Project design document form
(Version 11.0)

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

BASIC INFORMATION	
Title of the project activity	Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	Version 15.2
Completion date of the PDD	21/02/2021
Project participants	Hanwha Corporation (HWC)
Host Party	Republic of Korea
Applied methodologies and standardized baselines	ACM0019 (N2O abatement from nitric acid production,Version 4.0)
Sectoral scopes	Chemical industries (5)
Estimated amount of annual average GHG emission reductions	206,422tCO_2e/yr

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

The proposed project, Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant (hereafter, “the Project”), is developed by Hanwha Corporation (hereinafter “HWC”).
The purpose of the proposed project (Catalytic N_2O Abatement Project) activity is to reduce the current emissions of nitrous oxide (hereafter, “N_2O”) in the tail gas at nitric acid production process by installation of a N_2O decomposition (hereafter, “DeN_2O”) catalyst in Onsan Nitric Acid Plant of the HWC in Ulsan, Republic of Korea.

HWC mainly produces explosives and nitric acid. HWC had operated from 1991 in Incheon city, but moved to Ulsan city in 2004. And its commercial production was restarted on January in 2005. The amount of nitric acid production was 85,300 ton/yr based on 100% nitric acid in 2005 and will be planned 85,300–89,000ton based on 100% nitric acid in 2006. And the amount of nitric acid production will be planned 90,000–95,000 tonnes of 100% nitric acid in 2007. (Production design capacity for100% nitric acid: 107,100ton/yr).

N_2O is a by-product from the nitric acid (HNO_3) production which is formed in undesirable side reactions inside the ammonia burner. In order to produce nitric acid, ammonia (NH_3) is oxidized into nitric oxide (hereafter, “NO”)—desired product[1]—with air on precious metal catalyst gauzes (usually platinum-rhodium alloys) in the ammonia burner of the nitric acid plants. Through this process, some amount of undesired molecular nitrogen(N_2) and N_2O are formed as the gauzes' selective capability drop over time. N_2O produced in the reactor pass as an inert gas through the entire process and is typically released into the atmosphere since it does not have any economic value or toxicity at typical emission levels. N_2O is an important greenhouse gas which has a high global warming potential (hereafter, “GWP”) of 265.

From the nitric acid plant, N_2O, which is an undesired by-product of the nitric acid production process, is released into the atmosphere. HWC has one production line. The aim of the project activity is to reduce N_2O emissions by installation of DeN_2O Unit before the Stack, which is called Tertiary Catalyst System or Tail Gas System.

Selective Catalytic Reduction (hereafter, “SCR”) technology has been used to reduce Nitrogen Oxides(hereafter, “NOx”) concentration in the effluent gas to atmosphere. This technology is continued to be used, because of effluent gas compliance with local environmental regulations.

On the other hand, N_2O is not a toxic substance and is not regulated in Republic of Korea. Therefore, it has been released to atmosphere without any recovery or any specific treatment at the targeted facility of the HWC. HWC has no plan to implement N_2O abatement under such situation if the proposed project would not be implemented as Clean Development Mechanism(hereafter, “CDM”). There is no economic incentive to recover and utilize or sell N_2O as a product, technically and economically, except for Certified Emission Reductions(hereafter, “CERs”).

In addition, the tertiary N_2O destruction project will not result in HNO_3 production increase.
Therefore, without CERs, HWC will not be able to have an incentive to reduce N_2O emissions (i.e., will continue the current practice).

Based on monitoring data over the 2nd crediting period (27/06/2014~31/12/2019), around 38,014Nm^3/hr flue gas from production process is emitted. The project is to introduce catalytic

---

[1] At later stage, NO will be oxidized into NO_2 which absorbed in water to form acid (HNO_3).

DeN_2O equipment at the tail point before release to the atmosphere. The technologies are provided ECOPRO.
It is expected that the equipment can decompose more than 90% of the N_2O, which would be emitted otherwise.[2]

In addition to reduce N_2O emissions, the project transfers a clean technology which is not yet widely commercialized even in industrialized countries. It also includes the training course for operation of the DeN_2O equipment and also for accurate monitoring. The local employment will be created through the direct/indirect economic effects through the project activity.

A.2. Location of project activity

>>

(a) Host Party; Republic of Korea

(b) Region/state/province, etc.; Ulsan city

(c) City/town/community, etc.; 32, Sannam-gil, Onsan-eup, Ulju-gun
(As of January 1, 2014, Korea has officially changed the address naming system. The actual plant location has not changed and the above address indicates the same location as the previous one.)

(d) Physical/geographical location.
Onsan district is in the southern part of Ulsan city and is industrial Area.
Hanwha Onsan plant is located on Onsan Industrial Area, the physical/geographical location of the Onsan plant site is:
- 32, Sannam-gil, Onsan-eup, Ulju-gun, Ulsan city
- The latitude of 35.4139980°N and the longitude of 129.3392106°E

Figure 1. Location of Ulsan, Republic of Korea

[2] The reduced amount of N_2O is to be measured ex post as the methodology specifies

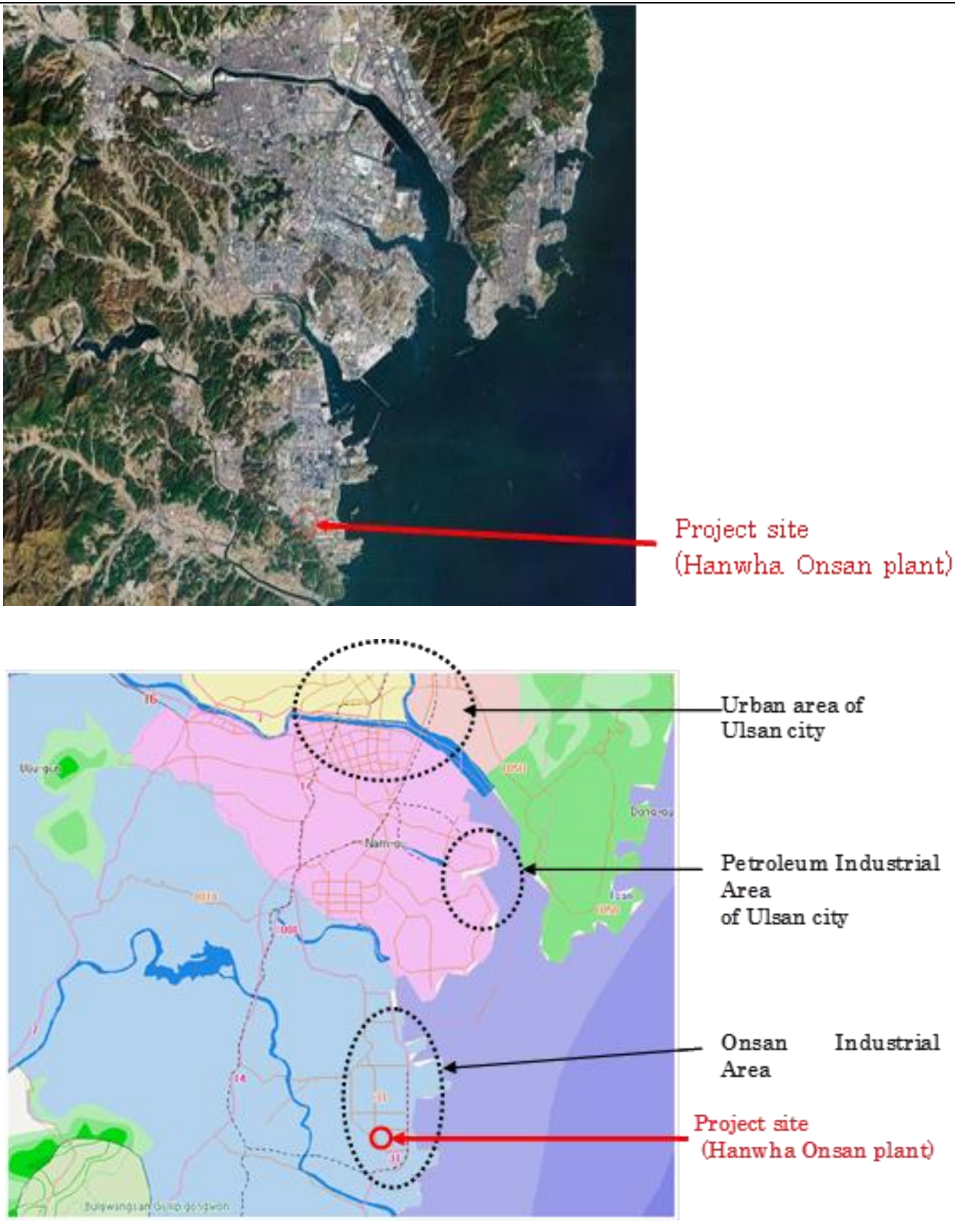


Figure 2. Location of Ulsan Nitric Acid plant of HWC (Ulsan, Republic of Korea)

A.3. Technologies/measures

>>

<u>Technologies</u>

HWC mainly produces chemical products such as explosive and nitric acid.
Ammonia is an important raw material for the production of the nitric acid.

Figure 3. Nitric Acid Plant of HWC

In the production process of nitric acid (HNO_3), NO is produced as an intermediate material from ammonia (NH_3). The associated chemical reactions of oxidizing ammonia and simultaneous unwanted reactions are as follows:

NH_3	+	$2O_2$	→	HNO_3	+	H_2O	(overall desired reaction)
$4NH_3$	+	$5O_2$	→	$4NO$	+	$6H_2O$	(desired in the NH_3 oxidization process)
$2NO$	+	O_2	→	$2NO_2$			(desired in the NO oxidization process)
$3NO_2$	+	H_2O	→	$2HNO_3$	+	NO	(desired in the NO_2 absorption process)
$4NH_3$	+	$3O_2$	→	$2N_2$	+	$6H_2O$	(undesired)
$4NH_3$	+	$4O_2$	→	$2N_2O$	+	$6H_2O$	(undesired)
$2NH_3$	+	$8NO$	→	$5N_2O$	+	$3H_2O$	(undesired)

Through the sixth and seventh reactions, some amount of N_2O is generated in the process.

When leaving the Ammonia Oxidation Reactor (hereinafter “AOR") there is no relevant loss of N_2O in the tail gas section unless an N_2O destruction facility is installed. Under no regulatory as well as no economically attractive condition, as in the case of Republic of Korea, the N_2O is released to the atmosphere as a part of exhaust gas.

The N_2O abatement technology is to introduce catalytic decomposition equipment at the tail gas downstream after the HNO_3 absorber and before the stack (tertiary method).[3] N_2O is decomposed as:

[3] There are three group of methods to reduce N_2O emissions from HNO_3 production process:

- Primary method: N_2O is prevented from forming. This requires modifications to the precious metal ammonia oxidation gauzes or utilization of another ammonia oxidization catalyst to reduce N_2O formation.

$$N_2O + 2NH_3 + O_2 \rightarrow 2N_2 + 3H_2O$$

$$3N_2O + 2NH_3 \rightarrow 4N_2 + 3H_2O$$

through the process.

In the tertiary abatement system N_2O is removed by catalytic reduction with ammonia. With SCR, ammonia is injected into the flue gas and reacts catalytically with NOx to produce molecular nitrogen and water vapor.

The tertiary method applied by the project is similar to the well-established catalytic NO_X reduction processes as an end-of-pipe technology. There is no interference with the HNO_3 production process.[4]

Under the project scenario, N_2O is removed from the tail gas downstream of the absorption tower by catalytic destruction. In general, the optimum position for a tertiary N_2O destruction facility is at the hottest position in the tail gas stream.

Before this registered project changed in the 2nd crediting period, the tertiary abatement facility had located between the heat exchanger and the tail gas turbine, which was the position with the highest tail gas temperature in the nitric acid production process. The high temperature at the stage permits very high rates of N_2O destruction. The tertiary abatement facility contains a catalyst through which the tail gas flows.

After post-registration change, the location for DeN_2O unit is switched in the hottest position in the tail gas steam and the applied catalyst was changed.

The tertiary abatement process used in the 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). Catalytic decomposition of N_2O occurs when the N_2O is split into its constituent elements by contact with a catalyst. A catalyst is a material which accelerates the speed of the reaction without itself being transformed or consumed by the reaction.

Additional to the decomposition of N_2O, emissions of NO_X are reduced, supported by feeding-in small amounts of ammonia (NH_3) vapour into the 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 applied technology provided by ECOPRO is chosen because it has almost no risks to decrease HNO_3 production as well as the operation of the equipment, higher N_2O decomposition rate, and total cost is lower than other technologies.

By introducing this technology, HWC obtains a clean technology which is not yet widely commercialized even in industrialized countries.

The DeN_2O equipment does not affect NO_X emissions.

- Secondary method: N_2O, once formed, is removed anywhere between the outlet of the ammonia oxidation gauzes and the inlet of the absorption tower.
- Tertiary method: N_2O is removed from the tail gas downstream of the absorption tower by catalytic destruction (either by catalytic decomposition or by catalytic reduction).

[4] The tertiary N_2O destruction technology will not result in HNO_3production increase. It means that there are no financial incentives for the implementation of the project activity.

It also includes the training course for operation of the DeN_2O equipment to ensure the proper handling of both, the N_2O abatement catalyst as well as the continuous and accurate N_2O monitoring system.
In addition, local engineering companies will enjoy job-creation benefits especially during engineering design, manufacturing of equipment parts and installation of equipment and catalyst.

Description of how services provided by the project would have been provided in baseline

According to the applied methodology ACM0019 "N_2O abatement from nitric acid production" (version 4.0) 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.

Since no laws or regulations exist at present, which mandate the complete or partial destruction of N_2O from nitric plant plants in the Republic of Korea, HWC has no economic incentives as mentioned just before. Hence, the baseline scenario is that the N_2O is emitted to the atmosphere with no N_2O abatement measure.

In the baseline scenario no N_2O emissions would have been reduced at nitric plant of HWC and all N_2O would have been emitted to the atmosphere as there is no economic incentive to prevent its release.

Facilities, systems, equipment in operation prior to implementation of project activity

The nitric acid plant started commercial operation before the implementation of the CDM project activity, and there was no tertiary N_2O abatement technology installed in the respective nitric acid plant.

This is not applicable since there was no equipment of the tertiary N_2O abatement in operation prior to implementation of the project.

List of facilities, systems, equipment in project scenario

As shown in section B.4 the baseline scenario was and continues to be the scenario existing prior to the implementation of the project.

The project activity introduces a tertiary N_2O abatement facility, physically located in the tail gas stream of the nitric acid plant. It is expected that the tertiary abatement facility will destroy N_2O emissions to a high extent. The remaining N_2O which is not destroyed and still present after the abatement facility is measured by the Automated Measuring Systems (hereafter "AMS") downstream of the tertiary abatement measure and is considered as project emissions.

As the tertiary N_2O abatement facility is operated without the use of fossil fuels, the only emissions to be considered in the project scenario is the N_2O not destroyed by the tertiary N_2O abatement facility.

Description of how technology, measures, know-how were transferred to host country

The installation of the decomposition technology enables economic and technical benefits to the host country by providing direct and in-direct employment and transfer of thermal decomposition technology within the Republic of Korea.

In order to monitor the N_2O reduction, the AMS, including non-dispersion infrared absorption analyzer (hereafter "NDIR") was installed, which is applicable to European standards and norms (EN 14181) or equivalent standards.

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)	Hanwha Corporation (HWC) [owner and operator of the nitric acid plant]	No

A.5. Public funding of project activity

>>

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

A.6. History of project activity

>>

The Project Participants confirm:
(a) The CDM project activity is already registered as a CDM project activity and with this Project Design Document (hereafter "PDD") version a request for renewal of crediting period is submitted;
(b) The CDM project activity is not a project activity that has been deregistered.

The Project Participants declare:
(a) The CDM project activity was not a Component Project Activities (hereafter "CPA") that has been excluded from a registered CDM Programme of Activities (hereafter "PoA");
(b) No other registered CDM project activity or a CPA under a registered CDM PoA exists in the same geographical location as the CDM project activity.

Summary of post-registration change throughout the 2nd crediting period

1) **(correction, The accuracy level of NDIR)** The information on 'the measurement method and procedure' of '$V_{i,t,db}$' in the monitoring plan has been corrected.
2) **(Permanent changes from registered monitoring plan)** In the process of the maintenance during the overhaul period, HWC has conducted overall works for the efficiency improvement of the process in the plant. Thus, HWC had decided to replace the DeN_2O unit resulting from the removal efficiency improvement. With this, the location for DeN_2O unit is switched in the hottest position in the tail gas steam and the applied catalyst was changed. This change does not impact the production design capacity of the registered project and do not adversely impact the application of the methodology and the scale of the project activity.
3) **(Permanent changes from registered monitoring plan, Deletion of parameters as per the fossil fuels used for operation of a DeN_2O unit)** According to switching location of DeN_2O unit, the LNG (which is fossil fuel) consuming equipment for maintaining optimal temperature of DeN_2O units will be removed in this project and the existing parameters related with the project emission by fossil fuel does not need to be monitored. Thus, these parameters are deleted in the monitoring plan.
4) **(Permanent changes from registered monitoring plan, Change of 'source of data' in the parameters)** The HNO_3 production on the ERP report does not reflect the actual amount of HNO_3 production due to adjustment done in the report for the internal purpose of sales and stock control. Thus, HWC has changed the data source of $P_{production,y}$ to the magnetic flow meter instead of ERP.
5) **(Permanent changes from registered monitoring plan, Installation of new flow meter with QAL1[5] to the provision of EN14181[6])** New flowmeter with QAL1 has installed for

[5] Quality Assurance Level 1, Make sure suitable monitoring instrumentation is used.

complying with EN14181 in accordance with approved methodology ACM0019 for renewal of 2nd crediting period.

6) **(Permanent changes from registered monitoring plan, clarify monitoring method of the produced HNO3 concentration)** To determine HNO3 concentration, specific gravity method is applied with daily measured specific gravity and temperature.

A.7. Debundling

>>

Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>>

<u>Applicable baseline and monitoring methodology</u>

• ACM0019 “N_2O abatement from nitric acid production” (version 4.0)[7].

<u>Methodological tools referred to in ACM0019 as applied in this PDD:</u>

• TOOL08 “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)[8]

• TOOL03 “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (version 03.0)[9]

- Due to the fact, that no fossil fuels are used for the operation of the N_2O abatement facility in the project activity, this tool is not applicable to the project activity.

No standardized baselines are used according to the applied methodology.

B.2. Applicability of methodologies and standardized baselines

>>

The chosen baseline methodology ACM0019 is applicable to projects in which tertiary N_2O abatement technology is installed in the tail gas leaving the absorption column in the nitric acid plant. This corresponds with the proposed project activity.

The applicability criteria of the chosen methodology are met by the project:

[6] EN 14181 (Quality Assurance of Automated Testing Systems) is a European standard that covers approval, calibration, testing and performance of automated measuring systems (AMS), also commonly known as continuous emissions measuring systems (CEMs).

[7] https://cdm.unfccc.int/methodologies/PAmethodologies/approved

[8] https://cdm.unfccc.int/Reference/tools/index.html

[9] https://cdm.unfccc.int/Reference/tools/index.html

No	Applicability condition	Condition fulfilled?	Justification
1	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 N_2O abatement technology installed in the respective nitric acid plant.	Yes	The project activity introduces N_2O abatement measures in a nitric acid plant. The project activity destroys N_2O emissions by the reduction of N_2O in the tail gas stream of the nitric acid plant. Since the start of the commercial operation, no secondary or tertiary abatement technology was installed in HWC´s nitric acid plant prior to the implementation of the CDM project in 2007 (first crediting period). Evidence for this was demonstrated during first crediting period.
2	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.	Yes	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 complete AMS was installed in the plant prior to the beginning of the first crediting period of the project activity.
3	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.	Yes	At present, laws and/or regulations, which would mandate the complete or partial destruction of N_2O from nitric acid plants, do not exist in the host country, the Republic of Korea.

In addition, the following applicability condition included in TOOL08 applies and is met:
• Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions.

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

No standardized baselines are used according to the applied methodology.

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

>>

Flow diagram

The only baseline emissions considered are the N_2O emissions formed in the AO R, a part of the nitric acid plant.
The project activity introduces a tertiary N_2O abatement facility, physically located in the tail gas stream of the nitric acid plant (after the absorption tower). It is expected that the tertiary abatement

measure will destroy N_2O emissions to a high extent. The remaining N_2O which is not destroyed and still present downstream of the abatement facility is measured by the AMS and considered as project emissions. Fossil fuels are not required and used for the operation of the N_2O abatement facility in the project activity, hence emissions from this source are considered to be zero.

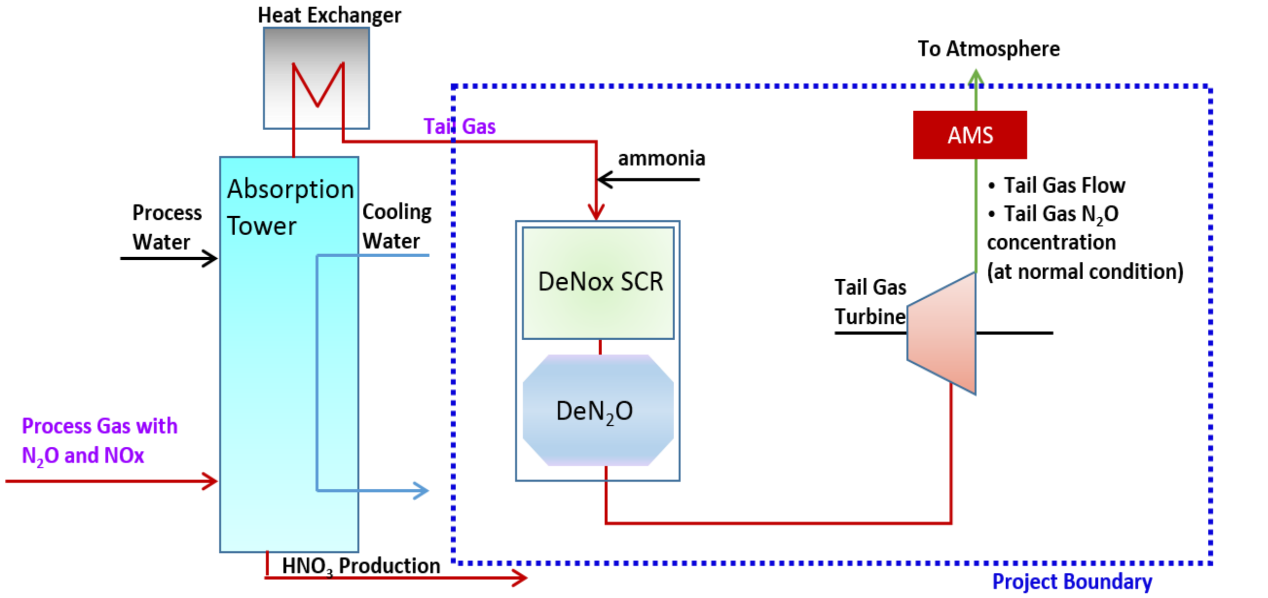


Figure 1. Configuration of the N_2O abatement system and tail gas flow

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

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	NH3 oxidation at the primary catalyst gauze	CO_2	NO	The project activity has no influence on these types of emissions, if present
		CH_4	NO	
		N_2O	Yes	Included, main emission source
Project scenario	NH3 oxidation at the primary catalyst gauze	CO_2	NO	The project activity has no influence on these types of emissions, if present
		CH_4	NO	
		N_2O	Yes	Included, main emission source
	Operation of a tertiary N_2O Abatement facility	CO_2	NO	No fossil fuels are used as reducing agent and/or for decomposing the tail gas as part of a tertiary N_2O abatement facility. CO_2 emissions arising from the production of ammonia are assumed to be small and **not** taken into account. Therefore, this source is not included in the project Boundary.
		CH_4	NO	
		N_2O	Yes	Included

B.4. Establishment and description of baseline scenario

>>

At present, laws and/or regulations, which would mandate the complete or partial destruction of N_2O from nitric acid plants, **do not exist** in the host country, the Republic of Korea. Applicable legislation on air pollutants in the Republic of Korea (i.e. the “Clean Air Conservation Act”) does not include any limitation on the emission of N_2O at all.

Any direct or indirect legal regulations in the Republic of Korea do not lead to any obligation or economic benefit that would require and/or favour the implementation of an N_2O abatement measure in the nitric acid plant of HWC.

Hence, in accordance with the applied methodology, the proposed 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

>>

According to the applied methodology ACM0019 version 4.0 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 plant has no economic incentives to take any N_2O abatement measures.

As clearly demonstrated in section B.4, at present laws and/or regulations, which would mandate the complete or partial destruction of N_2O from nitric acid plants, do not exist in the host country, the Republic of Korea. No economic benefit related to the abatement of N_2O emissions from the nitric acid plant could be generated based on any regulations.

Hence, in accordance with the applied methodology, the proposed CDM project is considered additional.

HWC has no economic incentives to implement any N_2O abatement measures in its nitric acid plant in the absence of such regulations, as this would entail capital and operating costs, but no financial benefits.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

>>

Baseline Emission for “case 1; for nitric acid plants that have used AM0028 or AM0034 in the first crediting period” shall be adopted.

AM0028 methodology has been applied for the proposed project of HWC nitric acid plants in the first crediting period and used ACM0019 v.2.0 (substituting the methodologies AM0028 and AM0034 for their use in N_2O reduction projects in for nitric acid plants) in the second crediting period.

Now, the methodology ACM0019 v.4.0 shall be applied for the third crediting period of the CDM project and the baseline emissions are calculated as follows:

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

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 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: For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

<u>Determination of the baseline N_2O emission factor for nitric acid plants that have used AM0028 in the first crediting period ($EF_{exisitng,y}$) will be calculated as follows:</u>

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

Where:

$EF_{existing,y}$	=	N_2O emission factor for nitric acid plants that have used AM0028 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)

Since the project activity used AM0028 in its 1st crediting period, Case 1 applies and Case 2 has not to be considered.

<u>Calculation of $h_{r,y}$ for "case 1; for nitric acid plants that have used AM0028 or AM0034 in the first crediting period"</u>

According to the applied methodology, the abatement system is deemed to be bypassed, not working, underperform or failed in the hour h in year y if:

(3) $F_{N2O,tail\ gas,h} > EF_{existing,y} \times P_{NA,h}$

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 in the first crediting period in year y (kg N_2O/t HNO_3)
$F_{N2O,tail\ gas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)

Since the project activity used AM0028 in its 1st crediting period, Case 1 applies and Case 2 has not to be considered.

<u>Project Emission</u>

Project emissions include emissions of N_2O 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.

Basically, this applies to the project activity as a tertiary N_2O abatement facility will be installed, however, no fossil fuels are used for the operation of the N_2O abatement facility and therefore CO_2 emissions from this source are considered zero.

Project emissions are calculated as follows:

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

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)

1. 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:

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

Where:

$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year y (t CO_2e)
GWP_{N2O}	=	Global warming potential of N_2O valid for the commitment period
$F_{N2O,tail\ gas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: For tertiary N_2O abatement. The abatement system is by-passed, underperforming or failed

Determination of $F_{N2O,tail\ gas,h}$

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[10] 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;

---

[10] Quality Assurance Level 2, Making sure the instrumentation is calibrated and set-up correctly in accordance with relevant standards.

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

(e) In the case that the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream.

For measuring of $F_{N2O,tail\ gas,h,}$ this project meet the above conditions:

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** (measurement options for option A: volume flow of gaseous stream on dry basis, volumetric fraction on dry or wet basis) of the tool will be applied, 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 (Tt) is less than 60°C (333.15 K) at the flow measurement point

This project applied Option A since the measured moisture content of the gaseous stream was less than 0.05 kg H_2O/m^3 dry gas during the first crediting period.
The mass flow of greenhouse gas i ($F_{i,t}$) [11] is determined as follows:

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

with

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

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^3dry 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)

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

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

According to the applied methodology the amount of 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 Pt and Tt 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” (see above) the N_2O density in the gaseous stream at normal conditions was determined to be 1.964 kg/m³ (P_t = 101,325 Pa; T_t = 273.15 K).

2. 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.

Basically, this applies to the project activity as a tertiary N_2O abatement facility will be installed, however, no fossil fuels are used for the operation of the N_2O abatement facility and therefore CO_2 emissions from this source are considered zero. Hence, instead of using the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”, the respective methodological parameter ($PE_{CO2,tertiary,n}$) is set to zero.

(8) $PE_{CO2,tertiary,y} = PE_{FF,y} = 0$

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)

Leakage

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

Emission Reduction

Emission reductions are calculated as follows:

(9) $ER_y = BE_y - PE_y$

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)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	Operating pressure
Data unit	KPa
Description	Operating pressure of the ammonia burner
Source of data	Manufacturer specifications
Value(s) applied	-
Choice of data or measurement methods and procedures	The parameter is used to determine whether the nitric acid plant operates at a low, medium or high pressure. According to the operating pressure of the ammonia burner in first and second crediting period, high pressure's default N_2O baseline emission factor is used for this project.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$EF_{historical}$
Data unit	kg N_2O/t HNO_3
Description	Historical baseline emission factor of the nitric acid plant
Source of data	Historical information from issuance reports of CDM-PDD documents
Value(s) applied	9.47
Choice of data or measurement methods and procedures	For plants that used AM0028 in the first crediting period: use the lowest baseline emission factor obtained in one calendar year, from 1 January to 31 December, obtained during the first crediting period;HWC plant used AM0028 in the first crediting period accordingly the lowest baseline emission factor obtained during the first crediting period is used. Calculation of $EF_{historical}$ is based on actual data of overall historical baseline emission factor obtained from 01/01/2008 to 31/12/2012 of the nitric acid plant of the first crediting period from issuance reports of CDM-PDD.
Purpose of data	Calculation of baseline emissions
Additional comment	This value will remain constant over the second and third crediting period

Data/Parameter	$EF_{default,y}$
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)

<table>
<tr><td>Source of data</td><td>This default N_2O baseline emission factor will vary every year. In the year 2021 the emission factors will be 11 kg N_2O/t HNO_3 for high-pressure ammonia burners. For each subsequent year, the emission factors will decrease by 0.2 kg N_2O/t HNO_3 until they reach a value of 9.6. 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>2021</td><td>3.9</td><td>6.8</td><td>11</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</td><td>10.2</td></tr>
<tr><td>2026</td><td>2.9</td><td>5.8</td><td>10</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>
</table></td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Year</th><th>High pressure (Over 600 kPa)</th></tr>
<tr><td>2021</td><td>11</td></tr>
<tr><td>2022</td><td>10.8</td></tr>
<tr><td>2023</td><td>10.6</td></tr>
<tr><td>2024</td><td>10.4</td></tr>
<tr><td>2025</td><td>10.2</td></tr>
<tr><td>2026</td><td>10</td></tr>
<tr><td>2027</td><td>9.8</td></tr>
<tr><td>2028</td><td>9.6</td></tr>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>According to the operating pressure of the ammonia burner over the 2nd crediting period specified in the submitted monitoring report (27/06/2014~ 31/12/2019), high pressure's default N2O baseline emission factor is used for this project.</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	**$EF_{new,y}$**
Data unit	kg N_2O/t HNO_3
Description	Baseline N_2O emission factor for nitric acid production in year y (related to 100 per cent pure acid)

Source of data	The baseline N_2O emission factor for nitric acid production will remain constant every year over this 3rd crediting period. - 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, as provided in the following table: <table><tr><th>Year</th><th>Emission factor (kgN2O/t HNO_3)</th></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>Yean n</td><td>2.50</td></tr></table>
Value(s) applied	<table><tr><th>Year</th><th>Emission factor (kgN_2O/t HNO_3)</th></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>2024</td><td>2.50</td></tr><tr><td>2025</td><td>2.50</td></tr><tr><td>2026</td><td>2.50</td></tr><tr><td>2027</td><td>2.50</td></tr><tr><td>2028</td><td>2.50</td></tr></table>
Choice of data or measurement methods and procedures	-
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	**$P_{product,max}$**
Data unit	t Product
Description	Design capacity of nitric acid production during the first crediting period
Source of data	Project operator
Value(s) applied	107,100 (tHNO_3/yr)
Choice of data or measurement methods and procedures	Specified in the methodology. HWC has experienced maximum daily production 306 ton/day and maximum operating days 350day. Therefore, yearly maximum is as follows; 306 (HNO_3/day) × 350(day/yr) Corresponding values given in the first crediting period by project operator, design capacity of nitric production apply over second and third crediting period.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is only for project activities applying case 1

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

Source of data	Relevant decisions by the CMP
Value(s) applied	265
Choice of data or measurement methods and procedures	The Executive Board of the clean development mechanism (the Board), at its 108th meeting, agreed on temporary measures, pending guidance from the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) at its sixteenth session. In this context, the Board agreed to inform project participants and coordinating/managing entities that, they shall apply as global warming potential (GWP) values, the lowest value from the Intergovernmental Panel on Climate Change (IPCC) assessment reports for each greenhouse gas (GHG) for a 100-year time horizon. As per the IPCC fifth assessment report (AR5), the GWP of N_2O is defined after 1 January 2021 under the temporary measures as 265 tCO_2/tN_2O.
Purpose of data	Calculation of baseline and project emissions
Additional comment	This GWP value is agreed on temporary measures in CDM EB 108th meeting.

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

Data/Parameter	R_u
Data unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	8,314
Choice of data or measurement methods and procedures	Specified in tool
Purpose of data	Calculation of project emissions
Additional comment	-

Data/Parameter	MM_i
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr><tr><td>Nitrous oxide</td><td>N₂O</td><td>44.02</td></tr></table>
Choice of data or measurement methods and procedures	Specified in tool
Purpose of data	Calculation of project emissions
Additional comment	-

Data/Parameter	**P_n**
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	101,325Pa
Choice of data or measurement methods and procedures	Flow of the gaseous stream is expressed in normalized cubic meters.
Purpose of data	Calculation of project emissions
Additional comment	This parameter is 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
Value(s) applied	273.15 K
Choice of data or measurement methods and procedures	Flow of the gaseous stream is expressed in normalized cubic meters.
Purpose of data	Calculation of project emissions
Additional comment	This parameter is used to determine the mass flow of the N_2O in the tail gas.

B.6.3. Ex ante calculation of emission reductions

>>

<u>Baseline Emission</u>

Since the CDM project activity used AM0028 in the first crediting period, Case 1 was applied and therefore baseline emissions are given by the following equation:

Baseline emissions are calculated as follows:

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

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 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: For tertiary N_2O abatement: the abatement system is by-passed, underperforming or failed

Year		BE_y	Min $\{P_{production,y};P_{product,max}\}$		$\min\{EF_{existing,y}\}$		h_y	$h_{r,y}$
			$P_{production,y}$	$P_{product,max}$	$EF_{historical,y}$	$EF_{default,y}$		
		tCO_2e	t HNO_3		kg N_2O/t HNO_3		h	
Year 1	27/06/2021~ 31/12/2021	117,987	48,834	55,164	9.47	11.00	4,099	154
Year 2	2022	229,070	94,810	107,100	9.47	10.80	7,958	300
Year 3	2023	229,070	94,810	107,100	9.47	10.60	7,958	300
Year 4	2024	229,070	94,810	107,100	9.47	10.40	7,958	300
Year 5	2025	229,070	94,810	107,100	9.47	10.20	7,958	300
Year 6	2026	229,070	94,810	107,100	9.47	10.00	7,958	300
Year 7	2027	229,070	94,810	107,100	9.47	9.80	7,958	300
Year 8	01/01/2028~ 26/06/2028	111,711	46,236	52,230	9.47	9.60	3,881	146
Total in t CO_2e		**1,604,117**						

Project Emission

Project emissions are calculated as follows:

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

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)

Year		PE_y	$PE_{N2O,y}$	$PE_{CO2,tertiary,y}$
		tCO_2e		
Year 1	27/06/2021~31/12/2021	11,707	11,707	0
Year 2	2022	22,729	22,729	0
Year 3	2023	22,729	22,729	0
Year 4	2024	22,729	22,729	0
Year 5	2025	22,729	22,729	0
Year 6	2026	22,729	22,729	0
Year 7	2027	22,729	22,729	0
Year 8	01/01/2028~26/06/2028	11,084	11,084	0
Total in t CO_2e		**159,166**		

1. 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:

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

Where:

$PE_{N2O,y}$	=	Project emissions of N_2O from the project plant in year y (t CO_2e)
GWP_{N2O}	=	Global warming potential of N_2O valid for the commitment period
$F_{N2O,tail\ gas,h}$	=	Mass flow of N_2O in the gaseous stream of the tail gas in the hour h (kg N_2O/h)
h_y	=	Number of hours in year y during which the plant was in operation (h)
$h_{r,y}$	=	Number of hours (h) in year y where: For tertiary N_2O abatement. The abatement system is by-passed, underperforming or failed

Year		$PE_{N2O,y}$	$F_{N2O,tail\ gas,h}$	GWP_{N2O}	h_y	$h_{r,y}$
		tCO_2e	kgN_2O/h	-	h	
Year 1	27/06/2021~31/12/2021	11,707	11.20	265	4,099	154
Year 2	2022	22,729	11.20	265	7,958	300
Year 3	2023	22,729	11.20	265	7,958	300
Year 4	2024	22,729	11.20	265	7,958	300
Year 5	2025	22,729	11.20	265	7,958	300
Year 6	2026	22,729	11.20	265	7,958	300
Year 7	2027	22,729	11.20	265	7,958	300
Year 8	01/01/2028~26/06/2028	11,084	11.20	265	3,881	146
Total in t CO_2e		**159,166**				

The mass flow of greenhouse gas i ($F_{i,t}$) [12]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^3dry 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) Total pressure at normal conditions (Pa) = 101,325 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)

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

Temperature at normal conditions (K) = 273.15 K

Year		$F_{N2O,tail\ gas,h}$ ($F_{i,t}$)	$\rho_{i,t}$	$V_{,t,db}$	$V_{i,t,db}$
		kg gas/h	kg gas i/m³ gas i	m³dry gas/h	m³ gas i/m³ dry gas
Year 1	27/06/2021~31/12/2021	11.20	1.964	38,014	0.00015
Year 2	2022	11.20	1.964	38,014	0.00015
Year 3	2023	11.20	1.964	38,014	0.00015
Year 4	2024	11.20	1.964	38,014	0.00015
Year 5	2025	11.20	1.964	38,014	0.00015
Year 6	2026	11.20	1.964	38,014	0.00015
Year 7	2027	11.20	1.964	38,014	0.00015
Year 8	01/01/2028~26/06/2028	11.20	1.964	38,014	0.00015

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

Determination of project emissions from the operation of the tertiary N_2O abatement facility ($PE_{CO2,tertiary,n}$) is determined ex-ante as follows:
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:

$PE_{CO2,tertiary,y} = PE_{FF,y} = 0$

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)

As described in the above sections, no emissions from the operation of the tertiary N_2O abatement facility occur as no fossil fuels are used, hence emissions from this source are considered zero.

Leakage

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

Emission Reduction

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)

Year		ER_y	BE_y	PE_y
		tCO_2e		
Year 1	27/06/2021~31/12/2021	106,280	117,987	11,707
Year 2	2022	206,341	229,070	22,729
Year 3	2023	206,341	229,070	22,729
Year 4	2024	206,341	229,070	22,729
Year 5	2025	206,341	229,070	22,729
Year 6	2026	206,341	229,070	22,729
Year 7	2027	206,341	229,070	22,729
Year 8	01/01/2028~26/06/2028	100,626	111,711	11,084
Total in t CO_2e		**1,444,951**		

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

Year		Baseline emissions (t CO2e)	Project emissions (t CO2e)	Leakage (t CO2e)	Emission reductions (t CO2e)
Year 1	27/06/2021~31/12/2021	117,987	11,707	0	106,280
Year 2	2022	229,070	22,729	0	206,341
Year 3	2023	229,070	22,729	0	206,341
Year 4	2024	229,070	22,729	0	206,341
Year 5	2025	229,070	22,729	0	206,341
Year 6	2026	229,070	22,729	0	206,341
Year 7	2027	229,070	22,729	0	206,341
Year 8	01/01/2028~26/06/2028	111,711	11,084	0	100,626
Total		**1,604,117**	**159,166**	**0**	**1,444,951**
Total number of crediting years		**7 years**			
Annual average over the crediting period		**229,160**	**22,738**	**0**	**206,422**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	**$P_{production,y}$**
Data unit	t HNO_3
Description	Nitric acid produced in year y
Source of data	Nitric acid flow meter
Value(s) applied	94,810 (332 days×286 tonnes per day) t HNO_3 is the value based on the actual records specified in the submitted monitoring report over the 2nd crediting period (27/06/2014~ 31/12/2019).

Measurement methods and procedures	The nitric acid production (as 100% HNO_3) is calculated based on produced nitric acid flow and produced HNO_3 concentration. Produced nitric acid flow is continuously measured by a flow meter and automatically monitored. <Nitric acid flow> ● Instrument Type: Coriolis Mass Flow Measuring System ● Manufacture: EMERSON ● Model: CMF200L518N2BIEZZZ ● Accuracy class Mass flow liquids: 0.1 Nitric acid concentration is determined by specific gravity method based on measured values using specific gravity hydrometer and thermometer in HWC's laboratory. Although the calibration frequency of the specific gravity hydrometer is 36months, calibration is performed internally in a shorter period for accuracy. <Specific gravity> ● Instrument Type: Specific gravity hydrometer ● Accuracy: <+/-0.002kg/m^3 ● Calibration frequency: 36 months <Temperature> ● Instrument Type: Liquid-in-glass thermometer ● Accuracy: < +/-1℃ ● Calibration frequency: 12 months This parameter is calculated as follows: $P_{production,y} = \sum(Q_{HNO3,daily} * C_{HNO3,daily})$ Where: ● $Q_{HNO3,daily}$: Daily total mass flow of produced nitric acid monitored (not converted to 100% base) in monitoring period (ton/h) ● $C_{HNO3,daily}$: Daily concentration measurements of produced nitric acid (not pure) (%)
Monitoring frequency	Nitric acid flow -Measuring frequency: Continuously -Reading frequency: Continuously (1s) -Recording frequency: Continuously (Hourly) Nitric Acid specific gravity and temperature -Measuring frequency: daily -Reading frequency: daily -Recording frequency: daily
QA/QC procedures	Periodic calibration will be performed according to supplier's recommendations. Cross – check of production, marketing and stock change data. Calibration of specific gravity hydrometer and thermometer will be performed according to manufacturer's recommendations refer to national regulation. The quality assurance and quality control procedures, in terms of equipment operations and maintenance, have been incorporated in the ISO 9001:2015
Purpose of data	Calculation of baseline emissions
Additional comment	The data monitored and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs.

Data and parameters monitored for project emissions

Data/Parameter	**h_y**
Data unit	h
Description	Number of hours of operation in year y

Source of data	Measurements by the ammonia oxidation reactor will be chosen in order to determine whether or not the nitric acid plant is in operation. (The flow of NH3 to the ammonia oxidation reactor indicates the operational status.)
Value(s) applied	7,958 hours is the value based on the actual records specified in the submitted monitoring report over the 2nd crediting period (27/06/2014~ 31/12/2019). The data was based on normally operating condition assumption run nearly at the designed capacity.
Measurement methods and procedures	Number of operating hours obtained from plant operation records.
Monitoring frequency	Measuring frequency: Continuously Reading frequency: Continuously (1s) Recording frequency: Continuously (Hourly)
QA/QC procedures	Cross check against event log
Purpose of data	Calculation of baseline/project emissions
Additional comment	Records to be maintained during project's lifetime. The data monitored and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs.

Data/Parameter	**$h_{r,y}$**
Data unit	h
Description	Number of hours of operation in year y where: For tertiary N_2O abatement. The abatement system is by-passed, underperforming or failed
Source of data	Measurements by the ammonia oxidation reactor will be chosen in order to determine whether or not the nitric acid plant is in operation. (The flow of NH3 to the ammonia oxidation reactor indicates the operational status.)
Value(s) applied	300 hours is the value based on the actual records specified in the submitted monitoring report over the 2nd crediting period (27/06/2014~ 31/12/2019).
Measurement methods and procedures	Number of underperforming or failed hours obtained from plant operation records. HWC's nitric acid plant has used AM0028 in the first crediting period, accordingly the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if: $F_{N2O,tailgas,h} > EF_{existing,y} \times P_{NA,h}$ The parameters mentioned above will be determined and monitored as explained in the respective sections/tables of this PDD ($EF_{existing,y}$ is needs not to be monitored, since it´s fixed for the crediting period). The parameters mentioned above will be determined and monitored as explained in the respective sections of this monitoring report: ● $P_{NA,h}$ see parameter $P_{production,y}$ ● $F_{N2O,tail\ gas,h}$ see parameters $V_{t,db,n}$, $v_{i,t,db}$ and $C_{H2O,t,db,n}$ ● $EF_{existing,y}$ needs not to be monitored, since it´s fixed for the crediting period.
Monitoring frequency	Measuring frequency: Continuously Reading frequency: Continuously Recording frequency: Continuously (Hourly)
QA/QC procedures	Cross check against event log
Purpose of data	Calculation of baseline/project emissions

Additional comment	Records to be maintained during project's lifetime. The parameter $P_{NA,h}$ (Nitric acid produced in the hour h) represents the hourly value of $P_{production,y}$ and is used for determining $h_{r,y}$ as described in the applied methodology.The data monitored and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs.

<u>Parameters from the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0)</u>

Data/Parameter	**$V_{t,db}$**
Data unit	Nm^3dry gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Source of data	Flow meter
Value(s) applied	38,014 Nm^3dry gas/h is the value based on the actual records specified in the submitted monitoring report over the 2nd crediting period (27/06/2014~ 31/12/2019).
Measurement methods and procedures	Volumetric flow measurement will be converted to normal conditions during the monitoring process by the AMS. Instruments with recordable electronic signal will be used. ● Instrument Type : Volume flow measuring system - Measuring principle : Differential pressure - Manufacture : Durag - Model : D-FL 100 - Accuracy : < 2% of measuring range ● Instrument Type : Resistance Temperature Detector - Manufacture : WISE controls - Model : R221+ MTM - Accuracy class : ±0.3% ,of full scale ● Instrument Type : Absolute Pressure Transmitter - Manufacture : Honeywell - Model : STG 944-E1G-00000-S1 - Accuracy class : ±0.075% ,of full scale
Monitoring frequency	Measuring frequency: Continuously Reading frequency: Continuously Recording frequency: Continuously (Hourly)
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications. QA/QC for the flow meter shall be subjected to the EN14181.
Purpose of data	Calculation of project emissions
Additional comment	According to applied tool, parameter is to be monitored in Option A (which is the case for the project activity) The data monitored and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs.

Data/Parameter	**$V_{i,t,db}$**
Data unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Source of data	Non-dispersion infrared absorption analyzer (NDIR)

Value(s) applied	0.00015 The assumed values for ex-ante Emission Reductions calculations can be found in respective section B.6.3. Tail gas N_2O concentration based on DeN_2O equipment specs (conservative number). DeN_2O ratio: 90% (expected lowest value, Warranted value from performance specification, Abatement facility operation& maintenance agreement)
Measurement methods and procedures	Continuous gas analyser operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature ● Instrument Type: Non-dispersion infrared absorption analyzer. ● Manufacture: ABB ● Model: AO2040/Uras 26 ● Accuracy class: ● Zero Drift ≤ ± 1% of span, according to the supplier's specification The N_2O concentration is converted to normal conditions according to the applied methodology. Therefore, the respective parameters were determined at normal conditions (P_t = 101,325 Pa; T_t = 273.15 K).
Monitoring frequency	Continuously
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. 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. In case Non-dispersion infrared absorption analyzer is used, it shall be checked by sampling by gas chromatography periodically. QA/QC for the analyzer shall be subjected to the EN14181.
Purpose of data	Calculation of project emissions
Additional comment	According to applied tool, parameter is to be monitored in Option A (which is the case for the project activity). The data monitored and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs.

Data/Parameter	**$C_{H2O,t,db,n}$**
Data unit	mg H_2O/m^3 dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t
Source of data	Measurements according to the USEPA CF42 method 4 - Gravimetric determination of water content
Value(s) applied	Below 50,000
Measurement methods and procedures	Discrete measurement procedure
Monitoring frequency	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements should coincide with the Annual Surveillance Test (AST, 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 (United States Environmental Protection Agency) CF42 method 4
Purpose of data	Calculation of project emissions

Additional comment	Monitoring is required if Option 1 described in the "Determination of the absolute humidity of the gaseous stream" section of the tool is applied, or as one of the ways of proving that the gaseous stream is dry (necessary for Options A or D) The data monitored and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs.

B.7.2. Sampling plan

>>

Not applicable: methodology ACM0019 version 04.0.0 does not specify any requirement on sampling.

B.7.3. Other elements of monitoring plan

>>

Measurement equipment will be calibrated on regular intervals as recommended by the manufacturers. Additionally, selected staffs of HWC will participate in initial training and be trained to operate the DeN_2O system as well as the measurement system.

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 04.0.0) and of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0.0) and of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 03).

<u>Measurement of the N_2O concentration and the total gas volumetric flow</u>

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 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 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" (Version 02.0.0). In applying the tool, the following provisions apply:

- 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;
- 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 2 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;
- 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;

- 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;
- In the case that the N_2O concentration and the volume or mass flow of the tail gas and by-pass are automatically converted to normal conditions by the AMS during the monitoring process, the parameters P_t and T_t do not need to be monitored except, if applicable, for the purpose of determining the moisture content in the gaseous stream;

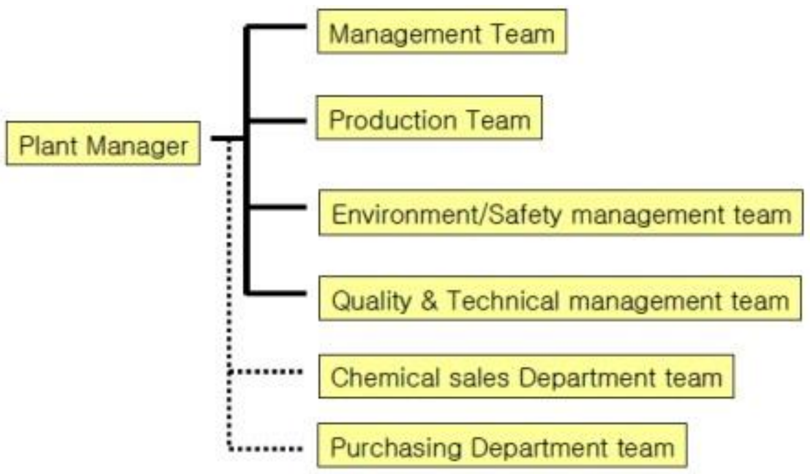
The European Norm EN 14181 stipulates three levels of quality assurance tests and one annual functional test for AMS, which are recommended to be used as guidance regarding the selection, installation and operation of the AMS under the applied monitoring methodology. The three quality assurance levels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

HWC has been operating the nitric acid plants since the commissioning of the plant and has sufficient and well-experienced staffs. HWC has been in production of the nitric acid for number of years and measurement of various production parameters including operation of analyzers which are managed by Production team. The monitoring of the N_2O for the project will be responsible by Production team and the operation and maintenance of the N_2O Monitoring system will incorporate the ISO 9001-2000 and EN 14181 standard procedures. The Monitoring of the relevant data will be done by the N_2O Monitoring system and recorded onto the electric media.

In case deviation in the Monitoring data is found, Production Team engineer will study the operating parameters of the nitric acid plant to identify the reason for the deviation and take remedial measures.
If there are no changes in the operating parameters of nitric acid plant, the Monitoring system will be examined. Once the default is identified, Quality & Technical Management team and Environment & Safety Management team will introduce a correction to the default. Production team engineer will report such irregular event to Plant Manager.

An illustrative scheme of the operational and management structure is as follows:



SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

01/07/2007

C.2. Expected operational lifetime of project activity

>>

25 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>

Renewable (Third crediting period)

C.3.2. Start date of crediting period

>>

27/06/2021

C.3.3. Duration of crediting period

>>

7 years, 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

Environmental Impacts :

- Gaseous matter : There is no additional pollution. The N_2O is destructed into harmless N_2 and O_2.
- Particular matter : There is no additional pollution.
- Waste water : Not applicable. The destruction reaction occurs in gaseous phase.
- Spent catalyst : The catalyst over its lifetime is recycled to get precious components and then reproduced to new catalyst. The catalyst has a long lifetime.

No trans boundary impacts are expected.

D.2. Environmental impact assessment

>>

Not applicable. The Environmental Impact Assessment (EIA) is not necessary for this project activity under the laws and regulations in the Republic of Korea as well as Ulsan City.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

A local stakeholder's meeting has been conducted by HWC on September 19, 2006 in Ulsan Lotte Hotel to collect stakeholders' comments on HWCCDM project (See Figure 6). 31persons including key stakeholders are invited, including Air Quality Management Division of Ulsan Metropolitan City Hall, Environment Management Division of Ulju Gun County Office, Local residents, Industrial neighbors, Professors, Onsan Industrial Complex Environment Management Association, Employee (HWC), Mitsubishi Corp etc.
Plant Manager, Mr. B.C. Song performed a welcome address to the stakeholders and Mr. C.C. Jeong introduced HWC.

Figure 2. Local stakeholder meeting

Mr. C.C. Jeong introduced the UNFCCC, CDM, nitric acid process, DeN_2O technologies, N_2O abatement project of Hanwha and resulting effects to the participants. At the same time, Mr. C.C. Jeong also welcomed comments and suggestions from all stakeholders. The participants expressed their strong interests and supports on the CDM project, and raised some questions about CDM and the project too.

Furthermore, in local stakeholder meeting, the opinions of attendants were collected in the form of questionnaires. (one person didn't return)

HWC released an announcement on HWC N_2O destruction CDM project at the "Kyungsang Daily Newspaper" and "Ulsan Daily Newspaper" on September 12, 2006 as the following:

E.2. Summary of comments received

>>

The questions raised by the stakeholders attending the meeting are briefly summarized as followings:

Question 1: In this Hanwha's CDM project, LNG seems to be consumed. LNG is another greenhouse gas. How is LNG consumption treated?

Question 2: By consuming the LNG, is there any additional NOx generation?

Then, table below shows of questionnaires:

Questions to the stakeholders	Yes	No
1. Have you ever heard of CDM (Clean Development Mechanism)?	25	5
2. Do you know that N_2O (nitrous oxide) is a greenhouse gas?	29	1
3. Do you or does your organization have a role in this project?	14	16
4. Do you think that Hanwha corporation explains this project in details?	29	0
5. Do you think that this project has more positive effect on the global environment as a whole?	30	0
6. Do you think that this project is able to contribute to improve the air quality of Ulsan Metropolitan City?	30	0
7. Do you or does your organization have a possibility to have a bad effect due to this project?	1	28
8. If you have any other opinion, please feel free to describe.	3	

Opinions regarding the question 8)

- It is requested that Korean company has more CERs than foreign company does.
- If the abatement project has to be implemented in some day, Hanwha had better start the project as soon as possible.
- Because this project is in the developing process, there is no real facilities and no emission reduction results. It is requested that the detail exercise will be re-presented after this project activity is effective.

E.3. Consideration of comments received

>>

On behalf of HWC Mr. C.C. Jeong answered the questions raised by the participants as detailed as possible, the answers are briefed as below:

Answer 1: LNG consumption rate is not so much. The annual CO_2 equivalent of LNG consumed will be only not more than 1,000 tonCO_2e. And the CO_2 equivalent due to LNG will be deducted from emission reductions. Moreover, the electricity due to the DeN_2O facilities will be also deducted. The monitoring and calculations will be strictly verified by DOE.

Answer 2: Hanwha adopted the catalytic N_2O destruction technology other than the thermal N_2O destruction technology. Because the temperature of the catalytic reaction is far lower than the thermal reaction, the additional NOx is unlikely to generate significantly. For your relief, Hanwha will also control the NOx emission under the national and local emission regulations by operating SCR adequately.

Then, the result of questionnaires is summarized as follows

The attendants were familiar with the greenhouse gases. Most of them knew the N_2O gas is a kind of greenhouse gas because of preceding N_2O and HFC abatement projects in the Ulsan City. The local stakeholders were interested in the local air quality, the global warming and furthermore the leakage from the project activity. They all agreed this project would improve the local air quality and suppress the global warming a little as a environmental benefit.
And there will be additional job opportunity created in the region during the engineering, production and installation of the abatement facilities as a social benefit.

SECTION F. Approval and authorization

>>

The project activity has received Host Country Approval from the host DNA (dated 06/02/2007), and it was submitted.
For the purpose of renewal of crediting period it is not necessary to obtain a new letter of approval from Parties involved.

Appendix 1. Contact information of project participants

Organization name	HANWHA Corporation
Country	Republic of Korea
Address	23F. Hanwha Bldg. 363, Samil-daero, Jung-gu, Seoul
Telephone	+82-2-729-1899
Fax	+82-2-729-1821
E-mail	woobj@hanwha.com
Website	http://www.hanwha.com/content/hanwha/en.html
Contact person	Mr. BomJe Woo,

Organization name	HANWHA Corporation
Country	Republic of Korea
Address	23F. Hanwha Bldg. 363, Samil-daero, Jung-gu, Seoul
Telephone	+82-2-729-1905
Fax	+82-2-729-1821
E-mail	youngbean@hanwha.com
Website	http://www.hanwha.com/content/hanwha/en.html
Contact person	Ms. YoungBean Koo

Appendix 2. Affirmation regarding public funding

No public funds are used for the financing of this project activity.

Appendix 3. Applicability of methodologies and standardized baselines

Please refer section B.

There is no further background information on applicability of selected methodology.

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

Please refer to attached excel file.

Appendix 5. Further background information on monitoring plan

Please refer to section B.7.3.
There is no further background information on monitoring plan.

Appendix 6. Summary report of comments received from local stakeholders

Please refer to section E.2.

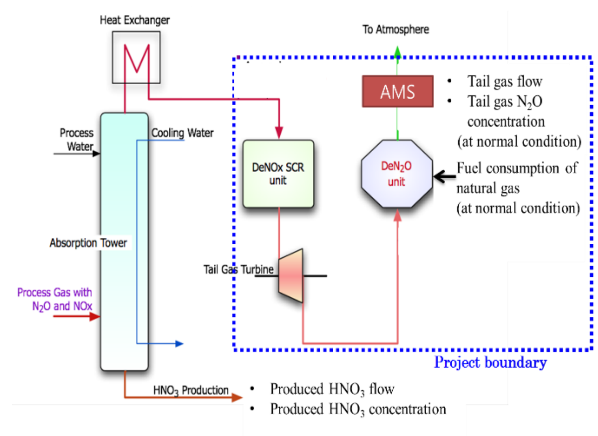
Appendix 7. Summary of post-registration changes

Below are changed after the registration.

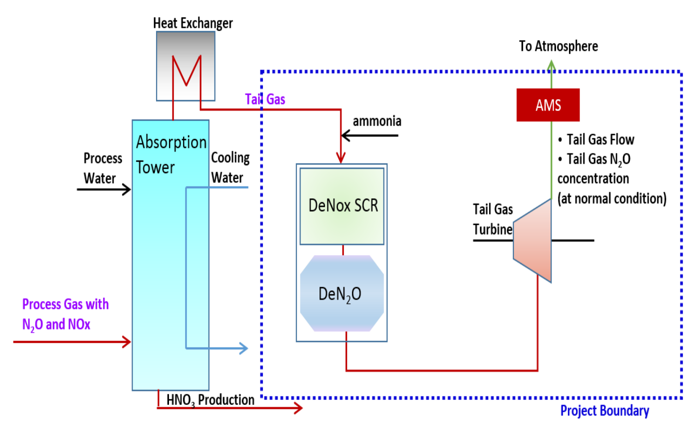
(1) Changes to the project design of a registered project activity: in SECTION A.

1) Switching location of the DeN_2O units

- For enhancing removal efficiency of N_2O reduction, the DeN_2O units will be changed its physical location in front of the tail gas turbine which was located in the tail gas stream of nitric acid plant.
- The boundary of the project still will be from the inlet of the Ammonia Oxidation Reactor to the outlet of the stack of the nitric acid plant.
- Fossil fuels are not required and used for the operation of the N_2O abatement facility in the project activity, hence emissions from this source are considered to be zero. Following diagram shows the state of equipment before and after PDD change.



<Before PRC>



<After PRC>

2) Change of the technical supplier of DeN_2O units

- The technologies are provided Sumiko Eco-Engineering (engineering) before conducting efficiency improvement of DeN_2O units.
- The applied technology provided by ECOPRO is chosen after conducting efficiency improvement of DeN_2O units because it has almost no risks to decrease HNO_3 production as well as the operation of the equipment, higher N_2O decomposition rate, and total cost is lower than other technologies.

(2) Permanent changes from registered monitoring plan, applied methodology: in SECTION B.

1) Source of data

- The data from the 'ERP(Enterprise Resource Planning)' is adopted for $P_{production,y}$, h_y, $h_{r,y}$.
- The HNO_3 production on the ERP report does not reflect the actual amount of HNO_3 production due to adjustment done in the report for the internal purpose of sales and stock control.
- Thus, the DCS is more accurate source because it can't control of raw data and it located at closer position from flow meter than ERP.

2) Amount of LNG Input for abatement facility; '0'

- LNG had been used for operating existing N_2O abatement facility. The project activity introduces a tertiary N_2O abatement facility, physically located in the tail gas stream of the nitric acid plant (after the absorption tower). Fossil fuels are not required and used for the operation of N_2O abatement as project emission, hence emissions from this source are considered to be zero.

3) Specification of the N_2O volume flowmeter
   - New flow meter with QAL 1 according to the provision of EN14181 is installed on 20 Sep, 2016.

(3) Contact information of project participants and responsible persons/entities: in Appendix 1. The information of project had been changed and thus, MoC was changed. The changed information is valid as of 05/04/2017.

Below post registration changes was occurred in 14 version of the PDD after the registration.

(1) Permanent changes from registered monitoring plan, applied methodology

1) Changes of the nitric acid flow meter

- In order to improve the measurement accuracy of the flow meter, new nitric acid flow meter was installed on 29 Jun. 2017 and same model flow meter was changed 5 Feb. 2018.

2) Measuring of the nitric acid concentration

- Mass of nitric acid is continuously measured by a flow meter. Production of nitric acid is calculated by multiplying nitric acid flow(ton/h) by nitric acid concentration. Nitric concentration is determined by daily laboratory analysis. In order to clarify the measurement method of parameter "$P_{production,y}$", a monitoring plan for nitric acid concentration measurement was added.

(2) Corrections

1) Parameter '$P_{production,y}$' of nitric acid produced in year y

- The '$P_{product}$,y' used to calculate baseline emissions has been corrected to '$P_{production,y}$' according to the methodology ACM0019.

No other post registration changes have been applied.

- - - - -

Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • 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.

Version	*Date*	*Description*
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.

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