

First Monitoring Report: „Catalytic Reduction of N₂O inside the Ammonia Burners of the Nitric Acid Plant at Caojing, Shanghai”

**Monitoring Reports for
Baseline and for
Project Campaign #1
Version 2**

The purpose of these monitoring reports is to provide

- (a) baseline calculation data which are also applicable to future calculations of emission reductions (Baseline Report),**
- (b) relevant information about GHG emission reductions achieved during the defined project period (Project Monitoring Report #1).**

The monitoring reports thus contain values of all parameters which have to be controlled according to the PD, the applied methodology AM0034 and the current monitoring plan (VER handbook). Both reports provide a summary of the implemented calculations for determination of emissions and emission reductions.

By reference to the comprehensive and up-to-date monitoring plan, the monitoring reports can be structured as concise documents, thus improving the usability of the content and supporting the transparency of the monitoring.

The reports have been prepared for first verification of the baseline emissions and the achieved emission reductions of the first project campaign at Caojing plant. As basic documentation for verification they refer to:

- **Approved baseline and monitoring methodology AM0034:** “Catalytic reduction of N₂O inside the ammonia burner of nitric acid plants”, v3.2, which is used in the PD.
- **Project documentation (PD)** to Caojing project in its validated version: “Catalytic Reduction of N₂O inside the Ammonia Burners of the Nitric Acid Plant at Caojing, Shanghai”, version 3, 24 June 2010, validated.
- **VCS 2007.1 Validation Report from TÜV Nord:** “CATALYTIC REDUCTION OF N₂O INSIDE THE AMMONIA BURNERS OF THE NITRIC ACID PLANT IN CAOJING, SHANGHAI”, Report No: 8000372692 - 09/208, revision 1, 2010-11-22.
- **Monitoring plan** as an up-to-date documentation to the monitoring procedures and their implementation: “VER Handbook”, v1.1, December 2010.
- **Extracted Durag AMS data and baseline/project calculation tools** where relevant calculations are presented in a transparent way.

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1 Baseline Monitoring Report

Project	Catalytic Reduction of N ₂ O inside the Ammonia Burners of the Nitric Acid Plant at Caojing, Shanghai
Plant Design Capacity	265,000 t HNO ₃ per year
Location (GPS)	30° 47' 13" N, 121° 27' 51" E
Date / Version of Monitoring Report	01 December 2010 / Version 2
Monitoring Period	Baseline Campaign, 13-03-2009 – 22-11-2009
Underlying PD	Version 3 from 24 June 2010, validated, amended by extended monitoring plan of the VER Handbook, Version 1.1, December 2010.
Validation Report No.	Report No: 8000372692 - 09/208, TÜV Nord

presented by:
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1.1 Project background

Title of project activity:

"Catalytic Reduction of N₂O inside the Ammonia Burners of the Nitric Acid Plant at Caojing, Shanghai"

Status of implementation:

Table 1 below illustrates the project implementation as of November 2010.

Table 1: Status of implementation

Activity	Date
Baseline measurement period	13-03-2009 – 22-11-2009
Onsite validation	08-07-2009 – 09-07-2009
First project campaign (PC1)	28-11-2009 – 30-06-2010
Onsite first verification	22-11-2010 – 24-11-2010

1.2 Applied methodology and monitoring plan

Calculation of baseline emissions is being realized on basis of the VER Handbook (v1.1) which constitutes an extended and amended/up-dated version to the monitoring section of the PD (v3). Methodological basis to the monitoring plan is approved methodology AM0034 (v3.2).

Where required, equipment was calibrated according to relevant national standards. Quality of stack monitoring equipment was ensured by applying EN14181.

1.3 Analysis of baseline campaign

The baseline campaign took place from 13 March 2009 to 22 November 2009.

1.3.1 Normal operation

As reference for analysis, both data from historical campaigns as well as design manual data was applied. Those data are included in the PD and have been validated.

Baseline campaign length

The average historical campaign length (CL_{normal}) has been used as a HNO₃ production maximum/cap on the length of the baseline period (CL_{BL}). Accordingly the baseline period is shorter than the average historical campaign.

Statistical evaluation

A statistical evaluation of process data values OT_{BC}, OP_{BC}, AFR_{BC} and AAR_{BC} of the defined baseline campaign shows that more than 50% of the hourly values (OH_{BC}) were within the permitted operating conditions (OT_{normal}, OP_{normal}, AFR_{max}, AAR_{max}). Values of normal operation are included in the table 2 of section 1.4 below. They are taken from the validated PD.

1.3.2 Gauze information

Information on the gauze supplier and the composition of the oxidation catalyst have been gathered and compared to the historical situation. It has been assured that the gauze composition during baseline period remains within the permissible deviation range of +/-2% (against composition during historical campaigns.) The gauze supplier has not changed.

1.3.3 Tail gas data measurement and calculations

An automated measuring system (AMS) has been installed using the guidance document EN 14181. It provides continuous separate readings for N₂O concentration and gas volume flow (average values for every 60 minutes of operation). Besides N₂O concentration and gas volume flow, the AMS also records temperature and pressure of the tail gas.

Before conducting calculations, tail gas data sets (NCTG_{BC}, VTG_{BC}, TTG_{BC}, PTG_{BC}) have been combined with respective process data sets.

Statistical percentile evaluation

For calculation of the baseline emission factor, only hourly data from the baseline period have been used when the system generally operated within the ranges defined by permitted operating conditions (OT_{normal}, OP_{normal}, AFR_{max}, AAR_{max}).

Furthermore, to eliminate mavericks from the VTG_{BC} and NCTG_{BC} samples, data sets have been statistically analyzed along AM0034 procedures (95% confidence interval).

AMS Uncertainty

The all-over uncertainty of the monitoring system has been calculated by an independent laboratory. According to the resulting QAL2 report, the combined uncertainty (UNC), entailing correction factors for AMS flow-rate and the N₂O analyser, is 4.59%

Calculated Parameters

EF _{BC}	Baseline emission factor
BE	Baseline emissions

Equations 1 and 2 of the validated PD are applied for calculation of baseline emissions and the baseline emission factor.

For AMS down-time intervals the IPCC default value (4.5 kgN₂O/tHNO₃) is applied.

1.3.4 Tail gas data quality assurance and quality control

Quality assurance procedures for the AMS are defined in the VER handbook (i.e. daily checks, calibrations, handling of calibration gas, maintenance, trouble shooting). Their implementation has been controlled by means of a data handling protocol where occurrence of relevant events has been recorded. Reliability of data is being checked at internal validation meetings which involves all relevant staff. Feasibility of improvements in quality assurance procedures including trouble shooting procedures and their implementation are discussed in these meetings also. Details on these procedures are also outlined in the up-to-date VER handbook.

1.4 Results from baseline campaign analysis

Table 2: Extracted PD reference data on normal operation

CL _{normal} [t HNO ₃]	AFR _{max} [t/h]	AAR _{max} [Vol-%]	OT _{normal} [°C]	OP _{normal} [MPa]
169,991.83	11.250	11.35	857.836 - 875.602	0.28 – 0.45

Table 3: Campaign length and normal operation

Campaign	Period	CL _{BC} [t HNO ₃]	OH _{BC} [hours]	“Normal” OH _{BC} [hours]	NOH _{BC} / OH _{BC} [%]
BC	13-03-2009 – 22-11-2009	169,958 (NCTG integ.) 180,988 (real)	5,551	5,220	94 %

Table 4: Percentile analysis of NCTG and VTG values

Campaign	VTG _{BC} mean [m ³ /h]	Percentile VTG _{BC} mean [m ³ /h]	NCTG _{BC} mean [mg/m ³]	Percentile NCTG _{BC} mean [mg/m ³]
BC	120,006.4608	120,135.2813	2,068.098059	2,071.088379

Table 5: Application of default emission factor

Campaign	NOH where AMS was down [hours]	IPCC default emission factor [t HNO ₃]
BC	66	4.5

Table 6: Calculated emissions and emission factor

Campaign	EF _{BC} [kgN ₂ O/tHNO ₃]	BE [tN ₂ O]
BC	7.25	1,381

Table 7: Significant events during campaign

Campaign	Date	Explanation
BC	30-05-2009 until 22-06-2009	Plant shut down for downtime maintenance (so called turnaround)
BC	13-03-2009 until 14-03-2009	AMS was not operational for first 40 operating hours after start of campaign. For calculation, downtime values have been applied.
BC	29-10-2009 until 30-10-2009	AMS indicates fault for consecutive 23 operating hours. For calculation, downtime values have been applied.

2 Project Monitoring Report #1

Project	Catalytic Reduction of N ₂ O inside the Ammonia Burners of the Nitric Acid Plant at Caojing, Shanghai
Plant Design Capacity	265,000 t HNO ₃ per year
Location (GPS)	30° 47' 13" N, 121° 27' 51" E
Date / Version of Monitoring Report	01 December 2010 / Version 2
Monitoring Period	1 st Project Campaign, 28-11-2009 – 30-06-2010; referring to Baseline Monitoring Report, v2 (01 December 2010),
Underlying PD	Version 3 from 24 June 2010, validated, amended by extended monitoring plan of the VER Handbook, Version 1, October 2010.
Validation Report No.	Report No: 8000372692 – 09/208, TÜV Nord

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2.1 Project background

Title of project activity:

"Catalytic Reduction of N₂O inside the Ammonia Burners of the Nitric Acid Plant at Caojing, Shanghai"

Status of implementation:

Table 1 below illustrates the project implementation as of November 2010.

Table 1: Status of implementation

Activity	Date
Baseline measurement period	13-03-2009 – 22-11-2009
Onsite validation	08-07-2009 – 09-07-2009
First project campaign (PC1)	28-11-2009 – 30-06-2010
Onsite first verification	22-11-2010 – 24-11-2010

2.2 Applied methodology and monitoring plan

Calculation of emission reductions is being realized on basis of the VER handbook (v1.1) which constitutes an extended and amended/up-dated version to the monitoring section of the PD (v3). Methodological basis to the monitoring plan is approved methodology AM0034 (v3.2).

Where required, equipment was calibrated according to relevant national standards. Quality of stack monitoring equipment was ensured by applying EN14181.

2.3 Analysis of project campaign #1

The first project campaign took place from 28 November 2009 to 30 June 2010.

2.3.1 Project campaign length

The project campaign is "longer" (=has a higher HNO₃ production volume) than the baseline campaign.

2.3.2 Gauze information

Information on the gauze supplier and the composition of the oxidation catalyst have been gathered and compared to the historical and baseline situation. It has been assured that the gauze composition during project campaign remains within the permissible deviation range of +/-2% (against composition during historical campaigns.) The gauze supplier has not changed.

2.3.3 Tail gas data measurement and calculations

An automated measuring system (AMS) has been installed using the guidance document EN 14181. It provides continuous separate readings for N₂O concentration and gas volume flow (average values for every 60 minutes of operation). Besides N₂O concentration and gas volume flow, the AMS also records temperature and pressure of the tail gas.

Before conducting calculations tail gas data sets (NCTG, VTG, TTG, PTG) have been combined with respective process data sets.

Statistical percentile evaluation

To eliminate mavericks from the VTG and NCTG samples, data sets have been statistically analyzed along AM0034 procedures (95% confidence interval).

Calculated Parameters

EF _n	Project emission factor
PE	Project emissions

Equations 3 and 4 of the validated PD have been applied for calculation of the project emissions and the project emission factor.

For AMS downtime intervals the highest measured emission factor of the project campaign has been applied.

The moving average emission factor (EF_{ma}) is not relevant to the analysis of a first project campaign (PC1). The same applies to the minimum project emission factor (EF_{min}) which is not applicable before the tenth campaign (PC10).

2.3.4 Tail gas data quality assurance and quality control

Quality assurance procedures for the AMS are defined in the VER handbook (i.e. daily checks, calibrations, handling of calibration gas, maintenance, trouble shooting). Their implementation has been controlled by means of a data handling protocol where occurrence of relevant events has been recorded. Reliability of data is being checked at internal validation meetings which involves all relevant staff. Feasibility of improvements in quality assurance procedures including trouble shooting procedures and their implementation are discussed in these meetings also. Details on these procedures are also outlined in the up-to-date VER handbook.

2.4 Calculation of emission reductions

Emission reductions have been calculated as per formula 7 of the validated PD. Data from the Baseline Monitoring Report have been applied.

2.5 Results from project campaign analysis

The NAP production level (CL_{PC1}) was within the plant design capacity.

Table 2: Campaign length and operation hours

Campaign	Period	CL_{PC1} [t HNO_3]	OH_{PC1} [hours]
PC1	28-11-2009 – 30-06-2010	190,717	5,091

Table 3: Percentile analysis of NCTG and VTG values

Campaign	VTG_{PC1} mean [m^3/h]	Percentile VTG_{PC1} mean [m^3/h]	$NCTG_{PC1}$ mean [mg/m^3]	Percentile $NCTG_{PC1}$ mean [mg/m^3]
PC	119,252.4422	120,694.6172	193.2855476	191.7777863

Table 4: Application of downtime emission factor

Campaign	OH where AMS was down [hours]	Downtime EF (= highest value) [kg N_2O /t HNO_3]
PC1	117	0.86

Table 5: Calculated campaign emissions and emission factor

Campaign	EF_{PC1} [kg N_2O /t HNO_3]	PE_{PC1} [t N_2O]
PC1	0.62	118

Table 6: Significant events during campaign

Campaign	Date	Explanation
PC1	23-06-2010 until 25-06-2010	Unscheduled plant shut down due to instrument failure.
PC1	25-06-2010 until 30-06-2010	AMS instrument failure after restart with unrealistic measurement values for 117 consecutive operating hours until end of campaign. For calculation, downtime values have been applied.

2.6 Extracted results from baseline calculation

The following data is taken from the baseline monitoring report:

Table 7: Extracted data from baseline monitoring report

Campaign	CL _{BC} [t HNO ₃]	EF _{BC} [kg N ₂ O/t HNO ₃]
BC	169,958	7.25

The baseline production volume (CL_{BC}) is smaller than the one of first project campaign PC1. Furthermore no N₂O emission legislation applying to nitric acid plants (EF_{reg}) has been introduced during baseline or project campaign. Thus the baseline is valid for the calculation of emission reductions of the first project campaign.

2.7 Results from calculation of emission reductions

Table 8: Applied parameters for calculation of emission reductions

EF _{PC1} [kgN ₂ O/tHNO ₃]	EF _{BC} [kgN ₂ O/tHNO ₃]	CL _{PC1} [t HNO ₃]	GWP (N ₂ O)
0.62	7.25	190,717	310

Table 9: Calculated emission reductions

Campaign	ER _{PC1} [tN ₂ O]	ER _{PC1} [tCO ₂ e]	ER _{PC1} in 2009 [tCO ₂ e]	ER _{PC1} in 2010 [tCO ₂ e]
PC1	1,263	391,678	61,277	330,401