



**Project design document form
(Version 11.0)**

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION

Title of the project activity	Catalytic N ₂ O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.
Scale of the project activity	<input checked="" type="checkbox"/> Large-scale <input type="checkbox"/> Small-scale
Version number of the PDD	05.1 (renewal of crediting period)
Completion date of the PDD	06/04/2020
Project participants	Hu-Chems Fine Chemical Corp. RWE Power AG Carbon Climate Protection GmbH
Host Party	Republic of Korea
Applied methodologies and standardized baselines	ACM0019 version 04.0 (N ₂ O abatement from nitric acid production) No standardized baselines applicable.
Sectoral scopes	5 – Chemical industries
Estimated amount of annual average GHG emission reductions	1,209,597 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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(1) Purpose of project activity

A project for GHG emission reduction by catalytic N₂O destruction has been implemented in Yeosu, Republic of Korea. The project activity includes development, design, engineering, procurement, finance, construction, operation and maintenance of three systems for catalytic reduction of N₂O. Hu-Chems operates the EnviNOx®-systems at its three nitric acid (NA) plants Hu-Chems II, Hu-Chems III and Hu-Chems IV, whereas all of them were constructed by UHDE before 2004. The EnviNOx® process used at plants Hu-Chems II and Hu-Chems III is based on the catalytic reduction of N₂O, supported by ammonia and propane (supplied as Liquefied Petroleum Gas – LPG) as reducing agent. The EnviNOx® process used at plant Hu-Chems IV is based on the catalytic decomposition of N₂O supported by ammonia.

a. Scenario existing prior to the implementation of the project activity

NA plants are, in the vast majority of cases part of a chemical complex. They are built and operated to supply acid for consumption in downstream process units. The most common use for NA is for fertilisers, with smaller quantities going into the manufacture of organic compounds and mining explosives. Nitrous oxide (N₂O) is an unwanted, invisible and previously neglected by-product of the manufacture of nitric acid. It is formed alongside the main, desired product nitric oxide (NO) during the catalytic oxidation of ammonia in air over noble metal gauzes. When leaving the ammonia oxidation reactor (AOR), there is no relevant loss of N₂O in the tail gas section unless a N₂O destruction facility is installed. N₂O that leaves the AOR is thus discharged to atmosphere in the tail gas, and has no economic value.

The scenario existing prior to the start of the implementation of the project activity is that the N₂O is emitted to the atmosphere with no N₂O abatement measure being implemented.

b. Baseline scenario

The baseline scenario is the identical to the scenario existing prior to the start of implementation of the project activity, which is the emission of N₂O to the atmosphere with no N₂O abatement measure being implemented. For identification of the baseline scenario, please refer to section B.4.

c. Project scenario

Under the project scenario, N₂O from NA production is removed from the tail gas downstream of the absorption tower by catalytic destruction in a tertiary N₂O abatement facility. This abatement facility contains a catalyst through which the tail gas flows and where the N₂O abatement occurs. This destruction process is described in detail in section A.3.

Annual average of GHG emission reductions during 3rd crediting period: 1,209,597 tCO₂e

Total GHG emission reductions over 3rd crediting period: 8,467,178 tCO₂e

(2) Project's contribution to sustainable development

Since the purpose of the project activity is to significantly reduce N₂O emissions from the production of NA at HUCHEM's NA plants II, III & IV, it leads to environmental, economic and social benefits, and therefore contributes to improve the sustainable development in the Republic of Korea.

The catalytic N₂O destruction project activity reduces N₂O emissions that would be emitted in the absence of the CDM project activity. This leads to significant environmental benefits on a global level and helps to mitigate dangerous climate change. The technology transfer leads to improved understanding of high advanced air cleaning technologies. Furthermore, plant personnel will benefit from training courses taking place for operation and maintenance purposes of the tertiary abatement facility.

A share of the income from the sale of the CERs are invested in a "Social Fund" to support social projects in the area of Yeosu (additional social benefit).

A.2. Location of project activity

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Host Party: Republic of Korea

Province: Jeonam-do

Town: Yeosu-si, 7-6, Wollae-dong

Unique geographic coordinates: Longitude: 127.743198 E, Latitude: 34.848686 N

Address: Hu-Chems Fine Chemical Corp.,
7-6, Wollae-dong, Yeosu-si, Jeonnam,
Republic of Korea



Address : [Zip code: 595-560] 7-6 Wollae-dong, Yeosu City, Jeonnam-do
Phone : 82-61-656-4500
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A.3. Technologies/measures

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(a) Description of the installed technology and equipment¹

In general, the applied technology, the EnviNOx®-process, is a tertiary measure for the destruction of N₂O from NA plant tail gas streams based on the catalytic decomposition or catalytic reduction of N₂O, located in the tail gas stream at positions with high tail gas temperatures. The installation of an EnviNOx®-system requires significant investment for the supply and installation of the equipment, as well as operating cost for any hydrocarbon used as well as for replacement of the catalyst and the ongoing monitoring and maintenance of the facility. The implementation of the project activity does not increase the production of NA of the plants.

• Technology used at plant Hu-Chems II

A catalytic reduction process is installed in Hu-Chems II NA plant. The EnviNOx® reactor 322-R-202 is located between the existing Selective Catalytic Reduction (SCR) DeNOx Reactor 37-R-201 and the tail gas turbine 37-C-201-T2, which is the position with the highest tail gas temperature in the NA production process at Hu-Chems II. The current tail gas temperature at this stage of the process is around 360°C and sufficient to permit very high rates of N₂O removal by virtue of the use of propane and ammonia as reducing agents for N₂O and NOx respectively. Hence, there is no need to make modifications to the NA plant to increase the tail gas temperature. The existing SCR DeNOx unit is still in operation.

The EnviNOx® reactor contains two catalyst beds: 1) an iron zeolite, 2) a cordierite monolith coated with a small quantity of platinum. For the efficient reduction of N₂O, the NOx concentration of the tail

¹ Hu-Chems NA plants were designed to be in operation in the long-term and therefore the technical lifetime of the equipment will exceed the CDM crediting period.

gas leaving the existing SCR-DeNO_x reactor must be further lowered. This is achieved simultaneously to the reduction of N₂O in the first catalyst bed. The reducing agents employed, ammonia and propane, are introduced into the tail gas upstream of the EnviNO_x® reactor via the static mixer 322-MX-203 as superheated vapours. The second bed in the EnviNO_x® reactor converts carbon monoxide arising from the use of propane in the first bed to carbon dioxide (CO₂). The amount of this greenhouse gas emission (CO₂) is insignificant in comparison to the reduction in greenhouse gas emissions that the process achieves by destroying N₂O, but will be monitored by measuring the flow of LPG to the EnviNO_x® system.

All the reactions taking place in the EnviNO_x® reactor are exothermic. The resulting higher temperature at the inlet of the tail gas turbine increases the amount of energy recovered and compensates for the slight reduction in energy recovery caused by the additional pressure drop of the new equipment.

Ammonia feed: Superheated ammonia from the existing plant ammonia evaporator and superheater is supplied to the EnviNO_x® system under flow control. If for any reason the supply of ammonia to the EnviNO_x® system must be interrupted, either due to a trip or operator intervention, an automatic double block and bleed system isolates the ammonia system from the tail gas side of the NA plant.

Liquefied Petroleum Gas (LPG) feed: LPG (main constituent is propane, which is effectively used as reducing agent in the process) is taken from a storage tank, vaporised, superheated and then supplied to the EnviNO_x® system under flow control. As with the ammonia supply system, the LPG feed is isolated from the tail gas side of the NA plant in case of an interruption of supply caused by operator action or an interlock by means of a double block and bleed arrangement.

Mixer: LPG gas and ammonia vapour are supplied to the lances of the tail gas / ammonia / LPG gas static mixer. This inline device ensures that the reducing agents ammonia and LPG are intimately mixed with the tail gas before the tail gas reaches the EnviNO_x® reactor.

N₂O and NO_x reduction: At the inlet of the EnviNO_x® reactor the NO_x concentration typically reaches about 100 ppm and the N₂O concentration is typically in an order of 2,000 ppm. The NO_x concentration increases with plant load and temperature in the absorption tower while increased absorption tower pressure reduces the NO_x concentration. Thus, the NO_x concentration is subject to short term fluctuations without any long-term trend.

While the tail gas N₂O concentration can also increase with increasing plant load it additionally depends significantly on the state of the ammonia oxidation platinum-rhodium gauzes in the ammonia burners. The state of the gauzes deteriorates over the length of a production campaign. So, the short-term fluctuations in N₂O concentration are generally – although not in every campaign – overlaid with a long-term trend to higher N₂O concentrations as the campaign advances.

The EnviNO_x® reactor contains two catalyst beds arranged in series as described above. In the first bed the EnviCat®-N₂O-2 catalyst reduces the concentration of NO_x and N₂O to very low levels by reaction with ammonia and hydrocarbons, respectively, while in the second bed carbon monoxide is oxidised to CO₂.

- **Technology used at plant Hu-Chems III**

The technology used at Hu-Chems III is congruent the technology used at Hu-Chems II (see above), whereas project equipment is identified as follows:

	HU-CHEMS II	HU-CHEMS III
EnviNO _x ® Reactor	322-R-202	323-R-302
Static mixer	322-MX-203	323-MX-303

- **Technology used at plant Hu-Chems IV**

A catalytic N₂O decomposition process is installed at Hu-Chems IV NA plant. The EnviNO_x® 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 current tail gas temperature here is around 435°C. The prior existing Selective Catalytic Reduction (SCR) DeNO_x unit installed

for NO_x reduction has been removed during the implementation of the project activity, with the EnviNOx® reactor taking on the function of the SCR DeNO_x unit. As far as the degree of NO_x removal is concerned the performance of the EnviNOx® reactor is superior to the formerly existing SCR DeNO_x unit.

The EnviNOx® reactor contains two catalyst beds filled with special iron zeolite catalysts. In the first bed a large part of the N₂O decomposes to nitrogen and oxygen, the high concentration of NO_x in the tail gas promoting this reaction. After the first bed, ammonia vapour is fed to the vessel and mixed inside with the tail gas. In the second bed, a large part of the NO_x is catalytically reduced to nitrogen and water vapour, so that very low concentrations of both NO_x and N₂O can be achieved at the reactor exit. The process is tolerant of excess ammonia, the catalyst neither being adversely affected by high ammonia concentrations nor allowing ammonia to leave the reactor unconverted. Ammonia consumption is similar to that of conventional SCR processes.

All the reactions taking place in the reactor are exothermic. The resulting higher temperature at the inlet of the tail gas turbine increases the amount of energy recovered and compensates for the slight reduction in energy recovery caused by the additional pressure drop of the new equipment.

Ammonia feed: Liquid ammonia is vaporised and superheated in the ammonia evaporator with low pressure steam. The superheated ammonia is supplied to the EnviNOx® system under flow control. If for any reason the supply of ammonia to the EnviNOx® system must be interrupted, either due to a trip or operator intervention, an automatic double block and bleed system isolates the ammonia system from the tail gas side of the NA plant.

Mixer: Ammonia vapour is supplied to the lance of the tail gas / ammonia static mixer. This inline device ensures that the ammonia is intimately mixed with the tail gas before the tail gas reaches the EnviNOx® reactor.

N₂O and NO_x reduction: At the inlet of the EnviNOx® reactor the NO_x concentration typically reaches about 500 ppm and the N₂O concentration is typically in an order of 1,000 ppm. The NO_x concentration increases with plant load and temperature in the absorption tower while increased absorption tower pressure reduces the NO_x concentration. Thus, the NO_x concentration is subject to short term fluctuations without any long-term trend.

While the tail gas N₂O concentration can also increase with increasing plant load it additionally depends significantly on the state of the ammonia oxidation platinum-rhodium gauzes in the ammonia burners. The state of the gauzes deteriorates over the length of a production campaign. So, the short-term fluctuations in N₂O concentration are generally – although not in every campaign – overlaid with a long-term trend to higher N₂O concentrations as the campaign advances.

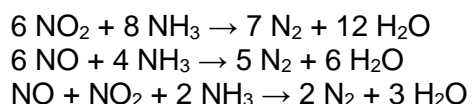
The EnviNOx® reactor contains two catalyst beds arranged in series as described above. Between the beds is an ammonia feed. In the first bed the EnviCat®-N₂O-1 catalyst reduces the concentration of N₂O to a low level by catalytic decomposition, while in the second EnviCat®-NO_x bed NO_x is reduced with ammonia and further destruction of N₂O takes place.

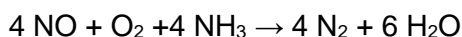
(b) Description of catalytic decomposition process (EnviNOx® process)

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

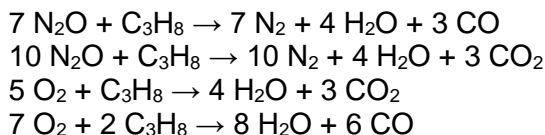
The EnviNOx® process used in the Hu-Chems II and Hu-Chems III NA plants is based on the catalytic reduction of NO_x (NO and NO₂) with ammonia (NH₃) and of nitrous oxide (N₂O) with a hydrocarbon. The hydrocarbon used is propane C₃H₈ (supplied as LPG). The reactions take place over an iron zeolite catalyst bed.

First the NO_x is reduced with ammonia according to such reactions as (effectively almost all the NO_x are removed):

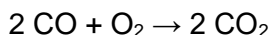




Secondly the N_2O is reduced with hydrocarbons over the iron zeolite according to such reactions as (N_2O reduction by these reactions is much more effective when NO_x is absent.):



A large proportion of the carbon monoxide that is formed is further oxidised to CO_2 over a second EnviCat®-CO / CH catalyst installed in the EnviNOx® reactor downstream of the first catalyst:

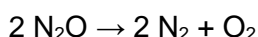


All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor. Compared with the reduction in greenhouse gas emissions achieved by the destruction of N_2O the additional greenhouse gas emissions (CO_2) caused by the use of hydrocarbons in the process are insignificant. The project activity reduces the N_2O emissions from Hu-Chems II and III NA plants by about 97% respectively and uses hydrocarbons (propane) as reducing agent. In this context it is important to emphasise that the hydrocarbon and ammonia are not employed as fuels to increase the temperature of the tail gas to a level at which high rates of N_2O decomposition can take place, but that they are used as genuine chemical reagents that take part in reactions with N_2O and NO_x respectively on specific sites on the surface of catalysts specially developed for the purpose by Uhde. Thus, the consumption of hydrocarbons corresponds to the stoichiometric ratio given in the reaction equations above.

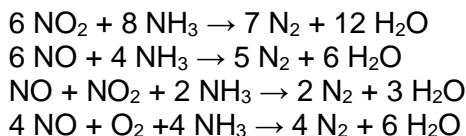
• Principles of the EnviNOx® process Hu-Chems IV

The EnviNOx® process used in NA plant IV is based on the catalytic decomposition of N_2O and catalytic reduction of NO_x (NO and NO_2) with NH_3 . This process works very well at temperatures above about 425°C , the reactions take place over two iron zeolite catalyst beds.

In the first bed, N_2O is catalytically decomposed into its elements (the rate of this reaction is enhanced by high concentrations of NO_x):



Before the tail gas enters the second catalyst bed, a small quantity of ammonia vapour is added. In the second bed a large part of the NO_x is reduced with ammonia according to such reactions as:



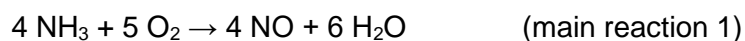
Some further destruction of N_2O also occurs. All the above reactions are exothermic and cause a temperature rise over the EnviNOx® reactor. The consumption of ammonia corresponds to the stoichiometric ratio given in the reaction equations above and does not differ significantly from the consumption of a conventional DeNOx unit.

The proposed project activity reduces the N_2O emissions from Hu-Chems IV NA plant by about 97%. No hydrocarbons are used in plant Hu-Chems IV.

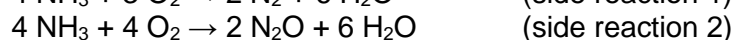
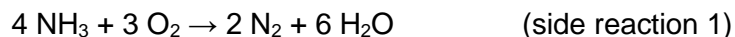
(c) Scenario existing prior to the implementation of the project activity

The three NA plants were designed without any N₂O abatement measure. The production of NA takes place in three main process steps as indicated by the following reactions:

1. NH₃ combustion to form NO:



Simultaneously N₂O, N and H₂O are formed as well in accordance with following equations:



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

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



3. (According to the technical process) Absorption of NO₂ in H₂O to form nitric acid (HNO₃):
(NO is oxidised to NO₂ according to main reaction 2)



When leaving the AOR, there is no relevant loss of N₂O in the tail gas section unless an N₂O destruction facility is installed. N₂O that leaves the AOR is thus discharged to atmosphere in the tail gas, and has no economic value.

According to the applied methodology ACM0019 “N₂O abatement from nitric acid production” (Version 04.0) operators of NA plants have no economic incentives to take any N₂O abatement measures in the absence of regulations requiring the abatement of N₂O emissions, because this entails capital and operating costs, but no financial benefits. Since no laws or regulations exist at present in the host country, the Republic of Korea, which mandate the complete or partial destruction of N₂O from NA plants, Hu-Chems has no economic incentives to take any N₂O abatement measures in its NA plants. Hence, the baseline scenario is that the N₂O is emitted to the atmosphere with no N₂O abatement measure being implemented.

(d) Know-how transfer

The technology transfer has led to improved understanding of high advanced air cleaning technologies within the Republic of Korea. Furthermore, plant personnel benefits from training courses taking place for operation and maintenance purposes of the tertiary abatement facilities.

A.4. Parties and project participants

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Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (Host Party)	Hu-Chems Fine Chemical Corp.	No
Federal Republic Germany	RWE Power AG	No
Austria	Carbon Climate Protection GmbH	No

A.5. Public funding of project activity

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No public funds are or were available for the financing of the project activity.

A.6. History of project activity

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The Project Participants confirm:

- (a) The CDM project activity is already registered as a CDM project activity and with this PDD version a request for renewal of crediting period is submitted.
- (b) The CDM project activity isn't a project activity that has been deregistered.

The Project Participants declare:

- (a) The CDM project activity wasn't a CPA that has been excluded from a registered CDM PoA.
- (b) No other registered CDM project activity or a CPA under a registered CDM PoA exists in the same geographical location as the CDM project activity.

A.7. Debundling

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Not applicable.

SECTION B. Application of methodologies and standardized baselines**B.1. References to methodologies and standardized baselines**

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Selected methodology: ACM0019 "N₂O abatement from nitric acid production" (version 04.0)²

Methodological tools:

- TOOL08 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)³
- TOOL03 "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" (version 03.0)⁴

No standardized baselines are used according to the applied methodology.

B.2. Applicability of methodologies and standardized baselines

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The project activity destroys N₂O from three NA plants of Hu-Chems by catalytic reduction of N₂O in the tail gas (i.e. tertiary destruction). Each of the following applicability conditions are met:

- (a) Applicability criteria #1: The methodology applies to project activities that introduce N₂O abatement measures in NA plants.
Justification #1: The project activity destroys N₂O emissions by the reduction of N₂O in the tail gas stream of the NA plants II, III & IV of Hu-Chems (tertiary abatement technology).
- (b) Applicability criteria #2: In the case that the NA plant started commercial operation before the implementation of the CDM project activity, the project participants shall demonstrate that there was no secondary or tertiary N₂O abatement technology installed in the respective NA plant;
Justification #2: Since the start of the commercial operation (plant Hu-Chems II: 1990, plant Hu-Chems III: 1997, plant Hu-Chems IV: 2003) no secondary or tertiary abatement technology

² <https://cdm.unfccc.int/methodologies/DB/HKCO7RKOQO748WNXJNDEW3BJT9XN8L>

³ <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf>

⁴ <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf>

was installed in these NA plants prior to the implementation of the CDM project in 2007 (1st crediting period). The original design documents of the NA plants clearly demonstrate that no such technologies were in place before. Besides, similar justifications and related evidence have already been provided for the (re-)validation of the 1st and 2nd crediting period.

- (c) Applicability criteria #3: Continuous real-time measurements of the N₂O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N₂O emissions throughout the crediting period of the project activity;

Justification #3: Continuous real-time measurements of the N₂O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N₂O emissions throughout the crediting period of the project activity. A dedicated Automated Monitoring System (AMS) was already installed prior to the beginning of the 1st crediting period of the project activity. This AMS will be adapted – if needed – in order to meet the requirements of the applied monitoring methodology.

- (d) Applicability criteria #4: No law or regulation which mandates the complete or partial destruction of N₂O from nitric acid plants exists in the host country where the CDM project activity is implemented.

Justification #4: At present no laws or regulations exist, which mandate the complete or partial destruction of N₂O from NA plants in the host country, the Republic of Korea.

In addition, the following applicability condition included in TOOL08 applies and is met:

- *Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions.*

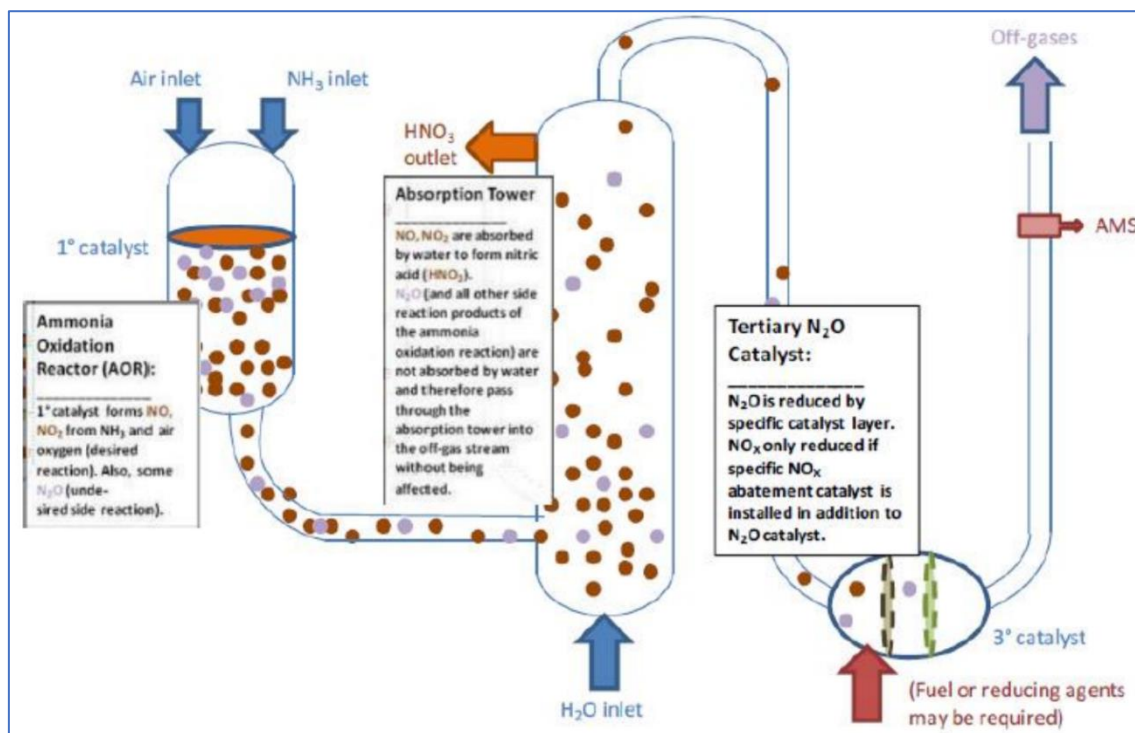
Justification: In the applied methodology the flow and composition of residual or flared gases or exhaust gases need to be measured for the determination of project emissions.

No standardized baselines are used according to the applied methodology.

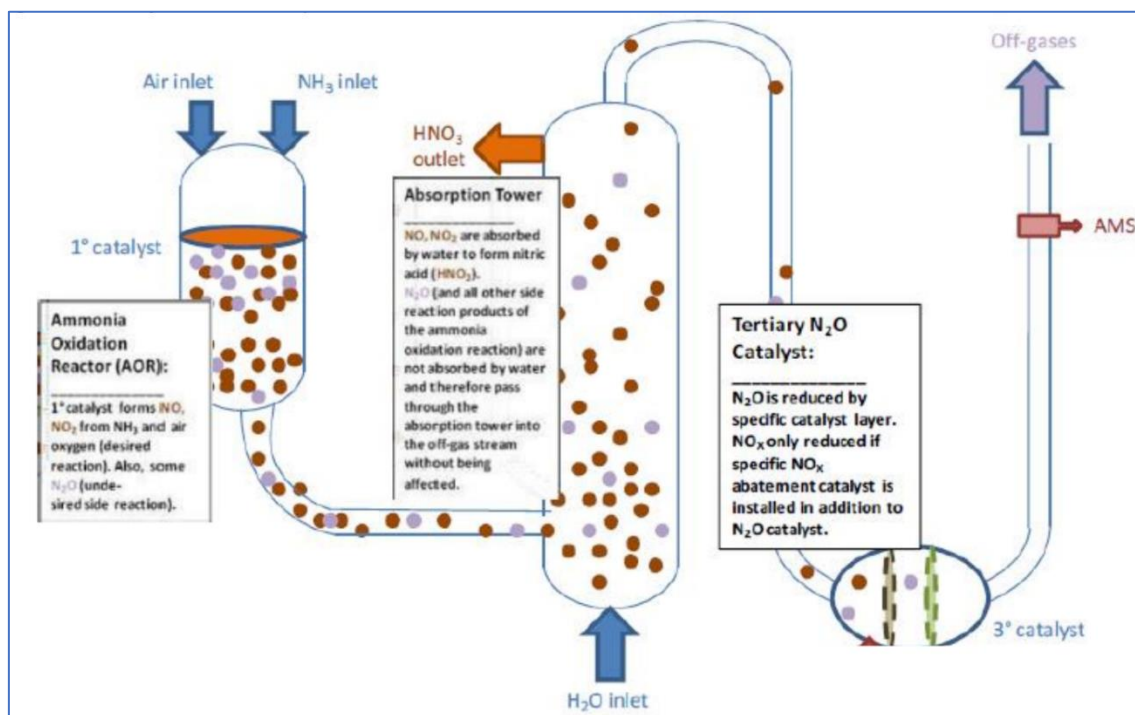
B.3. Project boundary, sources and greenhouse gases (GHGs)

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Following figures demonstrate the project boundary of the project activity (simplified standard NA plant layout displaying the location of the N₂O abatement catalyst, process sources of N₂O and the sampling point location for the AMS).



Project boundary Hu-Chems NA plants II & III



Project boundary Hu-Chems NA plant IV

As shown in the figures above, the only baseline emissions considered are the N_2O emissions formed in the AORs, a part of the NA plant, whereas the HNO_3 production is measured in order to determine the baseline emissions. Furthermore, status of plant operation is also monitored by measuring suitable plant operation parameters (e.g. NH_3 inlet to AOR).

The project activity includes tertiary N_2O abatement facilities in each plant, physically located in the tail gas stream of the NA plant, where N_2O emissions are destroyed to a high extent. The remaining amounts of N_2O which are not destroyed and still present after the abatement facilities are measured by the AMS (separately for each plant) downstream of the tertiary abatement measures and are considered as project emissions. Fossil fuel (propane, supplied as LPG) is used as reducing agent in plants Hu-Chems II & III, when operating the tertiary abatement facilities, for this reason emissions from this source are to be considered as well. No hydrocarbons are used in plant Hu-Chems IV.

The following table illustrates in detail, which emissions sources are included or excluded from the project boundary for determination of both baseline and project emissions:

Source		GHG	Included?	Justification/Explanation
Baseline	NH ₃ oxidation at the primary catalyst gauze	CO ₂	No	The project activity has no influence on these types of emissions, if present
		CH ₄	No	
		N ₂ O	Yes	Included, main emission source
Project activity	NH ₃ oxidation at the primary catalyst gauze	CO ₂	No	The project activity has no influence on these types of emissions, if present
		CH ₄	No	
		N ₂ O	Yes	Included, main emission source
	Operation of a tertiary N ₂ O Abatement facility	CO ₂	Yes	In some cases, fossil fuels are used as reducing agent and/or for decomposing the tail gas as part of a tertiary N ₂ O abatement facility. In this case the fossil fuels are mainly converted to CO ₂ . In this CDM project, propane is used as reducing agent for plants Hu-Chems II & III. No fossil fuels are used in plant Hu-Chems IV. CO ₂ emissions arising from the production of ammonia are assumed to be small and not taken into account.
		CH ₄	No	Not applicable, as per the methodology.
		N ₂ O	Yes	Included

The spatial extent of the project boundary encompasses the facility and equipment for the NA production process from the inlet of the ammonia burner (i.e. the AOR) to the outlet of the tail gas section (i.e. the stack).

B.4. Establishment and description of baseline scenario

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At present no laws or regulations exist, which mandate the complete or partial destruction of N₂O from NA plants in the host country, the Republic of Korea. In accordance with the methodology, Hu-Chems has no economic incentives to take any N₂O abatement measures in its NA plants in the absence of regulations requiring such measures, as this would entail capital and operating costs, but no financial benefits. Therefore, the CDM project is considered additional and the baseline scenario is that the N₂O emitted to the atmosphere with no N₂O abatement measure being implemented.

B.5. Demonstration of additionality

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According to the applied methodology ACM0019 the CDM project activity is considered additional in case of the absence of regulations requiring the abatement of N₂O emissions, as the operator of the NA plants has no economic incentives to take any N₂O abatement measures. Since it was clearly demonstrated in section B.4 above that in the Republic of Korea no regulations exist, which require the abatement of N₂O emissions in NA plants, the CDM project "Catalytic N₂O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp." is considered additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline Emissions for Case 1: For NA plants that have used AM0028 or AM0034 in the 1st CP

Due to the fact that the project activity includes three separate NA plants and N₂O destruction facilities, monitoring is done separate for each plant as well. Hence, in order to obtain the baseline emissions in year y (tCO₂e) a sum over plant specific baseline emissions is calculated.

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

Where:

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

The project activity used AM0028 v.1 in the 1st crediting period and used ACM0019 v.02.0 (substituting methodologies AM0028 and AM0034 for their use in N₂O reduction projects in NA plants) in the 2nd crediting period. Now, methodology ACM0019 v.04.0 shall be applied for the 3rd crediting period of the CDM project and the baseline emissions are calculated as follows:

For the calculation of baseline emissions, the described situation is covered in the methodology ACM0019 v.04.0 under “Case 1” (Case 2 has not to be considered) including specific formulae for calculation. In general, the following calculations are applicable to all three NA plants (Hu-Chems II, III & IV) similarly and separately, unless described otherwise. Plant specific suffixes have been neglected in this section to prevent confusion.

$$BE_y = \left(\min\{P_{production,y} ; P_{product,max}\} * EF_{existing,y} + \right) * \frac{(h_y - h_{r,y})}{h_y} * GWP_{N_2O} * 10^{-3} \quad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year y (t CO ₂ e)
$P_{product,max}$	=	Design capacity (t HNO ₃)
$P_{production,y}$	=	Production of nitric acid in year y (t HNO ₃)
$EF_{existing,y}$	=	N ₂ O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N ₂ O/t HNO ₃)
$EF_{new,y}$	=	Baseline N ₂ O emission factor for nitric acid production in year y (kg N ₂ O/t HNO ₃)
GWP_{N_2O}	=	Global Warming Potential of N ₂ O valid for the commitment period
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N ₂ O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N ₂ O abatement: the abatement system is by-passed, underperforming or failed

The N₂O emission factor for NA plants that used AM0028 or AM0034 in the 1st crediting period ($EF_{existing,y}$) will be calculated as follows:

$$EF_{existing,y} = \min\{EF_{historical} ; EF_{default,y}\} \quad \text{Equation (2)}$$

Where:

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

Calculation of $h_{r,y}$ for Case 1: For NA plants that have used AM0028 or AM0034 in the 1st crediting period

Similar to the calculation of BE_y “Case 1” applies to project activities that have used AM0028 or AM0034 in the 1st crediting period for the calculation of $h_{r,y}$ (Case 2 has not to be considered).

$$F_{N_2O, tail\ gas, h} > EF_{existing, y} * P_{NA, h}$$

Equation (4)

Where:

- $P_{NA, h}$ = Nitric acid produced in the hour h (t HNO₃)
 $EF_{existing, y}$ = Default N₂O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N₂O/t HNO₃)
 $F_{N_2O, tail\ gas, h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/h)

Project Emissions

Due to the fact that the project activity includes three separate NA plants and N₂O destruction facilities, monitoring is done separate for each plant as well. Hence, in order to obtain the project emissions in year y (tCO₂e) a sum over plant specific project emissions is calculated.

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

Where:

- PE_y = Project emissions in year y (t CO₂e)
 $PE_{y, II}$ = Project emissions of plant Hu-Chems II in year y (t CO₂e)
 $PE_{y, III}$ = Project emissions of plant Hu-Chems III in year y (t CO₂e)
 $PE_{y, IV}$ = Project emissions of plant Hu-Chems IV in year y (t CO₂e)

In general, the following calculations are applicable to all three NA plants (Hu-Chems II, III & IV) similarly and separately, unless described otherwise. Plant specific suffixes have been neglected in this section to prevent confusion.

Project emissions include N₂O emissions, which have not been destroyed by the project activity and, in case of the installation of a tertiary N₂O abatement facility, CO₂ emissions resulting from the operation of the N₂O abatement facility. Project emissions are calculated as follows:

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

Equation (6)

Where:

- PE_y = Project emissions in year y (t CO₂e)
 $PE_{N_2O, y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
 $PE_{CO_2, tertiary, y}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in year y (t CO₂)

Project emissions of N₂O from the project plant (PE_{N₂O, y})

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

$$PE_{N_2O, y} = \sum_{h=1}^{h_y - h_{r, y}} F_{N_2O, tail\ gas, h} * GWP_{N_2O} * 10^{-3}$$

Equation (7)

Where:

- $PE_{N_2O, y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
 GWP_{N_2O} = Global Warming Potential of N₂O valid for the commitment period
 $F_{N_2O, tail\ gas, h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/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 N₂O abatement. Abatement system was not installed, underperforming or failed;

- (b) For tertiary N₂O abatement. The abatement system is bypassed, underperforming or failed

Determination of $F_{N_2O, tail\ gas, h}$

The amount of N₂O emissions from the tail gas stream of the project plant shall be determined 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 N₂O 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 latest version of European Norm 14181;
- (b) The monitoring system should provide separate hourly average values for the N₂O 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 N₂O 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 N₂O 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 N₂O 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 N₂O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N₂O 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 N₂O 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 N₂O concentration and the volume or mass flow of the tail gas and bypass 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.

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, (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).

Based on currently available information **Option A** of the tool will be applied (measurement options for option A: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis), which states two ways how to demonstrate that the gaseous stream is dry. These are:

- a) Measure the moisture content of the gaseous stream ($C_{H_2O, t, db, n}$) and demonstrate that this is less or equal to 0.05 kg H₂O/m³ 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.

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

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

Equation (5) of tool

⁵ $F_{i,t}$ corresponds to the parameter $F_{N_2O, tail\ gas, h}$ of the methodology ACM0019.

With:

$$\rho_{i,t} = \frac{P_t \cdot MM_i}{R_u \cdot T_t} \quad \text{Equation (6) of tool}$$

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 (m³ 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 (m³ gas i/m³ dry gas)
- $\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ 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.m³/kmol.K)
- T_t = Temperature of the gaseous stream in time interval t (K)

Option A of the tool can be applied since the results of all measurements, which were performed during the 2nd crediting period, show that the moisture content of the gaseous stream ($C_{H_2O,t,db,n}$) of all plants is less than 0.05 kg H₂O/m³ dry gas and therefore the gas is considered to be dry. The moisture content of the gaseous stream will be measured according to the prevailing methodology and tool as well as to relevant current norms and standards.

According to the applied methodology the amount of N₂O emissions from the tail gas stream of the project plant shall be determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, but 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 – if the N₂O 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.

Since the N₂O concentration and the volume flow of the tail gas and by-pass are automatically converted to normal conditions, the parameters P_t and T_t need not to be monitored. The term m³ used in the units for the volumetric flow ($V_{t,db}$) and the volumetric fraction ($v_{i,t,db}$) refer to m³ at these mentioned standard conditions throughout this document. Therefore, when applying equation (6) of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” to determine a fixed value for the N₂O density at normal conditions ($P_t = P_n = 101,325$ Pa; $T_t = T_n = 273.15$ K), the N₂O density at normal conditions was determined to be 1.96 kg/m³⁶. Thus, respective parameters (P_t and T_t) need not to be monitored as per the applied methodology.

Project emissions from the operation of the tertiary N₂O abatement facility ($PE_{CO_2,tertiary,y}$)

This emission source only needs to be estimated, if a tertiary N₂O 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. This situation applies only to NA plants Hu-Chems II & III, where propane (supplied as LPG) is used as reducing agent in the tertiary N₂O 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 & III, whereas in plant Hu-Chems IV the value for $PE_{CO_2,tertiary,y}$ is set to zero due to inapplicability of this emission source (associated parameters are not monitored).

The emissions related to the operation of the N₂O destruction facility include only onsite emissions due to the fossil fuel use as input to the N₂O destruction facility:

$$PE_{CO_2,tertiary,y} = PE_{FF,y} \quad \text{Equation (8)}$$

Where:

- $PE_{CO_2,tertiary,y}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in year y (t CO₂)

⁶ $\rho_{i,t} = (P_n \times MM_i) / (T_n \times R_u) = 1.96$ kg/m³, where $P_t = P_n = 101,325$ Pa // $T_t = T_n = 273.15$ K // $MM_i = 44.02$ kg/kmol // $R_u = 8,314$ Pa.m³/kmol.K

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

Project proponents shall use the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” to calculate the project emissions related to fossil fuels used in year y. Specific guidance on the use of the tool:

- The parameter $PE_{FC,j,y}$ used in the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” corresponds to the parameter $PE_{FF,y}$ in this methodology; and
- The element process j in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N₂O abatement facility and/or the re-heating of the tail gas.

It shall be considered that for synchronizing the applied tool with the methodology “yr” and “y” are understood to cover the same time period unless otherwise explained.

According to the applied tool CO₂ emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO₂ emission coefficient of those fuels, as follows.

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} * COEF_{i,y} \quad \text{Equation (1) of tool}$$

Where:

$PE_{FC,j,y}$ = Are the CO₂ emissions from fossil fuel combustion in process j during the year y (tCO₂/yr)
 $FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)
 $COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (t CO₂/mass or volume unit)
 i = Are the fuel types combusted in process j during the year y

According to the applied tool the CO₂ emission coefficient $COEF_{i,y}$ can be calculated using one out of two options, depending on the availability of data on the fossil fuel type i . Option A should be the preferred approach, if the necessary data is available.

Based on currently available information **Option A** of the applied tool can be applied as the necessary data such as chemical composition of the used fossil fuel (i.e. LPG) will be provided by the supplier. According to Option A the CO₂ emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i , using the following approach:

If $FC_{i,j,y}$ is measured in a mass unit: $COEF_{i,y} = w_{C,i,y} * 44/12$ Equation (2) of tool

If $FC_{i,j,y}$ is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} * \rho_{i,y} * 44/12$ Equation (3) of tool

Where:

$COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i (tCO₂/mass or volume unit)
 $w_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)
 $\rho_{i,y}$ = Is the weighted average density of fuel type i in year y (mass unit/volume unit of the fuel)
 i = Are the fuel types combusted in process j during the year y

Since the amount of used fossil fuel is measured in a mass unit, Equation (2) of tool will be applied.

Leakage

Any leakage emissions sources are deemed to be negligible as per applied methodology.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Equation (9)

Where:

ER_y = Emission reductions in year y (t CO₂e)

BE_y = Baseline emissions in year y (t CO₂e)

PE_y = Project emissions in year y (t CO₂e)

B.6.2. Data and parameters fixed ex ante

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Data and parameters fixed ex-ante and relevant to all three NA plants (Hu-Chems II, III & IV):

Data/Parameter	EF _{new,y}																																												
Data unit	kg N ₂ O/t HNO ₃																																												
Description	Baseline N ₂ O emission factor for nitric acid production in year y (related to 100 per cent pure acid)																																												
Source of data	<p>The baseline N₂O emission factor for nitric acid production will decrease every year until it reaches a final value of 2.5 in the year 2020. The value of 2.5 will remain constant after 2020.</p> <table> <tr> <th>Year</th><th>Emission factor (kg N₂O/t HNO₃)</th></tr> <tr><td>2005</td><td>5.10</td></tr> <tr><td>2006</td><td>4.90</td></tr> <tr><td>2007</td><td>4.70</td></tr> <tr><td>2008</td><td>4.60</td></tr> <tr><td>2009</td><td>4.40</td></tr> <tr><td>2010</td><td>4.20</td></tr> <tr><td>2011</td><td>4.10</td></tr> <tr><td>2012</td><td>3.90</td></tr> <tr><td>2013</td><td>3.70</td></tr> <tr><td>2014</td><td>3.50</td></tr> <tr><td>2015</td><td>3.40</td></tr> <tr><td>2016</td><td>3.20</td></tr> <tr><td>2017</td><td>3.00</td></tr> <tr><td>2018</td><td>2.80</td></tr> <tr><td>2019</td><td>2.70</td></tr> <tr><td>2020</td><td>2.50</td></tr> <tr><td>2021</td><td>2.50</td></tr> <tr><td>2022</td><td>2.50</td></tr> <tr><td>2023</td><td>2.50</td></tr> <tr><td>...</td><td>...</td></tr> <tr><td>Year n</td><td>2.50</td></tr> </table>	Year	Emission factor (kg N ₂ O/t HNO ₃)	2005	5.10	2006	4.90	2007	4.70	2008	4.60	2009	4.40	2010	4.20	2011	4.10	2012	3.90	2013	3.70	2014	3.50	2015	3.40	2016	3.20	2017	3.00	2018	2.80	2019	2.70	2020	2.50	2021	2.50	2022	2.50	2023	2.50	Year n	2.50
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Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development.

Data/Parameter	GWP_{N2O}
Data unit	t CO ₂ e/t N ₂ O
Description	Global warming potential of N ₂ O valid for the commitment period
Source of data	Relevant decisions by the CMP
Value(s) applied	298
Choice of data or measurement methods and procedures	None
Purpose of data	Calculation of baseline and project emissions
Additional comment	N/A

Data and parameters fixed ex-ante and ONLY relevant to NA plant Hu-Chems II:

Data/Parameter	Operating pressure II
Data 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 NA plant operates at a low, medium or high pressure.
Additional comment	N/A

Data/Parameter	EF_{historical,II}
Data unit	kg N ₂ O/t HNO ₃
Description	Historical baseline emission factor of the nitric acid 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 1 st crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the 1 st crediting period; The plant used AM0028 in the 1 st crediting period, accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the 1 st crediting period is used. Calculation of EF _{historical} is based on actual data of overall historical baseline emission factor obtained in one calendar year of the NA plant of the 1 st crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the 2 nd and 3 rd crediting period.

Data/Parameter	EF_{default,y,II}																																																																												
Data unit	kg N ₂ O/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	<p>As per the applied methodology this default N₂O baseline emission factor will vary every year. For each subsequent year after 2013, the emission factors decreased / will decrease by 0.2 kg N₂O/t HNO₃ until they reach a value of 2.5 or 2.4. After reaching the values of 2.5 or 2.4 the emission factor will remain constant over time.</p> <table border="1"> <thead> <tr> <th>Year</th><th>Low pressure (0 – 200 kPa)</th><th>Medium pressure (200 – 600 kPa)</th><th>High pressure (Over 600 kPa)</th></tr> </thead> <tbody> <tr><td>2013</td><td>5.5</td><td>8.4</td><td>12.6</td></tr> <tr><td>2014</td><td>5.3</td><td>8.2</td><td>12.4</td></tr> <tr><td>2015</td><td>5.1</td><td>8.0</td><td>12.2</td></tr> <tr><td>2016</td><td>4.9</td><td>7.8</td><td>12.0</td></tr> <tr><td>2017</td><td>4.7</td><td>7.6</td><td>11.8</td></tr> <tr><td>2018</td><td>4.5</td><td>7.4</td><td>11.6</td></tr> <tr><td>2019</td><td>4.3</td><td>7.2</td><td>11.4</td></tr> <tr><td>2020</td><td>4.1</td><td>7.0</td><td>11.2</td></tr> <tr><td>2021</td><td>3.9</td><td>6.8</td><td>11.0</td></tr> <tr><td>2022</td><td>3.7</td><td>6.6</td><td>10.8</td></tr> <tr><td>2023</td><td>3.5</td><td>6.4</td><td>10.6</td></tr> <tr><td>2024</td><td>3.3</td><td>6.2</td><td>10.4</td></tr> <tr><td>2025</td><td>3.1</td><td>6.0</td><td>10.2</td></tr> <tr><td>2026</td><td>2.9</td><td>5.8</td><td>10.0</td></tr> <tr><td>2027</td><td>2.7</td><td>5.6</td><td>9.8</td></tr> <tr><td>2028</td><td>2.5</td><td>5.4</td><td>9.6</td></tr> <tr><td>2029</td><td>2.5</td><td>5.2</td><td>9.4</td></tr> <tr><td>2030</td><td>2.5</td><td>5.0</td><td>9.2</td></tr> </tbody> </table>	Year	Low pressure (0 – 200 kPa)	Medium pressure (200 – 600 kPa)	High pressure (Over 600 kPa)	2013	5.5	8.4	12.6	2014	5.3	8.2	12.4	2015	5.1	8.0	12.2	2016	4.9	7.8	12.0	2017	4.7	7.6	11.8	2018	4.5	7.4	11.6	2019	4.3	7.2	11.4	2020	4.1	7.0	11.2	2021	3.9	6.8	11.0	2022	3.7	6.6	10.8	2023	3.5	6.4	10.6	2024	3.3	6.2	10.4	2025	3.1	6.0	10.2	2026	2.9	5.8	10.0	2027	2.7	5.6	9.8	2028	2.5	5.4	9.6	2029	2.5	5.2	9.4	2030	2.5	5.0	9.2
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2018	4.5	7.4	11.6																																																																										
2019	4.3	7.2	11.4																																																																										
2020	4.1	7.0	11.2																																																																										
2021	3.9	6.8	11.0																																																																										
2022	3.7	6.6	10.8																																																																										
2023	3.5	6.4	10.6																																																																										
2024	3.3	6.2	10.4																																																																										
2025	3.1	6.0	10.2																																																																										
2026	2.9	5.8	10.0																																																																										
2027	2.7	5.6	9.8																																																																										
2028	2.5	5.4	9.6																																																																										
2029	2.5	5.2	9.4																																																																										
2030	2.5	5.0	9.2																																																																										
Value(s) applied	<p>Since plant Hu-Chems II is a high-pressure plant, corresponding values given in the methodology apply over the crediting period:</p> <table border="1"> <thead> <tr> <th>Year</th><th>High pressure (Over 600 kPa)</th></tr> </thead> <tbody> <tr><td>2021</td><td>11.0</td></tr> <tr><td>2022</td><td>10.8</td></tr> <tr><td>2023</td><td>10.6</td></tr> <tr><td>2024</td><td>10.4</td></tr> <tr><td>2025</td><td>10.2</td></tr> <tr><td>2026</td><td>10.0</td></tr> <tr><td>2027</td><td>9.8</td></tr> <tr><td>2028</td><td>9.6</td></tr> </tbody> </table>	Year	High pressure (Over 600 kPa)	2021	11.0	2022	10.8	2023	10.6	2024	10.4	2025	10.2	2026	10.0	2027	9.8	2028	9.6																																																										
Year	High pressure (Over 600 kPa)																																																																												
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2024	10.4																																																																												
2025	10.2																																																																												
2026	10.0																																																																												
2027	9.8																																																																												
2028	9.6																																																																												
Choice of data or measurement methods and procedures	N/A																																																																												
Purpose of data	Calculation of baseline emissions																																																																												
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development.																																																																												

Data/Parameter	P_{product,max,II}
Data unit	t product
Description	Design capacity of nitric acid production during the first crediting period of Hu-Chems II
Source of data	Manufacture's specifications
Value(s) applied	116,800

Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is only for project activities applying case 1.

Data and parameters fixed ex-ante and ONLY relevant to NA plant Hu-Chems III:

Data/Parameter	Operating pressure III
Data 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 comment	N/A

Data/Parameter	EF_{historical,III}
Data unit	kg N ₂ O/t HNO ₃
Description	Historical baseline emission factor of the nitric acid 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 1 st crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the 1 st crediting period; The plant used AM0028 in the 1 st crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the 1 st crediting period is used. Calculation of EF _{historical} is based on actual data of overall historical baseline emission factor obtained in one calendar year of the NA plant of the 1 st crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the 2 nd and 3 rd crediting period.

Data/Parameter	EF_{default,y,III}
Data unit	kg N ₂ O/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	As per the applied methodology this default N ₂ O baseline emission factor will vary every year. For each subsequent year after 2013, the emission factors decreased / will decrease by 0.2 kg N ₂ O/t HNO ₃ until they reach a value of 2.5 or 2.4. After reaching the values of 2.5 or 2.4 the emission factor will remain constant over time.			
	Year	Low pressure (0 – 200 kPa)	Medium pressure (200 – 600 kPa)	High pressure (Over 600 kPa)
	2013	5.5	8.4	12.6
	2014	5.3	8.2	12.4
	2015	5.1	8.0	12.2
	2016	4.9	7.8	12.0
	2017	4.7	7.6	11.8
	2018	4.5	7.4	11.6
	2019	4.3	7.2	11.4
	2020	4.1	7.0	11.2
	2021	3.9	6.8	11.0
	2022	3.7	6.6	10.8
	2023	3.5	6.4	10.6
	2024	3.3	6.2	10.4
	2025	3.1	6.0	10.2
	2026	2.9	5.8	10.0
	2027	2.7	5.6	9.8
	2028	2.5	5.4	9.6
	2029	2.5	5.2	9.4
	2030	2.5	5.0	9.2
Value(s) applied	Since plant Hu-Chems III is a high-pressure plant, corresponding values given in the methodology apply over the crediting period:			
	Year	High pressure (Over 600 kPa)		
	2021	11.0		
	2022	10.8		
	2023	10.6		
	2024	10.4		
	2025	10.2		
	2026	10.0		
	2027	9.8		
2028	9.6			
Choice of data or measurement methods and procedures	N/A			
Purpose of data	Calculation of baseline emissions			
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development.			

Data/Parameter	P_{product,max,III}
Data unit	t product
Description	Design capacity of nitric acid production during the first crediting period of Hu-Chems III
Source of data	Manufacture's specifications
Value(s) applied	116,800
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions

Additional comment	This parameter is only for project activities applying case 1.
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Data and parameters fixed ex-ante and ONLY relevant to NA plant Hu-Chems IV:

Data/Parameter	Operating pressure IV
Data 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 comment	N/A

Data/Parameter	EF_{historical,IV}
Data unit	kg N ₂ O/t HNO ₃
Description	Historical baseline emission factor of the nitric acid 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 1 st crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the 1 st crediting period; The plant used AM0028 in the 1 st crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the 1 st crediting period is used. Calculation of EF _{historical} is based on actual data of overall historical baseline emission factor obtained in one calendar year of the NA plant of the 1 st crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the 2 nd and 3 rd crediting period.

Data/Parameter	EF_{default,y,IV}
Data unit	kg N ₂ O/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	As per the applied methodology this default N ₂ O baseline emission factor will vary every year. For each subsequent year after 2013, the emission factors decreased / will decrease by 0.2 kg N ₂ O/t HNO ₃ until they reach a value of 2.5 or 2.4. After reaching the values of 2.5 or 2.4 the emission factor will remain constant over time.			
	Year	Low pressure (0 – 200 kPa)	Medium pressure (200 – 600 kPa)	High pressure (Over 600 kPa)
	2013	5.5	8.4	12.6
	2014	5.3	8.2	12.4
	2015	5.1	8.0	12.2
	2016	4.9	7.8	12.0
	2017	4.7	7.6	11.8
	2018	4.5	7.4	11.6
	2019	4.3	7.2	11.4
	2020	4.1	7.0	11.2
	2021	3.9	6.8	11.0
	2022	3.7	6.6	10.8
	2023	3.5	6.4	10.6
	2024	3.3	6.2	10.4
	2025	3.1	6.0	10.2
	2026	2.9	5.8	10.0
	2027	2.7	5.6	9.8
	2028	2.5	5.4	9.6
	2029	2.5	5.2	9.4
	2030	2.5	5.0	9.2
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)		
	2021	6.8		
	2022	6.6		
	2023	6.4		
	2024	6.2		
	2025	6.0		
	2026	5.8		
	2027	5.6		
2028	5.4			
Choice of data or measurement methods and procedures	N/A			
Purpose of data	Calculation of baseline emissions			
Additional comment	The decrease in the value for the baseline emission factor over time is to reflect the technological development.			

Data/Parameter	P_{product,max,IV}
Data unit	t product
Description	Design capacity of nitric acid production during the first crediting period of Hu-Chems IV
Source of data	Manufacture's specifications
Value(s) applied	467,200
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions

Additional comment	This parameter is only for project activities applying case 1.
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Data and parameters from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” relevant to all three NA plants (Hu-Chems II, III & IV):

Data/Parameter	R_u
Data 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 comment	N/A

Data/Parameter	MM _i								
Data 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		<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Nitrous oxide</td><td>N₂O</td><td>44.02</td></tr></table>	Compound	Structure	Molecular mass (kg/kmol)	Nitrous oxide	N ₂ O	44.02	
Compound	Structure	Molecular mass (kg/kmol)							
Nitrous oxide	N ₂ O	44.02							
Choice of data or measurement methods and procedures	Specified in the tool								
Purpose of data	Calculation of project emissions								
Additional comment	N/A								

Data/Parameter	P_n
Data 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 Pa
Choice of data or measurement methods and procedures	Specified in the tool
Purpose of data	Calculation of project emissions
Additional comment	This parameter will be used to determine the mass flow of the N ₂ O in the tail gas.

Data/Parameter	T_n
Data 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 K
Choice of data or measurement methods and procedures	Specified in the tool

Purpose of data	Calculation of project emissions
Additional comment	This parameter will be used to determine the mass flow of the N ₂ O in the tail gas.

B.6.3. Ex ante calculation of emission reductions

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Baseline emissions

Overall baseline emissions for the project activity are calculated as sum over plant specific baseline emissions:

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

Where:

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

	BE_y	$BE_{y,II}$	$BE_{y,III}$	$BE_{y,IV}$
Year	t CO ₂ e	t CO ₂ e	t CO ₂ e	t CO ₂ e
22/01/ - 31/12/2021	1,271,084	312,788	302,637	655,659
2022	1,336,808	325,849	315,274	695,685
2023	1,324,935	319,815	309,435	695,685
2024	1,313,062	313,780	303,597	695,685
2025	1,301,189	307,746	297,758	695,685
2026	1,289,317	301,712	291,920	695,685
2027	1,265,722	295,678	286,082	683,962
01/01/ - 21/01/2028	70,732	16,664	16,123	37,945

Plant specific baseline emissions ($BE_{y,II}$, $BE_{y,III}$, $BE_{y,IV}$) are calculated separately for each plant as per the methodology. Plant specific suffixes in parameter names have been omitted for all following parameters in order to prevent confusion.

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

Where:

BE_y	=	Baseline emissions in year y (t CO ₂ e)
$P_{product,max}$	=	Design capacity (t HNO ₃)
$P_{production,y}$	=	Production of nitric acid in year y (t HNO ₃)
$EF_{existing,y}$	=	N ₂ O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N ₂ O/t HNO ₃)
$EF_{new,y}$	=	Baseline N ₂ O emission factor for nitric acid production in year y (kg N ₂ O/t HNO ₃)
GWP_{N_2O}	=	Global Warming Potential of N ₂ O valid for the commitment period
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where:
	(a)	For secondary N ₂ O abatement: the abatement system was not installed, underperforming or failed;
	(b)	For tertiary N ₂ O abatement: the abatement system is by-passed, underperforming or failed

Plant Hu-Chems II	BE_y	$EF_{existing,y}$	$EF_{new,y}$	$P_{production,y}$	$P_{product,max}$	h_y	$h_{r,y}$	GWP
Year	t CO ₂ e	kg N ₂ O/ t HNO ₃	kg N ₂ O/ t HNO ₃	t HNO ₃	t HNO ₃	h	h	-
22/01/ - 31/12/2021	312,788	11.00	2.50	96,132	110,080	8,030	59	298
2022	325,849	10.80	2.50	102,000	116,800	8,520	63	298
2023	319,815	10.60	2.50	102,000	116,800	8,520	63	298
2024	313,780	10.40	2.50	102,000	116,800	8,520	63	298
2025	307,746	10.20	2.50	102,000	116,800	8,520	63	298
2026	301,712	10.00	2.50	102,000	116,800	8,520	63	298
2027	295,678	9.80	2.50	102,000	116,800	8,520	63	298
01/01/ - 21/01/2028	16,664	9.60	2.50	5,868	6,720	490	4	298

Plant Hu-Chems III	BE_y	$EF_{existing,y}$	$EF_{new,y}$	$P_{production,y}$	$P_{product,max}$	h_y	$h_{r,y}$	GWP
Year	t CO ₂ e	kg N ₂ O/ t HNO ₃	kg N ₂ O/ t HNO ₃	t HNO ₃	t HNO ₃	h	h	-
22/01/ - 31/12/2021	302,637	11.00	2.50	93,304	110,080	7,894	83	298
2022	315,274	10.80	2.50	99,000	116,800	8,376	88	298
2023	309,435	10.60	2.50	99,000	116,800	8,376	88	298
2024	303,597	10.40	2.50	99,000	116,800	8,376	88	298
2025	297,758	10.20	2.50	99,000	116,800	8,376	88	298
2026	291,920	10.00	2.50	99,000	116,800	8,376	88	298
2027	286,082	9.80	2.50	99,000	116,800	8,376	88	298
01/01/ - 21/01/2028	16,123	9.60	2.50	5,696	6,720	482	5	298

Plant Hu-Chems IV	BE_y	$EF_{existing,y}$	$EF_{new,y}$	$P_{production,y}$	$P_{product,max}$	h_y	$h_{r,y}$	GWP
Year	t CO ₂ e	kg N ₂ O/ t HNO ₃	kg N ₂ O/ t HNO ₃	t HNO ₃	t HNO ₃	h	h	-
22/01/ - 31/12/2021	655,659	5.70	2.50	386,411	440,320	7,894	3	298
2022	695,685	5.70	2.50	410,000	467,200	8,376	3	298
2023	695,685	5.70	2.50	410,000	467,200	8,376	3	298
2024	695,685	5.70	2.50	410,000	467,200	8,376	3	298
2025	695,685	5.70	2.50	410,000	467,200	8,376	3	298
2026	695,685	5.70	2.50	410,000	467,200	8,376	3	298
2027	683,962	5.60	2.50	410,000	467,200	8,376	3	298
01/01/ - 21/01/2028	37,945	5.40	2.50	23,589	26,880	482	0	298

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

Where:

- $EF_{existing,y}$ = N₂O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N₂O/t HNO₃)
 $EF_{historical,y}$ = Historical baseline emission factor of the nitric acid plant (kg N₂O/t HNO₃)
 $EF_{default,y}$ = Default emission factor according to the operating pressure of the ammonia burner in year y (kg N₂O/t HNO₃)

Plant Hu-Chems II	$EF_{existing,y}$	$EF_{historical}$	$EF_{default,y}$ (high pressure)
Year	kg N ₂ O/t HNO ₃	kg N ₂ O/t HNO ₃	kg N ₂ O/t HNO ₃
22/01/ - 31/12/2021	11.00	12.09	11.0
2022	10.80	12.09	10.8
2023	10.60	12.09	10.6
2024	10.40	12.09	10.4
2025	10.20	12.09	10.2
2026	10.00	12.09	10.0
2027	9.80	12.09	9.8
01/01/ - 21/01/2028	9.60	12.09	9.6

Plant Hu-Chems III	$EF_{existing,y}$	$EF_{historical}$	$EF_{default,y}$ (high pressure)
Year	kg N ₂ O/t HNO ₃	kg N ₂ O/t HNO ₃	kg N ₂ O/t HNO ₃
22/01/ - 31/12/2021	11.00	11.26	11.0
2022	10.80	11.26	10.8
2023	10.60	11.26	10.6
2024	10.40	11.26	10.4
2025	10.20	11.26	10.2
2026	10.00	11.26	10.0
2027	9.80	11.26	9.8
01/01/ - 21/01/2028	9.60	11.26	9.6

Plant Hu-Chems IV	$EF_{existing,y}$	$EF_{historical}$	$EF_{default,y}$ (medium pressure)
Year	kg N ₂ O/t HNO ₃	kg N ₂ O/t HNO ₃	kg N ₂ O/t HNO ₃
22/01/ - 31/12/2021	5.70	5.70	6.8
2022	5.70	5.70	6.6
2023	5.70	5.70	6.4
2024	5.70	5.70	6.2
2025	5.70	5.70	6.0
2026	5.70	5.70	5.8
2027	5.60	5.70	5.6
01/01/ - 21/01/2028	5.40	5.70	5.4

Project Emissions

Overall project emissions for the project activity are calculated as sum over plant specific project emissions:

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

Where:

- PE_y = Project emissions in year y (t CO₂e)
- $PE_{y,II}$ = Project emissions of plant Hu-Chems II in year y (t CO₂e)
- $PE_{y,III}$ = Project emissions of plant Hu-Chems III in year y (t CO₂e)
- $PE_{y,IV}$ = Project emissions of plant Hu-Chems IV in year y (t CO₂e)

	PE_y	$PE_{y,II}$	$PE_{y,III}$	$PE_{y,IV}$
Year	t CO ₂ e	t CO ₂ e	t CO ₂ e	t CO ₂ e
22/01/ - 31/12/2021	95,010	20,732	21,486	52,792
2022	100,810	21,998	22,797	56,015
2023	100,810	21,998	22,797	56,015
2024	100,810	21,998	22,797	56,015
2025	100,810	21,998	22,797	56,015
2026	100,810	21,998	22,797	56,015
2027	100,810	21,998	22,797	56,015
01/01/ - 21/01/2028	5,801	1,266	1,312	3,223

Plant specific project emissions ($PE_{y,II}$, $PE_{y,III}$, $PE_{y,IV}$) are calculated separately for each plant as per the methodology. Plant specific suffixes in parameter names have been omitted for all following parameters in order to prevent confusion.

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

Where:

- PE_y = Project emissions in year y (t CO₂e)
- $PE_{N2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
- $PE_{CO2,tertiary,y}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in year y (t CO₂)

Plant Hu-Chems II	PE_y	$PE_{N_2O,y}$	$PE_{CO_2,tertiary,y}$
Year	t CO ₂ e	t CO ₂ e	t CO ₂
22/01/ - 31/12/2021	20,732	19,655	1,077
2022	21,998	20,855	1,143
2023	21,998	20,855	1,143
2024	21,998	20,855	1,143
2025	21,998	20,855	1,143
2026	21,998	20,855	1,143
2027	21,998	20,855	1,143
01/01/ - 21/01/2028	1,266	1,200	66

Plant Hu-Chems III	PE_y	$PE_{N_2O,y}$	$PE_{CO_2,tertiary,y}$
Year	t CO ₂ e	t CO ₂ e	t CO ₂
22/01/ - 31/12/2021	21,486	20,409	1,077
2022	22,797	21,654	1,143
2023	22,797	21,654	1,143
2024	22,797	21,654	1,143
2025	22,797	21,654	1,143
2026	22,797	21,654	1,143
2027	22,797	21,654	1,143
01/01/ - 21/01/2028	1,312	1,246	66

Plant Hu-Chems IV	PE_y	$PE_{N_2O,y}$	$PE_{CO_2,tertiary,y}$
Year	t CO ₂ e	t CO ₂ e	t CO ₂
22/01/ - 31/12/2021	52,792	52,792	0
2022	56,015	56,015	0
2023	56,015	56,015	0
2024	56,015	56,015	0
2025	56,015	56,015	0
2026	56,015	56,015	0
2027	56,015	56,015	0
01/01/ - 21/01/2028	3,223	3,223	0

No fossil fuels are used in plant Hu-Chems IV and as described above the parameter $PE_{CO_2,tertiary,y}$ is set to zero for this NA plant (respective parameters are not monitored).

Project emissions of N₂O from the project plant ($PE_{N_2O,y}$)

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

Where:

- $PE_{N_2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)
- GWP_{N_2O} = Global Warming Potential of N₂O valid for the commitment period
- $F_{N_2O,tail\ gas,h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/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 N₂O abatement. Abatement system was not installed, underperforming or failed;
 - (b) For tertiary N₂O abatement. The abatement system is bypassed, underperforming or failed

Plant Hu-Chems II	$PE_{N_2O,y}$	$F_{N_2O,tailgas,h}$	h_y	$h_{r,y}$	GWP_{N_2O}
Year	t CO ₂ e	kg N ₂ O/h	h	h	t CO ₂ /t N ₂ O
22/01/ - 31/12/2021	19,655	8.28	8,030	59	298
2022	20,855	8.28	8,520	63	298
2023	20,855	8.28	8,520	63	298
2024	20,855	8.28	8,520	63	298
2025	20,855	8.28	8,520	63	298
2026	20,855	8.28	8,520	63	298
2027	20,855	8.28	8,520	63	298
01/01/ - 21/01/2028	1,200	8.28	490	4	298

Plant Hu-Chems III	$PE_{N_2O,y}$	$F_{N_2O,tailgas,h}$	h_y	$h_{r,y}$	GWP_{N_2O}
Year	t CO ₂ e	kg N ₂ O/h	h	h	t CO ₂ /t N ₂ O
22/01/ - 31/12/2021	20,409	8.77	7,894	83	298
2022	21,654	8.77	8,376	88	298
2023	21,654	8.77	8,376	88	298
2024	21,654	8.77	8,376	88	298
2025	21,654	8.77	8,376	88	298
2026	21,654	8.77	8,376	88	298
2027	21,654	8.77	8,376	88	298
01/01/ - 21/01/2028	1,246	8.77	482	5	298

Plant Hu-Chems IV	$PE_{N_2O,y}$	$F_{N_2O,tailgas,h}$	h_y	$h_{r,y}$	GWP_{N_2O}
Year	t CO ₂ e	kg N ₂ O/h	h	h	t CO ₂ /t N ₂ O
22/01/ - 31/12/2021	52,792	22.45	7,894	3	298
2022	56,015	22.45	8,376	3	298
2023	56,015	22.45	8,376	3	298
2024	56,015	22.45	8,376	3	298
2025	56,015	22.45	8,376	3	298
2026	56,015	22.45	8,376	3	298
2027	56,015	22.45	8,376	3	298
01/01/ - 21/01/2028	3,223	22.45	482	0	298

The mass flow of greenhouse gas i ($F_{i,t}$)⁷ is determined as follows:

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

With:

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

Where:

- $F_{i,t}$ = Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
- $V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis (m³ 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 (m³ gas i/m³ dry gas)
- $\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ 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.m³/kmol.K)
- T_t = Temperature of the gaseous stream in time interval t (K)

When applying normal conditions and as described in section B.6.1 above, 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/m³⁸. Hence, respective parameters need not to be monitored according to the applied methodology.

⁷ $F_{i,t}$ corresponds to the parameter $F_{N_2O,tail gas,h}$ of the methodology ACM0019.

⁸ $\rho_{i,t} = (P_n \times MM_i) / (T_n \times R_u) = 1.96$ kg/m³

Plant Hu-Chems II	$F_{N_2O, tailgas, h} = F_{i, t}$	$\rho_{i, t}$	$V_{t, db}$	$V_{i, t, db}$
Year	kg N ₂ O/h	kg gas i/m ³ gas i	m ³ dry gas/h	m ³ gas i/ m ³ dry gas
22/01/ - 31/12/2021	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
2022	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
2023	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
2024	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
2025	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
2026	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
2027	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$
01/01/ - 21/01/2028	8.28	1.96	46,300	$9.10 \cdot 10^{-5}$

Plant Hu-Chems III	$F_{N_2O, tailgas, h} = F_{i, t}$	$\rho_{i, t}$	$V_{t, db}$	$V_{i, t, db}$
Year	kg N ₂ O/h	kg gas i/m ³ gas i	m ³ dry gas/h	m ³ gas i/ m ³ dry gas
22/01/ - 31/12/2021	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
2022	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
2023	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
2024	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
2025	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
2026	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
2027	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$
01/01/ - 21/01/2028	8.77	1.96	46,500	$9.60 \cdot 10^{-5}$

Plant Hu-Chems IV	$F_{N_2O, tailgas, h} = F_{i, t}$	$\rho_{i, t}$	$V_{t, db}$	$V_{i, t, db}$
Year	kg N ₂ O/h	kg gas i/m ³ gas i	m ³ dry gas/h	m ³ gas i/ m ³ dry gas
22/01/ - 31/12/2021	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
2022	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
2023	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
2024	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
2025	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
2026	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
2027	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$
01/01/ - 21/01/2028	22.45	1.96	180,000	$6.35 \cdot 10^{-5}$

Project emissions from the operation of the tertiary N₂O abatement facility ($PE_{CO_2, tertiary, y}$)

Please note that this section is only applicable for plants Hu-Chems II & III, since no fossil fuels are used in plant Hu-Chems IV.

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

Where:

- $PE_{CO_2, tertiary, y}$ = Project emissions of CO₂ from the operation of the tertiary N₂O abatement facility in year y (t CO₂)
- $PE_{FF, y}$ = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (t CO₂)

- The parameter $PE_{FC, j, y}$ used in the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” corresponds to the parameter $PE_{FF, y}$ in this methodology, and
- The element process j in the tool corresponds to the consumption of fossil fuels for the operation of the tertiary N₂O abatement facility and/or the re-heating of the tail gas.

Plant Hu-Chems II	$PE_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
Year	t CO ₂ /yr
22/01/ - 31/12/2021	1,077
2022	1,143
2023	1,143
2024	1,143
2025	1,143
2026	1,143
2027	1,143
01/01/ - 21/01/2028	66

Plant Hu-Chems III	$PE_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
Year	t CO ₂ /yr
22/01/ - 31/12/2021	1,077
2022	1,143
2023	1,143
2024	1,143
2025	1,143
2026	1,143
2027	1,143
01/01/ - 21/01/2028	66

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

Where:

- $PE_{FC,j,y}$ = Are the CO₂ emissions from fossil fuel combustion in process j during the year y (tCO₂/yr)
 $FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)
 $COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (t CO₂/mass or volume unit)
 i = Are the fuel types combusted in process j during the year y

Plant Hu-Chems II	$PE_{FC,j,y}$	$FC_{i,j,y}$	$COEF_{i,y}$
Year	t CO ₂ /yr	t/yr	t CO ₂ /t
22/01/ - 31/12/2021	1,077	358	3.01
2022	1,143	380	3.01
2023	1,143	380	3.01
2024	1,143	380	3.01
2025	1,143	380	3.01
2026	1,143	380	3.01
2027	1,143	380	3.01
01/01/ - 21/01/2028	66	22	3.01

Plant Hu-Chems III	$PE_{FC,j,y}$	$FC_{i,j,y}$	$COEF_{i,y}$
Year	t CO ₂ /yr	t/yr	t CO ₂ /t
22/01/ - 31/12/2021	1,077	358	3.01
2022	1,143	380	3.01
2023	1,143	380	3.01
2024	1,143	380	3.01
2025	1,143	380	3.01
2026	1,143	380	3.01
2027	1,143	380	3.01
01/01/ - 21/01/2028	66	22	3.01

The CO₂ emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i , using the following approach:

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

$FC_{i,j,y}$ is measured in a mass unit.

Where:

- $COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i (tCO₂/mass or volume unit)
 $w_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel)
 i = Are the fuel types combusted in process j during the year y

Plant Hu-Chems II	$COEF_{i,y}$	$w_{C,i,y}$
Year	t CO ₂ /t	t C/t
22/01/ - 31/12/2021	3.01	0.82
2022	3.01	0.82
2023	3.01	0.82
2024	3.01	0.82
2025	3.01	0.82
2026	3.01	0.82
2027	3.01	0.82
01/01/ - 21/01/2028	3.01	0.82

Plant Hu-Chems III	$COEF_{i,y}$	$w_{C,i,y}$
Year	t CO ₂ /t	t C/t
22/01/ - 31/12/2021	3.01	0.82
2022	3.01	0.82
2023	3.01	0.82
2024	3.01	0.82
2025	3.01	0.82
2026	3.01	0.82
2027	3.01	0.82
01/01/ - 21/01/2028	3.01	0.82

Leakage

According to the applied methodology any leakage emissions sources are deemed to be negligible.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

- ER_y = Emission reductions in year y (t CO₂e)
 BE_y = Baseline emissions in year y (t CO₂e)
 PE_y = Project emissions in year y (t CO₂e)

	ER_y	BE_y	PE_y
Year	t CO ₂ e	t CO ₂ e	t CO ₂ e
22/01/ - 31/12/2021	1,176,074	1,271,084	95,010
2022	1,235,998	1,336,808	100,810
2023	1,224,125	1,324,935	100,810
2024	1,212,252	1,313,062	100,810
2025	1,200,379	1,301,189	100,810
2026	1,188,507	1,289,317	100,810
2027	1,164,912	1,265,722	100,810
01/01/ - 21/01/2028	64,931	70,732	5,801

B.6.4. Summary of ex ante estimates of emission reductions

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Year	Baseline emissions (t CO ₂ e)	Project emissions (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions (t CO ₂ e)
22/01/ - 31/12/2021	1,271,084	95,010	0	1,176,074
2022	1,336,808	100,810	0	1,235,998
2023	1,324,935	100,810	0	1,224,125
2024	1,313,062	100,810	0	1,212,252
2025	1,301,189	100,810	0	1,200,379
2026	1,289,317	100,810	0	1,188,507
2027	1,265,722	100,810	0	1,164,912
01/01/ - 21/01/2028	70,732	5,801	0	64,931
Total	9,172,849	705,671	0	8,467,178
Total number of crediting years	7 years			
Annual average over the crediting period	1,310,407	100,810	0	1,209,597

Note that actual estimation of overall emission reductions as presented in chapters B.6.3 and B.6.4 has been done in an excel book. Conservative rounding has been made for final ER_y calculation only.

B.7. Monitoring plan**B.7.1. Data and parameters to be monitored**

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All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data will be monitored if not indicated otherwise in the tables below. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards. The accuracy of the N₂O emissions monitoring results will be ensured the installed monitoring system that has been certified to meet the requirements of the prevailing best industry practice or monitoring standards in terms of operation, maintenance and calibration. The latest applicable European standards and norms (EN 14181) will be used as the basis for selecting and operating the monitoring system.

The value(s) applied in the parameter tables below are an estimate of the data/parameters that will be monitored during this crediting period, but are used for the purpose of calculating estimated emission reductions above. The value(s) applied are generally based on historic values from the 2nd crediting period taking into consideration future trends.

Data and parameters from the applied methodology that are monitored and ONLY relevant to NA plant Hu-Chems II:

Data/Parameter	P _{production,y,II}
Data unit	t HNO ₃
Description	Nitric acid produced in year y of Hu-Chems II
Source of data	Production reports The NA produced is measured according to the installed instruments. The instrument signals as well as the acid concentration are recorded in the control room, the DCS generates daily reports including the daily NA production (recorded as 100% NA).
Value(s) applied	102,000

Measurement methods and procedures	322-FT-2-512 Type: Coriolis flowmeter Accuracy class: $\pm 0.1\%$ Calibration frequency: 60 months 322-TI-2-127 Type: Temperature transmitter Accuracy class: $\pm 0.15^{\circ}\text{C} \pm 0.03\%$ of span (according to IEC751) Calibration frequency: 24 months
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline emissions
Additional comment	The parameter $P_{NA,h,II}$ (Nitric acid produced in the hour h of Hu-Chems II) represents the hourly value of $P_{production,y,II}$ and is used for determining $h_{r,y,II}$ as described in the applied methodology.

Data/Parameter	$h_{y,II}$
Data unit	h
Description	Number of hours of operation in year y of Hu-Chems II
Source of data	Measured
Value(s) applied	8,520
Measurement methods and procedures	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 $500 \text{ Nm}^3/\text{h}$ during an hour, the reactor is considered in operation. 322-FT-2-503 Type: Differential pressure transmitter Accuracy class: $\pm 0.065\%$ of span Calibration frequency: 48 months
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime.

Data/Parameter	$h_{r,y,II}$
Data 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
Source of data	Measured
Value(s) applied	63
Measurement methods and procedures	Hu-Chems NA plant II has used AM0028 in the 1 st 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 in this formula will be measured/determined and monitored as explained in their respective parameter tables.
Monitoring frequency	Every monitoring period

QA/QC procedures	The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime. The parameter $P_{NA,h,II}$ as used in the formula (Nitric acid produced in the hour h of Hu-Chems II) represents the hourly value of $P_{production,y,II}$.

Data and parameters from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” ONLY relevant to NA plant Hu-Chems II:

Data/Parameter	$V_{t,db,II}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measured
Value(s) applied	46,300
Measurement methods and procedures	322-FT-2-522 Type: Differential pressure transmitter Accuracy class: according to QAL1 certificate Calibration frequency: as per EN 14181 Volumetric flow measurement will refer to normal conditions as per the applied methodology based on dry basis measurement.
Monitoring frequency	Continuous monitoring
QA/QC procedures	According to European Norm 14181. The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool. The volume flow is expressed at normal conditions according to the applied methodology. Therefore, the respective parameters were determined at normal conditions ($P_{t,II} = P_n = 101,325$ Pa; $T_{t,II} = T_n = 273.15$ K) and the monitoring of actual conditions ($P_{t,II}$, $T_{t,II}$) is not necessary. Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	$V_{i,t,db,II}$
Data unit	m ³ gas i/m ³ dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis of plant Hu-Chems II
Source of data	Measured
Value(s) applied	$9.10 \cdot 10^{-5}$
Measurement methods and procedures	322-AT-2-0127 Type: Non-dispersion infrared absorption analyser (NDIR) Accuracy class: $\pm 1\%$ (zero/span) Calibration frequency: as per EN 14181 Volumetric fraction measurement will refer to normal conditions as per the applied methodology based on dry basis measurement.
Monitoring frequency	Continuous monitoring

QA/QC procedures	According to European Norm 14181. Calibration should include zero verification with an inert gas (N ₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool. The volumetric fraction is expressed at normal conditions according to the applied methodology ($P_n = 101,325 \text{ Pa}$; $T_n = 273.15 \text{ K}$). Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	C_{H2O,t,db,n,II}
Data unit	mg H ₂ O/m ³ dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems II
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) applied	9,667 (Value used for ex-ante calculation is based on latest measurements performed during 2 nd crediting period.)
Measurement methods and procedures	Discrete measurement procedure
Monitoring frequency	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements will coincide with the Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the calibration of the flowmeter for the gaseous stream.
QA/QC procedures	According to the USEPA CF42 method 4
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter for proving that the gaseous stream is dry.

Data and parameters from the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” ONLY relevant to NA plant Hu-Chems II:

Data/Parameter	FC_{i,j,y,II}
Data unit	t/yr
Description	Quantity of fuel type i combusted in process j during the year y of Hu-Chems II
Source of data	Onsite measurements
Value(s) applied	380
Measurement methods and procedures	322-FT-2-5121 Type: Coriolis flowmeter Accuracy class: $\pm 0.35\%$ Calibration frequency: 60 months
Monitoring frequency	Continuous monitoring

QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant. As far as feasible the consistency of metered fuel consumption quantities should be 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 specific NA plant respectively), the metered fuel consumption quantities should be cross-checked with available purchase invoices from the financial records.
Purpose of data	Calculation of project emissions
Additional comment	The fuel (more exactly: hydrocarbon used as reducing agent) applied in the NA plant is LPG (Liquefied Petroleum Gas) with a major mass fraction (expected levels above 95%) of propane.

Data/Parameter	$W_{C,i,y,II}$						
Data unit	tC/t						
Description	Weighted average mass fraction of carbon in fuel type i in year y of plant Hu-Chems II						
Source of data	Certificate hydrocarbon supplier or measurements (if certificate is not available)						
Value(s) applied	0.82						
Measurement methods and procedures	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <tr> <td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source.</td></tr> <tr> <td>b) Measurements by the project participants</td><td>If a) is not available</td></tr> </tbody> </table> <p>Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.</p>	Data source	Conditions for using the data source	a) Values provided by the fuel supplier in invoices	This is the preferred source.	b) Measurements by the project participants	If a) is not available
Data source	Conditions for using the data source						
a) Values provided by the fuel supplier in invoices	This is the preferred source.						
b) Measurements by the project participants	If a) is not available						
Monitoring frequency	Measuring; In order to assure conservativeness a certificate from the fuel supplier is requested at least on a yearly basis. The mass fraction of carbon should be obtained regularly (if feasible for each fuel delivery), from which weighted average annual values should be calculated.						
QA/QC procedures	It will be 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 comment	Applicable where Option A of the tool is used. The fuel (more exactly: hydrocarbon used as reducing agent) applied in the NA plant is LPG (Liquefied Petroleum Gas) with a major mass fraction of propane (about >95%).						

Data and parameters from the applied methodology that are monitored and ONLY relevant to NA plant Hu-Chems III:

Data/Parameter	$P_{production,y,III}$
Data unit	t HNO ₃
Description	Nitric acid produced in year y of Hu-Chems III
Source of data	Production reports The NA produced is measured according to the installed instruments. The instrument signals as well as the acid concentration are recorded in the control room, the DCS generates daily reports including the daily NA production (recorded as 100% NA).
Value(s) applied	99,000

Measurement methods and procedures	323-FT-3-512 Type: Coriolis flowmeter Accuracy class: $\pm 0.1\%$ Calibration frequency: 60 months 323-TI-3-127 Type: Temperature transmitter Accuracy class: $\pm 0.15^{\circ}\text{C} \pm 0.03\%$ of span (according to IEC751) Calibration frequency: 24 months
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline emissions
Additional comment	The parameter $P_{NA,h,III}$ (Nitric acid produced in the hour h of Hu-Chems III) represents the hourly value of $P_{production,y,III}$ and is used for determining $h_{r,y,III}$ as described in the applied methodology.

Data/Parameter	$h_{y,III}$
Data unit	h
Description	Number of hours of operation in year y of Hu-Chems III
Source of data	Measured
Value(s) applied	8,376
Measurement methods and procedures	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 $500 \text{ Nm}^3/\text{h}$ during an hour, the reactor is considered in operation. 323-FT-3-503 Type: Differential pressure transmitter Accuracy class: $\pm 0.065\%$ of span Calibration frequency: 48 months
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime

Data/Parameter	$h_{r,y,III}$
Data 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
Source of data	Measured
Value(s) applied	88
Measurement methods and procedures	Hu-Chems NA plant III has used AM0028 in the 1 st 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 in this formula will be measured/determined and monitored as explained in their respective parameter tables.
Monitoring frequency	Every monitoring period

QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime. The parameter $P_{NA,h,III}$ as used in the formula (Nitric acid produced in the hour h of Hu-Chems III) represents the hourly value of $P_{production,y,III}$.

Data and parameters from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” ONLY relevant to NA plant Hu-Chems III:

Data/Parameter	$V_{t,db,III}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measured
Value(s) applied	46,500
Measurement methods and procedures	323-FT-3-522 Type: Differential pressure transmitter Accuracy class: according to QAL1 certificate Calibration frequency: as per EN 14181 Volumetric flow measurement will refer to normal conditions as per the applied methodology based on the dry basis measurement.
Monitoring frequency	Continuous monitoring
QA/QC procedures	According to European Norm 14181. The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool. The volume flow is expressed at normal conditions according to the applied methodology. Therefore, the respective parameters were determined at normal conditions ($P_{t,III} = P_n = 101,325$ Pa; $T_{t,III} = T_n = 273.15$ K) and monitoring of actual conditions ($P_{t,III}$, $T_{t,III}$) is not necessary. Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	$V_{i,t,db,III}$
Data unit	m ³ gas i/m ³ dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis of plant Hu-Chems III
Source of data	Measured
Value(s) applied	$9.60 \cdot 10^{-5}$
Measurement methods and procedures	323-AT-3-0127 Type: Non-dispersion infrared absorption analyser (NDIR) Accuracy class: $\pm 1\%$ (zero/span) Calibration frequency: as per EN 14181 Volumetric fraction measurement will refer to normal conditions as per the applied methodology based on the dry basis measurement.
Monitoring frequency	Continuous monitoring

QA/QC procedures	According to European Norm 14181. Calibration should include zero verification with an inert gas (N ₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool. The volumetric fraction is expressed at normal conditions according to the applied methodology ($P_n = 101,325 \text{ Pa}$; $T_n = 273.15 \text{ K}$). Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	C_{H2O,t,db,n,III}
Data unit	mg H ₂ O/m ³ dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems III
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) applied	9,000 (Value used for ex-ante calculation is based on latest measurements performed during 2 nd crediting period.)
Measurement methods and procedures	Discrete measurement procedure
Monitoring frequency	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements will coincide with the Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the calibration of the flowmeter for the gaseous stream.
QA/QC procedures	According to the USEPA CF42 method 4
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter for proving that the gaseous stream is dry.

Data and parameters from the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” ONLY relevant to NA plant Hu-Chems III:

Data/Parameter	FC_{i,j,y,III}
Data unit	t/yr
Description	Quantity of fuel type i combusted in process j during the year y of Hu-Chems III
Source of data	Onsite measurements
Value(s) applied	380
Measurement methods and procedures	323-FT-3-5121 Type: Coriolis flowmeter Accuracy class: $\pm 0.35\%$ Calibration frequency: 60 months
Monitoring frequency	Continuous monitoring

QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant. As far as feasible the consistency of metered fuel consumption quantities should be 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 specific NA plant respectively), the metered fuel consumption quantities should be cross-checked with available purchase invoices from the financial records.
Purpose of data	Calculation of project emissions
Additional comment	The fuel (more exactly: hydrocarbon used as reducing agent) applied in the NA plant is LPG (Liquefied Petroleum Gas) with a major mass fraction (expected levels above 95%) of propane.

Data/Parameter	$W_{C,i,y,III}$						
Data unit	tC/t						
Description	Weighted average mass fraction of carbon in fuel type i in year y of plant Hu-Chems III						
Source of data	Certificate hydrocarbon supplier or measurements (if certificate is not available)						
Value(s) applied	0.82						
Measurement methods and procedures	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <tr> <td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source.</td></tr> <tr> <td>b) Measurements by the project participants</td><td>If a) is not available</td></tr> </tbody> </table> <p>Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.</p>	Data source	Conditions for using the data source	a) Values provided by the fuel supplier in invoices	This is the preferred source.	b) Measurements by the project participants	If a) is not available
Data source	Conditions for using the data source						
a) Values provided by the fuel supplier in invoices	This is the preferred source.						
b) Measurements by the project participants	If a) is not available						
Monitoring frequency	Measuring; In order to assure conservativeness a certificate from the fuel supplier is requested at least on a yearly basis. The mass fraction of carbon should be obtained regularly (if feasible for each fuel delivery), from which weighted average annual values should be calculated.						
QA/QC procedures	It will be 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 comment	Applicable where Option A of the tool is used. The fuel (more exactly: hydrocarbon used as reducing agent) applied in the NA plant is LPG (Liquefied Petroleum Gas) with a major mass fraction of propane (about >95%).						

Data and parameters from the applied methodology that are monitored and ONLY relevant to NA plant Hu-Chems IV:

Data/Parameter	$P_{production,y,IV}$
Data unit	t HNO ₃
Description	Nitric acid produced in year y of Hu-Chems IV
Source of data	Production reports The NA produced is measured according to the installed instruments. The instrument signals as well as the acid concentration are recorded in the control room, the DCS generates daily reports including the daily NA production (recorded as 100% NA).
Value(s) applied	410,000

Measurement methods and procedures	324-FT-4-609 Type: Coriolis flowmeter Accuracy class: $\pm 0.1\%$ Calibration frequency: 60 months 324-TT-4-237 Type: Temperature transmitter Accuracy class: $\pm 0.15^{\circ}\text{C} \pm 0.03\%$ of span (according to IEC751) Calibration frequency: 24 months
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline emissions
Additional comment	The parameter $P_{NA,h,IV}$ (Nitric acid produced in the hour h of Hu-Chems IV) represents the hourly value of $P_{production,y,IV}$ and is used for determining $h_{r,y,IV}$ as described in the applied methodology.

Data/Parameter	$h_{y,IV}$
Data unit	H
Description	Number of hours of operation in year y of Hu-Chems IV
Source of data	Measured
Value(s) applied	8,376
Measurement methods and procedures	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 $500 \text{ Nm}^3/\text{h}$ during an hour, the reactor is considered in operation. 324-FT-4-5020 Type: Coriolis flowmeter Accuracy class: $\pm 0.35\%$ Calibration frequency: 60 months
Monitoring frequency	Every monitoring period
QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime.

Data/Parameter	$h_{r,y,IV}$
Data 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
Source of data	Measured
Value(s) applied	3
Measurement methods and procedures	Hu-Chems NA plant IV has used AM0028 in the 1 st 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 this formula will be measured/determined and monitored as explained in their respective parameter tables.
Monitoring frequency	Every monitoring period

QA/QC procedures	The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime. The parameter $P_{NA,h,IV}$ as used in the formula (Nitric acid produced in the hour h of Hu-Chems IV) represents the hourly value of $P_{production,y,IV}$.

Data and parameters from the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” ONLY relevant to NA plant Hu-Chems IV:

Data/Parameter	$V_{t,db,IV}$
Data unit	m ³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measured
Value(s) applied	180,000
Measurement methods and procedures	324-FT-4-522 Type: Differential pressure transmitter Accuracy class: according to QAL1 certificate Calibration frequency: as per EN 14181 Volumetric flow measurement will refer to normal conditions as per the applied methodology based on the dry basis flow measurement.
Monitoring frequency	Continuous monitoring
QA/QC procedures	According to European Norm 14181. The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool. The volume flow is expressed at normal conditions according to the applied methodology. Therefore, the respective parameters were determined at normal conditions ($P_{t,IV} = P_n = 101,325$ Pa; $T_{t,IV} = T_n = 273.15$ K) and monitoring of actual conditions ($P_{t,IV}$, $T_{t,IV}$) is not necessary. Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	$V_{i,t,db,IV}$
Data unit	m ³ gas i/m ³ dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis of plant Hu-Chems IV
Source of data	Measured
Value(s) applied	$6.35 \cdot 10^{-5}$
Measurement methods and procedures	324-AT-4-0107 Type: Non-dispersion infrared absorption analyser (NDIR) Accuracy class: $\pm 1\%$ (zero/span) Calibration frequency: as per EN 14181 Volumetric fraction measurement will refer to normal conditions as per the applied methodology based on the dry basis measurement.
Monitoring frequency	Continuous monitoring

QA/QC procedures	According to European Norm 14181. Calibration should include zero verification with an inert gas (N ₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. The quality assurance and quality control procedures in terms of equipment operations and maintenance have been incorporated in the ISO 9001 and ISO 14001 procedures of Hu-Chems. Accordingly, calibration and maintenance are part of regular QA/QC of the NA plant.
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter, according to the applied tool. The volumetric fraction is expressed at normal conditions according to the applied methodology ($P_n = 101,325 \text{ Pa}$; $T_n = 273.15 \text{ K}$). Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	C _{H2O,t,db,n,IV}
Data unit	mg H ₂ O/m ³ dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems IV
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) applied	7,333 (Value used for ex-ante calculation is based on latest measurements performed during 2 nd crediting period.)
Measurement methods and procedures	Discrete measurement procedure
Monitoring frequency	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements will coincide with the Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the calibration of the flow meter for the gaseous stream.
QA/QC procedures	According to the USEPA CF42 method 4
Purpose of data	Calculation of project emissions
Additional comment	Option A parameter for proving that the gaseous stream is dry.

B.7.2. Sampling plan

>>

Not applicable to this project activity.

B.7.3. Other elements of monitoring plan

>>

The emission reductions achieved by the project activity will be monitored using the requirements of the approved consolidated baseline and monitoring methodology ACM0019 “N₂O abatement from nitric acid production” (Version 04.0) and of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0) as well as “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” (Version 03.0).

Measurement of the N₂O concentration and the total gas volume flow:

The project employs the latest state of the art monitoring and control equipment that measures, records and reports all key parameters to determine the GHG emission reductions. The plant is equipped with an AMS in order to allow continuous real-time measurements of the N₂O concentration and the total gas volume flow, which is required by the methodology.

The amount of N₂O emissions from the tail gas stream of the project plant shall be determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. In applying the tool, the following provisions apply, as specified in the applied methodology:

- (a) Throughout the crediting periods of the project activity, the N₂O 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 latest version of European Norm 14181;
- (b) The monitoring system should provide separate hourly average values for the N₂O 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 N₂O 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 N₂O 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 N₂O 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 N₂O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N₂O 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 N₂O 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 N₂O 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.

The European Norm EN 14181 stipulates three levels of quality assurance tests and one annual functional test for AMS, which are recommended to be used as guidance regarding the selection, installation and operation of the AMS under the applied monitoring methodology. The three quality assurance levels (QAL) are as follows:

1. Quality assurance of tested AMS. AMS will have performance certificate with calculation of uncertainty before installation. The specific performance characteristics of the monitoring system chosen by the project will be listed in the Monitoring Reports.
2. Quality assurance of installation and calibration of the Automated Measuring System according to the Standard Reference Measurement Method (SRM) for concentration measurements, determination of the measurement uncertainty/variability of the AMS and inspection of the compliance with the prescribed measurement uncertainties. Such tests will be carried out by organisations that have an accredited quality assurance system.
3. Continuous quality assurance through the local operator/manager.
 - a) Permanent quality assurance during the plant operation by the operating staff;
 - b) Assurance of reliable and correct operation of the monitoring equipment (maintenance evidence);
 - c) Regular controls as scheduled by the manufacturer (maintenance intervals);

In addition, annual functionality tests including SRM measurements to check for uncertainties in the data measured by the AMS are planned. Such tests will be carried out by organisations that have an accredited quality assurance system.

Operational and Management structure:

Hu-Chems operates the EnviNOx®-System and the measurement equipment. The company has been operating the NA plants plant since their commissioning and has sufficient and well

experienced staff to operate similar technologies (like existing DeNOx-unit) and is quite experienced in calibrating and maintaining monitoring equipment. The company received the Korean safety and health management system certificate (KGS 18001 & OHSAS 18001). The EnviNOx® system is incorporated into Hu-Chems ISO 9001 and ISO 14001 standards. The operating personnel of the EnviNOx® system has been trained by the technology provider UHDE and the supplier of the digital process control system (DeltaV by EMERSON process management). Carbon Climate Protection GmbH is responsible for supervision and checks of monitoring and reporting data.

Data collection:

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 in the protected continuous historian server (CHS). The reporting module of the Delta V system automatically generates aggregated daily reports based on the stored raw data from the continuous historian server. Relevant parameters are exported from the digitally available daily reports to excel sheets for presentation of required parameters and calculation of baseline emissions, project emissions and emission reductions according to the formulae as required.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

22/12/2005

This is the date when the agreement to develop an N₂O reduction project between HUCHEMS and CARBON was signed.

C.2. Expected operational lifetime of project activity

>>

25 years, 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>

Renewable (3rd crediting period)

C.3.2. Start date of crediting period

>>

22/01/2021

C.3.3. Duration of crediting period

>>

7 years, 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

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The catalytic N₂O destruction project in the tail gas of the NA plants Hu-Chems II, III & IV is a sustainable project that contributes to the environmental, economic and social benefits in the Republic of Korea.

Besides the reduction of N₂O emissions, additionally, the EnviNOx®-System takes over the function of the DeNOx-unit at Hu-Chems IV as it accomplishes the reduction of NOx with ammonia too. As far as the amount of NOx removal is concerned the performance of the EnviNOx®-System is at least as good as the priorly existing DeNOx-system (additional environmental benefit). NOx emissions at Hu-Chems II & III are also be reduced.

No further environmental impacts are expected. No transboundary impacts are observed nor expected.

D.2. Environmental impact assessment

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Not applicable, as according to Article 4 of the Korean Environmental Impact Assessment (EIA) Law and the item 3 of the Article 2 of its Enforcement Ordinance, no EIA is required for the CDM project at Hu-Chems Fine Chemical ("Catalytic N₂O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.").

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

A local stakeholder conference was held by Hu-Chems and Carbon Climate Protection GmbH for the residents living near the project activity at the City-Hall of Yeosu on 17th of February 2006. 103 participants attended the stakeholder conference, questionnaires were distributed and 59 had been returned. Local public stakeholders were invited to the stakeholder meeting via announcement in local newspaper and personal invitation to the neighbours and companies around the area of Hu-Chems. Furthermore, local organizations and the Korean DNA were invited. An investigation on the local stakeholder comments on the project activity was carried out in the formats of issuing questionnaires to introduce the aims and characteristics of the project and addressing in particular its potential environmental impacts.



E.2. Summary of comments received

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Translation of stakeholder consultation meeting minutes:

Statistics of Stakeholder's Conference for CDM Project

1. Date : February 17, 2006.

2. Location : At a conference room of Yeosu city hall

3. Number of Attendants.

Classification	Number
Local Governmental Organisations	15
Local Non-Governmental Organisations	8
Newspapers	9
Broadcasting companies	10
Neighbouring companies	35
Huchems	20
Itochu	2
Carbon GmbH	2
KIECO	2
Total	103

4. Content of conference

- Welcoming address to the stakeholders by Mr. S. H. Kim (Executive Vice President of Huchems)
- Welcoming address to the stakeholders by Mr. Ferdinand Heilig (Managing Director of Carbon)
- Introduction of Huchems and CDM project by Mr. K. S. Hwang (General Manager of Huchems)
- Presentation of Carbon including the Methodology of Carbon and the EnviNOx system of Uhde by Mr. S. H. Kim (Managing Director of KIECO)
- Questionnaires and Answers
- A survey of the stakeholders

5. Statistics of a survey of the stakeholders for the CDM project of Huchems

- 59 stakeholders (out of 103 ones) filled out the questionnaires

Questions to the Stakeholders	Yes	No
Do you think that the region and the Korean people living in the region will benefit from this CDM-Project?	59	0
Is your company or the organization you are working for / you are presenting influenced by this CDM-Project?	37	22
Will your company or the organization you are working for / you are presenting play a role in the implementation of this CDM-Project?	20	39
Do you think that the Korean government shall support this project?	58	1
Do you think that the Republic of Korea shall take efforts towards reducing greenhouse gas emissions within Korea?	58	1
Do you consider that this CDM-Project will contribute to the sustainable development of Korea?	59	
Do you consider this CDM-Project as being "additional"?	55	4
Do you have any special remarks or questions the project participants shall answer to you? Which?		

Special remarks and questions discussed at the local stakeholder meeting:

- Benefit for local residents;
- Potential other CDM project in the Republic of Korea;
- Other possible CDM projects in Yeosu Petrochemical Complex;
- Sales price of CERs;
- Possible measures against global warming.

E.3. Consideration of comments received

>>

The main concern of the local stakeholders was the impact of the project on the local air quality. The project sponsor and the project operator explained and illustrated the guidelines for CDM projects under the United Nations Framework Convention on Climate Change and the effect of the proposed project activity on GHG emission reduction and NOx emission reduction.

Social Benefits: The project developer and the project operator agreed on spending a share of the total income from selling of the CERs for a Social Fund for the area of Yeosu. This fund shall contribute to the social benefit of the people living in the area of the CDM project activity by financing sustainable projects like projects in schools, hospitals and infrastructure.

Economic Benefit: The project developer agreed to pay a share of the income of the CERs to the project operator, who is a major job provider in the region. Additionally, value and jobs will be created in the region especially during the construction work of the EnviNOx®-systems.

All remarks and questions were discussed at great length. No further comments were received during the stakeholder consultation process. The project owner will pay attention to the comments and questions of stakeholders and will make all conceivable effort to achieve environmental benefits, social benefits and economic benefits.

SECTION F. Approval and authorization

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The letters of approval and authorization of the following Parties are available at the time of submitting the PDD to the validating DOE for renewal of crediting period:

- Republic of Korea (Host country)
- Germany
- Austria

Appendix 1. Contact information of project participants

Organization name	Hu-Chems Fine Chemical Corp.
Country	Republic of Korea
Address	963 Sangamro Yeosu-si Jeonnam, 59614
Telephone	+82-61-680-4723
Fax	+82-61-680-4699
E-mail	cyyu@huchems.com
Website	www.huchems.com
Contact person	Mr. Chang-young, You

Organization name	RWE Power AG
Country	Germany
Address	Huyssenallee 2, 45128 Essen
Telephone	+49 201 12 20 242
Fax	+49 201 12 24 132
E-mail	vlfocal-point@rwe.com
Website	-
Contact person	Mr. Ludwig Kons

Organization name	Carbon Climate Protection GmbH
Country	Austria
Address	Am Suedblick 7/2 3550 Langenlois
Telephone	+43 2734 322 70
Fax	+43 2734 322 70 99
E-mail	bichler@carbon-austria.com
Website	-
Contact person	Ms. Sonja Bichler

Appendix 2. Affirmation regarding public funding

No public funds are available for the financing of the project activity.

Appendix 3. Applicability of methodologies and standardized baselines

No additional information on the applicability of the methodology is to be mentioned.
No standardized baselines are used according to the applied methodology.

Appendix 4. Further background information on ex ante calculation of emission reductions

No additional information on the ex-ante calculation of emission reductions is to be mentioned.

Appendix 5. Further background information on monitoring plan

Please refer to chapter B.7.3 (Other elements of monitoring plan).

Appendix 6. Summary report of comments received from local stakeholders

Please refer to section E. Local stakeholder consultation.

Appendix 7. Summary of post-registration changes

Already before the first monitoring period, the starting date of the first crediting period has been changed from 15/12/2006 to 22/07/2007.

Upon a request by the CDM EB, a revision of the monitoring plan has been requested in November 2009 and has been approved by the CDM EB on the 18/03/2010.

In the course of verification of monitoring period 35 a post-registration change (type “corrections”) was submitted. The following corrections were done compared to the PDD v. 4.1:

- New version number and completion date of PDD;
- Update of information regarding project participants;
- Adding information to sections that were recently included to the PDD form;
- Correction and/or editorial changes of some information in the parameter tables (e.g. TAG number, measurement methods, etc.).

No other post registration changes have been applied.

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
11.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.

<i>Version</i>	<i>Date</i>	<i>Description</i>
09.0	24 May 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: <ul style="list-style-type: none"> • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Registration Keywords: project activities, project design document		