-0107** Type: NDIR Analyser Accuracy class: ±1% (zero/span) Serial number: 990861497818 Calibration frequency: 60 months (QAL 2 reference measurement) Date of last QAL 2: 23/09/2014 to 25/09/2014 (Validity: 24/09/2019) Date of penultimate AST test: 17/09/2015 – 18/09/2015 Date of last AST test: 08/09/2016 – 09/09/2016
Measuring/reading/recording frequency:	Measuring: Continuously Reading: Every 1 second Recording: Hourly
Calculation method (if applicable):	-
QA/QC procedures:	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 NA plant (please refer to section *C.3*). QA/QC procedure consider requirements as per EN 14181 – Calibration against a primary device provided by an independent accredited laboratory follows EN 14181 requirements (QAL 2 reference measurement). Please refer to section *C.3. Back Up plans / Emergency procedures for monitoring system* of this MR and respective subitems *Back Up Plans for measuring systems / Periodic observation of the automated monitoring system* and *Systematic measures for QA for monitoring data during analyser down times*. EMPK has been mandated to conduct monthly analyser health checks and quarterly inspection checks to ensure good instrument condition.
Purpose of data:	Calculation of project emissions
Additional comments:	The volumetric fraction of N_2O is determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K) according to the applied methodology. Monitoring of actual conditions ($P_{t,IV}$, $T_{t,IV}$) is therefore not necessary, as per the applied methodology.

Data/parameter:	**$C_{H2O,t,db,n,IV}$**
Unit	mg H_2O/m^3 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	**Below 5.0*10³** (equivalent to 0.005 kgH_2O/m^3 dry gas)
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 calibration of the flow meter for the gaseous stream (QAL 2), both associated with requirements of the EN 14181 standard. Latest repeated measurements were conducted by AIRTEC during AST in 2016.

Calculation method (if applicable):	-
QA/QC procedures:	According to USEPA CF 42 method 4
Purpose of data:	Calculation of project emissions
Additional comments:	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). 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: (a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) 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. In the case of this project activity, the first option (a) has been chosen. The measured values as noted above show that the moisture content of the gaseous stream is significantly below the maximum threshold value of 0.05 kg H_2O/m^3 dry gas.

Since the volumetric fraction of N_2O and the volumetric flow of the gaseous stream are both determined and expressed at normal conditions (P_n = 101,325 Pa; T_n = 273.15 K), the actual conditions ($P_{t,IV}$, $T_{t,IV}$) 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 v2, applicable tools and the project documentation (PDD, monitoring plan) and are transparently shown in the excel books (Appendix 3 to this MR). 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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<u>Overall baseline emissions:</u>
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_2e)
$BE_{y,II}$	=	Baseline emissions of plant Hu-Chems II in year y (t CO_2e)
$BE_{y,III}$	=	Baseline emissions of plant Hu-Chems III in year y (t CO_2e)

$BE_{y,IV}$ = Baseline emissions of plant Hu-Chems IV in year y (t CO_2e)

BE_y	$BE_{y,II}$	$BE_{y,III}$	$BE_{y,IV}$
tCO_2e	tCO_2e	tCO_2e	tCO_2e
398,625	0	27,002	371,623

Plant specific baseline emissions:

Plant specific baseline emissions are calculated separately for each plant as per provisions of the methodology & PDD, using the same set of 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.

$$BE_y = \begin{pmatrix} min\{P_{production,y}\ ; P_{product,max}\} \times EF_{existing,y} + \\ max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y} \end{pmatrix} \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N2O} \times 10^{-3}$$

Where:

BE_y = Baseline emissions in year *y* (t CO_2e)

$P_{product,max}$ = Design capacity (t HNO_3)

$P_{production,y}$ = Production of nitric acid in year *y* (t HNO_3)

$EF_{existing,y}$ = N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year *y* (kg N_2O/t HNO_3)

$EF_{new,y}$ = Baseline N_2O emission factor for nitric acid production in year *y* (kg N_2O/t HNO_3)

GWP_{N2O} = Global Warming Potential of N_2O 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_2O abatement: the abatement system was not installed, underperforming or failed;
- (b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

Hu-Chems II values for the covered monitoring period:

BE_y	$EF_{existing,y}$	$EF_{new,y}$	$P_{production,y}$	$P_{product,max}$	h_y	$h_{r,y}$	GWP_{N2O}
tCO_2e	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	$tHNO_3$	$tHNO_3$	h	h	tCO_2e / tN_2O
0	12.00	3.20	0	58,560	0	0	298

Hu-Chems III values for the covered monitoring period:

BE_y	$EF_{existing,y}$	$EF_{new,y}$	$P_{production,y}$	$P_{product,max}$	h_y	$h_{r,y}$	GWP_{N2O}
tCO_2e	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	$tHNO_3$	$tHNO_3$	h	h	tCO_2e / tN_2O
27,002	11.26	3.20	8,180	58,560	677	11	298

Hu-Chems IV values for the covered monitoring period:

***BE_y**	**$EF_{existing,y}$**	**$EF_{new,y}$**	**$P_{production,y}$**	**$P_{product,max}$**	**h_y**	**$h_{r,y}$**	**GWP_{N2O}**
tCO_2e	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	$tHNO_3$	$tHNO_3$	h	h	tCO_2e / tN_2O
371,623	5.70	3.20	218,782	234,240	4,234	0	298

*Value is conservatively rounded DOWN

The plant specific N_2O emission factor for NA plants that have used AM0028 or AM0034 in the first crediting period ($EF_{existing,y}$) is calculated based on following equation:

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

Where:

$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year *y* (kg N_2O/t HNO_3)
$EF_{historical}$	=	Historical baseline emission factor of the nitric acid plant (kg N_2O/t HNO_3)
$EF_{default,y}$	=	Default emission factor according to the operating pressure of the ammonia burner in year *y* (kg N_2O/t HNO_3)

Hu-Chems II values for the covered monitoring period:

$EF_{existing,y}$	**$EF_{historical}$**	**$EF_{default,y}$ (high pressure)**
kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$
12.00	12.09	12.00

Hu-Chems III values for the covered monitoring period:

$EF_{existing,y}$	**$EF_{historical}$**	**$EF_{default,y}$ (high pressure)**
kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$
11.26	11.26	12.00

Hu-Chems IV values for the covered monitoring period:

$EF_{existing,y}$	**$EF_{historical}$**	**$EF_{default,y}$ (medium pressure)**
kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$	kgN_2O / $tHNO_3$
5.70	5.70	7.80

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_2e)

$PE_{y,II}$ = Project emissions of plant Hu-Chems II in year y (t CO_2e)

$PE_{y,III}$ = Project emissions of plant Hu-Chems III in year y (t CO_2e)

$PE_{y,IV}$ = Project emissions of plant Hu-Chems IV in year y (t CO_2e)

PE_y	$PE_{y,II}$	$PE_{y,III}$	$PE_{y,IV}$
tCO_2e	tCO_2e	tCO_2e	tCO_2e
20,128	0	946	19,182

Plant specific project emissions:

Plant specific baseline emissions 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.

$$PE_y = PE_{N2O,y} + PE_{CO2,tertiary,y}$$

Where:

PE_y = Project emissions in year *y* (t CO_2e)

$PE_{N2O,y}$ = Project emissions of N_2O from the project plant in year *y* (t CO_2e)

$PE_{CO2,tertiary,y}$ = Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year *y* (t CO_2)

Hu-Chems II values for the covered monitoring period:

PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
t CO_2e	t CO_2e	t CO_2e
0	0	0

Hu-Chems III values for the covered monitoring period:

PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
t CO_2e	t CO_2e	t CO_2e
946	854	92

Hu-Chems IV values for the covered monitoring period:

PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
t CO_2e	t CO_2e	t CO_2e
19,182	19,182	0

The project emissions of N_2O from the project plant ($PE_{N2O,y}$) are the emissions from the N_2O contained in the tail gas stream of the plant, which is released to the atmosphere. Accordingly, the plant specific $PE_{N2O,y}$ is determined as follows:

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tail\ gas,h} \times GWP_{N2O} \times 10^{-3}$$

Where:

$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year *y* (t CO_2e)
GWP_{N2O}	=	Global warming potential of N_2O valid for the commitment period
$F_{N2O,tail\ gas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour *h* (kg N_2O/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: (a) For secondary N_2O abatement. Abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement. The abatement system is by-passed, underperforming or failed

Hu-Chems II values for the covered monitoring period:

$PE_{N2O,y}$	***$F_{N2O,tail\ gas,h}$***	**h_y**	**$h_{r,y}$**	**GWP_{N2O}**
tCO_2e	kgN_2O	h	h	tCO_2 / tN_2O
0	0	0	0	298

Hu-Chems III values for the covered monitoring period:

$PE_{N2O,y}$	***$F_{N2O,tail\ gas,h}$***	**h_y**	**$h_{r,y}$**	**GWP_{N2O}**
tCO_2e	kgN_2O	h	h	tCO_2 / tN_2O
854	2,865	677	11	298

Hu-Chems IV values for the covered monitoring period:

***$PE_{N2O,y}$**	***$F_{N2O,tail\ gas,h}$***	**h_y**	**$h_{r,y}$**	**GWP_{N2O}**
tCO_2e	kgN_2O	h	h	tCO_2 / tN_2O
19,182	64,366	4,234	0	298

*Value is conservatively rounded UP

The amount of N_2O emissions from the tail gas stream of the plant (= $F_{N2O,tailgas,h}$) 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:

(a) Throughout the crediting periods of the project activity, the N_2O 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 or any more recent update of that standard;

(b) The monitoring system should provide separate hourly average values for the N_2O 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_2O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;

(c) 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_2O 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;

(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;

(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.

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, which requires demonstrating that the gaseous stream is dry, whereas the tool suggests two options to do this:

(a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) 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.

In this monitoring period, this is not applicable for plant Hu-Chems II as it was in permanent shutdown, i.e. no Emission Reductions are claimed out of that plant. The measured value relevant to this monitoring period in plant Hu-Chems III respectively in Hu-Chems IV is below $5*10^3$ mg H_2O/m^3 dry gas respectively below $5*10^3$ mg H_2O/m^3 dry gas and demonstrates that the moisture content of the gaseous stream is significantly below the maximum 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.

The project emissions of N_2O from the project plant ($PE_{N2O,y}$) are the emissions from the N_2O contained in the tail gas stream of the plant, which is released to the atmosphere. Accordingly, the plant specific $PE_{N2O,y}$ are determined as follows:

The mass flow of greenhouse gas i ($F_{i,t}$)[5] is determined as follows:

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

With

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

[5] $F_{i,t}$ corresponds to the parameter $F_{N2O,tail\ gas,h}$ of the methodology ACM0019 v2.

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^3 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^3 gas i/m^3 dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m^3 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^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval t (K)

When applying normal conditions and as described in 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^3 [6]. Respective parameters need not to be monitored according to the methodology.

For calculation of $F_{N2O,tailgas,h}$, 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 MR.

The project emissions from the operation of the tertiary N_2O abatement facility ($PE_{CO2,tertiary,y}$) only need to be considered, if a tertiary N_2O 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 III, where propane (supplied as LPG) is used as reducing agent in the tertiary N_2O 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 III, whereas the value for $PE_{CO2,tertiary,y}$ **is set to zero** due to inapplicability of this emission source in plant Hu-Chems IV (associated parameters are not monitored accordingly).

$$PE_{CO2,tertiary,y} = PE_{FF,y}$$

Where:

$PE_{CO2,tertiary,y}$	=	Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year y (t CO_2)
$PE_{FF,y}$	=	Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO_2)

For determination of $PE_{FF,y}$, the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" shall be sued to calculate the project emissions related to fossil fuels used in year y. Specific guidance on the use of the tool are:

(a) The parameter $PE_{FC,j,y}$ used in the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" corresponds to the parameter $PE_{FF,y}$ in the methodology ACM0019 v2, and
(b) The element process *j* in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N_2O abatement facility and/or the re-heating of the tail gas.

During this monitoring period, plant Hu-Chems II was permanently out of operation and so was the respective tertiary abatement facility (EnviNOx® system). Thus, the value for $PE_{FC,j,y}$ **is set to zero** for plant Hu-Chems II.

[6] $\rho_{i,t} = (P_n \times MM_i) / (T_n \times R_u) = 1.96$ kg/m^3

Hu-Chems II values for the covered monitoring period:

$PE_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
tCO_2/yr
0

Hu-Chems III values for the covered monitoring period:

$PE_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
tCO_2/yr
92

According to the applied tool CO_2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 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_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/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_2 emission coefficient of fuel type *i* in year *y* (tCO_2/t)
i	=	Are the fuel types combusted in process *j* during the year *y*

Option A of the "Tool to calculate project or leakage CO_2 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 this option A the CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type *i*, using the following approach:

$$COEF_{i,y} = w_{C,i,y} \times 44/12$$ $FC_{i,j,y}$ is measured in a mass unit

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* ($t\ CO_2/t$)
$w_{C,i,y}$	=	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*

Hu-Chems II values for the covered monitoring period:

$PE_{CO2,tertiary,y}$	$FC_{i,j,y}$	$COEF_{i,y}$
tCO_2/yr	t/yr	tCO_2/t
0	0	0

Hu-Chems III values for the covered monitoring period:

$PE_{CO2,tertiary,y}$	$FC_{i,j,y}$	$COEF_{i,y}$
tCO_2/yr	t/yr	tCO_2/t
92	30,861	3.00

E.3. Calculation of leakage

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According to the applied methodology (ACM0019 v2) 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_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	398,625	20,128	0	N/A	378,497	378,497

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_2e)	1,241,313 tCO_2e → Corresponding amount for the duration of the monitoring period (183 days): 620,657 tCO_2e	378,497 (183 days)

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

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Actual emission reductions achieved during this monitoring period are lower than values estimated in ex-ante calculation of the registered PDD. Please find below the assessment plant-by-plant:

Comparison of ER with PDD values: Hu-Chems II	
Emission reduction estimation according to PDD	276,544 tCO_2e
Corresponding PDD estimation (over 183 days; rounded)	138,272 tCO_2e
Actual calculation of emission reduction in monitoring period (over 183 days)	0 tCO_2e

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 ER with PDD values: Hu-Chems III	
Emission reduction estimation according to PDD	291,595 tCO_2e
Corresponding PDD estimation (over 183 days; rounded)	145,798 tCO_2e
Actual calculation of emission reduction in monitoring period (over 183 days)	26,056 tCO_2e

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

Comparison of ER with PDD values: Hu-Chems IV	
Source	**Value**
Emission reduction estimation according to PDD	673,174 tCO_2e
Corresponding PDD estimation (over 183 days; rounded)	336,587 tCO_2e
Actual calculation of emission reduction in monitoring period (over 183 days)	352,441 tCO_2e

Actual emission reductions in plant Hu-Chems IV were only slightly above the ex-ante PDD estimation for this monitoring period due to shorter NA plant shutdown and less maintenance periods as expected.

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

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Hu-Chems Fine Chemical Corp.
Street/P.O. Box	19th Floor Kukdong Bldg., 60-1, Chungmuro 3ga. Jung-gu
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Contact person	Ferdinand Heilig

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Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
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Website	-
Contact person	Mr. Ludwig Kons
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Salutation	-
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Middle name	-
First name	Ludwig
Department	-
Mobile	-
Direct fax	-
Direct tel.	-
Personal e-mail	-

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 as 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)
- Social Fund 2014: 149,753,580 WON (~ 104,000 Euro)
- Social Fund 2015: 317,118,434 WON (~ 241,000 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#31_UNFCCC_v1_CONFIDENTIAL.xlsx, HUC-0765_III_MP#31_UNFCCC_v2_CONFIDENTIAL.xlsx, HUC-0765_IV_MP#31_UNFCCC_v2_CONFIDENTIAL.xlsx, HUC-0765_OVERALL_MP#31_UNFCCC_v2_CONFIDENTIAL.xlsx

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Document information

Version	*Date*	*Description*
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
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, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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