



VERIFICATION / CERTIFICATION REPORT

REDUCTION OF N₂O EMISSIONS FROM THE NEW NITRIC ACID PLANT #5 OF HU-CHEMS FINE CHEMICAL CORP.

(UNFCCC Registration Ref. No. 6637)

Monitoring Period:
25 February 2013 to 31 August 2013

REPORT No. 2013-9513

REVISION No. 01

DET NORSKE VERITAS



VERIFICATION / CERTIFICATION REPORT

Date of first issue: 29 July 2014	Project No.: PRJC-491377-2013-CCS-NOR	DNV CLIMATE CHANGE SERVICES AS Veritasveien 1, 1322 HØVIK, Norway Tel: +47 67 57 99 00 Fax: +47 67 57 99 11 http://www.dnv.com Org. No: NO 994 774 352 MVA
Approved by: Michael Lehmann	Organisational unit: Accredited Climate Change Services	
Client: Hu-Chems Fine Chemical Corp.	Client ref.: Mr. HyunSu Kim	
Summary: DNV Climate Change Services AS (DNV) has performed the verification of the emission reductions reported for the project activity "Reduction of N ₂ O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp." in the Republic of Korea (UNFCCC Registration Ref. No. 6637) for the period 25 February 2013 to 31 August 2013. In our opinion, the GHG emission reductions reported for the project in the monitoring report (version 2) of 28 June 2014 are fairly stated. The GHG emission reductions were calculated correctly on the basis of the approved monitoring methodology ACM0019 (version 1) and the monitoring plan contained in the Project Design Document (version 1.4) of 22 June 2012. DNV Climate Change Services AS is able to certify that the emission reductions from the project activity "Reduction of N ₂ O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp." in the Republic of Korea during the period 25 February 2013 to 31 August 2013 amount to 230 375 tonnes of CO ₂ equivalent.		

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Work verified by: Patrice Massicard; Trine Kopperud			
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Abbreviations

AOR	Ammonia oxidation reactor
AST	Annual Surveillance Test
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CER	Certified Emission Reduction(s)
CHS	Continuous historian server
CL	Clarification Request
CMP	COP/MOP Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CO ₂	Carbon dioxide
CO _{2e}	Carbon dioxide equivalent
DCS	Distributive Control System
DNV	Det Norske Veritas
DOE	Designated Operational Entity
FAR	Forward Action Request
GHG	Greenhouse gas(es)
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
NA	Nitric Acid
N ₂ O	Nitrous oxide
NG	Natural Gas
PDD	Project Design Document
PP	Project participant
PS	Clean Development Mechanism Project Standard
QAL	Quality Assurance Level
QMS	Quality Management System
UNFCCC	United Nations Framework Convention on Climate Change
VVS	Clean Development Mechanism Validation and Verification Standard



1 INTRODUCTION

Hu-Chems Fine Chemical Corp. has commissioned DNV Climate Change Services AS (DNV) to carry out the verification and certification of emission reductions reported for the CDM project activity 6637 “Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp.” in Republic of Korea (the project) in the period 25 February 2013 to 31 August 2013. This report contains the findings from the verification 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 “Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp.” for the period 25 February 2013 to 31 August 2013, in accordance with paragraph 62 of CDM modalities and procedure.

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 and that all physical features (technology, project equipment, and monitoring and metering equipment) of the project are in place;
- The monitoring report and other supporting documents provided are complete in accordance with latest applicable version of the completeness checklist for requests for issuance of CERs and verifiable and in accordance with applicable CDM requirements;
- The monitoring plan complies with the monitoring methodology and the actual monitoring systems and procedures comply with the monitoring systems and procedures described in the monitoring plan, including applicable tools and the approved methodology, and there is compliance with any guidance provided by the Board regarding deviations from the provisions of the monitoring plan and/or methodology;
- Data is recorded and stored as per the monitoring methodology ACM0019 (version 01) and the calculation of GHG emission reductions have been assessed to correctly support the emission reductions being claimed.

Furthermore, it was DNV's objective to identify any concerns related to the conformity of the actual project activity and its operation with the registered project design document and



determine whether any deviation or proposed or actual changes in the implementation or operation of the project activity comply with the requirements of the CDM Project Standard /37/.

The verification shall ensure that reported emission reductions are complete and accurate in order to be certified. The verification is incorporating both quantitative and qualitative information on emission reductions.

1.3 Description of the project activity

Project Parties:	Republic of Korea (Host Party), Austria
Title of project activity:	Reduction of N ₂ O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp.
UNFCCC registration No:	6637
Baseline and monitoring methodology	ACM0019 (version 1)
Project Participants:	Carbon CDM Korea Ltd.; Hu-Chems Fine Chemical Corp. (authorized by the Republic of Korea) Carbon Climate Protection GmbH (authorized by Austria)
Location of the project activity:	Yeosu, 7-6, Wollae-dong, Jeollanam-do, Republic of Korea
Registered PDD:	22 June 2012 (Version 1.4)
Validation:	Performed by TÜV SÜD, Validation report of 03 July 2012
Registration date:	17 July 2012
Project's crediting period:	25 February 2013 to 24 February 2023 (Fixed, changed from 01 September 2012 to 31 August 2022)
Period verified in this verification:	25 February 2013 to 31 August 2013

The project has been in operation since 25 February 2013 /13/ and was registered on 17 July 2012. As per the PDD, the fixed crediting period for the project was chosen from 1 September 2012 to 31 August 2022. However, since the actual start date of the project activity was on 25 February 2013, the fixed crediting period has been changed to 25 February 2013 to 24 February 2023, and this change was accepted by the UNFCCC.

The project has installed tertiary N₂O reduction technology in the tail gas stream of the newly-constructed acid production plant #5 of Hu-Chems Fine Chemical Corp. (hereafter called "Hu-Chems") in Yeosu, Korea. Nitrous oxide, formed as a by-product of the nitric acid production, is removed by an EnviNOx® System provided by UHDE GmbH /13/.

The emission reductions reported from the project for the period from 25 February 2013 to 31 August 2013 equate to 230 375 tonnes of CO₂ equivalents /3/.



2 METHODOLOGY

The verification of the emission reductions has assessed all factors and issues that constitute the basis for emission reductions from the project. All relevant records of data from the EnviNOx® System and records from the production logs of the nitric acid production have been examined and verified for the reporting period.

The verification team has during its preparations identified the key reporting risks and used the assessment to determine to which extent the project operator's control systems were adequate for mitigation of these key reporting risks. In addition, other areas that can have an impact on reported emission reductions have also undergone detailed audit testing.

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

2.1 Verification process

DNV has made publicly available the monitoring report received from the project participants. Only verification activities after the publication of the monitoring report on the UNFCCC CDM website have been used as a basis for conclusion of verification. The verification process includes desk review of the monitoring report published (and any updated versions, if available), emission reduction calculation spreadsheets and other supporting documents and data. Further, onsite assessments and interviews with those involved in project management and operations are conducted. This follows preparation of draft verification report summarizing desk review and on-site assessment findings (i.e. CARs, CLs, and FARs). Upon successful closing of the CARs and CLs raised (if any), the final verification report is prepared. The final report then undergoes a technical review and final approval according to DNV's internal quality assurance procedures.

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 Hu-Chems, CARBON CDM Korea Ltd., Carbon Climate Protection GmbH, and observation of 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, as well as to verify the correct application of the approved monitoring methodology. Furthermore, this has enabled the verification team to assess and determine that the implementation and operation of the project activity as well as the steps taken to report emission reductions in compliance with the CDM criteria and relevant guidance provided by the Board.

In addition, all parameters, as required (and as applicable) by the monitoring methodology ACM0019 (version 1) as well as the monitoring plan and the management system were assessed during the site visit.



2.2 Verification team

<i>Role</i>	<i>Last Name</i>	<i>First Name</i>	<i>Country</i>	<i>Type of involvement</i>					
				Desk review	Site visit	Reporting	Supervision of work	Technical review	TA 1.2 competence
Team leader (Verifier)	Li	Cheng	China	✓	✓	✓	✓		✓
Translator	Kim	Tae Ho	Korea		✓				
Technical reviewer	Massicard	Patrice	Norway					✓	
Technical reviewer	Kopperud	Trine	Norway					✓	✓

Duration of verification

Monitoring report publication: 11 September 2013
 Desk review: 11 September 2013 to 25 September 2013
 On-site assessment: 26 September 2013
 Reporting, calculation checks and QA/QC: 27 September 2013 to 29 July 2014

2.3 Desk review

In addition to the monitoring report /1/ (version 01 dated 11 September 2013 and version 2 dated 28 June 2014), as well as their respective MS Excel spreadsheets for ER Calculation /3/, DNV reviewed:

- The PDD for the project activity (version 1.4 dated 22 June 2012) /2/ and the corresponding validation report /5/
- The approved baseline and monitoring methodology ACM0019, version 1 /39/.

DNV's verification process takes into consideration all the CDM rules and guidances applicable to the project activity, such as:

- Clean Development Mechanism Validation and Verification Standard, version 05.0 /36/,
- Clean Development Mechanism Project Standard, version 05.0 /37/,
- Clean Development Mechanism Project Cycle Procedure, version 05.0 /38/, including the Completeness Checklist (Ver. 01.1) and the Information & Reporting Checklist (version 01.0) for requests for issuance;
- Relevant decisions, clarifications and guidance from the CMP and the CDM Executive Board and other information and references relevant to the project activity's resulting emission reductions.



- The project operator has in addition supplied the verification team with procedures from its management system as well as other documentation and spreadsheets with all data necessary for verification of the emission reductions /3/~ /29/.

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.

2.4 On-site assessment

Detailed verification of all data contained in the monitoring report was performed during the site visit at Hu-Chems Fine Chemicals Corp. on 26 September 2013. During the site visit, the personnel were interviewed or assisted the verification team /42/~ /44/.

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 confirmed:

- the implementation and operation of the CDM project activity;
- the information flow for generating, recording, aggregating and reporting of the monitoring parameters; and
- the operational and data collection procedures and their implementation in accordance with the monitoring plan.

Further, the following activities were performed:

- a cross-check between information provided in the monitoring report and data from other sources such as plant log books, inventories, purchase records or similar data sources;
- a check of the monitoring equipment including calibration performance and observations of monitoring practices against the requirements of the PDD, the monitoring plan and ACM0019 (version 1);
- 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 are in place to prevent or identify and correct any errors or omissions in the reported monitoring parameters.



2.5 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, including any guidance provided by the Board regarding deviations from the provisions of a registered/revised plan and/or methodology, 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 one CAR and three CLs. The CAR and CLs were satisfactorily addressed by the project participants by revising the monitoring report (please 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 2 dated 28 June 2014) were made compared to the initial version of the monitoring report received for verification (version 1 dated 11 September 2013):

- The description about the location of tail gas pressure transmitter and temperature transmitter was modified
- The information on the monitored parameter of " $C_{H_2O,t,db,n}$ " was added into the section D of MR.
- Carbon Climate Protection GmbH was added as project participant (as shown on the view page for this project on the CDM website)
- Information was transferred and adopted to the latest version 04.0 of the CDM-MR-FORM



3 VERIFICATION FINDINGS

This section summarises the findings from the verification of the emission reductions reported for the “Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp.” for the period 25 February 2013 to 31 August 2013.

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

The validation /5/ raised one FAR, requesting the verifying DOE to assess if there were any changes of the Greenhouse Gas and Energy Target Scheme or other legislation which affects the project activity’s emission reduction under the CDM. DNV was able to confirm that no substantial changes in the legislation took place and that there is no legal requirement for Hu-Chems Fine Chemical Corp. to reduce its N₂O emissions (refer to Appendix A for further details).

3.2 Post registration changes

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

Before the the verification of this monitoring period already, the start date of the crediting period was changed from 01 September 2012 (as mentioned in the registered PDD) to 25 February 2013. The project participants have provided sufficient information information on that change in the monitoring report /1/.

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 DeN₂O 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 newly-constructed Plant #5 was formally put into operation in September 2012, which has been confirmed by DNV during the site visit /4/. The project has been in operation since 25 February 2013. Guarantee test run was performed during 21 February 2013 to 25 February 2013. During the test runs it was demonstrated that the expected guaranteed value for the abatement efficiency 96% was exceeded by an actually achieved abatement efficiency of 98.6% /13/.

The verification team confirmed through visual inspection that all physical features of the CDM project activity including data collection systems and storage have been implemented in accordance with the registered PDD /2/.

Operation during the monitoring period:

For this 1st verification period, lasting 188 days, according to the service records /14/ and as observed from Delta-V trend-curves /4/, the following observations related to the operation of the EnviNOx® System and the AMS have been made:

- Between 26/03/2013 at 10:00 and 09/04/2013 at 11:00, the daily QAL3 results (as per EN 14181) for the parameter vi,t,db (Volumetric fraction of N₂O in the gaseous stream) were out of tolerance /24/. The physical condition of the analyser was good at any time (as confirmed by respective maintenance records by Emerson). Consequently, the maximum



observed surplus over the tolerance from QAL3 results has been conservatively added in determining $V_{i,t,db}$ during this period.

- On 18/07/2013, between 14:00 and 15:00, no data were recorded due to scheduled service works in the system, as part of regular services by Emerson Korea. No emission reductions have been claimed during this hour;
- On 08/08/2013, between 14:00 and 18:00, engineers from Hu-Chems have performed a regular calibration of the stack gas pressure transmitter. Due to the extended length of the procedure, the recorded values for Pt (Pressure of the gaseous stream) have been influenced over these hours. Mistakenly, Hu-Chems engineers have deactivated the instrument for measuring the volumetric flow of the gaseous stream (Parameter $V_{t,db}$) as well, even although it wouldn't have been necessary. Consequently, maximum values of the monitoring period have been applied for both affected parameters, leading to a conservative estimation of project emissions.

During the on-site visit, DNV verified all the observations mentioned above by checking against the daily report generated from the Delta-V System as well as operational records and maintenance records and could confirm the description was in compliance with the actual circumstances.

The procedure for recalculation of N_2O emissions during the above stated maintenance/calibration periods of the analysers is clearly and correctly implemented in excel spreadsheet /3/.

DNV confirms that the recalculations of N_2O emissions for the described periods above were done in accordance with the requirements from VVS /36/ and methodology /39/ and the registered PDD /2/. and the approach is conservative, since in these observed events, the PP either adopted the highest observed value (in respect to project emissions) or did not claim any emission reductions.

The project is fully implemented according to the description in the registered PDD and the monitoring plan. The verification team confirms, 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 and the monitoring plan. The project is completely operational which was confirmed by means of the on-site visit.

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

The project activity is implemented and operated according to the registered PDD and the monitoring of data and variables is conducted in accordance with the applied monitoring methodology and the monitoring plan.

The ex-ante estimation of emission reductions in the PDD was estimated as 421 789 tCO₂e for 2013, corresponding to 217 250 tCO₂e for the 188 days of the monitoring period. Emission reductions achieved during this monitoring period from 25 February 2013 to 31 August 2013 (188 days) were 230 375 tCO₂e. Hence, the reported emission reductions for the project activity are higher than the ex-ante emission reductions estimated in the PDD. The slight increase of the actual emission reduction during the monitoring period compared to the corresponding ex-ante estimation according to the PDD is mainly because of the high efficiency of the EnviNOx system (values of about 99% are observed whereas 96% were estimated in the ex-ante calculation).

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



All other information provided in the monitoring report is fully in accordance with information stated in the registered PDD.

3.5 Completeness of monitoring

The monitoring of the project is complete and in accordance with the monitoring plan and the approved monitoring methodology, ACM0019 (version 1). The monitoring plan and the applied methodology have been properly implemented and followed by the project participants.

All parameters stated in the monitoring plan, the applied methodology ACM0019 (version 1), respective methodological tools and relevant EB decisions have been sufficiently monitored and updated as applicable, including: project emission parameters; baseline emission parameters; leakage parameters; management and operational system. The responsibilities and authorities for monitoring and reporting are in accordance with the responsibilities and authorities stated in the monitoring plan.

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 completeness of the monitoring (including information flow) was assessed and summarized in section 3.7.1 to 3.7.5 of this verification report.

A procedure for monitoring N₂O regulation is included in the CDM procedure and the corresponding report shows that there is no regulation in Korea which limits the emissions of N₂O from the nitric acid plant #5 of Hu-Chems during the verification period from 25 February 2013 to 31 August 2013 /32/34/.

3.6 Compliance of monitoring plan with the monitoring methodology

DNV is able to confirm that the monitoring plan contained in the registered PDD, version 1.4 dated 22 June 2012 is in accordance with the approved methodology applied by the project activity, i.e. ACM0019 (version 1) and Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0 /39/40/.

3.7 Compliance of monitoring with the monitoring plan

The monitoring has been carried out in accordance with monitoring plan in the registered PDD, version 1.4 dated 22 June 2012 /2/. All parameters were monitored and determined as per the monitoring plan and the monitoring complies with any guidance provided by the EB regarding deviations from the provisions of a registered plan and/or methodology.

3.7.1 Information flow

The instruments transmitters continuously provide a 4 - 20 mA analogue signal according to range and units configured. These signals are transmitted to I/O cards (analogue input/output cards) and collected by the DeltaV Processor. Resulting digital values are made available in the network to be further processed (e.g. in controller blocks, calculation of other variables) and are stored as raw data in the protected continuous historian server (CHS).

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Modifications of the Delta-V, which are protected by security levels by the supplier, are tracked by a Version Control Tool.

The reporting module of the DeltaV system automatically generates aggregated daily reports based on the stored raw data from the continuous historian server. Daily reports contain following kinds of data relevant for calculation of claimed emission reductions:

- Nitric acid production ($P_{NA,n}$)
- Operating parameter of the nitric acid plant (NH_3 flow to AOR for determining h_n)
- Volumetric flow, temperature and pressure of the tail gas stream ($V_{t,db}$, T_t , P_t)
- Volumetric fraction of N_2O in the tail gas stream ($v_{i,t,db}$)

Relevant parameters as mentioned above are exported from the digitally available daily reports to an excel book for presentation of required parameters and calculation of baseline emissions /3/, project emissions and emission reductions according to formulae as required. Details on source of data of all relevant parameters can be found directly in the respective parameter tables below.

The verification of the information flow (where applicable) of all monitoring parameters was successfully done by means of the following documents and cross checks:

Data generation and aggregation:

- Calibration records and certificates
- Monthly Health Check reports
- Quarterly Inspection Check Reports
- General Maintenance service reports
- Plausibility of tail gas flow volume flows with ex-ante values in the PDD
- Monthly Emerson Service Reports, confirming the functionality of the data transmission system for all instruments
- Certificate of analysis of the standard test gas for analyzer calibration

Aggregation to recording:

- Monthly Emerson Service Reports, confirming the functionality of the data storage system for all instruments
- Data cross check between values from analyzers / transmitters and values in control room & data cross check between DeltaV Trend curves (directly generated from raw data) and DeltaV Reports

Calculation and reporting:

- Crosscheck of implemented calculations in Excel sheets against the PDD formulae
- Data cross check between DeltaV Report, production reports, and Excel Sheets

The operating and maintenance personal of the EnviNOx® system have been trained by the technology provider UHDE and the supplier of the digital process control system (Delta-V, M/s. process management), further Hu-Chems has established internal training plans on the CDM procedures, operation of the EnviNOx® system and the monitoring system to train staffs who are assigned to the project during the crediting period /10/.



CARBON is responsible for supervision and checks of monitoring and reporting of data. Furthermore CARBON prepares the CDM-MR and supporting documents and arranges additional doublechecking of data and information.

The verification team assessed the information flow and data collection system and confirms that it meets the requirements of the registered PDD and the monitoring plan as per the applied and approved methodology, ACM0019 (version 1).

The verification team confirms that the monitoring report includes all parameters and the monitored data at the interval required by the methodology and PDD.

Each parameter and the values verified are listed in the sections below.

3.7.2 Baseline emissions

According to the ACM0019 “N₂O abatement from nitric acid production”, version 1 /39/, the project baseline emissions are calculated as nitric acid production multiplied by default baseline emission factor of 2013, when the AOR is deemed under normal operation.

Data variable	Tag. No.	Reported value	Assessment/Observation
EF_{default,y} Default N ₂ O baseline emission factor in the calendar year y of the monitoring period n	-	3.70 kgN ₂ O/tHNO ₃	According to the applied methodology ACM0019 version 1 /39/, the default baseline emission factor during the production of nitric acid during the year of 2013 is 3.70 kgN ₂ O/tHNO ₃ . The default baseline emission factor will decrease year by year onwards until it reaches a final value of 2.5 kgN ₂ O/tHNO ₃ , and this value will remain constant after year 2020.
P_{NA,n} Nitric acid produced in the monitoring period n	325-FT-5-609 Range: 0-2268 kg/min Temperature compensation 325-TT-5-237	Total in monitoring period: 213 809 tHNO ₃	Instrument and location: Coriolis flow meter supplied by Emerson is used for monitoring of nitric acid produced /28/. Range is appropriate. The meter location is in the nitric acid line, downstream of the absorption tower. Meter location has been confirmed by physical inspection during the on site visit. Intervals: Measuring frequency: Continuous Reading frequency: 10 seconds Recording frequency: Hourly Intervals are in accordance with ACM0019 (version 1) Information Flow: Flow and



			<p>density are measured with a coriolis flow meter, temperature with a temperature measurement and concentration is determined based on measured parameters. Values are sent to the DCS and the nitric acid production (as 100% HNO₃) is automatically calculated based on mass flow and HNO₃ concentration. Final production values are exported in production reports through the DeltaV System. Data from DeltaV daily production reports are digitally transferred to spreadsheets where emission reduction calculations are performed /3/ /4/.</p> <p>The verification team checked the daily production reports and then compared the values reported in the spreadsheets. There were no errors in the digital transfer of data from the daily production reports to the spreadsheets for the calculation of emission reductions /3/.</p> <p>DNV successfully confirms the information flow of this parameter (see chapter 3.6.1).</p> <p>QA/QC: The QA is covered by the ISO 9001 and QMS procedures of the nitric acid plant. Valid calibration certificates covering the whole monitoring period are available (see details below) for the used equipments /25/.</p> <p><u>Flow</u> Type: Coriolis flow meter Serial No.: 14290236 Accuracy: $\pm 0.35\%$, valid for the entire measuring range. Latest calibration: 17 May 2012 /25/, Validity until: 16 May 2017 (Calibration is to be done every 5</p>
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			<p>years)</p> <p>Temperature Type: Temperature transmitter Serial No.: C2M408098 Accuracy: +/- 0.5°C + (+/- 0.03% of span). Latest calibration: 12 April 2012 /26/ Validity until: 11 April 2014 (Calibration is to be done every 2 years)</p> <p>The calibrations were carried out for a measuring range comparable with the actual measuring range, and the results confirmed proper functioning of the monitoring equipment and were valid for the monitoring period.</p> <p>The accuracy and the calibration interval of the monitoring equipment are in accordance with the relevant guidance provided by the CDM Executive Board and is controlled and calibrated in accordance with the monitoring plan and ACM0019 (version 1).</p>
h_n Number of hours of operation in a monitoring period n	325-FT-520 Range 0-537 916 m ³ /h	Total in monitoring period: 4 511	<p>Instruments and location: The flow of NH₃ to the ammonia oxidation reactor indicates the operational status. In case, the volume flow of NH₃ to the ammonia oxidation reactor lies above the threshold of 500 Nm³/h during an hour, the reactor is considered in normal operation. This has been confirmed by the plant designer UHDE, as stated in the registered PDD /2/. The flow meter is located in the ammonia supply line, upstream of the ammonia oxidation reactor.</p> <p>Intervals: Measuring frequency: Continuously Reading frequency: Every 10</p>



			<p>seconds</p> <p>Recording frequency: Hourly</p> <p>Intervals are in accordance with ACM0019 (version 1).</p> <p>Information flow: The information flow applicable to this parameter was described in detail in section 3.6.1, hourly values are available in the emission reduction spreadsheet /3/. A data check between trend curves (generated from raw data) and DeltaV daily reports /4/ has been performed. Furthermore, the verification team checked the DeltaV daily reports /4/ and compared the values reported in the spreadsheets. There were no errors in the digital transfer of data. DNV successfully confirms the information flow of this parameter (see chapter 3.6.1).</p> <p>QC/QA:</p> <p>The QA is covered by the ISO 9001 and Quality Management procedures of the nitric acid plant /8/ /12/. In addition, Valid calibration certificate covering the whole monitoring period is available (see details below) for the used equipments /27/</p> <p>Type: Coriolis flow meter</p> <p>Accuracy class: $\pm 0.35\%$, valid for the entire measuring range.</p> <p>Sereial No.: 14288859</p> <p>Latest calibration: 18 May 2012</p> <p>Valid until: 17 May 2017</p> <p>(Calibration is to be done every 5 years).</p> <p>The calibrations were carried out for a measuring range comparable with the actual measuring range, and the results confirmed proper functioning of the monitoring equipment and were valid for the monitoring period.</p>
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			The accuracy and the calibration interval of the monitoring equipment are in accordance with the relevant guidance provided by the CDM Executive Board and is controlled and calibrated in accordance with the monitoring plan and ACM0019 (version 1).
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3.7.3 Project emissions

$V_{t,db}$ Volumetric flow of the gaseous stream in time interval t on a dry basis	325-FT-5-522 Range 0 - 338 730 m ³ dry gas / h	Average value in the monitoring period: 241 559 m ³ dry gas / h	Instrument and location: The differential pressure transmitter of the tail gas supplied by DURAG is used for monitoring this parameter. Range is appropriate. The meter location is in the stack at the end of the tail gas line. Meter location has been confirmed by physical inspection during the on site visit. Intervals: Measuring frequency: Continuously Reading frequency: Every 1 second Recording frequency: Hourly Intervals are in accordance with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0" and with ACM0019 (version 1). Information Flow: The information flow applicable to this parameter was described in detail in section 3.6.1, hourly values are available in the emission reduction spreadsheet /3/. A data check between trend curves (generated from raw data) and DeltaV daily reports /4/ has been performed. Furthermore, the verification team checked the DeltaV daily reports /4/ and compared the values reported in the spreadsheets. There were no errors
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			<p>in the digital transfer of data.</p> <p>DNV successfully confirms the information flow of this parameter (see chapter 3.6.1).</p> <p>QC/QA:</p> <p>The QA is covered by the ISO 9001 and QMS procedures of the nitric acid plant /8/ /12/.</p> <p>In addition, the QA is covered by EN14181, especially QAL2 reference measurements. The initial QAL2 reference measurement was performed by an accredited laboratory at the start of the crediting period during 25 to 28 February 2013 /19/.</p> <p>The correction factor out of the calibration curve, determined during that measurement and documented in the QAL2 report /19/, has been correctly applied on an hourly basis in the emission reduction spreadsheet /3/. The QAL2 report (i.e. the QAL 2 reference measurement) is valid up to 24 February 2016.</p> <p>It was verified that the calibrations were carried out for a measuring range comparable with the actual measuring range and calibration results were within specified error range. The calibrations confirmed proper functioning of the monitoring equipment and were valid for the monitoring period.</p> <p>The accuracy and the calibration interval of the monitoring equipment are in accordance with the relevant guidance provided by the CDM Executive Board and is controlled and calibrated in accordance with the monitoring plan and ACM0019 (version 1).</p> <p><u>Differential Pressure Transmitter:</u></p>
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			<p>Type: Differential Pressure Transmitter</p> <p>Serial No.: 1230726</p> <p>Accuracy: $\pm 2\%$ of span, valid for the entire measuring range.</p> <p>Latest calibration (QAL2): 25-28 February 2013</p> <p>Validity until: 24 February 2016 (Calibration (QAL2) to be done every 3 years)</p>
<p>$V_{i,t,db}$</p> <p>Volumetric fraction of greenhouse gas i in a time interval t on a dry basis</p>	<p>325-AT-5-018</p> <p>Range</p> <p>$0-5.00 \cdot 10^{-4} \text{ m}^3 \text{ N}_2\text{O} / \text{m}^3 \text{ dry gas}$</p>	<p>Average value in the monitoring period:</p> <p>$1.28 \cdot 10^{-5} \text{ m}^3 \text{ N}_2\text{O} / \text{m}^3 \text{ dry gas}$</p>	<p>Instrument and location:</p> <p>The NDIR analyzer of the tail gas supplied by Emerson Process Management is used for monitoring this parameter. Range is appropriate. The sample tube is located in the stack at the end of the tail gas line, and sample gas was leaded to the analyzer house where analyzer were installed. The location has been confirmed by physical inspection during the on site visit.</p> <p>Intervals:</p> <p>Measuring frequency: Continuously</p> <p>Reading frequency: Every 1 second</p> <p>Recording frequency: Hourly</p> <p>Intervals are in accordance with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0" and with ACM0019 (version 1).</p> <p>Information Flow:</p> <p>The information flow applicable to this parameter was described in detail in section 3.6.1, hourly values are available in the emission reduction spreadsheet /3/. A data check between trend curves (generated from raw data) and DeltaV daily reports /4/ has been performed. Furthermore, the verification team checked the DeltaV daily reports /4/ and</p>



		<p>compared the values reported in the spreadsheets. There were no errors in the digital transfer of data.</p> <p>DNV successfully confirms the information flow of this parameter (see chapter 3.6.1).</p> <p>QA/QC:</p> <p>The QA is covered by the ISO 9001 and QMS procedures of the nitric acid plant /8/.</p> <p>In addition, the QA is covered by EN14181, especially QAL2 reference measurements. The initial QAL2 reference measurement was performed by an accredited laboratory at the start of the crediting period during 25 to 28 February 2013 /19/. The correction factor out of the calibration curve, determined during that measurement and documented in the QAL2 report /19/, has been correctly applied on an hourly basis in the emission reduction spreadsheet /3/. The QAL2 report (i.e. the QAL 2 reference measurement) is valid up to 24 February 2016. Emerson Process Management Korea has been performed monthly analyser health checks and quarterly inspection checks to ensure good instrument condition.</p> <p>QAL2 was performed every three years and AST was performed annually in between. QAL 3 calibrations were also automatically performed on a daily basis using the certificated calibration gas /6/ /7/. The results showed that between 26/03/2013 at 10:00 and 09/04/2013 at 11:00, the measured parameters were out of tolerance, in which the final ER calculation has been conservatively processed by adding the observed surplus over the</p>
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			<p>tolerance /3/; for the rest during the monitoring period, QAL 3 result confirmed the good physical conditions /24/.</p> <p>The accuracy and the calibration interval of the monitoring equipment are in accordance with the relevant guidance provided by the CDM Executive Board and is controlled and calibrated in accordance with the monitoring plan and ACM0019 (version 1).</p> <p><u>N₂O Analyzer:</u></p> <p>Type: NDIR analyzer</p> <p>Serial No.: 393709203380368</p> <p>Accuracy: $\pm 1\%$ of span, valid for the entire measuring range.</p> <p>Latest calibration (QAL2): 25-28 February 2013</p> <p>Validity until: 24 February 2016 (Calibration (QAL2) to be done every 3 years)</p>
<p>T_t</p> <p>Temperature of the gaseous stream in time interval t</p>	<p>325-TT-5-161</p> <p>Range</p> <p>273-523K</p>	<p>Average value in the monitoring period: 406.51K</p>	<p>Instrument and location: The temperature transmitter of the tail gas supplied by DURAG is used to monitor this parameter. Range is appropriate. The instrument is located in the stack at the end of the tail gas line. The location has been confirmed by physical inspection during the on site visit.</p> <p>Intervals:</p> <p>Measuring frequency: Continuously</p> <p>Reading frequency: Every 1 second</p> <p>Recording frequency: Hourly</p> <p>Intervals are in accordance with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0" and with ACM0019 (version 1).</p> <p>Information Flow:</p> <p>The information flow applicable to this parameter was described in</p>



			<p>detail in section 3.6.1, hourly values are available in the emission reduction spreadsheet /3/. A data check between trend curves (generated from raw data) and DeltaV daily reports /4/ has been performed. Furthermore, the verification team checked the DeltaV daily reports /4/ and compared the values reported in the spreadsheets. There were no errors in the digital transfer of data.</p> <p>DNV successfully confirms the information flow of this parameter (see chapter 3.6.1).</p> <p>QA/QC:</p> <p>The QA is covered by the ISO 9001 and QMS procedures of the nitric acid plant /8/ /12/.</p> <p>In addition, Valid calibration certificate covering the whole monitoring period is available (see details below) for the used equipments /19/</p> <p><u>Temperature transmitter</u></p> <p>Type: Temperature transmitter Accuracy class: +/- 0.5°C + (+/- 0.03% of span), valid for the entire measuring range. Sereial No.: 1230727 Latest calibration: 25 February 2013 Valid until: 24 February 2015 (Calibrations to be done every 2 years).</p> <p>The accuracy and the calibration interval of the monitoring equipment are in accordance with the relevant guidance provided by the CDM Executive Board and is controlled and calibrated in accordance with the monitoring plan and ACM0019 (version 1).</p>
P_t Pressure of the	325-PT-5-362 Range	Average value in the monitoring	Instrument and location: The pressure transmitter of the tail gas



gaseous stream in time interval t	$9 \cdot 10^4 - 11 \cdot 10^4$ Pa	period: 100 417 Pa	<p>supplied by ABB is used to monitor this parametr. Range is appropriate. The instrument is located in the stack at the end of the tail gas line. The location has been confirmed by physical inspection during the on site visit.</p> <p>Intervals: Measuring frequency: Continuously Reading frequency: Every 1 second Recording frequency: Hourly</p> <p>Intervals are in accordance with "Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0" and with ACM0019 (version 1).</p> <p>Information Flow: The information flow applicable to this parameter was described in detail in section 3.6.1, hourly values are available in the emission reduction spreadsheet /3/. A data check between trend curves (generated from raw data) and DeltaV daily reports /4/ has been performed. Furthermore, the verification team checked the DeltaV daily reports /4/ and compared the values reported in the spreadsheets. There were no errors in the digital transfer of data.</p> <p>DNV successfully confirms the information flow of this parameter (see chapter 3.6.1).</p> <p>QA/QC: The QA is covered by the ISO 9001 and QMS procedures of the nitric acid plant /8/ /12/.</p> <p>In addition, Valid calibration certificate covering the whole monitoring period is available (see details below) for the used equipments /29/</p> <p><u>Pressure Transmitter:</u></p>
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			<p>Type: Pressure transmitter Accuracy class: $\pm 0.1\%$ of span, valid for the entire measuring range. Sereial No.: 1230980 Calibration frequency: Monthly Calibration time: 25 February 2013 (QAL 2); 11 March 2013; 10 April 2013; 10 May 2013; 10 June 2013; 9 July 2013; 8 August 2013 /29/. The accuracy and the calibration interval of the monitoring equipment are in accordance with the relevant guidance provided by the CDM Executive Board and is controlled and calibrated in accordance with the monitoring plan and ACM0019 (version 1).</p>
<p>C_{H2O,t,db,n} Moisture content of the gaseous stream at normal conditions, in time interval t</p>	<p>Measurements as per USEPA CF42 method 4 – Gravimetric determination of water content</p>	<p>Applicable value in the monitoring period: Below $4 \cdot 10^3$ mg H₂O/m³ dry gas (equivalent to 0.004 kgH₂O/m³ dry gas and thus clearly below the threshold value of 0.05 kg H₂O/m³ dry gas). Therefore, Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0" can be applied.</p>	<p>Instrument and location: Gravimetric determination of water content was performed by the qualified, external entity AIRTEC /19/.</p> <p>Intervals: Repeated measurements (that coincided with the QAL 2 reference measurements), performed during 25/02/2013 to 28/02/2013. Intervals are in accordance with "Tool to determine the mass flow of a greenhouse gas in a gaseous steam, version 2.0.0" and with ACM0019 (version 1).</p> <p>Information Flow: Measurements were performed by the qualified, external entity AIRTEC, data (determined values) were provided in a respective report of that entity /19/.</p> <p>QA/QC: Mesurement according to USEPA CF42 method 4 is performed by the qualified, external entity AIRTEC.</p>



3.7.4 Other parameters determined ex-ante

GWP_{N2O} Global warming potential of N ₂ O valid for the commitment period	-	Value during monitoring period: 298 tCO ₂ e/tN ₂ O	According to the “ <i>Application of the global warming potentials to clean development mechanism project activities and programme of activities for the second commitment period of the Kyoto Protocol</i> ” /41/, since 1 January 2013, all the CDM project shall apply updated GWP value. For N ₂ O, the value of 298 shall be applied from 1 January 2013 onwards.
R_u Universal ideal gases constant	-	Value during monitoring period: 8.314 Pa.m ³ /kmol.K	According to “ <i>Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0</i> ” /40/, the universal ideal gases constant is 8.314 Pa.m ³ /kmol.K.
MM_i Molecular mass of N ₂ O	-	Value during monitoring period: 44.02 kg/kmol	According to “ <i>Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0</i> ” /40/, the molecular mass of N ₂ O is 44.02 kg/kmol.

3.7.5 Emission reductions

The amounts of emission reductions in this monitoring period were calculated as follow:

$$ER_y = BE_y - PE_y - L_y = 235\,745 - 5\,370 - 0 = 230\,375 \text{ tCO}_2\text{e.}$$

DNV confirms that appropriate methods and formulae for calculating emission reductions have been followed for this project activity. DNV furthermore confirms that the assumptions, emission factors that were applied in the calculations have been justified. This was verified by cross-checking in detail the formulae described and applied in the monitoring report /1/ and implemented in the emission reduction calculation spreadsheet /3/ against the formulae in the PDD /2/, the applied methodology (ACM0019, Version 1) /39/ as well as the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0.0 /40/.

As outlined above, the input data for calculating the emission reductions, the calculating process and the result are complete and transparent. Therefore, DNV is able to confirm the accuracy of the emission reductions.

3.8 Assessment of data calculation of emission reductions

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 ACM0019 (version 1) and the monitoring plan as per the registered PDD.



A complete set of data covering the monitoring period has been provided to DNV and reviewed during verification. Activity levels and non-activity (ex-ante) parameters have been monitored in accordance with the 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 Delta-V DCS 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.

Spreadsheets /3/, including corresponding re-calculations of data during events as described in the monitoring report, were made available for the verification team. The recalculations are in line with the applied methodology ACM0019 (version 1) and the monitoring plan as per the registered PDD and have been checked and found to be correct.

3.9 Quality of evidence to determine emission reductions

The main parameters are automatically collected by the Delta-V system provided by Emerson. All necessary documentation is collected, referenced and aggregated and is easily accessible in spreadsheets and daily reports in electronic format. Measurements are performed by calibrated equipment, and key data was cross-checked via other sources (if applicable), 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 /4/.

Relevant and applicable provisions out of the the European Norm EN 14181 have been followed in full and correctly applied.

All measuring and analytical instruments are calibrated as per the prescriptions in the registered PDD and as per the procedures used by the plant operators. These procedures are part of the ISO 9001 Quality Management System.

All instruments have a valid calibration covering the whole monitoring period, and no calibration delay beyond the calibration interval requirements has occurred. The calibration certificates were provided as evidence of the work performed. DNV confirms that all instruments are working within the specified error ranges, as per the certificates.

The equipments used for monitoring are controlled and calibrated in accordance with the monitoring plan, the applied methodology, relevant guidance by the CDM EB as well as the manufacturer's specification. The accuracy and the calibration frequency of the monitoring equipment is in accordance with the applied methodology and the monitoring plan, the relevant guidance provided by the board and complies with manufacturer's specification. The monitoring results are consistently recorded as per approved frequency and the quality assurance and quality control procedures have been applied in accordance with the monitoring plan. All meters and measuring equipment necessary for the project activity are located at the nitric acid plant of Hu-Chems Fine Chemical Corp. as per the PDD.

3.10 Management system and quality assurance

The project is operated by Hu-Chems Fine Chemical Corp. responsibility for monitoring and reporting of data under the CDM activity has been contracted to CARBON. 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 9001:2009 and ISO 14001:2009 /8/ /9/.

There are two data streams coming from Hu-Chems Fine Chemical Corp. nitric acid plants (plant operation & production data) and EnviNOx system (N₂O reduction system operation parameters), which are compiled by CARBON and used in emission reduction calculations and monitoring report.

The EnviNOx system and the monitoring system are designed as an automatic process, so the involvement of the personnel during normal operation is minimised. In case of any deficiency, appropriate procedures are in place. In addition, two separate service agreements is in place for the analyser system and the Delta-V system between Hu-Chems and Emerson Process Management Korea Ltd. /11/. These contracts cover regular preventive checks on operational condition of the analyser system (on a monthly basis), "On site" Delta V system health checks (on a monthly basis), 24 hour emergency service, inspections visits (on a quarterly basis) and respective reporting. The services reports and health check records were made available for verification /14/.

The the monitoring report includes a detailed description of the periodical observations of the EnviNOx system and the monitoring instrument; in case of failures responsibilities are defined. Service reports of performed maintenance activities, calibrations and health checks were made available for verification.

In addition, during the monitoring period, the project operator Hu-Chems also carried out visual on-site analyser cabinet inspections and related installation on a shift basis (3 times daily). The records have been confirmed by DNV during the site visit /16/ /17/.

Local operators and instrumentation engineers of the system have been trained by the equipment suppliers /10/. Data handling solutions involve redundancy, data manipulation protection, integrity check as well as proper archiving. The related procedures were kept on site and were easily available /12/.

Hu-Chems Fine Chemical Corp. covers all CDM activities in the internal audit and management reviews. The last internal audit was conducted in August 2013 /18/. The plant manager reviewed their management system in August 2013 and the latest external audit was conducted in September 2012 /18/.

Quality Control / Quality Assurance Procedures for N₂O emission measurements

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

- QAL 1: The QAL 1 report for N₂O analyser and flow meter have been conducted by TÜV Energie und Umwelt GmbH /22/ /23/ and TÜV Rheinland Immissionsschutz und Energiesysteme GmbH. /20/ /21/, confirming that the equipment is suitable for the continuously monitoring usage.
- The QAL 2 was conducted by AIRTEC in accordance with EN 14181 on 25~28 February 2013. AIRTEC has certified according to ISO/IEC 17025.
- QAL 3: The QAL 3 calibration was automatically and periodically conducted by the system with adequate equipment such as certificated test sample gas /6/. Records on results (SHEWART Cards) were made available to the DNV for verification /7/.



4 CERTIFICATION STATEMENT

DNV Climate Change Services AS (DNV) has performed the verification of the emission reductions that have been reported for the CDM project activity 6637 “Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp.” in the Republic of Korea for the period 25 February 2013 to 31 August 2013.

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 activity.

It is DNV’s responsibility to express an independent verification statement on the reported GHG emission reductions from the project activity. 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 baseline and monitoring methodology ACM0019 (version 1), the registered PDD (version 1.4 dated 22 June 2012) and the monitoring plan contained in that PDD and the monitoring report (version 2) dated 28 June 2014. 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 reported for the project activity for the period 25 February 2013 to 31 August 2013 are fairly stated in the monitoring report (version 2) dated 28 June 2014.

The data generation, aggregation, recording, calculation and reporting of GHG emission reductions were conducted correctly on the basis of the approved baseline and monitoring methodology ACM0019 (version 1) and the monitoring plan contained in the PDD (version 1.4 of 22 June 2012).

DNV Climate Change Services AS is able to certify that the emission reductions from the CDM project activity 6637 “Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp.” in the Republic of Korea during the period 25 February 2013 to 31 August 2013 amount to 230 375 tonnes of CO₂ equivalent.

Beijing and Oslo, 29 July 2014

Li Cheng
Verifier
DNV Beijing, China

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



5 REFERENCE

5.1.1 Documentation provided by the project participants

- /1/ Monitoring report: "Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp." for the monitoring period 25 February 2013 to 31 August 2013, version 1 dated 11 September 2013 and version 2 dated 28 June 2014
- /2/ CDM Project Design Document: Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp., version 1.4 dated 22 June 2012
- /3/ CDM Project Spreadsheet for the verification period from 25 February 2013 to 31 August 2013:
HUC#5_MP01_UNFCCC_CONFIDENTIAL.xlsx
- /4/ Daily monitoring reports, generated by Delta-V system (cvs files), from 25 February 2013 to 31 August 2013.
Alarms & Events Logfiles. Trend curves with relevant operating parameters from Delta-V system.

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

- /5/ TÜV SÜD Industrie Service GmbH: Validation Report for the "Reduction of N₂O emissions from the new nitric acid plant #5 of Hu-Chems Fine Chemical Corp." project. Report No. 600500803, Rev 3, dated 3 July 2012
- /6/ Certificates of analysis of calibration test gases:
Certificates of analysis:
 - PRAXAIR NV, Cylinder ID: DJ10142, N₂O: 80.0 ppm, Uncertainty: 1%, dated 12 October 2012, stable until: 15 October 2015.
- /7/ Hu-Chems: SHEWART CARD of QAL 3 calibration records
- /8/ ISO 9001:2009 Certificate, issued by Korean Foundation for Quality, valid until 6 November 2014.
- /9/ ISO 14001:2009 Certificate, issued by Korean Foundation for Quality, valid until 6 November 2014.
- /10/ Hu-Chems: Internal training and records in 2012 and 2013
- /11/ Service Support Agreement Analyser System for EnviNOx between Hu-Chems and Emerson Process Management Korea Ltd, dated 2 April 2013.
- /12/ Hu-Chems Fine Chemical Corp., QMS CDM operation procedure: HCSEP-448, Rev.2.
- /13/ Uhde Guarantee Test Run Protocols for the EnviNOx® system for Hu-Chems nitric acid plants #5, dated 25 February 2013.
- /14/ Maintenance & Service records:
 - 25~26 March 2013, Emerson Process Management Korea, Monthly Health Check Report of monitoring instruments and & DeltaV System in plant #5;
 - 16~17 April 2013, Emerson Process Management Korea, Monthly Health Check and Quarterly Inspection Report of monitoring instruments & DeltaV System in plant #5;
 - 14~15 May 2013, Emerson Process Management Korea, Monthly Health Check Report of monitoring instruments and & DeltaV System in plant #5;
 - 17~18 June 2013, Emerson Process Management Korea, Monthly Health Check

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- Report of monitoring instruments and & DeltaV System in plant #5;
- 17~18 July 2013, Emerson Process Management Korea, Monthly Health Check and Quarterly Inspection Report of monitoring instruments and & DeltaV System in plant #5;
 - 12~13 August 2013, Emerson Process Management Korea, Monthly Health Check Report of monitoring instruments and & DeltaV System in plant #5;
- /15/ Service Support Agreement Delta-V System for EnviNOx between Hu-Chems and Emerson Process Management Korea Ltd, dated 2 April 2013.
- /16/ Hu-Chems: CDM analyser cabinet Check lists and Key lists.
- /17/ Hu-Chems: CDM Check Sheet of EnviNOx systems (daily).
- /18/ Internal audit records, September 2012 and August 2013;
External audit records, September 2012 and August 2013;
Management review report, October 2012.
- /19/ AIRTEC Gesellschaft für Umweltmessungen mbH: Moisture content and QAL 2 Test according EN 14181, performed on 25~28 February 2013, valid until 24 February 2016 (applicable to 325-AT-5-018 and 325-FT-5-522)
The AIRTEC's accreditation of EN14181 standard:
<http://airtechcs.com/services/stack-emission-testing/>
- /20/ TÜV Rheinland Energie und Umwelt GmbH.: QAL 1 test report with positive consequence for the flow meter manufactured by DURAG (type DFL 100), report No. 936/21218492/B, dated 22 January 2013 (applicable to 325-FT-5-522).
- /21/ TÜV Rheinland Immissionsschutz und Energiesysteme GmbH and Deutscher Akkreditierungs Rat: QAL 1 certificate, declaration of suitability for the flow meter manufactured by DURAG (type of DFL 100) dated 16 October 2008 (applicable to 325-FT-5-522)
TÜV Rheinland Energie und Umwelt GmbH. and German Federal Environment Agency: QAL 1 certificate, declaration of suitability for the flow meter manufactured by DURAG (type of DFL 100), certification No. 0000032298, dated 5 March 2013 and valid until 4 March 2018 (applicable to 325-FT-5-522) and replacing the previous certificate (from 16 October 2008).
- /22/ TÜV Rheinland Energie und Umwelt GmbH.: QAL 1 test report with positive consequence for the N2O analyzer manufactured by Emerson Process Management (type of NGA 2000), report No. 936/21219398/A, dated 21 October 2012 (applicable to 325-AT-5-018)
- /23/ TÜV Rheinland Energie und Umwelt GmbH: Preliminary QAL 1 certificate & declaration of suitability for the analyser (type NGA 2000 MLT 2 for N2O), dated 22 December 2012 and valid until 21 June 2013 (and applicable to 325-AT-5-018)
TÜV Energie und Umwelt GmbH. and German Federal Environment Agency: QAL 1 certificate, declaration of suitability for the N2O analyzer manufactured by Emerson Process Management (type of NGA 2000), certification No.: 0000032299, dated 5 March 2013 and valid until 4 March 2018 (applicable to 325-AT-5-018) and replacing the temporary certificate (from 22 December 2012).
- /24/ Hu-Chems: Shewartcard spreadsheet (Daily QAL 3 records).
- /25/ Micor Motion Inc.: Calibration records of the Coriolis flow meter 325-FT-5-609 for nitric acid production, performed on 17 May 2012 and valid until 16 May 2017
- /26/ YOKOGAWA: Calibration records of temperature transmitter 325-TT-5-237 of nitric



- acid production, dated 12 April 2012 and valid until 11 April 2014.
- /27/ Micor Motion Inc.: Calibration records of the Coriolis flow meter 325-FT-5-520 for the ammonia flow rate to the oxidation reactor, dated 18 May 2012 and valid until 17 May 2017.
- /28/ Department diagram of Emerson Process System, indicating that Micro Motion is one of the branches of Emerson, available at:
http://www2.emersonprocess.com/siteadmincenter/PM%20Rosemount%20Documents/Emerson_background.pdf
- /29/ HU-CHEMS Fine Chemical Corp.: monthly calibration records of pressure transmitter 325-PT-5-362 for the pressure of the gaseous stream
- 11 March 2013
 - 10 April 2013
 - 10 May 2013
 - 10 June 2013
 - 9 July 2013
 - 8 August 2013
- /30/ AIRTEC Gesellschaft für Umweltmessungen mbH: Calibration record for the pressure transmitter 325-PT-5-362, dated 25 February 2013
- /31/ AIRTEC Gesellschaft für Umweltmessungen mbH: Calibration record for the temperature transmitter 325-TT-5-161, dated 25 February 2013 and valid until 24 February 2015
- /32/ Ministry of Environment: Clean Air Conservation Act of the Republic of Korea, latest version in July 2012.
- /33/ Hu-Chems: Report on environmental regulations (N₂O and NO_x), up to 31 August 2013.
- /34/ Ministry of Environment: Framework Act on Low Carbon Green Growth, published in January 2010 and effective in April 2010.
- /35/ Letter from Ministry of Knowledge, Economy: Confirming that Hu-Chems' plants do not have an obligation from the relevant environmental regulations, dated 21 October 2011.

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

- /36/ CDM Executive Board: *Clean Development Mechanism Validation and Verification Standard*, version 05.0
- /37/ CDM Executive Board: *Clean Development Mechanism Project Standard*, version 05.0
- /38/ CDM Executive Board: *Clean Development Mechanism Project Cycle Procedure*, version 05.0
- /39/ CDM Executive Board: *Baseline and monitoring methodology ACM0019 "N₂O abatement from nitric acid production"*, version 1
- /40/ CDM Executive Board: *Tool to determine the mass flow of a greenhouse gas in a gaseous steam*, version 2.0.0
- /41/ CDM Executive Board: *Application of the global warming potentials to clean development mechanism project activities and programme of activities for the second commitment period of the Kyoto Protocol*



5.1.4 Persons interviewed during the verification

/42/ Hu-Chems Fine Chemical Corp.:

J. H. Kim, Hu-Chems Production Team #1, Team assistant manager

J.H. Kim, Hu-Chems Production Team #2, Team assistant manager

S.H. Kyung, Hu-Chems engineering & Management Team, Team assistant manager

C.H. Yi, Hu-Chems maintenance control department, Assistance chief clerk

/43/ D.H. Kim, Carbon CDM Korea, Section Chief

/44/ Andreas Moser-Rammelmüller, Carbon Climate Protection GmbH, Responsible for CDM projects, Project 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	In the MR of GSP, it was stated that the "Correction factor derived from QAL 2 report must be applied to both the N ₂ O concentration and the volume or mass flow of the tail gas"; However, DNV found that in the ER calculation process, the correction factor was not applied to the N ₂ O concentration of the tail gas, which is not in line with the MR and also not conservative.	<p>As per the finding of the DOE, the correct value (i.e. including the correction factors from EN14181/QAL) have been applied in the revised version, the XLS Spreadsheet is changed respectively. All links/formulae have been checked repeatedly, no other reason for changes has been identified.</p> <p>The calculation is now conservative, since it considers correction factors derived from EN14181/QAL. Calculations now are fully in line with the methodology/tools applied.</p>	<p>OK.</p> <p>DNV has checked the updated MR and the ER calculation sheet and was able to confirm that the correction factor from QAL 2 report has been correctly applied for the calculation of ER.</p> <p>CAR 1 is closed.</p>

Clarification requests

CL ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
CL 1	During the on-site audit, DNV found that the serial No. of the N ₂ O analyser at the stack gas outlet was inconsistent with the information provided in the MR of GSP. Clarification from the PP is required on this discrepancy.	The serial number has been confused with the NO _x analyser, which is contained in the same installation. The respective sections in the MR have been updated in order to show the correct serial number.	<p>OK.</p> <p>By checking the updated MR, DNV could confirm that the updated serial No. of the analyser in the MR is consistent with the SV and the original calibration report QAL 2</p> <p>CL 1 is closed.</p>

CL ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
CL 2	<p>In the section B of MR of GSP, it was mentioned that “on 08/08/2013, engineers from Hu-Chems have performed a regular calibration of the stack gas pressure transmitter,, the recorded values for the parameters $V_{t,db}$ (Volumetric flow of the gaseous stream) and P_t (Pressure of the gaseous stream) have been both influenced over these hours”. However, since the calibration was only conducted for the pressure transmitter, why the value of flow rate was also influenced? PP is required to clarify on this.</p>	<p>During the calibration action of the stack gas pressure transmitter (respective parameter: P_t – Pressure of the gaseous stream), the instrument for the stack gas volume flow (Respective parameter $V_{t,db}$ – Volumetric flow of the gaseous stream) has been mistakenly deactivated as well, even although no calibration was conducted nor necessary.</p> <p>This singular issue has only been observed at this occasion.</p> <p>As described in the MR, conservative estimation of values during the affected few hours have been made (by applying maximum values of the monitoring period).</p> <p>A further clarification has been added in the MR in order to prevent confusion.</p>	<p>OK</p> <p>DNV checked the raw data as well as updated MR and could confirm that the description is in line with actual circumstances and also the corresponding ER calculation is conservative. CL 2 is close.</p>

CL ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
CL 3	<p>During the audit, DNV found some discrepancies on the information of the monitoring instruments between the MR and original records, such as the serial No. of the ammonia flow rate meter, the stack gas temperature and pressure transmitter; the calibration date of the NA Coriolis flow meter, the TAG number and accuracy information (i.e. information of the monitoring instrument) of the Temperature Transmitter with regard to the nitric acid production. PP is required to clarify on these discrepancies.</p>	<p>Due to the first compilation of the monitoring report, some numbers were confused when preparing it and the background documents. Instrument information for all monitoring equipment has been double checked again with instruments, calibration documentation and monitoring documentation in order to ensure consistency. The MR has been changed in the respective sections, information for temperature measurement involved in the determination of the nitric acid production has also been added.</p> <p>It shall be noted that all instruments applied during the monitoring period had a valid calibration at any time.</p> <p>For a better overview, a line diagram showing was added in the MR.</p>	<p>OK.</p> <p>DNV has checked the updated MR and could confirm that all the incorrect information about the monitoring instruments has been updated to be consistent with the actual information verified during the SV.</p> <p>CL 3 is close.</p>

Forward action requests from validation / previous verification

FAR ID	Forward action request	Sum of how FAR has been addressed in this reporting period	Assessment of how FAR has been addressed
FAR 1	<p>In accordance with paragraph 62(g) of the CDM Modalities and Procedure, the DOE contracted by the project participant to perform verification shall, "Identify and inform the project participants of any concerns related to the conformity of the actual project activity and its operation with the registered project design document. Project participants shall address the concerns and supply relevant additional information;"</p> <p>Hu-Chems is mandatory participant of the Greenhouse Gas and Energy Target Scheme and thus, the new nitric acid plant is one GHG emission source which has also been reported to the authority for target setting. The validation opinion is based on the current laws and regulations which are described in Validation Report. Any change of the Greenhouse Gas and Energy Target Scheme or other legislation which affects the project activity's emission reduction under the CDM should be assessed by the verifying DOE.</p>	<p>Hu Chems Environmental team regularly checks, if any regulation on N₂O limitation is in place (relevant laws are the Clean Air Conservation Act and the Framework Act on Low Carbon, Green Growth). The latest report is available from 31 August 2013, showing that no regulation of N₂O limitation is in place which would restrict the emission of N₂O in Hu-Chems nitric acid plant #5.</p> <p>No substantial changes in the legislation took place, there is no legal requirement for Hu-Chems to reduce its N₂O emissions.</p>	<p>In addition to reviewing the latest report by the Hu Chems Environmental team /33/, DNV checked the relevant Korean environmental regulations including such, which could impact N₂O emissions. In April 2010, new Korean regulations became effective (The Framework Act on Low Carbon, Green Growth), introducing the GHG and Energy Target Scheme. Hu-Chems nitric acid plant #5 does not have any target obligation on GHG emissions from this GHG and Energy Target Scheme, as verified by the responsible Ministry of Knowledge and Economy /35/. DNV confirms, that there are currently no restrictions related to N₂O emissions which have impact on the project activity and emission reduction calculations.</p>

Forward action requests from this verification

FAR ID	Forward action request	Response by Project Participants
	N.A.	N.A.

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	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Not applicable
Temporary deviations from the registered monitoring plan and/or monitoring methodology	Not applicable	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Not applicable
Permanent changes from the registered monitoring plan or applied methodology	Not applicable	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Not applicable
Changes to the project design of a registered project activity	Not applicable	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> 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 Appendix 1 to the CDM Project Standard /8/

APPENDIX C

CURRICULA VITAE OF THE VERIFICATION TEAM MEMBERS

Mr. Li Cheng holds a Bachelor Degree in Chemical Engineering. Having a overall experience of around six years. Prior to joinning DNV, having three years experience in oil drilling industry covering field technical service and three years in chemical production industry covering field management of product line.

His qualification, industial experience demonstrate his sufficient sector competence in "Chemical Process Industries/Oil and Gas Industries"

Tae Ho Kim: holds a Bachelor of Applied Biology & Chemistry, and works at DNV Certification Korea as business assurance auditor.

Patrice Massicard: holds a Master degree in Mechanical Engineering. Having 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 equipment, and 1 year experience in the validation of CDM projects. His qualification, industrial experience and experience in CDM demonstrate him sufficient sectoral competence in the filed oil & gas and mechanical industries.

Trine Kopperud: holds a Bachelor First Honours Degree in Chemical and Process Engineering with an overall experience of around_25 years in chemical process industries. Prior to joining DNV she has gained experience from fertiliser production (including ammonia, nitric acid and catalysts production and sales), magnesium production and energy efficiency. Positions in research and operations including 6 years experience in N₂O abatement technologies (research & development, operation, application and sales).

She has experience of 7 years in validation and verification of CDM projects/JI and other 3rd party validation/verification services in several countries including China, Africa, India, Middle East and Eastern Europe.

Her qualification, industrial experience and experience in CDM/JI demonstrate her sufficient sectoral competence in Chemical Processes Industries and Metal production