THIRD MONITORING REPORT

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

Prepared by:

VERTIS

VERTIS FINANCE

September 2, 2011

Monitoring periods

Line 2
Project campaign 3

FROM:	13/10/2009
TO:	21/10/2010
ERUs	200,400

Line 3
Project campaign 3

FROM:	17/06/2009
TO:	16/11/2010
ERUs	48,619

Line 4
Project campaign 3

FROM:	03/08/2010
TO:	09/03/2011
ERUs	99,159

Line 5
Project campaign 3

FROM:	12/08/2010
TO:	17/03/2011
ERUs	103,817

Line 7
Project campaign 3

FROM:	03/11/2009
TO:	08/12/2010
ERUs	150,615

Line 8
Project campaign 3

FROM:	21/11/2009
TO:	25/10/2010
ERUs	91,448

Line 2
Project campaign 4

FROM:	22/10/2010
TO:	12/05/2011
ERUs	160,448

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 2
MONITORING PERIOD:
FROM: 13/10/2009

TO: 21/10/2010

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 third 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 third project period from 13/10/2009 through 21/10/2010 on Line 2 is **200 400 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	9.51	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.00	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	86 079	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**200 400**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**79.0%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		13 Oct 2009	01 Jan 2010
Date To		31 Dec 2009	21 Oct 2010
Nitric Acid Production		17 444	68 634
Emission Reduction		**40 612**	**159 787**
*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 third project campaign after installation of secondary catalysts on Line 2, which started on 13/10/2009 and went through 21/10/2010 with secondary catalyst installed and commissioned on 07/11/2008, is 2.00 $kgN_2O/tHNO_3$.

During the project campaign 86 079 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)

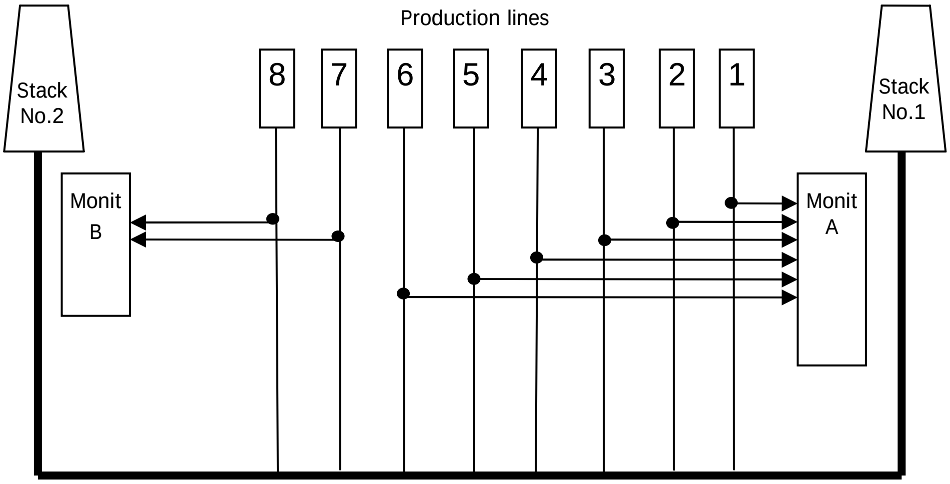
5. MONITORING PLAN

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.

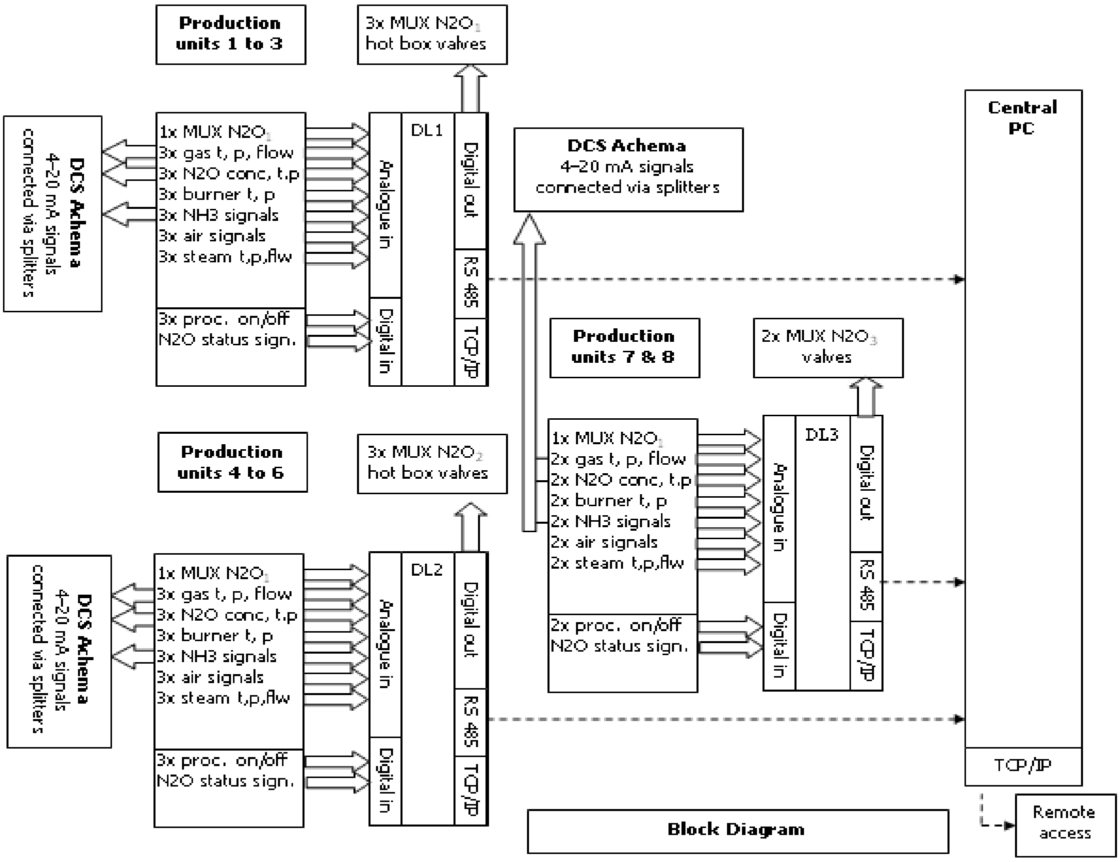
Monitoring System (MS) for purpose of this monitoring plan means:

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.

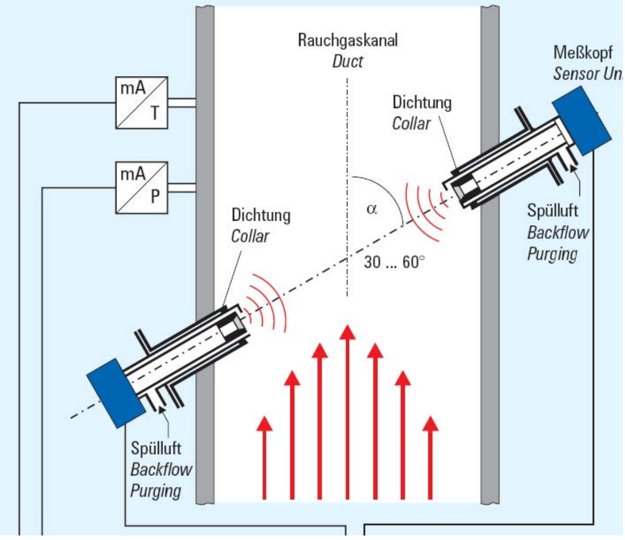
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

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.

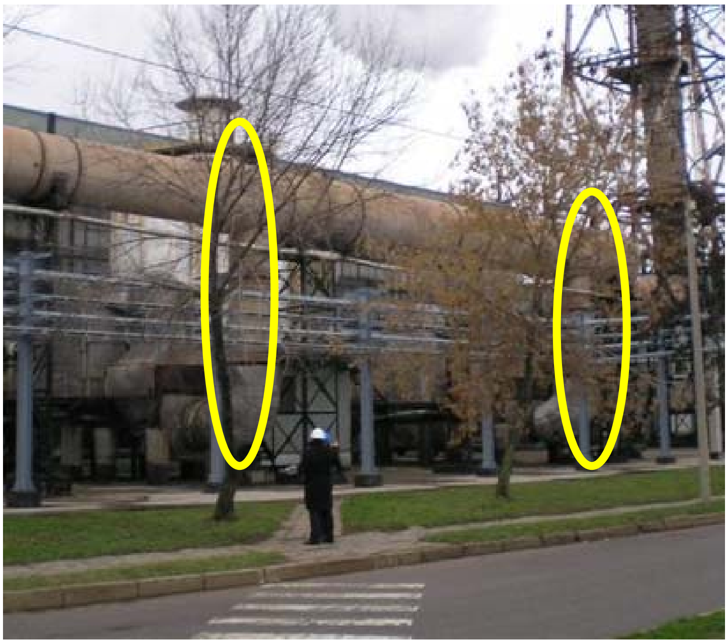
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

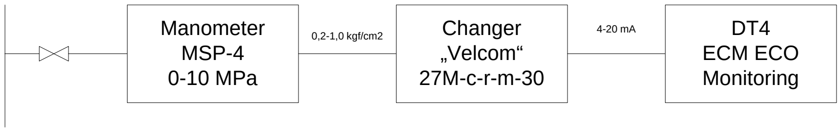
Operating conditions

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

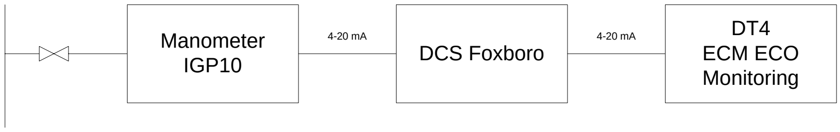
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

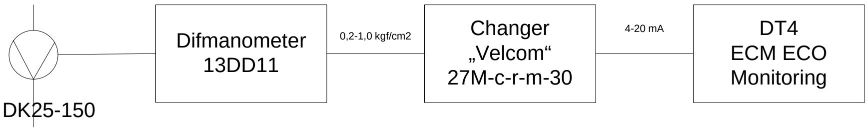
P in mixer 1-6 line



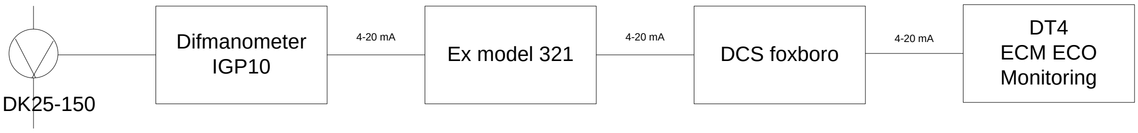
P in mixer 7-8 line



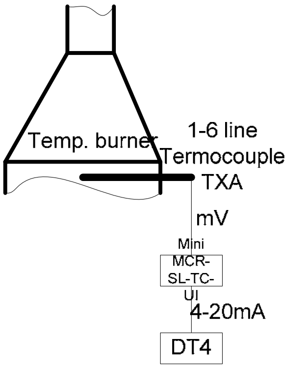
NH3 to mixer 1-6 line

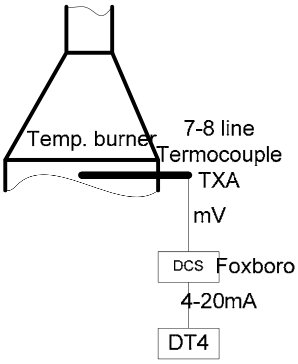


NH3 to mixer 7-8 line



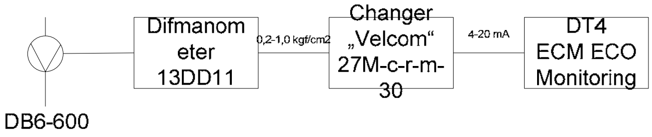
T in burner



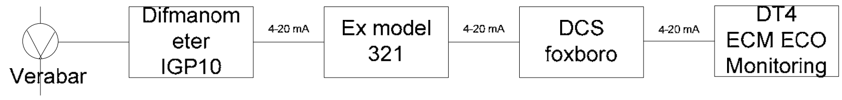


Air to mixer

1-6 line



7-8 line

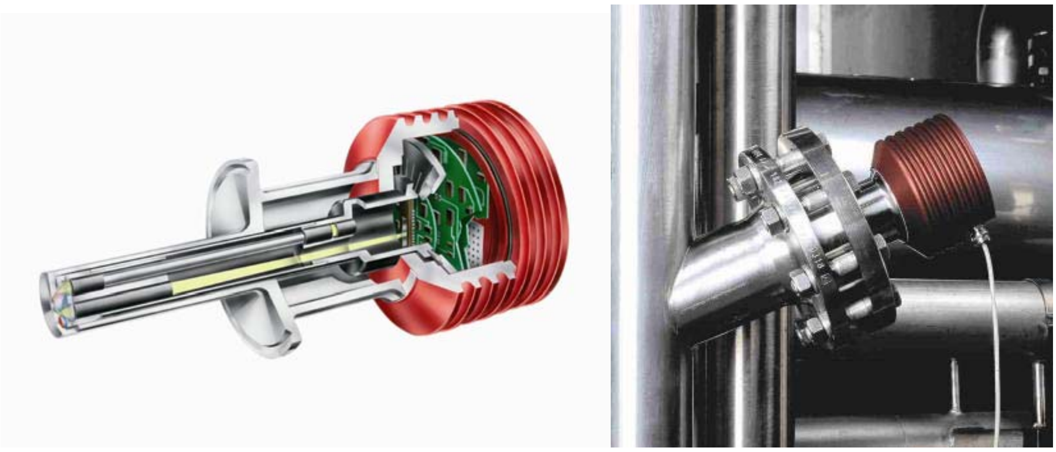


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, 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:

$$X_o = X_n = X$$

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 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	86 079	13 Oct 2009	21 Oct 2010	373	231	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

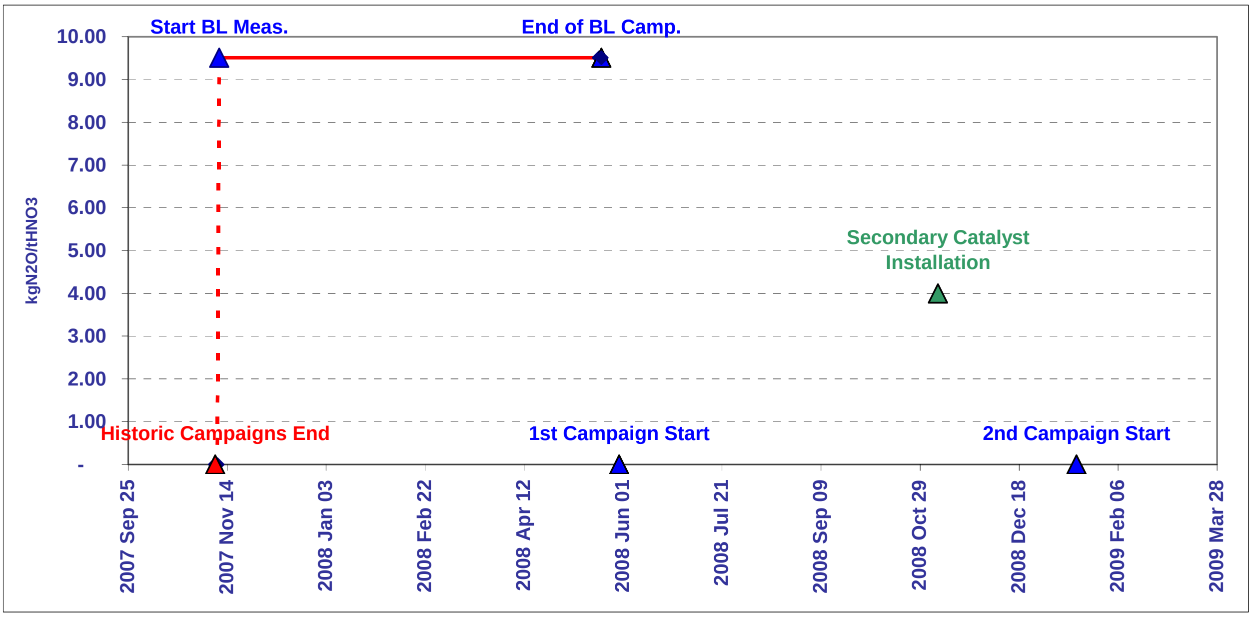


Table T 4 illustrates the calculation of the baseline emission factor on Line 2 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 09/11/2007 through 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 13/10/2009 and went through 21/10/2010.

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 2.00 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	**5 920**	5 895	5 768	5 880	7 351	6 207	8 949	8 935
as % of Dataset	*66%*	*66%*	*64%*	*66%*	*82%*	*69%*	*100%*	*100%*
Minimum		0.95	3	50 032	293	4	6	1
Maximum		18.90	633	98 491	7 902	19.56	1 100	712
Mean		14.60	359	82 917	5 574	10.74	646	523
Standard Deviation		1.37	67	4 044	1 296	0.79	394	180
Total		86 079						

N2O Emissions (VSG * NCSG * OH)	176	t N2O
Emission Factor	2.05	kgN2O / tHNO3

Data within the confidence interval	NCSG	VSG
95% Confidence interval		
Lower bound	227	74 990
Upper bound	491	90 843
Count	5 374	5 456
as % of Operating Hours	*91%*	*92%*
Minimum	228	75 154
Maximum	491	90 838
Mean	353	82 315
Standard Deviation	56	3 238

N2O Emissions (VSG * NCSG * OH)	**172**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.00**	**kgN2O / tHNO3**
Abatement Ratio	**79.0%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.80	1.80
2	1.84	1.84
3	2.00	2.00
4	-	

Project Emission Factor (EF_P)	**2.00**	**kgN2O / tHNO3**
Abatement Ratio	**79.0%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 2
MONITORING PERIOD:
FROM: 22/10/2010

TO: 12/05/2011

Prepared by:

VERTIS

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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 fourth 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 fourth project period from 22/10/2010 through 12/05/2011 on Line 2 is **160 448 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	9.51	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	1.83	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	67 392	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**160 448**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**82.4%**	

EMISSION REDUCTION PER YEAR			
Year	2099	2010	2011
Date From		22 Oct 2010	01 Jan 2011
Date To		31 Dec 2010	12 May 2011
Nitric Acid Production		25 426	41 966
Emission Reduction		**60 535**	**99 913**
*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 fourth project campaign after installation of secondary catalysts on Line 2, which started on 22/10/2010 and went through 12/05/2011 with secondary catalyst installed and commissioned on 07/11/2008, is 1.83 $kgN_2O/tHNO_3$.

During the project campaign 67 392 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 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)

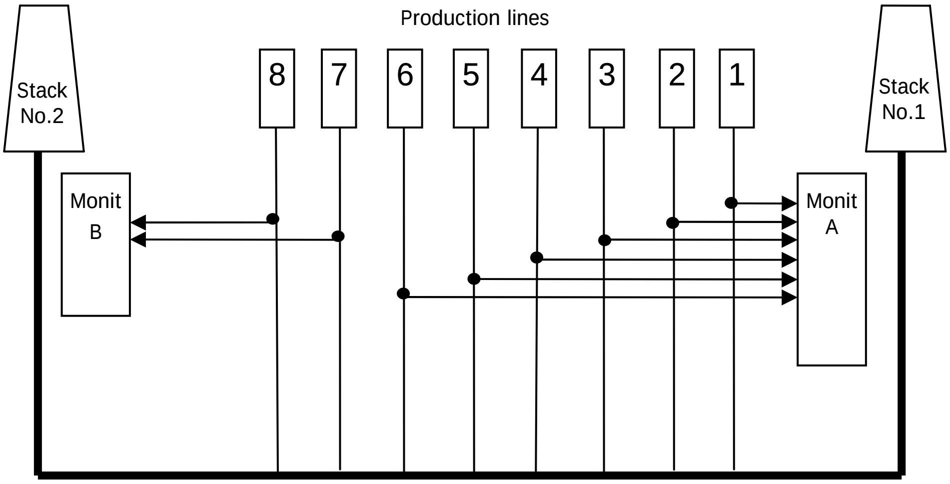
5. MONITORING PLAN

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.

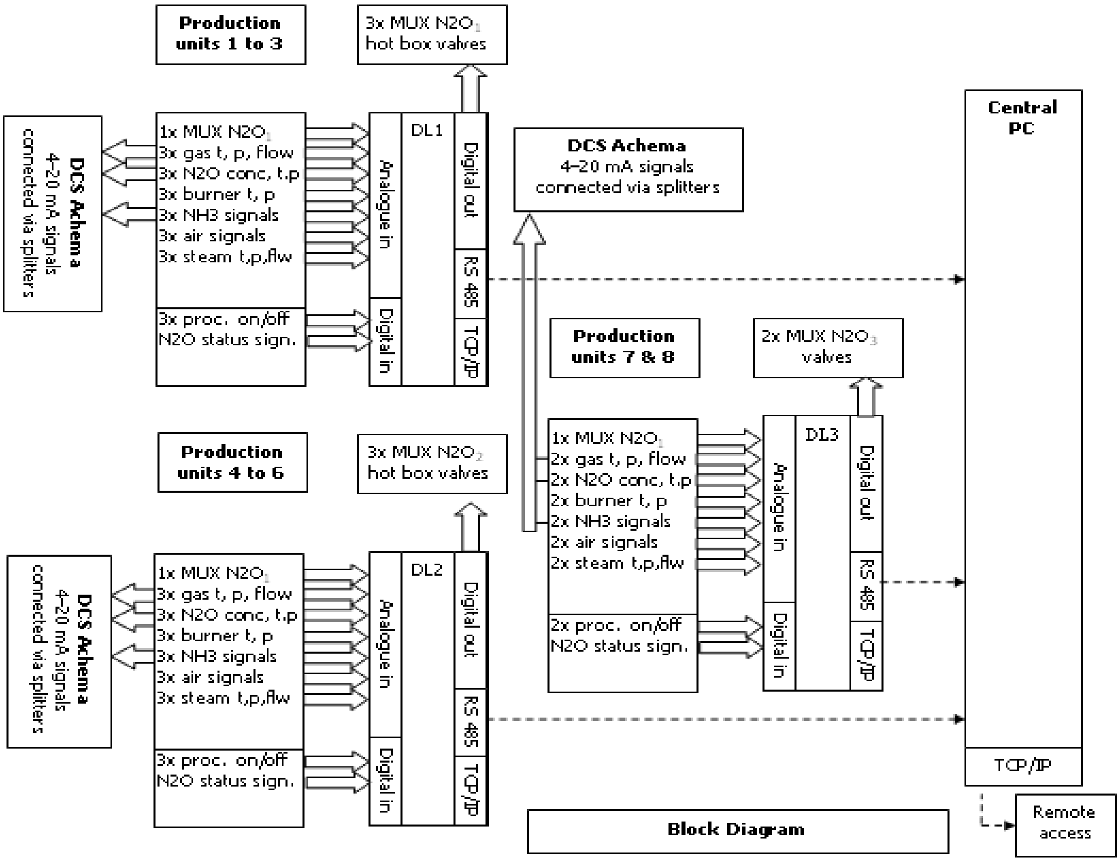
Monitoring System (MS) for purpose of this monitoring plan means:

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.

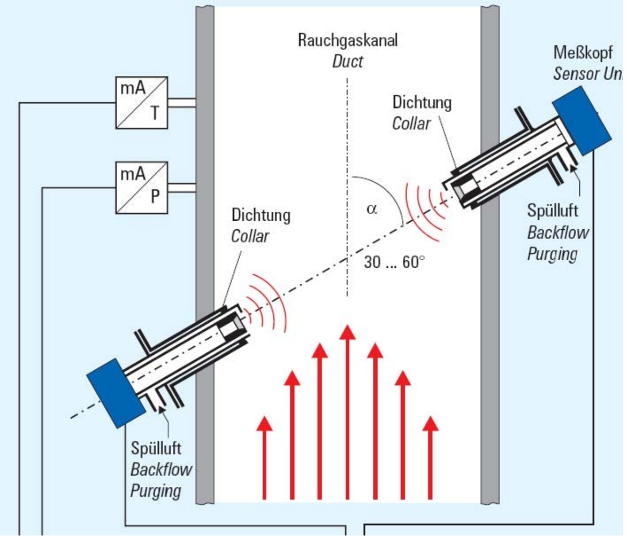
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

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.

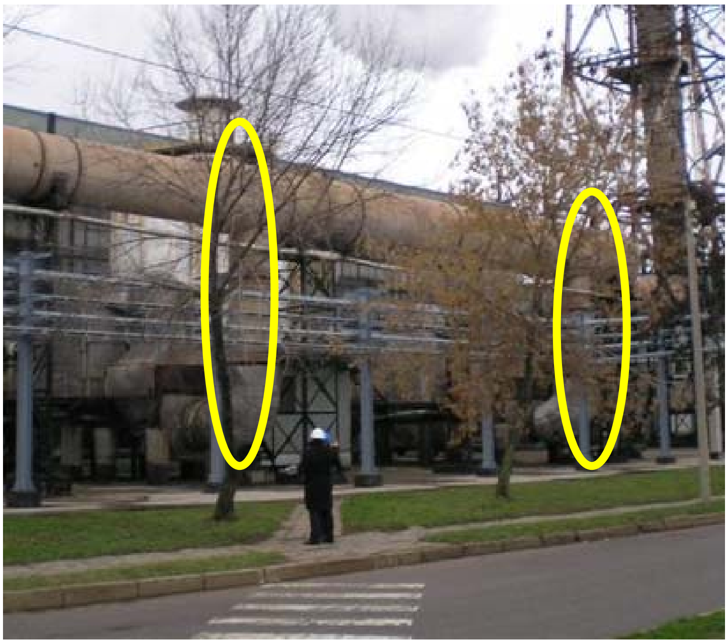
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

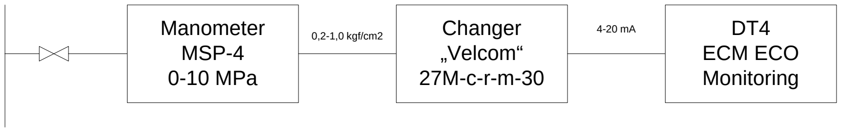
Operating conditions

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

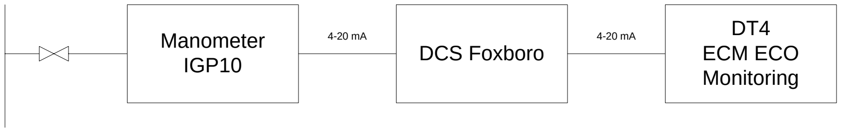
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

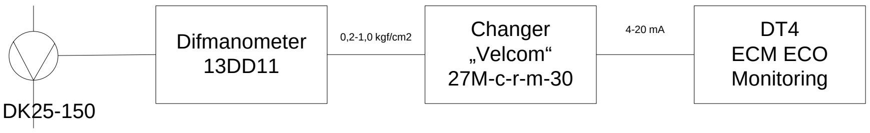
P in mixer 1-6 line



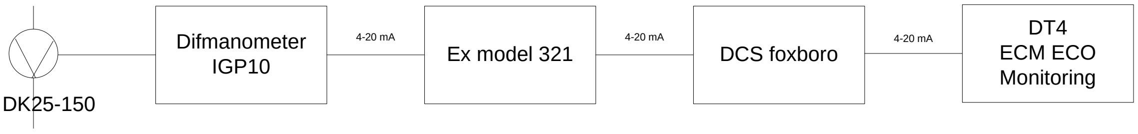
P in mixer 7-8 line



NH3 to mixer 1-6 line

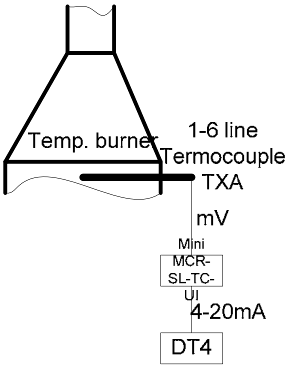


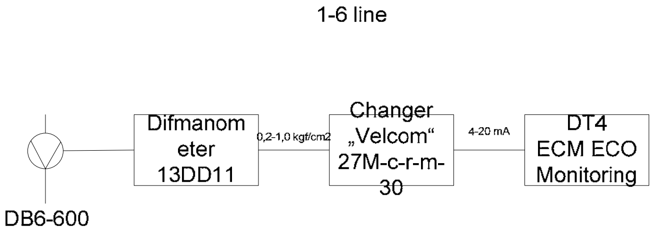
NH3 to mixer 7-8 line

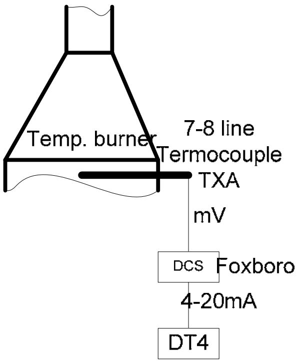


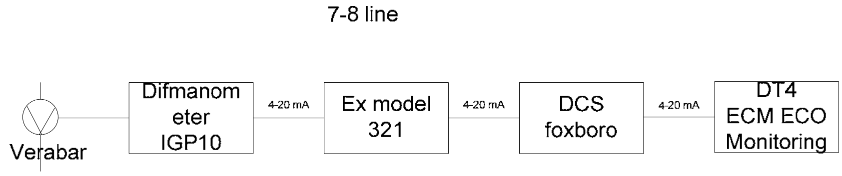
T in burner

Air to mixer







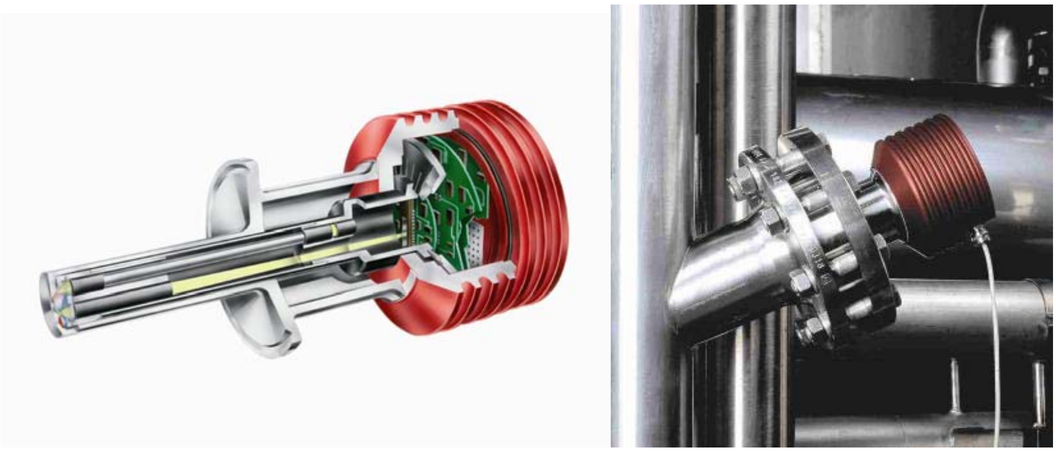


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, 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	67 392	22 Oct 2010	12 May 2011	202	334	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

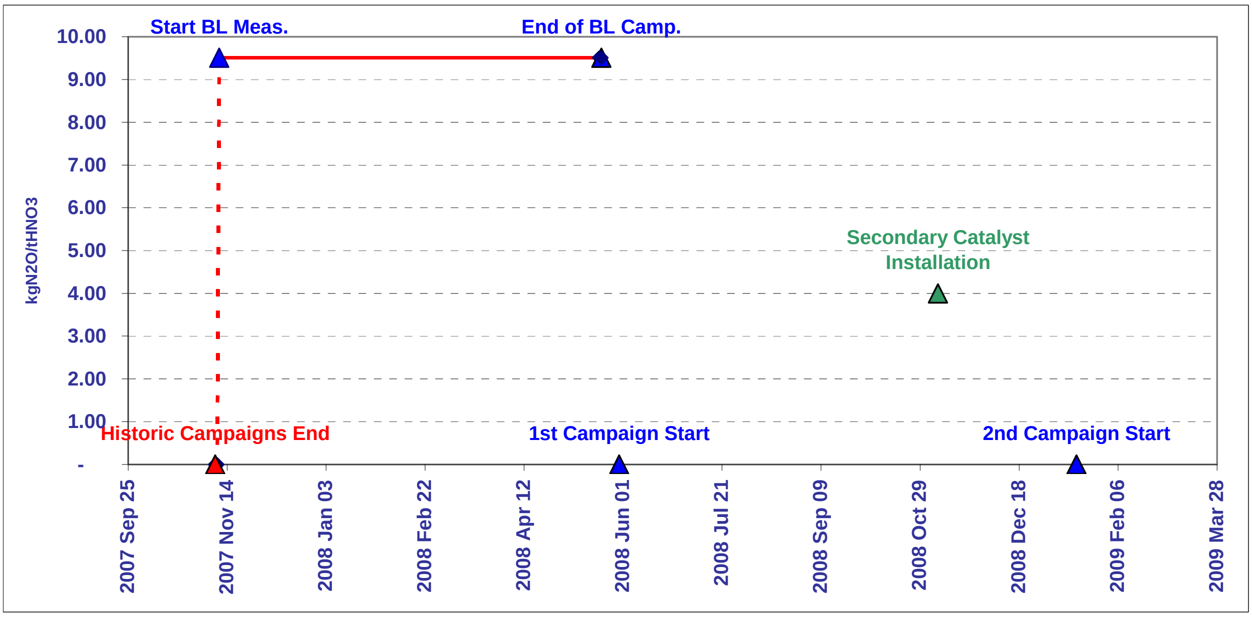


Table T 4 illustrates the calculation of the baseline emission factor on Line 2 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 09/11/2007 through 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 22/10/2010 and went through 12/05/2011.

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 1.83 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	**4 254**	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	**4 520**	4 543	4 442	4 485	4 828	4 548	4 845	4 824
as % of Dataset	*93%*	*94%*	*92%*	*93%*	*100%*	*94%*	*100%*	*100%*
Minimum		0.67	151	37 339	316	2	5	0
Maximum		18.63	591	94 149	7 678	14.86	1 100	711
Mean		14.83	349	72 365	6 088	10.44	846	614
Standard Deviation		1.37	68	3 529	456	0.27	195	87
Total		67 392						
N2O Emissions (VSG * NCSG * OH)	114	t N2O						
Emission Factor	1.69	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			215	65 447				
Upper bound			482	79 283				
Count			4 122	4 369				
as % of Operating Hours			*91%*	*97%*				
Minimum			215	65 654				
Maximum			482	79 229				
Mean			346	72 021				
Standard Deviation			58	2 592				
N2O Emissions (VSG * NCSG * OH)	**113**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**1.67**	**kgN2O / tHNO3**						
Abatement Ratio	**82.4%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	1.80	1.80						
2	1.84	1.84						
3	2.00	2.00						
4	1.67	1.83						
Project Emission Factor (EF_P)	**1.83**	**kgN2O / tHNO3**						
Abatement Ratio	**80.8%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 3
MONITORING PERIOD:
FROM: 17/06/2009

TO: 16/11/2010

Prepared by:

VERTIS

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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 third 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 third project period from 17/06/2009 through 16/11/2010 on Line 3 is **48 619 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	5.45	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	3.59	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	84 321	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**48 619**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**34.1%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		17 Jun 2009	01 Jan 2010
Date To		31 Dec 2009	16 Nov 2010
Nitric Acid Production		35 016	49 304
Emission Reduction		**20 190**	**28 429**
*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$_2$O/tHNO$_3$.

Project emission factor during third project campaign after installation of secondary catalysts on Line 3, which started on 17/06/2009 and went through 16/11/2010 with secondary catalyst installed and commissioned on 04/07/2008, is 3.59 kgN$_2$O/tHNO$_3$.

During the project campaign 84 321 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 third 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)

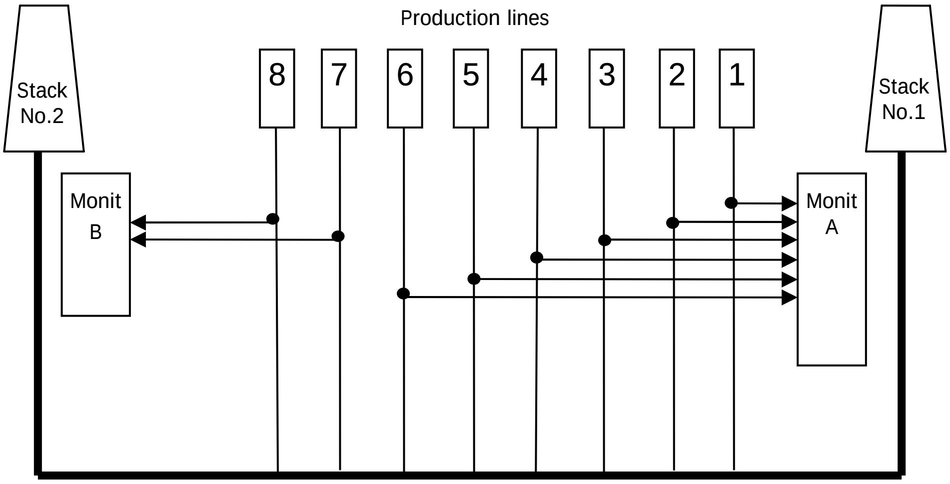
5. MONITORING PLAN

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.

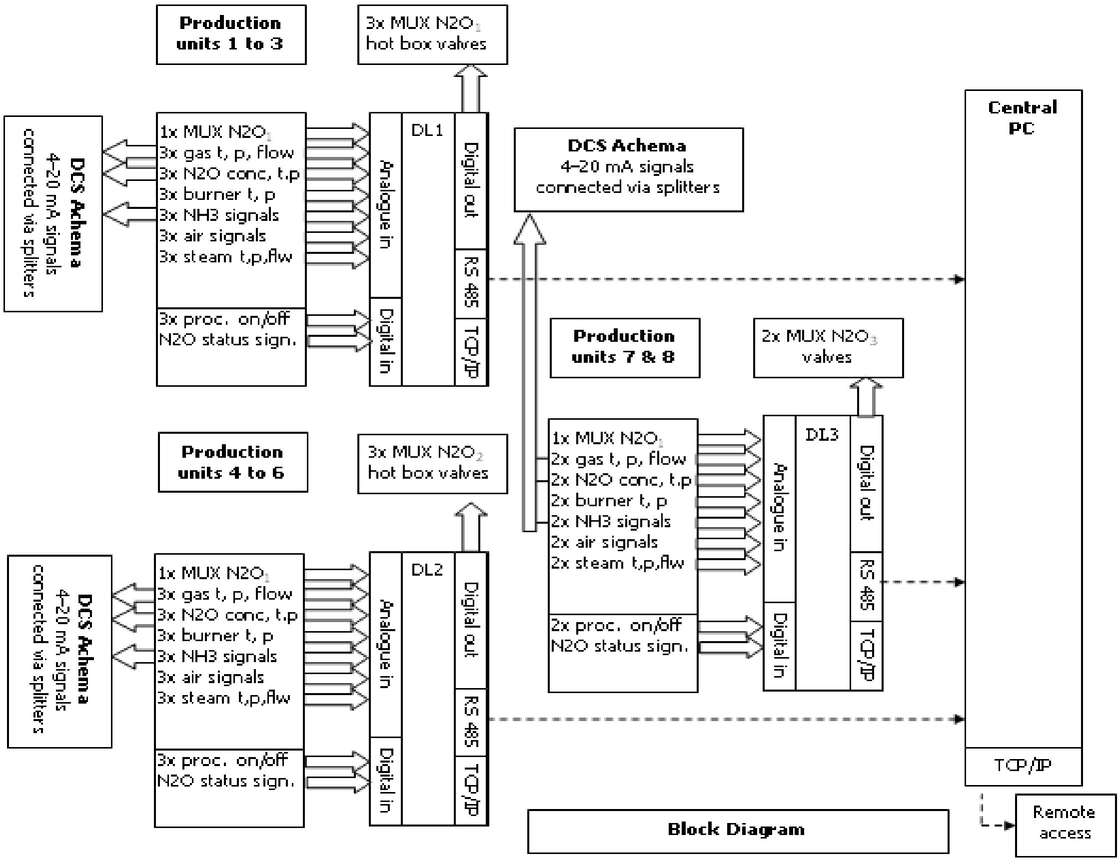
Monitoring System (MS) for purpose of this monitoring plan means:

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.

There are 8 production lines falling under scope of the JI project (lines 1-8). N_2O concentration is measured by 3 concentration meters on a switched basis.

- 1st analyzer measures 1, 2 and 3 lines.
- 2nd analyzer measures 4, 5 and 6 lines.
- 3rd analyzer measures 7 and 8 lines.

Switching between lines is managed by the AMS software. Switching intervals between lines are 300 seconds (5 minutes). 60 seconds (1 minute) of 300 seconds are for purging, i.e. no measurement during that time. Next 240 seconds (4 minutes) are for measuring, i.e. AMS is registering N_2O concentration values of selected line.

1st analyser complete 15 minutes measuring cycle:

Lines	Line 1		Line 2		Line 3	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

2nd analyser complete 15 minutes measuring cycle:

Lines	Line 4		Line 5		Line 6	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

3rd analyser complete 10 minutes measuring cycle:

Lines	Line 7		Line 8	
process	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes

Emission values are product of

- operating hours
- mean of the hourly measurements N_2O concentration
- mean of the hourly measured VSG

BE = OH * mean(NCSG) * mean(VSG)

The additional uncertainty comes from the additional deviation of mean(NCSG) in the equation, that stems from lower sampling rate. We calculate the deviation of mean(NCSG) under 2 sec sampling intervals, as well as the actual, and take the difference.

The deviation of mean(NCSG) depends on

- deviation of the hourly measurements
- sample size
- number of measurements

stdev(mean(“Actual hourly NCSG”)) = stdev(“Actual hourly NCSG”) / sqrt(“OH of NCSG measurement”)

where OH is the number of hours (or observations) that are taken into account in the calculation of NCSG, that are not eliminated due to various reasons (like short project campaign, etc). Actual means the number we have with under-sampling.

The hourly NCSG values we receive are in fact the averaged values of NCSG readings collected on a 2 seconds interval. Had we sampled every 2 seconds, we would have 1800 samples per hour. In case of two lines on the same device (with 4 minutes measurement, 1 minute of purge time), we have 720 samples per hour (or 480 in case of 3 lines per device).

“sample size” = “logging interval time” / ((“measurement time” + “switching time”) * “no. of lines”) * “measurement time” / “sampling interval time”

We can estimate the deviation of the second level NCSG measured by the device from the deviation of the hourly samples by taking into account the sample size and that they are the average of the second level readings. From this we can calculate what would be the deviation of the hourly NCSG in case we had a full sampling rate.

stdev(“Actual hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Actual sample size”)
stdev(“Ideal hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Ideal sample size”)

or

stdev(“Ideal hourly NCSG”) = stdev(“Actual hourly NCSG”) * sqrt(“Actual sample size”) / sqrt(“Ideal sample size”)

Afther that, we take into account the OH of the NCSG measurement to get the ideal deviation of the mean of the hourly values under normal sampling.

stdev(mean(“Ideal hourly NCSG”)) = stdev(“Ideal hourly NCSG”) / sqrt(“OH of NCSG measurement”)

The additional uncertainty is the difference between the ideal and the under-sampled deviation of the mean of the hourly values.

Diff = stdev(mean(“Actual hourly NCSG”)) - stdev(mean(“Ideal hourly NCSG”))

Combined UNC = sqrt(UNC^2 + Diff^2)

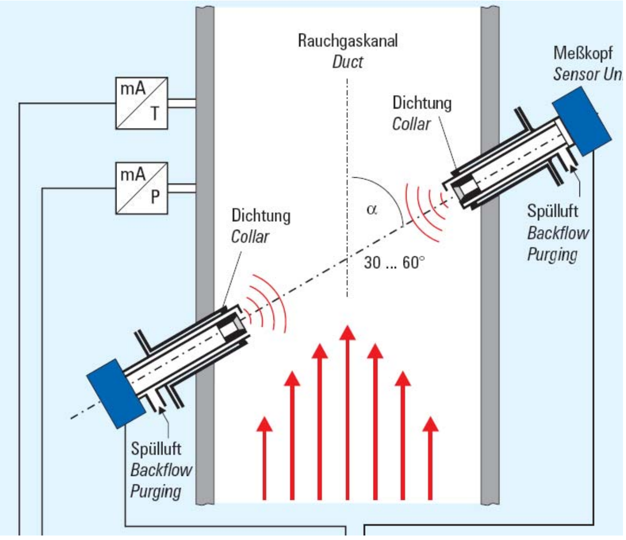
Where UNC is the QAL2 uncertainty.

Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

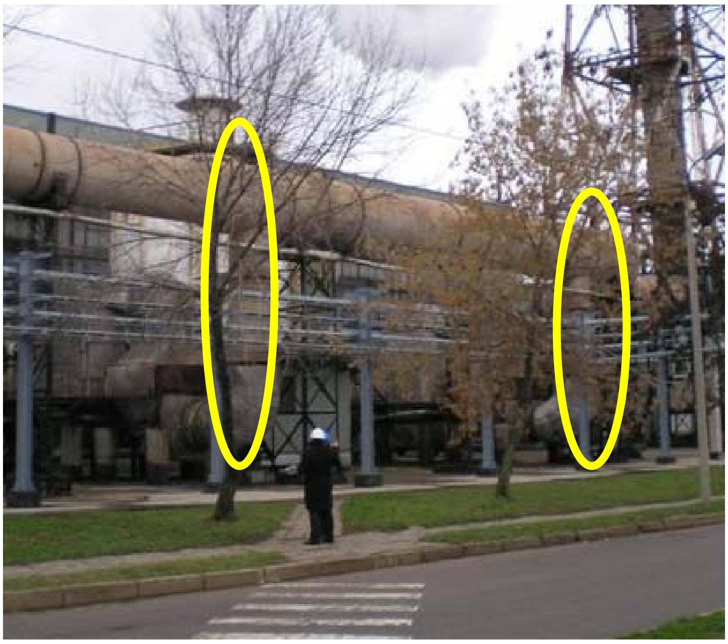
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

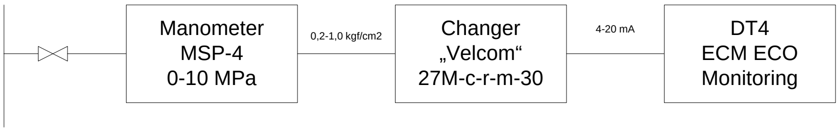
Operating conditions

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

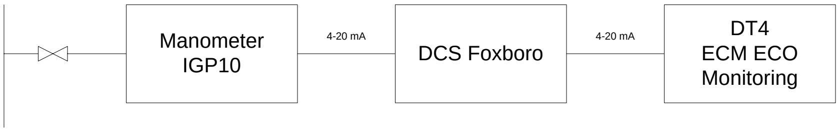
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

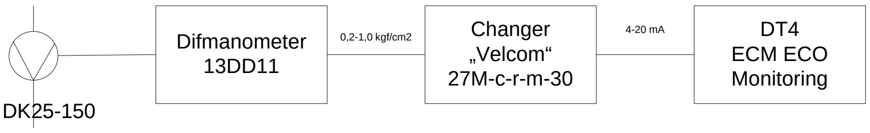
P in mixer 1-6 line



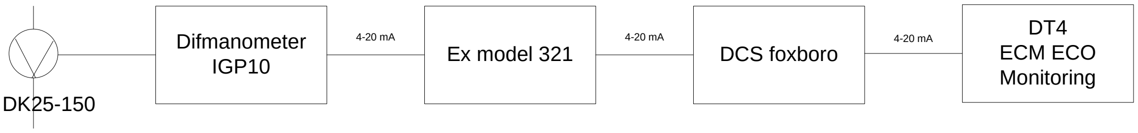
P in mixer 7-8 line



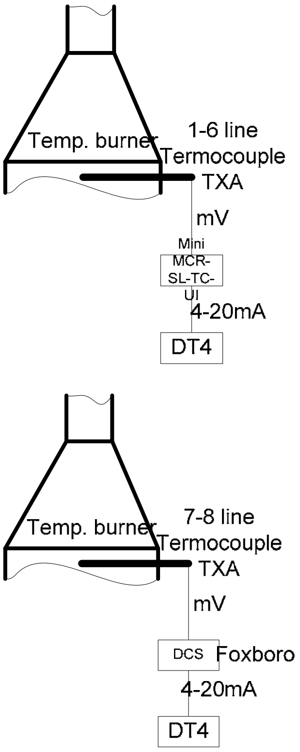
NH3 to mixer 1-6 line



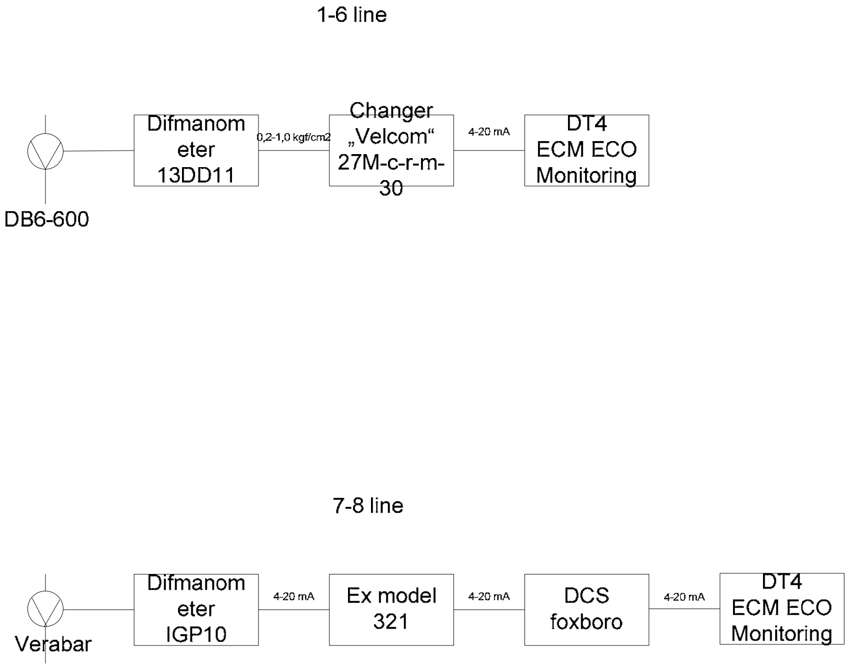
NH3 to mixer 7-8 line



T in burner



Air to mixer

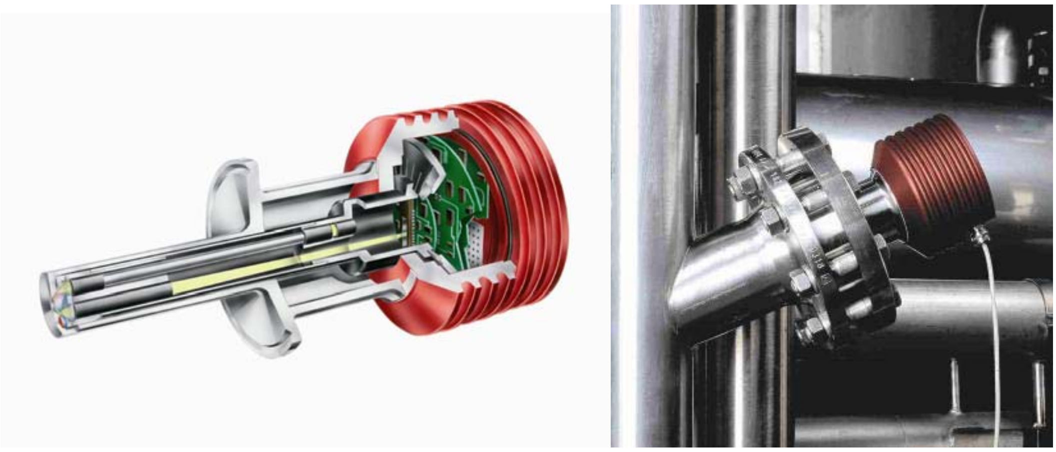


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, 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.

In case of refractometer's malfunction the HNO3 concentration is measured in laboratory.

The sample point of nitric acid production is in the output of the aggregate – in the pipe after the bleaching column. In the laboratory HNO3 concentration is tested by titration method. This method is defined in the company's standard (No.IST 5666739-32:2002) of nitric acid production. The laboratory controller, who performs the testing, is trained according "Training program for laboratory assistant performing chemical analysis"," Toxic chemical goods worker training program" and has qualification of chemistry's laboratory assistance.

Until 2010 year the testing frequency was once a week. This periodicity is usual in Achema and it is also the usual industry practice. Since 2010 year the testing frequency is once a day during the period of refractometers eventual malfunction. The laboratory NAC results are recorded in the laboratory registers No.Z42-303-40/303/08 and No.Z14-303-40/303/08. From laboratory registers NAC data are inputted in to Excel sheet manually.

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:

X_n: X new
Y_o: 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	84 321	17 Jun 2009	16 Nov 2010	517	163	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

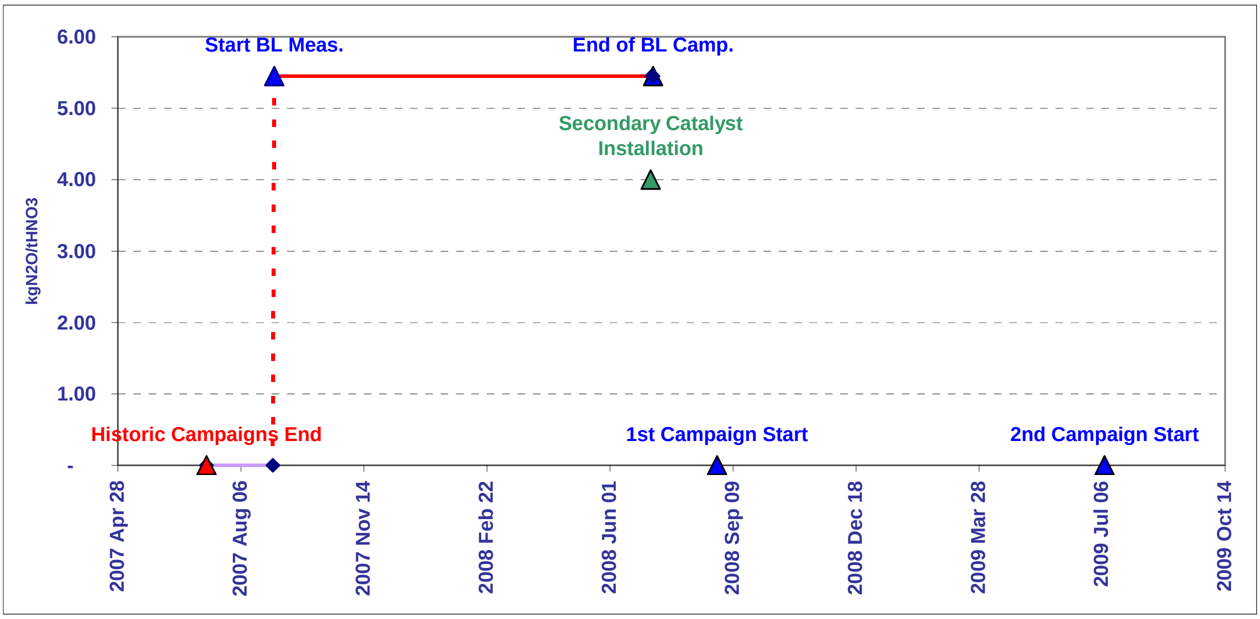


Table T 4 illustrates the calculation of the baseline emission factor on line 3 using the method as defined in the CDM methodology AM0034 and in the PDD.

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 17/06/2009 and went through 16/11/2010.

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 (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 3.59 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	**6 096**	8 857	5 966	6 014	12 398	6 262	12 398	12 398
as % of Dataset	*49%*	*71%*	*48%*	*48%*	*100%*	*50%*	*100%*	*100%*
Minimum		0.67	21	2 885	126	1	14	1
Maximum		14.70	2 188	81 300	8 000	19.99	1 100	693
Mean		9.52	705	71 132	3 654	10.43	490	546
Standard Deviation		4.96	253	3 584	2 871	1.22	400	112
Total		84 321						
N2O Emissions (VSG * NCSG * OH)	306	t N2O						
Emission Factor	3.63	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			210	64 107				
Upper bound			1 201	78 156				
Count			5 583	5 814				
as % of Operating Hours			*92%*	*95%*				
Minimum			297	64 152				
Maximum			1 201	78 143				
Mean			696	71 359				
Standard Deviation			246	2 349				
N2O Emissions (VSG * NCSG * OH)	**303**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**3.59**	**kgN2O / tHNO3**						
Abatement Ratio	**34.1%**							

Moving Average Emission Factor Correction		**Actual Factors**	**Moving Average Rule**
	1	1.92	1.92
	2	3.01	3.01
	3	3.59	3.59
	4	-	

Project Emission Factor (EF_P)	**3.59**	**kgN2O / tHNO3**
Abatement Ratio	**34.1%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 4
MONITORING PERIOD:
FROM: 03/08/2010

TO: 09/03/2011

Prepared by:

VERTIS

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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 third 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 third project period from 03/08/2010 through 09/03/2011 on Line 4 is **99 159 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	7.73	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.33	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	58 683	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	59 235	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**99 159**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**75.9%**	

EMISSION REDUCTION PER YEAR			
Year	2009	2010	2011
Date From		03 Aug 2010	01 Jan 2011
Date To		31 Dec 2010	09 Mar 2011
Nitric Acid Production		38 627	20 608
Emission Reduction		**64 662**	**34 498**
*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 7.73 kgN_2O/tHNO_3.

Project emission factor during the third project campaign after installation of secondary catalysts on Line 4, which started on 03/08/2010 and went through 09/03/2011 with secondary catalyst installed and commissioned on 06/10/2008, is 2.33 kgN_2O/tHNO_3.

During the project campaign 59 235 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 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)

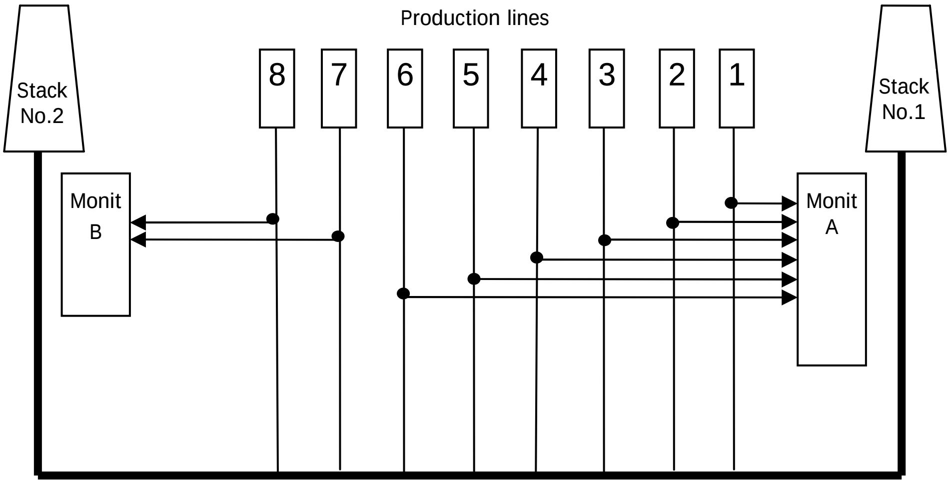
5. MONITORING PLAN

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.

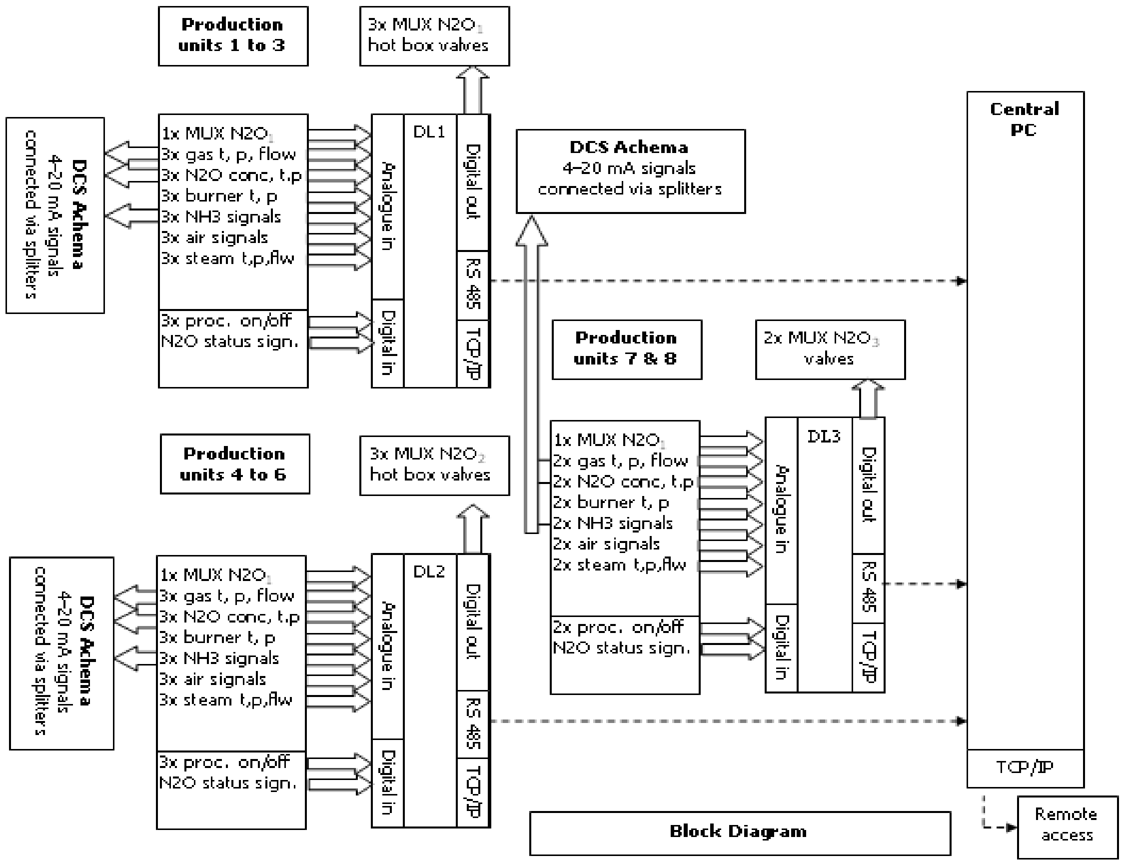
Monitoring System (MS) for purpose of this monitoring plan means:

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.

There are 8 production lines falling under scope of the JI project (lines 1-8). N_2O concentration is measured by 3 concentration meters on a switched basis.

- 1st analyzer measures 1, 2 and 3 lines.
- 2nd analyzer measures 4, 5 and 6 lines.
- 3rd analyzer measures 7 and 8 lines.

Switching between lines is managed by the AMS software. Switching intervals between lines are 300 seconds (5 minutes). 60 seconds (1 minute) of 300 seconds are for purging, i.e. no measurement during that time. Next 240 seconds (4 minutes) are for measuring, i.e. AMS is registering N_2O concentration values of selected line.

1st analyser complete 15 minutes measuring cycle:

Lines	Line 1		Line 2		Line 3	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

2nd analyser complete 15 minutes measuring cycle:

Lines	Line 4		Line 5		Line 6	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

3rd analyser complete 10 minutes measuring cycle:

Lines	Line 7		Line 8	
process	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes

Emission values are product of

- operating hours
- mean of the hourly measurements N_2O concentration
- mean of the hourly measured VSG

BE = OH * mean(NCSG) * mean(VSG)

The additional uncertainty comes from the additional deviation of mean(NCSG) in the equation, that stems from lower sampling rate. We calculate the deviation of mean(NCSG) under 2 sec sampling intervals, as well as the actual, and take the difference.

The deviation of mean(NCSG) depends on
- deviation of the hourly measurements
- sample size
- number of measurements

stdev(mean(“Actual hourly NCSG”)) = stdev(“Actual hourly NCSG”) / sqrt(“OH of NCSG measurement”)

where OH is the number of hours (or observations) that are taken into account in the calculation of NCSG, that are not eliminated due to various reasons (like short project campaign, etc). Actual means the number we have with under-sampling.

The hourly NCSG values we receive are in fact the averaged values of NCSG readings collected on a 2 seconds interval. Had we sampled every 2 seconds, we would have 1800 samples per hour. In case of two lines on the same device (with 4 minutes measurement, 1 minute of purge time), we have 720 samples per hour (or 480 in case of 3 lines per device).

“sample size” = “logging interval time” / ((“measurement time” + “switching time”) * “no. of lines”) * “measurement time” / “sampling interval time”

We can estimate the deviation of the second level NCSG measured by the device from the deviation of the hourly samples by taking into account the sample size and that they are the average of the second level readings. From this we can calculate what would be the deviation of the hourly NCSG in case we had a full sampling rate.

stdev(“Actual hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Actual sample size”)
stdev(“Ideal hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Ideal sample size”)

or

stdev(“Ideal hourly NCSG”) = stdev(“Actual hourly NCSG”) * sqrt(“Actual sample size”) / sqrt(“Ideal sample size”)

Afther that, we take into account the OH of the NCSG measurement to get the ideal deviation of the mean of the hourly values under normal sampling.

stdev(mean(“Ideal hourly NCSG”)) = stdev(“Ideal hourly NCSG”) / sqrt(“OH of NCSG measurement”)

The additional uncertainty is the difference between the ideal and the under-sampled deviation of the mean of the hourly values.

Diff = stdev(mean(“Actual hourly NCSG”)) - stdev(mean(“Ideal hourly NCSG”))

Combined UNC = sqrt(UNC^2 + Diff^2)

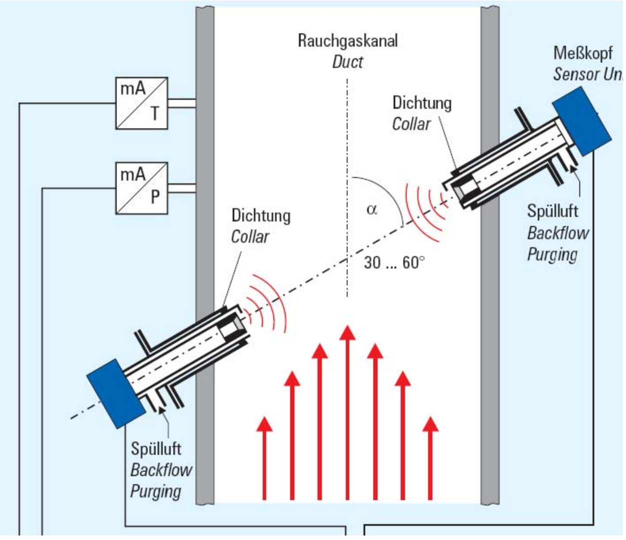
Where UNC is the QAL2 uncertainty.

Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

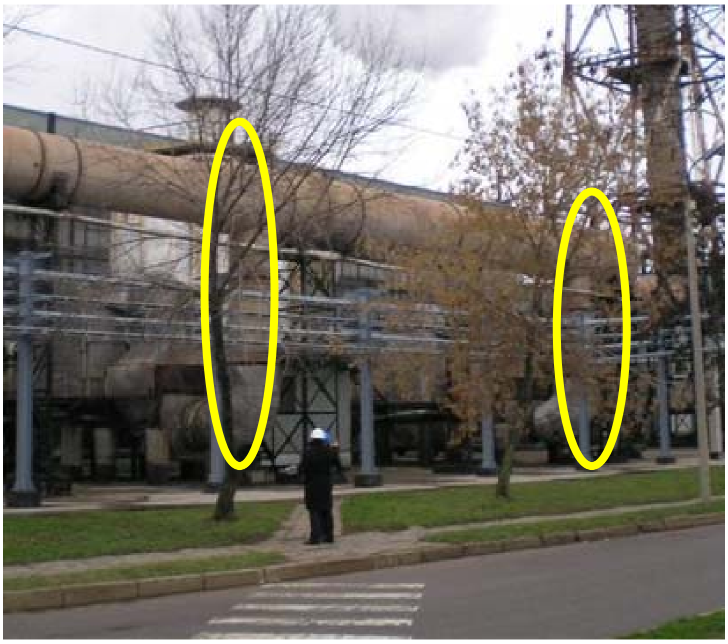
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

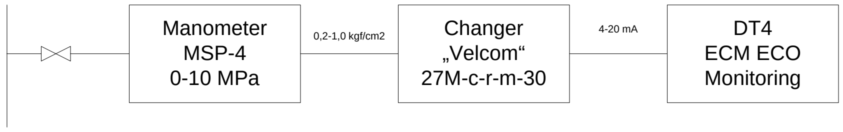
Operating conditions

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

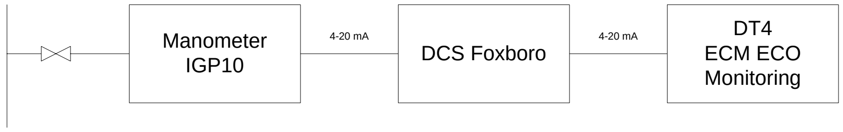
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

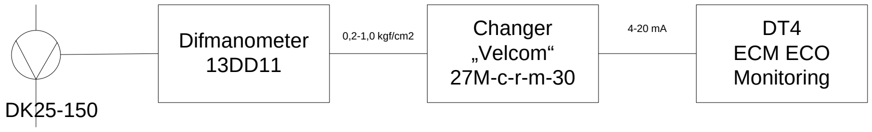
P in mixer 1-6 line



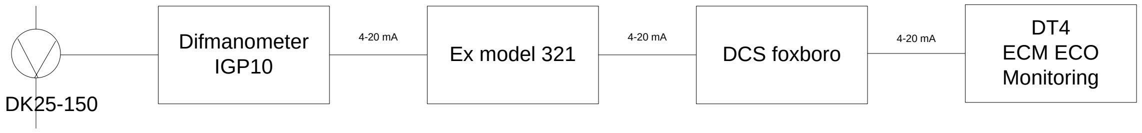
P in mixer 7-8 line



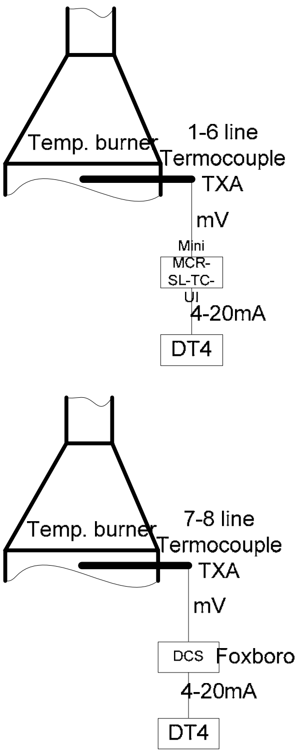
NH3 to mixer 1-6 line



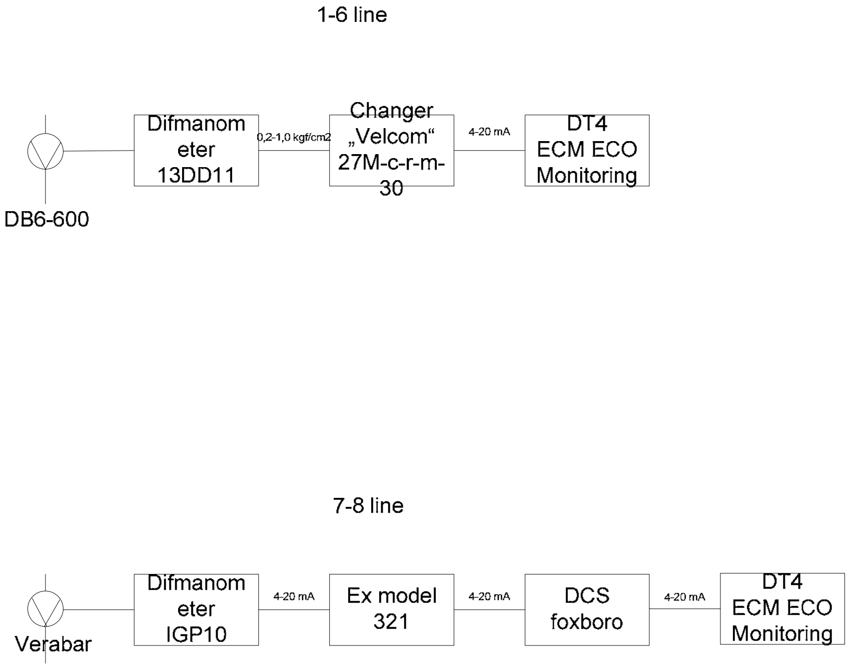
NH3 to mixer 7-8 line



T in burner



Air to mixer

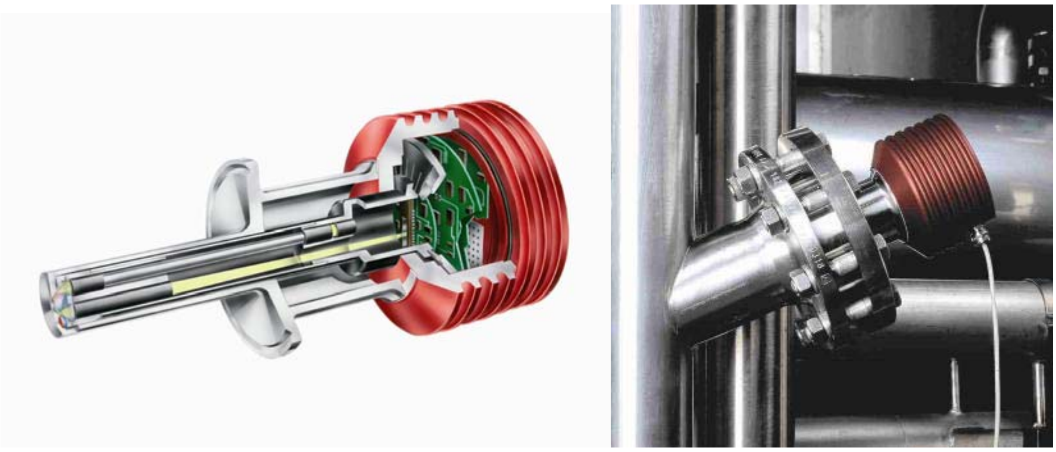


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, 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.

In case of refractometer's malfunction the HNO3 concentration is measured in laboratory.

The sample point of nitric acid production is in the output of the aggregate – in the pipe after the bleaching column. In the laboratory HNO3 concentration is tested by titration method. This method is defined in the company's standard (No.IST 5666739-32:2002) of nitric acid production. The laboratory controller, who performs the testing, is trained according "Training program for laboratory assistant performing chemical analysis"," Toxic chemical goods worker training program" and has qualification of chemistry's laboratory assistance.

Until 2010 year the testing frequency was once a week. This periodicity is usual in Achema and it is also the usual industry practice. Since 2010 year the testing frequency is once a day during the period of refractometers eventual malfunction. The laboratory NAC results are recorded in the laboratory registers No.Z42-303-40/303/08 and No.Z14-303-40/303/08. From laboratory registers NAC data are inputted in to Excel sheet manually.

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 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	59 235	03 Aug 2010	09 Mar 2011	218	272	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 Jul 31	2008 Jul 31	2008 Aug 01
Baseline Factor kgN2O/tHNO3	-	-	7.73	7.73	7.73
Production tHNO3		-	58 683	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

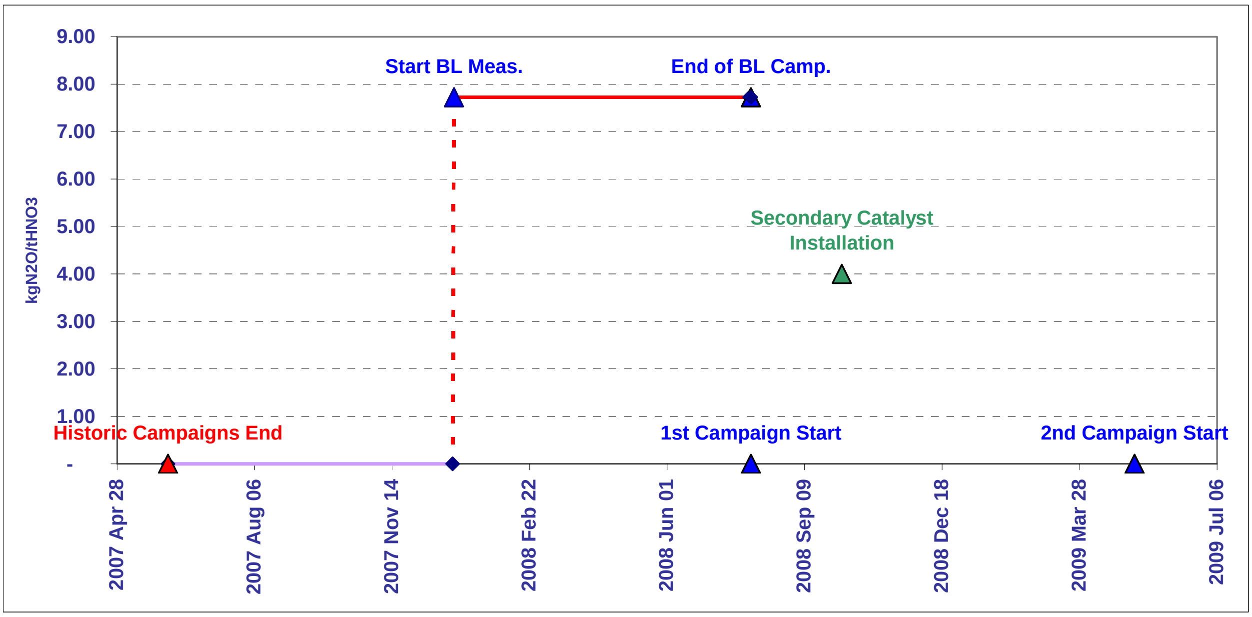


Table T 4 illustrates the calculation of the baseline emission factor on Line 4 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 28/12/2007 through 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 479 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 0.104% due to under-sampling. As a result we have arrived to the baseline emission factor of 7.73 $kgN_2O/tHNO_3$.

Table T 5 shows the calculation of the project emission factor on Line 4 during the project campaign. Project campaign started on 03/08/2010 and went through 09/03/2011.

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 2.33 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**
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	4 891	4 467	4 733	5 086	5 161	4 755	4 028	4 906
as % of Dataset	*88%*	*95%*	*94%*	*86%*	*91%*	*98%*	*100%*	*92%*	*78%*	*95%*
Minimum		-	0	-	266	-	1	3		-
Maximum		15.12	2 925	83 541	6 465	19.28	906	634		15
Mean		11.96	1 485	66 846	5 718	9.71	791	572		12
Standard Deviation		4.35	378	10 182	881	2.96	272	62		4
Total		58 683								58 683
N2O Emissions (VSG * NCSG * OH)	453	t N2O								
Emission Factor	7.30	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**		4 152	4 210					4 028	
as % of Operating Hours	***96%***		*91%*	*92%*					*88%*	
Minimum			511	-						
Maximum			2 208	75 876						
Mean			1 511	67 275						
Standard Deviation			274	8 270						
N2O Emissions (VSG * NCSG * OH)	464	t N2O								
Emission Factor	7.47	kgN2O / tHNO3								
Data within the confidence interval										
95% Confidence interval										
Lower bound			973	51 066						
Upper bound			2 048	83 484						
Count			3 735	4 149						
as % of Operating Hours			*82%*	*91%*						
Minimum			1 108	59 513						
Maximum			2 046	75 876						
Mean			1 540	68 235						
Standard Deviation			203	2 154						
N2O Emissions (VSG * NCSG * OH)	**479**	**t N2O**								
Emission Factor (EF_BL)	**7.73**	**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	**4 379**	4 674	4 262	4 348	4 872	4 433	5 233	5 057
as % of Dataset	*84%*	*89%*	*81%*	*83%*	*93%*	*85%*	*100%*	*97%*
Minimum		0.61	215	33 308	367	3	1	1
Maximum		16.65	989	77 286	7 622	19.59	909	686
Mean		12.67	385	67 218	5 617	10.35	761	593
Standard Deviation		2.81	87	3 837	591	0.45	303	86
Total		59 235						
N2O Emissions (VSG * NCSG * OH)	113	t N2O						
Emission Factor	1.91	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			215	59 697				
Upper bound			555	74 739				
Count			4 040	4 204				
as % of Operating Hours			*92%*	*96%*				
Minimum			236	59 701				
Maximum			554	74 735				
Mean			375	67 237				
Standard Deviation			75	3 551				
N2O Emissions (VSG * NCSG * OH)	**110**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**1.86**	**kgN2O / tHNO3**						
Abatement Ratio	**75.9%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	2.77	2.77						
2	2.37	2.57						
3	1.86	2.33						
Project Emission Factor (EF_P)	**2.33**	**kgN2O / tHNO3**						
Abatement Ratio	**69.8%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 5
MONITORING PERIOD:
FROM: 12/08/2010

TO: 17/03/2011

Prepared by:

VERTIS

VERTIS FINANCE

www.vertisfinance.com

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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 third 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 third project period from 12/08/2010 through 17/03/2011 on Line 5 is **103 817 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	6.61	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.22	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	76 285	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**103 817**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**68.7%**	

EMISSION REDUCTION PER YEAR			
Year	2009	2010	2011
Date From		12 Aug 2010	01 Jan 2011
Date To		31 Dec 2010	17 Mar 2011
Nitric Acid Production		48 928	27 358
Emission Reduction		**66 585**	**37 231**
*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$_2$O/tHNO$_3$.

Project emission factor during the third project campaign after installation of secondary catalysts on Line 5, which started on 12/08/2010 and went through 17/03/2011 with secondary catalyst installed and commissioned on 02/07/2008, is 2.22 kgN$_2$O/tHNO$_3$.

During the project campaign 76 285 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 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)

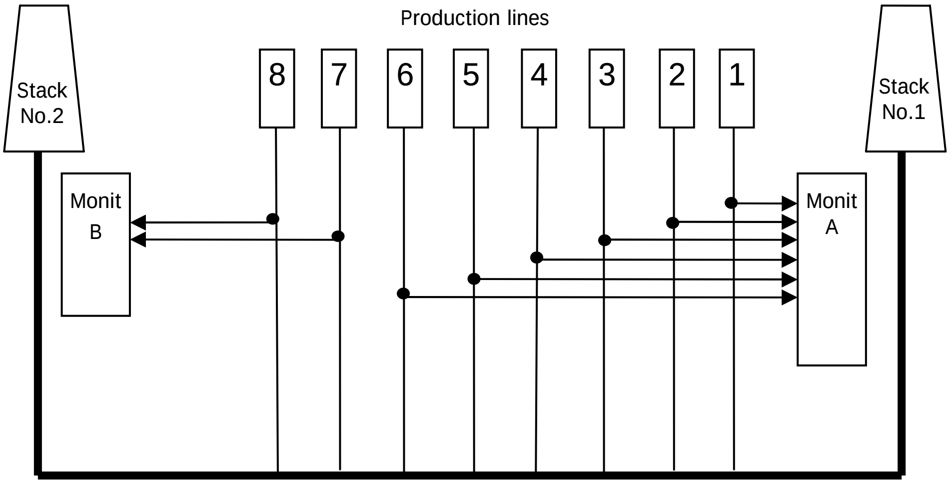
5. MONITORING PLAN

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.

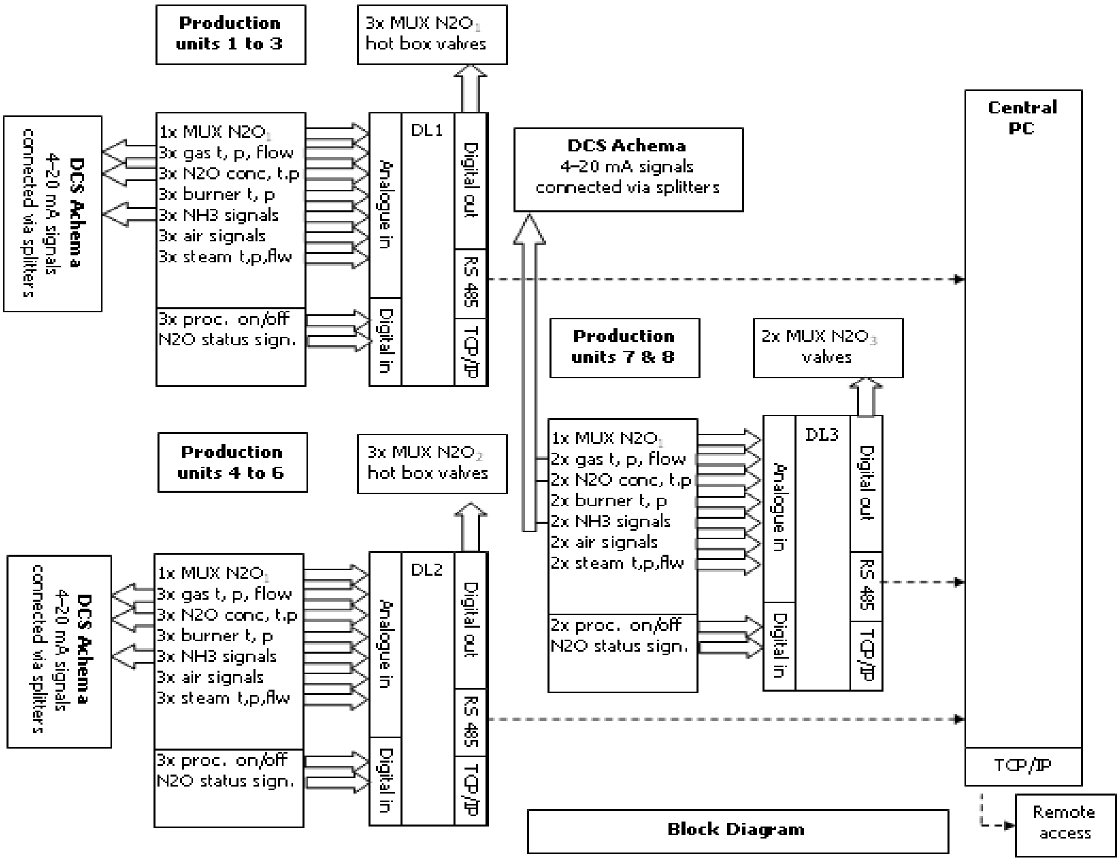
Monitoring System (MS) for purpose of this monitoring plan means:

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.

There are 8 production lines falling under scope of the JI project (lines 1-8). N_2O concentration is measured by 3 concentration meters on a switched basis.

- 1st analyzer measures 1, 2 and 3 lines.
- 2nd analyzer measures 4, 5 and 6 lines.
- 3rd analyzer measures 7 and 8 lines.

Switching between lines is managed by the AMS software. Switching intervals between lines are 300 seconds (5 minutes). 60 seconds (1 minute) of 300 seconds are for purging, i.e. no measurement during that time. Next 240 seconds (4 minutes) are for measuring, i.e. AMS is registering N_2O concentration values of selected line.

1st analyser complete 15 minutes measuring cycle:

Lines	Line 1		Line 2		Line 3	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

2nd analyser complete 15 minutes measuring cycle:

Lines	Line 4		Line 5		Line 6	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

3rd analyser complete 10 minutes measuring cycle:

Lines	Line 7		Line 8	
process	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes

Emission values are product of
- operating hours
- mean of the hourly measurements N_2O concentration
- mean of the hourly measured VSG

$$BE = OH * mean(NCSG) * mean(VSG)$$

The additional uncertainty comes from the additional deviation of mean(NCSG) in the equation, that stems from lower sampling rate. We calculate the deviation of mean(NCSG) under 2 sec sampling intervals, as well as the actual, and take the difference.

The deviation of mean(NCSG) depends on
- deviation of the hourly measurements
- sample size
- number of measurements

stdev(mean(“Actual hourly NCSG”)) = stdev(“Actual hourly NCSG”) / sqrt(“OH of NCSG measurement”)

where OH is the number of hours (or observations) that are taken into account in the calculation of NCSG, that are not eliminated due to various reasons (like short project campaign, etc). Actual means the number we have with under-sampling.

The hourly NCSG values we receive are in fact the averaged values of NCSG readings collected on a 2 seconds interval. Had we sampled every 2 seconds, we would have 1800 samples per hour. In case of two lines on the same device (with 4 minutes measurement, 1 minute of purge time), we have 720 samples per hour (or 480 in case of 3 lines per device).

“sample size” = “logging interval time” / ((“measurement time” + “switching time”) * “no. of lines”) * “measurement time” / “sampling interval time”

We can estimate the deviation of the second level NCSG measured by the device from the deviation of the hourly samples by taking into account the sample size and that they are the average of the second level readings. From this we can calculate what would be the deviation of the hourly NCSG in case we had a full sampling rate.

stdev(“Actual hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Actual sample size”)
stdev(“Ideal hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Ideal sample size”)

or

stdev(“Ideal hourly NCSG”) = stdev(“Actual hourly NCSG”) * sqrt(“Actual sample size”) / sqrt(“Ideal sample size”)

Afther that, we take into account the OH of the NCSG measurement to get the ideal deviation of the mean of the hourly values under normal sampling.

stdev(mean(“Ideal hourly NCSG”)) = stdev(“Ideal hourly NCSG”) / sqrt(“OH of NCSG measurement”)

The additional uncertainty is the difference between the ideal and the under-sampled deviation of the mean of the hourly values.

Diff = stdev(mean(“Actual hourly NCSG”)) - stdev(mean(“Ideal hourly NCSG”))

Combined UNC = sqrt(UNC^2 + Diff^2)

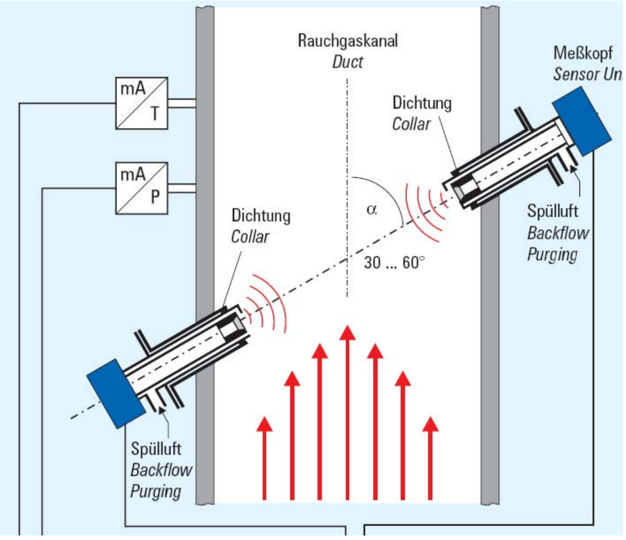
Where UNC is the QAL2 uncertainty.

Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

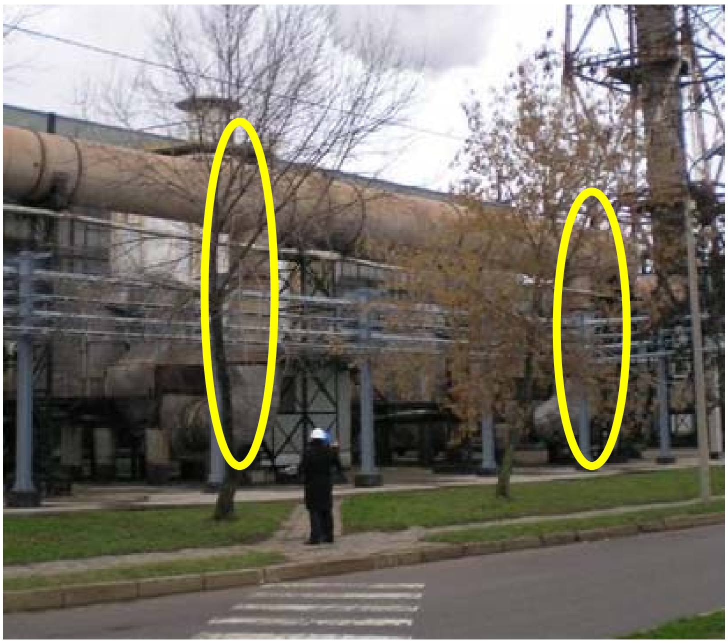
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

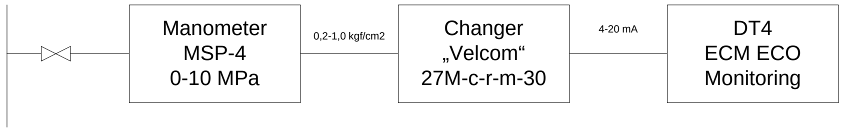
Operating conditions

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

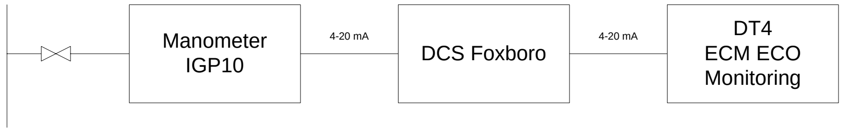
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

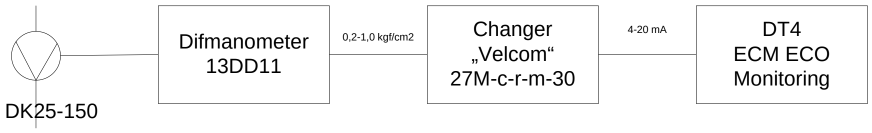
P in mixer 1-6 line



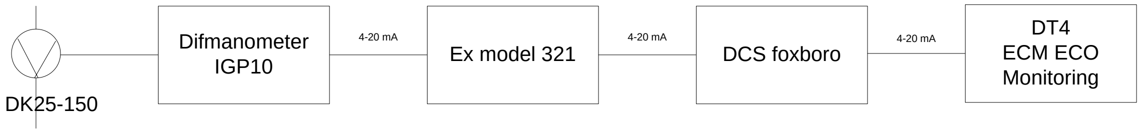
P in mixer 7-8 line



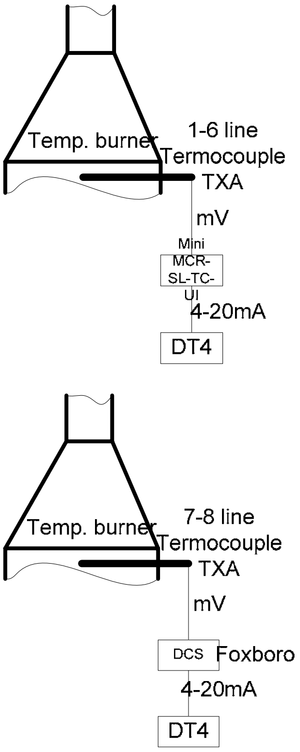
NH3 to mixer 1-6 line



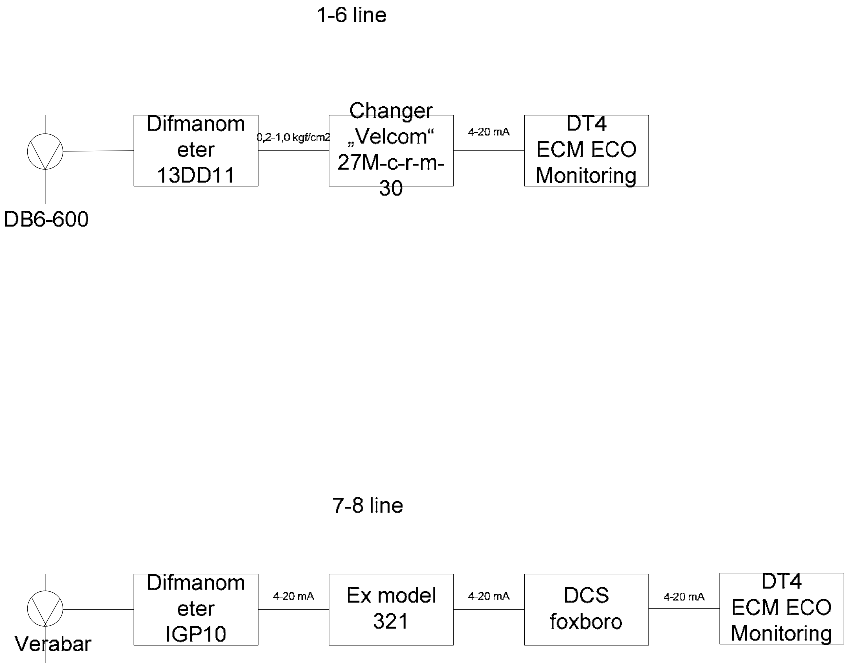
NH3 to mixer 7-8 line



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.

In case of refractometer's malfunction the HNO3 concentration is measured in laboratory.

The sample point of nitric acid production is in the output of the aggregate – in the pipe after the bleaching column. In the laboratory HNO3 concentration is tested by titration method. This method is defined in the company's standard (No.IST 5666739-32:2002) of nitric acid production. The laboratory controller, who performs the testing, is trained according "Training program for laboratory assistant performing chemical analysis"," Toxic chemical goods worker training program" and has qualification of chemistry's laboratory assistance.

Until 2010 year the testing frequency was once a week. This periodicity is usual in Achema and it is also the usual industry practice. Since 2010 year the testing frequency is once a day during the period of refractometers eventual malfunction. The laboratory NAC results are recorded in the laboratory registers No.Z42-303-40/303/08 and No.Z14-303-40/303/08. From laboratory registers NAC data are inputted in to Excel sheet manually.

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	76 285	12 Aug 2010	17 Mar 2011	218	350	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

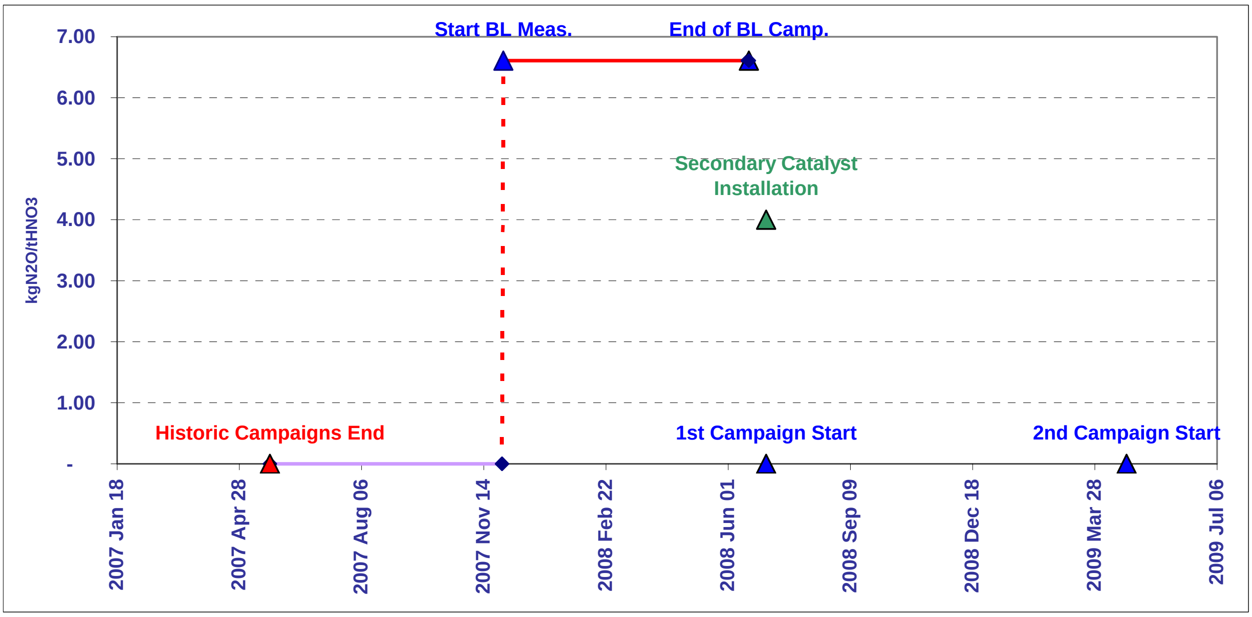


Table T 4 illustrates the calculation of the baseline emission factor on Line 5 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 29/11/2007 through 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 12/08/2010 and went through 17/03/2011.

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 2.22 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	**4 519**	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	**5 118**	5 143	4 999	5 064	5 209	5 142	5 230	5 179
as % of Dataset	*98%*	*98%*	*96%*	*97%*	*100%*	*98%*	*100%*	*99%*
Minimum		3.95	208	57 735	299	7	(1)	28
Maximum		17.45	1 058	81 816	6 460	19.54	911	716
Mean		15.00	470	67 638	6 042	10.22	882	633
Standard Deviation		1.43	59	3 502	490	0.36	116	37
Total		77 141						

N2O Emissions (VSG * NCSG * OH)	163	t N2O
Emission Factor	2.11	kgN2O / tHNO3

Data within the confidence interval	NCSG	VSG
95% Confidence interval		
Lower bound	355	60 775
Upper bound	585	74 501
Count	4 750	4 700
as % of Operating Hours	*93%*	*92%*
Minimum	355	61 272
Maximum	585	74 495
Mean	466	66 909
Standard Deviation	50	2 486

N2O Emissions (VSG * NCSG * OH)	**159**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.07**	**kgN2O / tHNO3**
Abatement Ratio	**68.7%**	

Moving Average Emission Factor Correction		**Actual Factors**	**Moving Average Rule**
	1	1.68	1.68
	2	2.90	2.90
	3	2.07	2.22

Project Emission Factor (EF_P)	**2.22**	**kgN2O / tHNO3**
Abatement Ratio	**66.5%**	

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 7
MONITORING PERIOD:
FROM: 03/11/2009

TO: 08/12/2010

Prepared by:

VERTIS

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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 third 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 third project period from 03/11/2009 through 08/12/2010 on Line 7 is **150 615 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	9.09	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.31	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	71 660	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**150 615**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**79.9%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		03 Nov 2009	01 Jan 2010
Date To		31 Dec 2009	08 Dec 2010
Nitric Acid Production		8 079	63 581
Emission Reduction		**16 980**	**133 635**
*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 third project campaign after installation of secondary catalysts on Line 7, which started on 03/11/2009 and went through 08/12/2010 with secondary catalyst installed and commissioned on 03/07/2008, is 2.31 kgN_2O/tHNO_3.

During the project campaign 71 660 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 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)

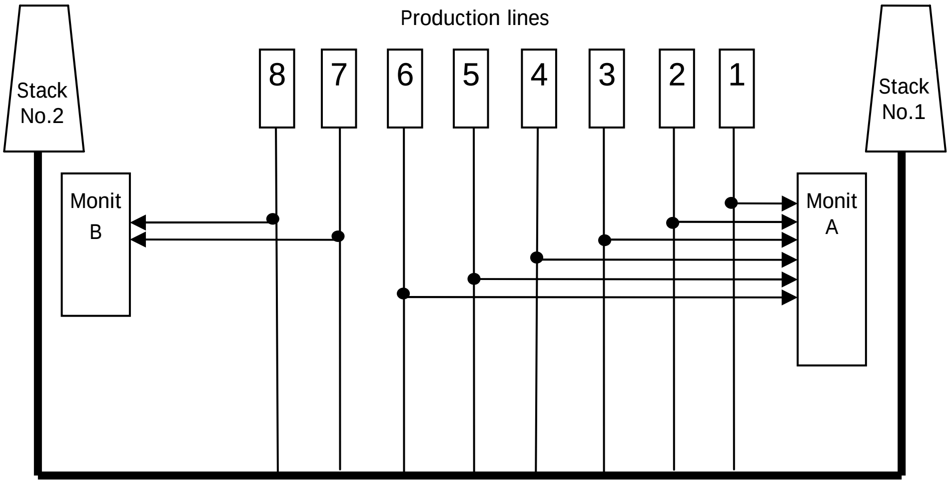
5. MONITORING PLAN

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.

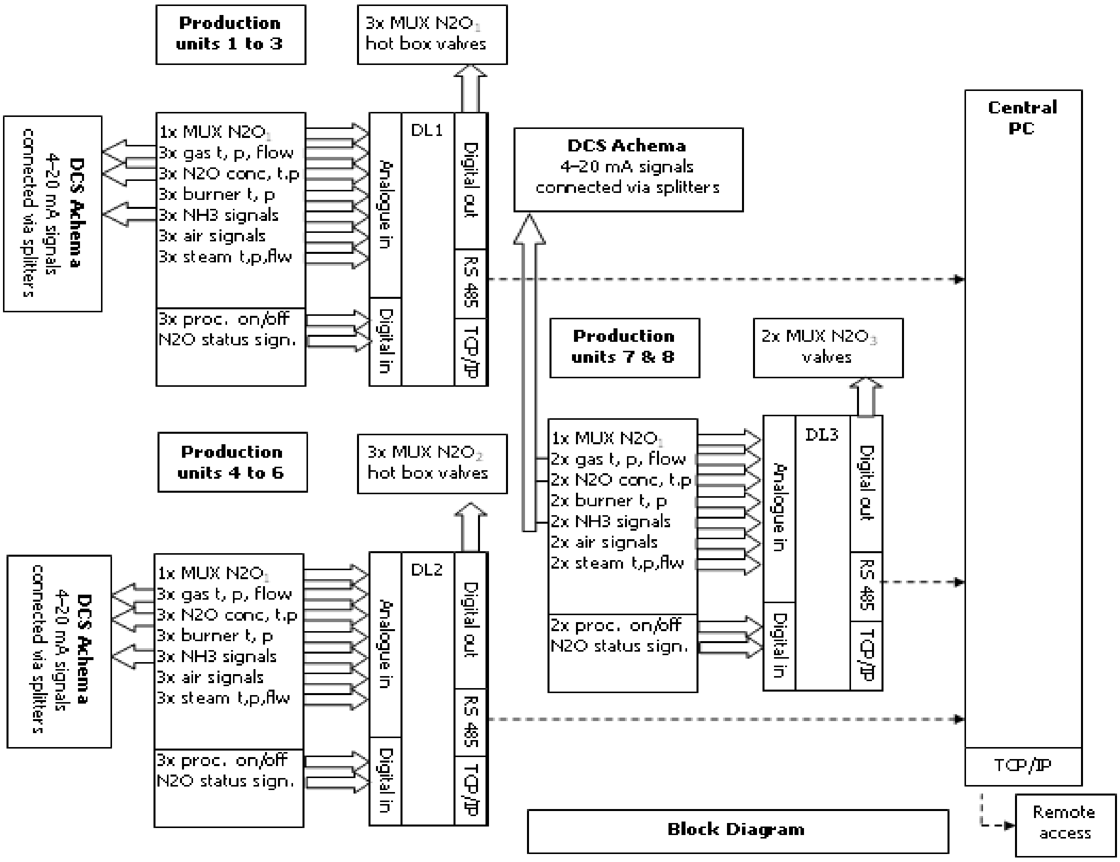
Monitoring System (MS) for purpose of this monitoring plan means:

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.

There are 8 production lines falling under scope of the JI project (lines 1-8). N_2O concentration is measured by 3 concentration meters on a switched basis.

- 1st analyzer measures 1, 2 and 3 lines.
- 2nd analyzer measures 4, 5 and 6 lines.
- 3rd analyzer measures 7 and 8 lines.

Switching between lines is managed by the AMS software. Switching intervals between lines are 300 seconds (5 minutes). 60 seconds (1 minute) of 300 seconds are for purging, i.e. no measurement during that time. Next 240 seconds (4 minutes) are for measuring, i.e. AMS is registering N_2O concentration values of selected line.

1st analyser complete 15 minutes measuring cycle:

Lines	Line 1		Line 2		Line 3	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

2nd analyser complete 15 minutes measuring cycle:

Lines	Line 4		Line 5		Line 6	
process	purging	measuring	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes	1 minute	4 minutes

3rd analyser complete 10 minutes measuring cycle:

Lines	Line 7		Line 8	
process	purging	measuring	purging	measuring
interval	1 minute	4 minutes	1 minute	4 minutes

Emission values are product of
- operating hours
- mean of the hourly measurements N_2O concentration
- mean of the hourly measured VSG

BE = OH * mean(NCSG) * mean(VSG)

The additional uncertainty comes from the additional deviation of mean(NCSG) in the equation, that stems from lower sampling rate. We calculate the deviation of mean(NCSG) under 2 sec sampling intervals, as well as the actual, and take the difference.

The deviation of mean(NCSG) depends on
- deviation of the hourly measurements
- sample size
- number of measurements

stdev(mean(“Actual hourly NCSG”)) = stdev(“Actual hourly NCSG”) / sqrt(“OH of NCSG measurement”)

where OH is the number of hours (or observations) that are taken into account in the calculation of NCSG, that are not eliminated due to various reasons (like short project campaign, etc). Actual means the number we have with under-sampling.

The hourly NCSG values we receive are in fact the averaged values of NCSG readings collected on a 2 seconds interval. Had we sampled every 2 seconds, we would have 1800 samples per hour. In case of two lines on the same device (with 4 minutes measurement, 1 minute of purge time), we have 720 samples per hour (or 480 in case of 3 lines per device).

“sample size” = “logging interval time” / ((“measurement time” + “switching time”) * “no. of lines”) * “measurement time” / “sampling interval time”

We can estimate the deviation of the second level NCSG measured by the device from the deviation of the hourly samples by taking into account the sample size and that they are the average of the second level readings. From this we can calculate what would be the deviation of the hourly NCSG in case we had a full sampling rate.

stdev(“Actual hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Actual sample size”)
stdev(“Ideal hourly NCSG”) = stdev(“Second level NCSG”) / sqrt(“Ideal sample size”)

or

stdev(“Ideal hourly NCSG”) = stdev(“Actual hourly NCSG”) * sqrt(“Actual sample size”) / sqrt(“Ideal sample size”)

Afther that, we take into account the OH of the NCSG measurement to get the ideal deviation of the mean of the hourly values under normal sampling.

stdev(mean(“Ideal hourly NCSG”)) = stdev(“Ideal hourly NCSG”) / sqrt(“OH of NCSG measurement”)

The additional uncertainty is the difference between the ideal and the under-sampled deviation of the mean of the hourly values.

Diff = stdev(mean(“Actual hourly NCSG”)) - stdev(mean(“Ideal hourly NCSG”))

Combined UNC = sqrt(UNC^2 + Diff^2)

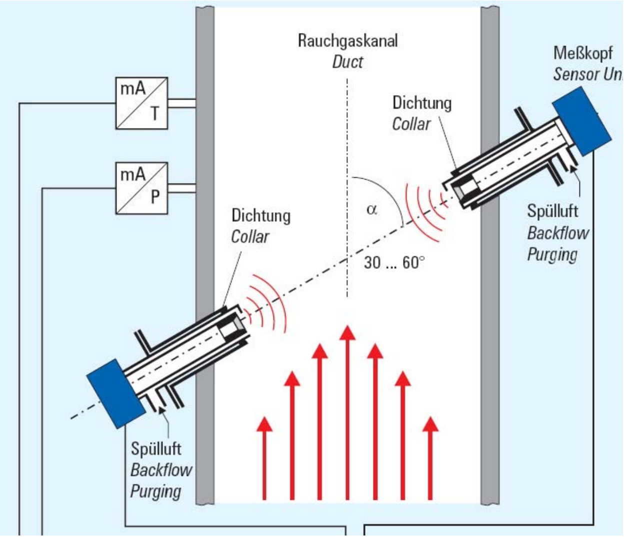
Where UNC is the QAL2 uncertainty.

Under-sampling uncertainty is part of both - the project emissions calculations and baseline emission factor calculations.

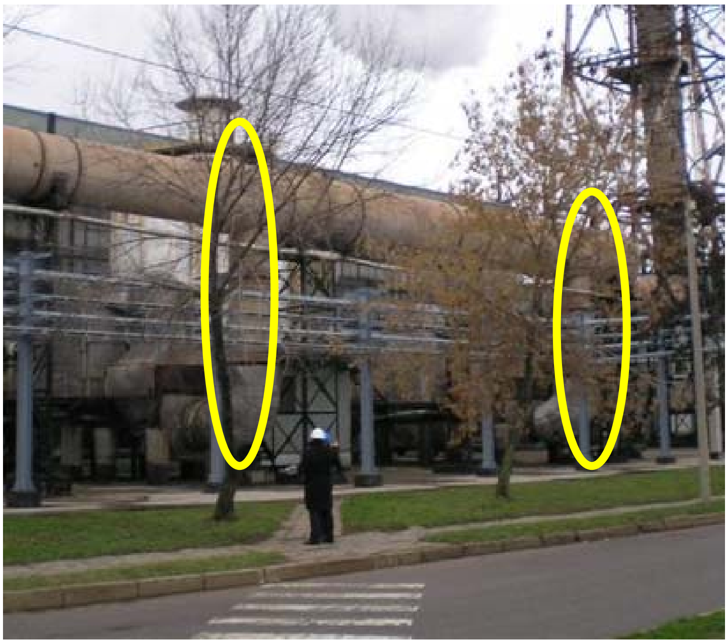
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

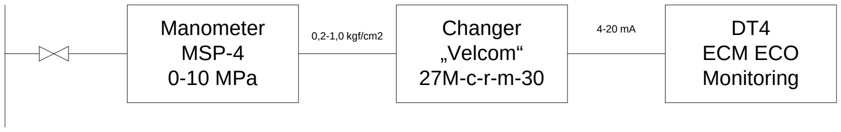
Operating conditions

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

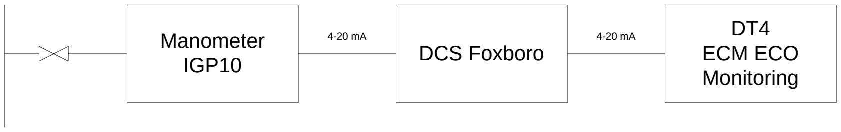
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

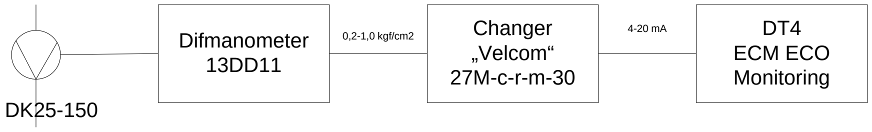
P in mixer 1-6 line



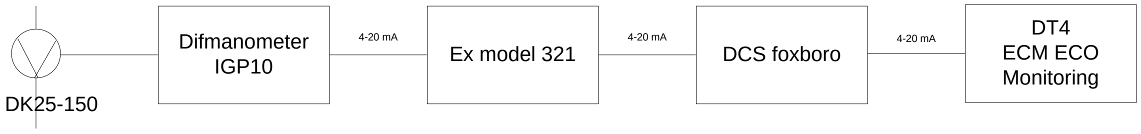
P in mixer 7-8 line



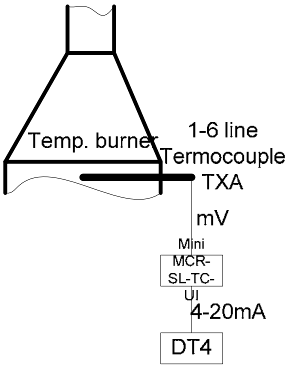
NH3 to mixer 1-6 line

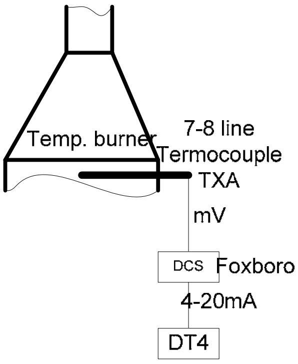


NH3 to mixer 7-8 line

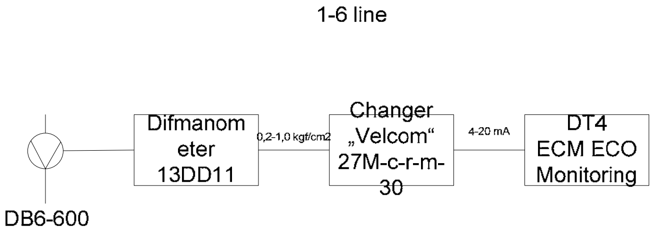


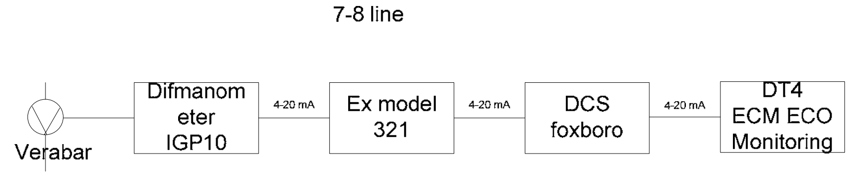
T in burner





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.

In case of refractometer's malfunction the HNO3 concentration is measured in laboratory.

The sample point of nitric acid production is in the output of the aggregate – in the pipe after the bleaching column. In the laboratory HNO3 concentration is tested by titration method. This method is defined in the company's standard (No.IST 5666739-32:2002) of nitric acid production. The laboratory controller, who performs the testing, is trained according "Training program for laboratory assistant performing chemical analysis"," Toxic chemical goods worker training program" and has qualification of chemistry's laboratory assistance.

Until 2010 year the testing frequency was once a week. This periodicity is usual in Achema and it is also the usual industry practice. Since 2010 year the testing frequency is once a day during the period of refractometers eventual malfunction. The laboratory NAC results are recorded in the laboratory registers No.Z42-303-40/303/08 and No.Z14-303-40/303/08. From laboratory registers NAC data are inputted in to Excel sheet manually.

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	71 660	03 Nov 2009	08 Dec 2010	400	179	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

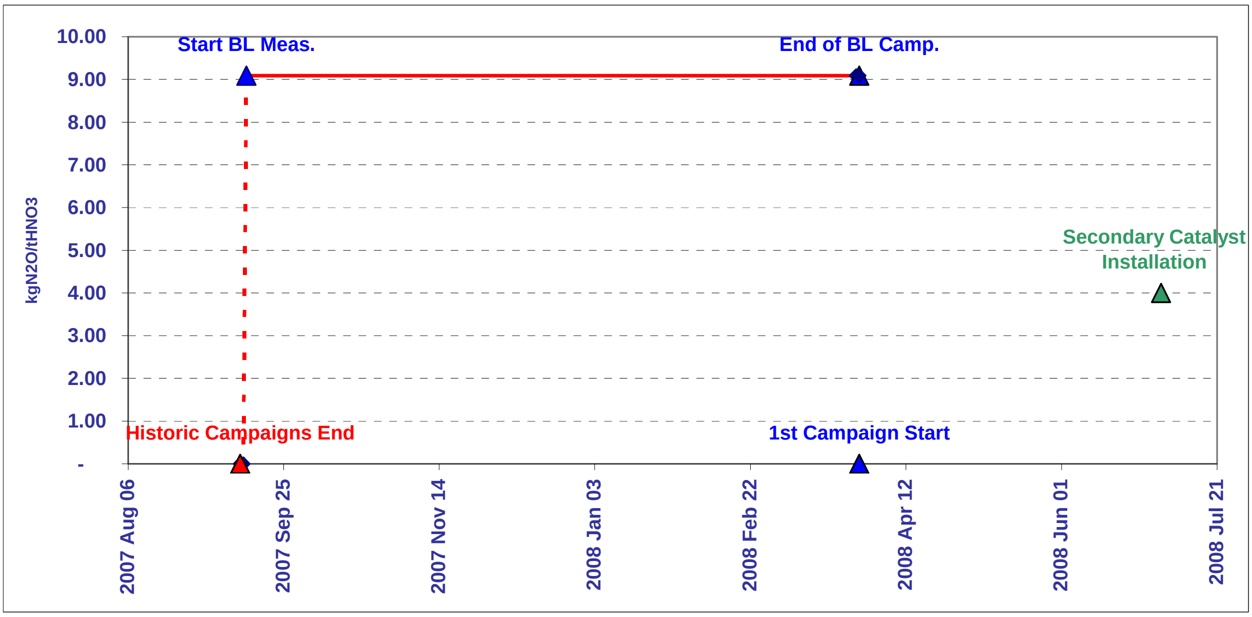


Table T 4 illustrates the calculation of the baseline emission factor on Line 7 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 12/09/2007 through 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 03/11/2009 and went through 08/12/2010.

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 2.31 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	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	**4 948**	7 468	4 948	4 937	9 598	7 762	9 598	9 598
as % of Dataset	*52%*	*78%*	*52%*	*51%*	*100%*	*81%*	*100%*	*100%*
Minimum		0.03	227	59 270	4	0	14	1
Maximum		17.70	1 138	101 494	8 000	17.14	905	669
Mean		9.60	383	73 188	3 975	10.19	498	464
Standard Deviation		6.51	103	7 323	2 655	0.64	408	232
Total		71 660						
N2O Emissions (VSG * NCSG * OH)	139	t N2O						
Emission Factor	1.94	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			182	58 834				
Upper bound			585	87 541				
Count			4 688	4 441				
as % of Operating Hours			*95%*	*90%*				
Minimum			227	58 967				
Maximum			583	87 532				
Mean			372	70 955				
Standard Deviation			91	3 530				
N2O Emissions (VSG * NCSG * OH)	**131**	**t N2O**						
Actual Project Emission Factor (EF_PActual)	**1.82**	**kgN2O / tHNO3**						
Abatement Ratio	**79.9%**							
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**						
1	2.18	2.18						
2	2.93	2.93						
3	1.82	2.31						
4	-							
Project Emission Factor (EF_P)	**2.31**	**kgN2O / tHNO3**						
Abatement Ratio	**74.6%**							

MONITORING REPORT

PROJECT: ACHEMA UKL nitric acid plant N_2O abatement project
LINE: Line 8
MONITORING PERIOD:
FROM: 21/11/2009

TO: 25/10/2010

Prepared by:

VERTIS

VERTIS FINANCE

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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 third 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 third project period from 21/11/2009 through 25/10/2010 on Line 8 is **91 448 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	6.96	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	3.56	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	86 762	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**91 448**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**70.4%**	

EMISSION REDUCTION PER YEAR			
Year	2008	2009	2010
Date From		21 Nov 2009	01 Jan 2010
Date To		31 Dec 2009	25 Oct 2010
Nitric Acid Production		10 657	76 105
Emission Reduction		**11 233**	**80 215**
*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 third project campaign after installation of secondary catalysts on Line 8, which started on 21/11/2009 and went through 25/10/2010 with secondary catalyst installed and commissioned on 11/06/2008, is 3.56 kgN_2O/tHNO_3.

During the project campaign 86 762 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)

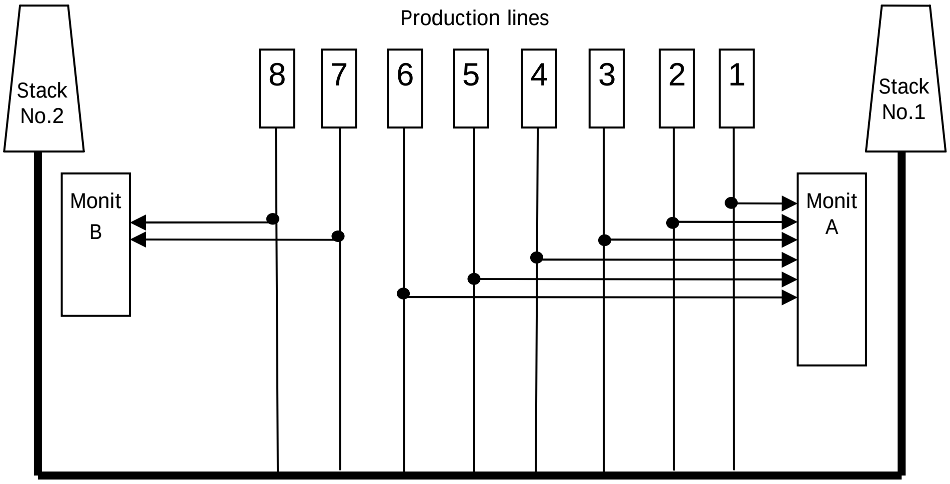
5. MONITORING PLAN

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.

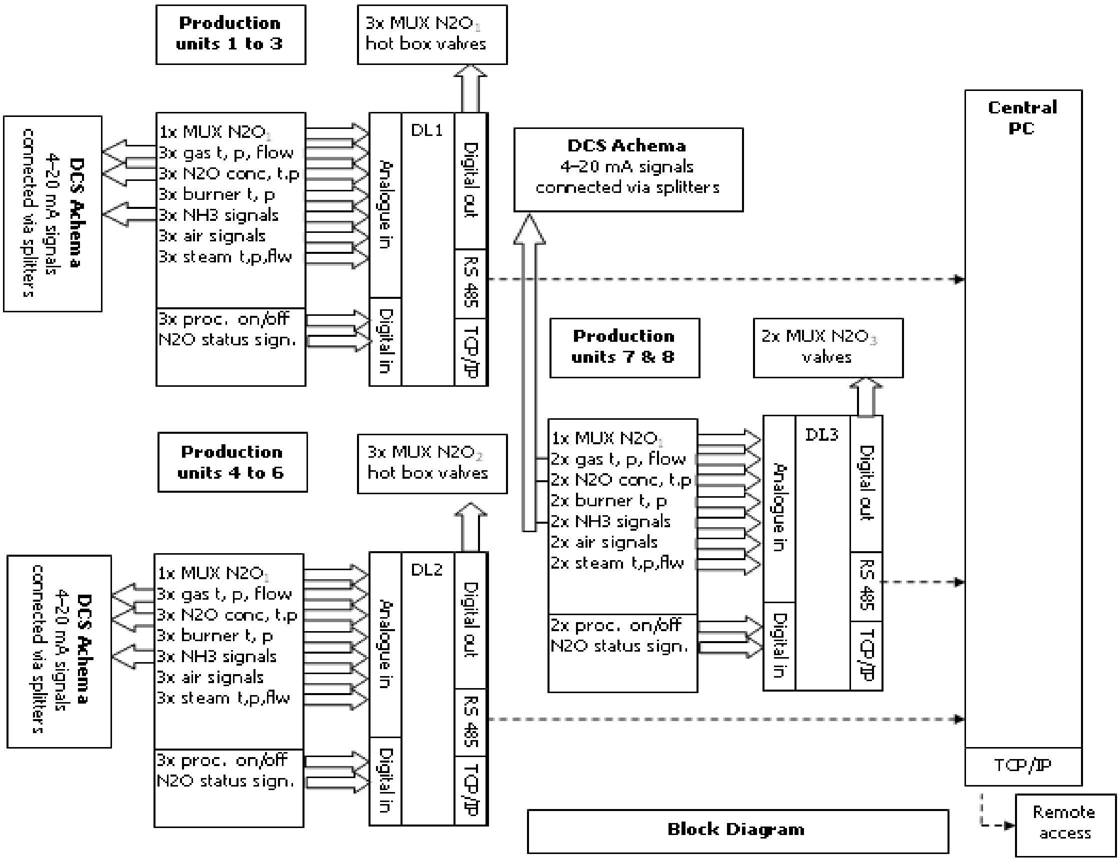
Monitoring System (MS) for purpose of this monitoring plan means:

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.

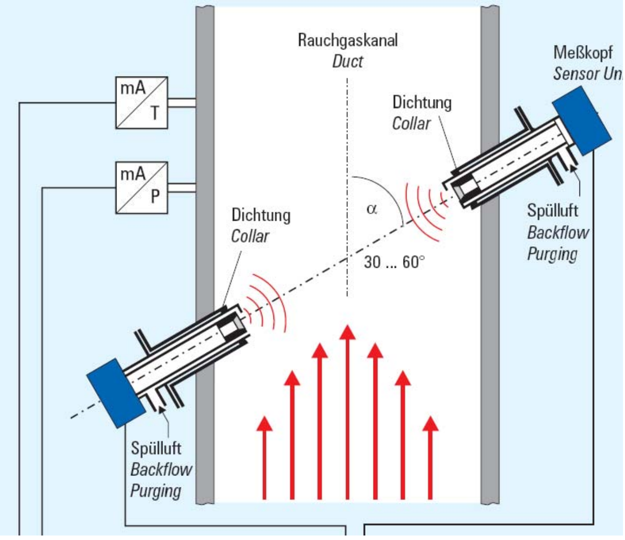
N_2O concentration is measured by concentration infrared absorption principle meters Xentra 4900 using GFX monitoring technology.

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.

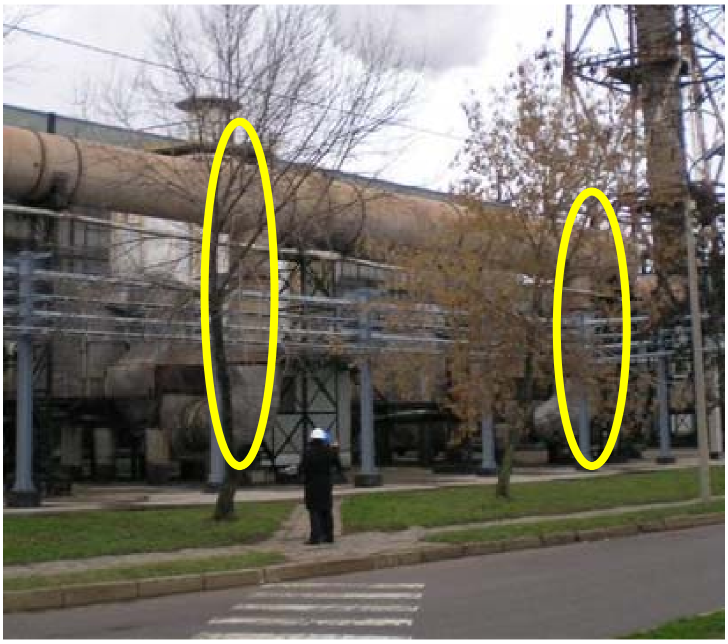
N_2O concentration measured data are sent from the concentration meter on a 2 sec basis in a form of 4-20mA signal to the datalogger and processed further.

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.

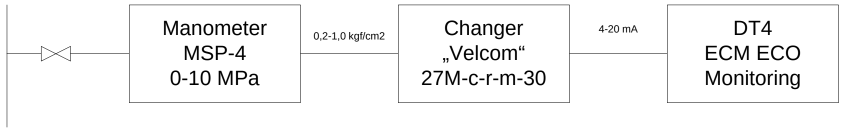
Operating conditions

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

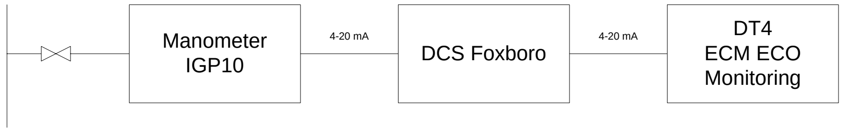
Ammonia flow
Ammonia temperature
Ammonia pressure
Primary air flow
Primary air temperature
Primary air pressure
Oxidation temperature
Oxidation pressure

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

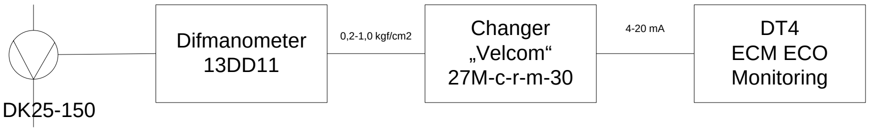
P in mixer 1-6 line



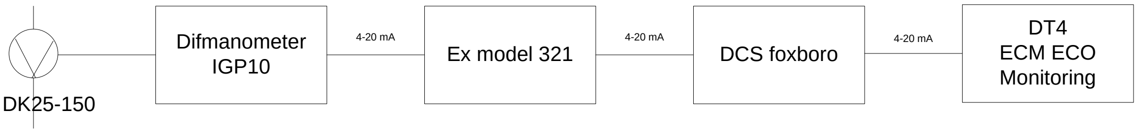
P in mixer 7-8 line



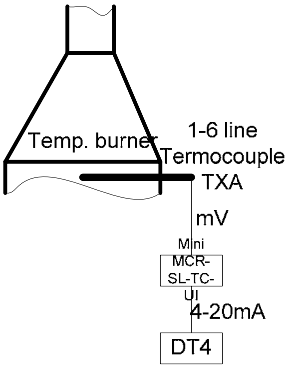
NH3 to mixer 1-6 line

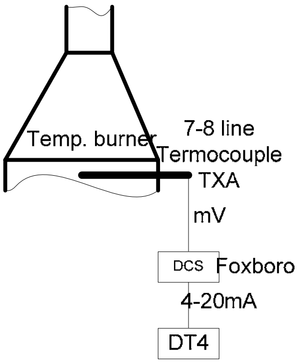


NH3 to mixer 7-8 line



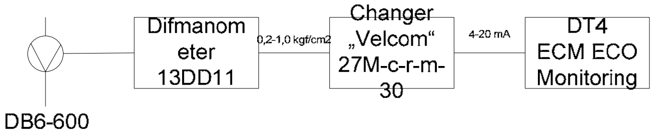
T in burner



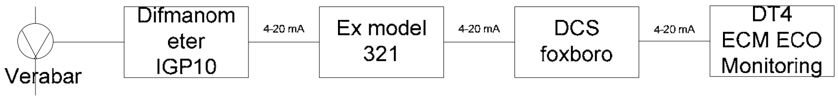


Air to mixer

1-6 line



7-8 line

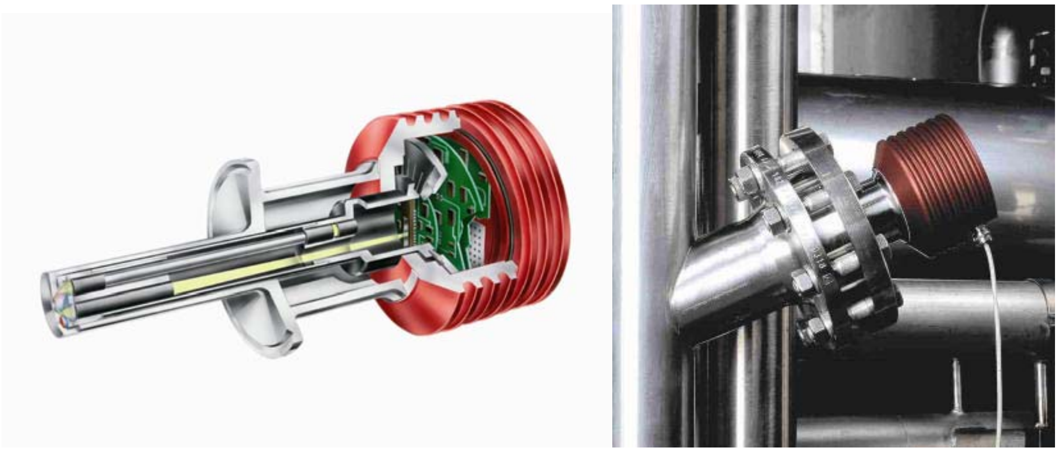


Signals obtained from these measurement devices from production Lines 1-6 are converted from pneumatic to 4-20mA analog signals. Operating conditions measurement devices installed in production Lines 7-8 provide the 4-20mA signals which are digitalized and provided to the monitoring system dataloggers, 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 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	86 762	21 Nov 2009	25 Oct 2010	338	257	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

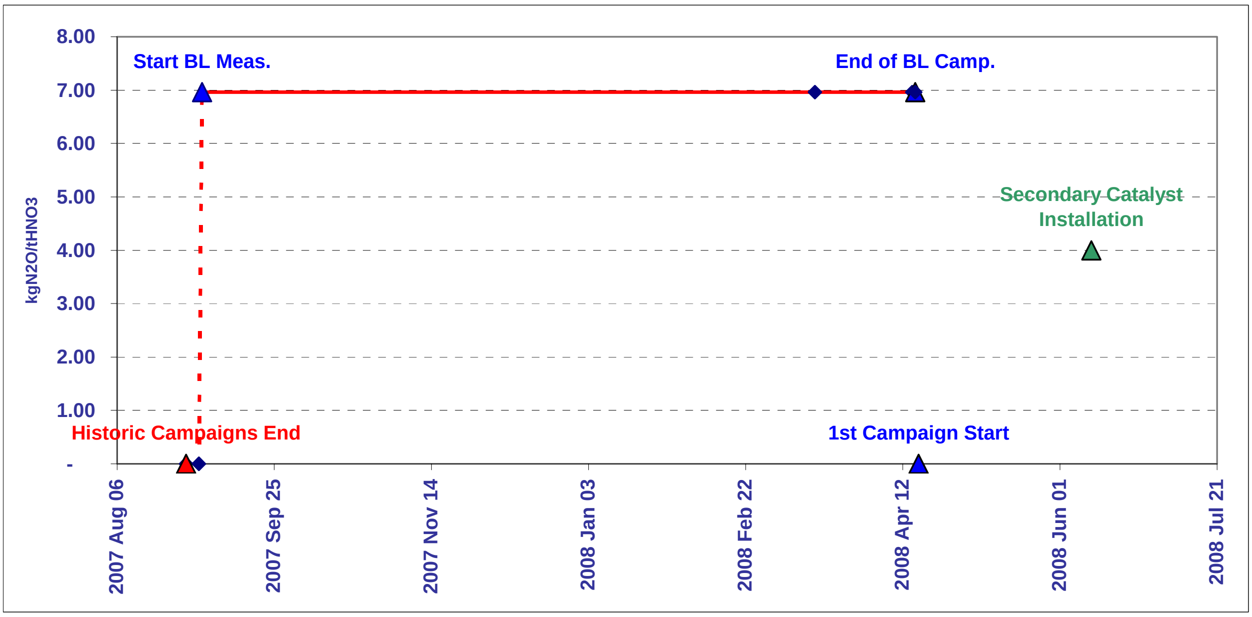


Table T 4 illustrates the calculation of the baseline emission factor on Line 8 using the method as defined in the CDM methodology AM0034 and in the PDD. We have not used overlapping approach allowed by the PDD. Baseline emission factor was determined based on raw data measured from 01/09/2007 through 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 21/11/2009 and went through 25/10/2010.

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 3.56 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	**5 907**	8 108	5 914	5 893	8 110	6 460	8 110	8 110
as % of Dataset	*73%*	*100%*	*73%*	*73%*	*100%*	*80%*	*100%*	*100%*
Minimum		0.02	193	66 410	2	0	13	6
Maximum		17.91	1 100	99 082	8 000	19.99	914	709
Mean		10.70	388	78 705	4 865	9.44	672	564
Standard Deviation		6.41	55	6 726	2 305	2.56	371	149
Total		86 762						

N2O Emissions (VSG * NCSG * OH)	180	t N2O
Emission Factor	2.08	kgN2O / tHNO3

Data within the confidence interval		
95% Confidence interval		
Lower bound	281	65 521
Upper bound	495	91 889
Count	5 704	5 564
as % of Operating Hours	*97%*	*94%*
Minimum	281	66 410
Maximum	495	91 886
Mean	388	78 034
Standard Deviation	48	6 189

N2O Emissions (VSG * NCSG * OH)	**179**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.06**	**kgN2O / tHNO3**
Abatement Ratio	**70.4%**	

Moving Average Emission Factor Correction		**Actual Factors**	**Moving Average Rule**
	1	4.35	4.35
	2	4.26	4.30
	3	2.06	3.56
	4	-	

Project Emission Factor (EF_P)	**3.56**	**kgN2O / tHNO3**
Abatement Ratio	**48.9%**	

REVISIONS TO THE MONITORING PLAN

PROJECT: **ACHEMA UKL nitric acid plant N_2O abatement project**

Prepared by:

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VERTIS FINANCE

As required by PROCEDURES REGARDING CHANGES DURING PROJECT IMPLEMENTATION (Version 01) issued by the Joint Implementation Supervisory Committee we are listing here all changes occurred to the Achema UKL-7 JI project from time when the PDD document including the Monitoring Plan was deemed to be final (November 27, 2009) until December 8, 2010:

Section D.1. (pages 18-19 and 57-58)

Updated information on the N_2O concentration measurements done on the switched basis. It does not relate to any change comparing to the Monitoring Plan as determined, it is just insertion of more detailed description.

Section D.1. (pages 20-21 and 59-60)

Achema injects steam into tail gas of the UKL-7 plant. This steam is eliminated fro the JI project calculations. Monitoring plan has been updated with detailed description of how this elimination is performed in practice.

Section D.1. (pages 21-23 and 62-64)

Achema measures nitric acid production by refractometers and also by laboratory analysis. Insertion into the Monitoring Plan describes in details how these measurements are performed and used.