MONITORING REPORT

Second periodic verification

(version 6, February 15, 2012)

PROJECT: **Project aimed at N_2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA, company situated in Targu Mures, Romania**

Prepared by:

VERTIS

VERTIS FINANCE

Monitoring periods

Line NA2
Project campaign 2

FROM:	24/07/2010
TO:	09/10/2011
ERUs	881,629

Line NA3
Project campaign 2

FROM:	14/04/2010
TO:	10/07/2011
ERUs	953,653

Line NA4
Project campaign 2

FROM:	17/12/2009
TO:	30/03/2011
ERUs	638,903

Third monitoring period start and end: **December 17, 2009 – October 9, 2011**

Third monitoring period ERUs in total: **2,474,185**

MONITORING REPORT

PROJECT: **Project aimed at N_2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA, company situated in Targu Mures, Romania**

LINE: **Line 2**

MONITORING PERIOD:

FROM: **24/07/2010**

TO: **09/10/2011**

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1. EXECUTIVE SUMMARY

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

Total quantity of emission reductions generated during the period from 24/07/2010 through 09/10/2011 on Line 2 is **881 629 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	13.48	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.17	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	207 983	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	207 983	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	251 448	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**881 629**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**83.9%**	

EMISSION REDUCTION PER YEAR			
Year	2009	2010	2011
Date From		24 Jul 2010	01 Jan 2011
Date To		31 Dec 2010	09 Oct 2011
Nitric Acid Production		90 570	160 878
Emission Reduction		**317 558**	**564 071**
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 2 is 13.48 $kgN_2O/tHNO_3$. The baseline was carried out from 13/07/2007 through 20/10/2008.

The secondary catalyst on Line 2 was installed on 27/10/2008. Project emission factor during the second project campaign, which started on 24/07/2010 and went through 09/10/2011, is 2.17 $kgN_2O/tHNO_3$.

During the project campaign 251 448 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 Joint Implementation project aimed at N2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA company, situated at Târgu Mures, Romania.

Azomures 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 all 3 nitric acid plants.

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 the three 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 requirement 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 a line-specific basis. Campaign used for baseline measurements on the Line 2 has been carried out from 13/07/2007 through 20/10/2008. Nitric acid production during this campaign did not exceed the historic nitric acid production established as an average production during previous historic campaigns.

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 calculated based on the 2008 QAL2 report in its sections 7.5 (also in table 10.5) where separate UNC values for N2O concentration and tail gas flow are defined. The NA2 QAL2 test report does not contain calculation of total AMS UNC value, only separate UNC values for N2O concentration and tail gas flow. Total AMS UNC is therefore calculated as $UNC = \sqrt{(2.83^2 + 1.81^2)}$. Total UNC is then 3.36%.

Corrective 2009 tail gas flow QAL2 test does not impact the emission reductions calculations, because AMS UNC is used only for baseline calculations. Baseline measurements on NA2 were completed on October 20, 2008 while results of 2009 corrective tail gas flow QAL2 test are to be applied only from August 2009. It means, that we use results of this 2009 report only for correction of tail gas flow figures from August 2009.

The N2O 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

• the impulse line is the same as the NOx outlet line

• the circuit is the same as for measuring NOx outlet concentration, including up to the pressure reducing valve outlet.

• the gas for the N_2O analyzer is taken from here through a water discharge cooler. The analyzer is produced by Environement S.A., France and is based on non-dispersive infrared absorption principle; it is placed in the same cabinet as the NOx analyzer. The N2O concentration measurement range is between 0 – 2000 ppm.

• the outlet analyzer signal is of 4 – 20 mA, proportional to the value of the concentration. This signal is transmitted through an electric cable at the plant's central control panel. The electric cable is approx. 100 m long.

• the device that converts the 4 – 20 mA signal in nitrogen oxides concentration is a ISU – MMC- 24C digital indicator produced by Infostar Pascani. The device has 16 inlet circuits of 4 – 20 mA. The readings are digitally displayed and are recorded every 2 seconds. Data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

3.1.2 Tail gas flow, temperature and pressure

• the measuring point is located on the expansion turbine outlet pipe towards the discharge nozzle; Pytot type sensor with multiple holes; operating conditions: absolute p = 2.5 bar, t = 80°C

• pneumatic connection line (12 mm diameter and approx. 1 m long hoses) between the sensor and the electric switch box where the Dp cell is located; pneumatic connection line (6 mm diameter and approx. 2 m long hose) between the sensor and the electric switch box where the absolute pressure measuring cell is located

• measuring device: Dp differential transducer, produced by ABB, measuring range between 0 – 30 mbar; absolute pressure transducer produced by Endress&Hauser,

measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

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 Composition of the ammonia oxidation catalyst

It is business-as-usual in Azomures to change composition of oxidation catalysts installed between campaigns, so the composition during historic and the baseline campaigns is varying.

Reason for switching from Heraeus to Johnson Matthey supplier of primary catalysts for plant NA2 between baseline campaign and second project campaign was of financial nature. Type of the catalyst and its composition (just minor change in the composition caused by slightly different ratio between 3 main precious metal components) remained the same, just the supplier has changed. This change had no impact on N2O formation underneath the primary catalysts and in the tail gas. Use of this type of primary catalysts is the industry standard.

3.4 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 4 campaigns), has been used as a cap on the length of the baseline campaign.

3.5 Regulatory baseline emissions factor

There are no regulatory limits of N2O whether defined as mass or concentration limits existent in Romania and there are no limits defined in the Azomures IPPC permit. Project thus uses baseline emission factor as measured during the baseline campaign.

4. PROJECT EMISSIONS

During the second 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 a continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

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

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

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

where:

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

4.1.2 Derivation of a moving average emission factor

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

4.2 Minimum project emission factor

Because this campaign was second project campaign on Line 2 there has been no minimum average emission factor established yet for this campaign. This factor will be established after 10^{th} project campaign.

4.3 Project Campaign Length

Project campaign length was shorter than the campaign length normal and at the same time the baseline campaign length was also shorter than the campaign length normal and thus entire baseline campaign measurements were used for calculation of the baseline emission factor.

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

5.1 Main air flow

• the measuring point is located on the compressor air discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 10 m long

• measuring device: Fischer Roesmount differential electronic transducer, having a measuring range between 0 – 45.24 mbar; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 30 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.2 Secondary air flow

• the measuring point is located on the air compressor discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 15 m long

• measuring device: Fischer Roesmount differential electronic transducer, having a measuring range between 0 – 500 mm H2O; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 50 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.3 Casing protection air flow

• the measuring point is located on the air duct to the reactors casing, ramifications from the compressor discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 10 m long

• measuring device: FEPA Birlad differential electronic transducer, having a measuring range between 0 – 1500 mm H2O; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 60 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.4 Reactor sieves temperature

• the measuring point is located on the oxidation reactor; sensor; PtRh-Pt thermocouple, operating conditions: t = 800 - 1000°C

• electric signal transmission between the sensor and the transducer: PtRh-Pt correction cable, approx. 50 m long

• digital indicator measuring device; measuring range between 0 – 1000°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 6 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.5 Consumed liquid ammonia flow

• the measuring point is located on the ammonia evaporator inlet pipe; Coriolis type sensor; operating conditions: p = 12 bar, t = 8 – 10°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 90 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 0 – 20 t/h; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 10 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.6 Flow of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; electromagnetic sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 0 – 100 t/h; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.7 Temperature of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; Coriolis type sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between -50 – 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this

database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.8 Density of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; Coriolis type sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 1.2 – 1.4 kg/l; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.9 Tail gases flow, tail gases pressure, tail gases temperature

• the measuring point is located on the expansion turbine outlet pipe towards the discharge nozzle; Pytot type sensor with multiple holes; operating conditions: absolute p = 2.5 bar, t = 80°C

• pneumatic connection line (12 mm diameter and approx. 1 m long hoses) between the sensor and the electric switch box where the Dp cell is located; pneumatic connection line (6 mm diameter and approx. 2 m long hose) between the sensor and the electric switch box where the absolute pressure measuring cell is located

• measuring device: Dp differential transducer, produced by ABB, measuring range between 0 – 30 mbar; absolute pressure transducer produced by Endress&Hauser, measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.10 Oxidation reactor pressure

• the measuring point is located on the air compressor discharge pipe; sensor type: capsule for electronic transducer; operating conditions: absolute p = 3.5 bar, t = 200°C

• pneumatic connection line between the sensor and the transducer; pneumatic connection line of 8 mm diameter and approx. 10 m long

• measuring device: Foxboro transducer, measuring range between 0 – 5 bar; absolute pressure transducer produced by Endress&Hauser, measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 50 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.11 N_2O concentration

• the impulse line is the same as the NOx outlet line

• the circuit is the same as for measuring NOx outlet concentration, including up to the pressure reducing valve outlet.

• the gas for the N2O analyzer is taken from here through a water discharge cooler. The analyzer is produced by Environement S.A., France and is based on non-dispersive infrared

absorption principle; it is placed in the same cabinet as the NOx analyzer. The N2O concentration measurement range is between 0 – 2000 ppm.

• the outlet analyzer signal is of 4 – 20 mA, proportional to the value of the concentration. This signal is transmitted through an electric cable at the plant's central control panel. The electric cable is approx. 100 m long.

• the device that converts the 4 – 20 mA signal in nitrogen oxides concentration is a ISU – MMC- 24C digital indicator produced by Infostar Pascani. The device has 16 inlet circuits of 4 – 20 mA. The readings are digitally displayed and are recorded every 2 seconds. Data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

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.”

QAL2 test providing regression lines and the combined uncertainty as further used in the model was performed in February 5 – 8, 2008 by company Airtec holding the ISO 17025 accreditation. During the AST test performed in August 3 – 6, 2009 by company SGS holding the ISO 17025 accreditation the NA2 tail gas flow measurement failed to pass the AST test. Azomures thus ordered and performed the corrective NA2 tail gas flow measurement QAL2 test in November 2 – 4, 2009 done by company SGS holding the ISO 17025 accreditation. New corrected regression lines and the combined uncertainty resulting from the corrective QAL2 test are applied to the Azomures raw data from date of the failed AST test, i.e. from August 2009. During AST test in November 1, 2010 done by company SGS holding the ISO 17025 accreditation the NA2 measurements passed the test.

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
Xo: X 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 in “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

The measurement system captures and logs normalized stack volume flow in an integrated manner, calculating the final figure from the mA signal of the endpoints by itself, as opposing to storing just temperature and pressure and deriving the volume flow later. Therefore, the volume flow values can be used as input for QAL2 recalibration transformation without de-normalization and the need for temperature, pressure, and duct cross-section area. The normalized calibrated stack gas flow rates are further fed into the emission calculation model for 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 ppm (parts per million). After QAL2 re-calibration, the values are converted to mgN2O/Nm3 (mg N2O per normalized cubic meter) to make it fit into the formulas set out in the methodology.

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 4 previous campaigns. Average production in campaigns preceding the baseline campaign was 260 782 tHNO3 and time duration was on average 401 days. Table contains also information on suppliers of primary catalysts for Line 2 (4 burners). As shown in the table, it is usual practice in Azomures to use primary catalysts from two suppliers.

T 2 Historic campaigns

Line	AzoMures-2		Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	1	t HNO3	-	-	-	-	n/a	N/A	N/A
	2	t HNO3	241 277	11 Sep 2001	15 Jun 2003	642	376	Engelhart-Cal	N/A *
	3	t HNO3	250 030	19 Jun 2003	01 Aug 2004	409	611	OMG AG	N/A *
	4	t HNO3	319 467	20 Aug 2004	14 Feb 2006	543	588	Umicore Degussa	N/A *
	5	t HNO3	232 352	03 Apr 2006	21 May 2007	413	563	Umicore Degussa	N/A *
Average HNO3 production		t HNO3	**260 782**			**401**	**650**	* Confidential, but available for verification	
Project Campaigns	BL	t HNO3	207 983	13 Jul 2007	20 Oct 2008	465	447	Heraous	N/A *
	PL	t HNO3	251 448	24 Jul 2010	09 Oct 2011	443	568	Johnson Matthey	N/A *

The project campaign production value of 251 448 tHNO3 was lower than historic nitric acid production set at level of 260 782 tHNO3.

T 3 and Chart C 1 define the length of the baseline campaign set according to the historic campaign length. Baseline campaign measurements was carried out from 13/07/2007 through 20/10/2008. During baseline campaign, a total of 207 983 tHNO3 was produced, NCSG measurements are taken into account until the production of 207 983 tHNO3 was reached.

The project campaign production value of 251 448 tHNO3 was lower than historic nitric acid production set at level of 260 782 tHNO3.

T 3 Baseline campaign length

AzoMures-2	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 May 21	2007 Jul 13	2008 Oct 20	2008 Oct 20	2008 Oct 21
Baseline Factor kgN2O/tHNO3	-	-	13.48	13.48	13.48
Production tHNO3		-	207 983	207 983	-
Per Day Production tHNO3	649.7				
Baseline less Historic Production	**(52 799.0)**				
Baseline less Historic Days	**(81.3)**				

C 1 Baseline campaign length

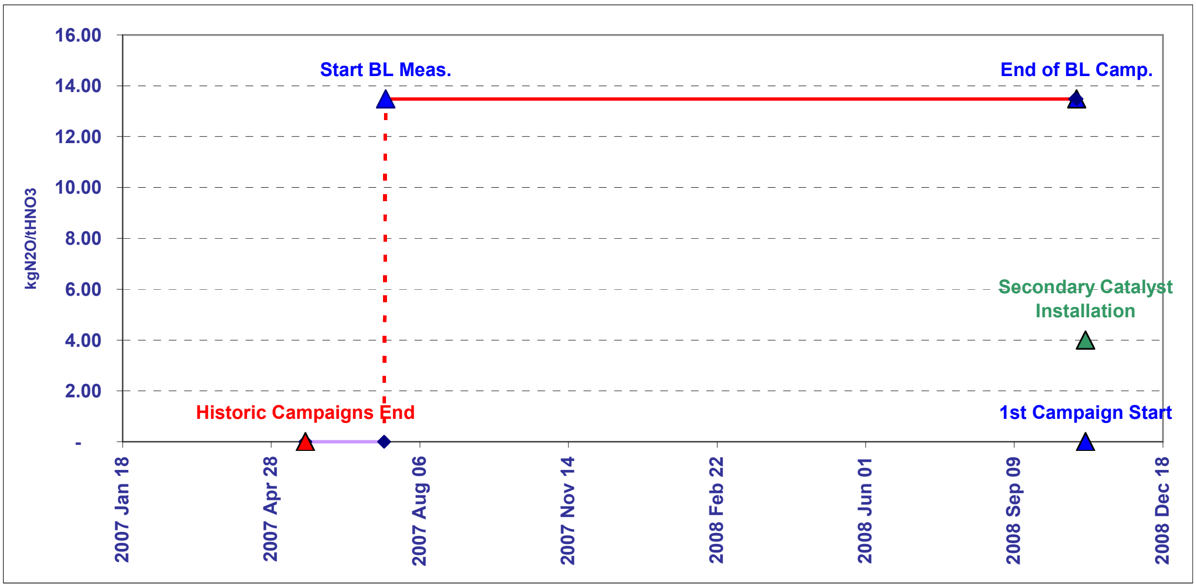

Table T 4 illustrates the calculation of the baseline emission factor on Line 2 using the method as defined in the CDM methodology AM0034 and in the PDD. Baseline measurement was carried out from 13/07/2007 through 20/10/2008.

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 640˚C occurred. Calculated baseline N2O emissions were 1,194 tN_2O.

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

The UNC factor defined by the QAL2 report is 3.360%. As a result we have arrived to the baseline emission factor of 13.48 $kgN_2O/tHNO_3$.

Table shows the calculation of the project emission factor on Line 2 during the project campaign. Project campaign started on 24/07/2010 and went through 09/10/2011.

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 (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 640˚C occurred.

By dividing total mass o N2O emissions by the nitric acid production (capped by nameplate capacity 725 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.17 kgN2O/tHNO3.

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

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

T 4 Baseline emission factor

BASELINE EMISSION FACTOR								
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
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		60.00	5 000	200 000	18 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**8 132**	10 112	9 907	10 109	10 100	10 108	10 107	9 299
as % of Dataset	*80%*	*100%*	*98%*	*100%*	*100%*	*100%*	*100%*	*92%*
Minimum		-	3	576	-	0	(26)	-
Maximum		40.70	4 321	130 424	16 424	1.37	876	403
Mean		20.57	2 765	102 619	9 743	0.16	735	309
Standard Deviation		9.36	1 311	31 897	3 817	0.15	280	140
Total		207 983						
N2O Emissions (VSG * NCSG * OH)	2 307	t N2O						
Emission Factor	10.72	kgN2O / tHNO3						
Permitted Range								
Minimum					7 800	0	800	0
Maximum					12 000	0.13	880	400
Data within the permitted range								
Count	**5 750**		5 732	5 750				
as % of Operating Hours	***71%***		*70%*	*71%*				
Minimum			6	-				
Maximum			4 321	130 424				
Mean			3 056	113 928				
Standard Deviation			967	8 069				
N2O Emissions (VSG * NCSG * OH)	2 831	t N2O						
Emission Factor	13.16	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			1 161	98 112				
Upper bound			4 951	129 744				
Count			5 602	5 726				
as % of Operating Hours			*69%*	*70%*				
Minimum			1 176	99 844				
Maximum			4 321	129 653				
Mean			3 121	114 289				
Standard Deviation			875	4 903				
N2O Emissions (VSG * NCSG * OH)	**2 901**	**t N2O**						
Emission Factor (EF_BL)	**13.48**	**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		60.00	5 000	200 000	18 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**9 759**	10 587	9 918	10 590	291	10 266	10 590	9 959
as % of Dataset	*92%*	*100%*	*94%*	*100%*	*3%*	*97%*	*100%*	*94%*
Minimum		-	0	-	-	0	(31)	-
Maximum		38.40	1 558	107 373	12 782	19.98	875	399
Mean		23.75	571	90 707	3 651	0.18	667	355
Standard Deviation		7.15	274	22 726	5 351	0.51	352	50
Total		251 448						

N2O Emissions (VSG * NCSG * OH)	506	t N2O
Emission Factor	2.01	kgN2O / tHNO3

Data within the confidence interval		
95% Confidence interval	NCSG	VSG
Lower bound	34	46 165
Upper bound	1 108	135 250
Count	9 677	9 758
as % of Operating Hours	*99%*	*100%*
Minimum	134	49 568
Maximum	1 108	107 373
Mean	575	97 134
Standard Deviation	264	4 097

N2O Emissions (VSG * NCSG * OH)	**545**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.17**	**kgN2O / tHNO3**
Abatement Ratio	**83.9%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	0.93	0.93
2	2.17	2.17

Project Emission Factor (EF_P)	**2.17**	**kgN2O / tHNO3**
Abatement Ratio	**83.9%**	

MONITORING REPORT

PROJECT: Project aimed at N_2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA, company situated in Targu Mures, Romania

LINE: Line 3

MONITORING PERIOD:

FROM: 14/04/2010

TO: 10/07/2011

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 3 of Azomures nitric acid plant and quantity of emission reduction generated during the second project campaign on the line 3.

Total quantity of emission reductions generated during the period from 14/04/2010 through 10/07/2011 on Line 3 is **953 653 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	12.32	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.94	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	215 669	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	215 669	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	328 035	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**953 653**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**76.1%**	

EMISSION REDUCTION PER YEAR			
Year	2009	2010	2011
Date From		14 Apr 2010	01 Jan 2011
Date To		31 Dec 2010	10 Jul 2011
Nitric Acid Production		186 774	141 260
Emission Reduction		**542 985**	**410 668**
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 3 is 12.32 $kgN_2O/tHNO_3$. The baseline was carried out from 02/03/2007 through 14/07/2008.

The secondary catalyst on Line 3 was installed on 18/07/2008. Project emission factor during the second project campaign, which started on 14/04/2010 and went through 10/07/2011, is 2.94 $kgN_2O/tHNO_3$.

During the project campaign 328 035 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 Joint Implementation project aimed at N2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA company, situated at Târgu Mures, Romania.

Azomures 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 all 3 nitric acid plants.

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 the three 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 requirement 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 a line-specific basis. Campaign used for baseline measurements on the Line 3 has been carried out from 02/03/2007 through 14/07/2008. Nitric acid production during this campaign did not exceed the historic nitric acid production established as an average production during previous historic campaigns.

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 2008 QAL2 report in its section 10.7 as 2.44%, but this value is not correct, since correct result of the total UNC equation $\sqrt{(1.84^2 + 2.60^2)}$ is 3.185% and not 2.44%. Separate UNC values for N2O concentration and tail gas flow can be found in sections 7.5 (also in table 10.5) of the QAL2 test report. AMS UNC value as calculated by us is also higher than not correct 2.44% value defined in the section 10.7 of the report and thus use of the 3.185% is both correct and conservative.

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

• the impulse line is the same as the NOx outlet line

• the circuit is the same as for measuring NOx outlet concentration, including up to the pressure reducing valve outlet.

• the gas for the N_2O analyzer is taken from here through a water discharge cooler. The analyzer is produced by Environement S.A., France and is based on non-dispersive infrared absorption principle; it is placed in the same cabinet as the NOx analyzer. The N2O concentration measurement range is between 0 – 2000 ppm.

• the outlet analyzer signal is of 4 – 20 mA, proportional to the value of the concentration. This signal is transmitted through an electric cable at the plant's central control panel. The electric cable is approx. 100 m long.

• the device that converts the 4 – 20 mA signal in nitrogen oxides concentration is a ISU – MMC- 24C digital indicator produced by Infostar Pascani. The device has 16 inlet circuits of 4 – 20 mA. The readings are digitally displayed and are recorded every 2 seconds. Data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

3.1.2 Tail gas flow, temperature and pressure

• the measuring point is located on the expansion turbine outlet pipe towards the discharge nozzle; Pytot type sensor with multiple holes; operating conditions: absolute p = 2.5 bar, t = 80°C

• pneumatic connection line (12 mm diameter and approx. 1 m long hoses) between the sensor and the electric switch box where the Dp cell is located; pneumatic connection line (6 mm diameter and approx. 2 m long hose) between the sensor and the electric switch box where the absolute pressure measuring cell is located

• measuring device: Dp differential transducer, produced by ABB, measuring range between 0 – 30 mbar; absolute pressure transducer produced by Endress&Hauser,

measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

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 Composition of the ammonia oxidation catalyst

It is business-as-usual in Azomures to change composition of oxidation catalysts installed between campaigns, so the composition during historic and the baseline campaigns is varying.

Reason for changing composition of the Johnson Matthey primary catalysts for plant NA3 between baseline campaign and second project campaign was of technological nature. Azomures had decided to start using the precious metal catchment system on the line NA3, since during the baseline campaign there was no precious metal catchment system installed. This change resulted in changed ratios between 3 main precious metal components. Use of this precious metal catchment system is the industry standard and its use had no impact on N2O formation underneath the primary catalysts and in the tail gas.

3.4 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 4 campaigns), has been used as a cap on the length of the baseline campaign.

3.5 Regulatory baseline emissions factor

There are no regulatory limits of N2O whether defined as mass or concentration limits existent in Romania and there are no limits defined in the Azomures IPPC permit. Project thus uses baseline emission factor as measured during the baseline campaign.

4. PROJECT EMISSIONS

During the second 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 a continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

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

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

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

where:

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

4.1.2 Derivation of a moving average emission factor

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

4.2 Minimum project emission factor

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

4.3 Project Campaign Length

Project campaign length was longer than the campaign length normal and thus all N2O values measured during the project campaign were used for calculation of the emission factor.

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

5.1 Main air flow

• the measuring point is located on the compressor air discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 10 m long

• measuring device: Fischer Roesmount differential electronic transducer, having a measuring range between 0 – 45.24 mbar; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 30 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.2 Secondary air flow

• the measuring point is located on the air compressor discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 15 m long

• measuring device: Fischer Roesmount differential electronic transducer, having a measuring range between 0 – 500 mm H_2O; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 50 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.3 Casing protection air flow

• the measuring point is located on the air duct to the reactors casing, ramifications from the compressor discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 10 m long

• measuring device: FEPA Birlad differential electronic transducer, having a measuring range between 0 – 1500 mm H_2O; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 60 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.4 Reactor sieves temperature

• the measuring point is located on the oxidation reactor; sensor; PtRh-Pt thermocouple, operating conditions: t = 800 - 1000°C

• electric signal transmission between the sensor and the transducer: PtRh-Pt correction cable, approx. 50 m long

• digital indicator measuring device; measuring range between 0 – 1000°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 6 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.5 Consumed liquid ammonia flow

• the measuring point is located on the ammonia evaporator inlet pipe; Coriolis type sensor; operating conditions: p = 12 bar, t = 8 – 10°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 90 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 0 – 20 t/h; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 10 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.6 Flow of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; electromagnetic sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 0 – 100 t/h; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.7 Temperature of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; Coriolis type sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between -50 – 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this

database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.8 Density of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; Coriolis type sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 1.2 – 1.4 kg/l; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.9 Tail gases flow, tail gases pressure, tail gases temperature

• the measuring point is located on the expansion turbine outlet pipe towards the discharge nozzle; Pytot type sensor with multiple holes; operating conditions: absolute p = 2.5 bar, t = 80°C

• pneumatic connection line (12 mm diameter and approx. 1 m long hoses) between the sensor and the electric switch box where the Dp cell is located; pneumatic connection line (6 mm diameter and approx. 2 m long hose) between the sensor and the electric switch box where the absolute pressure measuring cell is located

• measuring device: Dp differential transducer, produced by ABB, measuring range between 0 – 30 mbar; absolute pressure transducer produced by Endress&Hauser, measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.10 Oxidation reactor pressure

• the measuring point is located on the air compressor discharge pipe; sensor type: capsule for electronic transducer; operating conditions: absolute p = 3.5 bar, t = 200°C

• pneumatic connection line between the sensor and the transducer; pneumatic connection line of 8 mm diameter and approx. 10 m long

• measuring device: Foxboro transducer, measuring range between 0 – 5 bar; absolute pressure transducer produced by Endress&Hauser, measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 50 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.11 N_2O concentration

• the impulse line is the same as the NOx outlet line

• the circuit is the same as for measuring NOx outlet concentration, including up to the pressure reducing valve outlet.

• the gas for the N2O analyzer is taken from here through a water discharge cooler. The analyzer is produced by Environement S.A., France and is based on non-dispersive infrared

absorption principle; it is placed in the same cabinet as the NOx analyzer. The N2O concentration measurement range is between 0 – 2000 ppm.

• the outlet analyzer signal is of 4 – 20 mA, proportional to the value of the concentration. This signal is transmitted through an electric cable at the plant's central control panel. The electric cable is approx. 100 m long.

• the device that converts the 4 – 20 mA signal in nitrogen oxides concentration is a ISU – MMC- 24C digital indicator produced by Infostar Pascani. The device has 16 inlet circuits of 4 – 20 mA. The readings are digitally displayed and are recorded every 2 seconds. Data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

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."

QAL2 test providing regression lines and the combined uncertainty as further used in the model was performed in July 9 – 11, 2008 by company Airtec holding the ISO 17025 accreditation. During AST tests in August 3 – 6, 2009 and November 3, 2010 done by company SGS holding the ISO 17025 accreditation the NA3 measurements passed the test.

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
Xo: X 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 in “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

The measurement system captures and logs normalized stack volume flow in an integrated manner, calculating the final figure from the mA signal of the endpoints by itself, as opposing to storing just temperature and pressure and deriving the volume flow later. Therefore, the volume flow values can be used as input for QAL2 recalibration transformation without de-normalization and the need for temperature, pressure, and duct cross-section area. The normalized calibrated stack gas flow rates are further fed into the emission calculation model for 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 ppm (parts per million). After QAL2 re-calibration, the values are converted to mgN2O/Nm3 (mg N2O per normalized cubic meter) to make it fit into the formulas set out in the methodology.

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 4 previous campaigns. Average production in campaigns preceding the baseline campaign was 286 940 tHNO3 and time duration was on average 383 days. Table contains also information on suppliers of primary catalysts for Line 3 (4 burners). As shown in the table, it is usual practice in Azomures to use primary catalysts from two suppliers.

T 2 Historic campaigns

Line	AzoMures-3		Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	1	t HNO3	-	-	-	-	n/a	0	N/A
	2	t HNO3	210 275	12 Oct 2001	27 Oct 2002	380	553	Engelhart-Cal	N/A *
	3	t HNO3	325 002	08 Nov 2002	13 Apr 2004	522	623	Engelhart-Cal	N/A *
	4	t HNO3	349 459	20 Apr 2004	02 Oct 2005	530	659	Engelhart-Cal	N/A *
	5	t HNO3	263 025	19 Oct 2005	16 Feb 2007	485	542	Johnson Matthey	N/A *
Average HNO3 production		t HNO3	286 940			383	748	* Confidential, but available for verification	
Project Campaigns	BL	t HNO3	215 669	02 Mar 2007	14 Jul 2008	500	432	Johnson Matthey	N/A *
	PL	t HNO3	328 035	14 Apr 2010	10 Jul 2011	453	724	Johnson Matthey	N/A *

Table The project campaign production value of 328 035 tHNO3 was higher than historic nitric acid production set at level of 286 940 tHNO3.

T 3 and Chart C 1 define the length of the baseline campaign set according to the historic campaign length. Baseline campaign measurements was carried out from 02/03/2007 through 14/07/2008. During baseline campaign, a total of 215 669 tHNO3 was produced, NCSG measurements are taken into account until the production of 215 669 tHNO3 was reached.

The project campaign production value of 328 035 tHNO3 was higher than historic nitric acid production set at level of 286 940 tHNO3.

T 3 Baseline campaign length

AzoMures-3	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2007 Feb 16	2007 Mar 02	2008 Jul 14	2008 Jul 14	2008 Jul 15
Baseline Factor kgN2O/tHNO3	-	-	12.32	12.32	12.32
Production tHNO3		-	215 669	215 669	-
Per Day Production tHNO3	748.4				
Baseline less Historic Production	(71 271.0)				
Baseline less Historic Days	(95.2)				

C 1 Baseline campaign length

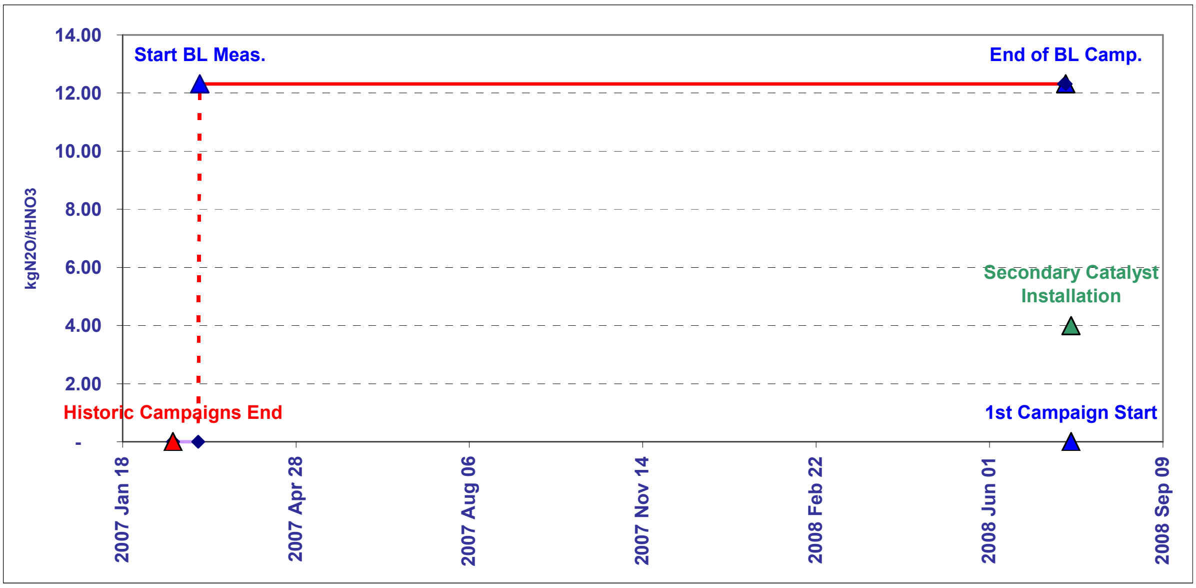

Table T 4 illustrates the calculation of the baseline emission factor on Line 3 using the method as defined in the CDM methodology AM0034 and in the PDD. Baseline measurement was carried out from 02/03/2007 through 14/07/2008.

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 640˚C occurred. Calculated baseline N2O emissions were 1,194 tN_2O.

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

The UNC factor defined by the QAL2 report is 3.185%. As a result we have arrived to the baseline emission factor of 12.32 $kgN_2O/tHNO_3$.

Table T5 shows the calculation of the project emission factor on Line 3 during the project campaign. Project campaign started on 14/04/2010 and went through 10/07/2011.

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 (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 640˚C occurred.

By dividing total mass o N2O emissions by the nitric acid production (capped by nameplate capacity 725 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.94 kgN2O/tHNO3.

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

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

T 4 Baseline emission factor

BASELINE EMISSION FACTOR								
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	100	20 000	0	0	- 50	0
Upper Limit		60.00	5 000	200 000	18 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**8 624**	7 388	6 243	6 482	11 915	11 174	11 989	11 431
as % of Dataset	*72%*	*62%*	*52%*	*54%*	*99%*	*93%*	*100%*	*95%*
Minimum		0.10	161	20 263	-	-	(31)	-
Maximum		40.54	4 321	136 304	15 445	19.94	864	400
Mean		29.19	3 902	95 572	7 882	8.53	623	104
Standard Deviation		4.80	462	15 376	4 881	4.22	356	117
Total		215 669						
N2O Emissions (VSG * NCSG * OH)	3 216	t N2O						
Emission Factor	14.44	kgN2O / tHNO3						
Permitted Range								
Minimum					8 000	0	800	0
Maximum					12 500	11.50	860	260
Data within the permitted range								
Count	**8 291**		6 877	6 924				
as % of Operating Hours	***96%***		*80%*	*80%*				
Minimum			271	-				
Maximum			4 321	415 934				
Mean			3 286	93 138				
Standard Deviation			1 163	21 931				
N2O Emissions (VSG * NCSG * OH)	2 640	t N2O						
Emission Factor	11.85	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			1 007	50 153				
Upper bound			5 565	136 122				
Count			6 636	6 468				
as % of Operating Hours			*77%*	*75%*				
Minimum			1 028	50 192				
Maximum			4 321	135 386				
Mean			3 374	94 322				
Standard Deviation			1 086	14 628				
N2O Emissions (VSG * NCSG * OH)	**2 745**	**t N2O**						
Emission Factor (EF_BL)	**12.32**	**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	100	20 000	0	0 -	50	0
Upper Limit		60.00	5 000	200 000	18 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**9 302**	9 164	9 115	9 359	10 869	9 612	10 872	10 303
as % of Dataset	*86%*	*84%*	*84%*	*86%*	*100%*	*88%*	*100%*	*95%*
Minimum		0.11	101	20 536	-	-	(31)	-
Maximum		49.17	2 479	121 795	16 731	19.01	864	266
Mean		35.80	935	111 084	9 649	10.39	666	219
Standard Deviation		5.10	247	7 123	3 972	1.55	344	71
Total		328 035						

N2O Emissions (VSG * NCSG * OH)	966	t N2O
Emission Factor	2.94	kgN2O / tHNO3

Data within the confidence interval

	NCSG	VSG
95% Confidence interval		
Lower bound	451	97 122
Upper bound	1 418	125 046
Count	8 733	8 833
as % of Operating Hours	*94%*	*95%*
Minimum	471	97 177
Maximum	1 417	121 795
Mean	930	111 624
Standard Deviation	237	4 421

N2O Emissions (VSG * NCSG * OH)	**965**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.94**	**kgN2O / tHNO3**
Abatement Ratio	**76.1%**	

Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.45	1.45
2	2.94	2.94

Project Emission Factor (EF_P)	**2.94**	**kgN2O / tHNO3**
Abatement Ratio	**76.1%**	

MONITORING REPORT

PROJECT: **Project aimed at N_2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA, company situated in Targu Mures, Romania**

LINE: **Line 4**

MONITORING PERIOD:

FROM: **17/12/2009**

TO: **30/03/2011**

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 4 of Azomures nitric acid plant and quantity of emission reduction generated during the second project campaign on the line.

Total quantity of emission reductions generated during the period from 17/12/2009 through 30/03/2011 on Line 4 is **638 903 ERUs**.

T 1 Emission reduction calculations

EMISSION REDUCTION			
Baseline Emission Factor	EF_BL	9.14	kgN2O/tHNO3
Project Campaign Emission Factor	EF_P	2.22	kgN2O/tHNO3
Nitric Acid Produced in the Baseline Campaign	NAP_BL	213 874	tHNO3
Nitric Acid Produced in the NCSG Baseline Campaign	NAP_BL_NCSG	213 874	tHNO3
Nitric Acid Produced in the Project Campaign	NAP_P	297 442	tHNO3
GWP	GWP	310	tCO2e/tN2O
Emission Reduction	**ER**	**638 903**	**tCOe**
*ER=(EF_BL-EF_P)*NAP_P*GWP/1000*			
Abatement Ratio		**75.8%**	

EMISSION REDUCTION PER YEAR			
Year	2009	2010	2011
Date From	17 Dec 2009	01 Jan 2010	01 Jan 2011
Date To	31 Dec 2009	31 Dec 2010	30 Mar 2011
Nitric Acid Production	11 396	220 139	65 908
Emission Reduction	**24 478**	**472 856**	**141 569**
*ER_YR = ER * NAP_P_YR / NAP_P*			

Baseline emission factor established for the Line 4 is 9.14 $kgN_2O/tHNO_3$. The baseline was carried outusing overlapping technique. The first part of the basline is the interval from 10/03/2008 to 10/08/2008, and it is completed by the second part from 06/04/2007 to 10/03/2008, thus adding up to a comparable campaign.

The secondary catalyst on Line 4 was installed on 11/08/2008. Project emission factor during the second project campaign, which started on 17/12/2009 and went through 30/03/2011, is 2.22 $kgN_2O/tHNO_3$.

During the project campaign 297 442 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 Joint Implementation project aimed at N2O emissions reduction by installation of secondary catalyst inside ammonia oxidation reactors at 3 nitric acid production plants NA2, NA3 and NA4 of Azomures SA company, situated at Târgu Mures, Romania.

Azomures 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 all 3 nitric acid plants.

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 the three 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 requirement 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 a line-specific basis. Campaign used for baseline measurements on the Line 4 has been carried out using overlapping technique. The first part of the basline is the interval from 10/03/2008 to 10/08/2008, and it is completed by the second part from 06/04/2007 to 10/03/2008, thus adding up to a comparable campaign. Nitric acid production during this campaign did not exceed the historic nitric acid production established as an average production during previous historic campaigns.

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

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

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

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

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

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

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 calculated based on the 2008 QAL2 report in its sections 7.5 (also in table 10.5) where separate UNC values for N2O concentration and tail gas flow are defined. The NA4 QAL2 test report does not contain calculation of total AMS UNC value, only separate UNC values for N2O concentration and tail gas flow. Total AMS UNC is therefore calculated as $UNC = \sqrt{(2.88^2 + 1.83^2)}$. Total UNC is then 3.41%.

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

• the impulse line is the same as the NOx outlet line

• the circuit is the same as for measuring NOx outlet concentration, including up to the pressure reducing valve outlet.

• the gas for the N_2O analyzer is taken from here through a water discharge cooler. The analyzer is produced by Environement S.A., France and is based on non-dispersive infrared absorption principle; it is placed in the same cabinet as the NOx analyzer. The N2O concentration measurement range is between 0 – 2000 ppm.

• the outlet analyzer signal is of 4 – 20 mA, proportional to the value of the concentration. This signal is transmitted through an electric cable at the plant's central control panel. The electric cable is approx. 100 m long.

• the device that converts the 4 – 20 mA signal in nitrogen oxides concentration is a ISU – MMC- 24C digital indicator produced by Infostar Pascani. The device has 16 inlet circuits of 4 – 20 mA. The readings are digitally displayed and are recorded every 2 seconds. Data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

3.1.2 Tail gas flow, temperature and pressure

• the measuring point is located on the expansion turbine outlet pipe towards the discharge nozzle; Pytot type sensor with multiple holes; operating conditions: absolute p = 2.5 bar, t = 80°C

• pneumatic connection line (12 mm diameter and approx. 1 m long hoses) between the sensor and the electric switch box where the Dp cell is located; pneumatic connection line (6 mm diameter and approx. 2 m long hose) between the sensor and the electric switch box where the absolute pressure measuring cell is located

• measuring device: Dp differential transducer, produced by ABB, measuring range between 0 – 30 mbar; absolute pressure transducer produced by Endress&Hauser,

measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

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 Composition of the ammonia oxidation catalyst

It is business-as-usual in Azomures to change composition of oxidation catalysts installed between campaigns, so the composition during historic and the baseline campaigns is varying.

Supplier of primary catalysts for plant NA4 between baseline campaign and second project campaign remained same as well as its composition (just minor change in the composition caused by slightly different ratio between 3 main precious metal components). This slight change had no impact on N2O formation underneath the primary catalysts and in the tail gas. Use of this type of primary catalysts is the industry standard.

3.4 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 4 campaigns), has been used as a cap on the length of the baseline campaign.

3.5 Regulatory baseline emissions factor

There are no regulatory limits of N2O whether defined as mass or concentration limits existent in Romania and there are no limits defined in the Azomures IPPC permit. Project thus uses baseline emission factor as measured during the baseline campaign.

4. PROJECT EMISSIONS

During the second 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 a continuous basis.

4.1.1 Estimation of campaign-specific project emissions factor

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

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

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

where:

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

4.1.2 Derivation of a moving average emission factor

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

4.2 Minimum project emission factor

Because this campaign was second project campaign on Line 4 there has been no minimum average emission factor established yet for this campaign. This factor will be established after 10^{th} project campaign.

4.3 Project Campaign Length

Project campaign length was longer than the campaign length normal and thus all N2O values measured during the project campaign were used for calculation of the emission factor.

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

5.1 Main air flow

• the measuring point is located on the compressor air discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 10 m long

• measuring device: Fischer Roesmount differential electronic transducer, having a measuring range between 0 – 45.24 mbar; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 30 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.2 Secondary air flow

• the measuring point is located on the air compressor discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 15 m long

• measuring device: Fischer Roesmount differential electronic transducer, having a measuring range between 0 – 500 mm H_2O; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 50 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.3 Casing protection air flow

• the measuring point is located on the air duct to the reactors casing, ramifications from the compressor discharge pipe

• diaphragm type sensor with ring-like chambers

• operating conditions: p = 2.5 – 3 bars, t = 150°C

• pneumatic signal transmission between the sensor and the transducer through 2 impulse pipes, approx. 10 m long

• measuring device: FEPA Birlad differential electronic transducer, having a measuring range between 0 – 1500 mm H_2O; output signal: analogue 4 – 20 mA

• signal transmission: electric wires, approx. 60 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.4 Reactor sieves temperature

• the measuring point is located on the oxidation reactor; sensor; PtRh-Pt thermocouple, operating conditions: t = 800 - 1000°C

• electric signal transmission between the sensor and the transducer: PtRh-Pt correction cable, approx. 50 m long

• digital indicator measuring device; measuring range between 0 – 1000°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 6 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.5 Consumed liquid ammonia flow

• the measuring point is located on the ammonia evaporator inlet pipe; Coriolis type sensor; operating conditions: p = 12 bar, t = 8 – 10°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 90 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 0 – 20 t/h; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 10 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.6 Flow of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; electromagnetic sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 0 – 100 t/h; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.7 Temperature of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; Coriolis type sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between -50 – 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the "data logger" are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer's hard disk. From this

database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.8 Density of produced nitric acid

• the measuring point is located on the column 4 outlet pipe towards the nitric acid storehouse; Coriolis type sensor; operating conditions: p = 2.5 bar, t = 40°C

• electric signal transmission between the sensor and the transducer: 2-wire cable, approx. 100 m long

• measuring device: DZL363 flowmeter adapter produced by Endress&Hauser; measuring range between 1.2 – 1.4 kg/l; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.9 Tail gases flow, tail gases pressure, tail gases temperature

• the measuring point is located on the expansion turbine outlet pipe towards the discharge nozzle; Pytot type sensor with multiple holes; operating conditions: absolute p = 2.5 bar, t = 80°C

• pneumatic connection line (12 mm diameter and approx. 1 m long hoses) between the sensor and the electric switch box where the Dp cell is located; pneumatic connection line (6 mm diameter and approx. 2 m long hose) between the sensor and the electric switch box where the absolute pressure measuring cell is located

• measuring device: Dp differential transducer, produced by ABB, measuring range between 0 – 30 mbar; absolute pressure transducer produced by Endress&Hauser, measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 5 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.10 Oxidation reactor pressure

• the measuring point is located on the air compressor discharge pipe; sensor type: capsule for electronic transducer; operating conditions: absolute p = 3.5 bar, t = 200°C

• pneumatic connection line between the sensor and the transducer; pneumatic connection line of 8 mm diameter and approx. 10 m long

• measuring device: Foxboro transducer, measuring range between 0 – 5 bar; absolute pressure transducer produced by Endress&Hauser, measuring range between 0 – 0.3 bar; Pt100 thermal resistance with built-in adapter, measuring range between 0 - 200°C; analogue output signal 4 – 20 mA

• signal transmission: electric wires, approx. 50 m long, analogue signal 4 – 20 mA

• signal conversion device: ISU 24M digital indicator; placed inside the control panel; converts the analogue signal into digital signal; recording period: 2 seconds.

• data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

5.11 N_2O concentration

• the impulse line is the same as the NOx outlet line

• the circuit is the same as for measuring NOx outlet concentration, including up to the pressure reducing valve outlet.

• the gas for the N2O analyzer is taken from here through a water discharge cooler. The analyzer is produced by Environement S.A., France and is based on non-dispersive infrared

absorption principle; it is placed in the same cabinet as the NOx analyzer. The N2O concentration measurement range is between 0 – 2000 ppm.

• the outlet analyzer signal is of 4 – 20 mA, proportional to the value of the concentration. This signal is transmitted through an electric cable at the plant’s central control panel. The electric cable is approx. 100 m long.

• the device that converts the 4 – 20 mA signal in nitrogen oxides concentration is a ISU – MMC- 24C digital indicator produced by Infostar Pascani. The device has 16 inlet circuits of 4 – 20 mA. The readings are digitally displayed and are recorded every 2 seconds. Data recorded into the “data logger” are transmitted through an optic fiber network to a computer designated particularly for this type of monitoring. This computer is located in the Instrumentation Plant. Data are stored in a database on the computer’s hard disk. From this database data are afterwards processed in order to obtain all data necessary for the project. The entire database is periodically saved on graphic and magnetic support as an Excel file.

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."

QAL2 test providing regression lines and the combined uncertainty as further used in the model was performed in February 25 28, 2008 by company Airtec holding the ISO 17025 accreditation. During AST tests in August 3 – 6, 2009 and October 28, 2010 done by company SGS holding the ISO 17025 accreditation the NA4 measurements passed the test.

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
Xo: X 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 in “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

The measurement system captures and logs normalized stack volume flow in an integrated manner, calculating the final figure from the mA signal of the endpoints by itself, as opposing to storing just temperature and pressure and deriving the volume flow later. Therefore, the volume flow values can be used as input for QAL2 recalibration transformation without de-normalization and the need for temperature, pressure, and duct cross-section area. The normalized calibrated stack gas flow rates are further fed into the emission calculation model for processing as set out by the Approved Baseline and Monitoring Methodology AM_0034.

6.3 Nitrous oxide concentration in stack gas

The nitric acid concentration in the raw data set from the AMS is in ppm (parts per million). After QAL2 re-calibration, the values are converted to mgN2O/Nm3 (mg N2O per normalized cubic meter) to make it fit into the formulas set out in the methodology.

7. EMISSION REDUCTION CALCULATIONS

Table T 2 illustrates the establishment of historic campaign length based on 4 previous campaigns. Average production in campaigns preceding the baseline campaign was 275 871 tHNO3 and time duration was on average 408 days. Table contains also information on suppliers of primary catalysts for Line 4 (4 burners). As shown in the table, it is usual practice in Azomures to use primary catalysts from two suppliers.

T 2 Historic campaigns

Line	AzoMures-4	Production	Start	End	Days	Production per day	Primary Catalyst	Composition
Historic Campaigns	1 t HNO3	-	-	-	-	n/a	N/A	N/A
	2 t HNO3	237 767	08 Dec 2000	16 Apr 2002	494	481	Engelhart-Cal	N/A *
	3 t HNO3	271 545	21 May 2002	20 Nov 2003	548	496	Engelhart-Cal	N/A *
	4 t HNO3	308 263	27 Nov 2003	06 Feb 2005	437	705	Engelhart-Cal	N/A *
	5 t HNO3	285 908	23 Feb 2005	05 Sep 2006	559	511	Heraeus	N/A *
Average HNO3 production	t HNO3	**275 871**			**408**	**677**	* Confidential, but available for verification	
Project Campaigns	**BL** t HNO3	213 874	06 Apr 2007	10 Aug 2008	492	435	Heraeus	N/A *
	PL t HNO3	297 442	17 Dec 2009	30 Mar 2011	468	636	Heraeus	N/A *

Table The project campaign production value of 297 442 tHNO3 was higher than historic nitric acid production set at level of 275 871 tHNO3.

T 3 and Chart C 1 define the length of the baseline campaign set according to the historic campaign length. Baseline campaign measurements was carried out using overlapping technique. The first part of the basline is the interval from 10/03/2008 to 10/08/2008, and it is completed by the second part from 06/04/2007 to 10/03/2008, thus adding up to a comparable campaign. During baseline campaign, a total of 213 874 tHNO3 was produced, NCSG measurements are taken into account until the production of 213 874 tHNO3 was reached.

The project campaign production value of 297 442 tHNO3 was higher than historic nitric acid production set at level of 275 871 tHNO3.

T 3 Baseline campaign length

AzoMures-4	Historic Campaings End	Start of Baseline Measurement	End of Baseline Measurement NCSG	End of Baseline Measurement	End of Baseline Campaign
Dates	2006 Sep 05	2007 Apr 06	2008 Mar 10	2008 Aug 10	2008 Aug 11
Baseline Factor kgN2O/tHNO3	-	-	9.14	9.14	9.14
Production tHNO3		-	213 874	213 874	-
Per Day Production tHNO3	676.8				
Baseline less Historic Production	**(61 996.8)**				
Baseline less Historic Days	**(91.6)**				

C 1 Baseline campaign length

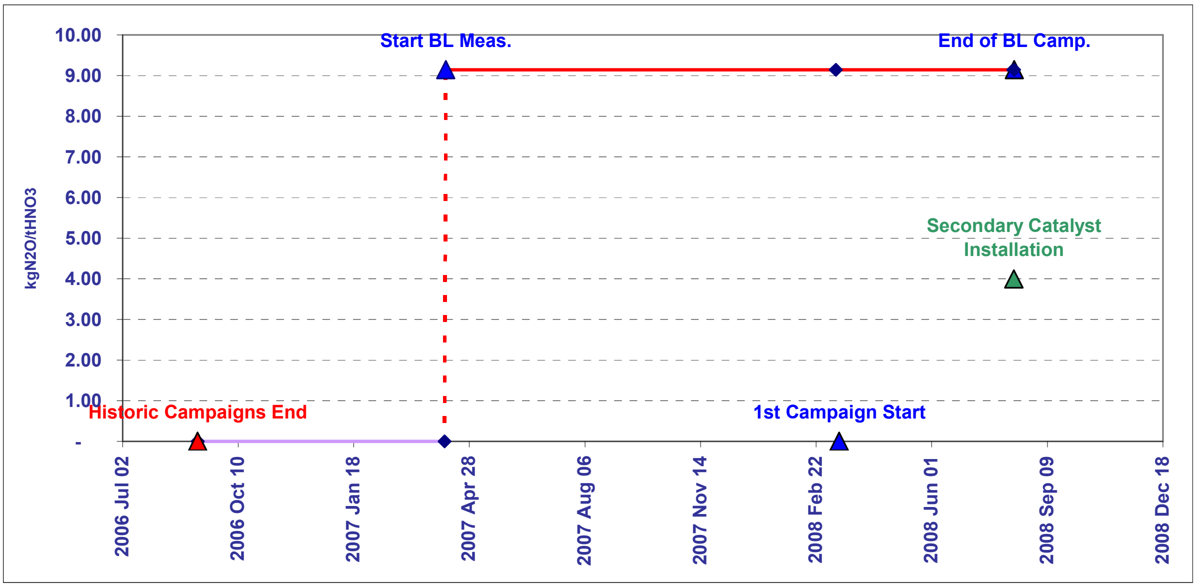

Table T 4 illustrates the calculation of the baseline emission factor on Line 4 using the method as defined in the CDM methodology AM0034 and in the PDD. Baseline measurement was carried out using overlapping technique. The first part of the basline is the interval from 10/03/2008 to 10/08/2008, and it is completed by the second part from 06/04/2007 to 10/03/2008, thus adding up to a comparable campaign.

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 640˚C occurred. Calculated baseline N2O emissions were 1,194 tN_2O.

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

The UNC factor defined by the QAL2 report is 3.412%. As a result we have arrived to the baseline emission factor of 9.14 $kgN_2O/tHNO_3$.

Table T5 shows the calculation of the project emission factor on Line 4 during the project campaign. Project campaign started on 17/12/2009 and went through 30/03/2011.

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 (PEn) as follows:

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

Operating hours (OH) defined as hours, when nitric acid production at least 0.1 tHNO3 and oxidation temperature at least 640˚C occurred.

By dividing total mass o N2O emissions by the nitric acid production (capped by nameplate capacity 725 tHNO3/day) we have determined the project campaign specific emission factor at value of 2.22 kgN2O/tHNO3.

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

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

T 4 Baseline emission factor

BASELINE EMISSION FACTOR								
Parameter	Operating Hours	Nitric Acid Production	N2O Concentration	Gas Volume Flow	Ammonia Flow Rate	Ammonia to Air Ratio	Oxidation Temperature	Oxidation Pressure
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	100	20 000	0	0 -	50	0
Upper Limit		60.00	5 000	200 000	18 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**8 186**	7 063	7 498	7 986	11 803	10 639	11 809	10 866
as % of Dataset	*69%*	*60%*	*63%*	*68%*	*100%*	*90%*	*100%*	*92%*
Minimum		0.19	101	22 057	-	-	(25)	-
Maximum		51.11	4 321	132 738	14 347	19.98	864	449
Mean		30.28	2 814	94 338	8 396	9.20	628	149
Standard Deviation		5.57	788	20 732	4 887	3.36	338	143
Total		213 874						
N2O Emissions (VSG * NCSG * OH)	2 173	t N2O						
Emission Factor	9.81	kgN2O / tHNO3						
Permitted Range								
Minimum					8 000	0	800	180
Maximum					13 800	11.50	860	300
Data within the permitted range								
Count	**4 682**		4 682	4 682				
as % of Operating Hours	*57%*		*57%*	*57%*				
Minimum			192	64 742				
Maximum			4 321	689 625				
Mean			2 548	98 624				
Standard Deviation			673	26 454				
N2O Emissions (VSG * NCSG * OH)	2 057	t N2O						
Emission Factor	9.29	kgN2O / tHNO3						
Data within the confidence interval								
95% Confidence interval								
Lower bound			1 229	46 774				
Upper bound			3 868	150 474				
Count			4 493	4 650				
as % of Operating Hours			*55%*	*57%*				
Minimum			1 331	64 742				
Maximum			3 860	150 376				
Mean			2 544	97 244				
Standard Deviation			599	12 186				
N2O Emissions (VSG * NCSG * OH)	**2 025**	**t N2O**						
Emission Factor (EF_BL)	**9.14**	**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	100	20 000	0	0 -	50	0
Upper Limit		60.00	5 000	200 000	18 000	20.00	1 200	1 000
Raw Data Measured Range								
Count	**8 882**	9 076	8 933	8 972	11 233	10 082	11 233	10 568
as % of Dataset	*79%*	*81%*	*80%*	*80%*	*100%*	*90%*	*100%*	*94%*
Minimum		0.11	101	21 351	-	-	(31)	-
Maximum		51.89	1 524	119 813	13 761	19.76	788	304
Mean		32.77	716	108 062	8 899	10.17	562	236
Standard Deviation		5.36	230	7 124	4 556	2.27	313	101
Total		297 442						

N2O Emissions (VSG * NCSG * OH)	687	t N2O
Emission Factor	2.31	kgN2O / tHNO3

Data within the confidence interval	NCSG	VSG
95% Confidence interval		
Lower bound	266	94 099
Upper bound	1 166	122 024
Count	8 305	8 788
as % of Operating Hours	*94%*	*99%*
Minimum	284	94 221
Maximum	1 165	121 139
Mean	683	108 657
Standard Deviation	189	5 036

N2O Emissions (VSG * NCSG * OH)	**659**	**t N2O**
Actual Project Emission Factor (EF_PActual)	**2.22**	**kgN2O / tHNO3**
Abatement Ratio	**75.8%**	
Moving Average Emission Factor Correction	**Actual Factors**	**Moving Average Rule**
1	1.48	1.48
2	2.22	2.22
Project Emission Factor (EF_P)	**2.22**	**kgN2O / tHNO3**
Abatement Ratio	**75.8%**	