




**Validation report form for renewal of crediting period for
CDM project activities
(Version 03.0)**

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

BASIC INFORMATION

Title and UNFCCC reference number of the project activity	Catalytic N ₂ O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea (0922)
Number and duration of the next crediting period	3 rd , 27/06/2021- 26/06/2028
Version number of the validation report	3.0
Completion date of the validation report	21/02/2021
Version number of PDD to which this report applies	Version 15.2
Project participants	Hanwha Corporation (HWC)
Host Party	Republic of Korea
Applied methodologies and standardized baselines	Applied methodology : ACM0019, N ₂ O abatement from nitric acid production (Version 4.0) Standardized baseline : N/A
Mandatory sectoral scopes	Sectoral Scope : 5 – Chemical Industries
Conditional sectoral scopes, if applicable	-
Estimated amount of annual average GHG emission reductions or GHG removals by sinks in the next crediting period	206,422 tCO ₂ e/yr
Name and UNFCCC reference number of the DOE	Korea Testing & Research Institute (KTR) / E-0056
Name, position and signature of the approver of the validation report	Jintae KIM, Director 

SECTION A. Executive summary

KTR has performed a validation of renewal of crediting period of the aforementioned CDM Project activity "Catalytic N₂O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea (0922)". The validation is based on the currently valid documentation of the United Nations Framework Convention on Climate Change (UNFCCC).

The validation process consists of three phases:

- Desk review of documents;
- Follow-up interviews with the relevant personnel;
- Resolution of outstanding issues and the issuance of final report and opinion.

The proposed project, Catalytic N₂O 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 activity is to reduce the emissions of nitrous oxide (N₂O) in the tail gas at nitric acid production process by installing a DeN₂O catalyst in Onsan Nitric Acid Plant of the HWC in Ulsan, Republic of Korea.

Nitrous oxide (N₂O) is a by-product from the nitric acid (HNO₃) production which is formed in undesirable side reactions inside the ammonia burner. In order to produce nitric acid, ammonia (NH₃) is oxidized into desired product NO 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 N₂ and N₂O are formed as the gauzes' selective capability drops over time. N₂O produced in the reactor passes 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. N₂O is an important greenhouse gas having high global warming potential (GWP) of 265

The N₂O of GWP value is agreed on temporary measures in CDM EB 108th meeting .

From the plant, nitrous oxide (N₂O), an undesired by-product from the nitric acid production process, is released into the atmosphere. HWC has one production line. The aim of the project activity is to reduce N₂O emissions by installing a DeN₂O Unit before the Stack, which is called Tertiary Catalyst System or Tail Gas System.

Selective Catalytic Reduction (hereinafter "SCR") technology has been used to reduce NO_x 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, N₂O 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 the HWC's Nitric Acid Plant concerned.

Applied baseline and monitoring methodology, and tools are ACM0019 "N₂O abatement from nitric acid production" (version 4.0), TOOL08, and TOOL03.

The third period will be started from 27/06/2021.

Two Clarification Requests (CLs), two Corrective Action Requests (CARs) were raised during the course of validation process of renewal of crediting period and has been successfully closed.

In accordance with the decision of temporary measures from EB 108th meeting, lowest GWP of N₂O has been applied in the revised PDD and the two FARs were raised accordingly.

The total emission reductions from the project are estimated to be 206,422 tCO₂e per year on average over the 3rd renewable crediting period.

The monitoring plan provides framework for the monitoring of the project's emission reductions.

The monitoring arrangements described in the monitoring plan are feasible within the project design. KTR is of opinion that the CDM project activity "Catalytic N₂O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea (0922)" meets all relevant UNFCCC requirements for the renewal of the crediting period. Hence KTR requests the renewal of the crediting period of the project.

SECTION B. Validation team, technical reviewer and approver**B.1. Validation team member**

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)	Involvement in			
						Desk/document review	On-site inspection	Interview(s)	Validation findings
1.	Team Leader (Under observation)	IR	CHOI	Jiseon	KTR	X	X	X	X
2	Lead Validator	IR	JUNG	Kyuhong	KTR	X	X	X	X
3.	Validator	EI	SHIN	Woochul	KTR	X	X	X	X

B.2. Technical reviewer and approver of the validation report for RCP

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)
1.	Technical reviewer	IR	KIM	Kyungmoon	KTR
2	Approver	IR	KIM	Jintae	KTR

SECTION C. Means of validation**C.1. Desk/document review**

The information presented in the PDD on the technical design has been assessed for accuracy and completeness using standard auditing techniques such as Document review and follow up actions, and review of reference materials.

Document review included review of data and cross checks between information in the PDD and information from other sources. If necessary, independent background investigations were performed. Follow up actions included interviews with relevant stakeholders and personnel knowledgeable about the project activity, and crosschecking of the information from different interviewees, in order to ensure accuracy and completeness of the information reviewed.

A complete list of all documents reviewed is attached as Appendix 3 to this report.

C.2. On-site inspection

Duration of on-site inspection: 01/07/2020 to 01/07/2020				
No.	Activity performed on-site	Site location	Date	Team member
1.	On-site visit to validate the PA description, baseline, equipment, implementation and monitoring. Monitoring plan updates, Document review and check of all supporting documentation, ER calculations and PDD review.	Onsan Nitric Acid Plant of the HWC	01/07/2020	· Jiseon CHOI · Kyuhong JUNG · Woochul SHIN
2	Validity of the original baseline impact of new relevant national and/or sectoral policies/ circumstances on the baseline, correctness of the application of the approved methodologies and tools assessment	Onsan Nitric Acid Plant of the HWC	01/07/2020	· Jiseon CHOI · Kyuhong JUNG · Woochul SHIN

C.3. Interviews

No.	Interviewee			Date	Subject	Team member
	Last name	First name	Affiliation			
1.	SONG	Byeongcheol	HWC	01/07/2020	1. Validity of the original baseline impact of new relevant national and/or sectoral policies and circumstances on the baseline, correctness of the application of the approved methodologies. 2. Monitoring plan updates, Maintenance of Monitoring equipment, Annual Surveillance Test (AST), Quality Assurance Level (QAL)	· Jiseon CHOI · Kyuhong JUNG · Woochul SHIN
2	KWEON	Youngbo	HWC	01/07/2020		
3	PARK	Heeyoung	HWC	01/07/2020		
4	JIN	Ahjin	HWC	01/07/2020		
5	KO	Kyeongmin	HWC	01/07/2020		
6	KIM	Sungeun	Innergen Consulting	01/07/2020	Document review and check of all supporting documentation, procedures of ER calculations and PDD review	· Jiseon CHOI · Kyuhong JUNG · Woochul SHIN
7	MOON	Seonyoung	Innergen Consulting	01/07/2020		

C.4. Sampling approach

Not applicable

C.5. Clarification requests (CLs), corrective action requests (CARs) and forward action requests (FARs) raised

Area of validation findings	No. of CL	No. of CAR	No. of FAR
Compliance with PDD form	0	0	0
Application and selection of methodologies and standardized baselines	0	0	0
Validity of original baseline or its update	1	1	1(FAR01)
Estimated emission reductions or net anthropogenic removals	0	0	0(FAR01)
Validity of monitoring plan	0	1	0
Crediting period	0	0	1(FAR02)
Project participants	1	0	0
Post-registration changes	0	0	0
Others (specify)	0	0	0
Total	2	2	2

SECTION D. Validation findings

D.1. Compliance with PDD form

Means of validation	The validation team has checked the final PDD form provided by the project participant (PP) against the latest version of the PDD form in order to determine, whether the PDD form is in compliance with it and confirms the following: a) The PP is mentioned in the relevant sections of the PDD in accordance with the relevant requirements in PS for PA version 02.0. b) The most recent version of the PDD form is used.
Findings	There are no CARs/CLs raised in this section.
Conclusion	The PDD is compliant with relevant form and guidance as provided by UNFCCC. Hence the validation team confirmed that the PP used a later valid version of the PDD form version 11.0 for the updated PDD than the version of the form of the registered PDD. The information transferred to the revised PDD is materially the same as that in the registered PDD.

D.2. Application and selection of methodologies and standardized baselines

Means of validation	DOE has verified whether the PP uses the valid version of the methodology applied in the registered PDD as per para. 279/ PS for PA version 02.0. The PP has applied the latest methodology version ACM0019 version 04.0 in the updated PDD, the latest version at the time of the submission of the request for renewal of crediting period.				
Findings	There are no CARs/CLs raised in this section.				
Conclusion	<p>The project activity applies one approved methodology: "ACM0019 version 04.0" In addition, relevant tool is applied: • TOOL08 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) However, TOOL03 version 03 is not applicable to the project during 3rd renewable crediting period. Details are given in Section D.4 of this report. The proposed project activity is to reduce N₂O emissions from the nitric acid plant by reducing N₂O in the tail gas steam. The project does not apply standardized baseline. Thus, the validation team checked the applicability of methodology (ACM0019 version 04.0) as follows:</p> <table border="1"> <tr> <th>Applicability Conditions</th><th>Validation opinion</th></tr> <tr> <td>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 N₂O abatement technology installed in the respective nitric acid plant.</td><td>The project activity introduces N₂O abatement measures in a nitric acid plant. The nitric acid plant operated before the implementation of the project activity had not installed any N₂O abatement technology. Since the start of the commercial operation, there was no secondary or tertiary abatement technology installed in the HWC's nitric acid plant prior to the</td></tr> </table>	Applicability Conditions	Validation opinion	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 ₂ O abatement technology installed in the respective nitric acid plant.	The project activity introduces N ₂ O abatement measures in a nitric acid plant. The nitric acid plant operated before the implementation of the project activity had not installed any N ₂ O abatement technology. Since the start of the commercial operation, there was no secondary or tertiary abatement technology installed in the HWC's nitric acid plant prior to the
Applicability Conditions	Validation opinion				
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 ₂ O abatement technology installed in the respective nitric acid plant.	The project activity introduces N ₂ O abatement measures in a nitric acid plant. The nitric acid plant operated before the implementation of the project activity had not installed any N ₂ O abatement technology. Since the start of the commercial operation, there was no secondary or tertiary abatement technology installed in the HWC's nitric acid plant prior to the				

		implementation of the CDM project in 2007 (first crediting period). This has been verified by reviewing the testing report of N ₂ O concentration in the tail gas of the nitric acid plant (dated on 22/02/2006) and previous validation report published by TÜV SÜD Industrie Service GmbH
	Continuous real-time measurements of the N ₂ O concentration and the total gas volume flow can be carried out in the tail gas stream after the abatement of N ₂ O emissions throughout the crediting period of the project activity.	The plant is equipped with a complete Automated Monitoring System (AMS) which enables the PP to continuously measure N ₂ O concentration and total gas volume flow in the stack during the plant's operation throughout the crediting period. The validation team confirmed it by reviewing the data from monitoring instructions and physical inspection during on-site visit
	No law or regulation which mandates the complete or partial destruction of N ₂ O from nitric acid plants exists in the host country where the CDM project activity is implemented.	By checking all the relevant currently effective national regulations or laws in the host country Korea, it was found that the host country does not apply any legal requirements to reduce N ₂ O emissions from nitric acid plants.
	Therefore, it is concluded that the approved baseline methodology ACM0019 version 04.0 is applicable to the project activity.	

D.3. Validity of original baseline or its update

Means of validation	Assessment of the validity of the original/current baseline and update of the baseline at the renewal crediting period is performed according to para. 283-286/ PS for PA version 02.0.
Findings	There are 1CL, 1CAR and 1FAR raised in this section.
Conclusion	<p>As per para. 283-286/ PS for PA version 02.0, the stepwise procedure to assess the validity of the original baseline or to update it for the project is as follows:</p> <p>Step 1: Assess the modalities to calculate GHG emission reductions or net anthropogenic GHG removals that would have resulted from that scenario to demonstrate the validity of the original baseline or its update.</p> <p>In accordance with para. 283 PS for PA version 02.0, PP is not required to reassess the baseline scenario. Instead, the PP shall assess the GHG emission reductions or net anthropogenic GHG removals that would have resulted from that scenario.</p> <p>As per para17/ ACM0019, in the absence of regulation of N₂O emissions, the operator of the nitric acid plant has no economic incentives to take any N₂O abatement measures because this entails capital and operating costs but no financial benefits. Therefore, proposed project is considered additional and the baseline scenario is that the N₂O is emitted to the atmosphere without any N₂O abatement measure being implemented.</p> <p>At present, laws and/or regulations, which would mandate the complete or partial destruction of N₂O from nitric acid plants, do not exist in the host country, the Republic of Korea.</p> <p>Thus, the current baseline scenario is still valid as per the methodology ACM0019 version 04.0.</p> <p>The annual emission reduction for renewal of crediting period is re-calculated in accordance with the methodology.</p> <p>The PP has updated the the data and parameters in accordance with the revised PDD version 15.2.</p> <p>Further information for the updated parameters to calculate GHG emission reductions can be also seen in the PDD version 15.2.</p> <p>Step 2: Assess and incorporate the impact of national and/or sectoral policies and circumstances, existing at the time of requesting renewal of crediting period, on the current baseline GHG emissions, without reassessing the baseline scenario.</p>

Applicable legislation, national and sectorial policies in the Republic of Korea are “Clean Air Conservation Act (Act no. 16266)”, “Framework act on environmental policy (Act no. 14532)” and “Air Environment Ordinance” from local government (No.1640), Ulsan Metropolitan City.

The validation team reviewed all above laws, regulation and policies and found that the host country does not apply any legal requirements to reduce N₂O emissions from nitric acid plants.

Thus, any direct or indirect legal regulation in the Republic of Korea does not lead to any legal obligation or economic benefit that would require and/or favour the implementation of an N₂O abatement measure at the nitric acid plant of the HWC.

Hence, in accordance with the applied methodology, for the proposed CDM project, the baseline scenario is that the N₂O emitted to the atmosphere without any N₂O abatement measure being implemented.

Step 3: Assess whether the requirements contained in Step 2 above are applicable to a registered PDD applying the valid version of an applicable approved standardized baseline that standardizes baseline scenario

The PP updated the PDD with the latest methodology “ACM0019” and it indicates that in the absence of the proposed project, the amount of N₂O in the tail gas of the nitric acid plant is emitted to the atmosphere without any N₂O abatement measure.

Step 4: Assess whether the requirements contained in Step 3 above are not applicable to a registered CDM project activity applying the valid version of an applicable approved standardized baseline

The standardized baseline is not applied in this project.

Thus, this step is not applicable to renewal of the crediting period.

Step 5: Assess whether data and parameters used for determining the original baseline, that were determined ex ante and not monitored during the crediting period, are no longer valid, the project participants shall update such data and parameters in accordance with the “Methodological tool: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”.

Step 5.1: Assessment of the validity of the data and parameters

The validation team checked whether the data and parameters for ex ante are still valid and need to be updated as follows:

Data and Parameters	Unit	Ex-ante Determined	Evidence document	Up-date	Source of data used
EF _{historical}	kg N ₂ O/t HNO ₃	9.47	Actual records from 1 st MR – 5 th MR during 1 st crediting period (from 01/01/2008 to 31/12/2012)	No	In case of plants that used AM0028 in the first crediting period, use the lowest baseline emission factor obtained in one calendar year. This parameter has been verified against 1 st MR – 5 th MR for the historical N ₂ O emission factor of each whole calendar year uploaded on the UNFCCC web.

							Review of the MRs confirmed that the applied N ₂ O emission factor of 9.47 kg N ₂ O/t HNO ₃ was the lowest figure throughout the first crediting period
	EF _{default,y}	Kg N ₂ O/t HNO ₃			Methodology ACM0019 version 04 - Actual pressure data of the nitric acid plant from 10 th MR to 14 th MR in 2 nd crediting period. - Process flow diagram of the nitric acid plant	Yes	The CL01 has been raised and closed successfully. The minimum actual operation pressure of the ammonia burner is higher than the threshold of high pressure 600 kPa indicated in the methodology, It is verified by reviewing actual pressure data of the nitric acid plant from the 10 th MR to 14 th MR & the process flow diagram of the nitric acid plant and found them to be correct. Thus, according to the methodology, the ex-ante value of EF _{default,y} should be selected within the “high-pressure” range.
			Year	High pressure (KPa)			
			2021	11.00			
			2022	10.80			
			2023	10.60			
			2024	10.40			
			2025	10.20			
			2026	10.00			
	2027	9.80					
2028	9.6						
EF _{new,y}	Kg N ₂ O/t HNO ₃	2.50		Methodology ACM0019 version 04	Yes	The value of 2.5 will remain constant after 2020. It has been verified against the applied methodology ACM0019 version 04.0.	
P _{product,max}	t product	107,100		Final acceptance certificate, Technical specification of N ₂ O abatement system for Nitric acid plant, PDD version 08	No	The design capacity of nitric acid production multiplies 306 tHNO ₃ /day by 350 day. The designed capacity, 306 (tHNO ₃ /day) is verified by reviewing the final acceptance	

				(17/11/2006)		certificate from the nitric acid production manufacturer, UHDE GmbH. and found to be correct. The maximum operating day (350 days) has been verified by reviewing the technical specification of the N ₂ O abatement system for the nitric acid plant (DoC No: 06P794-001) and found to be correct. Also, It has been verified against the registered PDD for the first crediting period and confirmed that the applied values are consistent with the those applied in the 1st crediting period and in compliance with the applied methodology ACM0019 version 04.0.
	GWP _{N₂O}	-	265	EB 108 th meeting.	Yes	CAR02 has been rased and closed successfully. N ₂ O of GWP from IPCC fifth assessment reports(AR5) for a 100-year time horizon, EB 108th meeting Report(Reference: Global warming potential values under the temporary measures) has been applied . However, FAR01 has been raised and will be further investigated during the next periodic verification process.
	Ru	Pa.m ³ /kmol.K	8,314	TOOL08 version 03.0	No	It has been verified against the applied

					methodological tool.
MMi	kg/kmol	44.02	TOOL08 version 03.0	No	It has been verified against the applied methodological tool.
Pn	Pa	101,325	TOOL08 version 03.0	No	It has been verified against the applied methodological tool.
Tn	K	273.15	TOOL08 version 03.0	No	It has been verified against the applied methodological tool.

These parameters ($EF_{\text{default},y}$, $EF_{\text{new},y}$) as a fixed ex-ante, need to be determined at the start of the 3rd crediting period. Previous values for these parameters are not valid anymore. Therefore, the current baseline has been updated for the renewal of credit period by applying Step 5.2:

Step 5.2: Update the current baseline and the data and parameters

Step 5.2.1: Update the current baseline
As per the Step 1 above, the current baseline scenario is still valid as per the methodology ACM0019 version 04.0. The identified baseline scenario of the project is defined as follows:
In the absence of the project activity, the amount of N₂O in the tail gas of the nitric acid plant is emitted to the atmosphere without any N₂O abatement measure. Thus, this step is not applicable.

Step 5.2.2 : Update the data and parameters
The parameters described under step 5.1 were properly updated, considering the latest applied methodology and TOOL08 version 03.0.

In result, the validation team concluded that the current baseline is still valid for the third crediting period. However, data and parameters needed to be updated in accordance with the latest version of ACM0019 (version 04.0), TOOL08.

D.4. Estimated emission reductions or net anthropogenic removals

Means of validation	The validation team has assessed the calculation of GHG emission of the updated PDD and its compliance with the applied methodology and requirement of the CDM PS for PA version 02.0.
Findings	There are 1 FAR raised in this section.
Conclusion	<p>The implementation of the project activity is expected to result in average emission reductions of 206,422tCO₂e per year for the 3rd renewable crediting period. According to the methodology any leakage emissions sources are deemed to be negligible, hence mission reductions are calculated as follows: $ER_y = BE_y - PE_y$</p> <p>Baseline Emission: For this nitric acid plant, the methodology AM0028 has been used in the first crediting period. Case 1 was selected in accordance with the methodology ACM0019 version 04.0. Therefore, the baseline emissions are calculated as follows:</p> $BE_y = (\min \{P_{\text{production},y}; P_{\text{product,max}}\} \times EF_{\text{existing},y} + \max \{P_{\text{production},y} - P_{\text{product,max}}; 0\} \times EF_{\text{new},y}) \times (h_y - h_{r,y}) / h_y \times GWP_{N_2O} \times 10^{-3}$ <p>Project Emissions: $PE_y = PE_{N_2O,y} + PE_{CO_2,tertiary,y}$ Where: $PE_{N_2O,y}$ = Project emissions of N₂O from the project plant in year y (t CO₂e)</p>

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

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

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

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

Where:

$F_{N_2O, \text{tail gas}, h}$ = Mass flow of N₂O in the gaseous stream of the tail gas in the hour h (kg N₂O/h)

As the tail gas of the project was estimated on a dry basis, the option A of the tool was applied for the proposed project according to the applied TOOL08 Tool to determine the mass flow of a greenhouse gas in a gaseous stream version 03.0.

The mass flow of greenhouse gas i ($F_{i, t}$, Corresponding to the " $F_{N_2O, \text{tail gas}, h}$ " mentioned above) 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:

P_t = Absolute pressure of the gaseous stream in time interval t (Pa);

T_t = Temperature of the gaseous stream in time interval t (K)

Temperature at normal conditions (K) = 273.15 K

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

This emission source only needs to be estimated if a tertiary N₂O abatement facility is installed under the project activity and if fossil fuels are used to operate the facility or re-heat the gas after the facility.

The only emissions related to the operation of the N₂O destruction facility is the on-site emissions due to the fossil fuel fed to the N₂O destruction facility

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

Where:

$PE_{FF, y}$ = Project emissions related to fossil fuel input to the destruction facility and/or re-heater in year y (tCO₂)

According to the applied TOOL 03 "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion, version 03", CO₂ emissions from fossil fuel combustion in process j (tertiary N₂O abatement facility) are calculated based on the quantity of fuels combusted and the CO₂ emission coefficient of those fuels, as follows:

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

Where:

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

	<p>$COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)</p> <p>In the tertiary abatement system, N₂O is removed by catalytic reduction with ammonia. With Selective Catalytic Reduction (SCR), ammonia is injected into the flue gas and reacts catalytically with NO_x to produce molecular nitrogen and water vapor. Under the project scenario, N₂O is removed from the tail gas downstream of the absorption tower by catalytic destruction and the optimum position for a tertiary N₂O destruction facility is at the hottest position in the tail gas stream.</p> <p>Therefore, DeN₂O unit has been relocated to the hottest position in the tail gas stream.</p> <p>In addition, the applied catalyst was changed to the catalyst suitable for the N₂O destruction at lower temperature (approximately 370°C).</p> <p>Operation of the N₂O destruction facility at lower temperature eliminated the need for the fossil fuel (LNG) to maintain optimum temperature of the facility. Consequently, monitoring of the existing parameters related with the project emission became unnecessary.</p> <p>The validation team physically checked the DeN₂O units to find the dismantled fuel supply pipe lines during on-site visit. and Furthermore, the validation team interviewed the operation staffs and reviewed the specification and brochure of the catalyst for the N₂O abatement system in the nitric acid plants dated 09/04/2015 and the PRC validation report version01 dated 06/07/2016, validated by KFQ, and found them consistent.</p> <p>In conclusion, no emissions from the operation of the tertiary N₂O abatement facility occur as no fossil fuels are used, hence emissions from this source are considered as zero and the TOOL03 version 03 is not applicable to the project for the 3rd renewable crediting period.</p> <p>All assumptions and data used by the PP are listed in the PDD version 15.2 and supporting documents, including their references and sources. All documentation used by the PP as the basis for assumptions and source of data is correctly quoted and interpreted in the PDD. All values used in the PDD are considered reasonable in the context of the proposed CDM project activity. The baseline methodology has been applied correctly in calculating project emissions, baseline emissions, and leakage and emission reductions. All estimates of the baseline, project and leakage emissions can be replicated using the data and parameter values provided in the PDD.</p> <p>The GWP of N₂O will be updated in the PDD if any requirements of the CMP guidance is introduced. Please refer to the FAR01.</p>
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D.5. Validity of monitoring plan

Means of validation	<p>The project activity applies the approved monitoring methodology ACM0019 version 4.0 for renewal of crediting period.</p> <p>The original monitoring plan following the requirements of the CDM methodology was updated based on requirements of the applied methodology. The monitoring plan presented in the updated PDD complies with the requirements of the applicable methodology.</p> <p>The validation team has verified all parameters in the monitoring plan against the requirements of the methodology.</p>				
Findings	There are 1 CAR raised in this section				
Conclusion	<p>The project monitoring plan is in compliance with the monitoring methodology ACM0019 version 04.0 and TOOL08 version 03.0.</p> <p>The parameters that need to be monitored ex-post are as listed below.</p>				
	Data and Parameters	Unit	Report ed value	Evidence document	Description of reported value, monitoring equipment, measurement, calibration routines and uncertainty

	$P_{\text{production},y}$ (Nitric acid produced in year y)	$t\text{HNO}_3$	94,810	Actual records from 10 th MR – 14 th MR in 2 nd crediting period.	<p>The actual records, generated from 10th MR -14th MR in 2nd crediting period, have been used to estimate annual emission reduction for 3rd crediting period. However, the CAR01 has been raised and closed successfully.</p> <p>The nitric acid production is calculated based on produced nitric acid flow and produced HNO_3 concentration as follows:</p> $P_{\text{product},y} = \sum Q_{\text{HNO}_3,\text{daily}} \times C_{\text{HNO}_3,\text{daily}}$ <p>The meters have been checked against the specification and by physical inspection and found to be consistent.</p> <p>The meters' information have been given as follows:</p> <p><Flow meter> Instruments type: Coriolis Mass Flow Measuring System Manufacture: EMERSON Model: CMF200L518N2BIEZZZ Accuracy Class: 0.1% - Measuring and Recording frequency: continuously and hourly</p> <p>The daily nitric acid concentration ($C_{\text{NO}_3,\text{daily}}$) will be determined by specific gravity method based on measured values using specific gravity hydrometer and thermometer.</p> <p><Specific gravity> Instruments type: Specific gravity hydrometer Accuracy : $\leq \pm 0.002\text{kg/m}^3$</p> <p><Temperature> Instruments type: Liquid-in-glass thermometer Accuracy : $\leq \pm 1^\circ\text{C}$</p> <p>Measuring and recording frequency: continuous measuring and hourly recording for flowmeter, daily measuring and recording for specific gravity and temperature.</p>
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					<p>QA/QC procedure: Periodic calibration will be performed according to supplier's recommendations.</p> <p>For the specific gravity hydrometer, the calibration frequency of the meter is 36 months.</p> <p>For the temperature, the calibration frequency will be performed once a year.</p> <p>In terms of equipment operation and maintenance, the procedures are incorporated in the ISO 9001: 2005.</p> <p>The monitored data will be cross-checked against the production records, marketing and stock change data.</p>
	h_y (Number of hours operation in year y)	hours	7,958	Actual records from 10 th MR – 14 th MR in 2 nd crediting period	<p>The actual records, generated from 10th MR -14th MR in 2nd crediting period, have been used to estimate annual emission reduction for 3rd crediting period.</p> <p>However, the CAR01 has been raised and closed successfully.</p> <p>The flow meter has been checked against the specification and by physical inspection and found to be consistent.</p> <p>The meter's information has been given as follows:</p> <p><Flow meter> Instruments type: Coriolis Mass Flow Measuring System Manufacture: EMERSON Model: CMF200L518N2BIEZZZ Accuracy Class: 0.1%</p> <p>Measuring and Recording frequency: continuously and hourly.</p> <p>QA/QC procedure: Periodic calibration will be performed according to supplier's recommendations.</p>
	$h_{r,y}$ (Number of hours operation in year y where: For tertiary N ₂ O abatement. The	hours	300	Actual records from 10 th MR – 14 th MR in 2 nd crediting period	<p>AM0028 has been used for this nitric acid plant in the first crediting period and thus the abatement system is deemed to be by-passed, not working or failed in the hour h in year y if:</p> $F_{N2O,tail,gas,h} > EF_{existing} \times P_{NA,h}$

	abatement system is by-passed, underperforming or failed)				<p>The parameters, $F_{N_2O,tail,gas,h}$, $P_{NA,h}$, will be monitored as explained in this section.</p> <ul style="list-style-type: none"> · $P_{NA,h}$: see parameter $P_{production,y}$ · $F_{N_2O,tail,gas,h}$ see parameters $V_{t,db,n}$, $V_{i,t,db}$ and $C_{H_2O,t,db,n}$ · $EF_{existing,y}$ needs not to be monitored, since it's fixed for the crediting period. <p>The actual records, generated from 10th MR -14th MR in 2nd crediting period, have been used to estimate annual emission reduction for 3rd crediting period. However, the CAR01 has been raised and closed successfully. Measuring and Recording frequency: continuously and hourly. QA/QC procedure: Periodic calibration for the flow meter of measuring nitric acid flow will be performed according to supplier's recommendations.</p>
	$V_{t,db}$ (Volumetric flow of the gaseous stream in time interval t on a dry basis)	Nm ³ dry gas/h	38,014	Actual records from 10 th MR – 14 th MR in 2 nd crediting period	<p>The actual records, generated from 10th MR -14th MR in 2nd crediting period, have been used to estimate annual emission reduction for 3rd crediting period. However, the CAR01 has been raised and closed successfully. The meters have been checked against the specification and by physical inspection and found to be consistent. Measured volumetric flow data will be automatically converted to the data under normal condition during the monitoring process by the AMS.</p> <p>The meters' information have been given as follows:</p> <p>< Volume flow measuring system></p> <ul style="list-style-type: none"> • Type : Differential Pressure Manufacture : Durag Model : D-FL 100 Accuracy class : < 2% of measuring range • Type : Resistance Temperature Detector Manufacture : WISE controls Model : R221+ MTM Accuracy class : $\pm 0.3\%$,of full scale

					<ul style="list-style-type: none"> Instrument Type : Absolute Pressure Transmitter - Manufacture : Honeywell - Model : STG 944-E1G-00000-S1 - Accuracy class : $\pm 0.075\%$,of full scale <p>Measuring and Recording frequency: continuously and hourly.</p> <p>QA/QC procedure: The calibration shall be subjected to the EN14181 in accordance with methodology.</p> <p>As per the standard, the flow meter will be tested and calibrated in accordance with ISO IEC 17025.</p> <p>The QAL2, which encompasses AST, will be conducted every 3 years. The AST will be conducted once a year.</p> <p>The validation team confirmed that above QA/QC process is in complied with the EN14181.</p>
	$V_{i,t,db}$ (Volumetric fraction of greenhouse gas i in a time interval t on a dry basis)	m^3 gas i/m^3 dry gas	0.00015	- Abatement Facility Operation & Maintenance agreement - Testing report of the N_2O concentration in the tail gas of the nitric acid plant	<p>The value was assumed based on the average concentration at the inlet of the abatement system as well as the abatement ratio(DeN_2O ratio: 90%) sourced from the abatement facility operation & maintenance agreement and the testing report of the N_2O concentration in the tail gas of the nitric acid plant (dated on 22/02/2006).</p> <p>The value will be measured and recorded by Non-dispersion infrared absorption analyzer. The analyzer has been checked against the specification and by physical inspection and found to be consistent.</p> <p>The analyzer's information has been given as follows: Instrument Type : Non-dispersion infrared absorption analyzer. - Manufacturer: ABB - Model: AO2040/Uras 26 - Accuracy class : zero drift $\leq \pm 1\%$ of span</p> <p>Measuring and Recording frequency: continuously</p>

					<p>QA/QC procedure: The analyzer will be tested and calibrated by an external laboratory with ISO IEC 17025 Accreditation. The QAL2 test will be conducted once every 3 years; the AST will be conducted once per year. Every 3 years the AST is a part of the QAL2 test. Calibration is intended to be done by the plant operator with routine procedure for QAL3 certification of the system.</p> <p>The validation team confirmed that above QA/QC process is complied with the EN14181.</p>
	$C_{H_2O,t,db,n}$ (Moisture content of the gaseous stream at normal conditions, in time interval t)	mg H_2O/m^3 dry gas	Below 50,000	Methodology ACM0019 version 04	<p>Monitoring and Recording frequency: the mean value of three consecutive measurements performed in the same day (at least 2 hours each) will be considered. Measurements will be made in conjunction with the AST (associated with requirements of the EN 14181 standard) or the calibration of the flow meter for the gaseous stream.</p> <p>QA/QC procedure: According to the applied tool, the measurements and determination should be in accordance with USEPA CF42 method 4 - Gravimetric determination of water content.</p>
	<p>No deviations have been found compared to the monitoring methodology in the ACM0019 version 2.0 applied during 2nd crediting period.</p> <p>The PP has appropriately mentioned the maintenance and calibration frequency of monitoring equipment and monitoring frequency for each monitoring parameter. The CDM monitoring manual (dated 12/2018) prepared by the PP has been reviewed by the validation team during the document review and the validation team interviewed the relevant personnel. The information provided has enable the validation team to confirm that the monitoring plan is feasible. Several points related to the monitoring plan have been discussed with the PP: specifically specific procedures of the project activity, location of meters, data management, and quality assurance and quality control procedures to be implemented in the context of the project activity.</p> <p>The nitric acid plant has been operated by the PP since the commissioning of the plant and has sufficient and well-experienced staffs. The plant has carried out measurements of various production parameters including analyzer operation the production team. The monitoring of the N_2O for the project is a responsibility of the production team, and the operation and maintenance of the N_2O monitoring system incorporates 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 electronically.</p>				

	<p>In case a deviation in the monitoring data is found, the production team engineer will investigate the operating parameters of the plant to identify the reason for the deviation and take remedial measures.</p> <p>If there are no changes in the operating parameters of nitric acid plant, the monitoring system will be examined. Once a problem in the default is identified, the Quality & Technical management team and the Environment & Safety Management team will introduce a correction to the default. The production team engineer will report such irregular event to the plant manager.</p> <p>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 for operation of the De N₂O system as well as the measurement system.</p> <p>The project employs the latest state of the art monitoring and control equipment that measures, records and reports all key parameters to determine the GHG emission reductions. The plant is equipped with an Automated Monitoring System (AMS) in order to allow continuous real-time measurements of the N₂O concentration and the total gas volume flow, which is required to be monitored by the applied methodology.</p> <p>Thus, the validation team concluded that PP is fully capable of implementing the monitoring plan.</p>
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D.6. Crediting period

Means of validation	The purpose of a validation related to the duration or day of renewal of crediting period is an assessment according to the VVS for PA version 02.0 and includes an assessment of an updated PDD in accordance with the relevant sections of the PS for PA version 02.0 related to the duration of renewal of PA period and in particular to the next crediting period of the registered CDM PA
Findings	There are 1 FAR raised in this section .
Conclusion	<p>At first, the project has been registered on 03/05/2007 and the crediting period started on 01/07/2007.</p> <p>However the starting date of the first crediting period has been changed to 27/06/2007, i.e., the first crediting period has been changed to 27/06/2007 - 26/06/2014 And the subsequent crediting period also has been changed to 27/06/2014 - 26/06/2021.</p> <p>Consequently, the 3rd crediting period is set to 27/06/2021 - 26/06/2028.</p> <p>The next crediting period of the registered project activity shall commence on the day after the current crediting period expires.</p> <p>The validation team confirmed that the start date and the duration of the crediting period are in compliance with the VVS for PA version 02.0.</p> <p>However, the FAR02 has been raised and will be further investigated during the next periodic verification process.</p>

D.7. Project participants

Means of validation	<p>As per, PS for PA version 02.0, the PP shall ensure that the Modalities of Communication (MoC) statement is up to date.</p> <p>The validation team checked business licenses of the PPs and other relevant documentation to validate the corporate identity of all project participants, the CME and focal points included in the MoC statement.</p>
Findings	There is 1 CL raised in this section.
Conclusion	<p>During interview with the PP, the validation team found that the name of the PP included in the updated PDD are consistent with the name of the PP.</p> <p>However, the latest version of the MoC statement shall be provide for validation. Therefore, the CL 02 has been raised</p> <p>The validation team crosschecked the identities with business license of the PP and the MOC signed by PPs, PDD version 15.2 and the onsite interviews, and confirmed the information was consistent. The validation team was able to conclude that name and/or address for the corporate PP are accurate and correct.</p>

D.8. Post-registration changes

Type of post-registration changes (PRCs)	Confirmation (Y/N)	Validation report for PRCs	
		Version	Completion date
Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents ¹	-	-	-
Corrections	-	-	-
Change to the start date of the crediting period	-	-	-
Inclusion of a monitoring plan	-	-	-
Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents	-	-	-
Changes to the project design	-	-	-
Changes specific to afforestation and reforestation project activities	-	-	-

SECTION E. Internal quality control

Internal quality control within the team is assured by means of a technical review process that takes place after the on-site assessment and after closure of findings. The internal quality control in the validation process is given by the final decision made by the KTR.

¹ Other standards, methodologies, methodological tools and guidelines (to be) applied in accordance with the applied(selected) methodologies are collectively referred to as the other (applied) methodological regulatory documents).

SECTION F. Validation opinion

KTR has performed a validation for renewal of crediting period of the aforementioned existing project activity. Standard auditing techniques have been used during the validation process. The validation has been performed following the requirements of the latest version of the CDM VVS for PA version 2.0 & CDM PS for PA version 2.0 and included an assessment of “

- (a) Impact of new relevant national and/or sectoral policies and circumstances on the baseline, taking into account relevant guidance from the Board with regard to renewal of the crediting period of a registered CDM project activity, at the time of requesting renewal of crediting period of the project activity, and
- (b) Correctness of the application of the approved methodologies for the determination of the continued validity of the baseline or its update, and the estimation of GHG emission reductions or net anthropogenic GHG removals for the applicable crediting period of the registered CDM project activity.

The review of the updated PDD, subsequent follow-up interviews, and further references have provided the validation team with sufficient evidence to determine the validity of the original baseline and the update of data & parameters.

The project correctly applies the baseline and the monitoring methodology ACM0019 version 04.0. The monitoring plan provides framework for the monitoring of project's emission reductions. The monitoring arrangements described in the monitoring plan are feasible within the project design, and the validation team confirms that the PP is able to implement the monitoring plan.

The findings raised during this validation have been closed satisfactorily.

The validation team is of opinion that the project meets all relevant UNFCCC requirements

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RESPONSE of TEMPORARY MEASURES FOR CDM PROCESSES DUE TO THE POSTPONEMENT OF CMP 16

The DOE acknowledges that the CDM Executive Board agreed to clarify the application of the temporary measures at their 109th meeting in March 2021. Until that time, requests related to CDM process may continue to be submitted as per the standard procedure Requests of registration of the proposed project activity that have a crediting period starting on or after 1 January 2021 will be processed in accordance with the CDM rules and CMP decisions that are in force as at the date of adoption of the EB 108th meeting report and with any other decisions of the Board taken before CMP 16.

Therefore, KTR confirms that this project is able to request for the renewal of the crediting period of this project starting on 27/06/2021 which is later on 01/01/2021.

In case of global warming potential values, The PP applies global warming potential values the lowest value from the Intergovernmental Panel on Climate Change (IPCC) assessment reports for each greenhouse gas for a 100-year time horizon.

the PDD will be updated in accordance with any requirements of the CMP guidance,

The validation report (version 03.0) is included in FARs raised for above issues.

The FARs are raised to indicate any future DOE to follow the latest CMP decision as above mentioned.

Based on the above, KTR requests the renewal of the crediting period of this project.

Appendix 1. Abbreviations

Abbreviations	Full texts
ACM	Approved Consolidated Methodology
AM	Approved Methodology
AMS	Automated Measuring System
AST	Annual Surveillance Test
BE	Baseline Emission
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CER	Certified Emission Reduction(s)
CL	Clarification Request
CMP	COP/MOP Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CO ₂ e	Carbon dioxide equivalent
DCS	Distributed Control System
DOE	Designated Operational Entity
EB	Executive Board
EN	European Norm
ER	Emission Reductions
FAR	Forward Action Request
GHG	Greenhouse gas(es)
GWP	Global Warming Potential
HWC	Hanwha Corporation
IEC	International electrotechnical commission
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KFQ	Korean Foundation for Quality
KTR	Korea Testing & Research Institute
MoC	Modalities of Communication
MP	Monitoring Plan
NDIR	Non-dispersion infrared absorption analyzer
PA	Project Activity
PDD	Project Design Document
PE	Project Emission
PP	Project Participant
PRC	Post-registration change
PS	Clean Development Mechanism Project Standard
QA/QC	Quality Assurance / Quality Control
QAL	Quality Assurance Level
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VVS	Clean Development Mechanism Validation and Verification Standard

Appendix 2. Competence of team members and technical reviewers

Certificate for Achievement



KTR
한국화학융합시험연구원
K O R E A T E S T I N G & R E S E A R C H I N S T I T U T E

Certificate of Authorization

Name : CHOI, Jiseon

Date of Birth : September 21th, 1984

Certificate Number : 2018CDM - 001

We, hereby certify that above mentioned person is qualified for the technical areas specified below in compliance with Appendix 2 of CDM Accreditation Standard Ver 7.0 and CDM Quality procedure (CDM-QP-07)

Scope of Authorization :

CODE	TECHNICAL AREA	STATUS
1.1	Thermal energy generation	Full-time Validator/Verifier
1.2	Renewables	Full-time Validator/Verifier
3.1	Energy demand	Full-time Validator/Verifier
13.1	Solid waste and waste water	Full-time Validator/Verifier
13.2	Manure	Full-time Validator/Verifier

Valid until : August 6th, 2021

August 7th, 2018



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한국화학융합시험연구원

K O R E A T E S T I N G & R E S E A R C H I N S T I T U T E

Certificate of Authorization

Name : JUNG, Kyuhong
 Date of Birth : February 1st, 1977
 Certificate Number : 2019CDM - 001

We, hereby certify that above mentioned person is qualified for the technical areas specified below in compliance with Appendix 2 of CDM Accreditation Standard Ver 7.0 and CDM Quality procedure (CDM-QP-07)

Scope of Authorization :

CODE	TECHNICAL AREA	STATUS
1.1	Thermal energy generation	Lead Validator/Verifier
1.2	Renewables	Lead Validator/Verifier
3.1	Energy demand	Lead Validator/Verifier
4.1	Cement and lime production	Lead Validator/Verifier
13.1	solid waste and wastewater	Lead Validator/Verifier

Valid until : July 4th, 2022

July 5th, 2019



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한국화학융합시험연구원

K O R E A T E S T I N G & R E S E A R C H I N S T I T U T E

Certificate of Authorization

Name : SHIN, Woorhul
 Date of Birth : January 10th, 1957
 Certificate Number : 2020CDM - 001

We, hereby certify that above mentioned person is qualified for the technical areas specified below in compliance with Appendix 2 of CDM Accreditation Standard Ver 7.0 and CDM Quality procedure (CDM-QP-07)

Scope of Authorization :

CODE	TECHNICAL AREA	STATUS
1.2	Renewables	Part-time Validator/Verifier
5.1	Chemical industry	Part-time Validator/Verifier
5.2	Caprolactam, nitric and adipic acid	Part-time Validator/Verifier
10.1	Fugitive emissions from oil and gas	Part-time Validator/Verifier
11.1	Emissions of fluorinated gas	Part-time Validator/Verifier
11.2	Refrigerant gas production	Part-time Validator/Verifier
13.1	Solid waste and waste water	Part-time Validator/Verifier

Valid until : May 31st, 2023

June 1st, 2020



한국화학융합시험연구원장
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한국화학융합시험연구원

K O R E A T E S T I N G & R E S E A R C H I N S T I T U T E

Certificate of Authorization

Name : KIM, Kyungmun
 Date of Birth : December 19th, 1977
 Certificate Number : 2017CDM - 006

We, KTR, hereby certify that above mentioned person is qualified for the technical areas specified below in compliance with Appendix 2 of CDM Accreditation Standard Ver 6.0 and Quality System of the KTR CDM.

Scope of Authorization :

CODE	TECHNICAL AREA	STATUS
5.1	Chemical industry	Technical Expert
5.2	Caprolactam, nitric and adipic acid	Technical Expert

Valid until : December 18th, 2020

December 19th, 2017



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Appendix 3. Documents reviewed or referenced

No.	Author	Title	References to the document	Provider
1	HWC	PDD	version 14.0 20/12/2018 version 15.0 11/06/2020 version 15.1 14/07/2020 version 15.2 21/02/2021	PP
2	KFQ	PRC validation report	version01.1 (02/01/2019)	Others
3	KFQ	PRC validation report	version01(06/07/2016)	Others
4	TÜV SÜD Industrie Service GmbH	CDM Validation Report: Catalytic N ₂ O Abatement project in the tail gas of the nitric acid plant of the HWC in Ulsan (Ref. No.:0922).	version01 (08/02/2007)	Others
5	DNV	CDM Validation Opinion (Renewal): 'Catalytic N ₂ O Abatement project in the tail gas of the nitric acid plant of the HWC in Ulsan (Ref. No.:0922) Report No. 2014-9033 (12/02/2014)	version01(07/05/2014)	Others
6	HWC	Construction completion report of switching location of DeN ₂ O unit	29/11/2016	PP
7	HWC	CDM Monitoring Manual of HWC	12/2018	PP
8	HWC	- Daily operation report (excel files, pdf files) -DCS -Event log files	01/01/2019-31/12/2019	PP
9	EMERSON	Product Data Sheet (Specifications of HNO ₃ flow meter)	PS-00374	Others
10	HWC	Internal standard for testing HNO ₃	HWO-C-101 Version 01 (01/06/2005)	PP
11	UHDE GmbH	Operation manual - Technical standard for determination of HNO ₃ concentration	07/1992	Others
12	HWC	Calibration report of gravity hydrometer	13/04/2018	PP
13	HWC	Calibration report of thermometer	16/02/2018	PP
14	DURAG	Specification on Volume flow measuring system (D-FL100)	-	Others
15	HWC	MoC statement	14/07/2020	PP
16	Ministry of Environment	Clean Air Conservation Act of the Republic of Korea	Act (Act no. 16266) 15/01/2019	Others
17	Office for Government Policy Coordination	Framework Act on Low Carbon, Green Growth	(Act no. 14532) 31/12/2018	Others
18	Ulsan Metropolitan City, local government	Air Environment Ordinance	(No.1640), 29/09/2016	Others
19	CEN (European committee for Standardization)	EN14181 Stationary source emissions - Quality assurance of automated measuring systems	2004	Others
20	HWC	Industrial process diagram of the nitric acid production line	10210002	PP

21	SUMIKO ECO-ENGINEERING CO.,LTD	Technical specification of the N ₂ O abatement facility for the nitric acid production line including the operating time/Abatement efficiency	06P794-001	Others
22	HWC	Testing report of the N ₂ O concentration in the tail gas of the nitric acid plant	22/02/2006	PP
23	HWC	Maximum daily HNO ₃ production	02/06/1989	PP
24	HWC	N ₂ O inlet concentration from Nitric acid plant design document.	Hanwha Environmental Laboratory	PP
25	UNFCCC	Standard – CDM Validation and Verification Standard for project activities version 02.0 Standard – CDM Project Standard for project activities version 02.0 : Procedure – CDM project cycle procedure for project activities version 02.0 : Form - Project design document form version 11.0 Form - Modalities of Communication statement (MOC, version 03.0) Methodology - ACM0019 version 04.0 Tool to calculate project or leakage CO ₂ emissions from fossil fuel combustion(TOOL 03 version 03) Tool to determine the mass flow of a greenhouse gas in a gaseous stream TOOL 08 version 03	CDM-EB93-A05-STAN CDM-EB93-A04-STAN CDM-EB93-A06-PROC CDM-PDD-FORM CDM-MOC-FORM EB 101, Annex 10 EB 96 annex 4 EB 87, Annex 10	Others
26	Mitsubishi Corporation	1st Monitoring report/ 1st ER calculation sheet	version 2(01/03/2008)	Others
27	HWC & Mitsubishi Corporation	2nd Monitoring report/ 2nd ER calculation sheet	version 2(11/03/2009)	Others
28	HWC & Mitsubishi Corporation	3rd Monitoring report/ 3rd ER calculation sheet	version 6(27/08/2010)	Others
29	HWC & Mitsubishi Corporation	4th Monitoring report/ 4th ER calculation sheet	version 5(20/01/2012)	Others
30	HWC & Mitsubishi Corporation	5th Monitoring report/ 5th ER calculation sheet	version 3(28/03/2012)	Others
31	HWC & Mitsubishi Corporation	6th Monitoring report/ 6th ER calculation sheet	version 4(10/07/2013)	Others
32	HWC & Mitsubishi Corporation	6th Monitoring report/ 6th ER calculation sheet	version 3(20/09/2012)	Others
33	HWC & Mitsubishi Corporation	7th Monitoring report/ 7th ER calculation sheet	version 2(15/11/2012)	Others
34	HWC & Mitsubishi Corporation	8th Monitoring report/ 8th ER calculation sheet	version 2(08/02/2013)	Others
35	HWC & Mitsubishi Corporation	9th Monitoring report/ 9th ER calculation sheet	version 2(13/02/2015)	Others
36	HWC	10th Monitoring report/ 10th ER calculation sheet (1 st Monitoring report/ 1st ER calculation sheet for 2nd crediting period)	version 2(02/05/2016)	Others

37	HWC	11th Monitoring report/ 11th ER calculation sheet (2nd Monitoring report/ 2nd ER calculation sheet for 2nd crediting period)	version 3(18/07/2017)	Others
38	HWC	12th Monitoring report/ 12th ER calculation sheet	version 4(02/01/2019)	Others
39	HWC	13th Monitoring report/ 13th ER calculation sheet	version 2.2(16/10/2019)	Others
40	HWC	14th Monitoring report	version 1.0	Others
41	DNV	1st Verification report	version 1(22/07/2008)	Others
42	DNV	2nd Verification report	version 1(26/11/2009)	Others
43	DNV	3rd Verification report	version 1(02/12/2010)	Others
44	DNV	4th Verification report	version 2(15/02/2012)	Others
45	DNV	5th Verification report	version 1(21/05/2012)	Others
46	DNV	6th Verification report(ver.04 MR-10/07/2013)	version 2(21/08/2013)	Others
47	DNV	6th Verification report(ver.03 MR-20/09/2012)	version 1(23/10/2012)	Others
48	DNV	7th Verification report	version 1(12/12/2012)	Others
49	DNV	8th Verification report	version 1(17/03/2013)	Others
50	KFQ	9th Verification report	version 1.1 (17/02/2015)	Others
51	KFQ	10th Verification report	version 2(19/05/2016)	Others
52	KFQ	11th Verification report	version 2(19/07/2017)	Others
53	KFQ	12th Verification report	version 2(03/01/2019)	Others
54	KFQ	13th Verification report	version 2.1(15/11/2019)	Others
55	HWC	ER Calculation sheet for 3 rd crediting period	version 1.0 11/06/2020 version 2.0 14/07/2020 version 3.0 21/02/2021	PP
56	ECOPRO	specification & commercial of catalyst for N ₂ O abatement CDM project in the nitric acid plants	09/04/2015	Others
57	HWC	Business License of HWC	20/05/1992	PP
58	UHDE GmbH	Final acceptance certificate	07/1992	Others
59	HWC	Process flow diagram nitric acid plant	10210002	PP
60	HWC	Actual pressure data of the nitric acid plant from 10 th MR to 14 th MR	-	PP
61	HWC	Abatement Facility Operation & Maintenance agreement	22/12/2006	PP
62	ABB	Specification of Non-dispersion infrared absorption analyzer	10/24-1.20 EN March 2007	Others
63	CDM Executive Board	CDM EB 108th meeting report	Version 1.0	Others
64	CDM Executive Board	Reference: Global warming potential values under the temporary measures	https://cdm.unfccc.int/filestorage/X/B/L/XBL3H024J87AVRZP19YUO6IGEDSMQT/eb108%20meeting%20report.pdf?t=ajV8cW92M2c5fDB0Rn_PH4dNLnIOZfMC2Qax	Others

Appendix 4. Clarification requests, corrective action requests and forward action requests

Table 1. CL from this validation

CL ID	01	Section no.	D.3	Date: 01/07/2020
Description of CL				
Default N ₂ O baseline emission factor varies every year and it depends on the ammonia reactor pressure. The PP choose the high pressure which excess over 600kPa. The PP was requested to submit the evidences whether the ammonia reactor pressure is over 600 kPa.				
Project participant response				Date: 15/07/2020
The evidences are submitted to the DOE.				
Documentation provided by project participant				
<ul style="list-style-type: none"> - Hanwha Corporation: Actual pressure data of the nitric acid plant from 10th MR to 14th MR - Process flow diagram nitric acid plant 				
DOE assessment				Date: 20/08/2020
<p>The pressure was measured continuously by the pressure instrument and the recorded data were checked against the actual operating parameter of the ammonia burner.</p> <p>The validation team also checked the process flow diagram of the nitric acid plant, and noticed that the minimum actual operation pressure of the ammonia burner (from 10th MR to 14th MR) was 600.8 kPa, which is higher than the threshold high pressure 600 kPa indicated in the methodology.</p> <p>In conclusion, the validation team confirmed that the ex-ante value of EF_{default,y} should be selected within the "high-pressure" range in accordance with the applied methodology during 3rd crediting period.</p> <p>Thus, the CL01 has been closed successfully.</p>				

CL ID	02	Section no.	D.7	Date: 01/07/2020
Description of CL				
The latest version of the MoC statement shall be provided for validation.				
Project participant response				Date: 15/07/2020
The updated MoC statement and supplementary documents have been submitted to the validation team.				
Documentation provided by project participant				
<ul style="list-style-type: none"> - Updated MoC statement 14/07/2020 - Business license 				
DOE assessment				Date: 20/08/2020
<p>The validation team reviewed the signed MoC and the business license to confirm that the updated MoC has been correctly completed with the latest version of the form, and signed by the PPs' authorized signatories. It has been confirmed that all corporate and personal details including specimen signatures are valid and accurate, compared with the PDD version 15.1.</p> <p>In conclusion, the corporate and personal details, employment status and specimen signatures included in the updated MoC statement/ revised PDD version 15.1 are valid and accurate.</p> <p>Thus, the CL02 has been closed successfully.</p>				

Table 2. CAR from this validation

CAR ID	01	Section no.	D.5	Date: 01/07/2020																																						
Description of CAR																																										
The actual data has been used to estimate annual emission reduction for 3 rd crediting period. The validation team found that the data generated from 14 th monitoring report (version 01) published on 29/04/2020 were not reflected in estimating the emission reduction.																																										
Project participant response				Date: 15/07/2020																																						
Both the revised ER calculation sheet version 02 and the revised PDD version 15.1 have been submitted to the validation team.																																										
Documentation provided by project participant																																										
<ul style="list-style-type: none"> - Revised PDD version 15.1 - ER calculation sheet version 02.0 - The log sheets(01/01/2019-31/12/2019) - Data sheet from DCS (01/01/2019-31/12/2019) 																																										
DOE assessment				Date: 20/08/2020																																						
<p>The validation team confirmed that the submitted documents are reliable and accurate to gather all actual records from the 2nd crediting period when the annual emission reduction is estimated during the 3rd renewable crediting period.</p> <p>The validation team checked the parameters to be monitored ex-post and found that the data and parameters, $P_{\text{production},y}$, h_y, $h_{r,y}$, $V_{t,db}$ are obtained from actual records.</p> <p>Five monitoring reports have been published or uploaded on the UNFCCC website as follows:</p> <table border="1"> <thead> <tr> <th>Number of MR</th> <th>Monitoring Period</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>10th</td> <td>27/06/14 – 26/06/2015</td> <td>CER issuance</td> </tr> <tr> <td>11th</td> <td>27/06/2015 – 26/08/2016</td> <td>CER issuance</td> </tr> <tr> <td>12th</td> <td>27/08/2016 – 31/08/2017</td> <td>CER issuance</td> </tr> <tr> <td>13th</td> <td>01/09/2017 – 31/12/2018</td> <td>CER issuance</td> </tr> <tr> <td>14th</td> <td>01/01/2019 – 31/12/2019</td> <td>A waiting for CER issuance</td> </tr> </tbody> </table> <p>The validation team checked the 14th monitoring report (version 01.0) and supplementary documents for above data and parameters and found them consistent with the daily log-sheet and records from HWC. The deviation table between the ER calculation sheet version 01 and the ER calculation sheet version 02 is given below:</p> <table border="1"> <thead> <tr> <th>Data and Parameters</th> <th>Unit</th> <th>value before revision</th> <th>Revised values</th> </tr> </thead> <tbody> <tr> <td>$P_{\text{production},y}$ (Nitric acid produced in year y)</td> <td>Ton</td> <td>115,302</td> <td>94,810</td> </tr> <tr> <td>h_y (Number of hours operation in year y)</td> <td>hours</td> <td>7,947</td> <td>7,958</td> </tr> <tr> <td>$h_{r,y}$ (Number of hours operation in year y where: For tertiary N₂O abatement. The abatement system is by-passed, underperforming or failed)</td> <td>hours</td> <td>366</td> <td>300</td> </tr> <tr> <td>$V_{t,db}$ (Volumetric flow of the gaseous stream in time interval t on a dry basis)</td> <td>Nm³dry gas/h</td> <td>36,890</td> <td>38,014</td> </tr> </tbody> </table> <p>The validation concluded that the revised ER calculation sheet version 02 and revised PDD version 15.1 are accurate and correct. No discrepancy has been found. Thus, the CAR01 has been closed successfully.</p>					Number of MR	Monitoring Period	Status	10 th	27/06/14 – 26/06/2015	CER issuance	11 th	27/06/2015 – 26/08/2016	CER issuance	12 th	27/08/2016 – 31/08/2017	CER issuance	13 th	01/09/2017 – 31/12/2018	CER issuance	14 th	01/01/2019 – 31/12/2019	A waiting for CER issuance	Data and Parameters	Unit	value before revision	Revised values	$P_{\text{production},y}$ (Nitric acid produced in year y)	Ton	115,302	94,810	h_y (Number of hours operation in year y)	hours	7,947	7,958	$h_{r,y}$ (Number of hours operation in year y where: For tertiary N ₂ O abatement. The abatement system is by-passed, underperforming or failed)	hours	366	300	$V_{t,db}$ (Volumetric flow of the gaseous stream in time interval t on a dry basis)	Nm ³ dry gas/h	36,890	38,014
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CAR ID	02	Section no.	D.3	Date: 20/02/2021
Description of CAR				
GWP value of N ₂ O shall be changed in accordance with the decision of CDM EB 108 th meeting.				
Project participant response				Date: 21/02/2021
<p>the GWP value is changed with the decision.</p> <p>The ER spreadsheet and PDD have been revised reflecting this issue accordingly.</p>				
Documentation provided by project participant				
<ul style="list-style-type: none"> - Revised PDD version 15.2 - ER calculation sheet version 03.0 				
DOE assessment				Date: 22/02/2021

the GWP value has been changed in accordance with the decision of CDM EB 108th meeting.
The validation team confirmed that all values used in the PDD including GWP for N₂O are considered reasonable in the context of the proposed CDM project activity.
Also it is confirmed that the methodology and the applied methodological tools have been applied correctly to calculate baseline, project and leakage GHG emissions, as well as GHG emission reductions.
And all estimates of the baseline GHG emissions can be replicated using the data and parameter values provided in the PDD.
Therefore, the CAR02 has been successfully closed.

Table 3. FAR from this validation

FAR ID	01	Section no.	D.3	Date: 05/01/2001
Description of FAR				
<p>The Board considered the implications of the postponement of CMP 16 on the operations of the CDM after the second commitment period and decided to make a recommendation to the CMP</p> <p>The Board agreed, as temporary measures pending CMP guidance at CMP 16</p> <p>In accordance with decision of CDM Executive Board 108th Meeting, to process requests for renewal of crediting periods that have a crediting period starting on or after 1 January 2021, the following actions shall be taken:</p> <p>(i) Apply any global warming potential values that may be adopted by the CMP for that period in their monitoring reports for any emission reductions achieved on or after 1 January 2021; and</p> <p>(ii) Update the PDD in accordance with any requirements of the CMP guidance.</p> <p>This measures will be further investigated during the next periodic verification process.</p>				
Project participant response				Date: N/A
N/A				
Documentation provided by project participant				
N/A				
DOE assessment				Date: N/A
N/A				

FAR ID	02	Section no.	D.6	Date: 05/01/2001
Description of FAR				
<p>The Board considered the implications of the postponement of CMP 16 on the operations of the CDM after the second commitment period and decided to make a recommendation to the CMP</p> <p>The Board agreed, as temporary measures pending CMP guidance at CMP 16</p> <p>In accordance with decision of CDM Executive Board 108th Meeting, to process requests for renewal of crediting periods that have a crediting period starting on or after 1 January 2021, the following actions shall be taken:</p> <p>(i) Apply any global warming potential values that may be adopted by the CMP for that period in their monitoring reports for any emission reductions achieved on or after 1 January 2021; and</p> <p>(ii) Update the PDD in accordance with any requirements of the CMP guidance.</p> <p>This measures will be further investigated during the next periodic verification process.</p>				
Project participant response				Date: N/A
N/A				
Documentation provided by project participant				
N/A				
DOE assessment				Date: N/A
N/A				