MONITORING REPORT

PROJECT: **ACHEMA UKL-7 plant N_2O abatement project**

Prepared by:

VERTIS

VERTIS FINANCE

Version 5

Monitoring periods

Line 2

Project campaign 1		Project campaign 2	
FROM:	07/11/2008	FROM:	16/01/2009
TO:	16/01/2009	TO:	12/10/2009
ERUs	23,510	ERUs	146,533

Line 3

Project campaign 1		Project campaign 2	
FROM:	04/07/2008	FROM:	27/08/2008
TO:	27/08/2008	TO:	16/06/2009
ERUs	10,478	ERUs	42,602

Line 4

Project campaign 1	
FROM:	06/10/2008
TO:	28/04/2009
ERUs	53,774

Line 5		**Line 5**	
Project campaign 1		Project campaign 2	
FROM:	02/07/2008	FROM:	23/04/2009
TO:	22/04/2009	TO:	14/01/2010
ERUs	92,048	ERUs	81,971

Line 6

Project campaign 1	
FROM:	25/07/2008
TO:	21/04/2009
ERUs	114,364

Line 7

Project campaign 1		Project campaign 2	
FROM:	03/07/2008	FROM:	29/01/2009
TO:	22/10/2008	TO:	01/11/2009
ERUs	55,271	ERUs	112,470

Line 8

Project campaign 1		Project campaign 2	
FROM:	11/06/2008	FROM:	09/12/2008
TO:	26/11/2008	TO:	20/11/2009
ERUs	31,654	ERUs	48,892

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 2
MONITORING PERIOD:
FROM: 07/11/2008

TO: 16/01/2009

Prepared by:

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1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 2 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 2.

The first project campaign on Line 2 started on 30/05/2008. Secondary catalyst was installed on 07/11/2008. Total quantity of emission reductions generated during the first project period from 07/11/2008 through 16/01/2009 on Line 2 is **23 510 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	7.92	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	1.80	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	60 767	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	12 380	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	12 392	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**23 510**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**77.3%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date from	07 Nov 2008	01 Jan 2009	
Date to	31 Dec 2008	16 Jan 2009	
Nitric Acid Production	12 151	241	
Emission Reduction	**23 053**	**457**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 2 during baseline measurement carried from 09/11/2007 through 20/05/2008 is 7.92 $kgN_2O/tHNO_3$.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 2, which started on 07/11/2008 and went through 16/01/2009 with secondary catalyst installed and commissioned on 07/11/2008, is 1.80 $kgN_2O/tHNO_3$.

During the project campaign 12 392 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 2 emission reductions including information on baseline emission factor setting for the Line 2.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 2 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 2 has been carried out from 09/11/2007 through 20/05/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 2 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 2 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 2 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP *GWPN_2O \ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

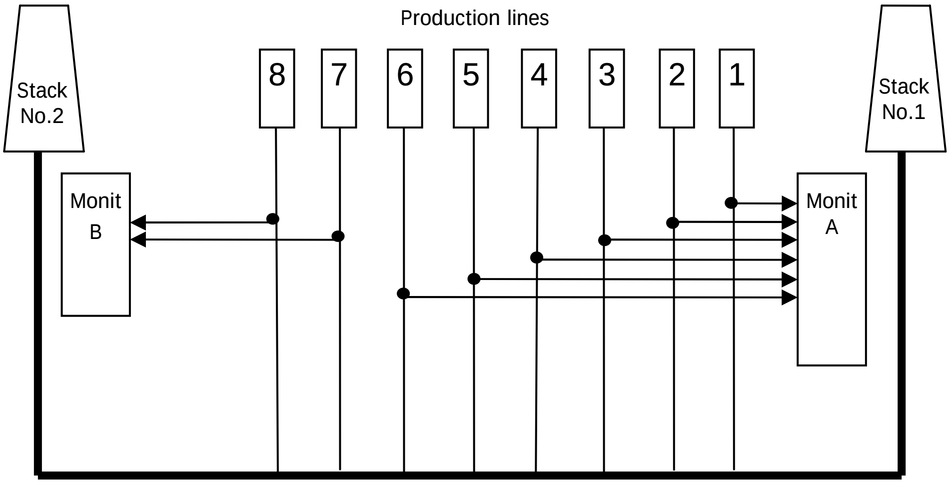
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

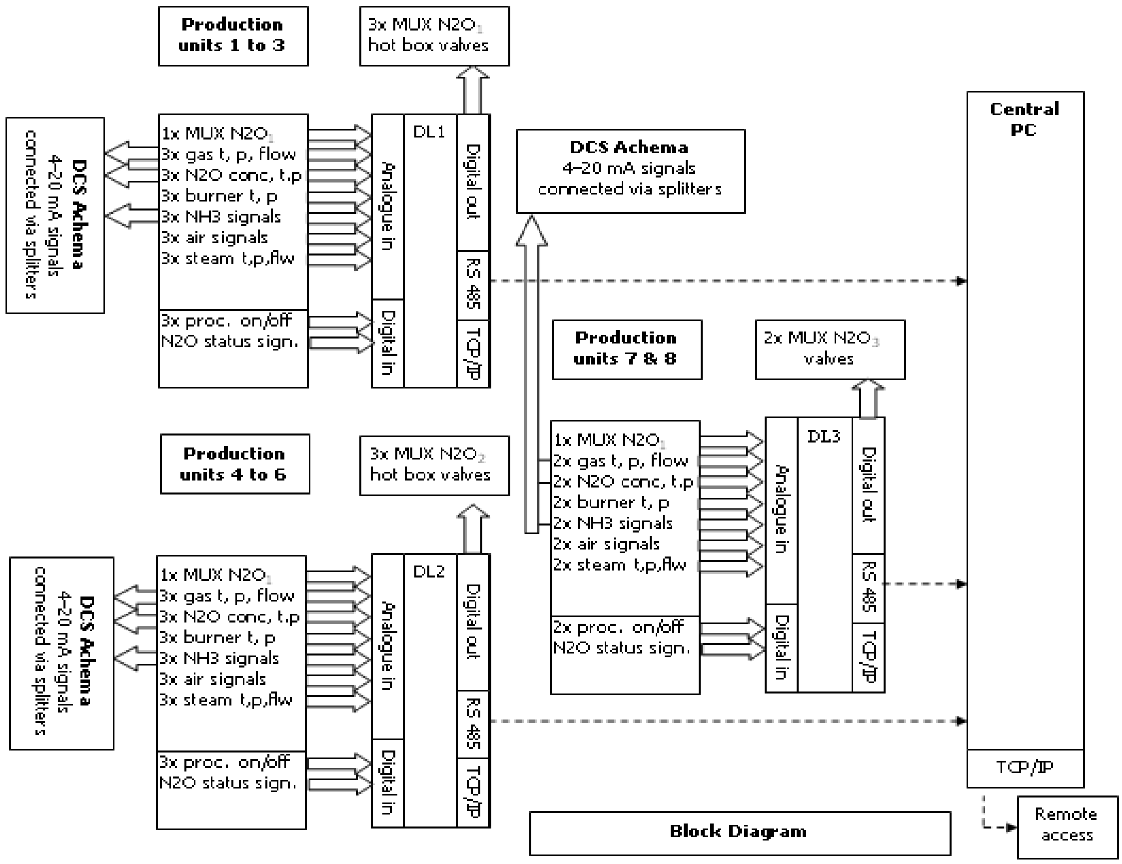
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

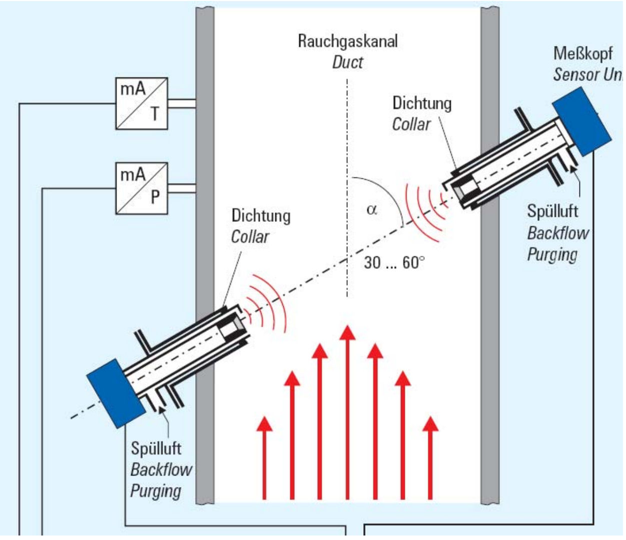
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

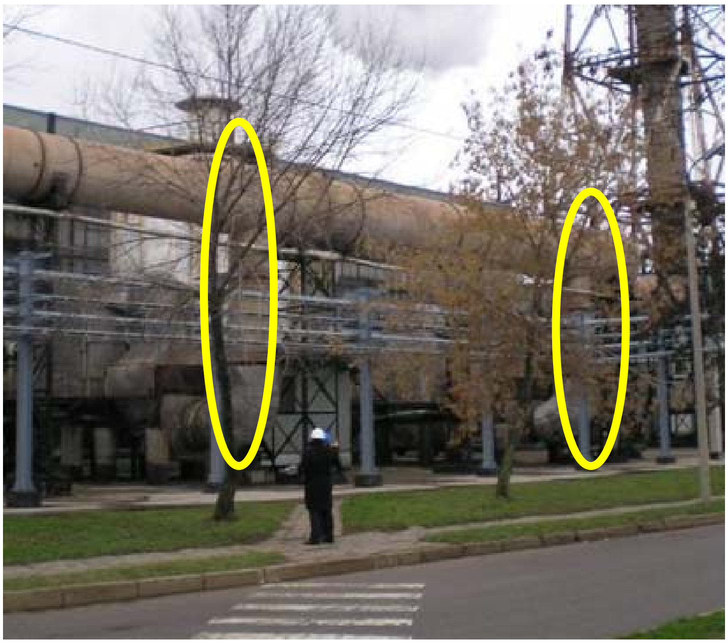
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

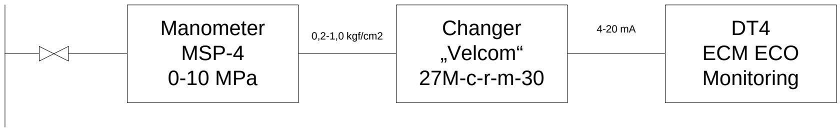
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

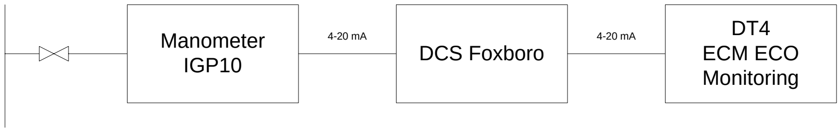
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

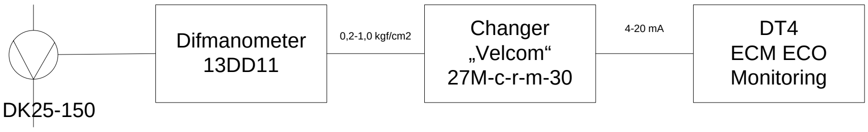
P in mixer 1-6 line



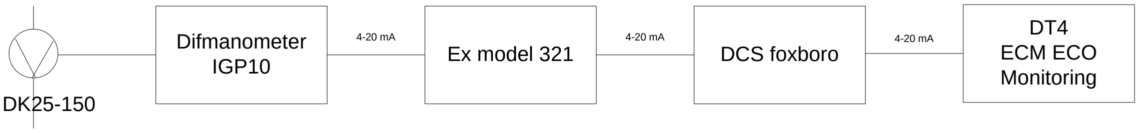
P in mixer 7-8 line



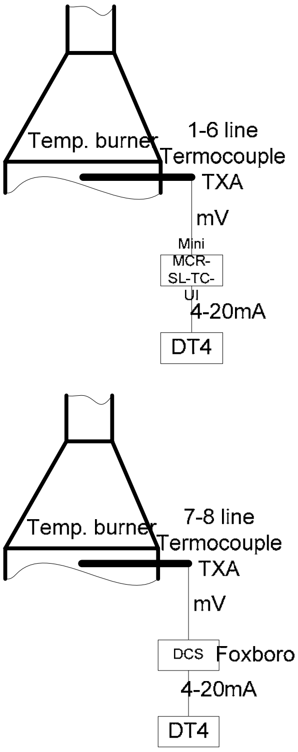
NH3 to mixer 1-6 line



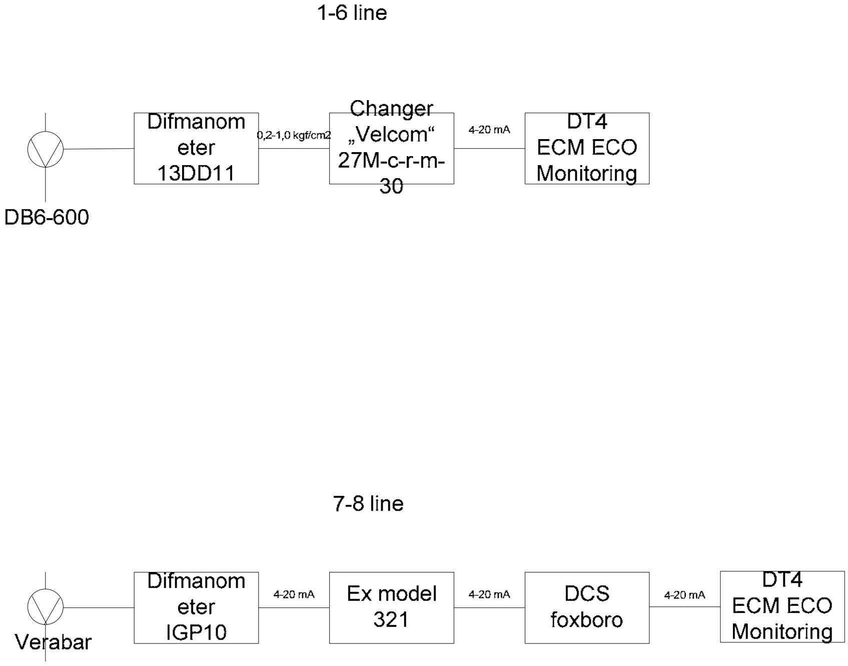
NH3 to mixer 7-8 line



T in burner



Air to mixer

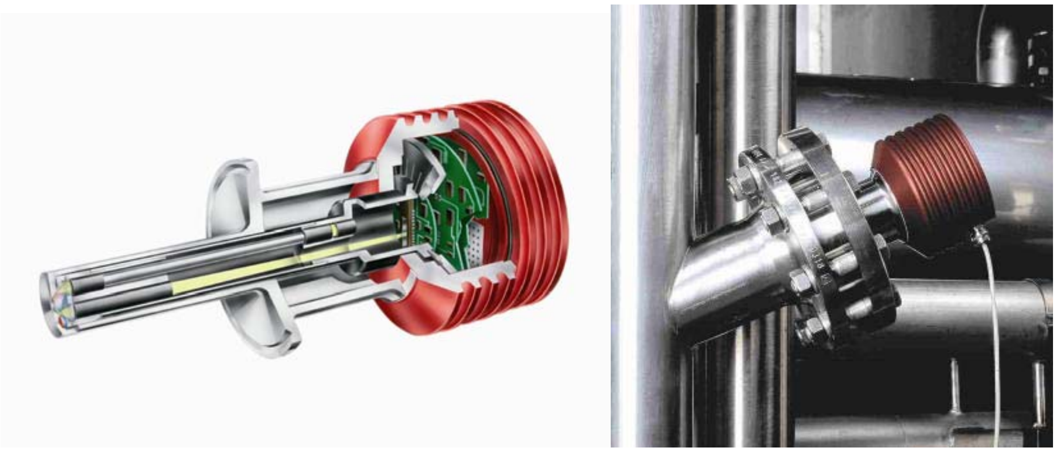


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

- Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
- Digital instrument – no calibration drift
- As it is a robust instrument it is maintenance free
- Dual connectivity if the installation positions allow.
- On-Line data logging, through Ethernet, on whichever web browser.
- No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 08/11/2007 and ending on 29/07/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 62 710 $tHNO_3$ and time duration was on average 239 days. Table contains also information on suppliers of primary catalysts for the line 2.

T 2 Historic campaigns

Line	**ACHEMA UKL-2**	**Production**	**Start**	**End**	**Days**	**Production per day**	**Primary Catalyst**	**Composition**
Historic Campaigns	**1** t HNO3	63 318	07 Jun 2004	26 Jan 2005	233	272	Heraeus	90/5/5
	2 t HNO3	65 490	27 Jan 2005	21 Sep 2005	237	276	Umicore	95/5
	3 t HNO3	51 101	22 Sep 2005	10 Apr 2006	200	256	Heraeus	62/4/34
	4 t HNO3	63 008	11 Apr 2006	24 Jan 2007	288	219	Heraeus	63/4/33
	5 t HNO3	70 635	14 Mar 2007	08 Nov 2007	239	296	Johnson Matthey	n.a.
Average HNO3 production	t HNO3	**62 710**			**239**	**262**		
Project Campaigns	**BL** t HNO3	60 767	09 Nov 2007	20 May 2008	193	315	Johnson Matthey	n.a.
	PL t HNO3	12 392	07 Nov 2008	16 Jan 2009	70	177	Johnson Matthey	n.a.

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 09/11/2007 and continued through 20/05/2008 when the 60 767 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-2	**Historic Campaings End**	**Start of Baseline Measurement**	**End of Baseline Measurement NCSG**	**End of Baseline Measurement**	**End of Baseline Campaign**
Dates	2007 Nov 08	2007 Nov 09	2007 Dec 27	2008 May 20	2008 May 21
Baseline Factor kgN2O/tHNO3	-	-	7.92	7.92	7.92
Production tHNO3		-	12 380	60 767	-
Per Day Production tHNO3	261.9				
Baseline less Historic Production	**(1 943.4)**				
Baseline less Historic Days	**(7.4)**				

C 1 Baseline campaign length

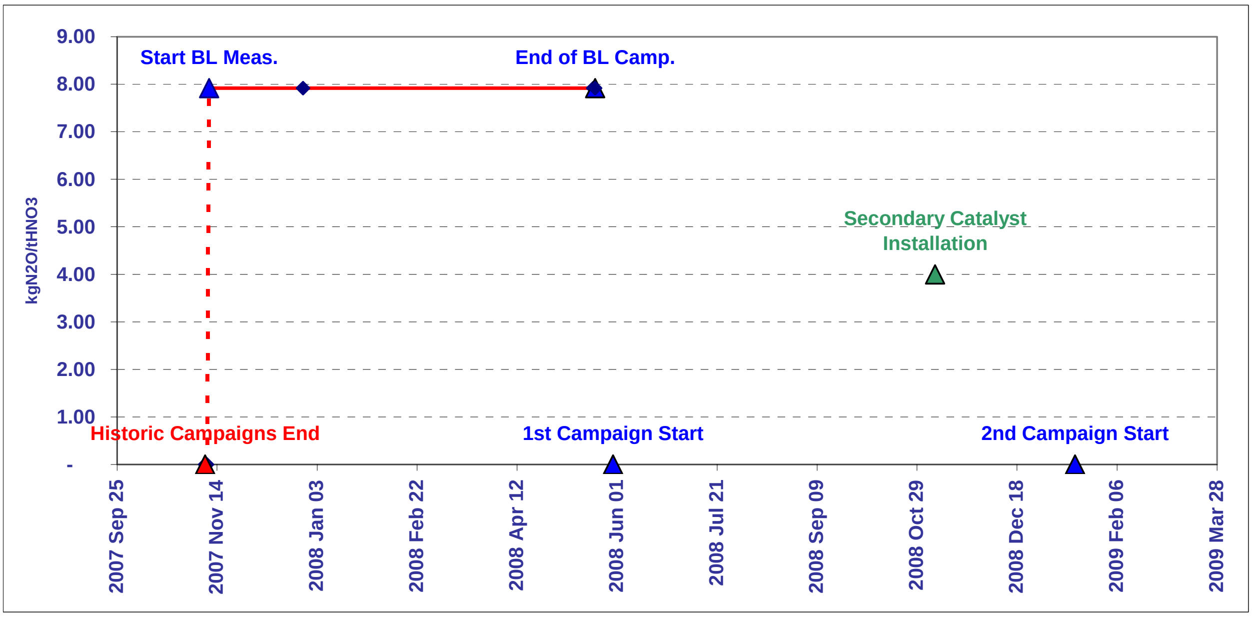


Table T 4 illustrates the calculation of the baseline emission factor on Line 2 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 09/11/2007 through 20/05/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 514 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 6.460%, which is further modified by an uncertainty of 0.166% due to under-sampling. As a result we have arrived to the baseline emission factor of 7.92 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 2 during the project campaign. Project campaign started on 07/11/2008 and went through 16/01/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH\ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 1.80 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n\ (tN_2O/tHNO_3)$$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure	AMS in Operation	Nitric Acid Production NCSG
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP		NAP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa	h	t/h
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 254**	4 633	1 012	4 216	4 296	4 277	4 606	4 576	3 828	1 153
as % of Dataset	*92%*	*100%*	*22%*	*91%*	*93%*	*92%*	*99%*	*99%*	*83%*	*25%*
Minimum		-	0	140	2 069	-	42	5		-
Maximum		15.73	1 757	106 649	6 243	18.13	1 100	679		16
Mean		13.12	1 279	83 679	5 815	9.78	843	604		11
Standard Deviation		3.81	441	18 036	263	1.67	207	45		6
Total		60 767								12 380
N2O Emissions (VSG * NCSG * OH)	455	t N2O								
Emission Factor	7.01	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**3 710**		406	3 710					3 828	
as % of Operating Hours	***87%***		*10%*	*87%*					*90%*	
Minimum			768	10 197						
Maximum			1 642	105 388						
Mean			1 364	85 591						
Standard Deviation			131	14 825						
N2O Emissions (VSG * NCSG * OH)	497	t N2O								
Emission Factor	7.65	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			1 108	56 534						
Upper bound			1 620	114 648						
Count			394	3 604						
as % of Operating Hours			*9%*	*85%*						
Minimum			1 118	77 416						
Maximum			1 612	105 388						
Mean			1 377	87 784						
Standard Deviation			94	7 591						
N2O Emissions (VSG * NCSG * OH)	**514**	**t N2O**								
Emission Factor (EF_BL)	**7.92**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**833**	1 218	854	907	1 259	940	1 681	1 655
as % of Dataset	*50%*	*73%*	*51%*	*54%*	*75%*	*56%*	*100%*	*99%*
Minimum		-	0	70	2 799	-	(9)	0
Maximum		16.01	472	110 018	6 148	12.82	897	661
Mean		10.17	272	85 294	5 287	9.12	468	485
Standard Deviation		6.34	64	29 327	899	3.31	416	167
Total		12 392						

N2O Emissions (VSG * NCSG * OH)	19	t N2O
Emission Factor	1.56	kgN2O / tHNO3

Data within the confidence interval	N2O Concentration	Gas Volume Flow
95% Confidence interval		
Lower bound	146	27 814
Upper bound	399	142 774
Count	791	824
as % of Operating Hours	*95%*	*99%*
Minimum	154	72 061
Maximum	396	105 028
Mean	282	95 015
Standard Deviation	44	6 969

N2O Emissions (VSG * NCSG * OH)	**22**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**1.80**	**kgN2O / tHNO3**
Abatement Ratio	**77.3%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.80	1.80
2	-	

Project Emission Factor (EF_P)	**1.80**	**kgN2O / tHNO3**
Abatement Ratio	**77.3%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 2
MONITORING PERIOD:
FROM: 16/01/2009

TO: 12/10/2009

Prepared by:

VERTIS

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 2 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the second project campaign on Line 2.

The first project campaign on Line 2 started on 30/05/2008. Secondary catalyst was installed on 07/11/2008. Total quantity of emission reductions generated during the second project period from 16/01/2009 through 12/10/2009 on Line 2 is **146 533 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	9.51	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	1.84	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	60 767	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	60 767	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	61 628	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**146 533**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**80.7%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		16 Jan 2009	
Date To		12 Oct 2009	
Nitric Acid Production		61 628	
Emission Reduction		**146 533**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 2 during baseline measurement carried from 09/11/2007 through 20/05/2008 is 9.51 kgN_2O/tHNO_3.

Project emission factor during the second project campaign after installation of secondary catalysts on Line 2, which started on 16/01/2009 and went through 12/10/2009 with secondary catalyst installed and commissioned on 07/11/2008, is 1.84 kgN_2O/tHNO_3.

During the project campaign 61 628 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 2 emission reductions including information on baseline emission factor setting for the Line 2.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 2 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 2 has been carried out from 09/11/2007 through 20/05/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 2 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 2 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP *GWPN_2O\ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

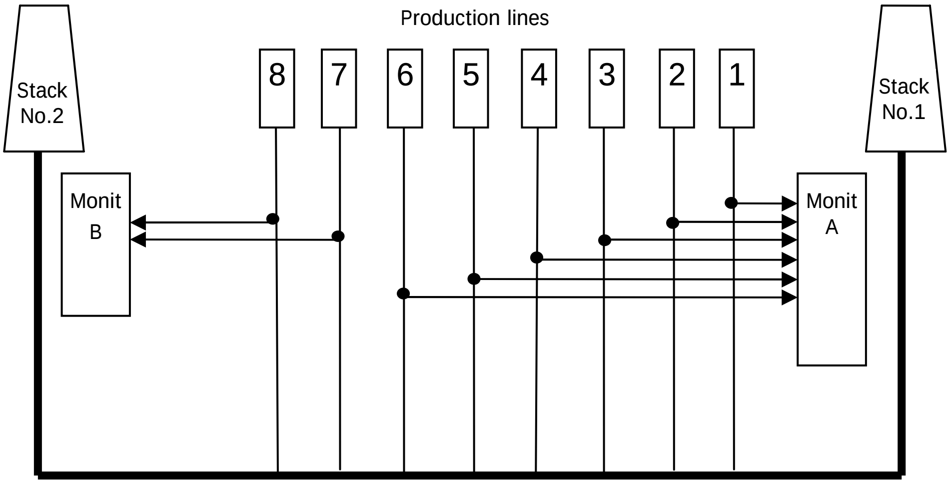
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

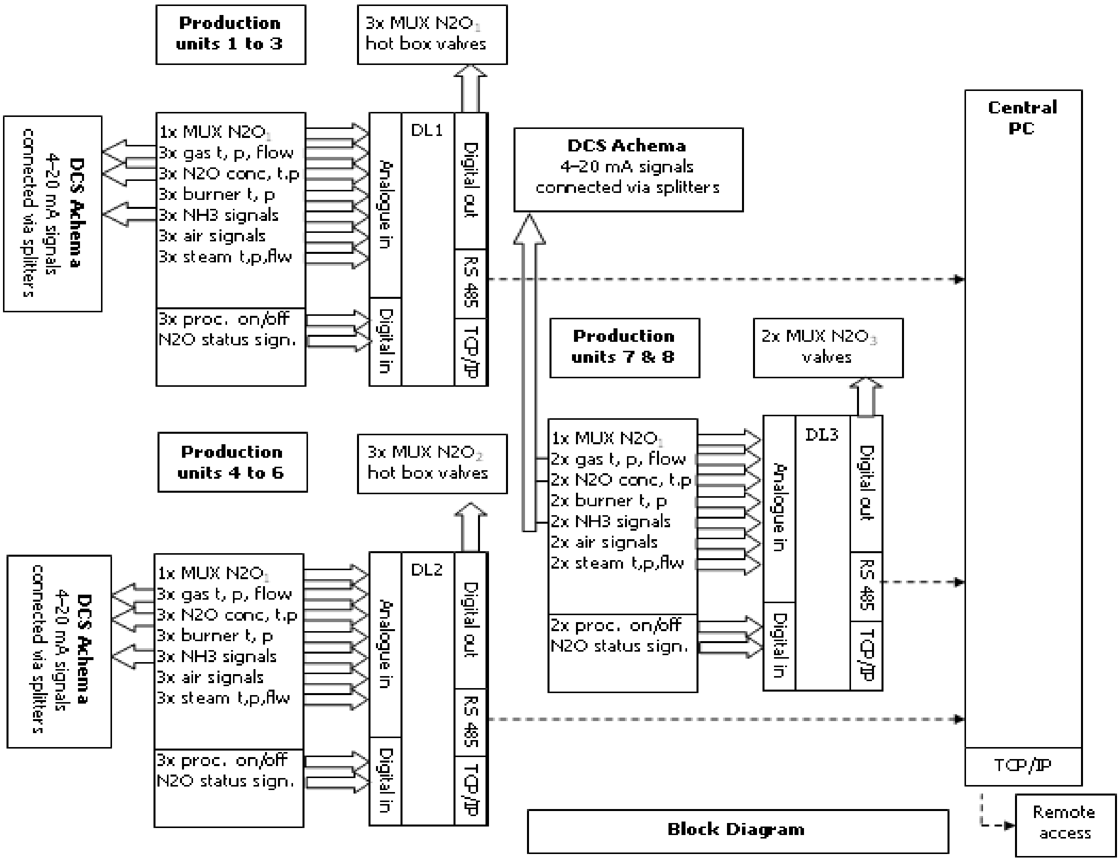
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

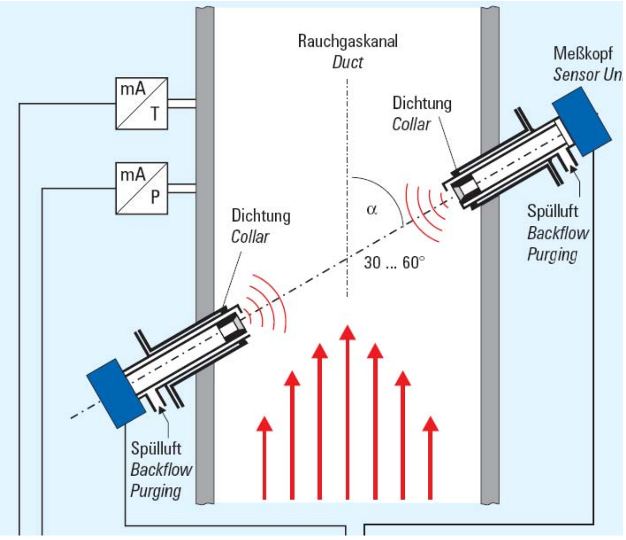
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

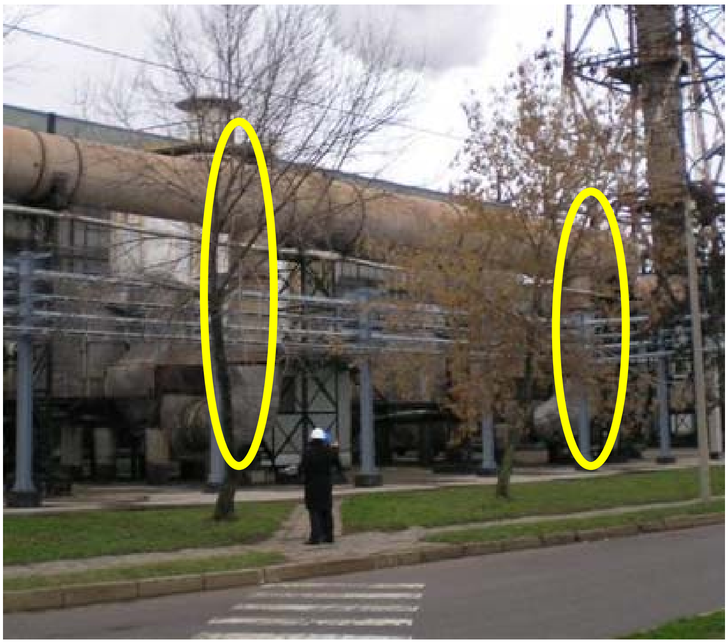
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

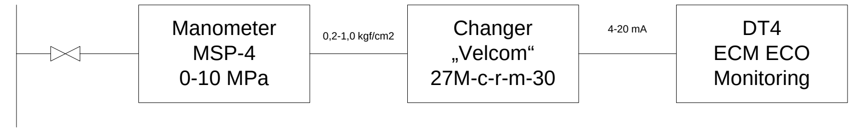
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

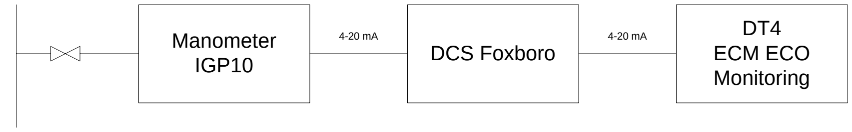
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

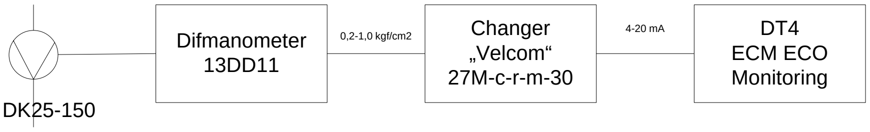
P in mixer 1-6 line



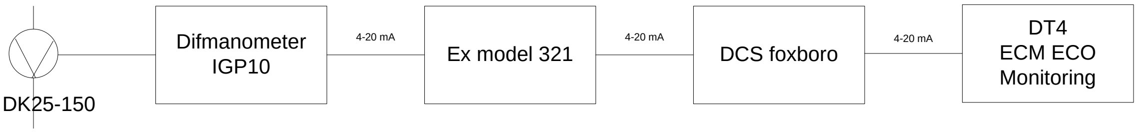
P in mixer 7-8 line



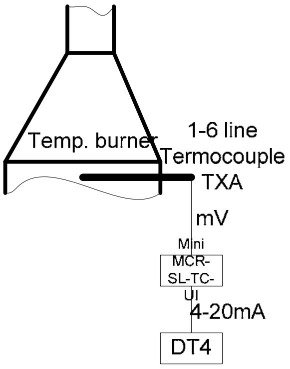
NH3 to mixer 1-6 line

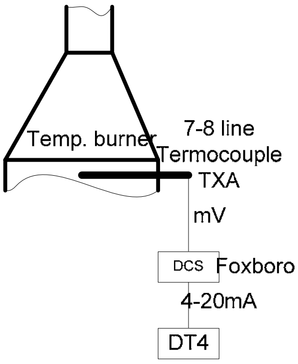


NH3 to mixer 7-8 line



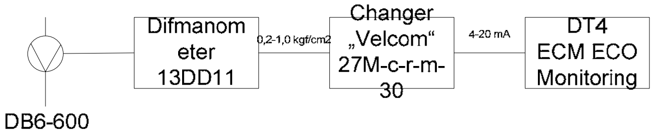
T in burner



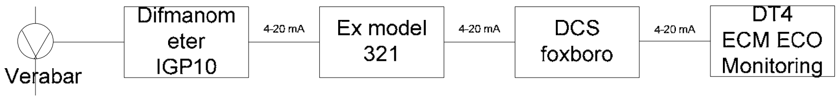


Air to mixer

1-6 line



7-8 line

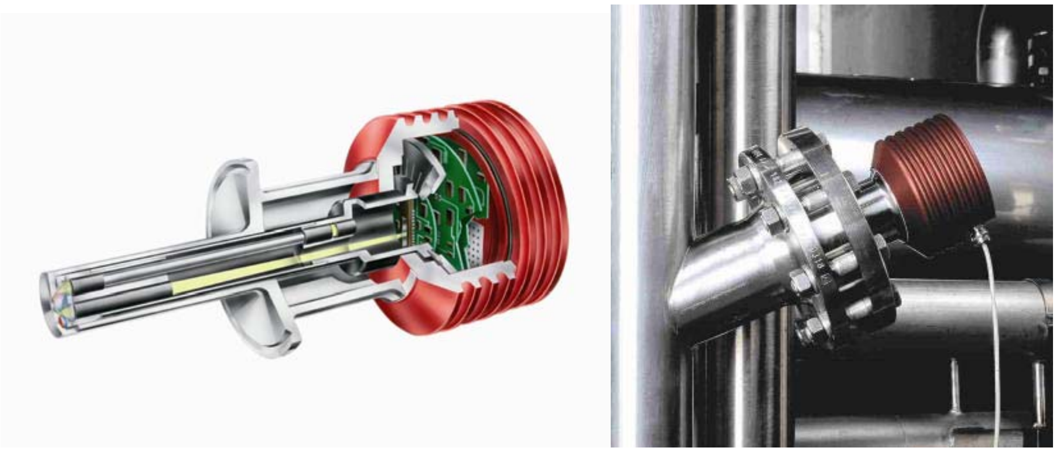


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 08/11/2007 and ending on 29/07/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 62 710 $tHNO_3$ and time duration was on average 239 days. Table contains also information on suppliers of primary catalysts for the line 2.

T 2 Historic campaigns

Line	ACHEMA UKL-2	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	63 318	07 Jun 2004	26 Jan 2005	233	272	Heraeus	90/5/5
	2 t HNO3	65 490	27 Jan 2005	21 Sep 2005	237	276	Umicore	95/5
	3 t HNO3	51 101	22 Sep 2005	10 Apr 2006	200	256	Heraeus	62/4/34
	4 t HNO3	63 008	11 Apr 2006	24 Jan 2007	288	219	Heraeus	63/4/33
	5 t HNO3	70 635	14 Mar 2007	08 Nov 2007	239	296	Johnson Matthey	n.a.
Average HNO3 production	t HNO3	**62 710**			**239**	**262**		
Project Campaigns	**BL** t HNO3	60 767	09 Nov 2007	20 May 2008	193	315	Johnson Matthey	n.a.
	PL t HNO3	61 628	16 Jan 2009	12 Oct 2009	268	230	Johnson Matthey	n.a.

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 09/11/2007 and continued through 20/05/2008 when the 60 767 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-2	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Nov 08	2007 Nov 09	2008 May 20	2008 May 20	2008 May 21
Baseline Factor kgN2O/tHNO3	-	-	9.51	9.51	9.51
Production tHNO3		-	60 767	60 767	-
Per Day Production tHNO3	261.9				
Baseline less Historic Production	**(1 943.4)**				
Baseline less Historic Days	**(7.4)**				

C 1 Baseline campaign length

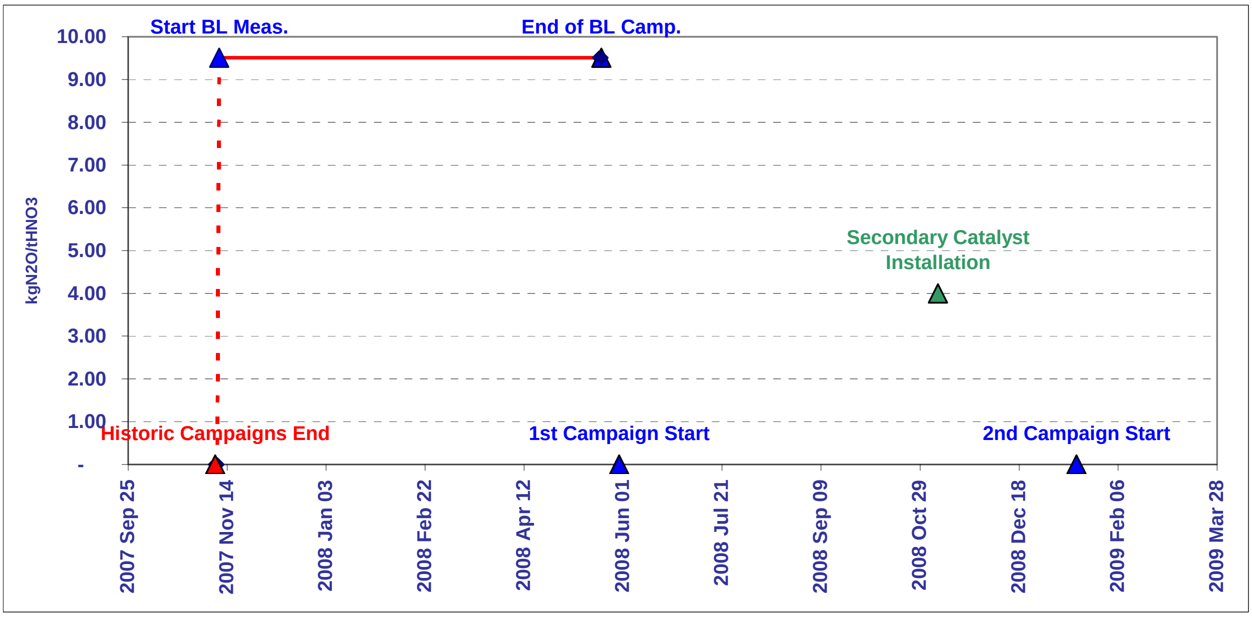


Table T 4 illustrates the calculation of the baseline emission factor on Line 2 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 09/11/2007 through 20/05/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 618 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 6.460%, which is further modified by an uncertainty of 0.087% due to under-sampling. As a result we have arrived to the baseline emission factor of 9.51 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 2 during the project campaign. Project campaign started on 16/01/2009 and went through 12/10/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH \ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 1.84 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n \ (tN_2O/tHNO_3)$$

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure	AMS in Operation	Nitric Acid Production NCSG
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP		NAP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa	h	t/h
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 254**	4 633	4 353	4 216	4 296	4 277	4 606	4 576	3 828	4 633
as % of Dataset	*92%*	*100%*	*94%*	*91%*	*93%*	*92%*	*99%*	*99%*	*83%*	*100%*
Minimum		-	0	140	2 069	-	42	5		-
Maximum		15.73	2 356	106 649	6 243	18.13	1 100	679		16
Mean		13.12	1 576	83 679	5 815	9.78	843	604		13
Standard Deviation		3.81	323	18 036	263	1.67	207	45		4
Total		60 767								60 767
N2O Emissions (VSG * NCSG * OH)	561	t N2O								
Emission Factor	8.64	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**3 710**		3 710	3 710					3 828	
as % of Operating Hours	***87%***		*87%*	*87%*					*90%*	
Minimum			465	10 197						
Maximum			2 356	105 388						
Mean			1 588	85 591						
Standard Deviation			293	14 825						
N2O Emissions (VSG * NCSG * OH)	578	t N2O								
Emission Factor	8.90	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			1 014	56 534						
Upper bound			2 162	114 648						
Count			3 430	3 604						
as % of Operating Hours			*81%*	*85%*						
Minimum			1 118	77 416						
Maximum			2 156	105 388						
Mean			1 654	87 784						
Standard Deviation			173	7 591						
N2O Emissions (VSG * NCSG * OH)	**618**	**t N2O**								
Emission Factor (EF_BL)	**9.51**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 420**	4 389	4 380	4 395	4 944	4 447	6 429	6 349
as % of Dataset	*69%*	*68%*	*68%*	*68%*	*77%*	*69%*	*100%*	*99%*
Minimum		0.86	109	4	2 242	7	(23)	0
Maximum		17.51	924	89 146	6 489	11.99	908	683
Mean		14.04	334	79 581	5 734	10.51	632	536
Standard Deviation		1.30	99	2 076	778	0.21	381	147
Total		61 628						

N2O Emissions (VSG * NCSG * OH)	118	t N2O
Emission Factor	1.91	kgN2O / tHNO3

Data within the confidence interval

95% Confidence interval	NCSG	VSG
Lower bound	140	75 513
Upper bound	528	83 649
Count	4 127	4 265
as % of Operating Hours	*93%*	*96%*
Minimum	164	75 557
Maximum	528	83 636
Mean	322	79 465
Standard Deviation	77	1 450

N2O Emissions (VSG * NCSG * OH)	**113**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**1.84**	**kgN2O / tHNO3**
Abatement Ratio	**80.7%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.80	1.80
2	1.84	1.84

Project Emission Factor (EF_P)	**1.84**	**kgN2O / tHNO3**
Abatement Ratio	**80.7%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 3
MONITORING PERIOD:
FROM: 04/07/2008

TO: 27/08/2008

Prepared by:

VERTIS

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 3 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 3.

The first project campaign on Line 3 started on 01/02/2008. Secondary catalyst was installed on 04/07/2008. Total quantity of emission reductions generated during the first project period from 04/07/2008 through 27/08/2008 on Line 3 is **10 478 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	4.42	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	1.92	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	42 999	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	12 741	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	13 520	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**10 478**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**56.7%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	04 Jul 2008		
Date To	27 Aug 2008		
Nitric Acid Production	13 520		
Emission Reduction	**10 478**		
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 3 during baseline measurement carried from 01/02/2008 through 30/06/2008 is 4.42 kgN$_2$O/tHNO$_3$.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 3, which started on 04/07/2008 and went through 27/08/2008 with secondary catalyst installed and commissioned on 04/07/2008, is 1.92 kgN$_2$O/tHNO$_3$.

During the project campaign 13 520 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 3 emission reductions including information on baseline emission factor setting for the Line 3.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 3 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 3 has been carried out from 01/02/2008 through 30/06/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 3 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 3 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	**Definition**
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 3 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP * GWPN_2O \ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

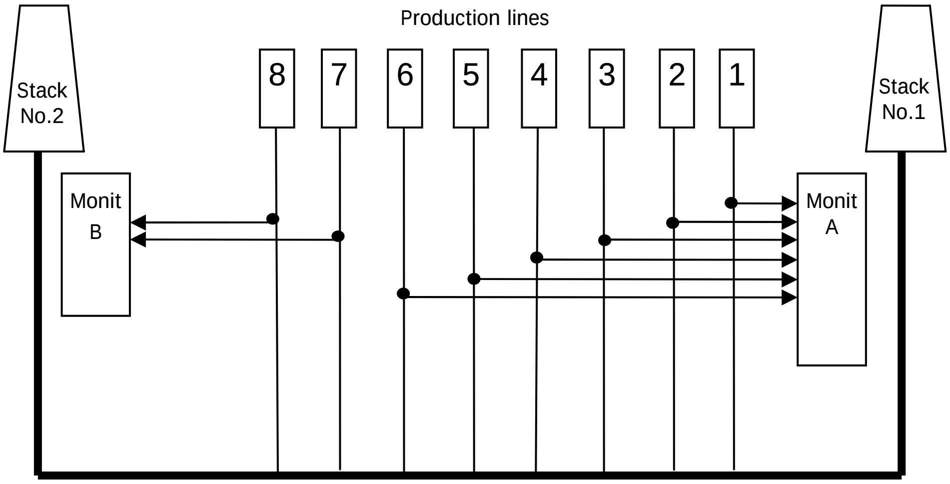
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

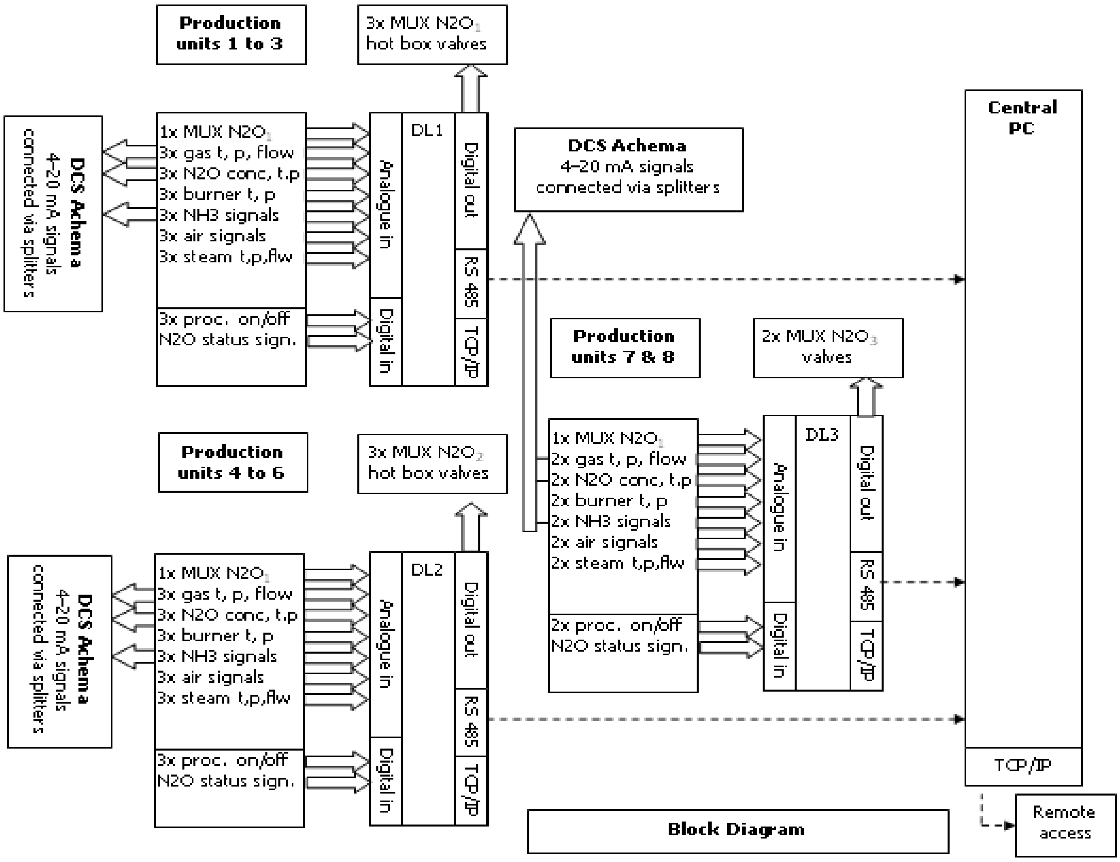
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

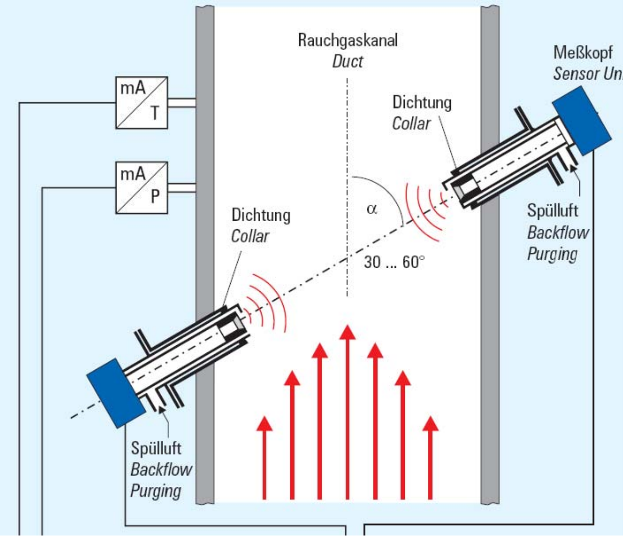
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

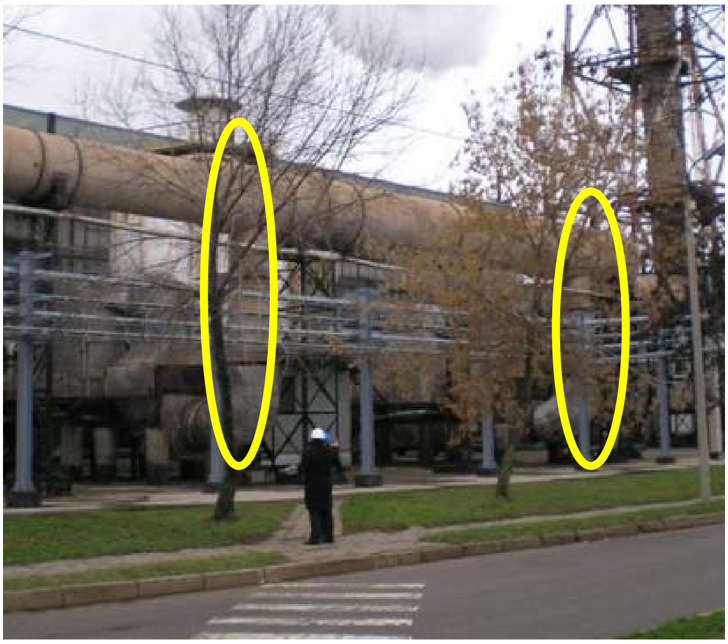
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

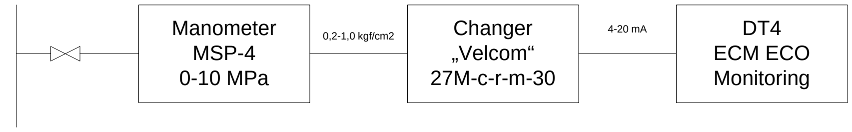
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

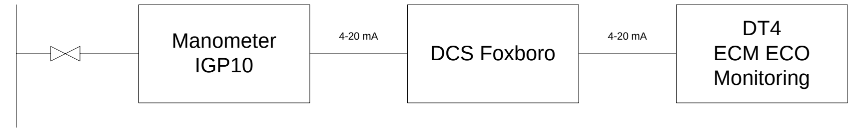
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

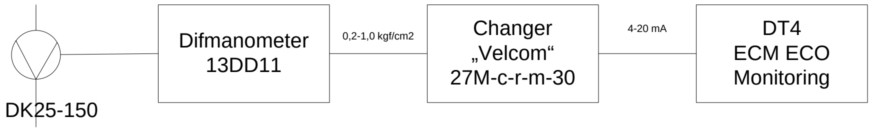
P in mixer 1-6 line



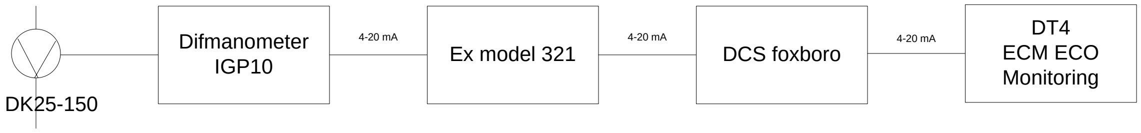
P in mixer 7-8 line



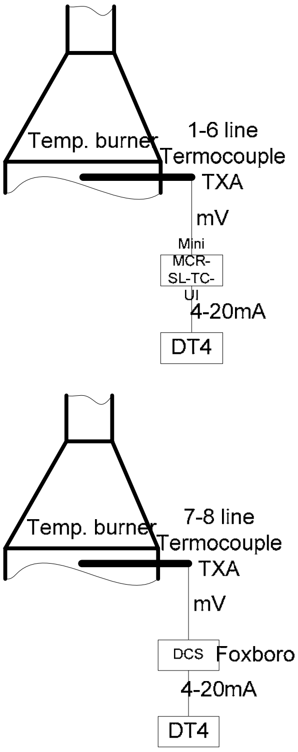
NH3 to mixer 1-6 line



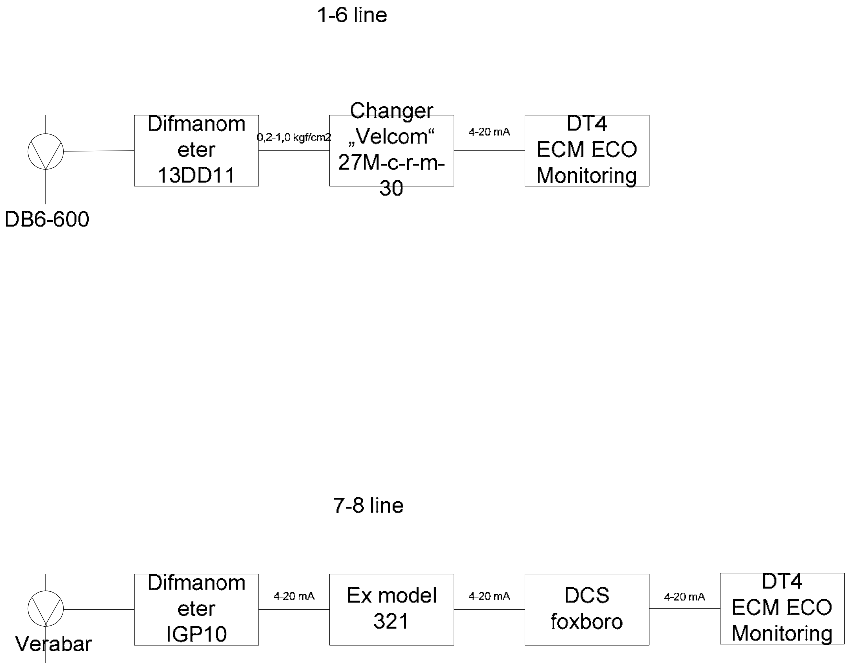
NH3 to mixer 7-8 line



T in burner



Air to mixer

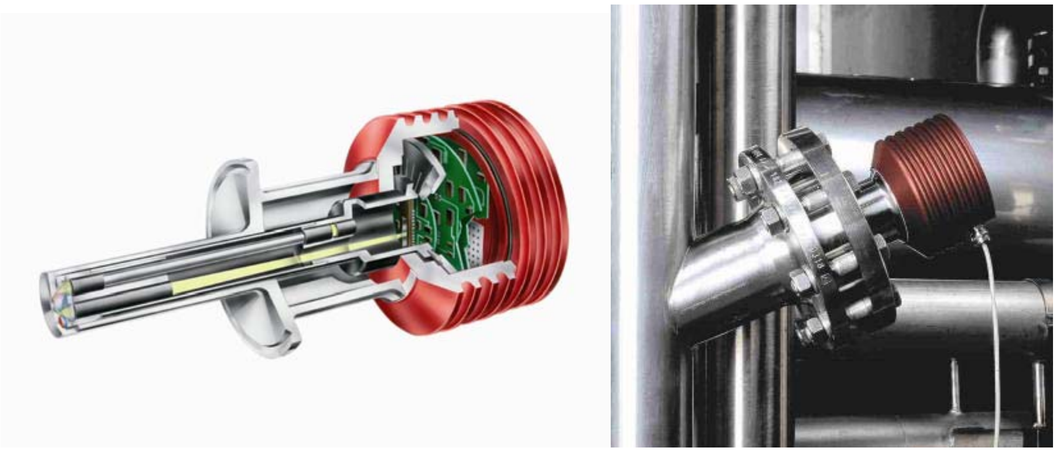


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

- Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
- Digital instrument – no calibration drift
- As it is a robust instrument it is maintenance free
- Dual connectivity if the installation positions allow.
- On-Line data logging, through Ethernet, on whichever web browser.
- No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 09/11/2007 and ending on 30/07/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 59 680 $tHNO_3$ and time duration was on average 316 days. Table contains also information on suppliers of primary catalysts for the line 3.

T 2 Historic campaigns

Line	ACHEMA UKL-3	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	64 017	05 Feb 2004	09 Oct 2005	612	105	Heraeus	63/4/33
	2 t HNO3	63 115	10 Oct 2005	28 Jun 2006	261	242	Heraeus	90/5/5
	3 t HNO3	59 912	01 Jul 2005	24 Jan 2006	207	289	Heraeus	63/4/33
	4 t HNO3	56 702	25 Jan 2006	23 Nov 2006	302	188	Heraeus	63/4/33
	5 t HNO3	54 654	24 Dec 2006	09 Jul 2007	197	277	Heraeus	63/4/33
Average HNO3 production	t HNO3	**59 680**			**316**	**189**		
Project Campaigns	**BL** t HNO3	42 999	01 Feb 2008	30 Jun 2008	150	287	Heraeus	63/4/33
	PL t HNO3	13 520	04 Jul 2008	27 Aug 2008	54	248	Heraeus	63/4/33

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 01/02/2008 and continued through 30/06/2008 when the 42 999 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-3	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Jul 09	2008 Feb 01	2008 Mar 08	2008 Jun 30	2008 Jul 01
Baseline Factor kgN2O/tHNO3	-	-	4.42	4.42	4.42
Production tHNO3		-	12 741	42 999	-
Per Day Production tHNO3	189.0				
Baseline less Historic Production	**(16 681.1)**				
Baseline less Historic Days	**(88.3)**				

C 1 Baseline campaign length

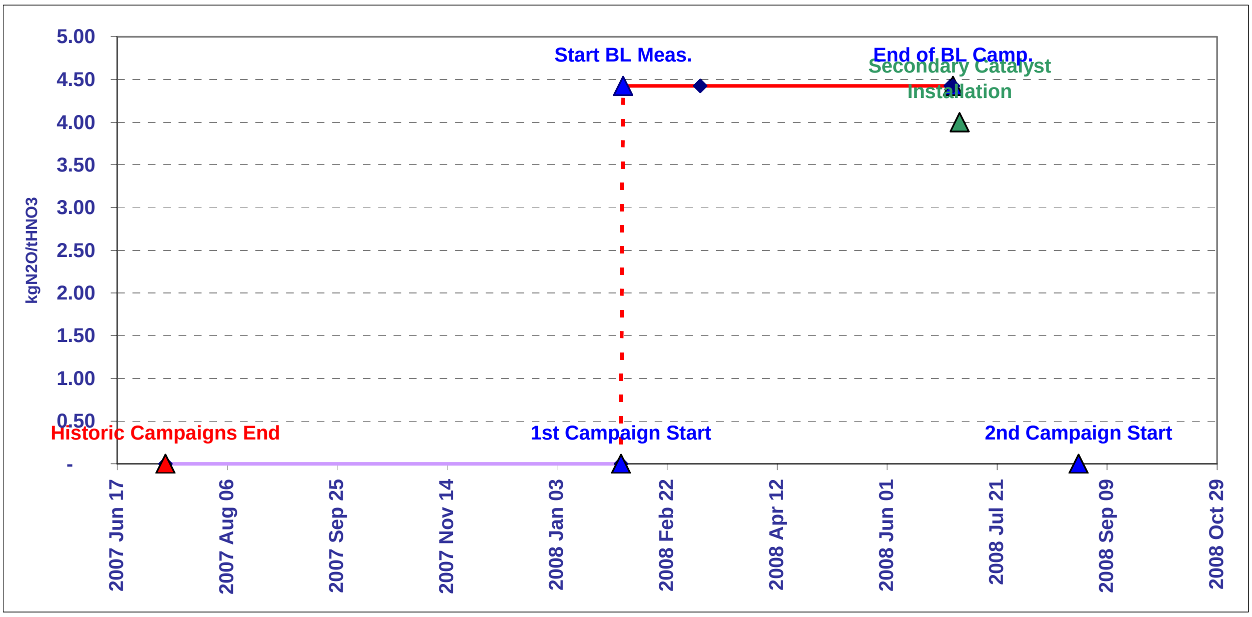


Table T 4 illustrates the calculation of the baseline emission factor on Line 3 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 01/02/2008 through 30/06/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 202 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.630%, which is further modified by an uncertainty of 0.089% due to under-sampling. As a result we have arrived to the baseline emission factor of 4.42 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 3 during the project campaign. Project campaign started on 04/07/2008 and went through 27/08/2008.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH\ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 1.92 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n\ (tN_2O/tHNO_3)$$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR

Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure	AMS in Operation	Nitric Acid Production NCSG
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**3 107**	3 552	860	3 234	3 592	3 365	3 593	3 593	3 024	865
as % of Dataset	*86%*	*99%*	*24%*	*90%*	*100%*	*93%*	*100%*	*100%*	*84%*	*24%*
Minimum		-	734	115	502	4	0	0		14
Maximum		16.11	1 701	89 631	6 221	19.99	906	626		16
Mean		12.11	960	66 609	5 136	10.91	785	549		15
Standard Deviation		4.73	112	10 278	1 643	1.32	265	103		1
Total		42 999								12 741
N2O Emissions (VSG * NCSG * OH)	199	t N2O								
Emission Factor	4.36	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**2 996**		854	2 989					3 024	
as % of Operating Hours	***96%***		*27%*	*96%*					*97%*	
Minimum			734	13 652						
Maximum			1 095	75 392						
Mean			944	68 156						
Standard Deviation			62	2 293						
N2O Emissions (VSG * NCSG * OH)	200	t N2O								
Emission Factor	4.39	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			822	63 662						
Upper bound			1 067	72 651						
Count			812	2 951						
as % of Operating Hours			*26%*	*95%*						
Minimum			822	63 694						
Maximum			1 063	72 648						
Mean			952	68 150						
Standard Deviation			50	1 836						
N2O Emissions (VSG * NCSG * OH)	**202**	**t N2O**								
Emission Factor (EF_BL)	**4.42**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**1 200**	1 074	1 258	1 062	1 286	1 176	1 286	1 286
as % of Dataset	*92%*	*82%*	*96%*	*81%*	*98%*	*90%*	*98%*	*98%*
Minimum		-	1	271	711	5	0	0
Maximum		13.71	2 046	75 798	5 999	19.98	911	586
Mean		12.59	492	64 145	5 391	10.55	838	552
Standard Deviation		1.88	445	5 749	1 178	1.14	201	72
Total		13 520						

N2O Emissions (VSG * NCSG * OH)	38	t N2O
Emission Factor	2.80	kgN2O / tHNO3

Data within the confidence interval			
95% Confidence interval			
Lower bound		- 380	52 878
Upper bound		1 364	75 413
Count		950	1 035
as % of Operating Hours		*79%*	*86%*
Minimum		175	60 127
Maximum		1 281	68 152
Mean		334	64 636
Standard Deviation		109	1 337

N2O Emissions (VSG * NCSG * OH)	**26**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**1.92**	**kgN2O / tHNO3**
Abatement Ratio	**56.7%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.92	1.92
2	-	

Project Emission Factor (EF_P)	**1.92**	**kgN2O / tHNO3**
Abatement Ratio	**56.7%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 3
MONITORING PERIOD:
FROM: 27/08/2008

TO: 16/06/2009

Prepared by:

VERTIS

VERTIS FINANCE

www.vertisfinance.com

Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 3 of ACHEMA UKLnitric acid plant and quantity of emission reduction generated during the second project campaign on Line 3.

The first campaign on Line 3 started on 27/08/2008. Secondary catalyst was installed on 04/07/2008. Total quantity of emission reductions generated during the second project period from 27/08/2008 through 16/06/2009 on Line 3 is **42 602 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	5.45	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	3.01	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	59 042	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	56 309	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	56 322	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**42 602**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**44.7%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	27 Aug 2008	01 Jan 2009	
Date To	31 Dec 2008	16 Jun 2009	
Nitric Acid Production	24 950	31 372	
Emission Reduction	**18 872**	**23 730**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 3 during baseline measurement carried using overlapping approach from 01/02/2008 to 04/07/2008 and from 01/09/2007 through 03/11/2007 is 5.45 kgN_2O/tHNO_3.

Project emission factor during second project campaign after installation of secondary catalysts on Line 3, which started on 27/08/2008 and went through 16/06/2009 with secondary catalyst installed and commissioned on 04/07/2008, is 3.01 kgN_2O/tHNO_3.

During the project campaign 56 322 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 3 emission reductions including information on baseline emission factor setting for the Line 3.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 3 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 3 has been carried out using overlapping approach from 01/02/2008 to 04/07/2008 and from 01/09/2007 through 03/11/2007.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 3 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room B, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD.

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 3 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PEn = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

4.2 Minimum project emission factor

Because this campaign was second project campaign on Line 3 there has been no minimum average emission factor established yet for this campaign. This factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP *GWPN_2O\ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

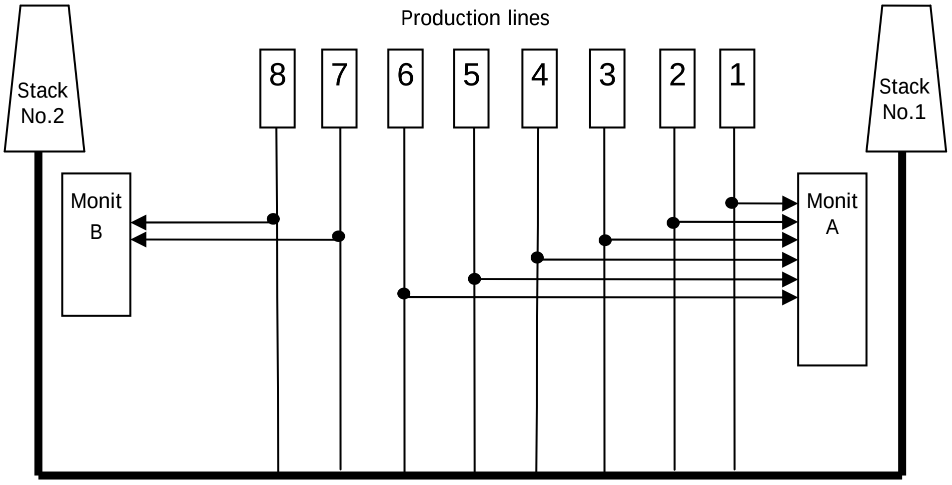
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

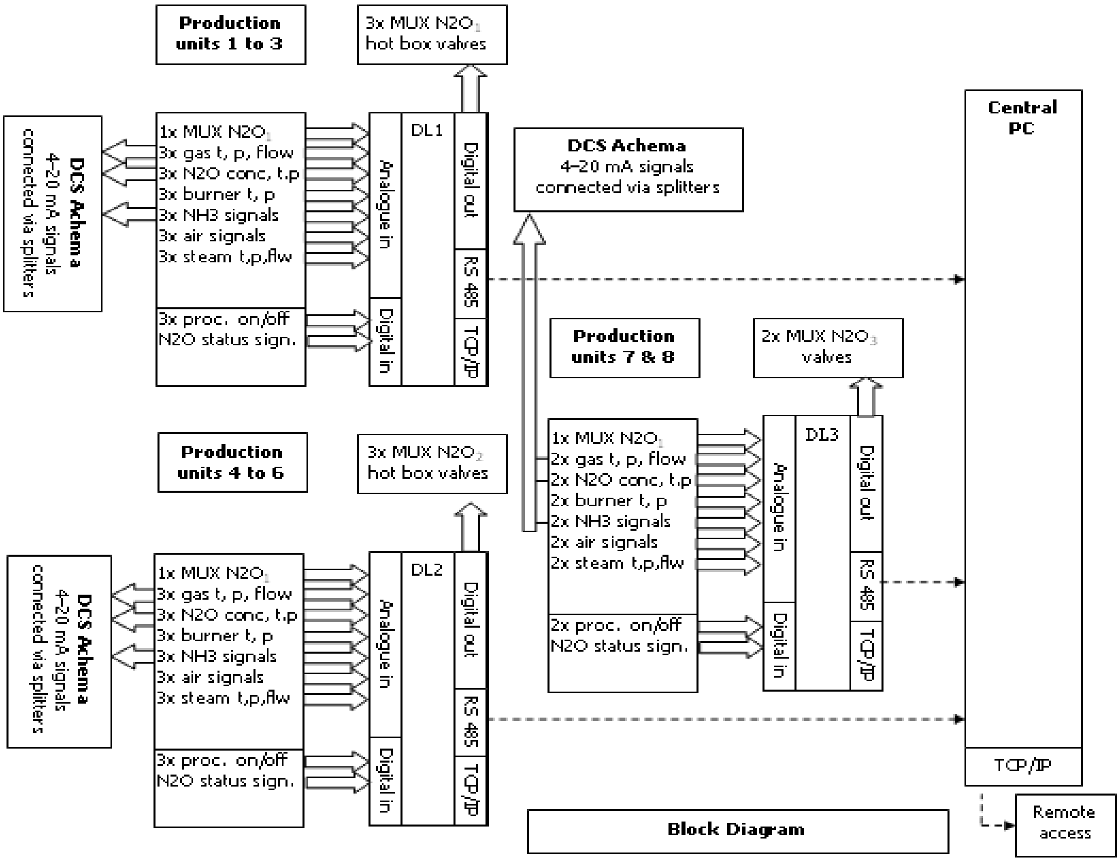
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

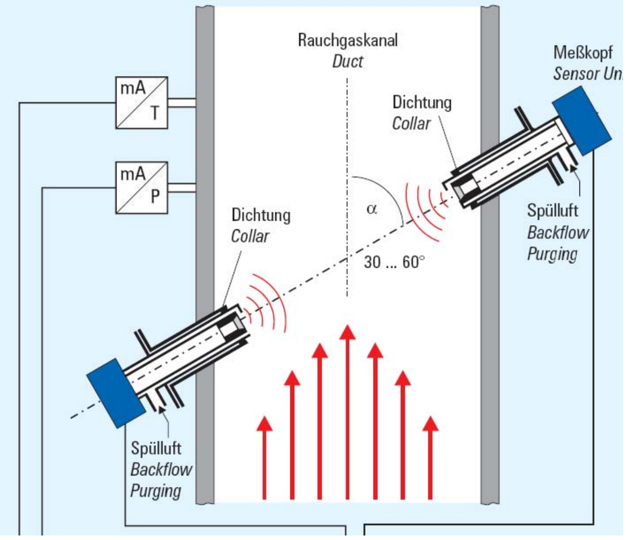
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

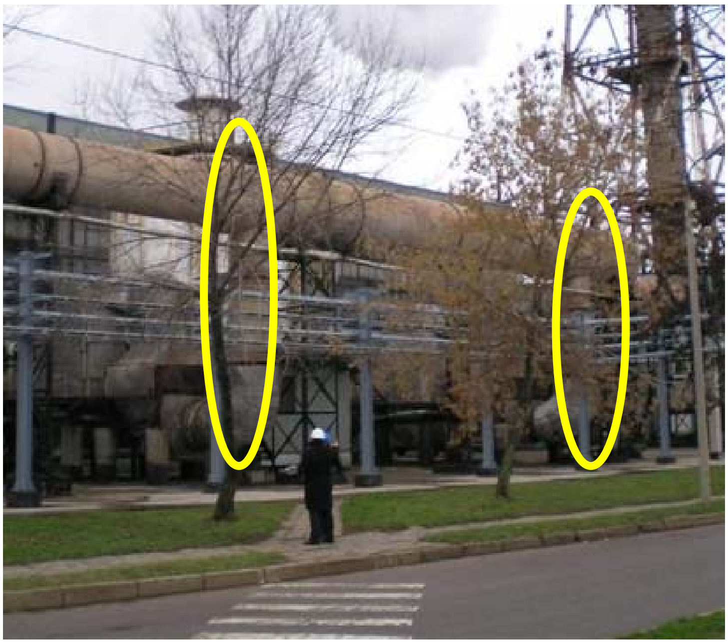
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

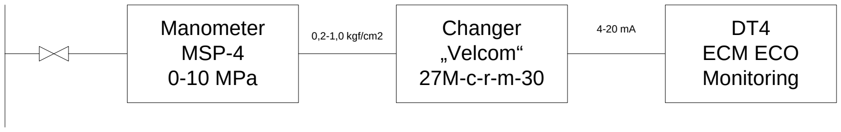
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

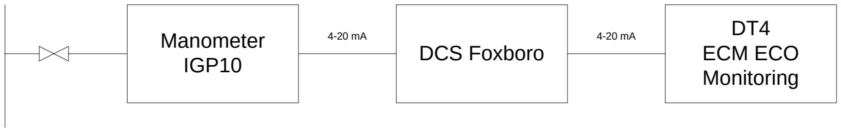
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

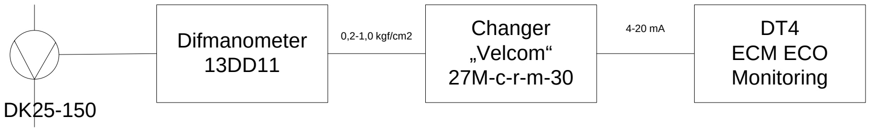
P in mixer 1-6 line



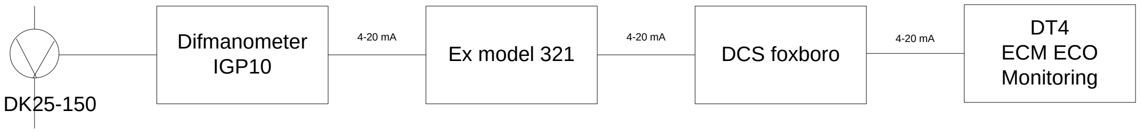
P in mixer 7-8 line



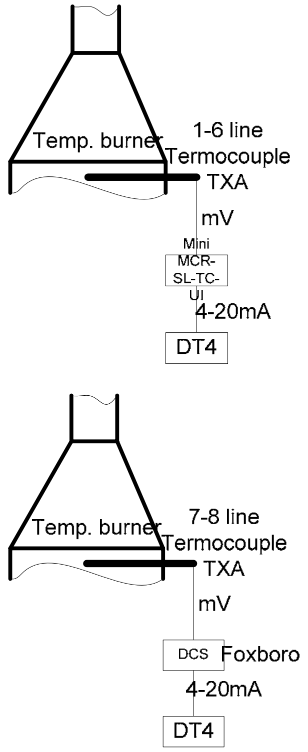
NH3 to mixer 1-6 line



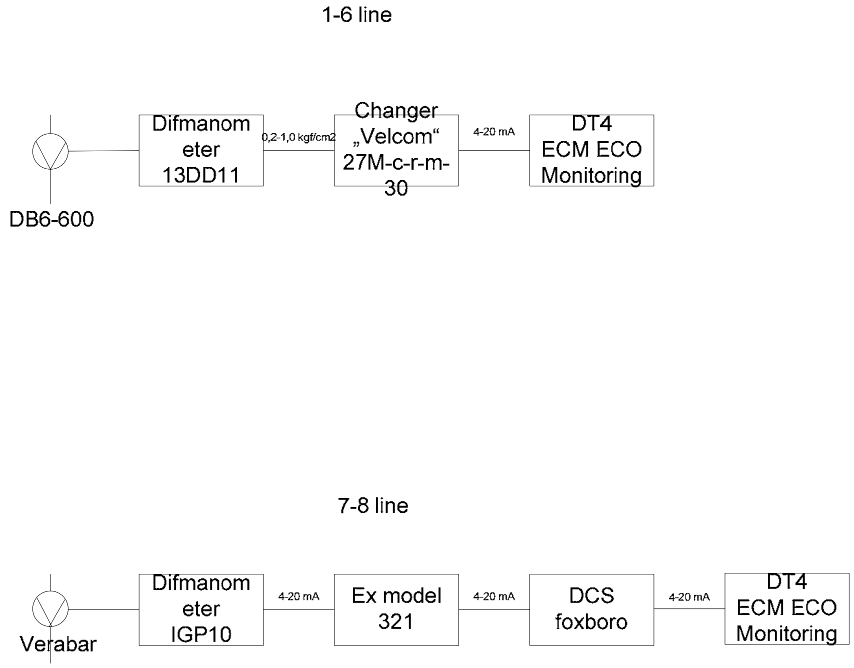
NH3 to mixer 7-8 line



T in burner



Air to mixer

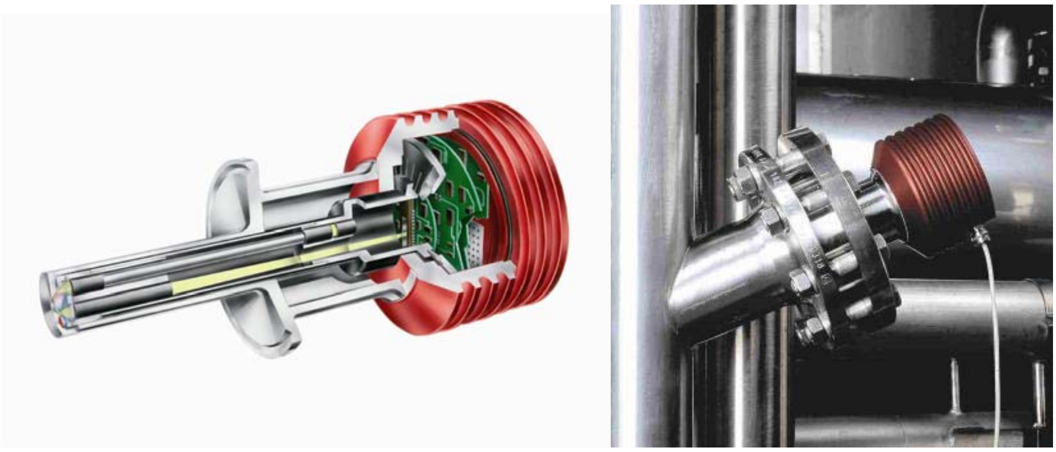


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

- Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
- Digital instrument – no calibration drift
- As it is a robust instrument it is maintenance free
- Dual connectivity if the installation positions allow.
- On-Line data logging, through Ethernet, on whichever web browser.
- No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 09/11/2007 and ending on 30/07/2008 project uses HNO3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$X_o=X_n=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 59 680 $tHNO_3$ and time duration was on average 316 days. Table contains also information on suppliers of primary catalysts for the line 3. As shown in the table, it is usual practice in Achema to use primary catalysts from various suppliers.

T 2 Historic campaigns

Line	ACHEMA UKL-3	**Production**	**Start**	**End**	**Days**	**Production per day**	**Primary Catalyst**	**Composition**
Historic Campaigns	**1** t HNO3	64 017	05 Feb 2004	09 Oct 2005	612	105	Heraeus	63/4/33
	2 t HNO3	63 115	10 Oct 2005	28 Jun 2006	261	242	Heraeus	90/5/5
	3 t HNO3	59 912	01 Jul 2005	24 Jan 2006	207	289	Heraeus	63/4/33
	4 t HNO3	56 702	25 Jan 2006	23 Nov 2006	302	188	Heraeus	63/4/33
	5 t HNO3	54 654	24 Dec 2006	09 Jul 2007	197	277	Heraeus	63/4/33
Average HNO3 production	t HNO3	**59 680**			**316**	**189**		
Project Campaigns	**BL** t HNO3	59 042	01 Sep 2007	04 Jul 2008	308	192	Heraeus	63/4/33
	PL t HNO3	56 322	27 Aug 2008	16 Jun 2009	292	193	Heraeus	63/4/33

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started using overlapping approach from 01/02/2008 to 04/07/2008 then from 01/09/2007 through 03/11/2007 when the 59 042 $tHNO_3$ nitric acid production was reached. The baseline measurement for N2O concentration (NCSG) was carried out until the production of 56 309 $tHNO_3$ was reached.

We have two campaigns available that we can use for the baseline. AMS was installed in the middle of the first campaign, whereas the secondary catalyst was installed in the middle of the consecutive second one. We use these two campaigns to construct the baseline campaign using the overlapping approach as set out by the PDD. To get a clear start, that is, the baseline series has to start with a primary catalyst change, we use the beginning of the second campaign as the basis, until the secondary catalyst installation is reached. If this baseline turns out to be shorter than the project line, we use data available from the first campaign from the AMS installation to overlap the two series, and get a comparable baseline. Since we use the earliest available data from the first campaign, where emissions are generally lower, this is a conservative approach and fully in line with the PDD.

T 3 Baseline campaign length

ACHEMA UKL-3	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Jul 09	2007 Sep 01	2008 Jul 04	2008 Jul 04	2008 Jul 05
Baseline Factor kgN2O/tHNO3	-	-	5.45	5.45	5.45
Production tHNO3		-	56 309	59 042	-
Per Day Production tHNO3	189.0				
Baseline less Historic Production	**(637.7)**				
Baseline less Historic Days	**(3.4)**				

C 1 Baseline campaign length

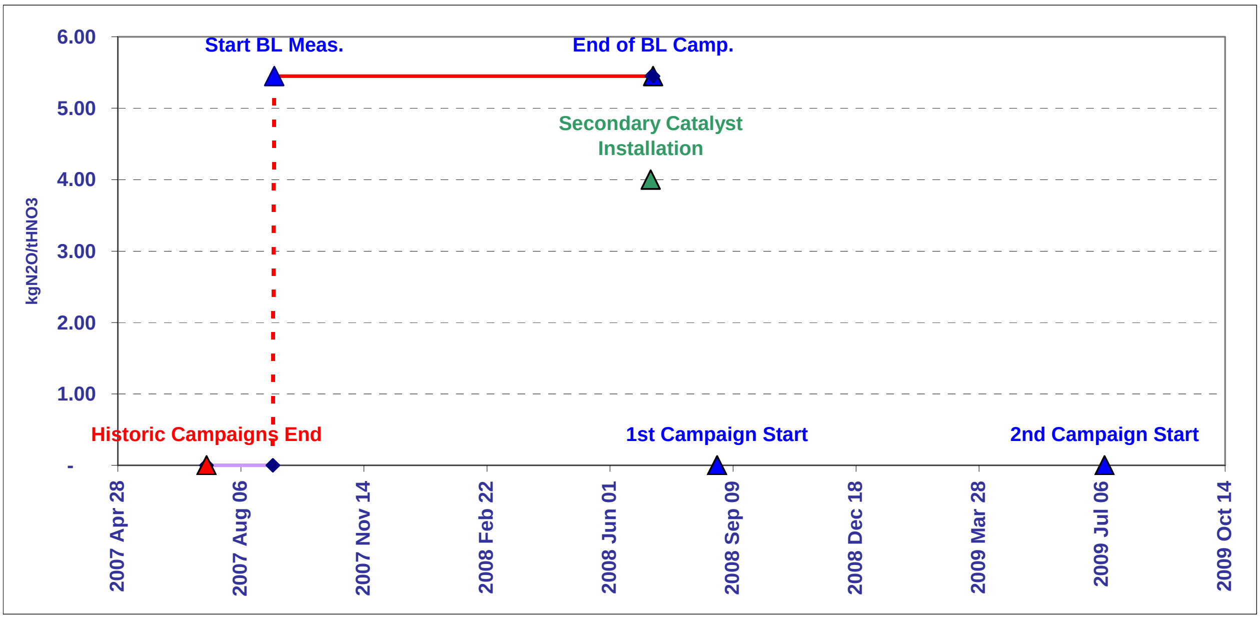


Table T 4 illustrates the calculation of the baseline emission factor on line 3 using the method as defined in the CDM methodology AM0034 and in the PDD.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 341 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100) (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.630%, which was further modified by an uncertainty of 0.094% due to under-sampling. As a result we have arrived to the baseline emission factor of 5.45 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 3 during the project campaign. Project campaign started on 27/08/2008 and went through 16/06/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PEn) as follows:

$$PEn = VSG * NCSG * 10-9 * OH (tN_2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 3.01 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n (tN_2O/tHNO_3)$$

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**	**AMS in Operation**	**Nitric Acid Production NCSG**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 524**	5 074	4 476	4 623	5 148	4 843	5 235	5 232	4 155	4 879
as % of Dataset	*86%*	*97%*	*85%*	*88%*	*98%*	*92%*	*100%*	*100%*	*79%*	*93%*
Minimum		-	0	10	1	0	0	0		-
Maximum		16.63	1 864	90 517	6 221	19.99	906	626		17
Mean		11.64	1 100	67 849	4 974	10.52	794	545		12
Standard Deviation		5.03	298	11 542	1 802	1.62	258	118		5
Total		59 042								56 309
N2O Emissions (VSG * NCSG * OH)	338	t N2O								
Emission Factor	5.40	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**4 087**		3 816	3 994					4 155	
as % of Operating Hours	***90%***		*84%*	*88%*					*92%*	
Minimum			381	-						
Maximum			1 864	77 232						
Mean			1 115	64 988						
Standard Deviation			148	14 287						
N2O Emissions (VSG * NCSG * OH)	328	t N2O								
Emission Factor	5.24	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			825	36 985						
Upper bound			1 406	92 991						
Count			3 482	3 816						
as % of Operating Hours			*77%*	*84%*						
Minimum			825	48 852						
Maximum			1 404	77 232						
Mean			1 108	68 019						
Standard Deviation			127	2 721						
N2O Emissions (VSG * NCSG * OH)	**341**	**t N2O**								
Emission Factor (EF_BL)	**5.45**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR

Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 366**	5 195	4 714	5 017	6 821	4 749	7 010	7 010
as % of Dataset	*62%*	*74%*	*67%*	*72%*	*97%*	*68%*	*100%*	*100%*
Minimum		-	0	1	126	0	0	3
Maximum		15.72	1 223	85 339	7 706	19.90	1 100	660
Mean		10.84	554	61 982	4 162	10.75	618	563
Standard Deviation		4.94	160	21 857	2 583	1.48	377	91
Total		56 322						
N2O Emissions (VSG * NCSG * OH)	150	t N2O						
Emission Factor	2.66	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			240	19 143				
Upper bound			867	104 821				
Count			4 065	4 271				
as % of Operating Hours			*93%*	*98%*				
Minimum			281	26 237				
Maximum			863	81 434				
Mean			558	69 713				
Standard Deviation			94	4 119				
N2O Emissions (VSG * NCSG * OH)	**170**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**3.01**	**kgN2O / tHNO3**						
Abatement Ratio	**44.7%**							

Moving Average Emission Factor Correction	Actual Factors	Moving Average Rule
1	1.92	1.92
2	3.01	3.01

Project Emission Factor (EF_P)	**3.01**	**kgN2O / tHNO3**
Abatement Ratio	**44.7%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 4
MONITORING PERIOD:
FROM: 06/10/2008

TO: 28/04/2009

Prepared by:

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 4 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 4.

The first project campaign on Line 4 started on 01/08/2008. Secondary catalyst was installed on 06/10/2008. Total quantity of emission reductions generated during the first project period from 06/10/2008 through 28/04/2009 on Line 4 is **53 774 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	7.20	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.77	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	58 683	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	38 721	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	39 157	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**53 774**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**61.5%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	06 Oct 2008	01 Jan 2009	
Date To	31 Dec 2008	28 Apr 2009	
Nitric Acid Production	11 753	27 403	
Emission Reduction	**16 141**	**37 633**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 4 during baseline measurement carried from 28/12/2007 through 31/07/2008 is 7.20 $kgN_2O/tHNO_3$.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 4, which started on 06/10/2008 and went through 28/04/2009 with secondary catalyst installed and commissioned on 06/10/2008, is 2.77 $kgN_2O/tHNO_3$.

During the project campaign 39 157 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 4 emission reductions including information on baseline emission factor setting for the Line 4.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 4 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 4 has been carried out from 28/12/2007 through 31/07/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 4 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 4 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	**Definition**
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 4 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP * GWPN_2O\ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

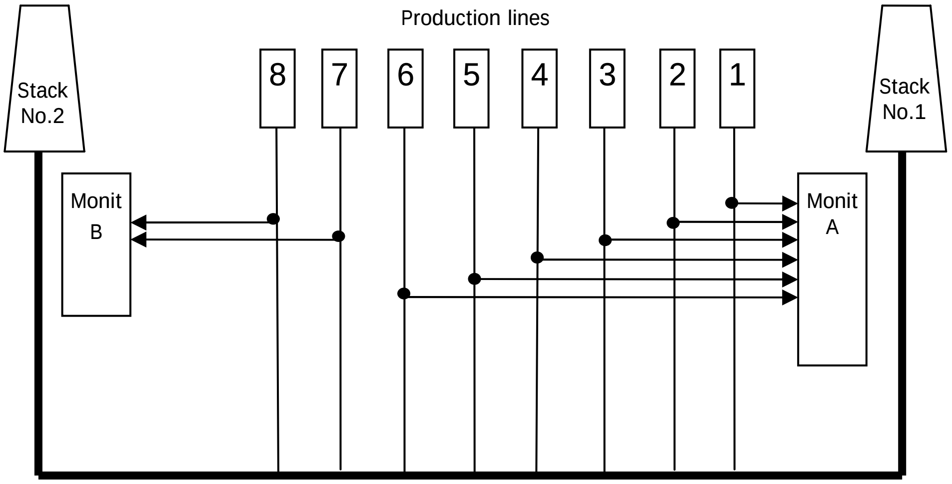
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

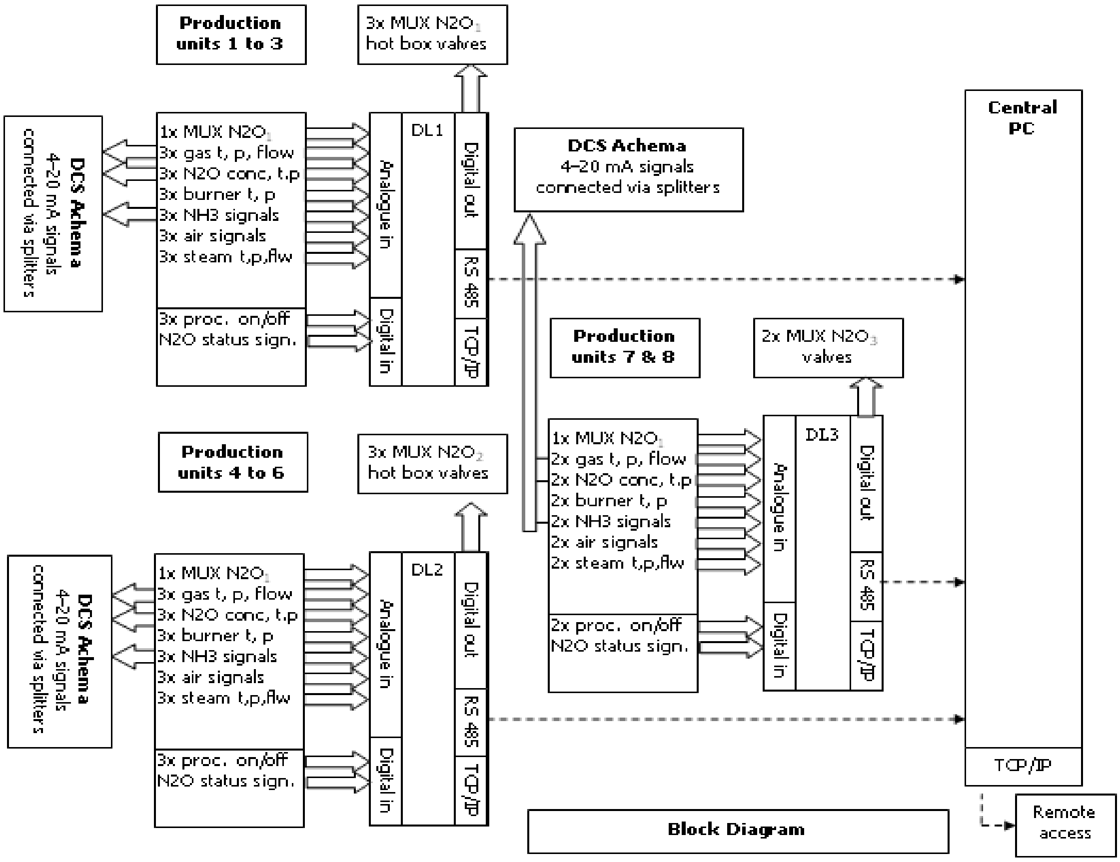
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

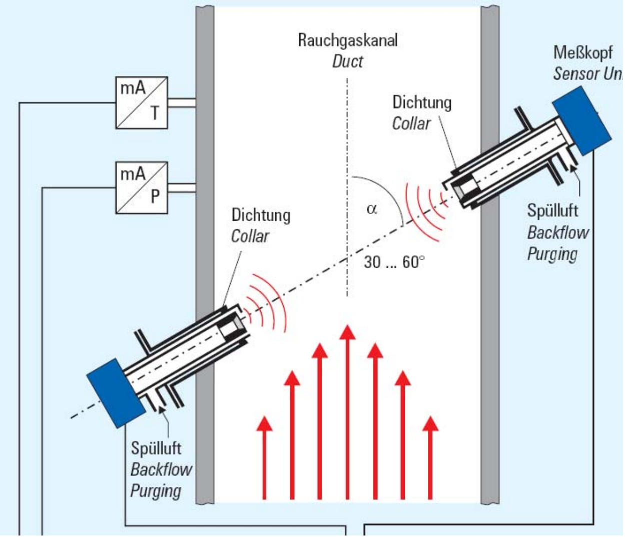
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

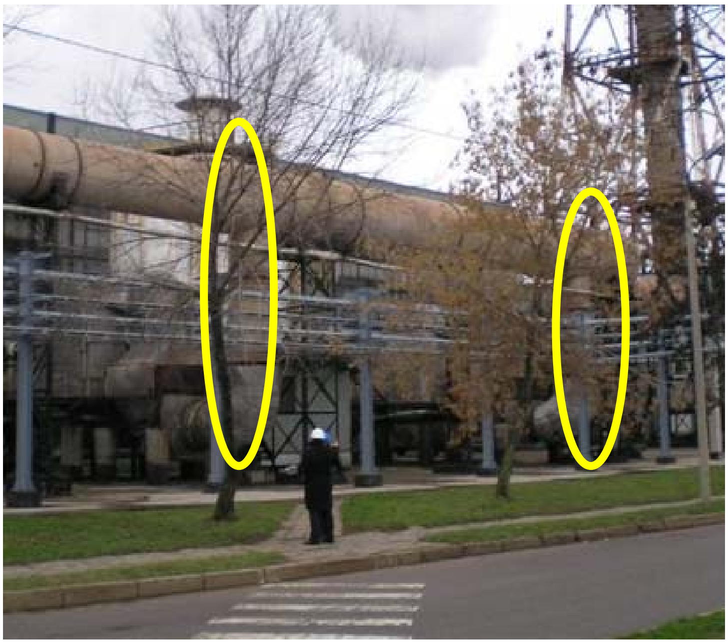
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

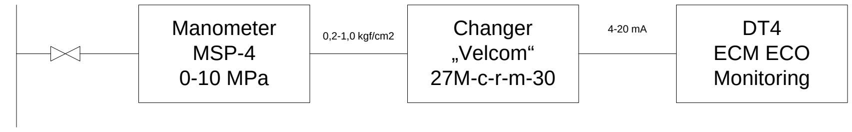
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

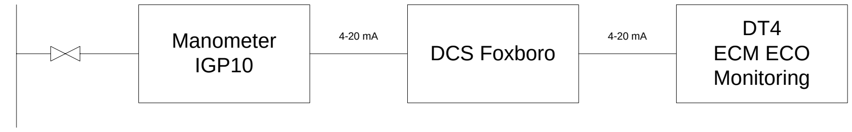
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

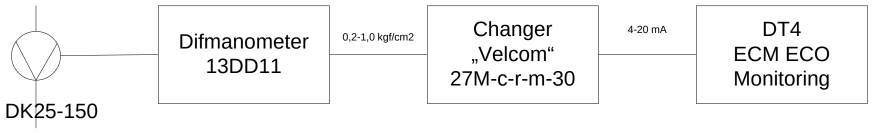
P in mixer 1-6 line



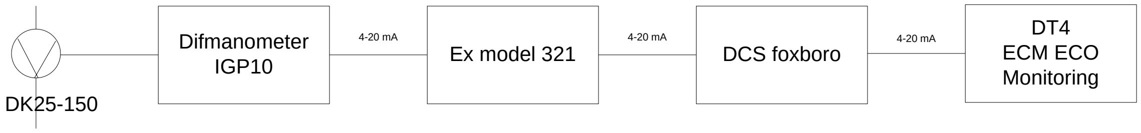
P in mixer 7-8 line



NH3 to mixer 1-6 line

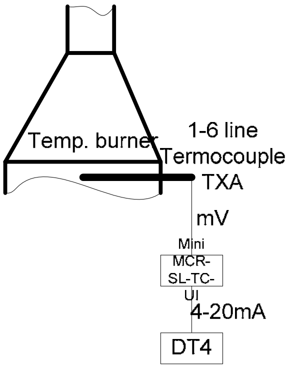


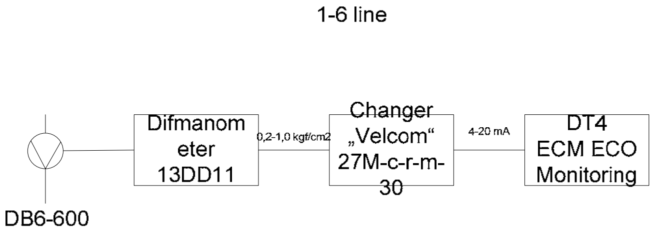
NH3 to mixer 7-8 line

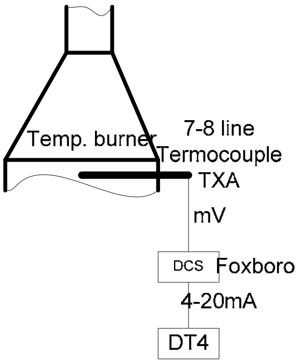


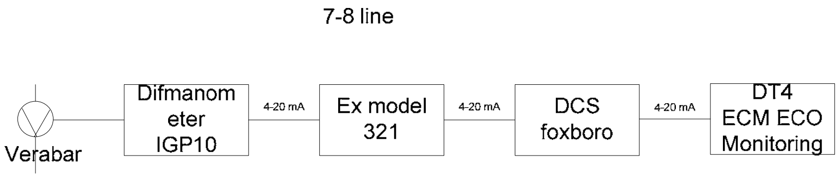
T in burner

Air to mixer







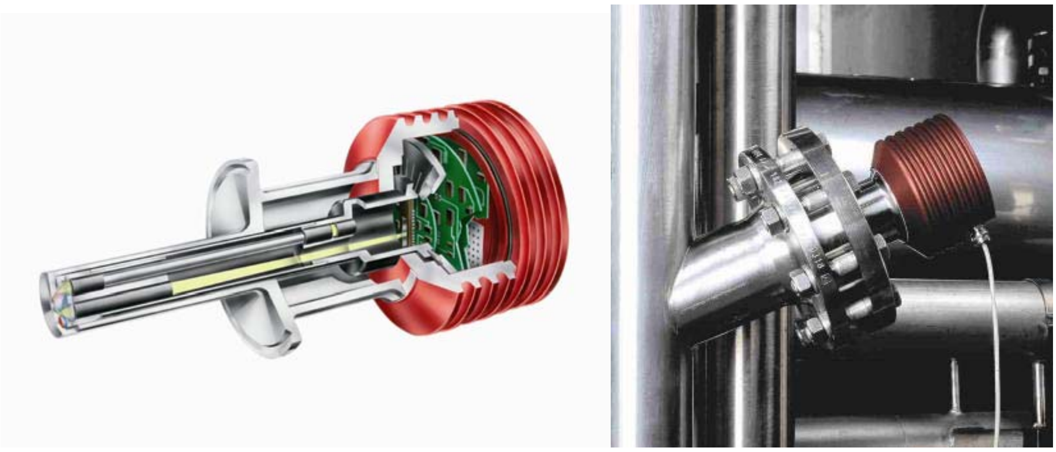


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 31/10/2007 and ending on 10/09/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$X_o=X_n=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 65 823 $tHNO_3$ and time duration was on average 275 days. Table contains also information on suppliers of primary catalysts for the line 4.

T 2 Historic campaigns

Line	ACHEMA UKL-4	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	69 782	18 Apr 2003	11 Dec 2003	237	294	Johnson Matthey	90/5/5
	2 t HNO3	65 420	11 Dec 2003	06 Dec 2004	361	181	Johnson Matthey	90/5/5
	3 t HNO3	66 129	07 Dec 2004	08 Nov 2005	336	197	Umicore	95/5
	4 t HNO3	66 826	22 Mar 2006	23 Nov 2006	246	272	Johnson Matthey	n.a.
	5 t HNO3	60 959	23 Nov 2006	04 Jun 2007	193	316	Johnson Matthey	n.a.
Average HNO3 production	t HNO3	**65 823**			**275**	**240**		
Project Campaigns	**BL** t HNO3	58 683	28 Dec 2007	31 Jul 2008	216	272	Johnson Matthey	n.a.
	PL t HNO3	39 157	06 Oct 2008	28 Apr 2009	204	192	Johnson Matthey	n.a.

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 28/12/2007 and continued through 31/07/2008 when the 58 683 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-4	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Jun 04	2007 Dec 28	2008 May 02	2008 Jul 31	2008 Aug 01
Baseline Factor kgN2O/tHNO3	-	-	7.20	7.20	7.20
Production tHNO3		-	38 721	58 683	-
Per Day Production tHNO3	239.7				
Baseline less Historic Production	**(7 140.4)**				
Baseline less Historic Days	**(29.8)**				

C 1 Baseline campaign length

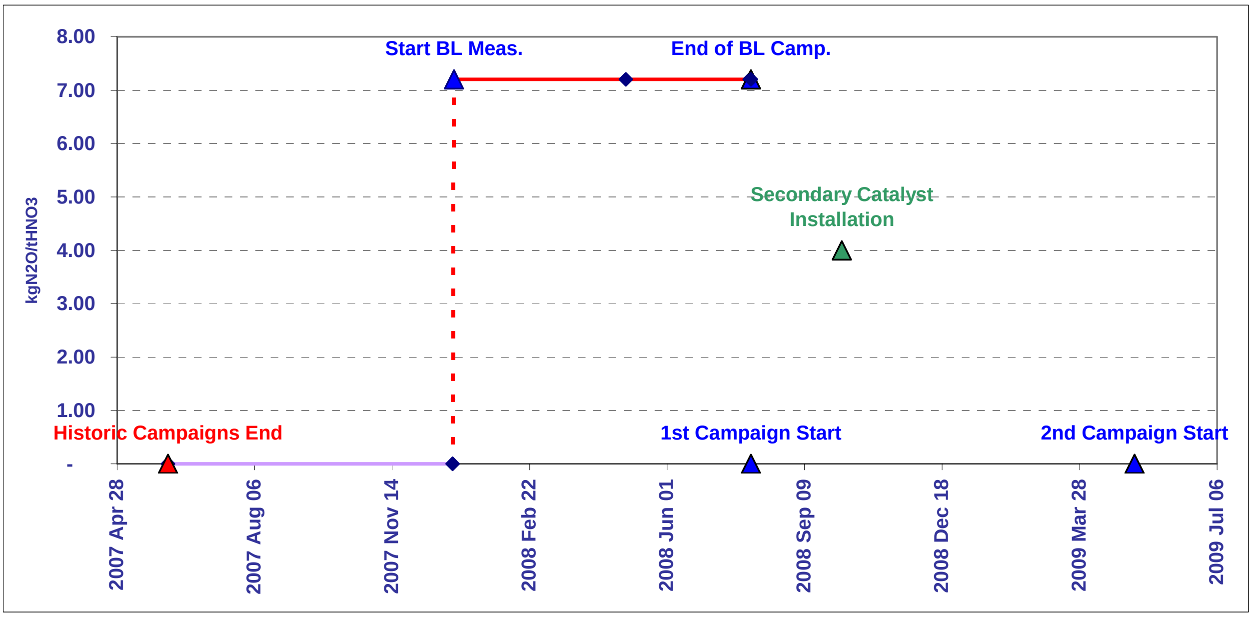


Table T 4 illustrates the calculation of the baseline emission factor on Line 4 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 28/12/2007 through 31/07/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 447 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.450%, which is further modified by an uncertainty of 0.065% due to under-sampling. As a result we have arrived to the baseline emission factor of 7.20 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 4 during the project campaign. Project campaign started on 06/10/2008 and went through 28/04/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH\ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.77 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n\ (tN_2O/tHNO_3)$$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR

Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**	**AMS in Operation**	**Nitric Acid Production**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 564**	4 906	2 973	4 467	4 733	5 086	5 161	4 755	4 028	2 935
as % of Dataset	*88%*	*95%*	*57%*	*86%*	*91%*	*98%*	*100%*	*92%*	*78%*	*57%*
Minimum		-	0	-	266	-	1	3		-
Maximum		15.12	2 132	83 541	6 465	19.28	906	634		15
Mean		11.96	1 399	66 846	5 718	9.71	791	572		13
Standard Deviation		4.35	230	10 182	881	2.96	272	62		3
Total		58 683								38 721
N2O Emissions (VSG * NCSG * OH)	427	t N2O								
Emission Factor	6.88	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**4 399**		2 699	4 210					4 028	
as % of Operating Hours	***96%***		*59%*	*92%*					*88%*	
Minimum			810	-						
Maximum			1 922	75 876						
Mean			1 418	67 275						
Standard Deviation			137	8 270						
N2O Emissions (VSG * NCSG * OH)	435	t N2O								
Emission Factor	7.02	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			1 150	51 066						
Upper bound			1 686	83 484						
Count			2 601	4 149						
as % of Operating Hours			*57%*	*91%*						
Minimum			1 160	59 513						
Maximum			1 683	75 876						
Mean			1 435	68 235						
Standard Deviation			98	2 154						
N2O Emissions (VSG * NCSG * OH)	**447**	**t N2O**								
Emission Factor (EF_BL)	**7.20**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR

Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**3 013**	3 531	3 368	3 217	4 327	3 538	4 893	4 869
as % of Dataset	*62%*	*72%*	*69%*	*66%*	*88%*	*72%*	*100%*	*99%*
Minimum		-	0	-	264	-	1	0
Maximum		16.18	896	81 622	7 672	19.62	903	683
Mean		11.09	483	63 740	4 617	9.93	581	556
Standard Deviation		4.75	151	16 869	2 223	2.12	391	154
Total		39 157						
N2O Emissions (VSG * NCSG * OH)	93	t N2O						
Emission Factor	2.37	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			187	30 677				
Upper bound			779	96 804				
Count			2 863	2 973				
as % of Operating Hours			*95%*	*99%*				
Minimum			355	56 348				
Maximum			771	74 209				
Mean			528	68 288				
Standard Deviation			78	1 530				
N2O Emissions (VSG * NCSG * OH)	**109**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**2.77**	**kgN2O / tHNO3**						
Abatement Ratio	**61.5%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	2.77	2.77						
2	-							
Project Emission Factor (EF_P)	**2.77**	**kgN2O / tHNO3**						
Abatement Ratio	**61.5%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 5
MONITORING PERIOD:
FROM: 02/07/2008

TO: 22/04/2009

Prepared by:

VERTIS

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 5 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 5.

The first project campaign on Line 5 started on 02/07/2008. Secondary catalyst was installed on 02/07/2008. Total quantity of emission reductions generated during the first project period from 02/07/2008 through 22/04/2009 on Line 5 is **92 048 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	6.61	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	1.68	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	55 079	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	55 079	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	60 229	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**92 048**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**74.6%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	02 Jul 2008	01 Jan 2009	
Date To	31 Dec 2008	22 Apr 2009	
Nitric Acid Production	39 871	20 358	
Emission Reduction	**60 935**	**31 113**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 5 during baseline measurement carried from 29/11/2007 through 17/06/2008 is 6.61 kgN_2O/tHNO_3.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 5, which started on 02/07/2008 and went through 22/04/2009 with secondary catalyst installed and commissioned on 02/07/2008, is 1.68 kgN_2O/tHNO_3.

During the project campaign 60 229 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 5 emission reductions including information on baseline emission factor setting for the Line 5.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 5 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 5 has been carried out from 29/11/2007 through 17/06/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \text{ (tN}_2\text{O)}$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100) \text{ (tN}_2\text{O/tHNO}_3\text{)}$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 5 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 5 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$

where:

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 5 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP *GWPN_2O\ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

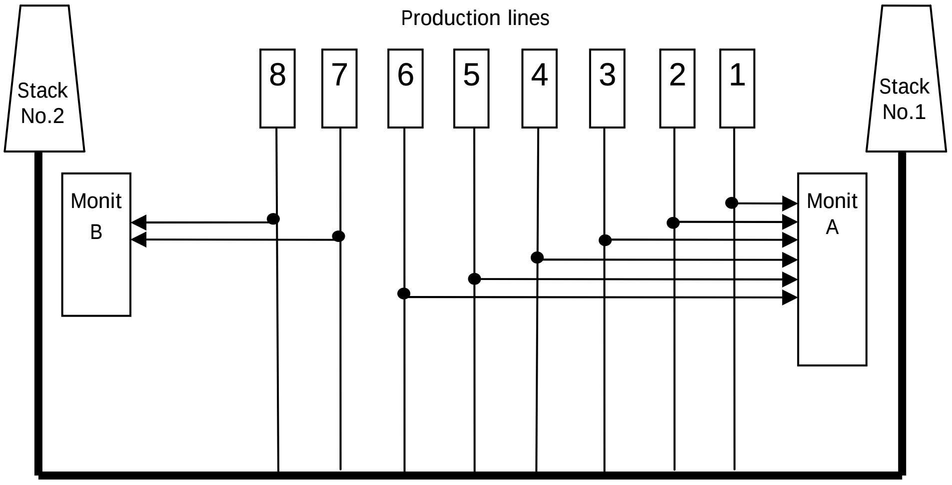
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

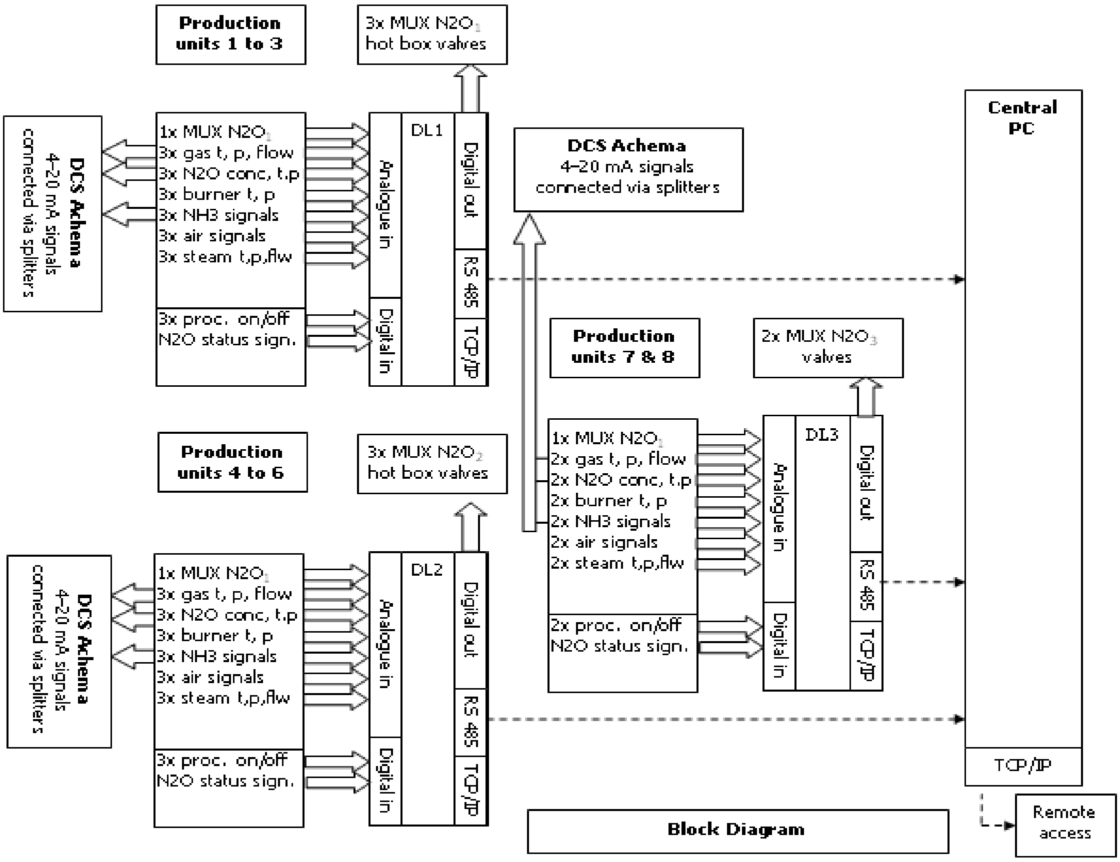
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

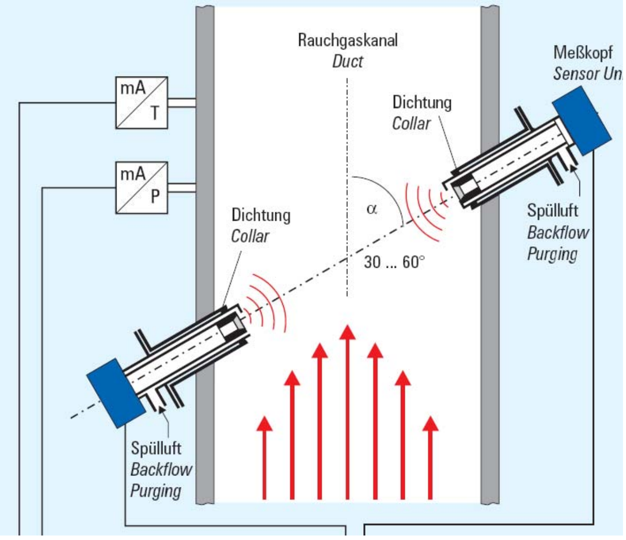
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

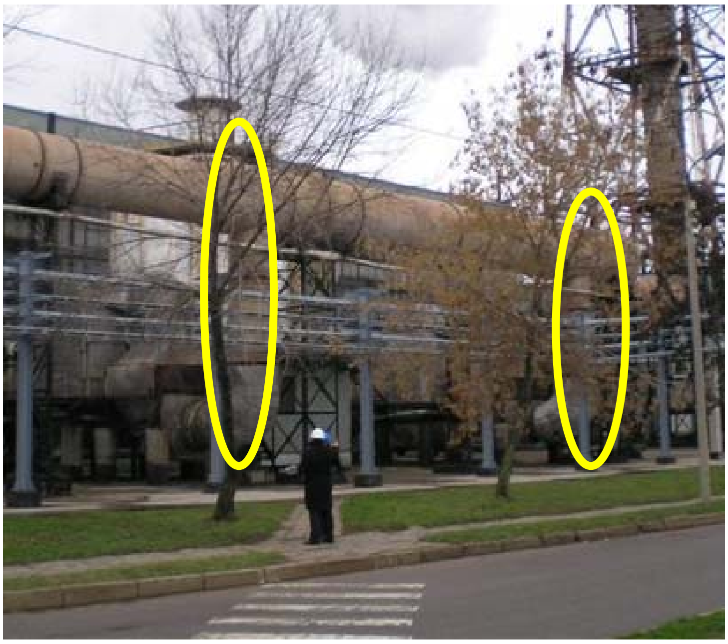
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

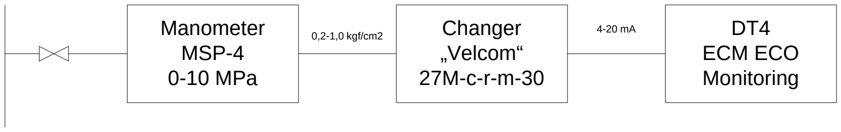
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

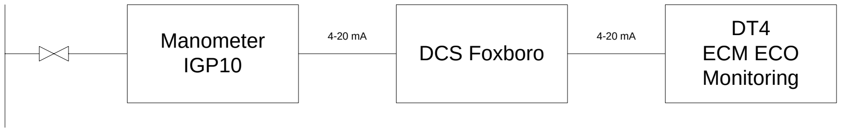
- Ammonia flow
- Ammonia temperature
- Ammonia pressure
- Primary air flow
- Primary air temperature
- Primary air pressure
- Oxidation temperature
- Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

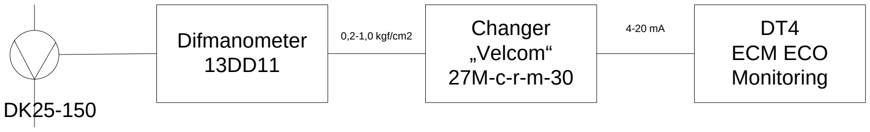
P in mixer 1-6 line



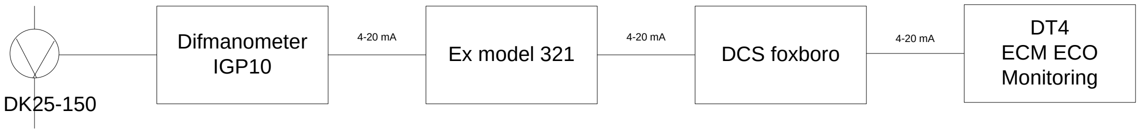
P in mixer 7-8 line



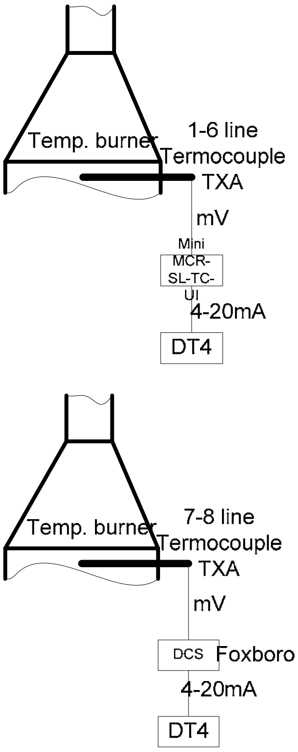
NH3 to mixer 1-6 line



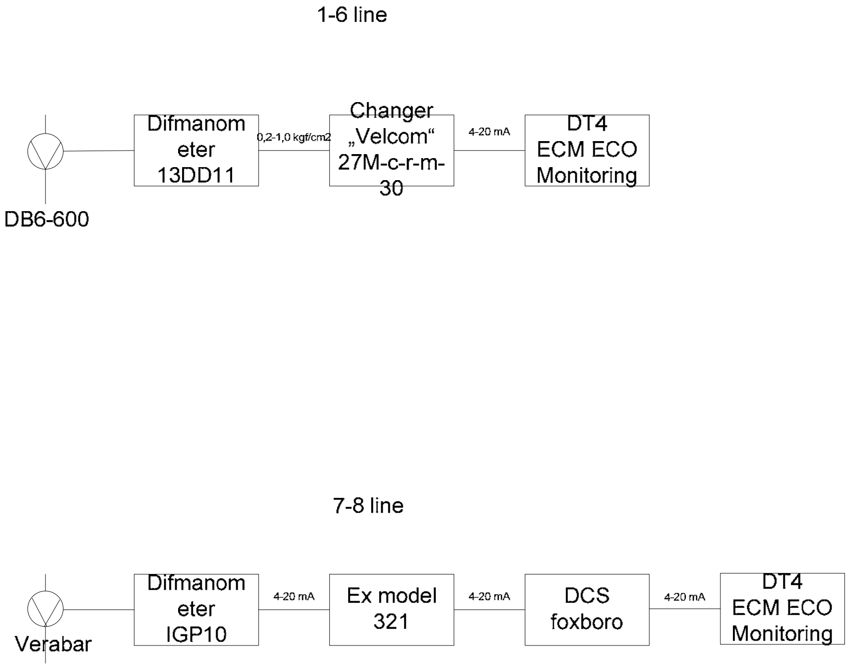
NH3 to mixer 7-8 line



T in burner



Air to mixer

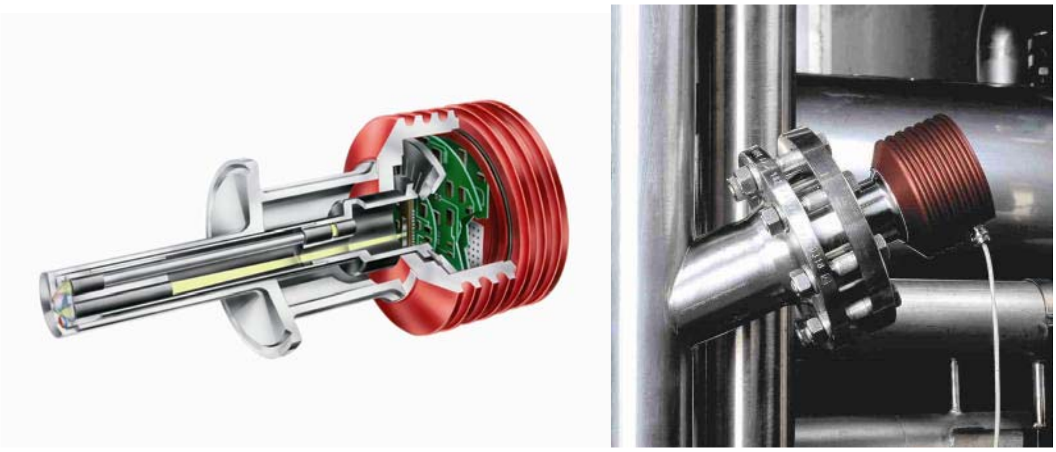


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 05/10/2007 and ending on 15/09/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 64 818 $tHNO_3$ and time duration was on average 238 days. Table contains also information on suppliers of primary catalysts for the line 5.

T 2 Historic campaigns

Line	ACHEMA UKL-5	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	65 664	06 Jun 2003	23 Dec 2003	200	328	Heraeus	90/5/5
	2 t HNO3	63 844	23 Dec 2003	24 Aug 2004	245	261	Heraeus	90/5/5
	3 t HNO3	58 961	01 Sep 2004	10 May 2005	251	235	Johnson Matthey	90/5/5
	4 t HNO3	66 432	12 May 2005	06 Mar 2006	298	223	Johnson Matthey	90/5/5
	5 t HNO3	69 189	06 Nov 2006	23 May 2007	198	349	Heraeus	63/4/33
Average HNO3 production	t HNO3	**64 818**			**238**	**272**		
Project Campaigns	**BL** t HNO3	55 079	29 Nov 2007	17 Jun 2008	201	274	Umicore	95/5
	PL t HNO3	60 229	02 Jul 2008	22 Apr 2009	294	205	Umicore	95/5

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 29/11/2007 and continued through 17/06/2008 when the 55 079 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-5	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 May 23	2007 Nov 29	2008 Jun 17	2008 Jun 17	2008 Jun 18
Baseline Factor kgN2O/tHNO3	-	-	6.61	6.61	6.61
Production tHNO3		-	55 079	55 079	-
Per Day Production tHNO3	271.9				
Baseline less Historic Production	**(9 739.2)**				
Baseline less Historic Days	**(35.8)**				

C 1 Baseline campaign length

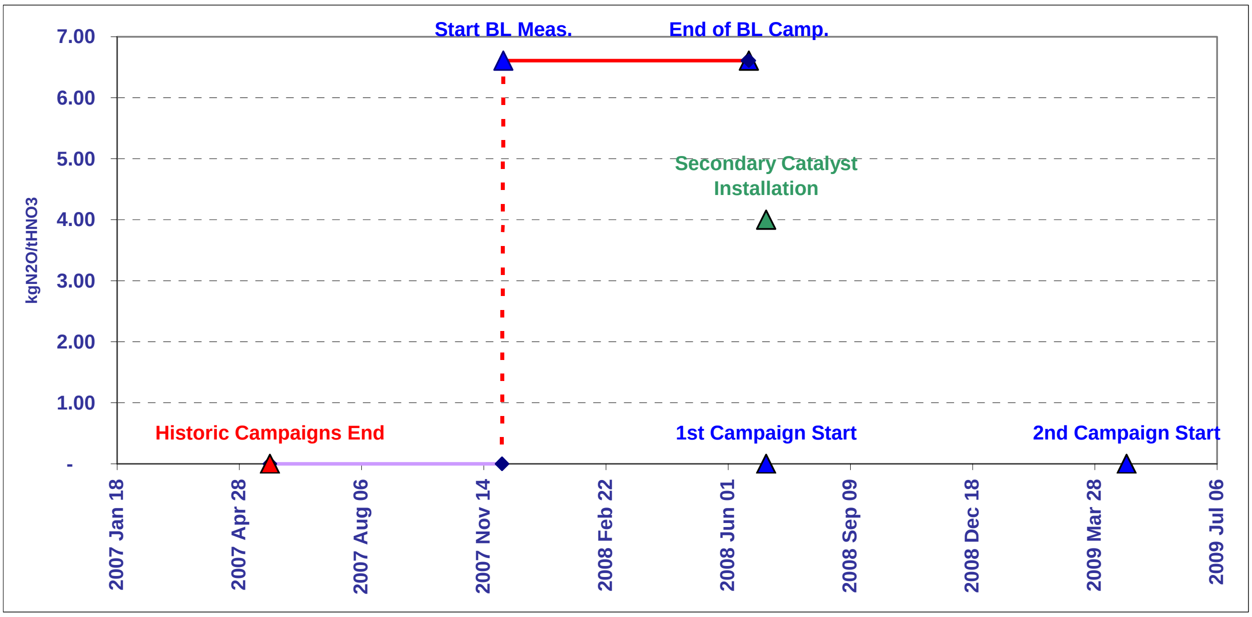


Table T 4 illustrates the calculation of the baseline emission factor on Line 5 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 29/11/2007 through 17/06/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 385 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.450%, which is further modified by an uncertainty of 0.126% due to under-sampling. As a result we have arrived to the baseline emission factor of 6.61 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 5 during the project campaign. Project campaign started on 02/07/2008 and went through 22/04/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH\ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 1.68 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n\ (tN_2O/tHNO_3)$$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure	AMS in Operation	Nitric Acid Production NCSG
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP		NAP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa	h	t/h
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 519**	4 571	4 660	4 558	4 701	4 414	4 797	4 698	4 064	4 571
as % of Dataset	*94%*	*95%*	*97%*	*94%*	*97%*	*92%*	*99%*	*97%*	*84%*	*95%*
Minimum		-	0	-	315	-	(0)	0		-
Maximum		15.02	2 289	82 389	6 482	19.73	908	673		15
Mean		12.05	1 239	65 232	5 932	10.24	844	613		12
Standard Deviation		3.12	268	15 041	990	0.81	195	46		3
Total		55 079								55 079
N2O Emissions (VSG * NCSG * OH)	365	t N2O								
Emission Factor	6.27	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**4 249**		4 211	4 211					4 064	
as % of Operating Hours	***94%***		*93%*	*93%*					*90%*	
Minimum			717	6 728						
Maximum			2 289	78 602						
Mean			1 234	68 731						
Standard Deviation			225	2 256						
N2O Emissions (VSG * NCSG * OH)	383	t N2O								
Emission Factor	6.58	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			793	64 309						
Upper bound			1 675	73 153						
Count			4 009	4 063						
as % of Operating Hours			*89%*	*90%*						
Minimum			796	64 317						
Maximum			1 674	73 152						
Mean			1 240	68 711						
Standard Deviation			204	1 796						
N2O Emissions (VSG * NCSG * OH)	**385**	**t N2O**								
Emission Factor (EF_BL)	**6.61**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 666**	5 245	5 165	5 076	5 832	5 678	7 032	7 009
as % of Dataset	*66%*	*74%*	*73%*	*72%*	*83%*	*80%*	*100%*	*99%*
Minimum		-	0	-	288	-	(0)	3
Maximum		15.61	2 072	80 784	6 628	19.99	910	732
Mean		11.48	325	59 435	5 615	9.75	619	580
Standard Deviation		4.86	193	21 868	1 477	3.64	397	152
Total		60 229						

N2O Emissions (VSG * NCSG * OH)	90	t N2O
Emission Factor	1.49	kgN2O / tHNO3

Data within the confidence interval								
95% Confidence interval								
Lower bound			- 53	16 573				
Upper bound			702	102 297				
Count			4 068	4 418				
as % of Operating Hours			*87%*	*95%*				
Minimum			2	23 703				
Maximum			650	82 213				
Mean			320	67 920				
Standard Deviation			65	2 865				

N2O Emissions (VSG * NCSG * OH)	**101**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**1.68**	**kgN2O / tHNO3**
Abatement Ratio	**74.6%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.68	1.68
2	-	

Project Emission Factor (EF_P)	**1.68**	**kgN2O / tHNO3**
Abatement Ratio	**74.6%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 5
MONITORING PERIOD:
FROM: 23/04/2009

TO: 14/01/2010

Prepared by:

VERTIS

VERTIS FINANCE

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 5 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the second project campaign on Line 5.

The first project campaign on Line 5 started on 02/07/2008. Secondary catalyst was installed on 02/07/2008. Total quantity of emission reductions generated during the second project period from 23/04/2009 through 14/01/2010 on Line 5 is **81 971 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	6.61	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.90	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	55 079	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	55 079	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	71 273	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**81 971**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**56.1%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		23 Apr 2009	01 Jan 2010
Date To		31 Dec 2009	14 Jan 2010
Nitric Acid Production		66 630	4642
Emission Reduction		**76 632**	**5339**
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 5 during baseline measurement carried from 29/11/2007 through 17/06/2008 is 6.61 kgN_2O/tHNO_3.

Project emission factor during the second project campaign after installation of secondary catalysts on Line 5, which started on 23/04/2009 and went through 14/01/2010 with secondary catalyst installed and commissioned on 02/07/2008, is 2.90 kgN_2O/tHNO_3.

During the project campaign 71 273 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 5 emission reductions including information on baseline emission factor setting for the Line 5.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 5 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 5 has been carried out from 29/11/2007 through 17/06/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 5 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 5 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL - EFP) * NAP * GWPN_2O \ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

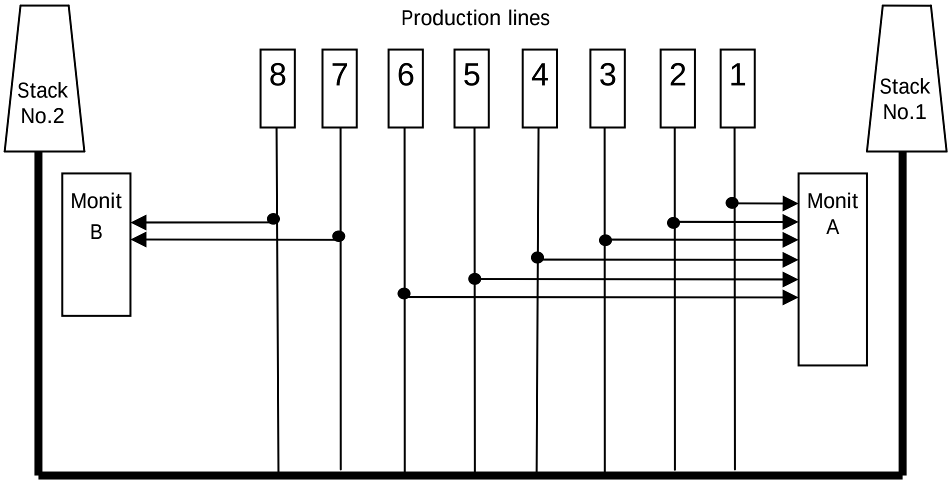
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

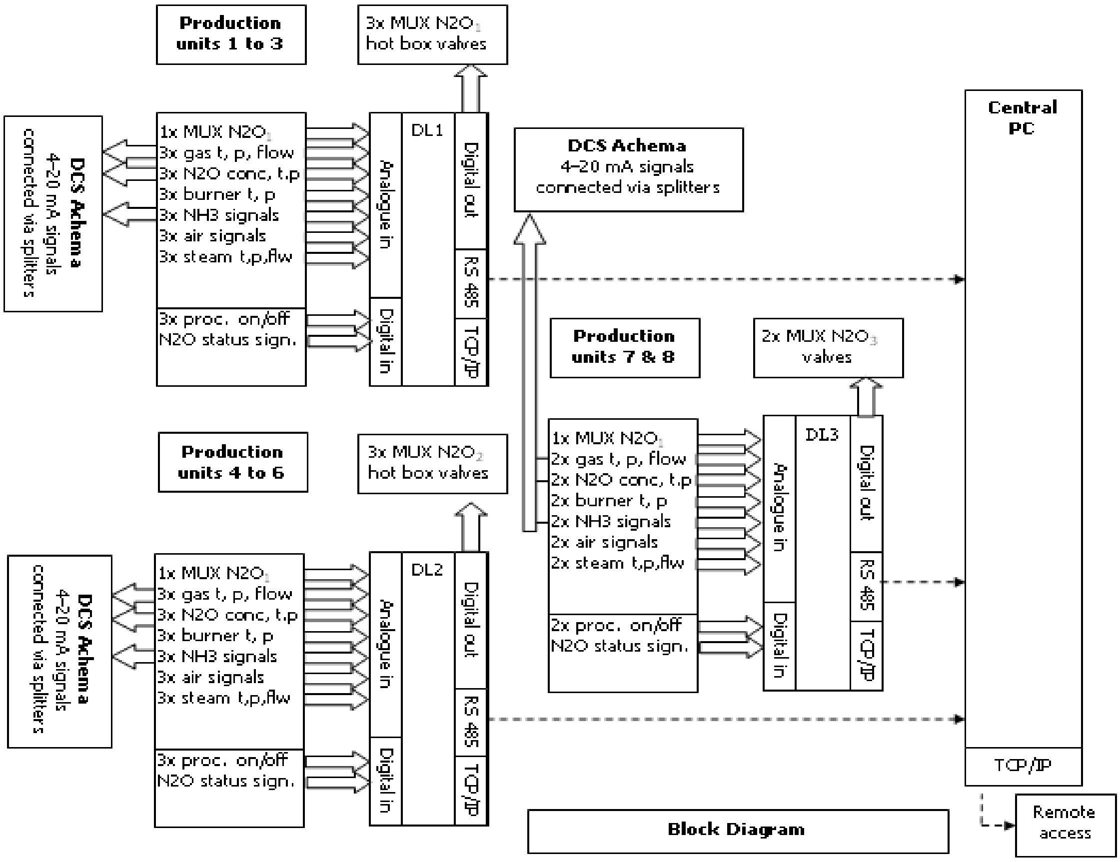
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

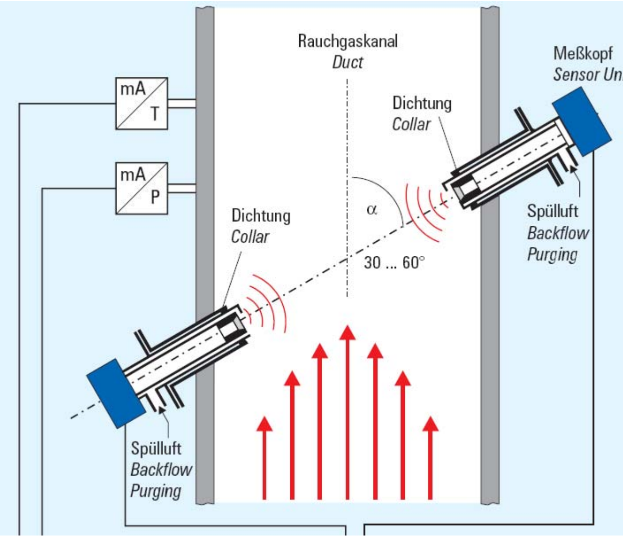
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

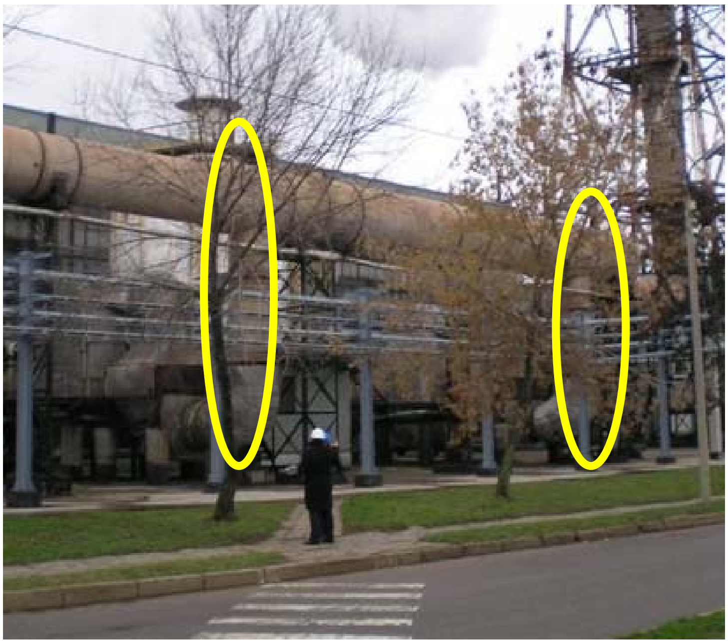
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

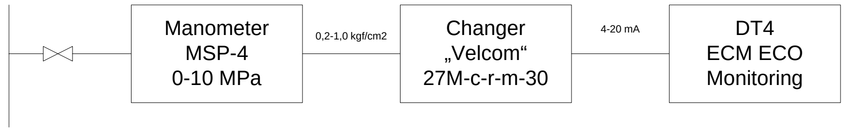
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

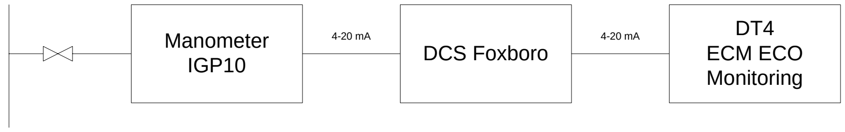
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

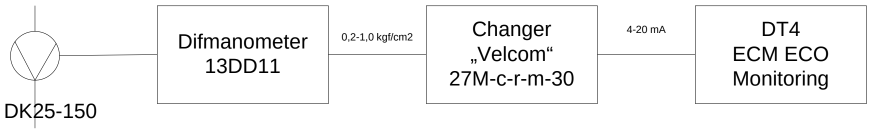
P in mixer 1-6 line



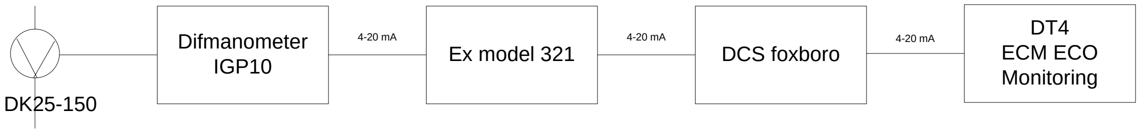
P in mixer 7-8 line



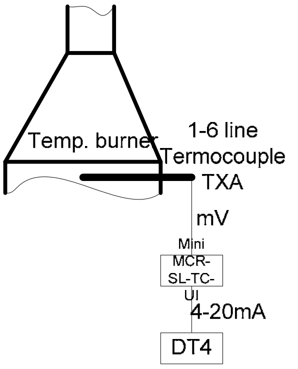
NH3 to mixer 1-6 line

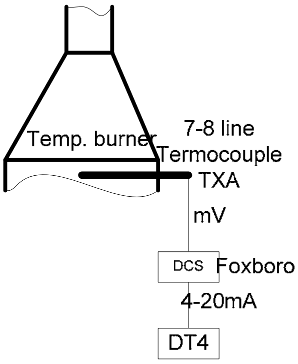


NH3 to mixer 7-8 line

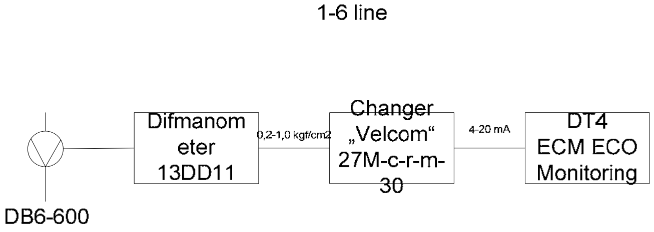


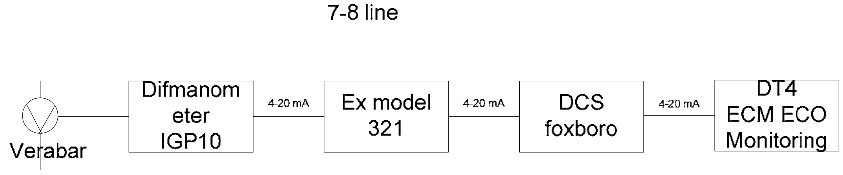
T in burner





Air to mixer



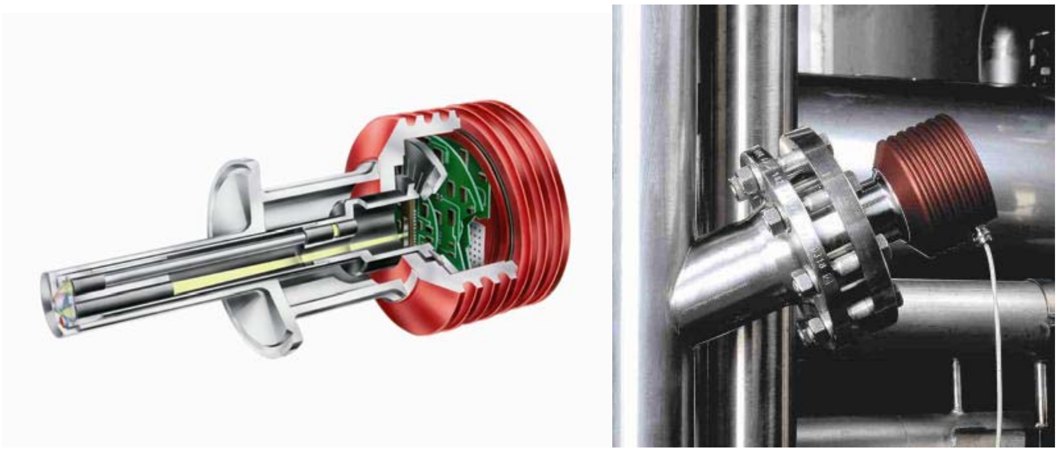


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

- Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
- Digital instrument – no calibration drift
- As it is a robust instrument it is maintenance free
- Dual connectivity if the installation positions allow.
- On-Line data logging, through Ethernet, on whichever web browser.
- No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 05/10/2007 and ending on 15/09/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 64 818 $tHNO_3$ and time duration was on average 238 days. Table contains also information on suppliers of primary catalysts for the line 5.

T 2 Historic campaigns

Line	ACHEMA UKL-5	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	65 664	06 Jun 2003	23 Dec 2003	200	328	Heraeus	90/5/5
	2 t HNO3	63 844	23 Dec 2003	24 Aug 2004	245	261	Heraeus	90/5/5
	3 t HNO3	58 961	01 Sep 2004	10 May 2005	251	235	Johnson Matthey	90/5/5
	4 t HNO3	66 432	12 May 2005	06 Mar 2006	298	223	Johnson Matthey	90/5/5
	5 t HNO3	69 189	06 Nov 2006	23 May 2007	198	349	Heraeus	63/4/33
Average HNO3 production	t HNO3	**64 818**			**238**	**272**		
Project Campaigns	**BL** t HNO3	55 079	29 Nov 2007	17 Jun 2008	201	274	Umicore	95/5
	PL t HNO3	71 273	23 Apr 2009	14 Jan 2010	266	268	Umicore	95/5

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 29/11/2007 and continued through 17/06/2008 when the 55 079 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-5	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 May 23	2007 Nov 29	2008 Jun 17	2008 Jun 17	2008 Jun 18
Baseline Factor kgN2O/tHNO3	-	-	6.61	6.61	6.61
Production tHNO3		-	55 079	55 079	-
Per Day Production tHNO3	271.9				
Baseline less Historic Production	**(9 739.2)**				
Baseline less Historic Days	**(35.8)**				

C 1 Baseline campaign length

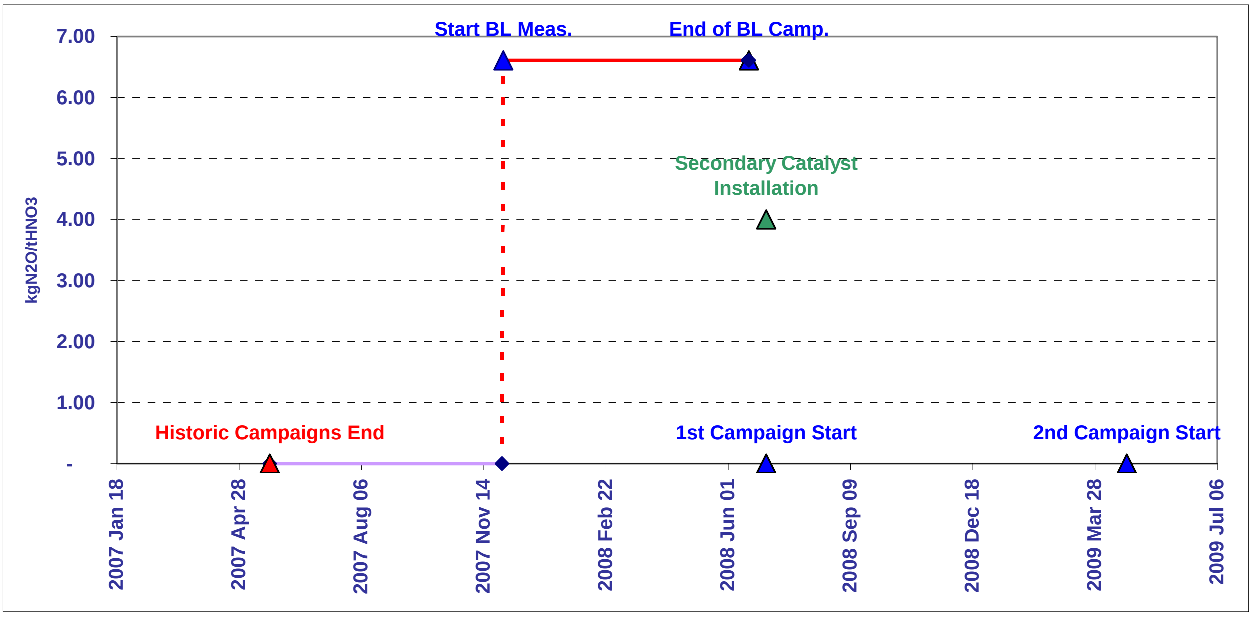


Table T 4 illustrates the calculation of the baseline emission factor on Line 5 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 29/11/2007 through 17/06/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 385 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.450%, which is further modified by an uncertainty of 0.126% due to under-sampling. As a result we have arrived to the baseline emission factor of 6.61 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 5 during the project campaign. Project campaign started on 23/04/2009 and went through 14/01/2010.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH \ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.90 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n \ (tN_2O/tHNO_3)$$

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**	**AMS in Operation**	**Nitric Acid Production NCSG**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 519**	4 571	4 660	4 558	4 701	4 414	4 797	4 698	4 064	4 571
as % of Dataset	*94%*	*95%*	*97%*	*94%*	*97%*	*92%*	*99%*	*97%*	*84%*	*95%*
Minimum		-	0	-	315	-	(0)	0		-
Maximum		15.02	2 289	82 389	6 482	19.73	908	673		15
Mean		12.05	1 239	65 232	5 932	10.24	844	613		12
Standard Deviation		3.12	268	15 041	990	0.81	195	46		3
Total		55 079								55 079
N2O Emissions (VSG * NCSG * OH)	365	t N2O								
Emission Factor	6.27	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**4 249**		4 211	4 211					4 064	
as % of Operating Hours	***94%***		*93%*	*93%*					*90%*	
Minimum			717	6 728						
Maximum			2 289	78 602						
Mean			1 234	68 731						
Standard Deviation			225	2 256						
N2O Emissions (VSG * NCSG * OH)	383	t N2O								
Emission Factor	6.58	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			793	64 309						
Upper bound			1 675	73 153						
Count			4 009	4 063						
as % of Operating Hours			*89%*	*90%*						
Minimum			796	64 317						
Maximum			1 674	73 152						
Mean			1 240	68 711						
Standard Deviation			204	1 796						
N2O Emissions (VSG * NCSG * OH)	**385**	**t N2O**								
Emission Factor (EF_BL)	**6.61**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 966**	5 612	4 902	4 888	5 633	5 100	6 377	6 377
as % of Dataset	*78%*	*88%*	*77%*	*77%*	*88%*	*80%*	*100%*	*100%*
Minimum		0.61	0	46 049	312	3	(0)	3
Maximum		16.85	1 369	89 781	6 541	19.29	914	714
Mean		12.70	611	68 113	5 711	10.68	709	577
Standard Deviation		4.13	93	2 048	1 214	0.62	350	170
Total		71 273						
N2O Emissions (VSG * NCSG * OH)	207	t N2O						
Emission Factor	2.90	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			430	64 098				
Upper bound			793	72 128				
Count			4 543	4 709				
as % of Operating Hours			*91%*	*95%*				
Minimum			430	64 099				
Maximum			792	72 104				
Mean			612	68 065				
Standard Deviation			70	1 793				
N2O Emissions (VSG * NCSG * OH)	**207**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**2.90**	**kgN2O / tHNO3**						
Abatement Ratio	**56.1%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	1.68	1.68						
2	2.90	2.90						
Project Emission Factor (EF_P)	**2.90**	**kgN2O / tHNO3**						
Abatement Ratio	**56.1%**							

MONITORING REPORT

PROJECT: **ACHEMA UKL nitric acid plant N_2O abatement project**
LINE: **Line 6**
MONITORING PERIOD:
FROM: **25/07/2008**

TO: **21/04/2009**

Prepared by:

VERTIS

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 6 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 6.

The first project campaign on Line 6 started on 21/07/2008. Secondary catalyst was installed on 25/07/2008. Total quantity of emission reductions generated during the first project period from 25/07/2008 through 21/04/2009 on Line 6 is **114 364 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	10.34	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	4.94	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	60 850	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	60 850	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	68 318	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**114 364**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**52.3%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	25 Jul 2008	01 Jan 2009	
Date To	31 Dec 2008	21 Apr 2009	
Nitric Acid Production	41 416	26 902	
Emission Reduction	**69 331**	**45 033**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 6 during baseline measurement carried from 11/01/2008 through 21/07/2008 is 10.34 $kgN_2O/tHNO_3$.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 6, which started on 25/07/2008 and went through 21/04/2009 with secondary catalyst installed and commissioned on 25/07/2008, is 4.94 $kgN_2O/tHNO_3$.

During the project campaign 68 318 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 6 emission reductions including information on baseline emission factor setting for the Line 6.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 6 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 6 has been carried out from 11/01/2008 through 21/07/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	**Definition**
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 6 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room A, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 6 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH\ (tN_2O)$$

where:

Variable	**Definition**
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 6 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP *GWPN_2O\ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

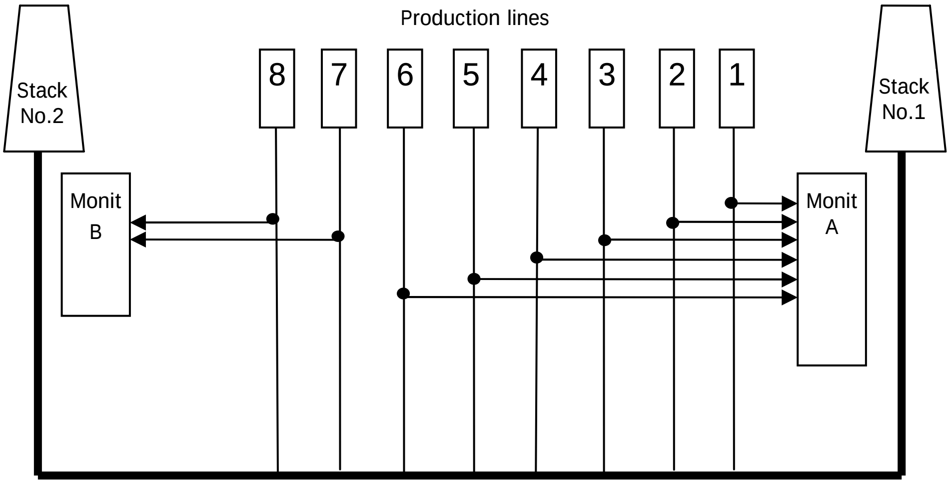
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

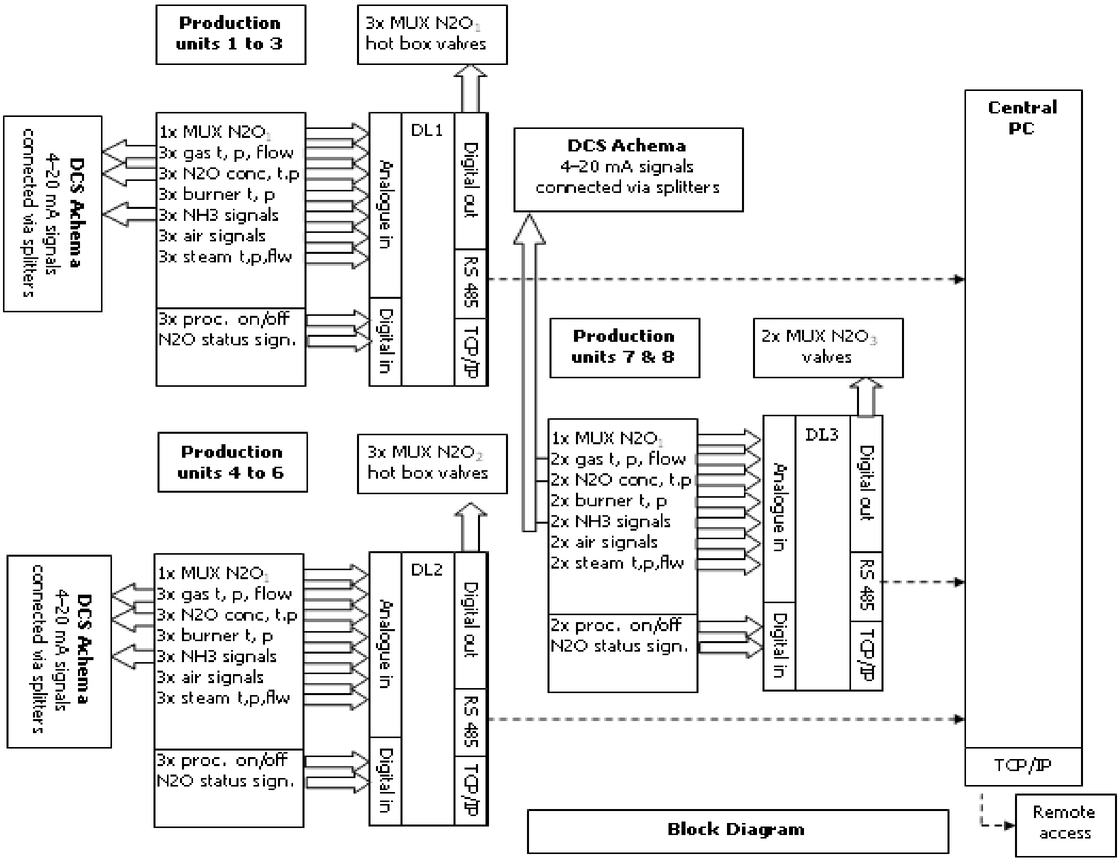
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

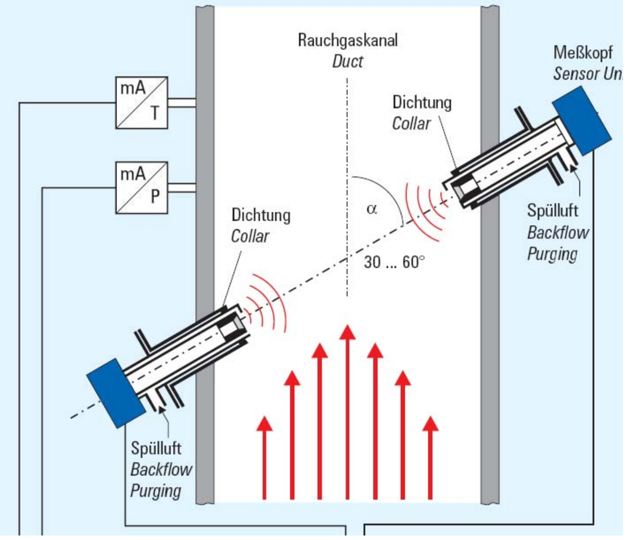
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

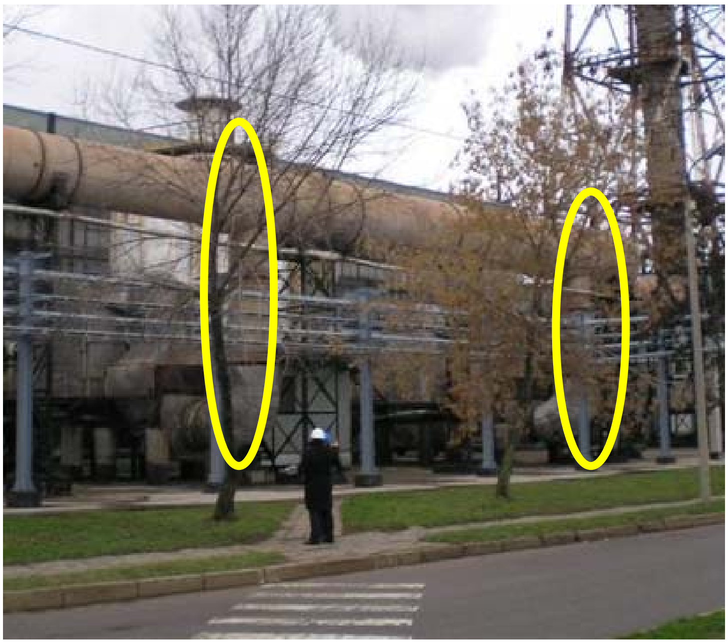
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

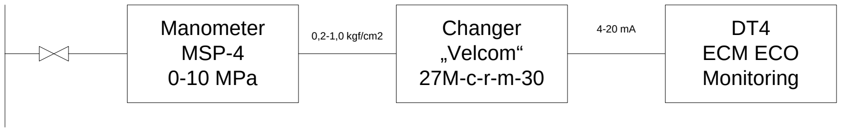
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

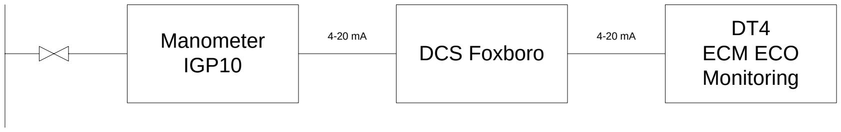
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

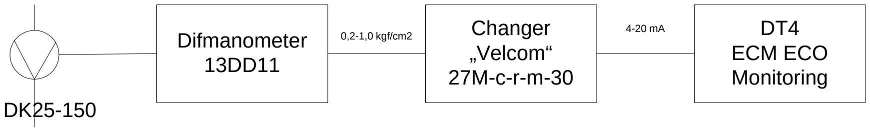
P in mixer 1-6 line



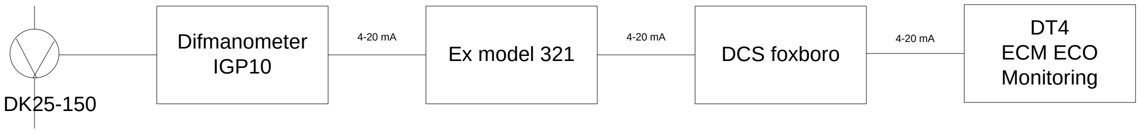
P in mixer 7-8 line



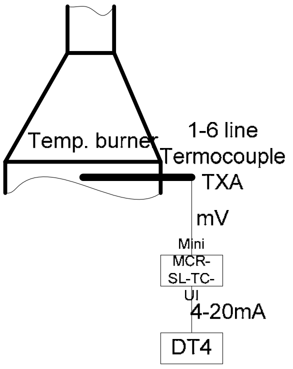
NH3 to mixer 1-6 line

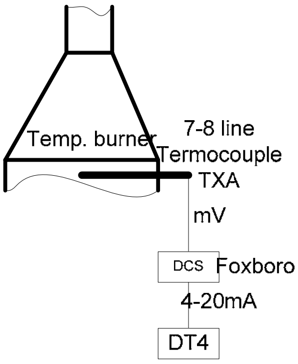


NH3 to mixer 7-8 line



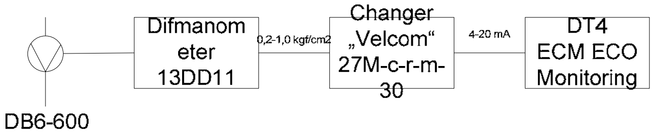
T in burner



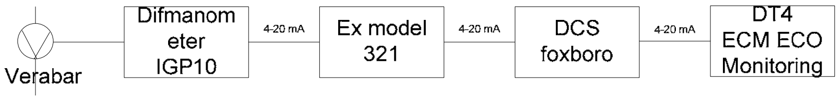


Air to mixer

1-6 line



7-8 line

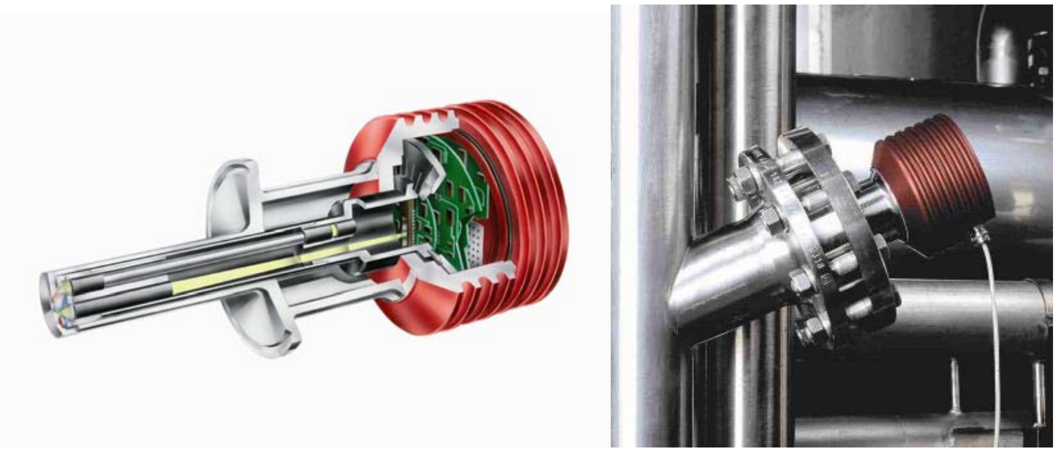


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 05/10/2007 and ending on 08/09/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y = a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 61 599 $tHNO_3$ and time duration was on average 241 days. Table contains also information on suppliers of primary catalysts for the line 6.

T 2 Historic campaigns

Line	ACHEMA UKL-6	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	62 918	28 Aug 2003	25 Mar 2004	210	300	Heraeus	90/5/5
	2 t HNO3	61 366	01 Apr 2004	02 Feb 2005	307	200	Johnson Matthey	90/5/5
	3 t HNO3	64 872	26 Jul 2005	10 Mar 2006	227	286	Johnson Matthey	90/5/5
	4 t HNO3	55 693	10 Mar 2006	29 Nov 2006	264	211	Umicore	90/5
	5 t HNO3	63 148	29 Nov 2006	12 Jun 2007	195	324	Heraeus	63/4/33
Average HNO3 production	t HNO3	**61 599**			**241**	**256**		
Project Campaigns	**BL** t HNO3	60 850	11 Jan 2008	21 Jul 2008	192	317	Heraeus	63/4/33
	PL t HNO3	68 318	25 Jul 2008	21 Apr 2009	270	253	Heraeus	63/4/33

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 11/01/2008 and continued through 21/07/2008 when the 60 850 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-6	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Jun 12	2008 Jan 11	2008 Jul 21	2008 Jul 21	2008 Jul 22
Baseline Factor kgN2O/tHNO3	-	-	10.34	10.34	10.34
Production tHNO3		-	60 850	60 850	-
Per Day Production tHNO3	256.0				
Baseline less Historic Production	**(749.3)**				
Baseline less Historic Days	**(2.9)**				

C 1 Baseline campaign length

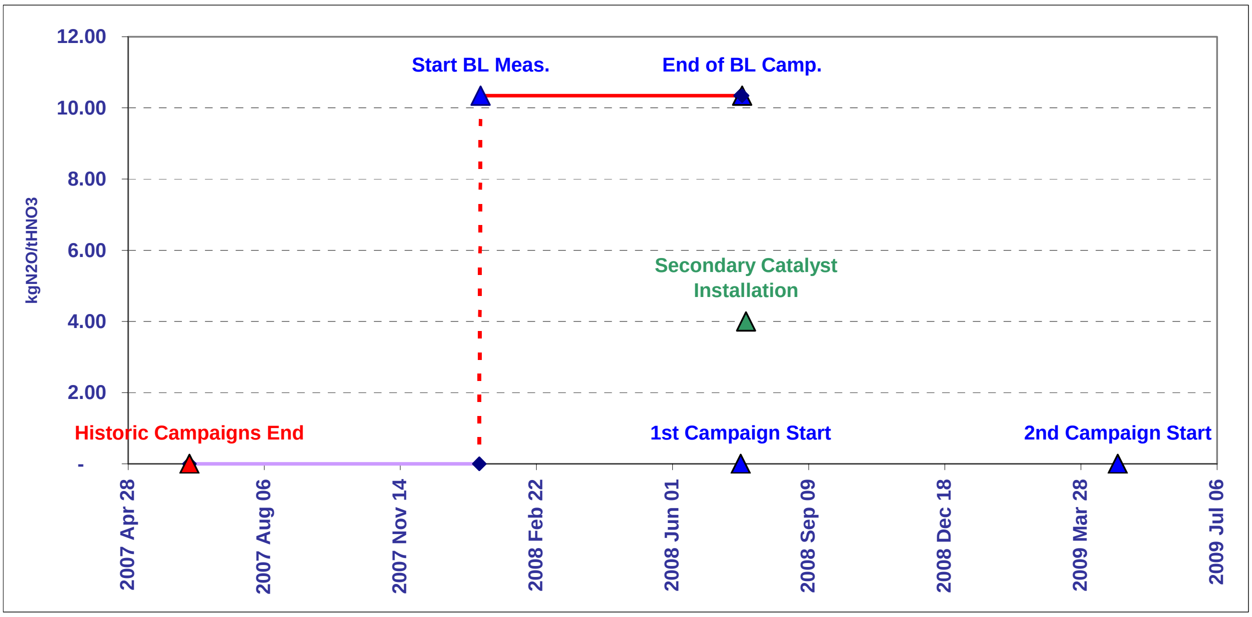


Table T 4 illustrates the calculation of the baseline emission factor on Line 6 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 11/01/2008 through 21/07/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 667 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 - UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.620%, which is further modified by an uncertainty of 0.105% due to under-sampling. As a result we have arrived to the baseline emission factor of 10.34 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 6 during the project campaign. Project campaign started on 25/07/2008 and went through 21/04/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$PE_n = VSG * NCSG * 10\text{-}9 * OH\ (tN2O)$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 4.94 kgN2O/tHNO3.

$EF_n = PE_n / NAP_n\ (tN_2O/tHNO_3)$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure	AMS in Operation	Nitric Acid Production NCSG
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 233**	4 363	4 494	4 290	4 324	4 361	4 585	4 564	3 944	4 363
as % of Dataset	*92%*	*95%*	*98%*	*93%*	*94%*	*95%*	*100%*	*99%*	*86%*	*95%*
Minimum		-	1	2	568	-	(1)	0		-
Maximum		16.37	2 303	117 970	6 423	15.58	905	634		16
Mean		13.95	1 422	99 960	6 050	10.50	833	583		14
Standard Deviation		3.18	416	17 673	456	1.70	201	44		3
Total		60 850								60 850
N2O Emissions (VSG * NCSG * OH)	602	t N2O								
Emission Factor	9.33	kgN2O / tHNO3								
Permitted Range										
Minimum					4 500	0	880	0		
Maximum					7 500	11.70	910	800		
Data within the permitted range										
Count	**4 116**		4 015	4 015					3 944	
as % of Operating Hours	***97%***		*95%*	*95%*					*93%*	
Minimum			7	10 156						
Maximum			2 074	110 925						
Mean			1 456	103 058						
Standard Deviation			312	2 541						
N2O Emissions (VSG * NCSG * OH)	635	t N2O								
Emission Factor	9.85	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			844	98 078						
Upper bound			2 068	108 039						
Count			3 695	3 991						
as % of Operating Hours			*87%*	*94%*						
Minimum			997	98 180						
Maximum			2 062	108 018						
Mean			1 528	103 105						
Standard Deviation			201	1 728						
N2O Emissions (VSG * NCSG * OH)	**667**	**t N2O**								
Emission Factor (EF_BL)	**10.34**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 620**	5 963	5 040	4 790	6 188	4 733	6 457	6 415
as % of Dataset	*71%*	*92%*	*78%*	*74%*	*95%*	*73%*	*100%*	*99%*
Minimum		-	0	2	-	-	(43)	-
Maximum		16.10	2 078	119 957	6 722	19.62	912	664
Mean		11.46	648	104 097	4 797	10.54	672	582
Standard Deviation		5.56	288	21 304	2 550	0.54	361	58
Total		68 318						
N2O Emissions (VSG * NCSG * OH)	312	t N2O						
Emission Factor	4.56	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			85	62 340				
Upper bound			1 212	145 853				
Count			4 238	4 391				
as % of Operating Hours			*92%*	*95%*				
Minimum			305	81 163				
Maximum			1 210	143 187				
Mean			674	108 248				
Standard Deviation			229	5 359				
N2O Emissions (VSG * NCSG * OH)	**337**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**4.94**	**kgN2O / tHNO3**						
Abatement Ratio	**52.3%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	4.94	4.94						
2	-							
Project Emission Factor (EF_P)	**4.94**	**kgN2O / tHNO3**						
Abatement Ratio	**52.3%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 7
MONITORING PERIOD:
FROM: 03/07/2008

TO: 22/10/2008

Prepared by:

VERTIS

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 7 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 7.

The first project campaign on Line 7 started on 28/03/2008. Secondary catalyst was installed on 03/07/2008. Total quantity of emission reductions generated during the first project period from 03/07/2008 through 22/10/2008 on Line 7 is **55 271 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	7.85	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.18	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	55 626	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	31 035	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	31 445	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**55 271**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**72.3%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	03 Jul 2008		
Date To	22 Oct 2008		
Nitric Acid Production	31 445		
Emission Reduction	**55 271**		
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 7 during baseline measurement carried from 12/09/2007 through 27/03/2008 is 7.85 kgN$_2$O/tHNO$_3$.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 7, which started on 03/07/2008 and went through 22/10/2008 with secondary catalyst installed and commissioned on 03/07/2008, is 2.18 kgN$_2$O/tHNO$_3$.

During the project campaign 31 445 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 7 emission reductions including information on baseline emission factor setting for the Line 7.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 7 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 7 has been carried out from 12/09/2007 through 27/03/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 7 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room B, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 7 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	**Definition**
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 7 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL - EFP) * NAP * GWPN_2O \ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

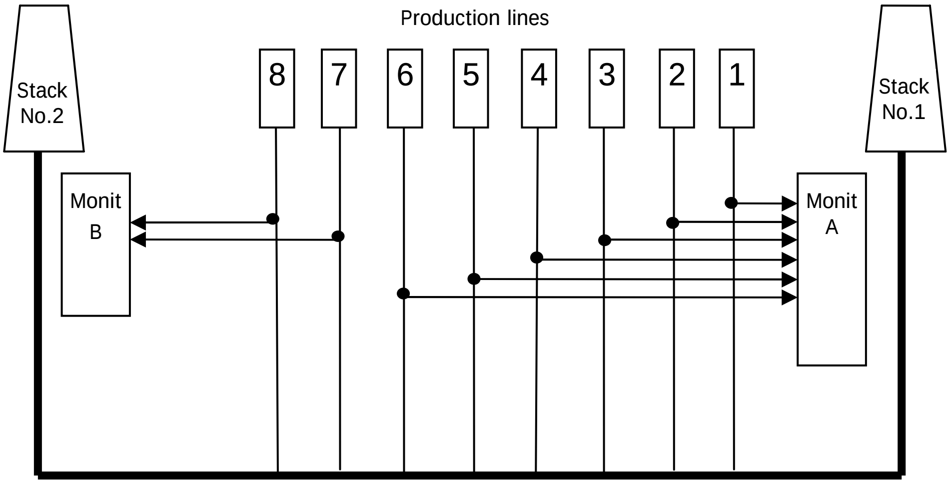
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

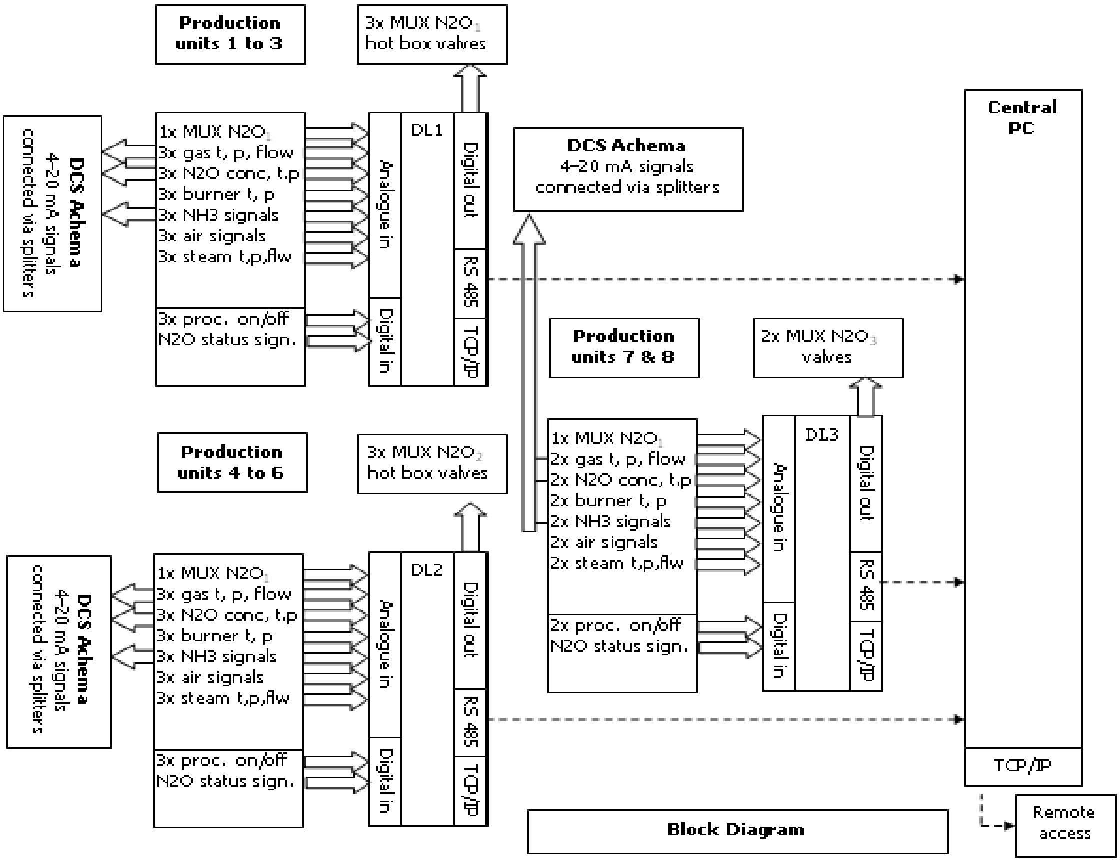
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

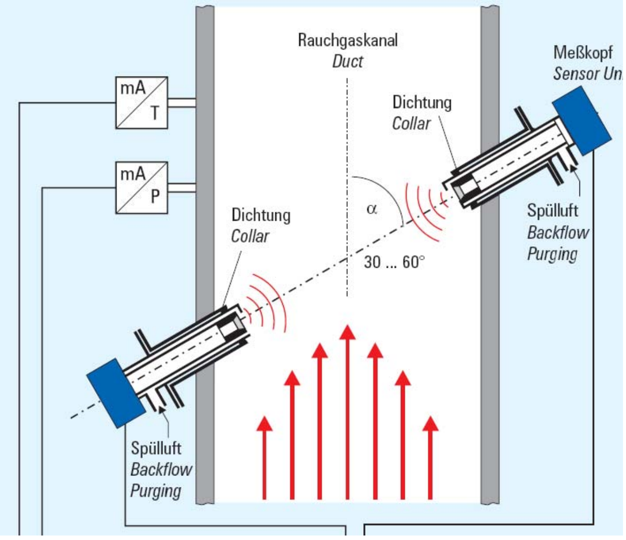
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

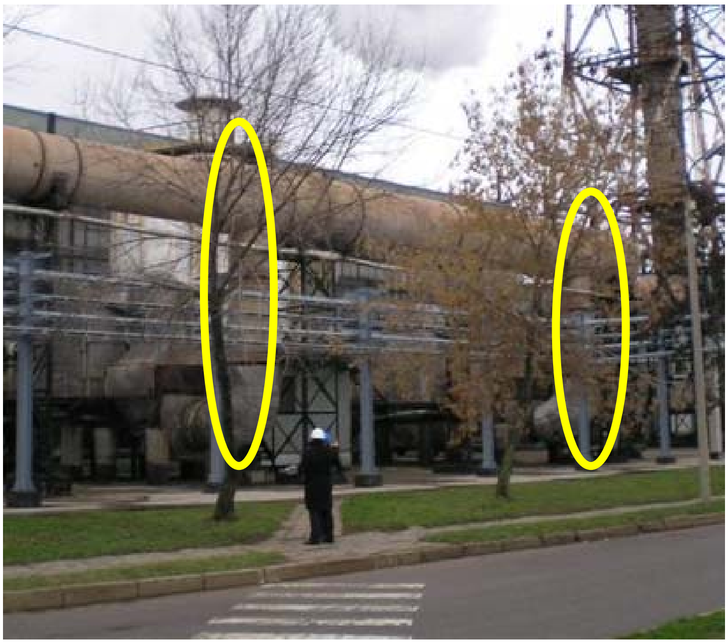
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° "knee".



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn’t allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

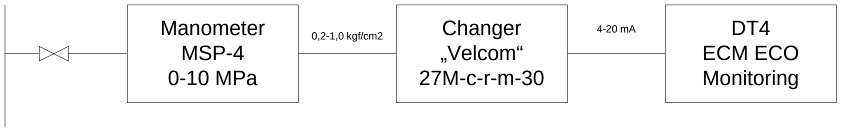
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

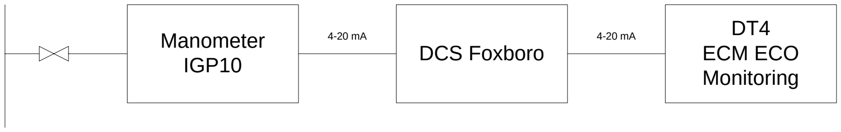
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

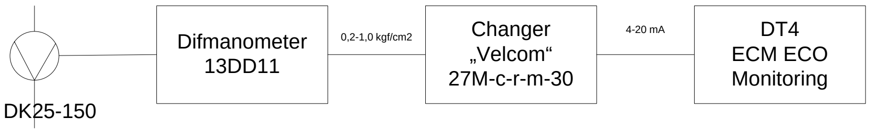
P in mixer 1-6 line



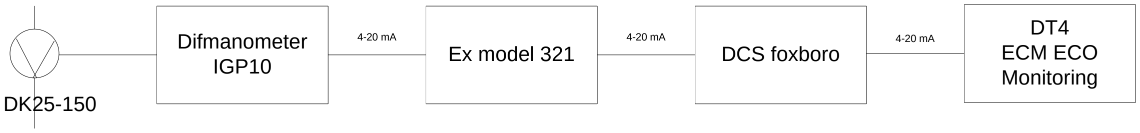
P in mixer 7-8 line

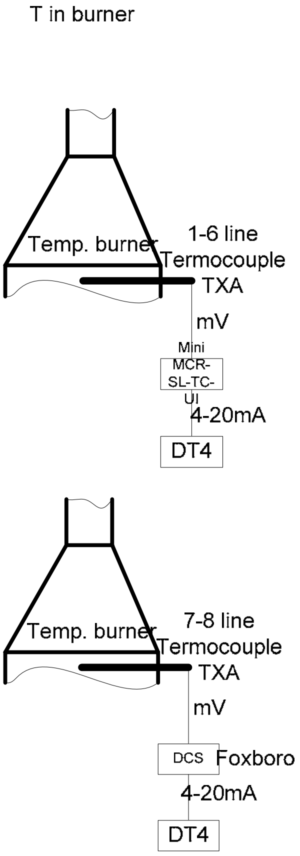


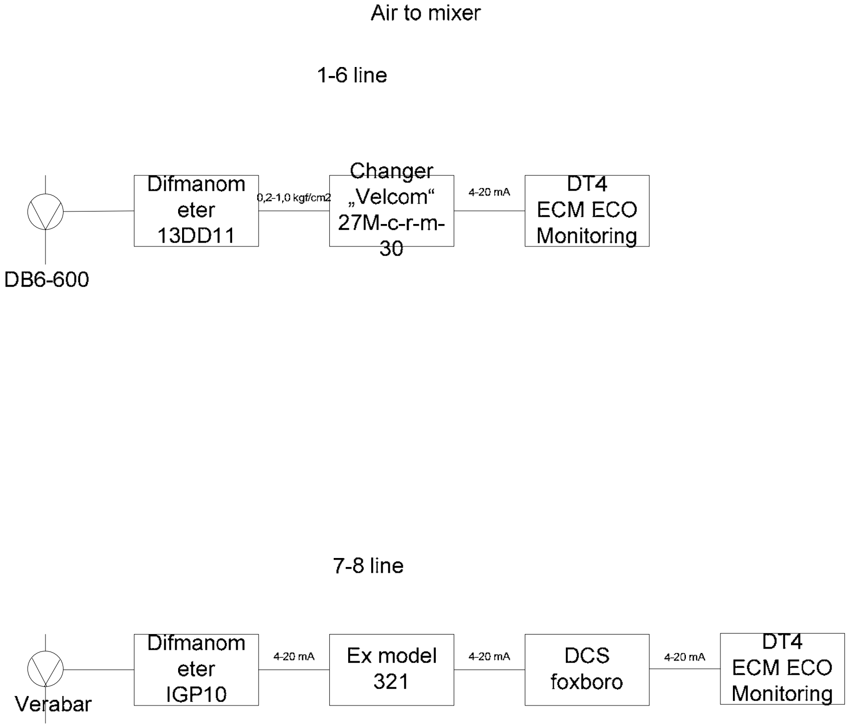
NH3 to mixer 1-6 line



NH3 to mixer 7-8 line







Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.

The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 04/05/2008 and ending on 18/08/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 64 274 $tHNO_3$ and time duration was on average 218 days. Table contains also information on suppliers of primary catalysts for the line 7.

T 2 Historic campaigns

Line	ACHEMA UKL-7	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	57 671	10 Sep 2004	16 Mar 2005	187	308	Heraeus	90/5/5
	2 t HNO3	70 015	16 Mar 2005	07 Nov 2005	236	297	Johnson Matthey	90/5/5
	3 t HNO3	55 426	08 Nov 2005	20 May 2006	193	287	Heraeus	63/4/33
	4 t HNO3	67 588	24 May 2006	04 Jan 2007	225	300	Johnson Matthey	0
	5 t HNO3	70 670	04 Jan 2007	11 Sep 2007	250	283	Umicore	95/5
Average HNO3 production	t HNO3	**64 274**			**218**	**295**		
Project Campaigns	**BL** t HNO3	55 626	12 Sep 2007	27 Mar 2008	197	282	Heraeus	63/4/33
	PL t HNO3	31 445	03 Jul 2008	22 Oct 2008	111	283	Heraeus	63/4/33

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 12/09/2007 and continued through 27/03/2008 when the 55 626 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-7	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Sep 11	2007 Sep 12	2008 Jan 07	2008 Mar 27	2008 Mar 28
Baseline Factor kgN2O/tHNO3	-	-	7.85	7.85	7.85
Production tHNO3		-	31 035	55 626	-
Per Day Production tHNO3	294.6				
Baseline less Historic Production	**(8 647.4)**				
Baseline less Historic Days	**(29.4)**				

C 1 Baseline campaign length

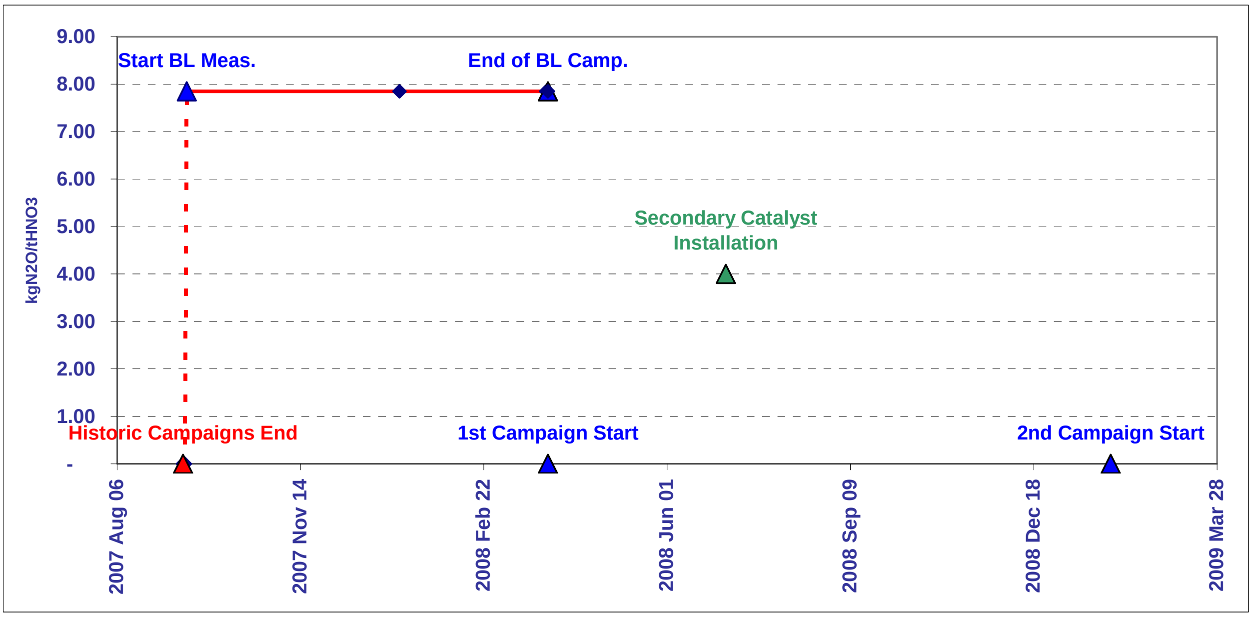


Table T 4 illustrates the calculation of the baseline emission factor on Line 7 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 12/09/2007 through 27/03/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 463 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.640%, which is further modified by an uncertainty of 0.237% due to under-sampling. As a result we have arrived to the baseline emission factor of 7.85 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 7 during the project campaign. Project campaign started on 03/07/2008 and went through 22/10/2008.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$PE_n = VSG * NCSG * 10\text{-}9 * OH \ (tN2O)$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.18 kgN2O/tHNO3.

$EF_n = PE_n / NAP_n \ (tN_2O/tHNO_3)$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure	AMS in Operation	Nitric Acid Production NCSG
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP		NAP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa	h	t/h
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	150 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 097**	4 238	2 559	4 238	4 708	4 485	4 708	4 708	3 888	2 373
as % of Dataset	*87%*	*90%*	*54%*	*90%*	*100%*	*95%*	*100%*	*100%*	*82%*	*50%*
Minimum		0.00	0	1 728	0	0	33	3		0
Maximum		16.41	1 728	112 864	6 476	18.83	915	667		16
Mean		13.13	1 075	81 347	5 394	9.92	811	590		13
Standard Deviation		4.69	414	24 945	1 806	1.37	228	112		5
Total		55 626								31 035
N2O Emissions (VSG * NCSG * OH)	358	t N2O								
Emission Factor	6.08	kgN2O / tHNO3								
Permitted Range										
Minimum					-	0	880	550		
Maximum					7 500	11.20	910	800		
Data within the permitted range										
Count	**3 121**		1 256	2 856					3 888	
as % of Operating Hours	***76%***		*31%*	*70%*					*95%*	
Minimum			733	57 328						
Maximum			1 728	99 189						
Mean			1 258	89 704						
Standard Deviation			288	5 772						
N2O Emissions (VSG * NCSG * OH)	462	t N2O								
Emission Factor	7.84	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			694	78 392						
Upper bound			1 822	101 016						
Count			1 256	2 841						
as % of Operating Hours			*31%*	*69%*						
Minimum			733	78 697						
Maximum			1 728	99 189						
Mean			1 258	89 816						
Standard Deviation			288	5 546						
N2O Emissions (VSG * NCSG * OH)	**463**	**t N2O**								
Emission Factor (EF_BL)	**7.85**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
Code	OH	NAP	NCSG	VSG	AFR	AIFR	OT	OP
Unit	h	t/h	mg N2O/Nm3	Nm3/h	Nm3/h	%	°C	kPa
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	150 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**2 301**	2 565	2 287	2 531	2 642	2 552	2 643	2 642
as % of Dataset	*86%*	*96%*	*86%*	*95%*	*99%*	*96%*	*99%*	*99%*
Minimum		-	0	145	3	0	65	6
Maximum		15.64	781	106 178	5 944	17.85	1 100	666
Mean		12.26	362	77 471	5 019	10.22	827	597
Standard Deviation		4.67	127	21 381	1 597	0.69	223	91
Total		31 445						
N2O Emissions (VSG * NCSG * OH)	65	t N2O						
Emission Factor	2.05	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			113	35 564				
Upper bound			611	119 378				
Count			1 690	2 183				
as % of Operating Hours			*73%*	*95%*				
Minimum			202	76 804				
Maximum			586	89 538				
Mean			359	82 795				
Standard Deviation			93	2 299				
N2O Emissions (VSG * NCSG * OH)	**68**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**2.18**	**kgN2O / tHNO3**						
Abatement Ratio	**72.3%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	2.18	2.18						
2	-							
Project Emission Factor (EF_P)	**2.18**	**kgN2O / tHNO3**						
Abatement Ratio	**72.3%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 7
MONITORING PERIOD:
FROM: 29/01/2009

TO: 01/11/2009

Prepared by:

VERTIS

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 7 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the second project campaign on Line 7.

The first project campaign on Line 7 started on 28/03/2008. Secondary catalyst was installed on 03/07/2008. Total quantity of emission reductions generated during the second project period from 29/01/2009 through 01/11/2009 on Line 7 is **112 470 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	9.09	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.93	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	55 626	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	55 626	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	58 897	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**112 470**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**67.8%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		29 Jan 2009	
Date To		01 Nov 2009	
Nitric Acid Production		58 897	
Emission Reduction		**112 470**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 7 during baseline measurement carried from 12/09/2007 through 27/03/2008 is 9.09 $kgN_2O/tHNO_3$.

Project emission factor during the second project campaign after installation of secondary catalysts on Line 7, which started on 29/01/2009 and went through 01/11/2009 with secondary catalyst installed and commissioned on 03/07/2008, is 2.93 $kgN_2O/tHNO_3$.

During the project campaign 58 897 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 7 emission reductions including information on baseline emission factor setting for the Line 7.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 7 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 7 has been carried out from 12/09/2007 through 27/03/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 7 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room B, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 7 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	**Definition**
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP *GWPN_2O\ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

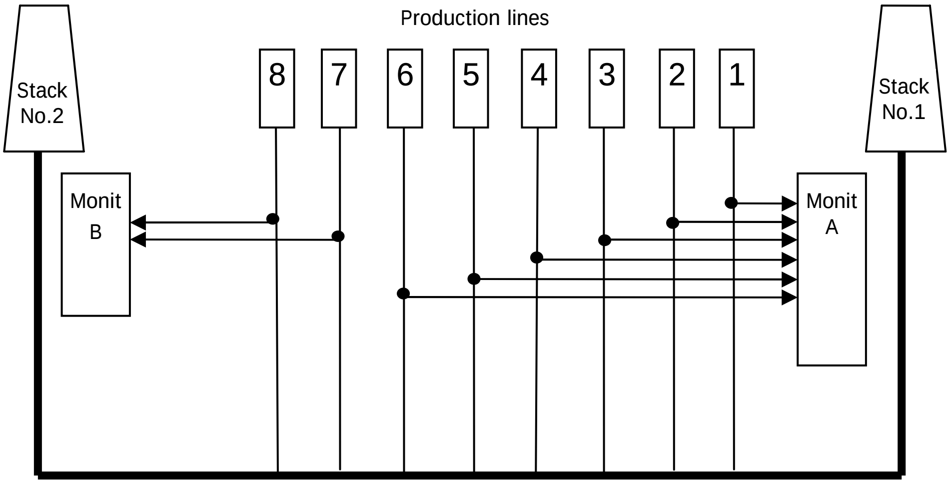
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

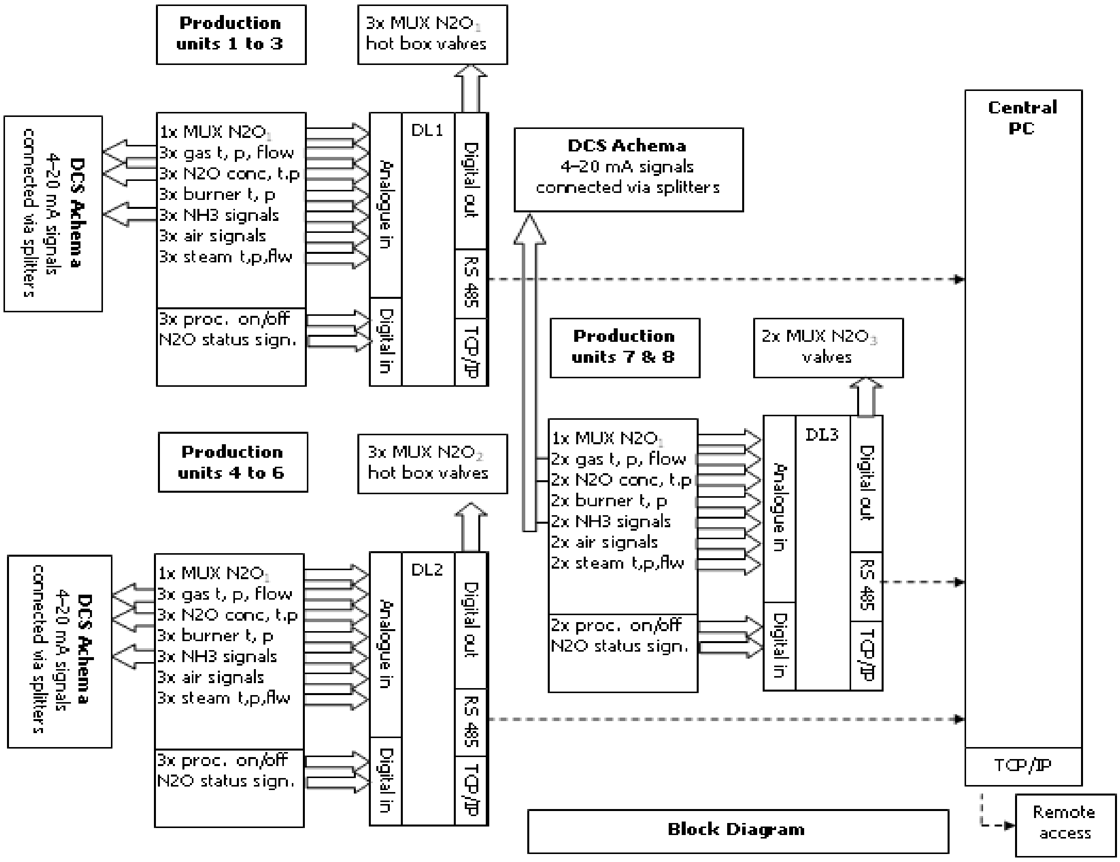
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

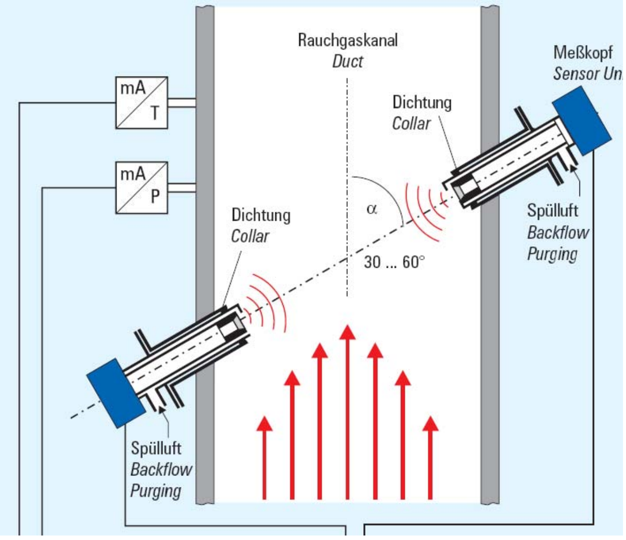
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

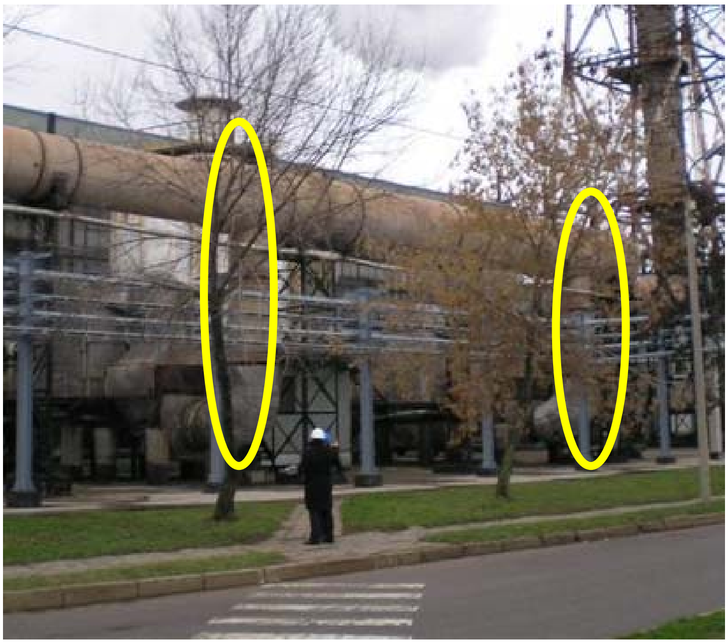
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

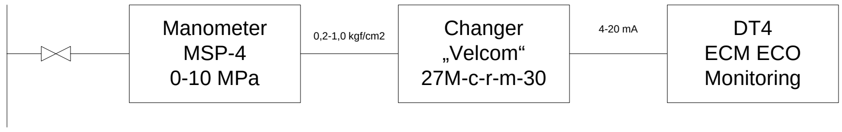
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

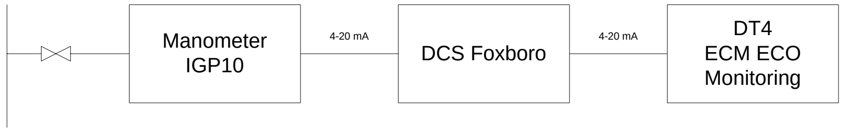
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

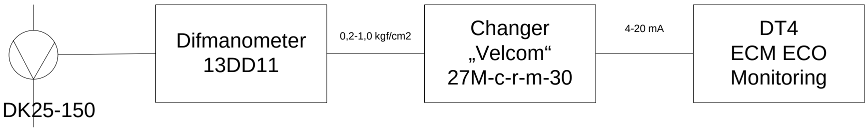
P in mixer 1-6 line



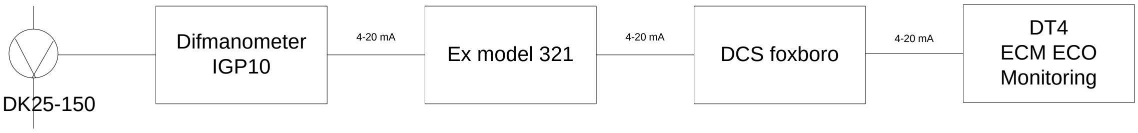
P in mixer 7-8 line



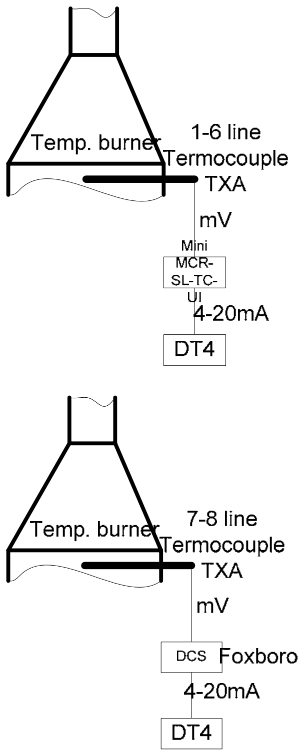
NH3 to mixer 1-6 line



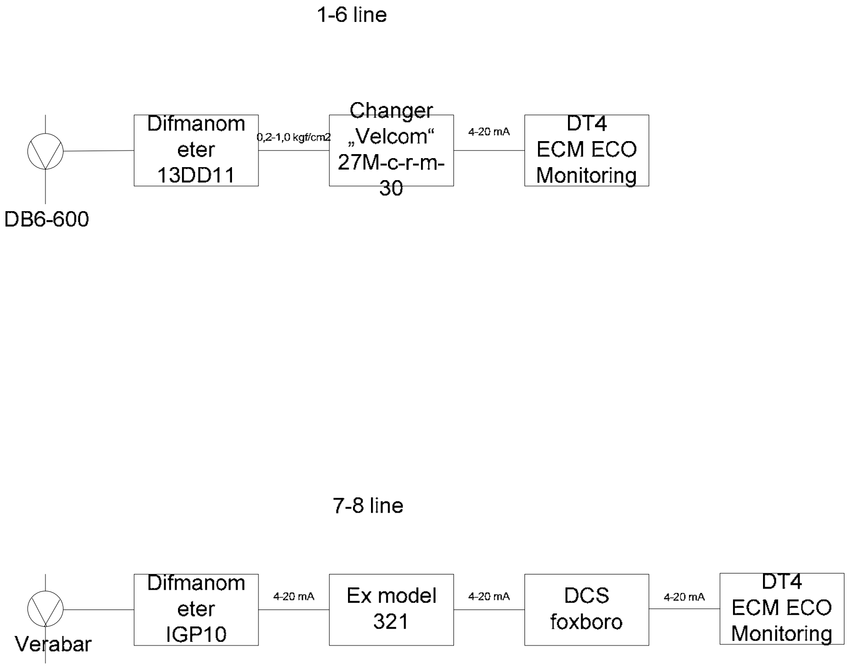
NH3 to mixer 7-8 line



T in burner



Air to mixer

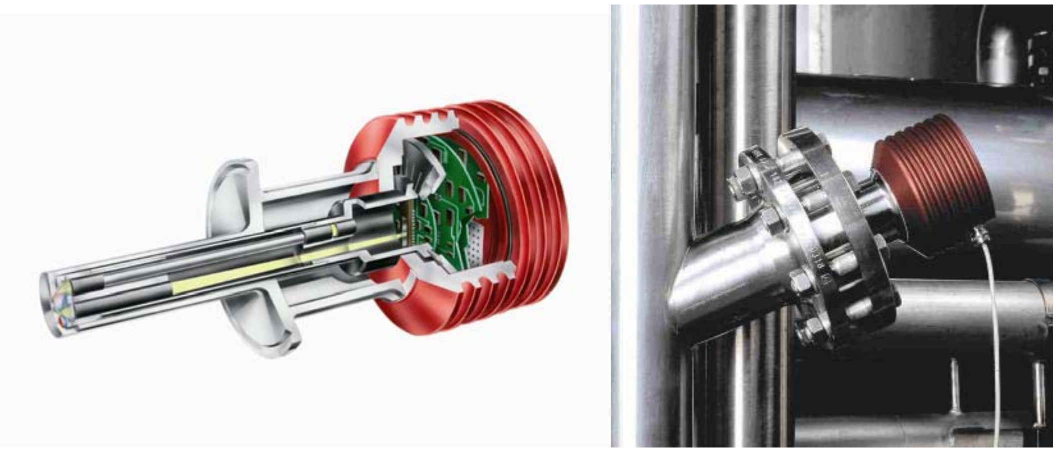


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 04/05/2008 and ending on 18/08/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 64 274 $tHNO_3$ and time duration was on average 218 days. Table contains also information on suppliers of primary catalysts for the line 7.

T 2 Historic campaigns

Line	**ACHEMA UKL-7**	**Production**	**Start**	**End**	**Days**	**Production per day**	**Primary Catalyst**	**Composition**
Historic Campaigns	**1** t HNO3	57 671	10 Sep 2004	16 Mar 2005	187	308	Heraeus	90/5/5
	2 t HNO3	70 015	16 Mar 2005	07 Nov 2005	236	297	Johnson Matthey	90/5/5
	3 t HNO3	55 426	08 Nov 2005	20 May 2006	193	287	Heraeus	63/4/33
	4 t HNO3	67 588	24 May 2006	04 Jan 2007	225	300	Johnson Matthey	n.a.
	5 t HNO3	70 670	04 Jan 2007	11 Sep 2007	250	283	Umicore	95/5
Average HNO3 production	t HNO3	**64 274**			**218**	**295**		
Project Campaigns	**BL** t HNO3	55 626	12 Sep 2007	27 Mar 2008	197	282	Heraeus	63/4/33
	PL t HNO3	58 897	29 Jan 2009	01 Nov 2009	276	213	Heraeus	63/4/33

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 12/09/2007 and continued through 27/03/2008 when the 55 626 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-7	**Historic Campaings End**	**Start of Baseline Measurement**	**End of Baseline Measurement NCSG**	**End of Baseline Measurement**	**End of Baseline Campaign**
Dates	2007 Sep 11	2007 Sep 12	2008 Mar 27	2008 Mar 27	2008 Mar 28
Baseline Factor kgN2O/tHNO3	-	-	9.09	9.09	9.09
Production tHNO3		-	55 626	55 626	-
Per Day Production tHNO3	294.6				
Baseline less Historic Production	**(8 647.4)**				
Baseline less Historic Days	**(29.4)**				

C 1 Baseline campaign length

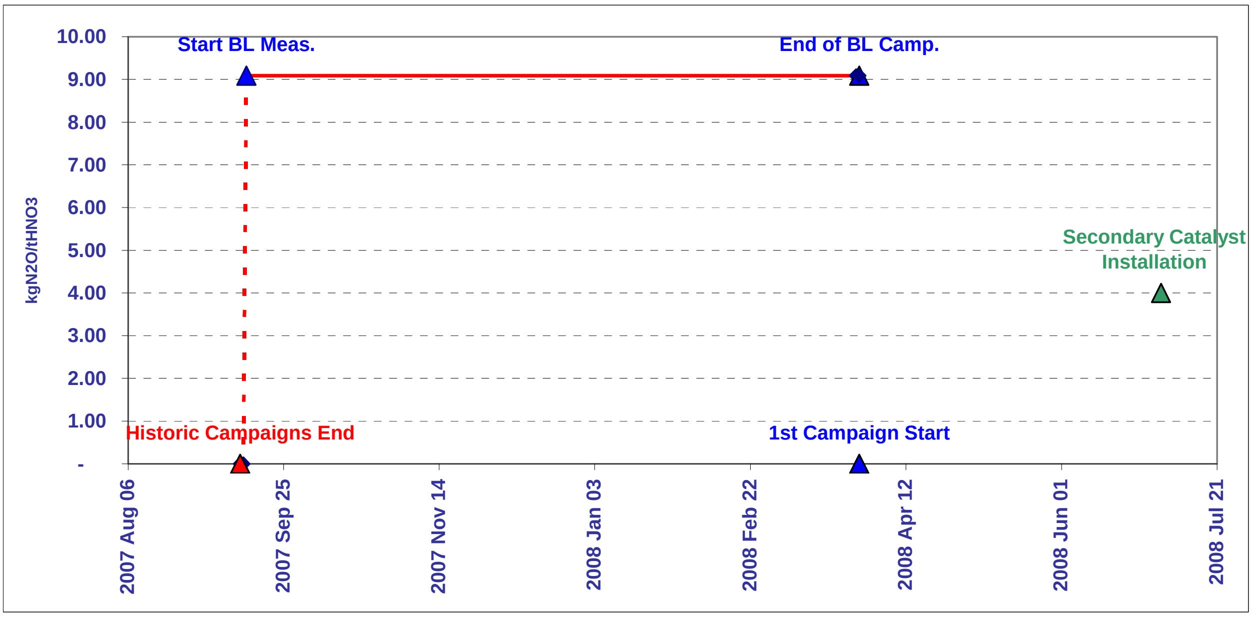


Table T 4 illustrates the calculation of the baseline emission factor on Line 7 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 12/09/2007 through 27/03/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 536 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.640%, which is further modified by an uncertainty of 0.124% due to under-sampling. As a result we have arrived to the baseline emission factor of 9.09 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 7 during the project campaign. Project campaign started on 29/01/2009 and went through 01/11/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH \ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.93 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n \ (tN_2O/tHNO_3)$$

Because the project emission factor measured was higher than the moving average EF of the campaigns on this line so far, we have used the actual project EF for the calculation of the quantity of emission reductions generated during this campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR *Parameter* *Code* *Unit*	Operating Hours OH h	Nitric Acid Production NAP t/h	N2O Concentration NCSG mg N2O/Nm3	Gas Volume Flow VSG Nm3/h	Ammonia Flow Rate AFR Nm3/h	Ammonia to Air Ratio AIFR %	Oxidation Temperature OT °C	Oxidation Pressure OP kPa	AMS in Operation h	Nitric Acid Production NCSG NAP t/h
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	150 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 097**	4 238	4 385	4 238	4 708	4 485	4 708	4 708	3 890	4 238
as % of Dataset	*87%*	*90%*	*93%*	*90%*	*100%*	*95%*	*100%*	*100%*	*82%*	*90%*
Minimum		0.00	0	1 728	0	0	33	3		0
Maximum		16.41	1 933	112 864	6 476	18.83	915	667		16
Mean		13.13	1 250	81 347	5 394	9.92	811	590		13
Standard Deviation		4.69	448	24 945	1 806	1.37	228	112		5
Total		55 626								55 626
N2O Emissions (VSG * NCSG * OH)	417	t N2O								
Emission Factor	7.07	kgN2O / tHNO3								
Permitted Range										
Minimum					-	0	880	550		
Maximum					7 500	11.20	910	800		
Data within the permitted range										
Count	**3 145**		2 856	2 856					3 890	
as % of Operating Hours	***77%***		*70%*	*70%*					*95%*	
Minimum			722	57 328						
Maximum			1 933	99 189						
Mean			1 433	89 644						
Standard Deviation			281	5 811						
N2O Emissions (VSG * NCSG * OH)	526	t N2O								
Emission Factor	8.93	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			882	78 254						
Upper bound			1 984	101 034						
Count			2 753	2 841						
as % of Operating Hours			*67%*	*69%*						
Minimum			913	78 697						
Maximum			1 933	99 189						
Mean			1 457	89 755						
Standard Deviation			257	5 588						
N2O Emissions (VSG * NCSG * OH)	**536**	**t N2O**								
Emission Factor (EF_BL)	**9.09**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	150 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 010**	6 173	3 968	3 990	6 446	5 459	6 446	6 447
as % of Dataset	*61%*	*93%*	*60%*	*60%*	*97%*	*82%*	*97%*	*97%*
Minimum		0.04	65	0	4	0	29	1
Maximum		17.60	1 250	110 628	7 323	19.23	911	651
Mean		9.54	466	94 605	4 389	10.35	612	526
Standard Deviation		6.74	118	6 110	2 319	0.69	370	155
Total		58 897						

N2O Emissions (VSG * NCSG * OH)	177	t N2O
Emission Factor	3.00	kgN2O / tHNO3

Data within the confidence interval		
95% Confidence interval		
Lower bound	235	82 630
Upper bound	697	106 579
Count	3 721	3 863
as % of Operating Hours	*93%*	*96%*
Minimum	262	82 642
Maximum	696	105 673
Mean	452	95 236
Standard Deviation	97	3 705

N2O Emissions (VSG * NCSG * OH)	**173**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.93**	**kgN2O / tHNO3**
Abatement Ratio	**67.8%**	

Moving Average Emission Factor Correction		**Actual Factors**	**Moving Average Rule**
	1	2.18	2.18
	2	2.93	2.93

Project Emission Factor (EF_P)	**2.93**	**kgN2O / tHNO3**
Abatement Ratio	**67.8%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 8
MONITORING PERIOD:
FROM: 11/06/2008

TO: 26/11/2008

Prepared by:

VERTIS

VERTIS FINANCE

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 8 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the first project campaign on Line 8.

The first project campaign on Line 8 started on 17/04/2008. Secondary catalyst was installed on 11/06/2008. Total quantity of emission reductions generated during the first project period from 11/06/2008 through 26/11/2008 on Line 8 is **31 654 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	6.61	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	4.35	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	63 396	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	45 057	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	45 181	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**31 654**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**34.2%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	11 Jun 2008		
Date To	26 Nov 2008		
Nitric Acid Production	45 181		
Emission Reduction	**31 654**		
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 8 during baseline measurement carried from 02/09/2007 through 15/04/2008 is 6.61 kgN_2O/tHNO_3.

Project emission factor during the first project campaign after installation of secondary catalysts on Line 8, which started on 11/06/2008 and went through 26/11/2008 with secondary catalyst installed and commissioned on 11/06/2008, is 4.35 kgN_2O/tHNO_3.

During the project campaign 45 181 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 8 emission reductions including information on baseline emission factor setting for the Line 8.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 8 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 8 has been carried out from 02/09/2007 through 15/04/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 8 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room B, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 8 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	Definition
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because this campaign was first project campaign on Line 8 there has been no moving average emission factor established yet for this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL – EFP) * NAP * GWPN_2O \ (tCO_2e)$$

Where:

Variable	**Definition**
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

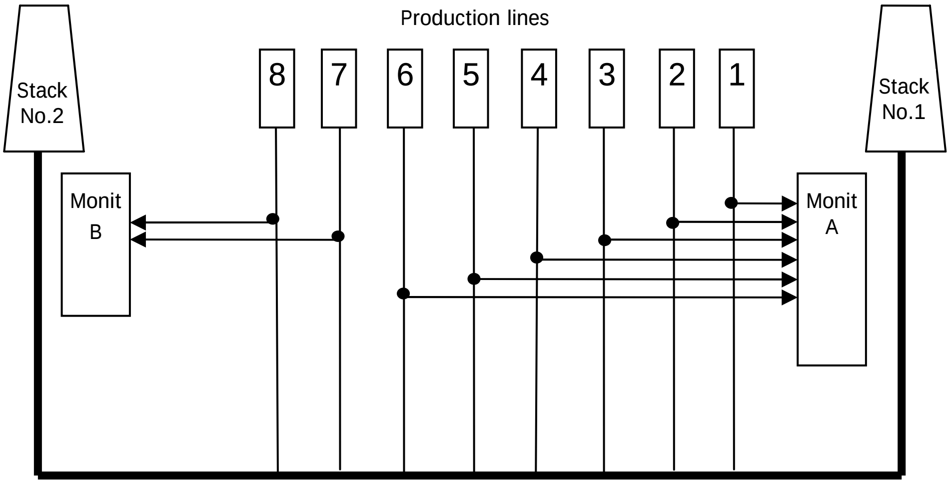
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

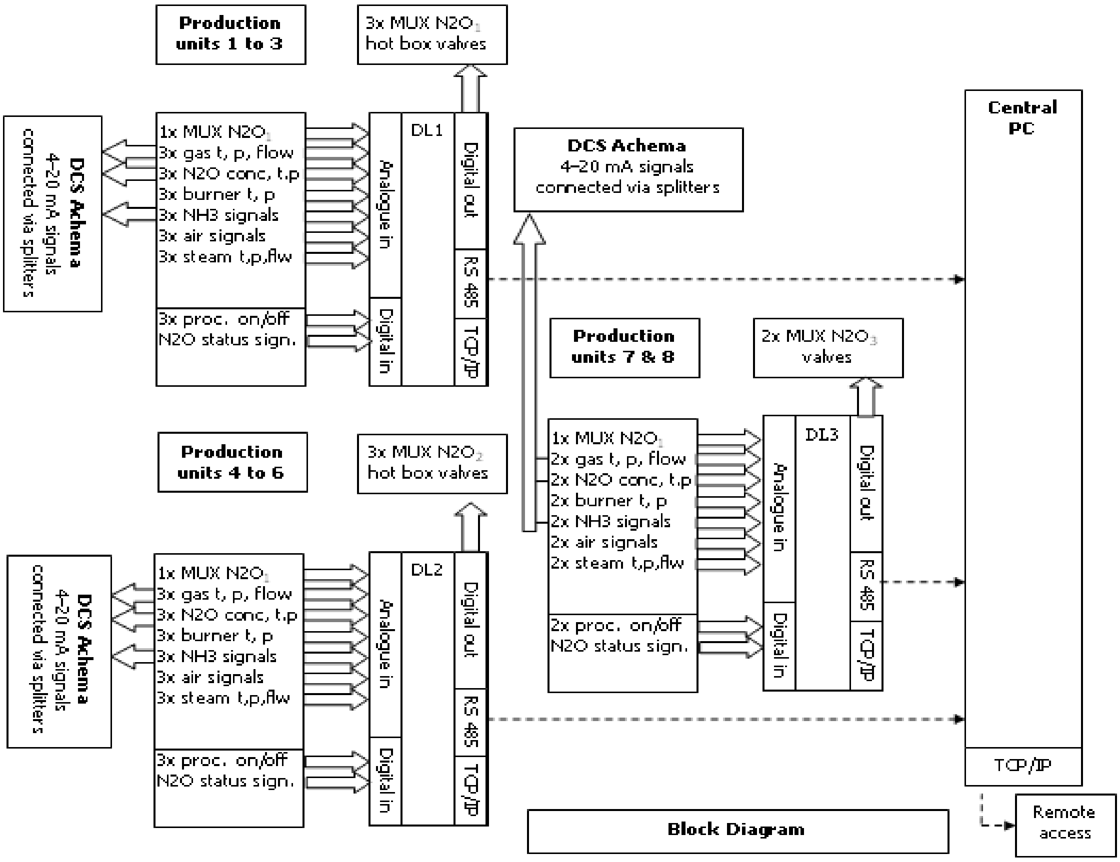
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

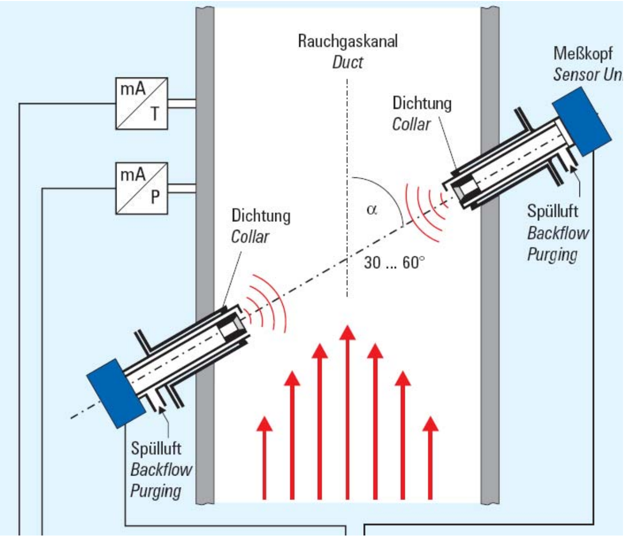
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

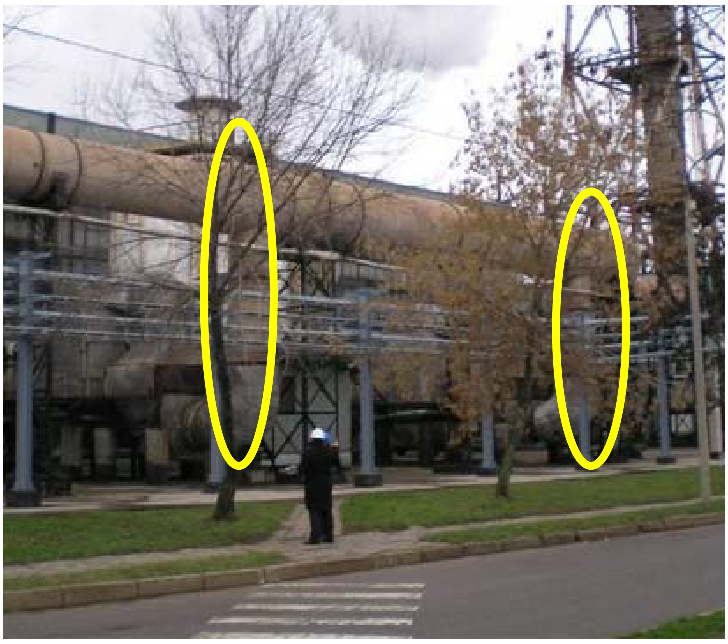
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° “knee”.



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

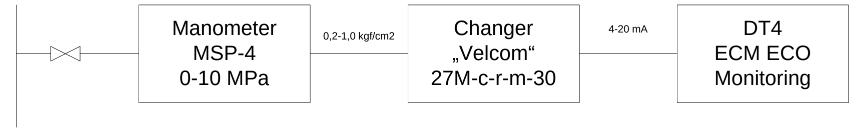
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

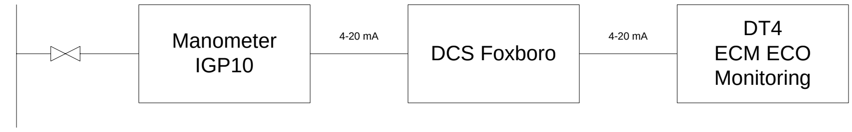
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

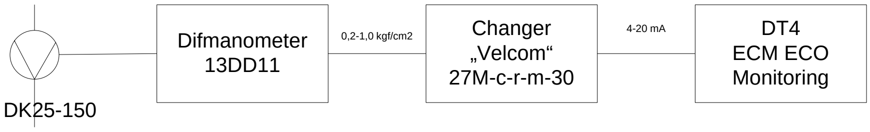
P in mixer 1-6 line



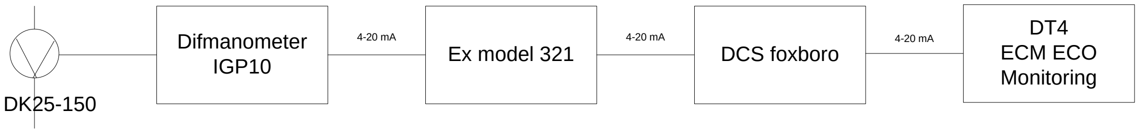
P in mixer 7-8 line



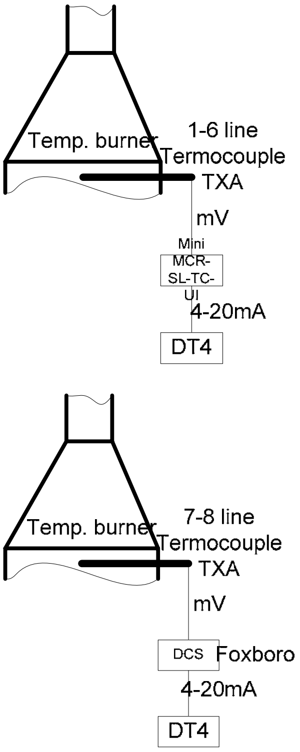
NH3 to mixer 1-6 line



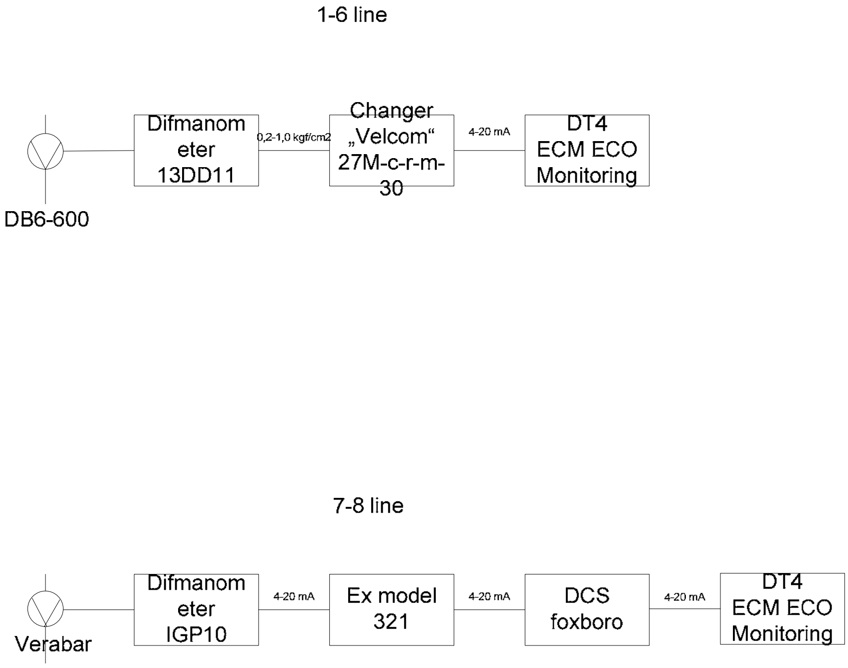
NH3 to mixer 7-8 line



T in burner



Air to mixer

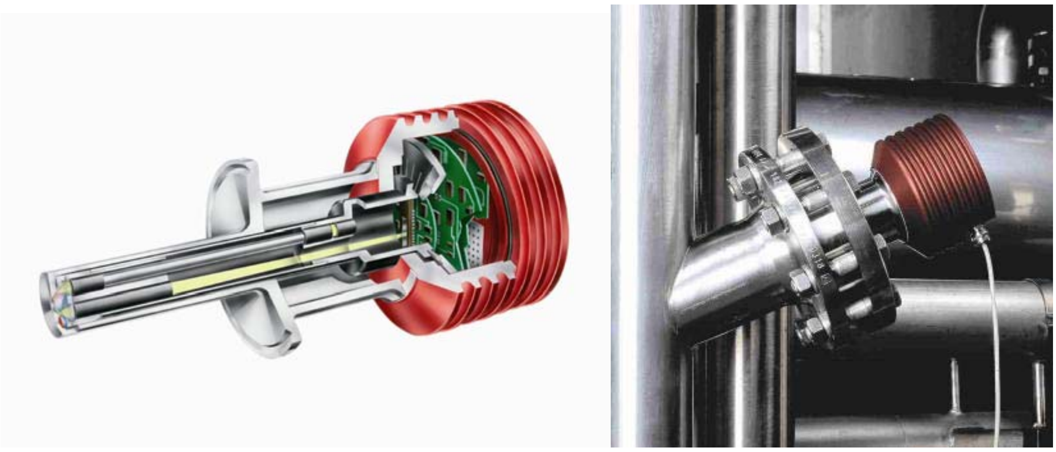


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.



The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 05/10/2007 and ending on 20/10/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: “The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis.”

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y= a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely “a” and “b” applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo=Xn=X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 63 620 $tHNO_3$ and time duration was on average 228 days. Table contains also information on suppliers of primary catalysts for the line 8.

T 2 Historic campaigns

Line	ACHEMA UKL-8	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	-	00 Jan 1900	00 Jan 1900	-	n/a	0	0
	2 t HNO3	62 575	10 Dec 2004	17 Aug 2005	250	250	Heraeus	90/5/5
	3 t HNO3	63 418	02 Nov 2005	14 Jun 2006	224	283	Umicore	95/5
	4 t HNO3	63 138	15 Jun 2006	01 Feb 2007	231	273	Johnson Matthey	n.a.
	5 t HNO3	65 347	02 Feb 2007	28 Aug 2007	207	316	Johnson Matthey	n.a.
Average HNO3 production	t HNO3	**63 620**			**228**	**279**		
Project Campaigns	**BL** t HNO3	63 396	02 Sep 2007	15 Apr 2008	226	281	Umicore	95/5
	PL t HNO3	45 181	11 Jun 2008	26 Nov 2008	168	269	Umicore	95/5

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 02/09/2007 and continued through 15/04/2008 when the 63 396 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-8	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Aug 28	2007 Sep 02	2008 Feb 20	2008 Apr 15	2008 Apr 16
Baseline Factor kgN2O/tHNO3	-	-	6.61	6.61	6.61
Production tHNO3		-	45 057	63 396	-
Per Day Production tHNO3	279.0				
Baseline less Historic Production	**(223.5)**				
Baseline less Historic Days	**(0.8)**				

C 1 Baseline campaign length

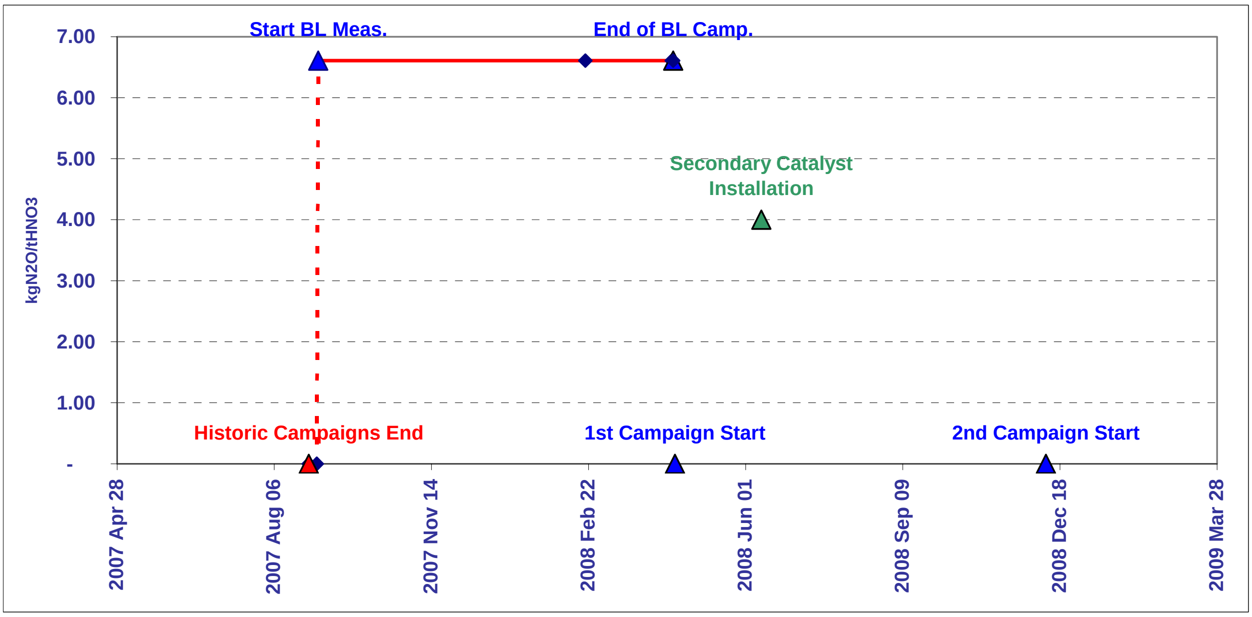


Table T 4 illustrates the calculation of the baseline emission factor on Line 8 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 02/09/2007 through 15/04/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 445 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.890%, which is further modified by an uncertainty of 0.105% due to under-sampling. As a result we have arrived to the baseline emission factor of 6.61 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 8 during the project campaign. Project campaign started on 11/06/2008 and went through 26/11/2008.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH\ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 4.35 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n\ (tN_2O/tHNO_3)$$

This emission factor has been used in further calculation of emission reductions. Neither moving average emission factor nor minimum emission factor was established, since it was the first project campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**	**AMS in Operation**	**Nitric Acid Production NCSG**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 696**	4 931	3 483	4 575	4 964	4 640	5 402	5 402	4 129	3 629
as % of Dataset	*87%*	*91%*	*64%*	*84%*	*92%*	*86%*	*100%*	*100%*	*76%*	*67%*
Minimum		0.00	0	4	0	0	27	5		0
Maximum		24.99	1 917	103 514	6 796	14.80	912	654		25
Mean		12.86	1 032	78 890	5 617	10.08	801	564		12
Standard Deviation		5.07	446	16 806	1 475	0.90	246	117		5
Total		63 396								45 057
N2O Emissions (VSG * NCSG * OH)	382	t N2O								
Emission Factor	5.67	kgN2O / tHNO3								
Permitted Range										
Minimum					-	0	880	550		
Maximum					7 500	11.20	910	800		
Data within the permitted range										
Count	**4 396**		2 745	4 118					4 129	
as % of Operating Hours	***94%***		*58%*	*88%*					*88%*	
Minimum			781	-						
Maximum			1 732	96 663						
Mean			1 193	77 880						
Standard Deviation			198	16 333						
N2O Emissions (VSG * NCSG * OH)	436	t N2O								
Emission Factor	6.48	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			806	45 867						
Upper bound			1 581	109 894						
Count			2 570	3 949						
as % of Operating Hours			*55%*	*84%*						
Minimum			828	75 503						
Maximum			1 580	96 663						
Mean			1 167	81 213						
Standard Deviation			169	2 729						
N2O Emissions (VSG * NCSG * OH)	**445**	**t N2O**								
Emission Factor (EF_BL)	**6.61**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR

Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**3 176**	3 927	3 612	3 516	3 283	3 183	4 010	4 010
as % of Dataset	*79%*	*97%*	*90%*	*87%*	*81%*	*79%*	*99%*	*99%*
Minimum		-	0	1	23	0	37	6
Maximum		16.48	1 886	93 304	7 764	18.38	902	620
Mean		11.51	639	71 903	5 792	10.37	747	540
Standard Deviation		5.94	317	22 429	379	0.36	301	124
Total		45 181						
N2O Emissions (VSG * NCSG * OH)	146	t N2O						
Emission Factor	3.23	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			17	27 943				
Upper bound			1 260	115 863				
Count			2 482	3 078				
as % of Operating Hours			*78%*	*97%*				
Minimum			368	72 761				
Maximum			1 088	89 002				
Mean			785	78 782				
Standard Deviation			72	1 778				
N2O Emissions (VSG * NCSG * OH)	**197**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**4.35**	**kgN2O / tHNO3**						
Abatement Ratio	**34.2%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	4.35	4.35						
2	-							
Project Emission Factor (EF_P)	**4.35**	**kgN2O / tHNO3**						
Abatement Ratio	**34.2%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 8
MONITORING PERIOD:
FROM: 09/12/2008

TO: 20/11/2009

Prepared by:

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Table of Contents

1. EXECUTIVE SUMMARY

This monitoring report determines baseline emission factor for the Line 8 of ACHEMA UKL nitric acid plant and quantity of emission reduction generated during the second project campaign on Line 8.

The first project campaign on Line 8 started on 17/04/2008. Secondary catalyst was installed on 11/06/2008. Total quantity of emission reductions generated during the second project period from 09/12/2008 through 20/11/2009 on Line 8 is **48 892 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	6.96	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	4.30	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	63 577	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	52 603	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	59 291	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**48 892**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**38.9%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From	09 Dec 2008	01 Jan 2009	
Date To	31 Dec 2008	20 Nov 2009	
Nitric Acid Production	5 513	53 779	
Emission Reduction	**4 546**	**44 346**	
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 8 during baseline measurement carried from 01/09/2007 through 15/04/2008 is 6.96 kgN_2O/tHNO_3.

Project emission factor during the second project campaign after installation of secondary catalysts on Line 8, which started on 09/12/2008 and went through 20/11/2009 with secondary catalyst installed and commissioned on 11/06/2008, is 4.30 kgN_2O/tHNO_3.

During the project campaign 59 291 tonnes of nitric acid was produced.

2. DESCRIPTION OF THE PROJECT ACTIVITY

Purpose of the Project (the “Project”) is the reduction of nitrous oxide (N_2O) emissions from nitric acid production Lines at the UKL-7 nitric acid plant of AB Achema (“Achema” or “the Company”). The Company is situated in Jonava, Lithuania.

Achema has installed and operates secondary N_2O reduction catalysts underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burners of the UKL-7 nitric acid plant.

This monitoring report contains information on Line 8 emission reductions including information on baseline emission factor setting for the Line 8.

The separate treatment of nitric acid lines and overlapping of the monitoring periods are allowed by the clarification issued Joint Implementation Supervisory Committee: “CLARIFICATION REGARDING OVERLAPPING MONITORING PERIODS UNDER THE VERIFICATION PROCEDURE UNDER THE JOINT IMPLEMENTATION SUPERVISORY COMMITTEE”. The Project meets all the requirements set out by the clarification:

1. The Project is composed of clearly identifiable components for which emission reductions or enhancements of removals are calculated independently; and

2. Monitoring is performed independently for each of these components, i.e. the data/parameters monitored for one component are not dependent on/effect data/parameters (to be) monitored for another component; and

3. The monitoring plan ensures that monitoring is performed for all components and that in these cases all the requirements of the JI guidelines and further guidance by the JISC regarding monitoring are met.

3. BASELINE SETTING

Baseline emission factor for line 8 has been established on the Line-specific basis. Campaign used for baseline measurements on the line 8 has been carried out from 01/09/2007 through 15/04/2008.

N_2O concentration and gas volume flow are monitored by monitoring system complying with requirements of the European Norm 14181.

Monitoring system provides separate readings for N_2O concentration and gas flow volume for every hour of operation as an average of the measured values for the previous 60 minutes.

Measurement results can be distorted before and after periods of downtime or malfunction of the monitoring system and can lead to mavericks. To eliminate such extremes and to ensure a conservative approach, the following statistical evaluation is applied to the complete data series of N_2O concentration as well as to the data series for gas volume flow. The statistical procedure is applied to data obtained after eliminating data measured for periods where the plant operated outside the permitted ranges:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

The average mass of N_2O emissions per hour is estimated as product of the NCSG and VSG. The N_2O emissions per campaign are estimates product of N_2O emission per hour and the total number of complete hours of operation of the campaign using the following equation:

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC} \ (tN_2O)$$

The Line specific baseline emissions factor representing the average N_2O emissions per tonne of nitric acid over one full campaign is derived by dividing the total mass of N_2O emissions by the total output of 100% concentrated nitric acid during baseline campaign.

The overall uncertainty of the monitoring system has been determined by the QAL2 report and the measurement error is expressed as a percentage (UNC). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EFBL) has been then be reduced by the percentage error as follows:

$$EF_{BL} = (BE_{BC} / NAP_{BC}) \ (1 – UNC/100) \ (tN_2O/tHNO_3)$$

where:

Variable	Definition
EF_{BL}	Baseline N_2O emissions factor ($tN_2O/tHNO_3$)
BE_{BC}	Total N_2O emissions during the baseline campaign (tN_2O)
$NCSG_{BC}$	Mean concentration of N_2O in the stack gas during the baseline campaign (mgN_2O/m^3)
OH_{BC}	Operating hours of the baseline campaign (h)
VSG_{BC}	Mean gas volume flow rate at the stack in the baseline measurement period (m^3/h)
NAP_{BC}	Nitric acid production during the baseline campaign ($tHNO_3$)
UNC	Overall uncertainty of the monitoring system (%), calculated as the combined uncertainty of the applied monitoring equipment.

3.1 Measurement procedure for N_2O concentration and tail gas volume flow

3.1.1 Tail gas N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from the Line 8 tail gas duct at sampling point located after expansion turbine and transported by sample Line to the Monitoring room B, where the analyzer is located.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis.

N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production lines. N_2O concentration is measured by 3 concentration meters on a switched basis.

N_2O concentration measured data are sent from the analyzer on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.1.2 Tail gas flow rate, pressure and temperature

Tail gas flow, pressure and temperature is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section. Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

3.2 Permitted range of operating conditions of the nitric acid plant

Under certain circumstances, the operating conditions during the measurement period used to determine baseline N_2O emission factor may be outside the permitted range or limit corresponding to normal operating conditions. N_2O baseline data measured during hours

where the operating conditions were outside the permitted range have been eliminated from the calculation of the baseline emissions factor.

Normal ranges for operating conditions have been determined for the following parameters:

oxidation temperature;
oxidation pressure;
ammonia gas flow rate,
air input flow rate.

The permitted range for these parameters has been established using the plant operation manual, as described in the PDD..

3.3 Historic Campaign Length

The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns used to define operating condition (the previous five campaigns), has not been used as a cap on the length of the baseline campaign because of shorter project campaign.

4. PROJECT EMISSIONS

During the first project campaign on line 8 the tail gas volume flow in the stack of the nitric acid plant as well as N_2O concentration have been measured on the continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N_2O concentration and gas flow volume for every hour of operation. Same statistical evaluation that was applied to the baseline data series has been applied to the project data series:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

$$PE_n = VSG * NCSG * 10^{-9} * OH \ (tN_2O)$$

where:

Variable	**Definition**
VSG	Mean stack gas volume flow rate for the project campaign (m^3/h)
NCSG	Mean concentration of N_2O in the stack gas for the project campaign (mgN_2O/m^3)
PE_n	Total N_2O emissions of the n^{th} project campaign (tN_2O)
OH	Is the number of hours of operation in the specific monitoring period (h)

4.1.2 Derivation of a moving average emission factor

Because the project emission factor measured was lower than the moving average EF of the campaigns on this line so far, we have used the average EF for the calculation of the quantity of emission reductions generated during this campaign.

4.2 Minimum project emission factor

The minimum average emission factor established factor will be established after 10th project campaign.

4.3 Project Campaign Length

Project campaign production of nitric acid has been below defined nameplate capacity and thus all NAP produced from date of installation of secondary catalysts has been used for calculation of emission reductions.

4.4 Leakage

No leakage calculation is required.

4.5 Emission reductions

The emission reductions for the project activity during this campaign have been determined by deducting the campaign-specific emission factor from the baseline emission factor and multiplying the result by the production output of 100% concentrated nitric acid over the campaign period and the GWP of N_2O:

$$ER = (EFBL - EFP) * NAP * GWPN_2O \ (tCO_2e)$$

Where:

Variable	Definition
ER	Emission reductions of the project for the specific campaign (tCO_2e)
NAP	Nitric acid production for the project campaign ($tHNO_3$). The maximum value of NAP shall not exceed the design capacity.
EFBL	Baseline emissions factor ($tN_2O/tHNO_3$)
EFP	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

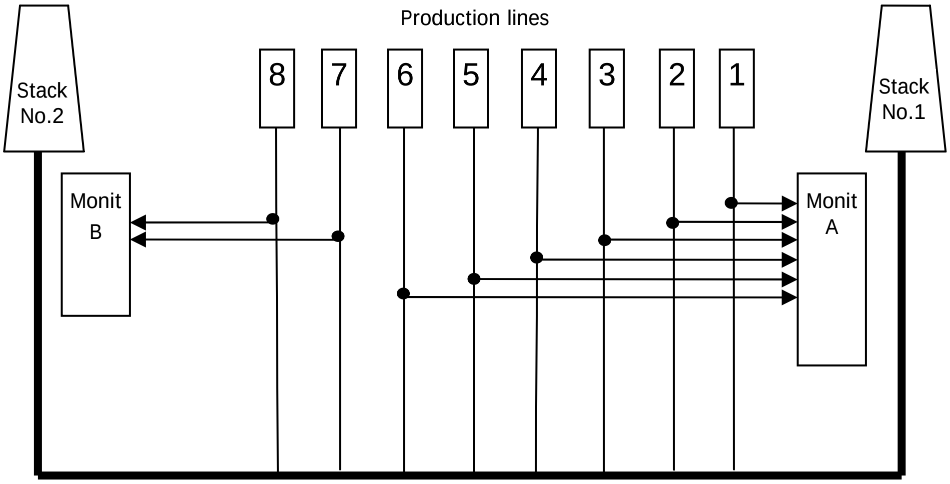
5. MONITORING PLAN

Purpose of the monitoring plan

The purpose of the monitoring plan is to describe the system used to monitor emissions of N_2O from the plant in such a way that is compliant with the prescriptions of the AM0034/Version 02.

Plant description

The UKL-7 nitric acid plant comprises 8 production Lines numbered from 1 through 8, each with its own burner, absorption column and expansion turbine. Each production Line represents a separate nitric acid production unit independent from each other. The tail gasses from each Line are after expansion turbines led to a common stack bus and vented through two interconnected stacks.



Primary catalyst is changed at different times thus it is necessary to measure the emissions from each Line individually. This means that eight separate sets of monitoring equipment are installed to measure tail gas flow, nitric acid production, nitric acid concentration, and the operating conditions. N_2O concentration in the tail gas is measured by 3 switched concentration meters.

Monitoring System architecture

Methodology AM0034/Version 02 requires installation of an N_2O monitoring system that includes both a gas volume flow meter to determine the tail gas mass volume flow and an infrared gas analyser to determine the concentration of N_2O.

But tail gas N_2O concentration meter and tail gas volume flow meter alone are not sufficient for a JI project purposes. In order of being able to calculate the baseline emission factor expressed as tonnage of N_2O in t CO_2e per 1 tonne of HNO_3 (100%), it is necessary to include also HNO_3 measurement, and in order of being able to document normal operating conditions it is necessary to include also operating conditions measurement.

Because of this we use the term Monitoring System (MS) to describe entire monitoring system directly and indirectly used for the JI purposes, while Automated Measurement System (AMS) covers only N_2O emissions and tail gas mass volume part of the MS.

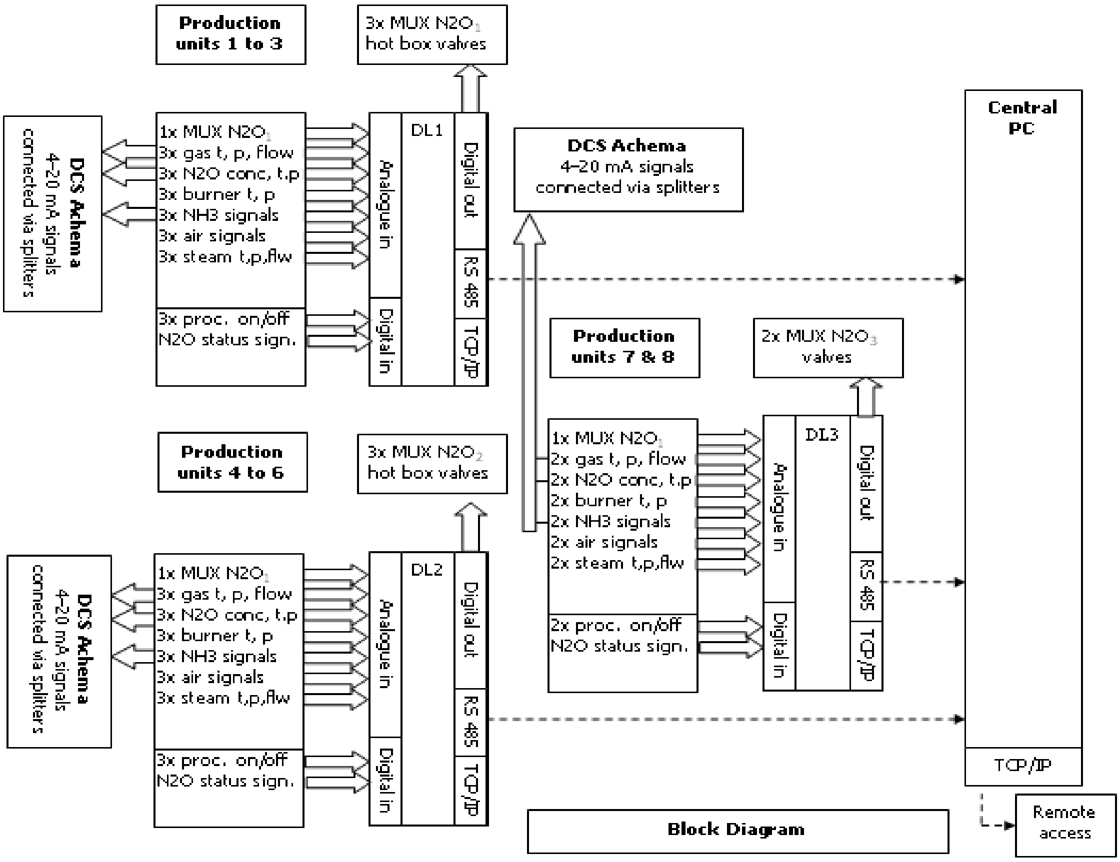
Monitoring System (MS) for purpose of this monitoring plan means:

monitoring system measuring operational conditions;
Ammonia volume flow
Ammonia temperature
Ammonia pressure
Primary air volume flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

nitric acid 100% concentrate production;
Nitric acid concentration
Nitric acid flow
Nitric acid temperature

and newly installed measurement devices for measurement of N2O concentration and tail gas flow, temperature and pressure (AMS)
N_2O concentration in the stack
Stack volume flow rate
Stack gas temperature
Stack gas pressure

Incorporation of the AMS into the MS by interfacing already existing and newly installed measurement devices is documented by the diagram below.



N_2O automated measurement system

Main purpose of the N_2O automated measurement system (AMS) is to measure total mass of N_2O emitted during particular campaigns (both baseline and project). In order of calculation of total mass of N_2O emitted during particular campaign it is necessary to measure on an extractive basis the N_2O concentration in a tail gas and on a non-extractive basis tail gas flow, pressure and temperature.

N_2O concentration

N_2O concentration is measured by extractive measurement system. Tail gas samples are taken from respective tail gas ducts at sampling points located after expansion turbines and transported by heated sample lines to the Monitoring room A located next to the main production hall. This applies to 2 concentration meters measuring lines 1-3 and lines 4-6. lines 7-8 are measured by third concentration meter located at the other side of the production hall (Monitoring room B) physically closer to respective production lines 7 and 8.

Tail gas samples are filtered and conditioned in the condensation dryer (4°C), so N_2O concentration is measured on a dry basis. Correction of dry basis ppmV value to real wet tail

gas conditions based on steam flow injected into the system is part of both - the project emissions calculations and baseline emission factor calculations.

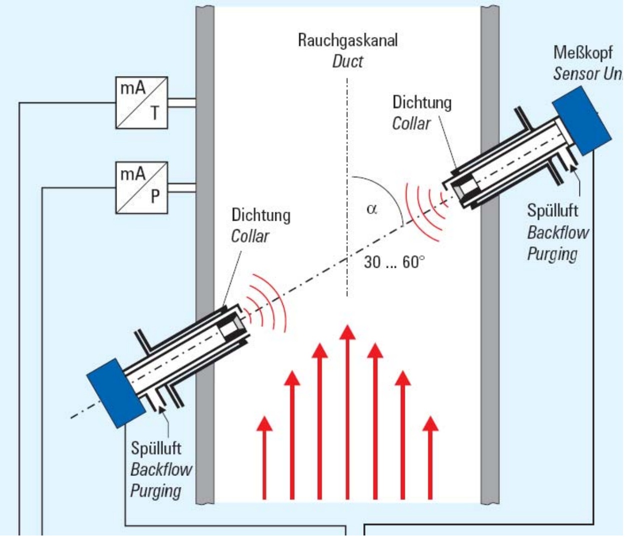
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

Recently there are 8 production Lines. N_2O concentration is measured by 3 concentration meters on a switched basis. Tail gas samples are automatically switched. Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

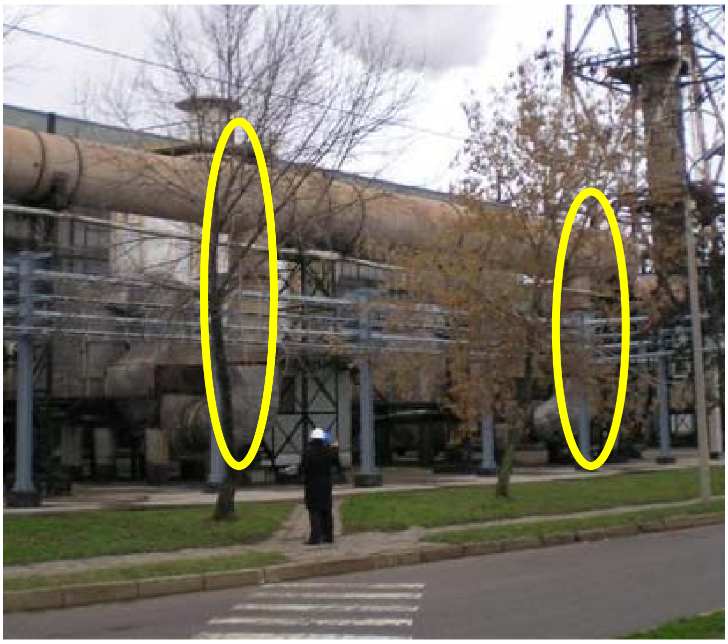
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas flow, pressure and temperature

Tail gas flow is measured by ultrasonic Durag DF-L 200 flowmeters based on ultrasonic pulse fly time across the entire duct cross-section.



The tail gas ducts do not allow any optimum location to perform the flow monitoring. The only possible location is the quite short vertical tube behind the 90° "knee".



Since the flow is not really laminar, a classical Pitot tube one point solution wouldn't allow good results. The ultrasonic system is under these conditions superior to differential pressure. Cross duct monitoring is more accurate than a couple of discrete point averaged pressure.

Tail gas flow, pressure and temperature measured data are sent from the flow meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

Tail gas steam injection elimination

Steam injected into the Achema UKL-7 tail gas for purpose of increasing the turbine output is eliminated from the tail gas mass flow calculation by following formulae:

flow - STVF=L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325)*((100-L1_Humi)/100)

where Humi (water content)=

(L1_Flow_steam*1.2436)/(L1_Flow_N2O*(273.15/(273.15+L1_Temp))*(L1_Press/101.325))*100+0.6

where 1.2436 is the conversion factor from kg/h to Nm3/h and 0.6% is a value of humidity present in a flue gas permanently without steam injection

The Flow_steam parameter necessary for calculation of the water content in the dataloggers is provided in the kg/h unit.

Achema measures steam flow in kg/h using formula Q=C*sqrt(dp) , where C is flow constant which is already integrated using an orifice plate sizing program. The orifice plate calculation for injection steam has been done for temperature 250˚C and pressure 6 bar.

Flow steam in kg/h measured by using the constant steam T and P values is then recalculated to actual steam T and P values valid for relevant hours and as result the STVF value cleaned of the steam injected is used for further emission reductions calculations.

EN14181 compliance

As required by the AM0034/Version 02 methodology the N_2O automated measurement system (AMS) complies with requirements of the technical norm EN14181. N_2O AMS consists from the N_2O concentration meter and integrated flowmeter (F, T, P). Both measurement devices are QAL1 certified (concentration meter for the N_2O measurand specifically) and after full commissioning of the monitoring system there was the QAL2 test carried out by an independent laboratory certified according to ISO17025.

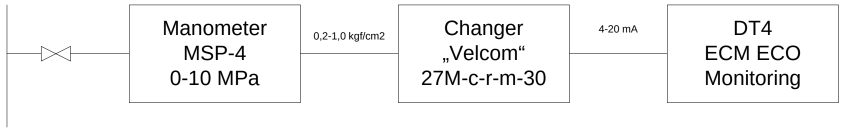
Operating conditions

For purpose of the baseline emissions factor setting it is necessary to monitor and report operating conditions in all 8 burners. Namely:

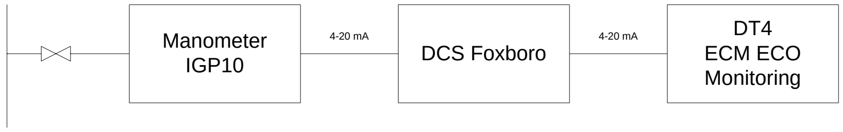
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

All these parameters are measured by the plant monitoring system as presented on diagrams below:

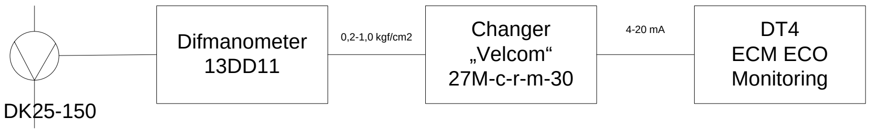
P in mixer 1-6 line



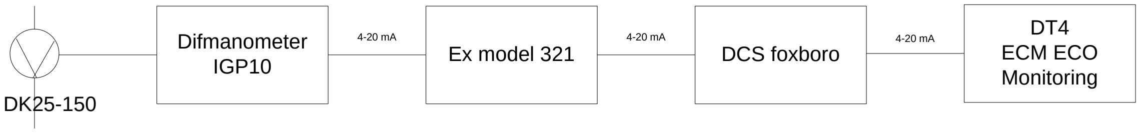
P in mixer 7-8 line

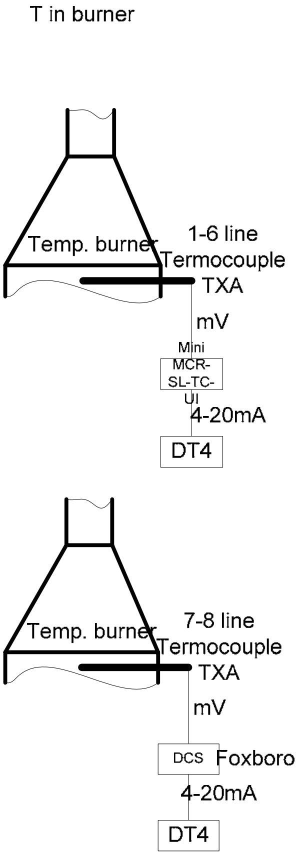


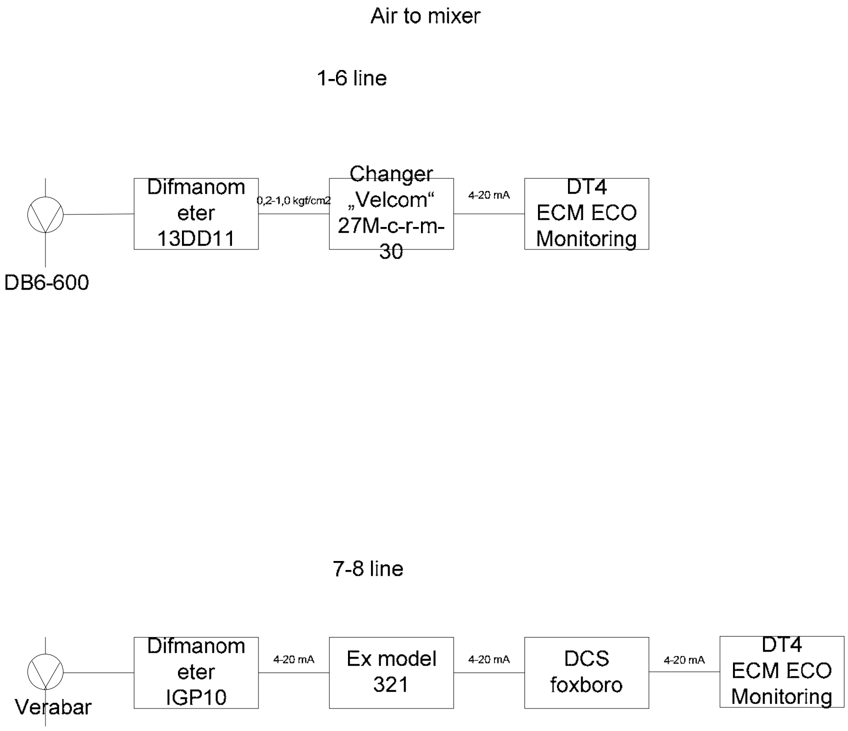
NH3 to mixer 1-6 line



NH3 to mixer 7-8 line







Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further. Maintenance procedures for the ammonia oxidation parameters follow the existing procedures for the operation of the nitric acid plant.

Nitric acid production

Nitric acid concentration is based on two components: nitric acid and water. Standard monitoring method is on-Line refractometry. Measurement of nitric acid (100%) mass volume production per campaign is necessary for calculation of the baseline emissions factor. Nitric acid concentration on all 8 Lines is measured by K-Patents PR-23-GP refractometers.

This analyzer is applying a prism to “return” a generated optical beam back to an LCD detector.

The detector is measuring refraction of monitored liquid based on known refraction of water and nitric acid. The instrument is calibrated for percent concentration of nitric acid. The analyzer is mounted on DIN-flange 2656, PN25 DN80. The optical prism does not require cleaning.

PR-23-GP characteristics:

Measuring RI is a direct concentration measurement principle. No need to rely or convert magnitudes.
Digital instrument – no calibration drift
As it is a robust instrument it is maintenance free
Dual connectivity if the installation positions allow.
On-Line data logging, through Ethernet, on whichever web browser.
No influence by bubbles or particles. It is very common that air enters the process pipeline and still the refractometer measures accurately.

Nitric acid concentration data are in an analog 4-20mA format provided to dataloggers which process these signals further.

In order of being able to calculate total mass volume of nitric acid 100% concentrate produced during the baseline campaign it is necessary to monitor also nitric acid flow and temperature. Measurement of pressure is not necessary for determination of the nitric acid mass volume flow, because nitric acid is in form of liquid and as such it has stabile pressure characteristic.

Signals obtained from the nitric acid flow and temperature measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Nitric acid flow and temperature measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, which process them further.

After installation of refractometers there have been occurrences of their failure and following repair service by the manufacturer. For this period starting from 05/10/2007 and ending on 20/10/2008 project uses HNO_3 concentration data provided by the laboratory measurements.

6. QAL 2 CALIBRATION ADJUSTMENTS

6.1 Applied principle

As required in the applicable norm EN14181: "The relation between the instrument readings of the recording measuring procedure and the quantity of the measuring objects has to be described by using a suitable convention method. The results have to be expressed by a regression analysis."

As it is described in the Calibration Report issued by Airtec laboratory, the measurement results derived from the analog signals (4 mA to 20 mA) provided the installed instruments have been compared to the comparative measurements.

Linearity check of the instruments characteristics is stated in the QAL2 Calibration Report issued by the laboratory. The valid ranges of Linearity are determined by statistical analysis according to the guideline and the Linearity assumptions are further used in the Calibration Report establishing Linear regression Lines.

The general formula of the regression Line, established in the EN14181 and used in the Calibration Report is:

$$Y = a + bX$$

where:

X is the measured value of the instrument in mA
Y is the value of the parameter being objective of the measurement
a is a constant of the regression Line
b is the slope of the regression Line

After a comparative test the laboratory issued the old and new regression Lines properties, namely "a" and "b" applying for all of the measured parameters that are subject to calibration as stated in the Calibration Report.

The QAL2 corrections are based on the fact that the actual analog current outputs (in mA) of the measurement instruments are relevant for both, the old and new regression Lines:

$$Xo = Xn = X$$

where:

Xn: X new
Yo: Y old

This allows us to derive a calibrating formula that gives us the corrected value of the measured physical parameters. The applied calibrating equation is:

$$Yn=An + (Bn/Bo)*(Yo-Ao)$$

In order to take into account the properties of the AMS and their implication to the QAL 2 implementation in the model, we will further introduce several remarks to the conversion and normalization of the data.

The units returned by the AMS “nm3/h” stand for normalized cubic meters of the gas volume at normal gas conditions (0° C, 1 atm.).

6.2 Stack gas volume flow

Based on the real conditions measured and applied by the AMS for normalization (TSG in °C and PSG in hPa), the stack gas volume flow values are converted to real conditions before the regression analysis using the ideal gas law. The actual gas volume flow rates are derived from gas velocity measurements, therefore, before applying the regression analysis the gas speed is calculated from the volume flow and the duct cross-section and is fed into the calibrating equation. The calibrated values derived from the calibrating equation then converted back to normalized units using the calibrated real conditions (calibrated TSG and PSG). The normalized calibrated stack gas flow rates are further fed into the emission calculation model for further processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitric acid concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in mgN_2O/m_3. The concentration was converted to ppmv to make it compatible with the regression Lines parameters. The nitrous gas concentration values are then calibrated using the provided regression Lines parameters and are input in the model.

6.4 Stack gas Temperature

The stack gas temperature was calibrated by the regression conversion formula

6.5 Stack gas Pressure

The calibration report provides us with a regression Line for the stack gas pressure. We calibrate the readings of the measurements system using the regression formula and applying the values (in kPa).

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 5 previous campaigns. Average production in 5 campaigns preceding the baseline campaign was 63 620 $tHNO_3$ and time duration was on average 228 days. Table contains also information on suppliers of primary catalysts for the line 8.

T 2 Historic campaigns

Line	ACHEMA UKL-8	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	**1** t HNO3	-	00 Jan 1900	00 Jan 1900	-	n/a	0	0
	2 t HNO3	62 575	10 Dec 2004	17 Aug 2005	250	250	Heraeus	90/5/5
	3 t HNO3	63 418	02 Nov 2005	14 Jun 2006	224	283	Umicore	95/5
	4 t HNO3	63 138	15 Jun 2006	01 Feb 2007	231	273	Johnson Matthey	n.a.
	5 t HNO3	65 347	02 Feb 2007	28 Aug 2007	207	316	Johnson Matthey	n.a.
Average HNO3 production	t HNO3	**63 620**			**228**	**279**		
Project Campaigns	**BL** t HNO3	63 577	01 Sep 2007	15 Apr 2008	227	280	Umicore	95/5
	PL t HNO3	59 291	09 Dec 2008	20 Nov 2009	346	171	Umicore	95/5

It is business as usual scenario in Achema UKL-7 plant to keep using primary catalysts from several suppliers and with several compositions. Selection of primary catalysts is determined by technical parameters of their use and price levels offered by suppliers in specific time. Primary catalysts used during the baseline campaign, if other than used in previous campaign/s, did not increase emissions of N2O as confirmed by relevant statements provided to the verifier.

T 3 and Chart C 1 define the length of the baseline campaign. Baseline campaign measurements for this project campaign started on 01/09/2007 and continued through 15/04/2008 when the 63 577 $tHNO_3$ nitric acid production was reached. The measurement of baseline Nitrous Acid Concentration (NCSG) was carried out until production reached - $tHNO_3$.

T 3 Baseline campaign length

ACHEMA UKL-8	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Aug 28	2007 Sep 01	2008 Mar 15	2008 Apr 15	2008 Apr 16
Baseline Factor kgN2O/tHNO3	-	-	6.96	6.96	6.96
Production tHNO3		-	52 603	63 577	-
Per Day Production tHNO3	279.0				
Baseline less Historic Production	**(42.6)**				
Baseline less Historic Days	**(0.2)**				

C 1 Baseline campaign length

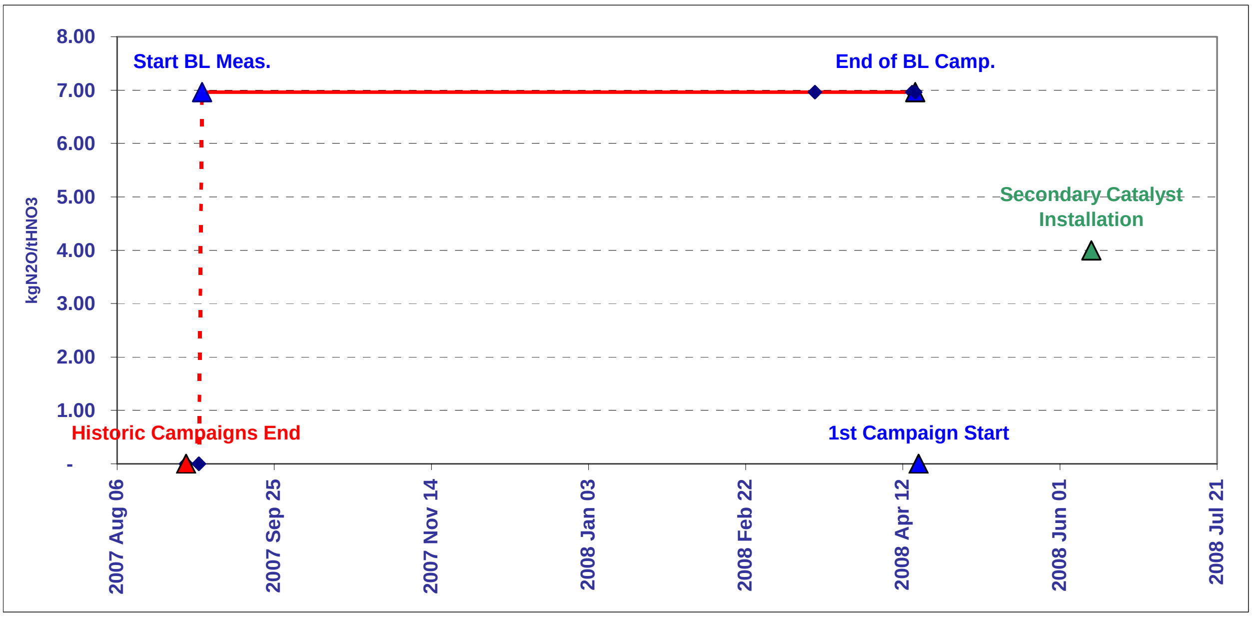


Table T 4 illustrates the calculation of the baseline emission factor on Line 8 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 01/09/2007 through 15/04/2008.

Extreme values and data measured during hours when one or more of operating conditions were outside of the permitted range have been eliminated from the calculations. As a next step we have eliminated data beyond 95% confidence interval and calculated new mean values of N_2O concentration and stack gas volume flow using following method:

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values (volume of stack gas (VSG) and N_2O concentration of stack gas (NCSG))

Using the means values we have calculated the baseline emissions as set out in the PDD.

$$BE_{BC} = VSG_{BC} * NCSG_{BC} * 10^{-9} * OH_{BC}\ (tN_2O)$$

Operating hours defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred. Calculated baseline N2O emissions were 470 tN_2O.

$$EF_{BL} = (BE_{BC} / NAP_{BC})\ (1 – UNC/100)\ (tN_2O/tHNO_3)$$

The UNC factor defined by the QAL2 report is 5.890%, which is further modified by an uncertainty of 0.106% due to under-sampling. As a result we have arrived to the baseline emission factor of 6.96 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 8 during the project campaign. Project campaign started on 09/12/2008 and went through 20/11/2009.

We have eliminated extreme values and data beyond the 95% confidence interval as prescribed by the PDD.

a) Calculate the sample mean (x)
b) Calculate the sample standard deviation (s)
c) Calculate the 95% confidence interval (equal to 1.96 times the standard deviation)
d) Eliminate all data that lie outside the 95% confidence interval
e) Calculate the new sample mean from the remaining values

Using the mean values we have calculated total mass of N_2O emissions (PE_n) as follows:

$$PE_n = VSG * NCSG * 10\text{-}9 * OH \ (tN2O)$$

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 600˚C occurred.

By dividing total mass of N_2O emissions by the nitric acid production (capped by nameplate capacity 350 tHNO3/day) we have determined the project campaign specific emission factor at value of 4.30 kgN2O/tHNO3.

$$EF_n = PE_n / NAP_n \ (tN_2O/tHNO_3)$$

Because the project emission factor measured was lower than the moving average EF of the campaigns on this line so far, we have used the average EF for the calculation of the quantity of emission reductions generated during this campaign.

T 4 Baseline emission factor

BASELINE EMISSION FACTOR										
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**	**AMS in Operation**	**Nitric Acid Production NCSG**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**		**NAP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**	**h**	**t/h**
Elimination of extreme values										
Lower limit		0	0	0	0	0	- 50	0		0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000		50
Raw Data Measured Range										
Count	**4 719**	4 954	4 059	4 598	4 987	4 663	5 425	5 425	4 129	4 211
as % of Dataset	*87%*	*91%*	*75%*	*84%*	*92%*	*86%*	*100%*	*100%*	*76%*	*77%*
Minimum		0.00	0	4	0	0	27	5		0
Maximum		24.99	1 968	103 514	6 796	14.80	912	654		25
Mean		12.83	1 067	78 981	5 591	10.07	801	564		12
Standard Deviation		5.07	458	16 813	1 520	0.93	245	116		5
Total		63 577								52 603
N2O Emissions (VSG * NCSG * OH)	398	t N2O								
Emission Factor	5.88	kgN2O / tHNO3								
Permitted Range										
Minimum					-	0	880	550		
Maximum					7 500	11.20	910	800		
Data within the permitted range										
Count	**4 453**		3 230	4 131					4 129	
as % of Operating Hours	***94%***		*68%*	*88%*					*87%*	
Minimum			781	-						
Maximum			1 732	96 663						
Mean			1 232	77 635						
Standard Deviation			206	16 881						
N2O Emissions (VSG * NCSG * OH)	452	t N2O								
Emission Factor	6.68	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			828	44 549						
Upper bound			1 637	110 722						
Count			3 167	3 949						
as % of Operating Hours			*67%*	*84%*						
Minimum			838	75 503						
Maximum			1 635	96 663						
Mean			1 227	81 213						
Standard Deviation			199	2 729						
N2O Emissions (VSG * NCSG * OH)	**470**	**t N2O**								
Emission Factor (EF_BL)	**6.96**	**kgN2O / tHNO3**								

T 5 Project emission factor

PROJECT EMISSION FACTOR								
Parameter	**Operating Hours**	**Nitric Acid Production**	**N2O Concentration**	**Gas Volume Flow**	**Ammonia Flow Rate**	**Ammonia to Air Ratio**	**Oxidation Temperature**	**Oxidation Pressure**
Code	**OH**	**NAP**	**NCSG**	**VSG**	**AFR**	**AIFR**	**OT**	**OP**
Unit	**h**	**t/h**	**mg N2O/Nm3**	**Nm3/h**	**Nm3/h**	**%**	**°C**	**kPa**
Elimination of extreme values								
Lower limit		0	0	0	0	0	- 50	0
Upper Limit		50.00	3 000	120 000	10 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**4 130**	7 450	4 108	4 104	7 176	6 706	7 828	7 829
as % of Dataset	*50%*	*90%*	*49%*	*49%*	*86%*	*81%*	*94%*	*94%*
Minimum		0.02	328	3	-	-	(20)	6
Maximum		16.73	1 940	105 236	7 575	19.05	911	649
Mean		7.96	689	89 125	3 489	7.05	507	569
Standard Deviation		7.19	170	5 104	2 842	4.71	407	68
Total		59 291						

N2O Emissions (VSG * NCSG * OH)	254	t N2O
Emission Factor	4.28	kgN2O / tHNO3

Data within the confidence interval		
95% Confidence interval		
Lower bound	357	79 121
Upper bound	1 022	99 130
Count	3 915	3 785
as % of Operating Hours	*95%*	*92%*
Minimum	357	79 132
Maximum	1 021	99 065
Mean	687	88 917
Standard Deviation	162	4 188

N2O Emissions (VSG * NCSG * OH)	**252**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**4.26**	**kgN2O / tHNO3**
Abatement Ratio	**38.9%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	4.35	4.35
2	4.26	4.30

Project Emission Factor (EF_P)	**4.30**	**kgN2O / tHNO3**
Abatement Ratio	**38.2%**	

Comparison of the baseline emission factors against N_2O mass limit in the IPPC permit

Achema UKL-7 IPPC permit defines the regulatory level as total mass of N_2O allowed to be emitted from the UKL-7 plant in the years 2008 through 2012. N_2O mass emissions of Achema UKL-7 plant were in both years 2008 and 2009, which are subject to the first periodic verification, below the IPPC mass limit value. IPPC limits for N_2O were introduced into Achema's IPPC permit from the year 2008.

For purpose of comparison of the regulatory level and actual baseline emission factors we had used the Sumproduct approach, i.e. we had derived from the IPPC mass N_2O limit the emission factor kg N_2O/t HNO_3.

The IPPC permit defines, that mass N_2O limit for the UKL-7 plant in 2008 was calculated for the nameplate capacity production of 8 units and 1/4 of the annual nameplate capacity production of the new 9th unit (not part of the JI project).

For 2009 is the N_2O mass limit based on the nameplate capacity production of all 9 lines.

As defined in the PDD in the section D.1.4. at page 38 the UKL-7 (8 lines) annual nameplate capacity is 1,022,000 $tHNO_3$. With addition of 1/4 of the 9th line HNO_3 production (=(1,022,000/8/4) the total UKL-7 HNO_3 production in the 2008, as used for the IPPC calculations, is 1,053,938 tHNO3/year.

This number represents the HNO_3 production to which we can relate the IPPC N_2O mass limit of 8,494.2 tN_2O for 2008. For year 2009 the nitric acid nameplate capacity is 1,135,556 $tHNO_3$ and N_2O mass limit 9,266.4 tN_2O.

By dividing total mass of N_2O limit by the nameplate capacity production in the years 2008 and 2009 we will arrive to the emission factor 8.06 $kgN_2O/tHNO_3$ for 2008 and 8.16 $kgN_2O/tHNO_3$ in 2009.

	IPPC N_2O mass limit	Actual N_2O emissions	Derived BEFreg
2008	8,494.2 tN_2O	5,314 tN_2O	8.06 $kgN_2O/tHNO_3$
2009	9,266.4 tN_2O	1,515.0 tN_2O	8.16 $kgN_2O/tHNO_3$

For calculation of actual baseline emission factor we had used the Sumproduct approach (Line 1 First campaign baseline*campaign's tHNO3 + Line 1 Second campaign baseline*campaign's tHNO3+ ....)/total tHNO3 of all campaigns), which resulted in the baseline emission factor 7.62 $kgN_2O/tHNO_3$.

	kgN2O/tHNO3	tHNO3	kgN2O
Regulatory BEF 2008	8.06	1,053,938	8,494,200
Regulatory BEF 2009	8.16	1,135,556	9,266,400
Sumproduct BEF	7.62		

			BEFs	t HNO3
Actual BEFs	Line 2	Campaign 1	7.92	12,380
		Campaign 2	9.51	60,767
	Line 3	Campaign 1	4.42	12,741
		Campaign 2	5.45	56,309
	Line 4	Campaign 1	7.20	38,721
	Line 5	Campaign 1	6.61	55,079
		Campaign 2	6.61	55,079
	Line 6	Campaign 1	10.34	60,850
	Line 7	Campaign 1	7.85	31,035
		Campaign 2	9.09	55,626
	Line 8	Campaign 1	6.61	45,057
		Campaign 2	6.96	52,603

It means that the Sumproduct baseline emission factor is lower than the regulatory emission factor and thus all actual measured baseline emission factors can be used for calculation of emission reductions achieved.