VERIFICATION / CERTIFICATION REPORT

CATALYTIC N2O ABATEMENT PROJECT IN THE TAIL GAS OF THE NITRIC ACID PLANT OF THE HANWHA CORPORATION (HWC) IN ULSAN, REPUBLIC OF KOREA

(UNFCCC Registration Ref. No. 0922)

Monitoring Period:
1 January 2012 to 30 June 2012

REPORT NO. 2012-9503
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VERIFICATION / CERTIFICATION REPORT

Date of first issue: 23 October 2012	Project No.: PRJC-404673-2012-CCS-CHN
Approved by: Michael Lehmann	Organisational unit: DNV KEMA Energy & Sustainability Accredited Climate Change Serrvices
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Summary:

DNV Climate Change Services AS (DNV) has performed the verification of the emission reductions reported for the "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" (UNFCCC Registration Ref. No. 0922) for the period 1 January 2012 to 30 June 2012.

In our opinion, the GHG emission reductions reported for the period in the monitoring report (version 3.0) of 20 September 2012 are fairly stated.

The GHG emission reductions were calculated correctly on the basis of the approved monitoring methodology AM0028 (version 03), the Project Design Document (version 8 of 17 November 2006) and the revised monitoring plan approved on 7 September 2010.

DNV Climate Change Services AS is able to certify that the emission reductions from the "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" during the period 1 January 2012 to 30 June 2012 amount to 153 562 tonnes of CO_2 equivalents.

Report No.: 2012-9503	Subject Group: Environment
Report title: Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea	
Work carried out by: Lin Wu	
Work verified by: Patrice Massicard, Rafi-ud-Din Khawaja	

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Abbreviations

AOR	Ammonia Oxidation Reactor
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CER	Certified Emission Reduction(s)
CH_4	Methane
CL	Clarification request
CM	Combined margin
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DNA	Designated National Authority
DNV	Det Norske Veritas
DOE	Designated Operational Entity
ERP	Enterprise Resource Planning
FAR	Forward Action Request
GHG	Greenhouse gas(es)
GWP	Global Warming Potential
HWC	Hanwha Corporation
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquid natural gas
MR	Monitoring Report
N_2O	Nitrous oxide
NDIR	Non Dispersive Infrared Absorption
PDD	Project Design Document
PP	Project participant
PS	Clean Development Mechanism Project Standard
UNFCCC	United Nations Framework Convention on Climate Change
VVS	Clean Development Mechanism Validation and Verification Standard

1 INTRODUCTION

Hanwha Corporation has commissioned DNV Climate Change Services AS (DNV) to carry out verification and certification of the emission reductions reported for the "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" (the project) for the period 1 January 2012 to 30 June 2012. This report contains the findings from this verification assignment and a certification statement for the certified emission reductions.

1.1 Objective

Verification is the periodic independent review and ex post determination by the Designated Operational Entity (DOE) of the monitored reductions in GHG emissions that have occurred as a result of the registered CDM project activity during a defined verification period.

Certification is the written assurance by a DOE that, during a specific period in time, a project activity achieved the emission reductions as verified.

The objective of this verification was to verify and certify emission reductions reported for "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" for the period 1 January 2012 to 30 June 2012.

1.2 Scope

The scope of the verification is to verify that:

- The project activity has been implemented and operated in accordance with the registered PDD or any approved revised PDD;
- The monitoring plan complies with the monitoring methodology and the actual monitoring complies with the monitoring plan, including compliance with any guidance provided by the Board regarding deviations from the provisions of a registered plan and/or methodology;
- The data and calculation of GHG emission reductions have been assessed to correctly support the emission reductions being claimed.

The verification shall ensure that reported emission reductions are complete and accurate in order to be certified.

1.3 Description of the project activity

Project Parties:	Republic of Korea (host party), Japan and Switzerland (other parties)
Title of 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
UNFCCC registration No:	0922

Baseline and monitoring methodology:	AM0028 (version 03)
Project Participants:	Hanwha Corporation, Mitsubishi Corporation (Korea) Ltd. Mitsubishi Corporation from Japan
	Hanwha Corporation from Switzerland
Location of the project activity:	Ulsan, eastern coast of the Republic of Korea
Project's crediting period:	27 June 2007 to 26 June 2014 (renewable)
Period verified in this verification:	1 January 2012 to 30 June 2012

The project has been in operation since June 2007, and was registered on 3 May 2007. The project covers one nitric acid plant and the first project campaign with abatement catalyst installed started operation from 27 June 2007. As per the PDD, the renewable crediting period for the project was from 1 July 2007 to 30 June 2014. However, since the actual start date of the project activity was on 27 June 2007, the renewable crediting period for the project has been changed to 27 June 2007 - 26 June 2014 and this change was accepted by the UNFCCC.

The project has installed tertiary N_2O reduction technology in the tail gas stream of the nitric acid production plant of Hanwha Corporation in Ulsan, Korea. Nitrous oxide, formed as a by-product of the nitric acid production, is removed by a DeN_2O system provided by N.E.Chemcat Corporation and Sumitomo Metal Mining Engineering Corporation.

The tail gas from the nitric acid facility is fed into the DeN_2O system and the nitrous oxide is reduced by more than 90% /29/. The stack gas volume flow and the nitrous oxide concentration inlet and outlet of the DeN_2O system are monitored and recorded. The natural gas used in the catalytic reduction is monitored in order to calculate the non-N_2O emissions of the project activity. Further the electricity used to operate the facility is measured and counted as leakage emissions.

The emission reductions reported from the project for the period from 1 January 2012 to 30 June 2012 equate to 153 562 tonnes of CO_2 equivalents /2/.

1.4 Methodology for determining emission reductions

As specified in the applied methodology, AM0028 (version 03) /36/, the emission reduction is determined by the following formulae:

$$ER_y = BE_y - PE_y - LE_y$$

Where,

ER_y emission reductions of the project activity during the year y (tCO_2e)

BE_y baseline emissions during the year y (tCO_2e)

PE_y project emissions during the year y (tCO_2e)

LE_y leakage emissions in the year y (tCO_2e)

Where,

BE_y = Minimum ($P_{product,max}$ or $P_{product,y}$) / $P_{product,y}$ * $\sum_{i=1}^{n}$ [$F_{TI,i}$ * $CI_{N2O,i}$ * M_i] * GWP_{N2O}

i:	Interval
n:	Number of intervals during the year
$F_{TI,i}$:	Volume flow rate at the inlet of the destruction facility during interval i (Nm^3/h)
$CI_{N2O,i}$:	N_2O concentration at destruction facility inlet during interval i (tN_2O/Nm^3)
M_i:	Measuring interval (1 hour)
GWP_{N2O}:	Global warming potential of N_2O
$P_{product,max}$:	Design capacity ($tHNO_3/yr$)
$P_{product,y}$:	Production of nitric acid in a year y ($tHNO_3/yr$)

$PE\_y = PE_{ND,y} + PE_{DF,y}$

$= PE_{ND,y} + HCE_{C,y} + HCE_{NC,y}$

$PE_{ND,y}$:	Project emissions from N_2O not destroyed in year y (tCO_2e/yr)
$PE_{DF,y}$:	Project emissions related to the operation of the destruction facility in year y (tCO_2e/yr)
$HCE_{C,y}$:	Converted hydrocarbon emissions in year y (tCO_2/yr)
$HCE_{NC,y}$:	Methane emissions in year y (tCO_2e/yr)

$PE_{ND,y} = \sum_{i=1}^{n}$ [$F_{TE,i}$ * $CO_{N2O,i}$ * M_i]* GWP_{N2O}

i:	Interval
n:	Number of intervals during the year
$F_{TE,i}$:	Volume flow rate at the exit of the destruction facility during interval i (Nm^3/h)
$CO_{N2O,i}$:	N_2O concentration in the tail gas of the N_2O destruction facility during interval i (tN_2O/Nm^3)
M_i:	Length of measuring interval i (h)
GWP_{N2O}:	Global warming potential of N_2O

$HCE_{C,y} = \rho_{NMHC} * Q_{NMHC,y} * EF_{NMHC}$

$HCE_{NC,y} = \rho_{HNC} * Q_{HNC,y} * GWP_{CH4}$

ρ_{NMHC}:	Hydrocarbon (Non-methane part of the natural gas) density (tNMHC/Nm³)
$Q_{NMHC,y}$:	Hydrocarbon (Non-methane part of the natural gas) input in year y (Nm³)
EF_{NMHC}:	Carbon emissions factor of hydrocarbon (Non-methane part of the natural gas) (tCO_2/tNMHC)
ρ_{NMHC}:	Methane (Non-methane part of the natural gas) density (tCH_4/Nm^3)
ρ_{HNC}:	Methane (Methane part of the natural gas) density (tCH_4/Nm^3)
$Q_{HNC,y}$:	Methane (Methane part of the natural gas) used in year y (Nm³)
GWP_{CH4}:	Global warming potential of methane

For this project, the above formulae conservatively assume that 0% of the methane is converted and 100% of NMHC is converted. That is because the fraction of methane unconverted is not being measured due to unreasonable costs as stated in the PDD, which is in line with the requirements in AM0028.

$LE_y = EI_{RCS,y} * EF_{RCS}$

$EI_{RCS,y}$:	Additional electricity input for running the DeN_2O unit (MWh/yr)
EF_{RCS}:	Emissions factor of the electricity for running the DeN_2O unit

Among the parameters described above, the followings are the main parameters determined ex ante:

- GWP_{N2O}: Global warming potential of N_2O: 310
- GWP_{CH4}: Global warming potential of CH_4: 21
- $P_{product,max}$: Design capacity of nitric acid production: 107 100 $tHNO_3$/yr
- EF_{RCS}: Emission factor of the electricity for running the DeN_2O unit: 0.62 tCO_2e/MWh

The following parameters are to be monitored during the monitoring period:

- $F_{TE,i}$: Volume flow rate at the exit of destruction facility during interval *i*
- $CO_{N2O,i}$: N_2O concentration at destruction facility outlet
- $CI_{N2O,i}$: N_2O concentration at destruction facility inlet
- $P_{product,y}$: Production of nitric acid in year y (t Product)
- $Q_{NMHC,y}$: Hydrocarbon (Non-methane part of the natural gas) input in year y
- $Q_{HNC,y}$: Methane (methane part of natural gas) input in year y
- ρ_{NMHC}: Hydrocarbon (non-methane part of natural gas) density
- ρ_{HNC}: Methane (methane part of natural gas) density
- $EI_{RCS,y}$: Additional electricity input for running the DeN_2O unit

2 METHODOLOGY

DNV has assessed and determined that the implementation and operation of the project activity, and the steps taken to report emission reductions comply with the CDM criteria and relevant guidance provided by the Board.

The assessment involved a desk review of relevant documentation as well as an on-site visit(s).

Verification team

				Type of involvement					
Role	***Last Name***	***First Name***	***Country***	Desk review	Site visit	Reporting	Supervision of work	Technical review	TA 5.1 competence
Team leader (Verifier)	Lin	Wu	China	✓	✓	✓	✓		✓
Technical reviewer	Massicard	Patrice	Norway					✓	
Technical reviewer	Khawaja	Rafi-ud-Din	Norway					✓	✓

In addition, Kim Tae Ho, an auditor of DNV Certification Ltd., Seoul, Korea supported the Team Leader during the site visit with translating.

Duration of verification

Monitoring report publication:	23 July 2012
Desk review:	6 August 2012 to 10 August 2012
On-site assessment:	14 August 2012
Reporting, calculation checks and QA/QC:	15 August 2012 to 23 October 2012

2.1 Desk review

In addition to the monitoring report (version 1.0 dated 19 July 2012 and version 3.0 dated 20 September 2012) /1/, DNV reviewed:

- The registered PDD /29/ and the corresponding validation report /30/, and approved revised monitoring plan /31/;
- The previous verification reports /32/;

- The approved baseline and monitoring methodology AM0028 (version 03) applied by the project /36/;
- Relevant decisions, clarifications and guidance from the CMP and the CDM Executive Board /35/; and
- Other information and references relevant to the project activity /2/-/28/.

During the desk review, DNV has applied standard auditing techniques to assess the quality of information provided. The following activities were performed:

- A review of the data and information presented to verify their completeness;
- A review of the monitoring plan and monitoring methodology, paying particular attention to the frequency of measurements, the quality of metering equipment including calibration requirements, and the quality assurance and quality control procedures; and
- An evaluation of data management and the quality assurance and quality control system in the context of their influence on the generation and reporting of emission reductions.

2.2 On-site assessment

On 14 August 2012, DNV auditor Lin Wu visited Hanwha Corporation, and performed on-site assessment. Key personnel of the project were interviewed by the verification team /37/-/39/.

During the on-site assessment, DNV has applied standard auditing techniques to assess the quality of information provided. The following aspects of the CDM project activity have been verified:

- The implementation and operation of the CDM project activity as described in the PDD;
- The information flow for generating, aggregating and reporting of the monitoring parameters; and
- The operational and data collection procedures are implemented in accordance with the monitoring plan in the PDD.

Further, the following activities were performed:

- A cross-check between information provided in the monitoring report and data from other sources;
- A check of the monitoring equipment including calibration performance and observations of monitoring practices against the requirements of the PDD and the selected methodology;
- A review of calculations and assumptions made in determining the GHG data and emission reductions; and

- An identification that quality control and quality assurance procedures in place to prevent or identify and correct any errors or omissions in the reported monitoring parameters.

The data presented in the monitoring report were assessed by review of the detailed project documentation and production records, as well as by interviews with personnel at Hanwha Corporation and Mitsubishi Corporation, and collection of measurements, observation of established monitoring and reporting practices and assessment of the reliability of monitoring equipment. This has enabled the verification team to assess the accuracy and completeness of reported monitoring results; to verify the correct application of the approved monitoring methodology and the determination of the reductions in N_2O emissions.

In addition all parameters required by the monitoring methodology AM0028 (version 03), and the management system were assessed during the site visit.

2.3 Closing out of verification findings

The objective of this phase of the verification was to resolve any issues which needed be clarified prior to DNV's conclusion that i) the project activity has been implemented and operated in accordance with the registered PDD or any approved revised PDD, ii) the monitoring plan complies with the monitoring methodology and the actual monitoring complies with the monitoring plan and iii) the data and calculation of GHG emission reductions are correct.

A corrective action request (CAR) is issued, where:

i. Non-conformities with the monitoring plan or methodology are found in monitoring and reporting and has not been sufficiently documented by the project participants, or if the evidence provided to prove conformity is insufficient;

ii. Modifications to the implementation, operation and monitoring of the registered project activity has not been sufficiently documented by the project participants;

iii. Mistakes have been made in applying assumptions, data or calculations of emission reductions which will impair the estimate of emission reductions;

iv. Issues identified in a FAR during validation to be verified during verification have not been resolved by the project participants.

A clarification request (CL) shall be raised if information is insufficient or not clear enough to determine whether the applicable CDM requirements have been met.

A forward action request (FAR) is issued for actions if the monitoring and reporting require attention and/or adjustment for the next monitoring period.

The verification identified four CARs and four CLs, but no FAR was raised. The CARs and CLs were satisfactorily addressed by the project participants in the revised monitoring report (refer to Appendix A for further details). In addition to the changes made to the monitoring report as a result of the verification findings, the following changes to the monitoring report (version 3.0 dated 20 September 2012) were made compared to the initial version of the monitoring report received for verification (version 1.0 dated 19 July 2012):

- The national regulation "Framework ACT Low Carbon Green Growth" was considered in the assessment of N_2O regulation on the project activity;

- The calculating formula for the baseline emissions (BE_y) listed in the MR was updated to follow the methodology and PDD.

3 VERIFICATION FINDINGS

This section summarises the findings from the verification of the emission reductions reported for the project "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" for the period 1 January 2012 to 30 June 2012.

3.1 Remaining issues, CARs, FARs from previous validation / verification

One FAR was remaining from the previous 5th verification of the project as follows:

- *The QAL3 tests have not been conducted always every 10 days in this monitoring period according to the calibration plan stipulated. The Uras analyser supplier ABB just requested three weeks calibration frequency, and also has stated in the calibration plan that the calibration results are available within three weeks. Hence, DNV considered that the QAL3 tests conducted in year 2011 did not have negative effect on the emission reductions claimed in this monitoring period. However, as the management system and quality assurance, the stipulated frequency (every 10 days) of QAL3 test should be followed. Hence, a FAR was raised for attention in next verification.*

During site visit, the QAL3 tests performed within the current monitoring period were verified by DNV to be conducted within every 10 days. The assessment of this FAR has been addressed and closed in Appendix A.

3.2 Post registration changes

There were no post registration changes identified by DNV during this verification.

3.3 Project implementation

The project was implemented and maintains its operation as described in the registered PDD. During the on-site visit DNV inspected the installation of the DeN_2O system and all instrumentation necessary for the monitoring of the emission reductions. All physical features (technology, project equipment and monitoring/metering equipment) of the project are in place as per the registered PDD.

The project has been in operation since 27 June 2007. Guarantee test runs were performed from 3 July to 6 July 2007. During the test runs it was demonstrated that all guarantee figures were exceeded /12/.

The verification team confirmed through visual inspection that all physical features of the proposed CDM project activity including data collection systems and storage have been implemented in accordance with the registered PDD (version 8 of 17 November 2006) /29/ and the revised monitoring plan accepted by the CDM EB on 7 September 2010 /31/. The project is completely operational which was confirmed by means of the on-site visit. Neither a notification nor approval of change has been requested to CDM Executive Board in this monitoring period.

Operation during the monitoring period:

The operation of the campaign and the installed catalyst are summarized in the following table. It was verified through the daily operation log of the nitric acid plant /23/ and the invoice from the catalyst supplier /9/.

Monitoring period 1 January 2012 to 30 June 2012	Project campaign period	AOR catalyst supplier and composition
1st campaign period related to this monitoring period	Start: 8 December 2011 End: 10 April 2012	Johnson Matthey Pt: 95%, Rh: 5%
2nd campaign period related to this monitoring period	Start: 11 April 2012 End: operation ongoing at the end of the monitoring period	Johnson Matthey Pt: 95%, Rh: 5%

During this monitoring period, lasting 182 days, the operation of the nitric acid plant was stopped for the duration mentioned below for the replacement of primary catalyst and other technical reasons, as confirmed by DNV through checking the daily operation records /23/. DNV can confirm that no emission reductions were claimed for those periods when the nitric acid plant was under shutdown /2/,

- 12 March 2012 (12:00) to 12 March 2012 (16:00) due to malfunction of instrument
- 10 April 2012 (5:00) to 11 April 2012 (2:00) due to replacement of primary catalyst

Except the documented downtimes of the nitric acid plant as listed above, DeN_2O unit was also stopped due to its maintenance and other technical reasons, which was confirmed through checking the daily operation records /23/. The downtimes of DeN_2O unit are as follows:

- 12 March 2012 (13:00) to 13 March 2012 (1:00) due to malfunction of instrument
- 10 April 2012 (4:00) to 11 April 2012 (9:00) due to plant shut down for replacement of primary catalyst
- 16 April 2012 (6:00) to 17 April 2012 (19:00) due to rotary valve trip of DeN_2O unit

Since the actual N_2O concentration at the destruction facilities outlet occasionally exceeded the upper limit of the measurement range of NDIR analyzer due to the lower N_2O destruction efficiency than expected, the upper limit of the measurement range of the N_2O outlet analyzer was expanded from 300 ppm to 500 ppm on 19 January 2010, and corresponding revision of the monitoring plan has been approved by EB on 7 September 2010. However, the N_2O concentration at the N_2O destruction facilities outlet in some periods still exceeded the upper limit of the measurement range (500 ppm) of NDIR analyzer during the following periods:

- 13 March 2012 (1:00) to 13 March 2012 (2:00)
- 10 April 2012 (4:00) to 10 April 2012 (5:00)
- 11 April 2012 (9:00) to 11 April 2012 (11:00)
- 16 April 2012 (6:00) to 18 April 2012 (2:00)

The project participants excluded the emission reductions during these periods while the N_2O concentration was out of the measurement range of the analyzer as the values obtained were not reliable. The verification team assessed the facts through confirming the data log sheet generated by the data logging system /23/ and concluded that the discounting was appropriate /2/.

3.4 Information (data and variables) provided in the monitoring report that is different from that stated in the registered PDD

The annual emission reductions in the PDD were estimated as 281 272 tCO_2e and the emission reductions achieved during this monitoring period from 1 January 2012 to 30 June 2012 (182 days) were 154 545 tCO_2e (emission reductions achieved before deducting excess emission reductions occurring during previous monitoring periods as described below), which corresponds to the yearly emission reductions of 309 939 tCO_2e (considering 365 calendar days). Hence, the reported emission reductions for the project activity are higher than the ex-ante emission reductions estimated in the PDD. The N_2O destruction efficiency in this monitoring period (88%) is slightly lower than the expected value of 90% indicated in the PDD, and the main reasons contributing to the higher emission reductions are as follows:

- longer valid operating time (178.75 days in this monitoring period) of DeN_2O unit (excluding the periods where the N_2O concentration was out of the measurement range of the analyzer) compared to the expected operating time of 165 days for this monitoring period (330 days operation was expected for each year in the PDD, corresponding to 165 days for half of year);
- Increased nitric acid production (52 013.84 $tHNO_3$ in this monitoring period, corresponding to yearly basis of 104 313 $tHNO_3$) compared to the amount estimated (97 020 $tHNO_3$) used in the ex-ante emission reduction calculation in the PDD, where the higher inlet flow rate was achieved. However, as stated in section 3.6.2, the actual nitric acid production of 52 013.84 t 100% HNO_3 for this monitoring period over 182 days is still below the design capacity according to the methodology.

Further, as discussed in CL4 in Appendix A, DNV found that incorrect historical operating pressures were applied in the published monitoring report (version 1.0 dated 19 July 2012). The same error also occurred in the emission reductions reported for the 4th and 5th monitoring periods (1 January 2010 - 31 December 2010 and 1 January 2011 - 31 December 2011), for which CERs have been issued. DNV re-assessed the emission reductions of 4th and 5th monitoring periods by considering the correct historical operating pressure /33/, and found there is no effect on the 5th monitoring period, but there are 983 tonnes CO_2e which were issued erroneously and in excess for the 4th monitoring period from 1 January 2010 - 31 December 2010. To correct this mistake, the excess CER claimed for the 4th monitoring period are deducted from the total emission reductions claimed in this monitoring period. Hence, the corrections results in a final emission reductions claimed for this monitoring period of 153 562 tCO_2e.

Therefore, DNV considers emission reductions claimed in the monitoring period are reasonable.

3.5 Compliance of the monitoring plan with the monitoring methodology

DNV is able to confirm that the monitoring plan contained in the registered PDD, version 8 of 17 November 2006 and revised monitoring plan accepted by the CDM EB on 7 September 2010 is in accordance with the approved methodology applied by the project activity, i.e. AM0028 (version 03).

3.6 Compliance of monitoring with the monitoring plan

The monitoring has been carried out in accordance with the monitoring plan in the registered PDD (version 8 of 17 November 2006) and the revised monitoring plan accepted by the CDM EB on 7 September 2010. All parameters were monitored and determined as per the monitoring plan.

All parameters stated in the validated monitoring plan are monitored and reported appropriately. The monitoring report lists each parameter required by the monitoring plan and the information flow (i.e. from data generation, aggregation, recording, calculation and reporting) for these parameters is provided in the monitoring report. The information flow for each parameter is further verified in the following sections. The monitoring methodologies and sustaining records are sufficient to enable verification of emission reductions.

The N_2O concentrations (destruction facilities inlet and outlet) are measured by NDIR; in addition Hanwha Corporation has a procedure for regularly measuring the concentration by gas chromatography from external laboratory /21/ /22/. The test reports were checked on-site and the NDIR data and the gas chromatography data were found consistent.

The completeness of the monitoring was assessed and summarized in section 3.6.2 to 3.6.5 of this verification report.

A procedure for monitoring N_2O regulation is included in the CDM procedure and the corresponding report shows there is no N_2O regulation in Korea applicable to the project activity in this monitoring period /24/ /28/.

3.6.1 Data flow

The recording in production logs, the calibration and maintenance routines for the below parameters are the responsibility of Hanwha Corporation and the related procedures are incorporated into the existing QA/QC management system. The recorded values for the operating temperature and pressure for the operation and ammonia inlet flow of the ammonia oxidation reactor are automatically transferred to the electric media in the redundant storage system. The nitric acid production is manually transferred to the electric media by the responsible project manager from Hanwha Corporation.

3.6.2 Permitted operating conditions

In order to avoid that the operation of the nitric acid production plant is manipulated in a way to increase the N_2O generation, and thereby increasing the CERs, the ammonia flow, operating temperature and pressure in the ammonia oxidation reactor and the use of ammonia oxidation catalyst is monitored and compared to the historical values as determined in the PDD. If a permitted operating limit is exceeded, the baseline N_2O emissions for that period shall be capped at the conservative IPCC default value of 4.5 kg $N_2O/tHNO_3$.

The permitted range of the ammonia oxidation reactors (temperature and pressure) and the ammonia input provided in the registered PDD were based on the historical data (January 2000 - November 2003 and January 2005 - October 2006) and the data for the type of ammonia oxidation catalyst is from the supplier /29/. However, it was found during the 1st verification report /32/, that the permitted operating conditions in the registered PDD (version 8 of 17 November 2006) were determined based on the upper 1.25% and lower 1.25% quantile of the historical operating data (temperature and pressure) while the applied methodology required the upper 2.5% and lower 2.5% quantile. The correction has been conducted in 1st verification report and the permitted operating conditions were determined as follows:

$\mathbf{T_{g,hist}}$	Historical operating temperature range AOR (°C): 867.4-905.2
$\mathbf{P_{g,hist}}$	Historical operating pressure range AOR (Pa gauge): 707 100-876 700
$\mathbf{A_{OR,hist}}$	Historical ammonia input to oxidation reactor (tNH_3/day): 88
$\mathbf{G_{sup,hist}}$	Historical supplier of the ammonia oxidation catalyst: Johnson Matthey
$\mathbf{G_{com,hist}}$	Historical composition of the ammonia oxidation catalyst: 95% Pt and 5% Rh

Through checking daily generated report /3/ /4/, DNV can confirm that in this monitoring period the operating conditions (temperature and pressure) of the ammonia oxidation reactor were all within the permitted range. Hence, the conservative emission factor of 4.5 kg $N_2O/tHNO_3$ was not applied in this monitoring period to baseline emission calculation.

The project and baseline emissions are limited to the design capacity of the existing nitric acid plant. If the actual production of nitric acid ($P_{product,y}$) exceeds the design capacity ($P_{product,max}$), then emissions related to the production above $P_{product,max}$ will neither be claimed for the baseline nor for the project scenario. The design capacity for Hanwha nitric acid plants described in the registered PDD is 107 100 $tHNO_3$/yr. During this monitoring period, the reported value is 52 013.84 $tHNO_3$/yr (corresponding to yearly basis of 104 313 $tHNO_3$) and thus below the design capacity. It was confirmed through the daily operation log /23/ and ERP data /25/.

Data variable	Tag. No.	Reported value	Assessment/Observation
$A_{OR,d}$ Actual ammonia input to oxidation reactor (tNH_3/day) * reported in tonnes	**10-FT-502** Range: 0-6000 Nm^3/h 10-PT-302 Range: 0-16 bar 10-TT-102 Range: 0-500 ^oC	Min.: 70.90 Max.: 87.47 Historical: 88 t/day	**Instrument:** • Ammonia flow meter, differential pressure transmitter • Pressure transmitter • Resistance temperature detector The range is appropriate. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly **Information flow:** The measurement is to be done at the upstream of ammonia/air mixer.

			The flow rates are to be normalised by temperature and pressure measurement. The instruments transfer the flow data (Nm^3) continuously to the distributed control system of the of the nitric acid plant. The plant operators record hourly cumulative values. These hourly reports include the actual ammonia input to oxidation reactor, and are digitally transferred to spreadsheet. The spreadsheet includes automatic checks, if daily values are exceeding the historical maximum. For conversion from Nm^3 to tNH_3, a correct constant factor (ammonia density) is used. The value of 0.7708 kg/cm^3 (under standard conditions) as the ammonia density from the Physics Handbook /34/ was referred. **QC/QA:** The QA is covered by the Quality Management procedures of the nitric acid plant. Ammonia flow meter, differential pressure transmitter (10-FT-502): Model: 3051CD2A02A1AM5E5S5Q4 Serial No.: 01564836 Accuracy: ± 0.10% of full scale Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012 Pressure transmitter (10-PT-302): Model: 3051TG3A2B21AB4E5M5Q4 Serial No.: 01624987 Accuracy: ± 0.065% of full scale Calibration frequency: 15 months Dates of calibration: 8 July 2011 Validity: 7 October 2012 Resistance temperature detector (10-TT-102): Model: R221 Serial No.: 04014993 Accuracy: ± 0.55 ^oC Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012

			The calibration /8/ covers the whole monitoring period. The calibration confirmed proper functioning of the monitoring equipment and is valid for the monitoring period. The actual ammonia input to the ammonia oxidation reactor described in the spread sheets /3/ /4/ provided from the project participant (PP) was confirmed to be in line with the raw data in the daily log by sampling /23/.
T_g Actual operating temperature AOR on day (°C)	**10-TT-115** Range: 0-1200 °C	Min.: 887.03 Max.: 903.67 Historical operating temperature range AOR (°C): 867.4-905.2	**Instrument:** The temperature in the ammonia reactor is monitored by an R type thermocouple. The range is appropriate. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly (average) **Information flow:** The measurement location is the catalyst basket filled with Raschig ring inside of the ammonia oxidation reactor. The range is appropriate. The instruments transfer the temperature data continuously to the distributed control system of the of the nitric acid plant. The plant operators record hourly instantaneous data and obtain the daily average from the 24 instantaneous data. **QC/QA** The thermocouple is normally changed approximately every 1 year depending on the shutdown schedule and then calibrated. Thermocouple: Model: YTA 110 Serial No.: C2E104013502 Accuracy: ± 1.5 °C of full scale Calibration frequency: 15 months Dates of calibration: 8 July 2011 Validity: 7 October 2012

			The calibration /8/ covers the whole monitoring period. The verification team confirmed the calibration results were within the error range. The equipment was deemed to be working properly during the monitoring period. The actual temperature of ammonia oxidation reactor described in the spread sheets /3/ /4/ was confirmed to be in line with the raw data in the daily log by sampling /23/. DNV can confirm that in this monitoring period the operating temperature of the ammonia oxidation reactor were all within the permitted range.
P_g Actual operating pressure AOR on day (Pa)	**10-PT-304** Range: 0-16*10^5 Pa	Min.: 7.20*10^5 Max.: 8.43*10^5 Historical operating pressure range AOR (Pa gauge): 7.071–8.767*10^5	**Instrument:** The transmitter is supplied by Honeywell. The operating pressure measuring point is between air compressor and NH_3 air mixer. The range is appropriate. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly (average) **Information flow:** The instruments transfer the pressure data continuously to the distributed control system of the of the nitric acid plant. The plant operators record hourly instantaneous data and obtain the daily average from the 24 instantaneous data. **QC/QA:** The QC/QA is covered by the Quality Management procedures of the nitric acid plant. Pressure transmitter: Model: STG 944-E1G-00000-S1 Serial No.: 0729 07062904012 Accuracy: ±0.065% of full scale Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012

			The calibration /8/ covers the whole monitoring period. The verification team confirmed the calibration results were within the error range. The equipment was deemed to be working properly during the monitoring period. The actual temperature of ammonia oxidation reactor described in the spread sheets /3/ /4/ was confirmed to be in line with the raw data in the daily log by sampling /23/. During the monitoring period, the daily average pressure of the ammonia oxidation reactor was out of the permitted range on the date of 15 February 2012, and re-calculation was conducted on the CER by applying the conservative IPCC default value of 4.5 $kgN_2O/tHNO_3$ to the baseline emission factor. It was confirmed through the spreadsheet /4/.
G_{sup} Supplier of the ammonia oxidation catalyst	-	**Johnson Matthey** Historical: Johnson Matthey	During the monitoring period, ammonia oxidation catalysts were replaced in April 2012 /23/. The commercial invoice was made available to verify the supplier /9/. The supplier was Johnson Matthey and same as the supplier of historical campaigns.
G_{com} Composition of the ammonia oxidation catalyst	-	**95% Pt, 5% Rh** Historical: 95% Pt, 5% Rh	The catalyst gauze was installed in April 2012 /23/. Commercial invoice was made available to verify the composition /9/. The composition was 95% Pt / 5% Rh, and same as composition of historical campaigns.
$P_{product, y}$ Plant output of nitric acid $tHNO_3$	**10-FT-512** Range: 0 – 20 m^3/h	**52 013.84 $tHNO_3$** Design capacity: 107 100 $tHNO_3/yr$	**Instrument:** The nitric acid flow is measured by two sets of magnetic flow meter supplied by YAMATAKE and ROSEMOUNT, respectively. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly **Information flow:** The hourly rate in m^3/h is automatically measured in the DCS. Average mass

			concentration and density of produced nitric acid are used to calculate the quantity of pure nitric acid. **QC/QA:** The QA is covered by the Quality Management procedures of the nitric acid plant. Magnetic flow meter: Rosemount/Emerson Model: 8705TPA020S1W0N0G3B3Q4 Serial No.: 06011102 Accuracy: ± 0.5% of span / ± 0.675% of span Calibration frequency: 15 months Dates of calibration: 29 June 2011 Validity: 28 September 2012 The calibration /8/ covers the whole monitoring period. The verification team confirmed the calibration results were within the error range. The equipment was deemed to be working properly during the monitoring period. The actual nitric acid production described in the spread sheets /3/ /4/ was confirmed to be in line with the raw data in the daily log by sampling /23/. The nitric acid production from 1 January 2012 to 30 June 2012 was 52 013.84 $tHNO_3$, corresponding to yearly basis of 104 313 $tHNO_3$, and less than the annual design capacity of 107 100 $tHNO_3$.

3.6.3 Monitored data for project emissions within the project boundary

The main emission source from the project is the remaining quantity of N_2O in the outlet of the destruction unit. The other sources are the emissions from the hydrocarbon used as a reheating fuel to enhance the efficiency of the catalytic reduction by raising the DeN_2O unit operating temperature. Natural gas is used as the reheating fuel for DeN_2O unit.

The following data has been assessed in detail:

Data variable	Tag. No.	Reported value	Assessment/Observation
$F_{TE,i}$ Volume flow rate at the exit of the gas destruction facility (Nm^3)	**10-FT-562** Range: 0-60 000 Nm^3/h **10-PT-362** Range: (-)0.1-0.1 bar **10-TT-162** Range: 0-500 ^oC	**167 975 214** Nm^3 (total volume during this monitoring period)	**Instrument:** A multi-hole sampling tube type flow meter is installed according to the manufacture's guidance. Differential pressure is measured before and behind the multi-hole pitot tube. For calculation of volume flow at standard conditions the system was equipped with temperature and pressure transmitters. The pressure transmitters were delivered by Honeywell. The temperature transmitter was delivered by Wise. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly (average) **Information flow:** The differential pressure transmitter generates data and transfers them to Durag. Durag generates the temperature/pressure compensated data and their hourly average concentration. **QC/QA:** The two sets of differential pressure transmitter, pressure transmitters and the temperature transmitter have been used and periodically calibrated. Ammonia flow meter, differential pressure transmitter (10-FT-562): Model: Honeywell STD924-W1H-00000-S2 Serial No.: 0712 07030214002 Accuracy: ±0.075% of full scale Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012 Pressure transmitter (10-PT-362): Model: Honeywell STG 944-E1G-00000-S1 Serial No.: 9853 00002001004

			Accuracy: ±0.065% of full scale Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012 Resistance temperature detector (10-TT-162): Model: WISE controls, R221+MTM Serial No.: WS-7M140 Accuracy: ±0.3% of full scale Calibration frequency: 15 months Dates of calibration: 8 July 2011 Validity: 7 October 2012 The calibration /8/ covers the whole monitoring period. The verification team confirmed the calibration results were within the error range. The equipment was deemed to be working properly during the monitoring period. The calibration also confirmed proper functioning of the monitoring equipment.
$CO_{N2O,i}$ N_2O concentration at destruction facility outlet (tN_2O/Nm^3)	**10-AT-062** Range: 0-500 ppmv	Average: **4.057487E-07** t N_2O/Nm^3 (corresponds to 207 ppmv)	**Instrument:** The concentration of N_2O in the tail gas is continuously measured by a NDIR analyser Uras26 provided by ABB. The measuring range was changed from 0-300 ppmv to 0-500 ppmv on 19 January 2010 during AST. Such change has been approved by CDM-EB on 7 September 2010 through a revision of the monitoring plan Accuracy N_2O analyser: ± 0.02% of full scale. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly (average) **Information flow:** The analyser generates every second data and transfers them to the Durag data acquisition system. Durag generates the temperature/pressure compensated data and their hourly average concentration data.

			QC/QA: The analyser was properly installed and calibrated prior to start-up. The analyser is self-calibrated, using a set of certified gases /7/. The calibration gases used is supplied by Deokyang Energen Corporation and found to cover the range of measurements in the verifying period. The calibration gases were marked to be stable at their bottles and certificates were available. **Calibration frequency:** As per EN14181, QAL2 test (determination of calibration function and its variability) is required at least every 3 years and AST (validation of calibration function) annually in-between QAL2. EN14181 requires that QAL3 calibrations (zero and span check) are carried out periodically. The AMS supplier ABB recommended every three weeks /27/. The QAL3 test frequency was changed to every 10 days during the 1st verification (27 June 2007 to 31 December 2007) /32/ due to the service agreement between Hanwha Corp. and Instrument & Analyser Corp. /15/ which is found acceptable according to EN14181, and also can be confirmed by the calibration plan agreed by Hanwha Corporation and Instrument & Analyzer Corporation on 2 January 2011 /26/. Hence, the frequency of QAL 3 test was every 10 days. **Calibration:** QAL2: 20 January 2011 AST: 17 January 2012 QAL3: The last QAL3 test was conducted on 23 June 2012. DNV have checked all QAL3 tests and confirmed that all QAL3 tests were conducted within every 10 days **Validity:** QAL2: 19 January 2014 AST: 16 January 2013 QAL3: 3 July 2012

			The QAL2/AST test /18/ /19/ and QAL3 test /20/ can confirm proper functioning of the monitoring equipment. The calibrations are valid for the whole monitoring period and the calibration of measuring equipment was conducted at a frequency following EN14181 which was stipulated in the methodology. The concentration is also cross-checked by gas chromatography (GC) /22/. Its analysis is conducted once every 3 months through sampling. The data from N_2O analyser is compared with that of GC. The measurements from GC showed that the measurements from Uras26 were proper. The specification of GC /21/ and standard gas certificate /7/ were kept on site.
$Q_{NG,y}$ Hydrocarbon (Nm^3)	**10-FT-563** Range: 0-100 Nm^3/h	**89 202.70** Nm^3	**Instrument:** The natural gas flow is measured with the Orifice flow meter supplied by Honeywell and Rosemount, respectively. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly **Information flow:** The flow meter located at the burner Inlet of DeN_2O unit. The hourly rate is recorded in the data management system. **QC/QA:** The QA is covered by the Quality Management procedures of the Nitric acid plant. Orifice flow meter: Rosemount/Emerson Model: 3095MFCCS020N040T32BA1AQ4I5M5 Serial No.: 02357885 Accuracy: ±1.00809% of full scale, ±0.78% of full scale Calibration frequency: 15 months Dates of calibration: 12 May 2011 Validity: 11 August 2012

			The calibration /8/ covers the whole monitoring period. The verification team confirmed the calibration results were within the error range. The equipment was deemed to be working properly during the monitoring period.

3.6.4 Monitored data for baseline emissions within the project boundary

The only emission source in the baseline is the inlet quantity of N_2O in the tail gas entering the DeN_2O System. The quantity of N_2O is determined from the concentration of N_2O and the volume tail gas flow. As there are no regulations on N_2O emissions in Korea the monitored N_2O quantity is thus the baseline emission. The following data reported in the monitoring report has been assessed in detail.

Data variable	Tag. No.	Reported value	Assessment/Observation
$F_{TI,i}$ Volume flow rate at the inlet of the destruction facility (Nm^3)	**10-FT-561** Range: 0-60000 Nm^3/h	**163 015 272** Nm^3	**Instrument:** A multi-hole sampling tube type flow meter is installed according to the manufacture's guidance. Differential pressure is measured before and behind the multi-point sampling tube. For calculation of volume flow at standard conditions the system was equipped with temperature and pressure transmitters. The pressure transmitters were delivered by Honeywell. The temperature transmitter was delivered by Wise. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly (average) **Information flow:** The differential pressure transmitter generates data and transfers them to Durag. Durag generates the temperature/pressure compensated data and their hourly average concentration. **QC/QA:** The two sets of differential pressure transmitter, pressure transmitters and the temperature transmitter have been used and periodically calibrated. Ammonia flow meter, differential pressure transmitter (10-FT-561):

			Model: Honeywell STD924-E1H-00000-S2 Serial No.: 0712 07030214004 Accuracy: ±0.075% of full scale Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012 Pressure transmitter (10-PT-361): Model: Honeywell STG 944-E1G-00000-S1 Serial No.: 0712 07030214004 Accuracy: ±0.065% of full scale Calibration frequency: 15 months Dates of calibration: 7 July 2011 Validity: 6 October 2012 Resistance temperature detector (10-TT-161): Model: WISE controls, R221+MTM Serial No.: WS-7M139 Accuracy: ±0.3% of full scale Calibration frequency: 15 months Dates of calibration: 15 July 2011 Validity: 14 October 2012 The calibration /8/ covers the whole monitoring period. The verification team confirmed the calibration results were within the error range. The equipment was deemed to be working properly during the monitoring period. The calibrations also confirmed proper functioning of the monitoring equipment.
$CI_{N2O,i}$ N_2O concentration at destruction facility inlet (tN_2O/Nm^3)	**10-AT-061** Range: 0-3000 ppmv	**3.525415E-06** tN_2O/Nm^3 (corresponds to 1 795 ppmv)	**Instrument:** The concentration of N_2O in the tail gas is continuously measured by a NDIR analyser Uras26 provided by ABB. Accuracy N_2O analyser: ± 0.02% of full scale. **Intervals:** Measuring frequency: Continuously Recording frequency: Hourly (average) **Information flow:** The analyser generates every second data and transfers them to the Durag data acquisition system. Durag generates the temperature/pressure compensated data and

			their hourly average concentration data. **QC/QA:** The analyser was properly installed and calibrated prior to start-up. The analyser is self-calibrated, using a set of certified gases /7/. The calibration gases used are supplied by Deokyang Energen Corporation and found to cover the range of measurements in the verifying period. The calibration gases were marked to be stable at their bottles and certificates were available. **Calibration frequency:** As per EN14181, QAL2 test (determination of calibration function and its variability) is required at least every 3 years and AST (validation of calibration function) annually in-between QAL2. EN14181 requires that QAL3 calibrations (zero and span check) are carried out periodically. The AMS supplier ABB recommended every three weeks /27/. The QAL3 test was changed to every 10 days during the 1st verification (27 June 2007 to 31 December 2007) /32/ due to the service agreement between Hanwha Corp. and Instrument & Analyser Corp. /15/ which is found acceptable by DNV according to EN14181, and also can be confirmed by the calibration plan agreed by Hanwha Corporation and Instrument & Analyzer Corporation on 2 January 2011 /26/. Hence, the frequency of QAL 3 test was every 10 days. **Calibration:** QAL2: 20 January 2011 AST: 18 January 2012 QAL3: The last QAL3 test was conducted on 23 June 2012. DNV have checked all QAL3 tests and confirmed that all QAL3 tests were conducted within every 10 days. **Validity:** QAL2: 19 January 2014 AST: 17 January 2013 QAL3: 3 July 2012

			The QAL2/AST test /18/ /19/ and QAL3 test /20/ can confirm proper functioning of the monitoring equipment. The calibration is valid for the whole monitoring period and the calibration of measuring equipment was conducted at a frequency following EN14181 which was stipulated in the methodology. The concentration is also checked by GC /22/. Its analysis is conducted quarterly through the sampling. The data from N_2O analyser is compared with that of GC. The measurements from GC showed that the measurements from Uras26 were proper. The specification of GC /21/ and standard gas certificate /7/ was kept at site.

3.6.5 Other factors and calculated parameters

The following parameters are used in the calculation of emissions reductions or are parameters needed to be reported in relation to regulation of N_2O emissions. The calculated parameters are generated in the electric media in the redundant storage system and automatically transferred to a spread sheet with all the main parameters for the verification period. The verification team has manually checked the calculated values by use of raw data. Other data are required parameters according to AM0028 and the source of data is checked.

Data variable	Reported value	Assessment/ Observation
$\boldsymbol{EF_{NG}}$ Hydrocarbon CO_2 emission factor tCO_2e/tNG	**3.067489525**	IPCC 2006 GHG Inventory Guidelines and data provided by the natural gas supplier /6/.
$\boldsymbol{EF_{HNC}}$ Emission factor of methane tCO_2/tCH_4	**2.75**	Theoretical calculation, which was verified by DNV /32/.
$\boldsymbol{EF_{NMHC}}$ Emission factor of hydrocarbon (Non-methane part of the natural gas) $tCO_2/tNMHC$	**4.51826**	Calculated by data of the natural gas and methane /6/, which was verified by DNV.
$\boldsymbol{NCV_{NG}}$ Net calorific value of the natural gas $kcal/Nm^3$	**10 404.03**	Kyungdong City Gas Corporation, a local supplier provided information /6/. The average value in this monitoring period was used in the ER calculation spread sheet /2/.

ρ_{NG} Hydrocarbon density t/Nm^3	**0.0007965**	The local supplier provided information. Monthly average data was used /6/.
Type$_{HC}$ Type of hydrocarbon	**Natural gas**	The natural gas was supplied by Kyungdong City Gas Corporation /6/.
ρ_{NMHC} Density of the hydrocarbon (Non-methane part of the natural gas) t/Nm^3	**0.001687462**	Calculated by data of the natural gas and methane /6/. This parameter is calculated as follows: $\rho_{NMHC} = (\rho_{NG} - \rho_{HNC} * C_{HNC}/100) / (1-(C_{HNC}/100)$ The calculated value has been verified by DNV /2/.
ρ_{HNC} Density of the hydrocarbon (Methane part of the natural gas) t/Nm^3	**0.000714**	Theoretical calculation, which was verified by DNV /32/.
$Q_{HNC,y}$ Methane (Methane part of the natural gas) used Nm^3	**81 642.85**	Calculated by the flow rate and the methane content of the natural gas /6/. This parameter is calculated as follows: $Q_{HNC,y} = Q_{NG,y} * C_{HNC} / 100$ The calculated value has been verified by DNV /2/.
$Q_{NMHC,y}$ Hydrocarbon (Non-methane part of the natural gas) input Nm^3	**7 559.85**	Calculated by the flow rate and the methane content of the natural gas. This parameter is calculated as follows: $Q_{NMHC,y} = Q_{NG,y} * (1-C_{HNC}/100)$ The calculated value has been verified by DNV /2/.
C$_{HNC}$ Methane content of hydrocarbon (natural gas) %	**91.525091**	The local supplier provided information. Monthly average data was used /6/.
$EI_{RCS,y}$ Additional electricity input for running the DeN_2O unit kWh/yr	**170 844**	**Instrument:** The data was measured by the power meter. **Intervals:** Measuring frequency: Continuously Recording frequency: Daily **Information flow:** The data was measured by the power meter, and is logged monthly at the site. **QC/QA:** The QC/QA is covered by the Quality Management

		procedures of the nitric acid plant. **Calibration:** The power meter was exchanged every year because it is not easy to find the third party to calibrate the existing power meter. The latest exchange was on 23 August 2011 /23/ during the annual overhaul. Power meter: Model: WL32STE, LD3310CP-005-TES Serial No.: 0297218 Accuracy: 1.0 class Calibration frequency: 15 months Date of calibration: 23 August 2011 Validity: 22 November 2012 The new power meter was exchanged every year, which is compliance with the calibration frequency of 15 months /8/. The equipment was deemed to be working properly during the monitoring period.
EF_{RCS} Emission factor of the electricity for running the DeN_2O unit tCO_2e/MWh	**0.62**	The value is calculated in the registered PDD /29/.
BE_y Baseline emissions in year y tCO_2e)	**176 553.45**	The baseline emissions are calculated from the N_2O concentration monitored in the tail gas inlet to the destruction unit, the tail gas flow, and the GWP_{N2O} of 310. DNV has checked the calculation process /2/ and confirmed that is correct.
QR_N_2O,y National Regulatory limit of N_2O emissions per output nitric acid tN_2O /$tHNO_3$	National regulation	The site CDM responsible personnel check a local environmental legislation of N_2O limitation periodically through the web site of the Ministry of Environment /24/ (relevant laws are the Clean Air Conservation Act, and the Framework Act on Low Carbon Green Growth /28/). DNV can confirm that during this verification period from 1 January 2012 to 30 June 2012, there is no regulation in Korea which limits the emissions of N_2O from the nitric acid plants for Hanwha Corporation.
CR_N_2O Regulatory limit for specific N_2O concentration during interval I tN_2O/m^3	National regulation	The site CDM responsible personnel check a local environmental legislation of N_2O limitation periodically through the web site of the Ministry of Environment /24/ (relevant laws are the Clean Air Conservation Act, and the Framework Act on Low Carbon Green Growth /28/). DNV can confirm that

		during this verification period from 1 January 2012 to 30 June 2012 there is no regulation in Korea which limits the emissions of N_2O from the nitric acid plants for Hanwha Corporation.
***RSE*$_{N2O,y}$** Regulation based on N_2O emissions per unit of nitric acid $tN_2O/tHNO_3$	National regulation	The site CDM responsible personnel check a local environmental legislation of N_2O limitation periodically through the web site of the Ministry of Environment /24/ (relevant laws are the Clean Air Conservation Act, and the Framework Act on Low Carbon Green Growth /28/). DNV can confirm that during this verification period from 1 January 2012 to 30 June 2012 there is no regulation in Korea which limits the emissions of N_2O from the nitric acid plants for Hanwha Corporation.
Reg_NOx National regulation on NOx emissions	200 ppmv	National regulation for NO_X emissions is Clean Conservation Act (CCA) of Korea. According to CCA, currently, NO_X regulation requires to limit the emission below 200 ppmv /24/. DNV can verify that the measured NO_X concentration during the monitoring period were below the limitation /4/.

3.6.6 Emissions outside the project boundary and leakages

GHG emissions related to the electricity consumption are insignificant (<1% of the total project emissions), but monitored and counted for as leakage for conservativeness.

3.7 Assessment of data and calculation of emission reductions

As stated in CL4 of Appendix A, by checking previous verification reports as well as spreadsheets, DNV found that incorrect historical operating pressures were applied in the published monitoring report (version 1.0 dated 19 July 2012). The same error also occurred in the previous 4th and 5th monitoring periods (1 January 2010 - 31 December 2010 and 1 January 2011 - 31 December 2011), for which CERs have been issued. DNV re-assessed the emission reductions reported for the 4th and 5th monitoring periods by considering the correct historical operating pressure /33/, and found there is no effect on 5th monitoring period, but there are 983 tonnes CO_2e which were issued erroneously and in excess for the 4th monitoring period from 1 January 2010 - 31 December 2010. To correct this mistake, the excess CER claimed for the 4th monitoring period are deducted from the emission reductions claimed in this monitoring period. Hence, the corrections results in a final emission reductions claimed in this monitoring period of 153 562 tCO_2e.

The calculation of baseline emissions, project emissions and emission reductions for the respective monitoring period was checked by the verification team and found to be correct as well as carried out in accordance with the formulae and methods described in the monitoring methodology AM0028 (version 03) and the revised monitoring plan (approved on 7 September 2010).

A complete set of data covering the monitoring period has been provided to DNV and reviewed during verification. Activity levels and non-activity parameters have been monitored in accordance with the revised monitoring plan. The verification team confirms

that all emission factors and default values (ex-ante values from the PDD) have been correctly justified. All the emission factors and default values are explicitly mentioned in the monitoring report and have been correctly applied. There is no uncertainty related to manual transfer of data used in the calculation of emission reduction since the monitored parameters are automatically collected by the DCS and DeN_2O system. There were no errors in the transfer of data for the calculation of emissions reductions. DNV confirms that rounding of digits has been applied both correctly and conservatively.

3.8 Quality of evidence to determine emission reductions

The main parameters are automatically collected by the electric media in the redundant storage system. All necessary documentation is collected, referenced and aggregated and is easily accessible in spread sheets. Measurements are performed by calibrated equipment, and the key data can also be cross-checked via other sources, such as production log sheets and meters available in the operators control room or on-site. No assumptions are used that have any material influence on reported emission reductions. All actions performed at the computer station are logged and the log file is available for the verifier.

When Hanwha Corporation restarts DeN_2O facility and begins to input natural gas, it usually takes a few hours until the DeN_2O facility operates normally (when the N_2O concentration outlet indicates less than 500 ppm, the DeN_2O unit operates normally). Thus, to ensure that the DeN_2O facility operates normally during nitric acid production, it is necessary to restart the DeN_2O facility a few hours earlier than the restart of the nitric acid production. Some natural gas consumption therefore occurs during shutdown periods of the nitric acid production, as shown in the summary sheet of the emission reductions calculation including the operating data /2/ /3/. Hanwha Corporation has properly deducted CO_2 emission from natural gas consumption before restart of nitric acid production from the total emission reductions.

Referring to the summary sheet of the emission reduction calculations including the operating data /2/ /3/, the system was recording some value for N_2O concentration for these days at the inlet although the plant was stopped. The reason is that, in spite of shutdown of the nitric acid plant and DeN_2O facility, there still remains N_2O gas stuck in the pipeline. However, this does not have any impact to emission reduction calculations because shutdown periods are eliminated.

3.9 Management system and quality assurance

The project is operated by Hanwha Corporation. Responsibility for monitoring and reporting of data under the CDM activity has been performed by Mitsubishi Corporation. The quality assurance and quality control procedures in terms of equipment operation and maintenance as well as data reporting are covered by project operator's management system which is certified to comply with ISO 9001 /11/.

There are two data streams: one from Hanwha Corporation (i.e. nitric acid production data) and one from DeN_2O system (i.e. N_2O reduction system operating parameters) which is compiled by Mitsubishi Corporation and used in emission reductions calculation and monitoring report.

The DeN_2O facility and the monitoring system are designed as an automatic process, so the involvement of the personnel during normal operation is minimal. In case of any deficiency, appropriate procedures are in place. Service agreements are in place for the analyzer system

and the electric media in the redundant storage system between Hanwha Corporation and Instrument & Analyzer Corporation /15/ /20/. These contracts cover regularly preventive checks of the operational conditions of the analyzer system. Hanwha Corporation has available two sets of N_2O analyzers for inlet and outlet measurement and Instrument & Analyzer Corporation also keeps main spare parts of the analyzer.

For the DeN_2O system, the quality assurance and control procedure is also according to EN14181 which stipulates three levels

- QAL1: The QAL1 for N_2O analyser was conducted by TÜV SÜD in June 2006 /17/. The uncertainty of the N_2O analyser is calculated according to ISO 14956, and the evaluation is deemed to be acceptable.
- QAL2: The QAL2 was conducted by AIRTEC in accordance with EN 14181 in January 2011 /18/. AIRTEC has certified according to ISO/IEC 17025.
- QAL3: The QAL3 was conducted by Instrument & Analyzer Corporation (a local agent of ABB) every 10 days /20/, which is compliance with the calibration frequency recommended by the AMS supplier.
- AST: The AST including SRM measurements to check for uncertainties in the data measured by the AMS was conducted by SGS in January 2012 /19/. SGS has certified according to ISO/IEC 17025.

Local operators and instrumentation engineers of the system have been trained by the equipment supplier /23/. Data handling solutions involve redundancy, data manipulation protection, integrity checks as well as proper archiving.

Hanwha Corporation covers all CDM activities in the internal audit and management reviews, which was conducted in December 2011 and July 2011 respectively /13/, and there were no findings or issues with regards to the CDM activity.

4 CERTIFICATION STATEMENT

DNV Climate Change Services AS (DNV) has performed the verification of the emission reductions that have been reported for the "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" (UNFCCC Registration Reference No. 0922) for the period 1 January 2012 to 30 June 2012.

The project participants are responsible for the collection of data in accordance with the monitoring plan and the reporting of GHG emissions reductions from the project.

It is DNV's responsibility to express an independent verification statement on the reported GHG emission reductions from the project. DNV does not express any opinion on the selected baseline scenario or on the validated and registered PDD.

DNV conducted the verification on the basis of the monitoring methodology AM0028 (version 03), registered Project Design Document, version 8 of 17 November 2006, the revised monitoring plan approved on 7 September 2010 and the monitoring report (version 3.0) dated 20 September 2012. The verification included i) checking whether the provisions of the monitoring methodology and the monitoring plan were consistently and appropriately applied and ii) the collection of evidence supporting the reported data.

DNV's verification approach draws on an understanding of the risks associated with reporting of GHG emission data and the controls in place to mitigate these. DNV planned and performed the verification by obtaining evidence and other information and explanations that DNV considers necessary to give reasonable assurance that reported GHG emission reductions are fairly stated.

In our opinion the GHG emissions reductions of the "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" (UNFCCC Registration Reference No. 0922) for the period 1 January 2012 to 30 June 2012 are fairly stated in the monitoring report (version 3.0) dated 20 September 2012.

The GHG emission reductions were calculated correctly on the basis of the approved baseline and monitoring methodology AM0028 (version 03) and the monitoring plan contained in the registered PDD (version 8 of 17 November 2006) and revised monitoring plan accepted by the EB on 7 September 2010.

DNV Climate Change Services AS (DNV) is able to certify that the emission reductions from the "Catalytic N2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea" (UNFCCC Registration Reference No. 0922) for the period 1 January 2012 to 30 June 2012 amount to 153 562 tonnes of CO_2 equivalent.

Beijing and Oslo, 23 October 2012

Wu Lin

Wu Lin
Verifier
DNV Beijing, China

Michael Lehmann
Director of Services and Technologies
DNV Climate Change Services AS

5 REFERENCES

5.1.1 Documentation provided by the project participants

/1/ Mitsubishi Corporation: Monitoring report of Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea, version 1.0 of 19 July 2012 and version 3.0 of 20 September 2012.

/2/ Mitsubishi Corporation: CDM Project spreadsheet for the verification period 1 January 2012 to 30 June 2012.

/3/ Hanwha Corporation: Hourly and daily spreadsheet for operating parameters, from 1 January 2012 to 30 June 2012.

/4/ Hanwha Corporation: Daily monitoring reports from January 2012 to June 2012.

/5/ Hanwha Corporation: Equipment list and specifications for monitoring equipment and analysers of DeN_2O systems.

/6/ Kyungdong City Gas Corporation: Monthly natural gas information, January to June 2012.

/7/ Deokyang Energen Corppration: Certificates of calibration test gases, 2011 and 2012.

/8/ Kolas: Calibration reports for instruments

- Calibration for pressure transmitter (10-PT-304), dated 7 July 2011
- Calibration for thermocouple (10-TT-115), dated 8 July 2011
- Calibration for nitric acid flow meter (10-FT-512), dated 29 June 2011
- Calibration for ammonia flow meter and differential pressure transmitter (10-FT-502), dated 7 July 2011
- Calibration for pressure transmitter (10-PT-302), dated 7 July 2011
- Calibration for resistance temperature detector (10-TT-102), dated 8 July 2011
- Calibration for natural gas meter (10-FT-563), dated 12 May 2011
- Calibration for flow meter (10-FT-561), dated 7 July 2011
- Calibration for pressure transmitter (10-PT-361), dated 7 July 2011
- Calibration for flow meter (10-TT-161), dated 15 July 2011
- Calibration for flow meter (10-FT-562), dated 7 July 2011
- Calibration for pressure transmitter (10-PT-362), dated 7 July 2011
- Calibration for flow meter (10-TT-162), dated 8 July 2011.

/9/ Johnson Matthey: Precious metal gauzes commercial invoices: SD86919 dated 28 July 2011 and SD87095 dated 24 October 2011.

/10/ Hanwha Corporation: Equipment specifications for monitoring equipment of ammonia oxidation reactor and nitric acid production.

/11/ KMAR: ISO 9001:2008 Certificate, valid until 15 December 2014.

/12/ N.E. Chemcat (catalyst) and Sumiko Eco-Engineering: Certificates of Guarantee test Run, 6 July 2007.

/13/ Hanwha Corporation: CDM internal audit record, 30 December 2011;
Hanwha Corporation: Management review record, 8 July 2011.

/14/ Hanwha Corporation: Training plan and internal training records, March 2011 and June 2012.

/15/ Hanwha Corporation and Instrument & Analyzer Corp.: Service support agreement analyser system for DeN_2O, 3 January 2008.

/16/ Hanwha Corporation: QMS process operation procedure, HWO-A-402, Rev.2.

/17/ TÜV SÜD: QAL1 report for N_2O analyzer, dated 30 June 2006.

/18/ AIRTEC: QAL2 report, dated 27 January 2011 (performed from 17 - 21 January 2011);
ISO 17025:2005 Certificate of AIRTEC, valid until 1 April 2012.

/19/ SGS Environmental Services: EN14181 AST N2O measurements at the Hanwha Corporation nitric acid plant located in Ulsan, dated 9 February 2012 (performed form 17 - 18 January 2012);
SGS Environmental Services is ISO17025:2005 accredited:
http://www.geochem.sgs.com/geochem.

/20/ Instrument & Analyzer Corp. (a local agent of ABB): QAL3 reports, every 10 days, from January 2012 to June 2012 (last QAL3 test in previous monitoring period was on 26 December 2011)

- January: 4 January, 13 January, 22 January and 31 January
- February: 9 February, 18 February and 27 February
- March: 7 March, 16 March and 25 March
- April: 3 April, 12 April, 21 April and 30 April
- May: 9 May, 18 May and 27 May
- June: 5 June, 14 June and 23 June.

/21/ ABB: GC specification, March 2007.

/22/ Korea Research Institute of Standard and Science: GC test reports, March and June 2012.

/23/ Hanwha Corporation: Nitric acid plant daily operation log, January 2012 to June 2012.

/24/ Hanwha Corporation: Report on environmental regulation.

/25/ Hanwha Corporation: Enterprise resource planning data.

/26/ Instrument & Analyzer Corporation: Calibration plan for NDIR analyser Uras26 in Hanwha Corporation, 2 January 2011.

/27/ ABB: Specification of Uras analyzer.

/28/ Relevant regulations in Korea:

- Clean Air Conservation Act of the Republic of Korea
- Framework Act on Low Carbon Green Growth

5.1.2 Other project documents or documents used by DNV to verify the information provided by the project participants

/29/ Mitsubishi Corporation: CDM Project Design Document of Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea, version 8 of 17 November 2006.

/30/ TÜV SUD: Validation report of Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea,

Report No. 910471, 8 February 2007.

/31/ Mitsubishi Corporation: Revised monitoring plan, version 1.0 of 1 June 2010; and approved by the CDM EB on 7 September 2010;

DNV: Validation opinion of revised monitoring plan, 28 May 2010.

/32/ DNV: Previous verification reports of "Catalytic N_2O Abatement Project in the Tail Gas of the Nitric Acid Plant of the Hanwha Corporation (HWC) in Ulsan, Republic of Korea.

/33/ Mitsubishi Corporation: CDM project spreadsheets for 4^{th} and 5^{th} verification periods (by applying correct historical operating pressure and wrong historical operating pressure).

/34/ Physics Handbook: Physical and chemical data

5.1.3 Methodologies, tools and other guidance by the CDM Executive Board

/35/ CDM Executive Board: Clean Development Mechanism Validation and Verification Standard, version 02.0.

/36/ CDM Executive Board: AM0028, Catalytic N_2O destruction in the tail gas of Nitric Acid Plants, version 3.

5.1.4 Persons interviewed during the verification

/37/ Hanwha Corporation:

TongKook Bae, Manager Chemicals Team/Hanwha Head office

ByeongCheol Song, Plant Manager Onsan plant

Kwang Yeol Lee, Plant manager

/38/ Takafumi Okamoto, Mitsubishi Corporation, Deputy General Manager, Emissions Reduction Business Unit

/39/ Masatoshi Wada, Mitsubishi Corporation, Korea, General Manager

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APPENDIX A

CORRECTIVE ACTION REQUESTS, CLARIFICATION REQUESTS AND FORWARD ACTION REQUESTS

Corrective action requests

CAR ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
CAR 1	There are two sets of monitoring instruments used in the project, one is under operation and the other is on standby. By checking the operation log sheets, DNV confirmed that the instruments exchange happened in year 2011, and only one set of monitoring instrument was used within this monitoring period. Hence, the information of monitoring instruments used in the monitoring period shall be updated in the MR.	The information of monitoring instruments used in this monitoring period was updated in the MR (Only one set of monitoring instrument was used within this monitoring period).	The update has been addressed in the MR /1/ and verified by DNV to reflect the actual implementation of monitoring instruments. CAR 1 is closed.
CAR 2	The following corrections shall be made in the CER spread sheet: 1. In the calculation of non-methane density, the density of hydrocarbon 0.0007966 t/Nm^3 was used, which shall be 0.0007965 t/Nm^3. 2. It is stated that "Electric consumption of 6 months (from Jan to Jun 2012) is 170 844 kWh x 200 (The multiple proportion of Watt-hour meter) = 34 168 800 kWh Hourly Average Data1)". By checking the electricity consumption records, only 170 844 kWh was consumed in this monitoring period. 3. The calculating formula for BE_y was as follows: SUM(J15:J4382)-SUM(J1731:J1745)-SUM(J2418:J2449)-SUM(J2568:J2608)	The typo-errors of the CER spread sheet were updated 1. In the calculation of non-methane density, the density of hydrocarbon 0.000795 t/Nm^3 was revised. 2.The remarks of the CER spread sheet were revised as "Electric consumption of 6 months (from Jan to Jun 2012) is 170 844 kWh". 3. The calculating formula for BE_y was revised as follows: SUM(J15:J4382)-SUM(J1731:J1744)-SUM(J2418:J2449)-SUM(J2564:J2608) 4. On Mar.12.01:00~Mar.12.13:00, On Apr.10.01:00~Apr.10.03:00, and On Apr.11.12:00~Apr.11.24:00, default value (NH_3 consumption, temp.	The corrections have been conducted in the updated spread sheet and verified by DNV. After these corrections, the emission reductions in this monitoring period were updated /2/. CAR 2 is closed.

CAR ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
	However, it was found the covering ranges in the formula are not corresponding to the actual periods of downtimes and daily events. According to the methodology, if the actual average daily operating temperature and/or pressure in the ammonia oxidation reactor (T_g and P_g) are outside a "permitted range" of operating temperatures and/or pressures ($T_{g,hist}$ and $P_{g,hist}$), or the daily ammonia input to the oxidation reactor($A_{OR,d}$) exceeds maximum historical ammonia input to oxidation reactor ($A_{OR,hist}$), the baseline N_2O emissions for that period are capped at 4.5kgN_2O/tonne of nitric acid conservatively applying the IPCC default value. However, in the spreadsheet, for the daily event happened on 12 March, 10 April and 11 April 2012, such conservative treatment has not been applied in the calculation.	press) of the data during shut-down is under the baseline. So the baseline N_2O emissions for that period are capped at 4.5 kgN_2O/tonne of nitric acid conservatively applying the IPCC default value.	
CAR 3	ISO 9001:2008 Certificate was issued for the project on 21 November 2011. The date shall be corrected in the MR.	The typo-error(ISO 9001:2008 Certificate) was updated in the MR	The correction has been addressed in the updated MR /1/ and verified by DNV. CAR 3 is closed.
CAR 4	In the spreadsheet "default_data_Jan_01_2012~_Jun_30_2012 ", form "AOR pressure (P1304-Dailly)", it found the pressure on 15 February 2012 exceeded the upper limitation of the historical operating condition. The conservative treatment shall be taken for such period in the CER calculation	The data was treated in accordance with the methodology. The pressure default value on 15 Feb. was excluded based on the IPCC default value.	During the monitoring period, the daily average pressure of the ammonia oxidation reactor was out of the permitted range on the date of 15 February 2012, and re-calculation was conducted on the CER by applying the conservative IPCC default value of 4.5 kgN_2O/tHNO_3 to the baseline emission factor. It was verified in the

CAR ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
	following the methodology.		updated MR /1/ and spreadsheet /4/. CAR 4 is closed.

Clarification requests

CL ID	Clarification request	Response by Project Participants	DNV's assessment of response by Project Participants
CL 1	In the CER spreadsheet, the period from 6:00 of 16 April 2012 to 2:00 of 18 April 2012 was excluded from the emission reduction calculation with the remark as "DeN_2O Unit was not operated or outlet N2O concentrate is over 500 ppm so its data should be deducted to calculate amount of N_2O (on Apr.16/17/18, CNG flow is '0'. So the data are excluded)". However, from 19:00 of 17 April 2012 to 2:00 of 18 April 2012, the hourly CNG flows are not equal to "0". The clarification was sought on such inconsistency.	MR was revised as below : "DeN_2O Unit was not operated or outlet N_2O concentrate was over 500 ppm so its data should be deducted to calculate amount of N_2O".	The MR and CER spreadsheet have been updated to reflect the monitoring practice. CL 1 is closed.
CL 2	It was found the emission reductions reported in this monitoring period is higher than the expectation in the PDD. The actual abatement efficiency in the monitoring period was calculated to be 88%, which is similar with the expectation of 90% in the PDD. Hence, the increase of N_2O concentration in the tail gas did not contribute to the higher	MR was revised as below : Compared to the PDD, the value of emission reductions was increased around 10.19% from 281 272 tCO_2e/year (365 days) to 309 939 tCO_2e/year (365 days equivalent). This is because of the following reasons:	The main reasons contributing to the high emission reductions are as follows: (1) longer valid operating time (178.75 days in this monitoring period) of DeN_2O unit (excluded the periods while the N_2O concentration was out of the measurement range of the analyzer) compared to the expected operating time of 165 days in the PDD (330 days operation was expected for

<table>
<tr><th>CL ID</th><th>Clarification request</th><th>Response by Project Participants</th><th>DNV's assessment of response by Project Participants</th></tr>
<tr><td></td><td>emission reductions. Further, since the actual nitric acid production in this monitoring period was below the design capacity, the increase of nitric acid production did not have direct contribution to the higher emission reductions. The reasons for the higher emission reductions are sought to be clarified.</td><td>(a) Increase of operation rate during this monitoring period as shown below :
<table><tr><td></td><td>6th monitoring period</td><td>Estimated values of PDD</td></tr><tr><td>Monitoring Period</td><td>182 days</td><td>356 days</td></tr><tr><td>Operation days</td><td>178 days + 18 hours</td><td>330 days</td></tr><tr><td>Operation rate</td><td>98.21 %</td><td>90.41 %</td></tr></table>and
(b) Increase of the nitric acid production rate during this monitoring period up to 97.5% of the designed capacity of production, which is about 7.5% higher than the expected production of PDD (97 020 $tHNO_3$/year : Page 8, Section A.4.4) where the value of inlet flow rate (F_{TI}) is higher than PDD value.</td><td>each year in the PDD, and half of year was equal to 165 days);
(2) Increasing nitric acid production (52 013.84 $tHNO_3$ in this monitoring period, corresponding to yearly basis of 104 313 $tHNO_3$) compared to the amount estimated (97 020 $tHNO_3$) in the PDD, where the higher inlet flow rate was achieved. As stated in section 3.6.2, the actual nitric acid production 52 013.84 t 100% HNO_3 for this monitoring period over 182 days is below the design capacity according to the methodology. It shall be noted that the nitric acid production comparison on yearly basis was used to assess the emission reductions between the values achieved in this monitoring period and estimation in the PDD, and is not related to cap the possible excess nitric acid production, which has been concluded clearly in section 3.6.2 that the actual nitric acid production is within the design capacity.
Therefore, DNV considers emission reductions claimed in the monitoring period are reasonable.
CL 2 is closed.</td></tr>
<tr><td>CL 3</td><td>In the spreadsheet "default_data_Jan_01_2012~_Jun_30_2012 ", form "NH_3 consumption (hourly)", 0.7741 kg/h was used as the density of NH_3 in the standard</td><td>Regarding NH_3 density we were used, it was acknowledged by technology transfer. And now there is no documentary evidence to make it prove. To clarify this issue, we</td><td>During interviewing with PP, it was told that the original ammonia density of 0.7741 kg/h can not find the resource. By checking the Physics Handbook /34/, DNV</td></tr>
</table>

CL ID	Clarification request	Response by Project Participants	DNV's assessment of response by Project Participants
	condition. The clarification is sought for the data source of this density and the assessment on the emission reductions.	intend to use 0.7708 kg/cm^3 as the density of NH_3 from the Physics handbook. This new value is lower than the before. So, even though this value is to be changed, the CER's volume is not changed.	confirmed that the ammonia density of 0.7708 kg/cm^3 (under standard conditions) sourced from the Physics Handbook is more reasonable to calculate the quantity of ammonia consumption. Further, by checking the ammonia consumption spreadsheet /4/, after the density correction, all ammonia consumptions were still within the permitted range. Hence, DNV confirmed that the change of ammonia density did not bring effect on the emission reductions in this monitoring period. CL 3 is closed.
CL 4	In the 1st verification report, it stated that there was a mistake in the registered PDD for the determination of historical operating temperature and pressure, and the correct upper 2.5% and lower 2.5% quantile of the historical operating data were used to determine historical operating temperature and pressure. The historical operating pressure was 7.071-8.767×10^5 Pa gauge. However, in the MR and spreadsheet, 7.022-8.806×10^5 Pa gauge was used as the historical operating pressure. The clarification is sought on such inconsistency.	In order to maintain consistency in the 3rd verification by DOE's instruction, the monitoring report was revised in accordance with the PDD. But, the wrong value was filled out along the way because it differs from the revised monitoring plan. And we applied the wrong data (7.022-8.806×105 Pa gauge) from the 4th monitoring period. To correct this inconsistency, we apply the right default value (7.071~8.767 x 105 Pa.g on the 4th and 5th monitoring data. Consequently, 983 tones should be deducted from the 4th monitoring period. But there is no effect on the 5th monitoring period. We comment this on the page 10 of Monitoring report.	By checking previous verification reports as well as spreadsheets, DNV confirmed that the correct historical operating pressure shall be 7.071-8.767×10^5 Pa gauge. The mistake happened in previous 4th and 5th monitoring periods. DNV re-assessed the emission reductions reported for the 4th and 5th monitoring periods by considering the correct historical operating pressure /33/, and found there is no effect on 5th monitoring period, but there are 983 tonnes CO_2e which were erroneously claimed in excess for the 4th monitoring period. These excess CERs are thus deducted from the emission reductions claimed for this monitoring period. Further, the correct historical operating pressure has been applied in this monitoring period.

CL ID	Clarification request	Response by Project Participants	DNV's assessment of response by Project Participants
			Hence, the corrections results in a final emission reductions claimed in this monitoring period of 153 562 tCO_2e. DNV considers the corrections are reasonable. CL 4 is closed.

Forward action requests from the previous verification

FAR ID	Forward action request	Summary of how FAR has been addressed in this reporting period	Assessment of how FAR has been addressed
FAR 1	The QAL3 tests have not been conducted always every 10 days in this monitoring period according to the calibration plan stipulated. The Uras analyser supplier ABB just requested three weeks calibration frequency, and also has stated in the calibration plan that the calibration results are available within three weeks. Hence, DNV considered that the QAL3 tests conducted in year 2011 did not have negative effect on the emission reductions claimed in this monitoring period. However, as the management system and quality assurance, the stipulated frequency (every 10 days) of QAL3 test should be followed. Hence, a FAR was raised for attention in next verification.	QAL3 tests were conducted every 10 days during the 6th monitoring period.	The last QAL3 test in previous monitoring period was on 26 December 2011, and the last QAL3 test in this monitoring period was conducted on 23 June 2012 /20/. DNV have checked all QAL3 tests and confirmed that all QAL3 tests were conducted within every 10 days. FAR 1 is closed.

Forward action requests from this verification

FAR ID	Forward action request	Response by Project Participants
FAR 1	NA	NA

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APPENDIX B

POST REGISTRATION CHANGES

Type of post registration change	**Description of post registration change***	**Is prior approval by CDM EB required**?**	**In case prior approval by CDM EB is required, when was post registration change approved?**
Corrections	*Not applicable*	☐ Yes ☐ No	*Not applicable*
Temporary deviations from the registered monitoring plan and/or monitoring methodology	*Not applicable*	☐ Yes ☐ No	*Not applicable*
Permanent changes from the registered monitoring plan or applied methodology	*Not applicable*	☐ Yes ☐ No	*Not applicable*
Changes to the project design of a registered project activity	*Not applicable*	☐ Yes ☐ No	*Not applicable*

* For further details refer to the "Post-registration changes request form" (F-CDM-PRC) and DNV's assessment opinion on the changes
** Refer to Appendix 1 to the CDM Project Standard

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APPENDIX C

CURRICULA VITAE OF THE VERIFICATION TEAM MEMBERS

Lin Wu: holds a Master Degree in Chemical Engineering & Process, a Bachelor Degree in Chemical Engineering & Process and a Bachelor Degree in Computer Science & Technology, having an overall experience of around 8 years. Prior to joining DNV, he has around four years' experience in chemical industry covering design of chemical process and system, piping design, commissioning and project management on site. His experience also covers the fields of desulphurization of flue gas in power plant industry.

He has experience of around 4 years in validation and verification of CDM/JI projects and other 3rd party validation/verification services.

His qualification, industrial experience and experience in CDM demonstrate his sufficient sectoral competence in "Energy Generation from Renewable Energy Sources" and "Chemical Processes Industries".

Patrice Massicard: holds a Master degree in Mechanical Engineering and has an overall experience of around 10 years. Prior to joining DNV, having around 3 years' experience in Oil & Gas industry and 5 years' experience in mechanical industry covering equipment design.
He has experience of around 2 years in DNV for the certification of oil & gas processing equipments, and 2 years' experience in the validation and verification of CDM projects. His qualification, industrial experience and experience in CDM demonstrate him sufficient sectoral competence in the filed oil & gas and mechanical industries.

Rafi-ud-Din Khawaja: holds a Master's Degree in Environmental Engineering with over 8 years of experience in air pollution control technology, air pollution monitoring, risk management reviews (RMR), ambient air quality analysis (AAQA), transport phenomena, urban and industrial air quality management .

He has acquired over four years of experience in validation and verification of numerous CDM and JI projects while working in DNV. He has been qualified as a CDM validator for technical area Renewables (hydro) and as a CDM validator/verifier as well as a Technical Reviewer (TR) for technical area N_2O under the Qualification Scheme of Climate Change Services of DNV.

His qualification, industrial experience and experience in CDM facilitate him to assess all technical areas to sufficient degree.

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