Project design document form
(Version 10.1)

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

BASIC INFORMATION	
Title of the project activity	Catalytic N_2O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.
Scale of the project activity	X Large-scale ☐ Small-scale
Version number of the PDD	4.2~~Version 4.1 (renewal of crediting period update)~~
Completion date of the PDD	18/12/2017~~14/10/2013~~
Project participants	CARBON CDM Korea Ltd. RWE Power AG Hu-Chems Fine Chemical Corp. Carbon Climate Protection GmbH
Host Party	Republic of Korea
Applied methodologies and standardized baselines	ACM0019 Version 2.0.0 (N_2O abatement from nitric acid production) No standardized baselines applicable.
Sectoral scopes linked to the applied methodologies	5 – Chemical industries
Estimated amount of annual average GHG emission reductions	1,234,654 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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(1) <u>Purpose of project activity</u>

CARBON CDM KOREA Ltd. has implemented a project for GHG emission reduction by catalytic N_2O destruction 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 N_2O. Hu-Chems operates the EnviNOx®-systems at its three nitric acid 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 N_2O, 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 N_2O supported by ammonia.

(a) <u>Scenario existing prior to the implementation of the project activity</u>

Nitric acid 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 nitric acid is for fertilisers, with smaller quantities going into the manufacture of organic compounds and mining explosives.

Nitrous oxide (N_2O) 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, there is no relevant loss of N_2O in the tail gas section unless a N_2O destruction facility is installed. N_2O that leaves the ammonia oxidation reactor 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 N_2O is emitted to the atmosphere with no N2O abatement measure being implemented.

(b) <u>Baseline scenario</u>

According to the applied methodology ACM0019 “N_2O abatement from nitric acid production” (Version 02.0.0) operators of nitric acid plants have no economic incentives to take any N_2O abatement measures in the absence of regulations requiring the abatement of N_2O emissions, because this entails capital and operating costs, but no financial benefits. Therefore, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O abatement measure being implemented.

Since <u>no laws or regulations exist at present</u>, which mandate the complete or partial destruction of N_2O from nitric acid plants in the host country, the Republic of Korea, Hu-Chems has no economic incentives to take any N_2O abatement measures in its nitric acid plant. Hence, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O abatement measure being implemented.

Annual average of GHG emission reductions during second crediting period:	1,234,654 tCO_2e
Total GHG emission reductions during second crediting period:	8,642,580 tCO_2e

(2) <u>Projects contribution to sustainable development</u>

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: Jeonnam (alias Jeollanam-do alias Chollanam-do)
Town: Yeosu (alias Yeosu-si)

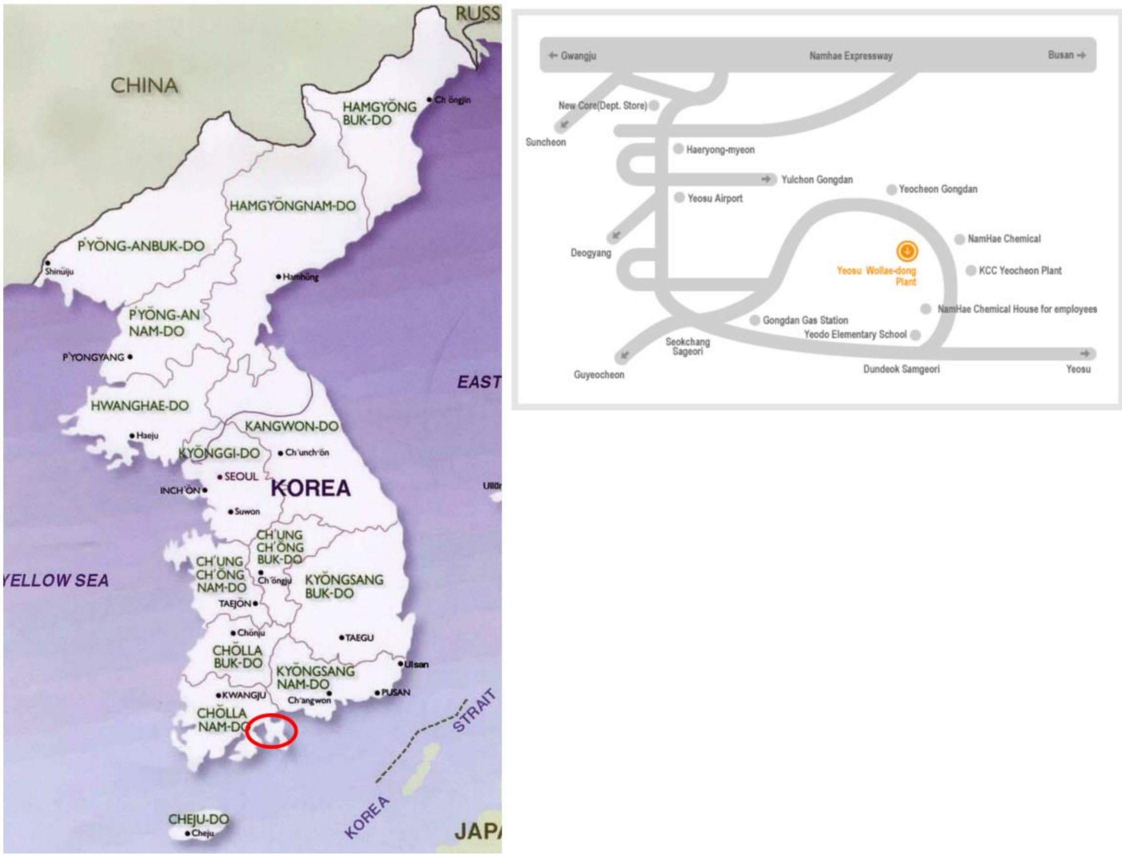

Figure 1: Location of the project and production site Hu-Chems

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

Unique geographic coordinates:

- Longitude: 127.743198 E
- Latitude: 34.848686 N

A.3. Technologies/measures

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(a) <u>Technologies and measures employed by the project activity</u>

In general, the applied technology, the EnviNOx®-process, is a tertiary measure for the destruction of N_2O from nitric acid plant tail gas streams based on the catalytic decomposition or catalytic reduction of N_2O, 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 nitric acid plants.

Technology used at plant Hu-Chems II:

A catalytic reduction process is installed in Hu-Chems II Nitric Acid Plant. The EnviNOx® reactor 322-R-202 is located between the existing SCR DeNOx reactor 37-R-201 and the tail gas turbine 37-C-201-T2 which is the position with the highest tail gas temperature in the nitric acid production process at HuChems II. The current tail gas temperature at this stage of the process is around 360°C and sufficient to permit very high rates of N_2O removal by virtue of the use of propane and ammonia as reducing agents for N_2O and NOX respectively. There is therefore no requirement to make modifications to the nitric acid plant to increase the tail gas temperature. The existing SCR (SCR= Selective Catalytic Reduction) DeNOx unit is still in operation.

The EnviNOx® reactor contains two catalyst beds, the first an iron zeolite, the second a cordierite monolith coated with a small quantity of platinum. For the efficient reduction of nitrous oxide, the NOx concentration of the tail gas leaving the existing SCR-DeNOx reactor must be further lowered. This is achieved simultaneously to the reduction of nitrous oxide in the first catalyst bed. The reducing agents employed, ammonia and propane, are introduced into the tail gas upstream of the EnviNOx® reactor via the static mixer 322-MX-203 as superheated vapours.

The second bed in the EnviNOx® reactor converts carbon monoxide arising from the use of propane in the first bed to carbon dioxide. The size of this greenhouse gas emission (CO_2) is insignificant in comparison to the reduction in greenhouse gas emissions that the process achieves by destroying nitrous oxide but will be monitored by measuring the flow of LPG to the EnviNOx® system.

All the reactions taking place in the EnviNOx® 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.

<u>Ammonia feed:</u>
Superheated ammonia from the existing plant ammonia evaporator and superheater 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 nitric acid plant.

<u>Liquefied Petroleum Gas (LPG) feed:</u>
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 EnviNOx® system under flow control. As with the ammonia supply system, the LPG feed is isolated from the tail gas side of the nitric acid plant in case of an interruption of supply caused by operator action or an interlock by means of a double block and bleed arrangement.

<u>Mixer:</u>
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 EnviNOx® reactor.

<u>N_2O and NOx reduction:</u>
At the inlet of the EnviNOx® reactor the NOx concentration typically reaches about 100 ppm and the N_2O concentration is typically in an order of 2,000 ppm.
The NOx concentration increases with plant load and temperature in the absorption tower while increased absorption tower pressure reduces the NOx concentration. Thus the NOx concentration is subject to short term fluctuations without any long term trend.

While the tail gas N_2O 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 N_2O concentration are generally – although not in every campaign – overlaid with a long term trend to higher N_2O concentrations as the campaign advances.

The EnviNOx® reactor contains two catalyst beds arranged in series as described above. In the first bed the EnviCat®-N_2O-2 catalyst reduces the concentration of NOx and N_2O to very low levels by reaction with ammonia and hydrocarbons, respectively, while in the second bed carbon monoxide is oxidised to carbon dioxide. Compared with the reduction in greenhouse gas emission achieved by the destruction of N_2O the additional greenhouse gas emissions (CO_2) caused by the use of the hydrocarbon in the process are insignificant but will be monitored.

Technology used at plant Hu-Chems III:

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

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

Technology used at plant Hu-Chems IV:

A catalytic N_2O decomposition process is installed at Hu-Chems IV Nitric Acid Plant. The EnviNOx® reactor 324-R-402 is located upstream of the tail gas turbine 324-C-401-T2 at the position with the highest tail gas temperature in the nitric acid production process at Hu-Chems IV. The current tail gas temperature here is around 435°C. The prior existing SCR DeNOx unit (SCR = Selective Catalytic Reduction) installed for NOx reduction has been removed during the implementation of the project activity, with the new EnviNOx® reactor taking on the function of the SCR DeNOx unit. As far as the degree of NOx removal is concerned the performance of the EnviNOx® reactor is superior to the formerly existing SCR DeNOx unit.

The EnviNOx® reactor contains two catalyst beds filled with special iron zeolite catalysts. In the first bed a large part of the nitrous oxide decomposes to nitrogen and oxygen, the high concentration of NOx 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 NOx is catalytically reduced to nitrogen and water vapour, so that very low concentrations of both NOx and nitrous oxide 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.

<u>Ammonia feed:</u>
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 nitric acid plant.

<u>Mixer:</u>
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.

<u>N_2O and NOx reduction:</u>
At the inlet of the EnviNOx® reactor the NOx concentration typically reaches about 500 ppm and the N_2O concentration is typically in an order of 1000 ppm.
The NOx concentration increases with plant load and temperature in the absorption tower while increased absorption tower pressure reduces the NOx concentration. Thus the NOx concentration is subject to short term fluctuations without any long term trend.

While the tail gas N_2O 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 N_2O concentration are generally – although not in every campaign – overlaid with a long term trend to higher N_2O 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®-N_2O-1 catalyst reduces the concentration of N_2O to a low level by catalytic decomposition, while in the second EnviCat®-NOx bed NOx is reduced with ammonia and further destruction of N_2O takes place.

(b) <u>Description of catalytic decomposition process (EnviNOx® process)</u>

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

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

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

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

Effectively almost all the NOx is removed.

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

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

N_2O reduction by these reactions is much more effective when NOX is absent.

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

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

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

The project activity reduces the N_2O emissions from Hu-Chems II and III Nitric Acid Plants by about 97% respectively.

The project in plants Hu-Chems II and Hu-Chems III uses hydrocarbons (propane) as reducing agent and 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 NOx 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 the Hu-Chems IV nitric acid plant is based on the catalytic decomposition of nitrous oxide (N_2O) and the catalytic reduction of NOx (NO and NO_2) with ammonia (NH_3). This process works very well at temperatures above about 425°C, the reactions take place over two iron zeolite catalyst beds.

In the first bed N2 N_2O O is catalytically decomposed into its elements:

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

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

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 NOX is reduced with ammonia according to such reactions as:

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

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

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

(c) <u>Scenario existing prior to the implementation of the project activity</u>

The nitric acid plants were designed without any N_2O abatement measure. The production of nitric acid takes place in three main process steps as indicated by the following reactions:

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

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

   Simultaneously nitrous oxide (N_2O), nitrogen (N) and water (H_2O) are formed as well, in accordance with the following equations:
   $4\ NH_3 + 3\ O_2 \rightarrow 2\ N_2 + 6\ H_2O$ (side reaction 1)
   $4\ NH_3 + 4\ O_2 \rightarrow 2\ N_2O + 6\ H_2O$ (side reaction 2)

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

2. NO is oxidised to nitrogen dioxide (NO_2):

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

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

$3 NO2 + H_2O \rightarrow 2 HNO_3 + NO$ (main reaction 3)

(NO is oxidised to NO_2 according to main reaction 2)

When leaving the ammonia oxidation reactor, there is no relevant loss of N_2O in the tail gas section unless a N_2O destruction facility is installed. N_2O that leaves the ammonia oxidation reactor is thus discharged to atmosphere in the tail gas, and has no economic value.

According to the applied methodology ACM0019 “N_2O abatement from nitric acid production” (Version 02.0.0) operators of nitric acid plants have no economic incentives to take any N_2O abatement measures in the absence of regulations requiring the abatement of N_2O emissions, because this entails capital and operating costs, but no financial benefits. Therefore, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O abatement measure being implemented.

Since no laws or regulations exist at present, which mandate the complete or partial destruction of N_2O from nitric acid plants in the host country, the Republic of Korea, Hu-Chems has no economic incentives to take any N_2O abatement measures in its nitric acid plants. Hence, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O 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

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

~~Host Country is the Republic of Korea. The Republic of Korea ratified the Kyoto Protocol on 08th November 2002.~~
~~CARBON CDM KOREA Ltd. (furthermore called “CARBON”) is registered under the laws of the Republic of Korea. The company is a daughter company of CARBON Projektentwicklung GmbH, Austria, and represents a foreign direct investment under the Foreign Investment Promotion Act (FIPA) of Korea.~~
~~CARBON Projektentwicklung GmbH was founded as a limited liability company located and registered in Austria under Austrian law in order to develop, finance and operate high quality JI/CDM Projects. CARBON Projektentwicklung GmbH has experience with CDM-Project development in Africa, Latin America and Asia and is specialized on the catalytic N2O destruction in the tail gas of nitric acid plants.~~
~~The RWE Group is one of Europe’s leading integrated electricity and gas companies. RWE Power AG is the continental power generation company within the RWE Group and Germany’s biggest power producer. RWE Power has a diverse generation portfolio including lignite, hard coal, nuclear energy, gas and renewable sources such as hydro, wind and biomass. RWE invests and~~

~~participates actively in projects under the Clean Development Mechanism and Joint Implementation. The RWE team combines a track record in global commodities and emissions trading as well as risk management with broad experience and a deep understanding of specific risks inherent in CDM and JI projects.~~

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

>>
Not applicable

A.7. Debundling

>>
Not applicable

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference to methodologies and standardized baselines

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(a) Selected methodology: ACM0019 “N_2O abatement from nitric acid production” (Version 02.0.0)[1]

(b) Any tools and other methodologies to which the selected methodology refers:
Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 02)[2]
Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)[3]

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 N_2O from three nitric acid plants of Hu-Chems by catalytic reduction of N_2O in the tail gas (i.e. tertiary destruction). Each of the following applicability conditions are met:

Applicability criteria #1: The methodology applies to project activities that introduce N_2O abatement measures in nitric acid plants.
Justification #1: The project activity destroys N_2O emissions by the reduction of N_2O in the tail gas stream of the nitric acid plants (II, III, IV) of Hu-Chems (tertiary abatement technology).

Applicability criteria #2: In the case that the nitric acid plant started commercial operation before the implementation of the CDM project activity, the project participants shall demonstrate that there was no secondary or tertiary abatement technology installed in the respective nitric acid 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 was installed in the Hu-Chems nitric acid plants prior to the implementation of the CDM project in 2007

[1] http://cdm.unfccc.int/methodologies/DB/MNMFNF10VUEOJACEIRX3EHYC9QXGDC

[2] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/

[3] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/

(first crediting period). The original design documents of the nitric acid plants clearly demonstrate that no such technologies were in place before. Besides, similar justifications and related evidence have been already provided for the validation/registration of the first crediting period.

Applicability criteria #3: Continuous real-time measurements of the N_2O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N_2O emissions throughout the crediting period of the project activity.
Justification #3: Continuous real-time measurements of the N_2O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N_2O emissions throughout the crediting period of the project activity. A dedicated Automated Monitoring System (AMS) was already installed in the plant prior to the beginning of the first crediting period of the project activity. This AMS will be adapted – if needed – in order to meet the requirements of the applied monitoring methodology.

Applicability criteria #4: No law or regulation which mandates the complete or partial destruction of N_2O 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 N_2O from nitric acid plants in the host country, the Republic of Korea.

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 nitric acid plant layout displaying the location of the N_2O abatement catalyst, process sources of N_2O and the sampling point location for the Automated Monitoring System (AMS)).

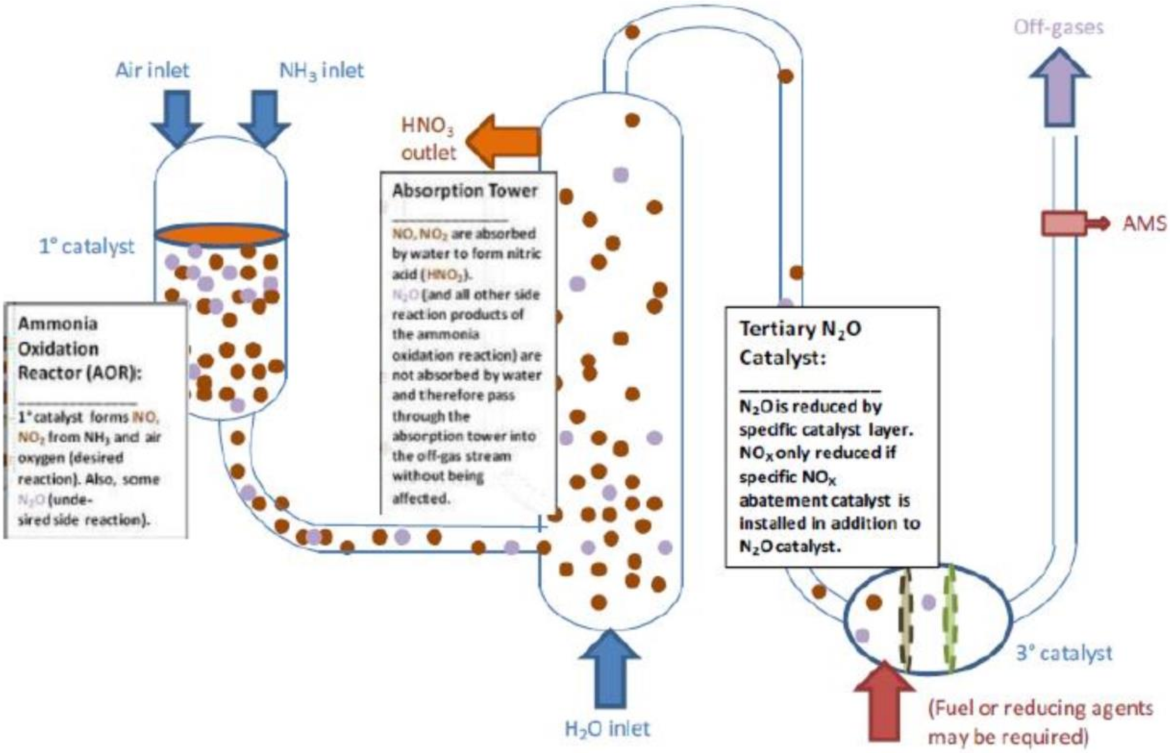

Figure 2: Project boundary Hu-Chems II and Hu-Chems III

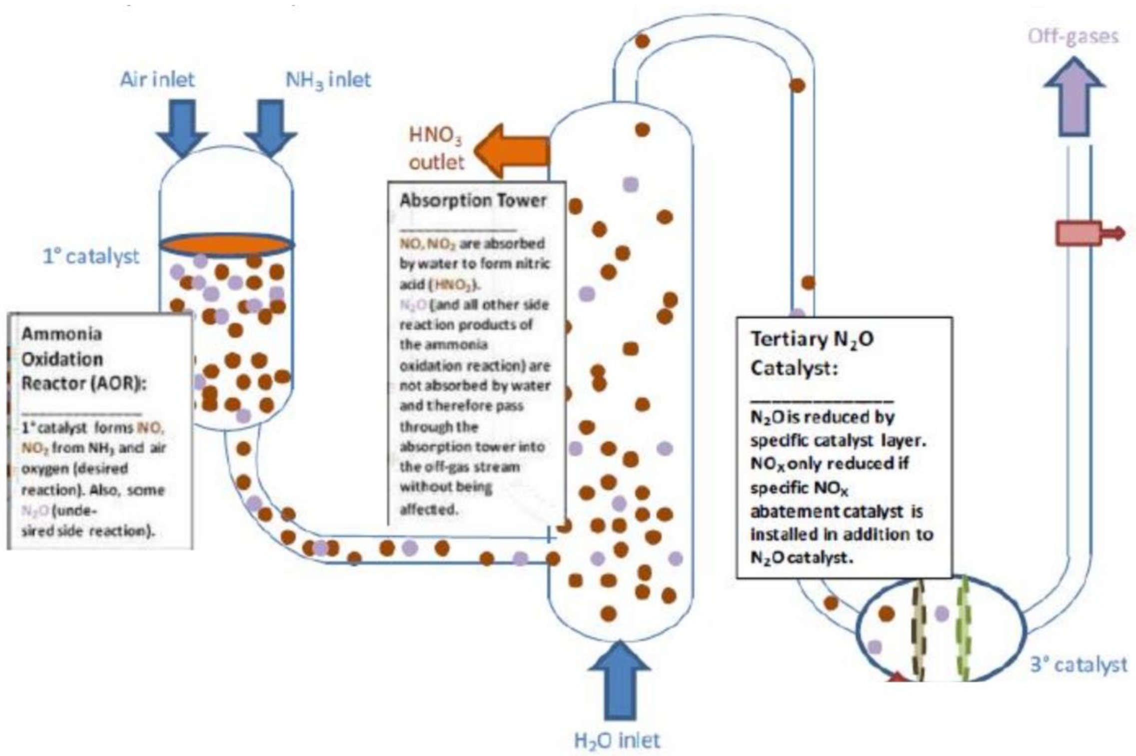

Figure 3: Project boundary Hu-Chems IV

As shown in the figures above, the only baseline emissions considered are the N_2O emissions formed in the Ammonia Oxidation Reactors (AOR), a part of the nitric acid 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 nitric acid 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 and Hu-Chems 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 and which are excluded from the project boundary for determination of both baseline and project emissions:

	Source	GHG	Included?	Justification/Explanation
Baseline	NH_3 oxidation at primary catalyst gauze	CO_2	No	The project activity has no influence on these types of emissions, if present (as per methodology).
		CH_4	No	
		N_2O	Yes	Included, main emission source.
Project activity	NH_3 oxidation at primary catalyst gauze	CO_2	No	The project activity has no influence on these types of emissions, if present (as per methodology).
		CH_4	No	
		N_2O	Yes	Included, main emission source.
	Operation of a tertiary N_2O 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_2O abatement facility. In this case the fossil fuels are mainly converted to CO_2. In this project activity, propane (supplied as Liquefied petroleum gas - LPG) is used in order to serve as reducing agent for the plants Hu-Chems II and Hu-Chems 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 (as per methodology).
		CH_4	No	Not applicable, as per the methodology.
		N_2O	Yes	Included.

The spatial extent of the project boundary encompasses the facility and equipment for the nitric acid production process from the inlet of the ammonia burner (i.e. the ammonia oxidation reactor) 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 N_2O from nitric acid plants in the host country, the Republic of Korea.

In accordance with the methodology, Hu-Chems has no economic incentives to take any N_2O abatement measures in its nitric acid 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 N_2O emitted to the atmosphere with no N_2O 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 N_2O emissions, as the operator of the nitric acid plants has no economic incentives to take any N_2O 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 N_2O emissions in nitric acid plants, the proposed project activity “Catalytic N_2O 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

Due to the fact, that the project activity includes three separate nitric acid plants and N_2O destruction facilities, monitoring is done separate for each plant as well. Hence, in order to obtain the baseline emissions in year y (tCO_2e), a sum over plant specific baseline emissions is built.

$$BE_y = BE_{y,II} + BE_{y,III} + BE_{y,IV} \quad \text{Equation (1)}$$

Where:

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

The project activity used AM0028, version 01 in the first crediting period. Then on May 31st, 2013, the methodology ACM0019 v.2.0.0 came into effect, substituting the methodologies AM0028 and AM0034 for their use in N_2O reduction projects in nitric acid plants. Hence, the methodology ACM0019 is applied for the second crediting period of this project activity.

For the calculation of baseline emissions, the described situation is covered in the methodology ACM0019 v.2.0.0 under “Case 1” including specific formulae for calculation.

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

Case 1: For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

$$BE_y = \begin{pmatrix} min\{P_{production,y} ; P_{product,max}\} \times EF_{existing,y} + \\ max\{P_{production,y} - P_{product,max}; 0\} \times EF_{new,y} \end{pmatrix} \times \frac{(h_y - h_{r,y})}{h_y} \times GWP_{N2O} \times 10^{-3} \quad \text{Equation (2)}$$

Where:

BE_y	=	Baseline emissions in year y (t CO_2e)
$P_{product,max}$	=	Design capacity (t HNO_3)
$P_{production,y}$	=	Production of nitric acid in year y (t HNO_3)
$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N_2O/t HNO_3)
$EF_{new,y}$	=	Baseline N_2O emission factor for nitric acid production in year y (kg N_2O/t HNO_3)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N_2O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

The N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period ($EF_{existing,y}$) is calculated as follows:

$$EF_{existing,y} = min\{EF_{historical}; EF_{default,y}\}$$ Equation (3)

Where:

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

Calculation of $h_{r,y}$

Similar to the calculation of BE_y, a specific "Case 1" applies to project activities that have used AM0028 or AM0034 in the first crediting period (please refer to explanation above) for the calculation of $h_{r,y}$.

Case 1: For nitric acid plants that have used AM0028 or AM0034 in the first crediting period

$$F_{N2O,tailgas,h} > EF_{existing,y} \times P_{NA,h}$$ Equation (4)

Where:

$P_{NA,h}$	=	Nitric acid produced in the hour h (t HNO_3)
$EF_{existing,y}$	=	Default N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N_2O/t HNO_3)
$F_{N2O,tailgas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)

<u>Project emissions</u>

Due to the fact, that the project activity includes three separate nitric acid plants and N_2O destruction facilities, monitoring is done separate for each plant as well. Hence, in order to obtain the project emissions in year y (tCO_2e), a sum over plant specific project emissions is built.

$$PE_y = PE_{y,II} + PE_{y,III} + PE_{y,IV}$$ Equation (5)

Where:

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

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

Project emissions include N_2O emissions, which have not been destroyed by the project activity and, in case of the installation of a tertiary N_2O abatement facility, CO_2 emissions resulting from the operation of the N_2O abatement facility. Project emissions are calculated as follows:

$$PE_y = PE_{N2O,y} + PE_{CO2,tertiary,y}$$ Equation (6)

Where:

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

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

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

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

$$PE_{N2O,y} = \sum_{1}^{h_y - h_{r,y}} F_{N2O,tailgas,h} \times GWP_{N20} \times 10^{-3}$$ Equation (7)

Where:

$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year y (t CO_2e)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
$F_{N2O,tailgas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N_2O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

Determination of $F_{N2O,tailgas,h}$

The amount of N_2O 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 N_2O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;

(b) The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on two seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;

(c) The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN14181 must be applied to both the N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;

(d) If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;

(e) In the case that the N_2O concentration and the volume or mass flow of the tail gas and 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 the 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 ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or
b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

The mass flow of greenhouse gas i ($F_{i,t}$)[4] is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \quad \text{Equation (8)}$$

With:

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \text{Equation (9)}$$

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 currently available information shows that the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) of all plants will be less than 0.05 kg H_2O/m^3 dry gas and therefore the gas is considered to be dry[5]. The moisture content of the gaseous streams will be measured according to the prevailing methodology and tool as well as to relevant current norms and standards.

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

[5] The ex-ante determination of the moisture content according to process parameters shows following values: HuChems II: 0.007 kgH_2O/m^3 dry gas, Hu-Chems III: 0.007 kgH_2O/m^3 dry gas and Hu-chems IV: 0.003 kgH_2O/m^3 dry gas.

According to the applied methodology the amount of N_2O 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 N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process.

Since the N_2O 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" (which is referred to as equation 9 of this PDD; see above) in order to determine a fixed value for the N_2O density at normal conditions ($P_t = P_n$ = 101,325 Pa; $T_t = T_n$ = 273.15 K), the N_2O density at normal conditions was determined to be 1.96 kg/m³ [6]. 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 N_2O abatement facility ($PE_{CO2,tertiary,y}$)

This emission source only needs to be estimated if a tertiary N_2O abatement facility is installed under the project activity and if fossil fuels are used to operate the facility or re-heat the gas after the facility.

Specifically to this project activity, this situation applies to plants Hu-Chems II and Hu-Chems III where propane (supplied as LPG) is used as reducing agent in the tertiary N_2O abatement facilities. No fossil fuel is used in plant Hu-Chems IV. Hence, the following set of equations is applied exclusively for plants Hu-Chems II and Hu-Chems III, whereas the value for $PE_{CO2,tertiary,y}$ is set to zero due to inapplicability of this emission source in plant Hu-Chems IV (associated parameters are not monitored accordingly).

The emissions related to the operation of the N_2O destruction facility include only on-site emissions due to the fossil fuel use as input to the N_2O destruction facility:

$$PE_{CO2,tertiary,y} = PE_{FF,y} \qquad \text{Equation (10)}$$

Where:

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

Project proponents shall use the latest version of 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 CO_2 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 N_2O 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.

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[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

According to the applied tool CO_2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows.

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad \text{Equation (11)}$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process j during the year y (t CO_2/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 CO_2 emission coefficient of fuel type i in year y (t CO_2/mass or volume unit)
i	=	Are the fuel types combusted in process j during the year y

According to the applied tool the CO_2 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 CO_2 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: $COEF_{i,y} = w_{C,i,y} \times 44/12$ Equation (12)

If $FC_{i,j,y}$ is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$ Equation (13)

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i (t CO_2/mass or volume unit)
$w_{C,i,y}$	=	Is the weighted average mass fraction of carbon in fuel type i in year y (t C/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 will be measured in a mass unit, Equation (12) will be applied.

<u>Leakage</u>

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

<u>Emission reductions</u>

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (14)}$$

Where:

ER_y	=	Emission reductions in year y (t CO_2e)
BE_y	=	Baseline emissions in year y (t CO_2e)
PE_y	=	Project emissions in year y (t CO_2e)

B.6.2. Data and parameters fixed ex ante

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

<table>
<tr><td>Data/Parameter</td><td>$EF_{new,y}$</td></tr>
<tr><td>Data unit</td><td>kg N_2O/t HNO_3</td></tr>
<tr><td>Description</td><td>Baseline N_2O emission factor for nitric acid production in year y (related to 100 per cent pure acid)</td></tr>
<tr><td>Source of data</td><td>The baseline N_2O emission factor for nitric acid production will vary every year. In year 2005 the emission factor will be 5.1 and then it 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.
<table>
<tr><th>Year</th><th>Emission factor (kg N_2O/t HNO_3)</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></td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Year</th><th>Emission factor (kg N_2O/t HNO_3)</th></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>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
</table>

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_2e/t N_2O
Description	Global warming potential of N2O 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 for 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 nitric acid plant operates at a low, medium or high pressure.
Additional comment	N/A

Data/Parameter	**$EF_{historical,II}$**
Data unit	kg N_2O/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 first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period; The plant used AM0028 in the first crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period is used. Calculation of $EF_{historical}$ is based on actual data of overall historical baseline emission factor obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the second and third crediting period.

Data/Parameter	**$EF_{default,y,II}$**
Data unit	kg N_2O/t HNO_3
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid) of Huchems II

Source of data	As per the applied methodology this default N_2O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N_2O/t HNO_3 for low, medium and high pressure ammonia burners, respectively. For each subsequent year, the emission factors will decrease by 0.2 kg N_2O/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 II is a high pressure plant, corresponding values given in the methodology apply over the crediting period:

Year	High pressure (Over 600 kPa)
2014	12.4
2015	12.2
2016	12.0
2017	11.8
2018	11.6
2019	11.4
2020	11.2
2021	11.0

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 for 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 nitric acid plant operates at a low, medium or high pressure.
Additional comment	N/A

Data/Parameter	$EF_{historical,III}$
Data unit	kg N_2O/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 first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period; The plant used AM0028 in the first crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period is used. Calculation of $EF_{historical}$ is based on actual data of overall historical baseline emission factor obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the second and third crediting period.

Data/Parameter	$EF_{default,y,III}$
Data unit	kg N_2O/t HNO_3
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid) of Huchems III

Source of data	As per the applied methodology this default N_2O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N_2O/t HNO_3 for low, medium and high pressure ammonia burners, respectively. For each subsequent year, the emission factors will decrease by 0.2 kg N_2O/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)
2014	12.4
2015	12.2
2016	12.0
2017	11.8
2018	11.6
2019	11.4
2020	11.2
2021	11.0

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	$\mathbf{P_{product,max,III}}$
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.

Data and parameters fixed ex-ante and ONLY relevant for 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 nitric acid plant operates at a low, medium or high pressure.
Additional comment	N/A

Data/Parameter	$EF_{historical,IV}$
Data unit	kg N_2O/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 first crediting period shall use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period; The plant used AM0028 in the first crediting period accordingly the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period is used. Calculation of $EF_{historical}$ is based on actual data of overall historical baseline emission factor obtained in one calendar year of the nitric acid plant of the first crediting period from issuance reports.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the second and third crediting period.

Data/Parameter	$EF_{default,y,IV}$
Data unit	kg N_2O/t HNO_3
Description	Default emission factor according to the operating pressure of the ammonia burner in year y (related to 100 per cent pure acid) of Huchems IV

<table>
<tr><td>Source of data</td><td>As per the applied methodology this default N_2O baseline emission factor will vary every year. In the year 2013 the emission factors will be 5.5; 8.4; and 12.6 kg N_2O/t HNO_3 for low, medium and high pressure ammonia burners, respectively. For each subsequent year, the emission factors will decrease by 0.2 kg N_2O/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.
<table>
<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>
<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>
</table></td></tr>
<tr><td>Value(s) applied</td><td>Since plant Hu-Chems IV is a medium pressure plant, corresponding values given in the methodology apply over the crediting period:
<table>
<tr><th>Year</th><th>Medium pressure (200 – 600 kPa)</th></tr>
<tr><td>2014</td><td>8.2</td></tr>
<tr><td>2015</td><td>8.0</td></tr>
<tr><td>2016</td><td>7.8</td></tr>
<tr><td>2017</td><td>7.6</td></tr>
<tr><td>2018</td><td>7.4</td></tr>
<tr><td>2019</td><td>7.2</td></tr>
<tr><td>2020</td><td>7.0</td></tr>
<tr><td>2021</td><td>6.8</td></tr>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>The decrease in the value for the baseline emission factor over time is to reflect the technological development.</td></tr>
</table>

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.

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

Data/Parameter	**R_u**
Data unit	Pa.m³/kmol.K
Description	Universal ideal gases constant
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0)
Value(s) applied	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" (Version 02.0.0)
Value(s) applied	<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Nitrous oxide</td><td>N_2O</td><td>44.02</td></tr></table>
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" (Version 02.0.0)
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_2O 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” (Version 02.0.0)
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_2O in the tail gas.

B.6.3. Ex ante calculation of emission reductions

>>
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_2e)
$BE_{y,II}$	=	Baseline emissions of plant Hu-Chems II in year y (t CO_2e)
$BE_{y,III}$	=	Baseline emissions of plant Hu-Chems III in year y (t CO_2e)
$BE_{y,IV}$	=	Baseline emissions of plant Hu-Chems IV in year y (t CO_2e)

Overall calculation	***BE_y***	***$BE_{y,II}$***	***$BE_{y,III}$***	***$BE_{y,IV}$***
Year	t CO_2e	t CO_2e	t CO_2e	t CO_2e
22/01/2014 - 31/12/2014	1,212,168	271,736	284,538	655,894
2015	1,286,166	288,324	301,908	695,935
2016	1,283,922	286,080	301,908	695,935
2017	1,279,154	281,312	301,908	695,935
2018	1,274,386	276,544	301,908	695,935
2019	1,269,618	271,776	301,908	695,935
2020	1,263,327	267,008	300,384	695,935
01/01/2021 - 21/01/2021	72,102	15,088	16,974	40,040

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.

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

Where:

BE_y	=	Baseline emissions in year y (t CO_2e)
$P_{product,max}$	=	Design capacity (t HNO_3)

$P_{production,y}$	=	Production of nitric acid in year y (t HNO_3)
$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 or AM0034 in the first crediting period in year y (kg N_2O/t HNO_3)
$EF_{new,y}$	=	Baseline N_2O emission factor for nitric acid production in year y (kg N_2O/t HNO_3)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N_2O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

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_2e	kg N_2O/ t HNO_3	kg N_2O/ t HNO_3	t HNO_3	t HNO_3	h	h	-
22/01/2014 - 31/12/2014	271,736	12.09	3.50	75,397	110,080	6,107	0	298
2015	288,324	12.09	3.40	80,000	116,800	6,480	0	298
2016	286,080	12.00	3.20	80,000	116,800	6,480	0	298
2017	281,312	11.80	3.00	80,000	116,800	6,480	0	298
2018	276,544	11.60	2.80	80,000	116,800	6,480	0	298
2019	271,776	11.40	2.70	80,000	116,800	6,480	0	298
2020	267,008	11.20	2.50	80,000	116,800	6,480	0	298
01/01/2021 - 21/01/2021	15,088	11.00	2.50	4,603	6,720	373	0	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_2e	kg N_2O/ t HNO_3	kg N_2O/ t HNO_3	t HNO_3	t HNO_3	h	h	-
22/01/2014 - 31/12/2014	284,538	11.26	3.50	84,822	110,080	6,786	0	298
2015	301,908	11.26	3.40	90,000	116,800	7,200	0	298
2016	301,908	11.26	3.20	90,000	116,800	7,200	0	298
2017	301,908	11.26	3.00	90,000	116,800	7,200	0	298
2018	301,908	11.26	2.80	90,000	116,800	7,200	0	298
2019	301,908	11.26	2.70	90,000	116,800	7,200	0	298
2020	300,384	11.20	2.50	90,000	116,800	7,200	0	298
01/01/2021 - 21/01/2021	16,974	11.00	2.50	5,178	6,720	414	0	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_2e	kg N_2O/ t HNO_3	kg N_2O/ t HNO_3	t HNO_3	t HNO_3	h	h	-
22/01/2014 - 31/12/2014	655,894	5.70	3.50	386,411	440,320	7,691	0	298
2015	695,935	5.70	3.40	410,000	467,200	8,160	0	298
2016	695,935	5.70	3.20	410,000	467,200	8,160	0	298
2017	695,935	5.70	3.00	410,000	467,200	8,160	0	298
2018	695,935	5.70	2.80	410,000	467,200	8,160	0	298
2019	695,935	5.70	2.70	410,000	467,200	8,160	0	298
2020	695,935	5.70	2.50	410,000	467,200	8,160	0	298

01/01/2021 - 21/01/2021	40,040	5.70	2.50	23,589	26,880	469	0	298

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

Where:

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

$EF_{historical}$ = Historical baseline emission factor of the nitric acid plant (kg N_2O/t HNO_3)

$EF_{default,y}$ = Default emission factor according to the operating pressure of the ammonia burner in year y (kg N_2O/t HNO_3)

Plant Hu-Chems II	***$EF_{existing,y}$***	***$EF_{historical}$***	***$EF_{default,y}$ (for high pressure)***
Year	kg N_2O/t HNO_3	kg N_2O/t HNO_3	kg N_2O/t HNO_3
22/01/2014 -31/12/2014	12.09	12.09	12.40
2015	12.09	12.09	12.20
2016	12.00	12.09	12.00
2017	11.80	12.09	11.80
2018	11.60	12.09	11.60
2019	11.40	12.09	11.40
2020	11.20	12.09	11.20
01/01/2021 -21/01/2021	11.00	12.09	11.00

Plant Hu-Chems III	***$EF_{existing,y}$***	***$EF_{historical}$***	***$EF_{default,y}$ (for high pressure)***
Year	kg N_2O/t HNO_3	kg N_2O/t HNO_3	kg N_2O/t HNO_3
22/01/2014 -31/12/2014	11.26	11.26	12.40
2015	11.26	11.26	12.20
2016	11.26	11.26	12.00
2017	11.26	11.26	11.80
2018	11.26	11.26	11.60
2019	11.26	11.26	11.40
2020	11.20	11.26	11.20
01/01/2021 -21/01/2021	11.00	11.26	11.00

Plant Hu-Chems IV	***$EF_{existing,y}$***	***$EF_{historical}$***	***$EF_{default,y}$ (for medium pressure)***
Year	kg N_2O/t HNO_3	kg N_2O/t HNO_3	kg N_2O/t HNO_3
22/01/2014 -31/12/2014	5.70	5.70	8.20
2015	5.70	5.70	8.00
2016	5.70	5.70	7.80
2017	5.70	5.70	7.60
2018	5.70	5.70	7.40
2019	5.70	5.70	7.20
2020	5.70	5.70	7.00
01/01/2021 -21/01/2021	5.70	5.70	6.80

Project Emissions

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

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

Where:

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

Overall calculation	PE_y	$PE_{y,II}$	$PE_{y,III}$	$PE_{y,IV}$
Year	t CO_2e	t CO_2e	t CO_2e	t CO_2e
22/01/2014 - 31/12/2014	40,157	8,987	9,719	21,451
2015	42,609	9,536	10,312	22,761
2016	42,609	9,536	10,312	22,761
2017	42,609	9,536	10,312	22,761
2018	42,609	9,536	10,312	22,761
2019	42,609	9,536	10,312	22,761
2020	42,609	9,536	10,312	22,761
01/01/2021 - 21/01/2021	2,451	549	593	1,310

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 CO_2e)
$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year y (t CO_2e)
$PE_{CO2,tertiary,y}$	=	Project emissions of CO_2 from the operation of the tertiary N_2O abatement facility in year y (t CO_2)

Plant Hu-Chems II	PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
Year	t CO_2e	t CO_2e	t CO_2
22/01/2014 -31/12/2014	8,987	8,343	645
2015	9,536	8,852	684
2016	9,536	8,852	684
2017	9,536	8,852	684
2018	9,536	8,852	684
2019	9,536	8,852	684
2020	9,536	8,852	684
01/01/2021 -21/01/2021	549	509	39

Plant Hu-Chems III	PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
Year	t CO_2e	t CO_2e	t CO_2
22/01/2014 -31/12/2014	9,719	8,978	741
2015	10,312	9,526	786
2016	10,312	9,526	786
2017	10,312	9,526	786
2018	10,312	9,526	786
2019	10,312	9,526	786
2020	10,312	9,526	786
01/01/2021 -21/01/2021	593	548	45

Plant Hu-Chems IV	PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
Year	t CO_2e	t CO_2e	t CO_2
22/01/2014 -31/12/2014	21,451	21,451	0
2015	22,761	22,761	0

2016	22,761	22,761	0
2017	22,761	22,761	0
2018	22,761	22,761	0
2019	22,761	22,761	0
2020	22,761	22,761	0
01/01/2021 -21/01/2021	1,310	1,310	0

~~Since n~~No fossil fuels are used in plant Hu-Chems IV~~, the emission source~~. As described in this PDD, parameter $PE_{CO2,tertiary,y}$ is therefore set to zero for this plant. Respective parameters are not monitored.

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

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

Where:

$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year y (t CO_2e)
GWP_{N2O}	=	Global Warming Potential of N_2O valid for the commitment period
$F_{N2O,tailgas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: (a) For secondary N_2O abatement: the abatement system was not installed, underperforming or failed; (b) For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

Plant Hu-Chems II	***PE_y***	***$F_{N2O,tailgas,h}$***	***h_y***	***$h_{r,y}$***	***GWP_{N2O}***
Year	t CO_2e	kg N_2O/h	h	h	t CO_2/t N_2O
22/01/2014 -31/12/2014	8,343	4.58	6,107	0	298
2015	8,852	4.58	6,480	0	298
2016	8,852	4.58	6,480	0	298
2017	8,852	4.58	6,480	0	298
2018	8,852	4.58	6,480	0	298
2019	8,852	4.58	6,480	0	298
2020	8,852	4.58	6,480	0	298
01/01/2021 -21/01/2021	509	4.58	373	0	298

Plant Hu-Chems III	***PE_y***	***$F_{N2O,tailgas,h}$***	***h_y***	***$h_{r,y}$***	***GWP_{N2O}***
Year	t CO_2e	kg N_2O/h	h	h	t CO_2/t N_2O
22/01/2014 -31/12/2014	8,978	4.44	6,786	0	298
2015	9,526	4.44	7,200	0	298
2016	9,526	4.44	7,200	0	298
2017	9,526	4.44	7,200	0	298
2018	9,526	4.44	7,200	0	298
2019	9,526	4.44	7,200	0	298
2020	9,526	4.44	7,200	0	298
01/01/2021 -21/01/2021	548	4.44	414	0	298

Plant Hu-Chems IV	***PE_y***	***$F_{N2O,tailgas,h}$***	***h_y***	***$h_{r,y}$***	***GWP_{N2O}***
Year	t CO_2e	kg N_2O/h	h	h	t CO_2/t N_2O
22/01/2014 -31/12/2014	21,451	9.36	7,691	0	298
2015	22,761	9.36	8,160	0	298

2016	22,761	9.36	8,160	0	298
2017	22,761	9.36	8,160	0	298
2018	22,761	9.36	8,160	0	298
2019	22,761	9.36	8,160	0	298
2020	22,761	9.36	8,160	0	298
01/01/2021 -21/01/2021	1,310	9.36	469	0	298

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

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

With:

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

Where:

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

When applying normal conditions and as described in section B.6.1, the density at normal conditions ($P_t = P_n$ = 101,325 Pa; $T_t = T_n$ = 273.15 K) was determined to be constantly 1.96 kg/m^3 [8]. Respective parameters need not to be monitored according to the methodology.

Plant Hu-Chems II	$F_{N2O,tailgas,h} = F_{i,t}$	$\rho_{i,t}$	$V_{t,db}$	$v_{i,t,db}$
Year	kg N_2O/h	kg gas i/m^3 gas i	m^3 dry gas/h	m^3 gas i/ m^3 dry gas
22/01/2014 -31/12/2014	4.58	1.96	38,200	$6.11 * 10^{-5}$
2015	4.58	1.96	38,200	$6.11 * 10^{-5}$
2016	4.58	1.96	38,200	$6.11 * 10^{-5}$
2017	4.58	1.96	38,200	$6.11 * 10^{-5}$
2018	4.58	1.96	38,200	$6.11 * 10^{-5}$
2019	4.58	1.96	38,200	$6.11 * 10^{-5}$
2020	4.58	1.96	38,200	$6.11 * 10^{-5}$
01/01/2021 -21/01/2021	4.58	1.96	38,200	$6.11 * 10^{-5}$

Plant Hu-Chems III	$F_{N2O,tailgas,h} = F_{i,t}$	$\rho_{i,t}$	$V_{t,db}$	$v_{i,t,db}$
Year	kg N_2O/h	kg gas i/m^3 gas i	m^3 dry gas/h	m^3 gas i/ m^3 dry gas
22/01/2014 -31/12/2014	4.44	1.96	40,000	$5.65 * 10^{-5}$
2015	4.44	1.96	40,000	$5.65 * 10^{-5}$
2016	4.44	1.96	40,000	$5.65 * 10^{-5}$
2017	4.44	1.96	40,000	$5.65 * 10^{-5}$

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

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

2018	4.44	1.96	40,000	$5.65 * 10^{-5}$
2019	4.44	1.96	40,000	$5.65 * 10^{-5}$
2020	4.44	1.96	40,000	$5.65 * 10^{-5}$
01/01/2021 -21/01/2021	4.44	1.96	40,000	$5.65 * 10^{-5}$

Plant Hu-Chems IV	$F_{N2O,tailgas,h} = F_{i,t}$	$\rho_{i,t}$	$V_{t,db}$	$v_{i,t,db}$
Year	kg N_2O/h	kg gas i/m³ gas i	m³ dry gas/h	m³ gas i/ m³ dry gas
22/01/2014 -31/12/2014	9.36	1.96	156,000	$3.05 * 10^{-5}$
2015	9.36	1.96	156,000	$3.05 * 10^{-5}$
2016	9.36	1.96	156,000	$3.05 * 10^{-5}$
2017	9.36	1.96	156,000	$3.05 * 10^{-5}$
2018	9.36	1.96	156,000	$3.05 * 10^{-5}$
2019	9.36	1.96	156,000	$3.05 * 10^{-5}$
2020	9.36	1.96	156,000	$3.05 * 10^{-5}$
01/01/2021 -21/01/2021	9.36	1.96	156,000	$3.05 * 10^{-5}$

Project emissions from the operation of the tertiary N_2O abatement facility ($PE_{CO2,tertiary,y}$)

This section is only applicable for plants Hu-Chems II and Hu-Chems III, since no fossil fuels are used in plant Hu-Chems IV.

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

Where:

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

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

Plant Hu-Chems II	$PEF_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
Year	t CO_2/yr
22/01/2014 -31/12/2014	645
2015	684
2016	684
2017	684
2018	684
2019	684
2020	684
01/01/2021 -21/01/2021	39

Plant Hu-Chems III	$PEF_{CO2,tertiary,y} = PE_{FF,y} = PE_{FC,j,y}$
Year	t CO_2/yr
22/01/2014 -31/12/2014	741
2015	786
2016	786
2017	786
2018	786
2019	786
2020	786
01/01/2021 -21/01/2021	45

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

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process j during the year y (t CO_2/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 CO_2 emission coefficient of fuel type i in year y (t CO_2/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
22/01/2014 -31/12/2014	645	215	3.00
2015	684	228	3.00
2016	684	228	3.00
2017	684	228	3.00
2018	684	228	3.00
2019	684	228	3.00
2020	684	228	3.00
01/01/2021 -21/01/2021	39	13	3.00

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
22/01/2014 -31/12/2014	741	247	3.00
2015	786	262	3.00
2016	786	262	3.00
2017	786	262	3.00
2018	786	262	3.00
2019	786	262	3.00
2020	786	262	3.00
01/01/2021 -21/01/2021	45	15	3.00

The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i, using the following approach:

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

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

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type i (t CO_2/t)
$w_{C,i,y}$	=	Is the weighted average mass fraction of carbon in fuel type i in year y (t C/t)
i	=	Are the fuel types combusted in process j during the year y

Plant Hu-Chems II	***$COEF_{i,y}$***	***$w_{C,i,y}$***
Year	t CO_2/t	t C/t
22/01/2014 -31/12/2014	3.00	0.82
2015	3.00	0.82
2016	3.00	0.82
2017	3.00	0.82
2018	3.00	0.82
2019	3.00	0.82
2020	3.00	0.82

01/01/2021 -21/01/2021	3.00	0.82

Plant Hu-Chems III	***$COEF_{i,y}$***	***$w_{C,i,y}$***
Year	t CO_2/t	t C/t
22/01/2014 -31/12/2014	3.00	0.82
2015	3.00	0.82
2016	3.00	0.82
2017	3.00	0.82
2018	3.00	0.82
2019	3.00	0.82
2020	3.00	0.82
01/01/2021 -21/01/2021	3.00	0.82

<u>Leakage</u>

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

<u>Emission reductions</u>

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

ER_y	=	Emission reductions in year y (t CO_2e)
BE_y	=	Baseline emissions in year y (t CO_2e)
PE_y	=	Project emissions in year y (t CO_2e)

Overall calculation	***ER_y***	***BE_y***	***PE_y***
Year	t CO_2e	t CO_2e	t CO_2e
22/01/2014 - 31/12/2014	1,172,010	1,212,168	40,157
2015	1,243,557	1,286,166	42,609
2016	1,241,313	1,283,922	42,609
2017	1,236,545	1,279,154	42,609
2018	1,231,777	1,274,386	42,609
2019	1,227,009	1,269,618	42,609
2020	1,220,718	1,263,327	42,609
01/01/2021 - 21/01/2021	69,650	72,102	2,451

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

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
22/01/2014 - 31/12/2014	1,212,168	40,157	0	1,172,010
2015	1,286,166	42,609	0	1,243,557
2016	1,283,922	42,609	0	1,241,313
2017	1,279,154	42,609	0	1,236,545
2018	1,274,386	42,609	0	1,231,777
2019	1,269,618	42,609	0	1,227,009
2020	1,263,327	42,609	0	1,220,718
01/01/2021 - 21/01/2021	72,102	2,451	0	69,650
Total	**8,940,843**	**298,262**	**0**	**8,642,580**
Total number of crediting years	**7 years**			

Annual average over the crediting period	**1,277,263**	**42,609**	**0**	**1,234,654**

Note that actual estimation of overall emission reductions as presented in chapters B6.3 and B6.4 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

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 N_2O emissions monitoring results will be ensured by installing a 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 the 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 1st crediting period, taking into consideration future trends.

<u>Parameters from the applied methodology (ACM0019, Version 2.0.0) which are monitored and ONLY relevant for plant Hu-Chems II</u>

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 nitric acid 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 nitric acid production (recorded as 100% nitric acid).
Value(s) applied	**80,000**
Measurement methods and procedures	**322-FT-2-512** Type: Flowmeter Accuracy class: ± 0.35% Calibration frequency: 60 months **322-TI-2-127** Type: Temperature Converter Accuracy class: ± 0.15% 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 nitric acid plant.
Purpose of data	Calculation of baseline and project 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 section 5.3.3 of the applied methodology (Equation 4 of the methodology and of this PDD).

Data/Parameter	$\mathbf{h_{y,II}}$
Data unit	h~~H~~
Description	Number of hours of operation in year *y* of Hu-Chems II
Source of data	Measured
Value(s) applied	**6,480**
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 Nm^3/h during an hour, the reactor is considered in operation. **322-FT-2-503** Type: Flow meter Accuracy class: ± 0.5% 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 nitric acid plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime.

Data/Parameter	$\mathbf{h_{r,y,II}}$
Data unit	h~~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	**0**
Measurement methods and procedures	Hu-Chems nitric acid plants has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if: $F_{N2O,tailgas,h,II} > EF_{existing,y,II} \times P_{NA,h,II}$ The parameters mentioned 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 nitric acid 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 $P_{production,y,II}$.

<u>Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) ONLY relevant for plant Hu-Chems II</u>

Data/Parameter	$V_{t,db,II}$
Data unit	m³ 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	**38,200**
Measurement methods and procedures	Volumetric flow measurement will refer to normal conditions (as per 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 nitric acid 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). Monitoring of actual conditions ($P_{t,II}$, $T_{t,II}$) is not necessary as per methodology. Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	$v_{i,t,db,II}$
Data unit	m³ gas i/m³ 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	**$6.11 * 10^{-5}$**
Measurement methods and procedures	**322-AT-2-0127** Type: Non-dispersion infrared absorption analyser (NDIR) Calibration frequency: as per EN 14181 Volumetric fraction measurement will refer to normal conditions (as per 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 nitric acid 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 Pa; T_n = 273.15 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_2O/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	Calculated value for ex-ante determination of emission reductions **is 7,000 mg H_2O/m^3 dry gas (= 0.007 kg H_2O/m^3 dry gas)**
Measurement methods and procedures	Discrete measurement procedure The mean value among three consecutive measurements performed in the same day (at least 2 hours each) will be considered. Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream. No measurements available at this stage of the project.
Monitoring frequency	Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream. 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.

Parameters from the"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02) ONLY relevant to 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	**228**
Measurement methods and procedures	**322-FT-2-5121** Type: Coriolis flow meter Accuracy class: ± 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 nitric acid 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 the specific 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 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	The following data sources may be used if the relevant conditions apply: <table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><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></table> Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.
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 plant is LPG (Liquefied Petroleum Gas) with a major mass fraction of propane (about >95%).

Parameters from the applied methodology (ACM0019, Version 2.0.0) which are monitored and ONLY relevant for 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 nitric acid 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 nitric acid production (recorded as 100% nitric acid).
Value(s) applied	**90,000**
Measurement methods and procedures	**323-FT-3-512** Type: Flowmeter Accuracy class: ± 0.35% Calibration frequency: 60 months **323-TI-3-127** Type: Temperature Converter Accuracy class: ± 0.15% 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 nitric acid plant.
Purpose of data	Calculation of baseline and project 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 section 5.3.3 of the applied methodology (Equation 4 of the methodology and of this PDD).

Data/Parameter	$\mathbf{h_{y,III}}$
Data unit	h
Description	Number of hours of operation in year *y* of Hu-Chems III
Source of data	Measured
Value(s) applied	**7,200**
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 Nm^3/h during an hour, the reactor is considered in operation. **323-FT-3-503** Type: Flow meter Accuracy class: ± 0.5% 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 nitric acid plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime

Data/Parameter	$\mathbf{h_{r,y,III}}$
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	**0**
Measurement methods and procedures	Hu-Chems nitric acid plants has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if: $F_{N2O,tailgas,h,III} > EF_{existing,y,III} \times P_{NA,h,III}$ The parameters mentioned 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 nitric acid 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 $P_{production,y,III}$.

<u>Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) ONLY relevant for plant Hu-Chems III</u>

Data/Parameter	$V_{t,db,III}$
Data unit	m³ 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	**40,000**
Measurement methods and procedures	Volumetric flow measurement will refer to normal conditions (as per 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 nitric acid 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). Monitoring of actual conditions ($P_{t,III}$, $T_{t,III}$) is not necessary as per methodology. Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	$v_{i,t,db,III}$
Data unit	m³ gas i/m³ 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	**$5.65 * 10^{-5}$**
Measurement methods and procedures	**323-AT-3-0127** Type: Non-dispersion infrared absorption analyser (NDIR) Calibration frequency: as per EN 14181 Volumetric fraction measurement will refer to normal conditions (as per 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 nitric acid 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 Pa; T_n = 273.15 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_2O/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	Calculated value for ex-ante determination of emission reductions is 7,000 mg H_2O/m^3 dry gas (= 0.007 kg H_2O/m^3 dry gas).
Measurement methods and procedures	Discrete measurement procedure ~~The mean value among three consecutive measurements performed in the same day (at least 2 hours each) will be considered. Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream.~~ No measurements available at this stage of the project.
Monitoring frequency	~~Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream.~~ 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.

Parameters from the"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02) ONLY relevant to 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	**262**
Measurement methods and procedures	**323-FT-3-5121** Type: Coriolis flow meter Accuracy class: ± 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 nitric acid 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 the specific 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 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	The following data sources may be used if the relevant conditions apply: **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 Composition of the delivered hydrocarbon is measured by the supplier and provided on specific certificates.
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 plant is LPG (Liquefied Petroleum Gas) with a major mass fraction of propane (about >95%).

Parameters from the applied methodology (ACM0019, Version 2.0.0) which are monitored and ONLY relevant for 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 nitric acid 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 nitric acid production (recorded as 100% nitric acid).
Value(s) applied	**410,000**
Measurement methods and procedures	**324-FT-4-609** Type: Flowmeter Accuracy class: ± 0.35% Calibration frequency: 60 months **32~~3~~4-TT-4-237** Type: Temperature Transmitter Accuracy class: ± 0.15% 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 nitric acid plant.
Purpose of data	Calculation of baseline and project 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 section 5.3.3 of the applied methodology (Equation 4 of the methodology and of this PDD).

Data/Parameter	$\mathbf{h_{y,IV}}$
Data unit	H
Description	Number of hours of operation in year *y* of Hu-Chems IV
Source of data	Measured
Value(s) applied	**8,160**
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 Nm³/h during an hour, the reactor is considered in operation. **324-FT-4-5020** Type: Coriolis flowmeter Accuracy class: ± 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 nitric acid plant.
Purpose of data	Calculation of baseline and project emissions
Additional comment	Records to be maintained during project's lifetime.

Data/Parameter	$\mathbf{h_{r,y,IV}}$
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	**0**
Measurement methods and procedures	Hu-Chems nitric acid plants has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if: $F_{N2O,tailgas,h,IV} > EF_{existing,y,IV} \times P_{NA,h,IV}$ The parameters mentioned in 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 nitric acid 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 $P_{production,y,IV}$.

Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0) ONLY relevant for plant Hu-Chems IV

Data/Parameter	$V_{t,db,IV}$
Data unit	m³ 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	**156,000**
Measurement methods and procedures	Volumetric flow measurement will refer to normal conditions (as per 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 nitric acid 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). Monitoring of actual conditions ($P_{t,IV}$, $T_{t,IV}$) is not necessary as per methodology. Dry basis flow measurement, since gaseous stream is considered to be dry.

Data/Parameter	$v_{i,t,db,IV}$
Data unit	m³ gas i/m³ 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	**$3.05 * 10^{-5}$**
Measurement methods and procedures	**324-AT-4-0107** Type: Non-dispersion infrared absorption analyser (NDIR) Calibration frequency: as per EN 14181 Volumetric fraction measurement will refer to normal conditions (as per 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 nitric acid 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 Pa; T_n = 273.15 K). Dry basis flow measurement, since gaseous stream is considered to be dry (please refer to parameter **$C_{H2O,t,db,n,IV}$**) for further explanation.

Data/Parameter	**$C_{H2O,t,db,n,IV}$**
Data unit	mg H_2O/m^3 dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t of Hu-Chems IV
Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) applied	Calculated value for ex-ante determination of emission reductions is 3,000 mg H_2O/m^3 dry gas (= 0.003 kg H_2O/m^3 dry gas).
Measurement methods and procedures	Discrete measurement procedure ~~The mean value among three consecutive measurements performed in the same day (at least 2 hours each) will be considered. Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream.~~ No measurements available at this stage of the project.
Monitoring frequency	~~Measurement will coincide with the first Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the first calibration of the flow meter for the gaseous stream.~~ 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 “N_2O abatement from nitric acid production” (Version 02.0.0) and of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 02.0.0) as well of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 02).

Measurement of the N_2O concentration and the total gas volume flow
The project will employ 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 will be equipped with an Automated Monitoring System (AMS) in order to allow continuous real-time measurements of the N_2O concentration and the total gas volume flow, which is required by the methodology.

The amount of N_2O 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 N_2O concentration and volume or mass flow of the tail gas are to be monitored continuously. The monitoring system is to

be installed and maintained throughout the crediting period based on the European Norm 14181 (2004), or any more recent update of that standard;

(b) The monitoring system should provide separate hourly average values for the N_2O concentration and the volume or mass flow of the tail gas based on two seconds (or shorter) interval readings that are recorded and stored electronically. These N_2O data sets shall be identified by means of a unique time/date key indicating when exactly the values were observed;

(c) The correction factors derived from the calibration curve of the QAL2 audit for the monitoring components as determined during the QAL2-test in accordance with EN14181 must be applied to both the N_2O concentration and the volume or mass flow of the tail gas. This can either be applied automatically to the raw data recorded by the data storage system at the plant or it can be applied to the calculated hourly averages as part of the calculation of project emissions;

(d) If data for either the N_2O concentration or the volume or mass flow of the tail gas are not available for more than 1/3 of any hour while the plant was in operation, the value for that hour shall be replaced with the maximum value of N_2O concentration or volume or mass flow of the tail gas observed during the monitoring period. If data for neither the N_2O concentration nor the volume or mass flow of the tail gas are available for more than 1/3 of any hour while the plant was in operation, the maximum value of mass flow of N_2O calculated during the monitoring period shall be applied to any such hour. Values observed during five operating hours before and after a plant start-up and shut-down shall not be used for the determination of the maximum values;

(e) In the case that the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters Pt and Tt 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 nitric acid plants plant since the commissioning of the plant and has sufficient and well experienced staff to operate similar technologies (like the existing DeNOx-unit) and is quite experienced in calibrating and maintaining monitoring equipment. The company is ISO 9002 and ISO 14001 certified and received the Korean safety and health management system certificate

(KGS18001 & OHSAS18001). The EnviNOx® system is incorporated into Hu-Chems ISO 9001:2008 and ISO 14001:2009 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 in Korea is responsible for monitoring and reporting of data under the CDM Project. In terms of performing general supervision and cross-checks of monitoring and reporting data Carbon in Austria supports Carbon in Korea.

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

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 (second crediting period)

C.3.2. Start date of crediting period

>>
22/01/2014

C.3.3. Duration of crediting period

>>
7 years, 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

The catalytic N_2O destruction project in the tail gas of the Nitric Acid Plants Hu-Chems II, Hu-Chems III and Hu-Chems IV is a sustainable project that contributes to the environmental, economic and social benefits in the Republic of Korea.

Environmental Impacts

Besides the reduction of N_2O emissions, additionally, the EnviNOx®-System takes over the function of the DeNOx-unit at Hu-Chems IV as it too accomplishes the reduction of NOx with ammonia. 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 and Hu-Chems III are also be reduced. No further environmental impacts are expected.

According to Article 4 of the Korean Environmental Impact Assessment Law and the item 3 of the Article 2 of its Enforcement Ordinance, no EIA was required for the CDM Project at Hu-Chems Fine Chemical (Catalytic N_2O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chems Fine Chemical Corp.).

No transboundary impacts are observed nor expected.

D.2. Environmental impact assessment

>>

Not applicable, as no environmental impact assessment is required.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

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CARBON has carried out investigation on the local stakeholder comments on the proposed project activity in the formats of issuing questionnaires to introduce the aims and characteristics of the project and addressing in particular its potential environmental impacts.

A local stakeholder conference has been held by CARBON and HU-CHEMS for the residents living near the proposed project at the City-Hall of Yeosu on 17^{th} 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.

E.2. Summary of comments received

>>

Translation of Environmental 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 stakeholoders 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 have 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.
For the purpose of implementation this CDM Project CARBON CDM KOREA Ltd. was founded and is registered under the laws of the Republic of Korea.

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)
- Germany
- Austria

Appendix 1. Contact information of project participants

Organization name	CARBON CDM KOREA Ltd.
Country	Republic of Korea
Address	3rd & 5th Floor Namdo Bldg., 12, Jangmoon-ro, Yongsan-gu,8th floor, Bongwoo Bldg., 31-7, 1Ga Jangchung-Dong, Jung-Gu
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Contact person	Mr. Ferdinand Heilig

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Website	-
Contact person	Mr. Ludwig Kons

Organization name	Hu-Chems Fine Chemical Corp.
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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

Version	*Date*	*Description*
10.1	28 June 2017	Revision to make editorial improvement.

Version	*Date*	*Description*
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • 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: • 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: • 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.

Version	*Date*	*Description*

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document