JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A.   General description of the <u>project</u>

A.1.   Title of the <u>project</u>:

Joint Implementation 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 at Târgu Mures, Romania.

Sectoral scope 5: Chemical industry

Version 1.6, date of the PDD completion August 17, 2010.

A.2.   Description of the <u>project</u>:

Purpose of the project is the reduction of nitrous oxide emissions from the three nitric acid production plants NA2, NA3 and NA4 at the Azomures SA ("Azomures" or "the Company"). The company is situated in Târgu Mures, Mures county, Romania.

N_2O formation is a result of unwanted chemical reaction that takes place during ammonia oxidation which is the first stage in the nitric acid production process. Some part of N_2O is destroyed already in the ammonia oxidation reactor, while the rest is carried out with the tail gases.

Azomures reduces N_2O emissions by installing secondary N_2O reduction catalyst underneath the primary catalyst precious metal catching and catalytic gauzes package in the ammonium burner. This N_2O abatement technology is applied at three nitric acid production plants NA2, NA3 and NA4. Secondary catalysts are installed in all ammonia oxidation reactors of three nitric acid plants. According to guarantees provided by major secondary catalyst suppliers installation of the secondary catalysts will allow more than 70% reduction of the N_2O content in the tail gas.

Baseline scenario has been identified as continuation of recent situation and baseline measurements have been executed from March 2007 according to requirements of the CDM approved methodology AM0034.

Since there is in Romania no regulation controlling N_2O emission caps and the catalyst is not an essential part of the acid production process, the implementation of the Project is voluntary and functionally serves only environmental purposes. The sole economic motivation for the Project is the income from the sale of Emission Reductions. Hence the decision to install the catalyst depends on the participation in a Joint Implementation project.

N_2O is a very potential greenhouse gas - comparing to the CO_2 it has 310 higher greenhouse warming potential. Reduction of N_2O has a very high importance from the view of climate change mitigation measures. Given that Azomures is one of the major producers of nitrogen fertilizers in Romania, N_2O abatement at this plant will be very significant for the overall climate change mitigation measures undertaken in Romania.

A.3.   Project participants:

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Party involved wishes to be considered as project participant (Yes/No)
Romania (Host)	Private entity Azomures SA	No

	(Project Owner)	
France (Investor)	Private entity Vertis Environmental Finance Ltd	No

This project design document (PDD) has been developed by Vertis Finance Kft., which is also the JI project advisor.

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A.4.   Technical description of the project:

A.4.1.   Location of the project:

A.4.1.1.   Host Party(ies):

Romania

A.4.1.2.   Region/State/Province etc.:

Mures county

A.4.1.3.   City/Town/Community etc.:

Târgu Mures

A.4.1.4.   Detail of physical location, including information allowing the unique identification of the project (maximum one page):

Address:
Azomures SA
Gh. Doja str., no. 300
540237 TÂRGU MURES
ROMANIA

Source: http://www.infoplease.com/atlas/country/romania.html


Source: Google Earth
Geographical coordinates of the plant are 46° 31'22 N; 24° 30'46 E

> **A.4.2.   Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:**

Nitrous oxide formation
The technology of acid production can be broken down into the following main steps:
1. ammonia oxidation (combustion)
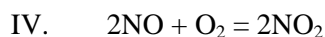2. absorption
3. tail gas purification.

The oxidation of ammonia and the absorption can occur at low (1-3 bar), medium (4-7 bar) or high (8-12 bar) pressure. Low pressure and high pressure support oxidation and absorption, respectively. From a technological point of view, the technology is optimal if combustion occurs at low pressure and absorption at high pressure. This so-called dual pressure technology includes an intermediate compression between the two stages. During the oxidation of ammonia, a 1:10 mixture of ammonia and air is driven through a primary catalyst in the ammonia oxidation reactor, where the following reactions take place:

I. $4NH_3 + 5O_2 = 4NO + 6H_2O$
II. $4NH_3 + 3O_2 = 2N_2 + 6H_2O$
III. $\mathbf{4NH_3 + 4O_2 = 2N_2O + 6H_2O}$
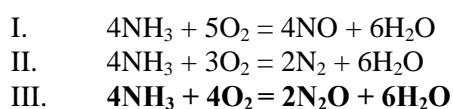
The reactions take place on a primary catalyst at a temperature of around 850ºC in a way that prevents side reactions II and III from occurring as much as possible, because these reactions have a negative effect on the rate of NO generation. Depending on the quality and condition of the catalyst utilization and on the residence time of combustion gases until their exit from ammonia oxidation reactor partial natural decomposition of N_2O may happen to a certain degree in the presence of high temperature. The rest of the N_2O gas proceeds along the nitric acid production process, being partially decomposed if tail gas reheating takes place before the inlet into the gas turbine, and exhausted through the stack at the end.

Primary catalyst consists of several knitted or woven gauzes made of platinum/rhodium alloy to achieve desired NO generating chemical reaction and increase the life cycle of the catalyst and decrease its maintenance costs. During ammonia oxidation process catalyst looses some of its platinum and rhodium content which is recovered by 60%-8-% into the platinum catchment system, installed under the catalyst. After a certain period of time called campaign catalyst undergoes substitution.

The water formed during the ammonia oxidation process is condensed in a cooler-condenser and transferred to the absorption tower. Nitric oxide (NO) generated in the reaction I is further oxidised to nitrogen dioxide (NO_2) by the oxygen content of air which is added to cooled combustion gases formed during the ammonia oxidation process:

IV. $2NO + O_2 = 2NO_2$

Nitrogen dioxide (NO_2) proceeds further into the absorption tower where the generation of nitric acid takes place due to the reaction with counter currently flowing water.

V. $\mathbf{3NO_2 + H_2O = 2HNO_3 + NO}$

Higher pressure and lower temperature favour the reaction inside the absorber. Generated nitric acid is then bleached by the secondary air to purify it from dissolved nitrogen oxides. Not absorbed tail gases leave absorption tower to be heated further in the waste heat boilers (superheaters), after which they pass through an NO_x abatement system and through a tail gas expander (gas heat exchanger) in order to recover the energy. Finally partially purified tail gas leaves through the stack.

History of the plant

Description of the plant
There are 3 nitric acid plants in Azomures.

Nitric acid plant 2 (NA2) was technologically designed by the DIDIER. It was constructed and commissioned in 1968. NA2 plant has its own ammonia and air preparation and feeding system, 3 ammonia oxidation chambers, heat exchange system, turbine, absorption tower and stack with individual production schedules (production, shut-downs, primary catalyst gauze changes, operating conditions). NA2 uses dual pressure technology with oxidation pressure 4bar and absorption pressure 8bar. Nameplate capacity of the NA2 plant is 241,425 $tHNO_3$(100%)/year with 333 operational days. Actual production capacity of nitric acid plant NA2 depends on number of operational hours per year and production load used. The length of the primary catalyst campaign in the ammonia oxidation reactor is, based on length of 4 previous campaigns, in average 502 days with average HNO_3(100%) production 260,782 $tHNO_3$(100%) per campaign. There is Rhodia de-NOx SCR facility installed.

NA2 diagram
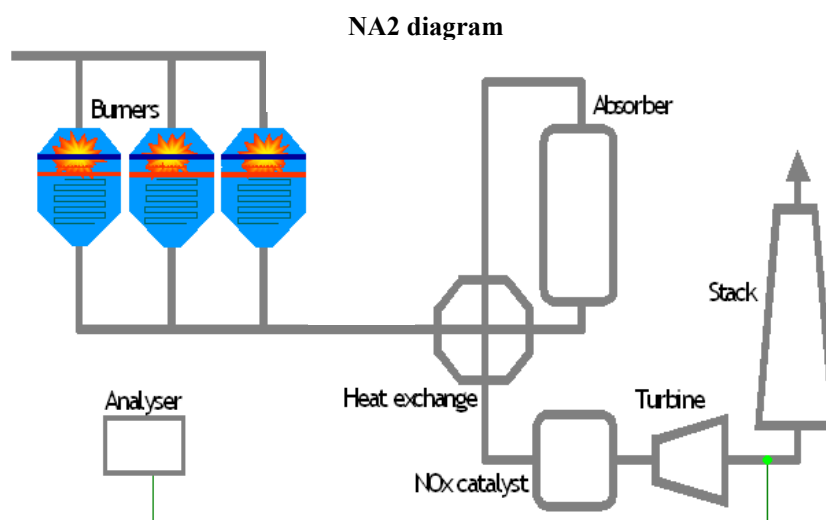
Nitric acid plant 3 (NA3) was technologically designed by the Grande Paroisse. It was constructed and commissioned in 1974. NA3 plant has its own ammonia and air preparation and feeding system, 4 ammonia oxidation chambers, heat exchange system, turbine, absorption tower and stack with individual production schedules (production, shut-downs, primary catalyst gauze changes, operating conditions). NA3 uses dual pressure technology with oxidation pressure 3.6bar and absorption pressure 8bar. Nameplate capacity of the NA3 plant is 240,000 $tHNO_3$(100%)/year. Actual production capacity of nitric acid plant NA3 depends on number of operational hours per year and production load used. The time length of the primary catalyst campaign in the ammonia oxidation reactor is, based on length of 4 previous campaigns, in average 479 days with average HNO_3(100%) production 286,940 $tHNO_3$(100%) per campaign. There is Rhodia de-NOx SCR facility installed.

NA3 diagram
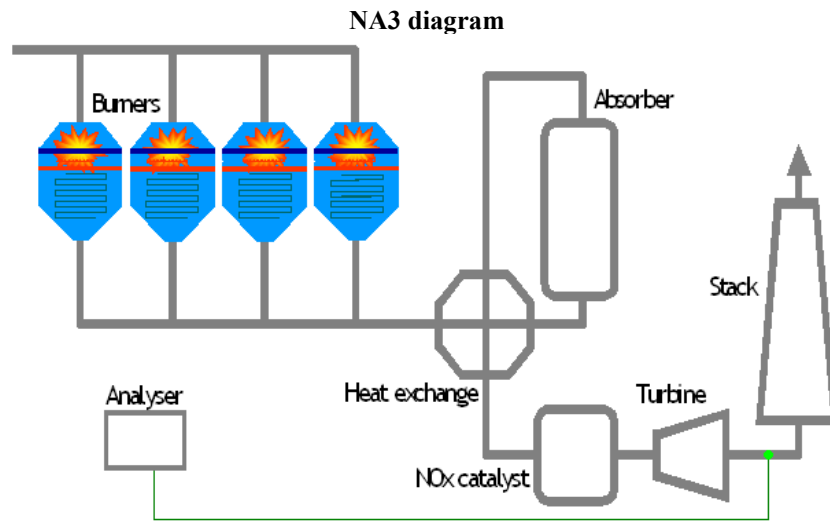
Nitric acid plant 4 (NA4) was technologically designed by the Grande paroisse. It was constructed and commissioned in 1978. NA4 plant has its own ammonia and air preparation and feeding system, 4 ammonia oxidation chambers, heat exchange system, turbine, absorption tower and stack with individual production schedules (production, shut-downs, primary catalyst gauze changes, operating conditions). NA4 uses dual pressure technology with oxidation pressure 4bar and absorption pressure 8bar. Nameplate capacity of the NA4 plant is 247,500 tHNO$_3$(100%)/year with 330 operational days. Actual production capacity of nitric acid plant NA4 depends on number of operational hours per year and production load used. The time length of the primary catalyst campaign in the ammonia oxidation reactor is, based on length of 4 previous campaigns, in average 510 days with average HNO$_3$(100%) production 275,871 tHNO$_3$(100%) per campaign. There is Rhodia de-NOx SCR facility installed.

NA4 diagram
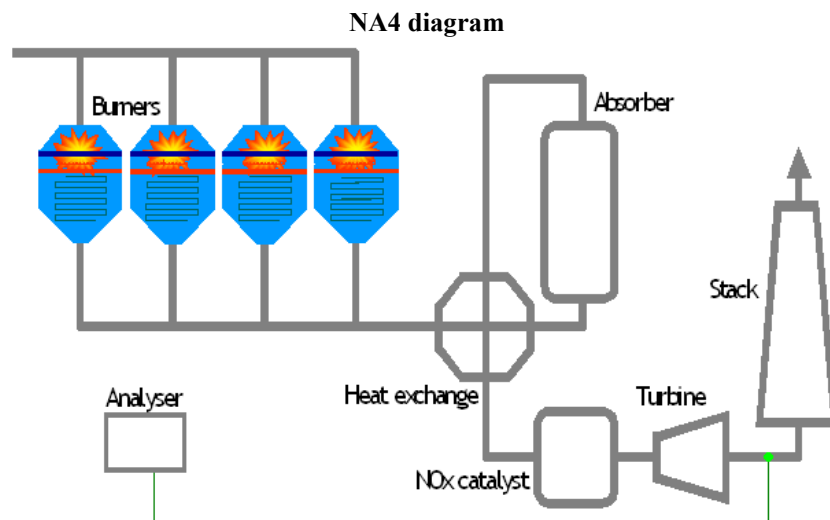
Nitrous oxide abatement technology used in the project

There are two types of technologies for the catalytic decomposition of N_2O, both of which are rather new, and there is only limited industrial experience with the use of these catalysts: the secondary catalyst which is installed in the main ammonia oxidation chamber beneath the main platinum gauzes for producing NO; and the tertiary catalyst which is contained in a separate vessel into which the tail gas from the oxidation chamber are conducted.

In the presence of the secondary catalyst at temperatures zone between 800°C and 950°C, the N_2O breaks down into N_2 and O_2 following the reaction:

$$2N_2O = 2N_2 + O_2$$
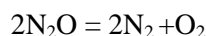
Neither of these gases are greenhouse gases. A secondary N_2O de-composing catalyst will be installed beneath the primary catalyst. Secondary catalyst will be placed in the appropriate support structure.

The secondary catalyst causes approximately from 70% up to 95% of the N_2O to be destroyed.

The technology will be provided by a major secondary catalyst manufacturer.

For information about the technology installed for measuring and recording the emissions of nitrous oxide from the plant, see the section D.1.2. below.

A.4.3.   Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

Brief description of additionality discussed in B.2.
Business as usual is not to install the nitrous oxide abatement system. There are three principal reasons for this. First, there is no legal obligation to install such a system. Romanian law does not require any abatement of nitrous oxide. Thus there is no requirement to abate nitrous oxide. Second, there is no economic benefit to the installation of a nitrous oxide abatement system except for the revenue from the sale of Emission Reduction Units within the framework of this JI project.

Installation of N_2O abatement technology is not a common practice in Romania, as at least two such projects in Central and Eastern Europe are known not to have worked first time, leading to stoppage in production. It is only within the framework of the JI project that the installation of the N_2O abatement equipment has any economic rationale and risk justifying solution.

A.4.3.1.   Estimated amount of emission reductions over the crediting period:

	Years
Length of the crediting period	4 years and 6 months (from July 24, 2008 until December 31, 2012)
Year	Estimate of annual emission reductions in tonnes of CO$_2$ equivalent
2008	910,797
2009	1,821,595
2010	1,821,595
2011	1,821,595
2012	1,821,595
Total estimated emission reductions over the	8,197,176

crediting period (tonnes of CO_2 equivalent)	
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	1,821,595

A.5.	**Project approval by the Parties involved:**

Azomures JI project received the Host Party Letter of Approval from Romanian Ministry of Environment on May 10, 2010 and Investor Party Letter of Approval issued to Vertis Environmental Finance Limited in relation to the Project by France on June 18, 2010.

SECTION B.	**Baseline**

B.1.	**Description and justification of the baseline chosen:**

Summary description of the baseline

The baseline methodology is based on CDM methodology AM0034.

The baseline chosen is the level of nitrous oxide emissions of the plant in the absence of the project. It reasonably represents the anthropogenic emissions by sources that would occur in the absence of the project. Baseline covers GHG emissions from all sources within the project boundary. Baseline is established on the project-specific basis. Baseline emissions factor shall be established in a transparent manner based on measurements and data calculations described later in this document. Baseline takes into account all relevant national and sectoral policies and circumstances. Baseline chosen does not allow the project to earn emission reduction units (ERUs) for decreases in activity levels outside the project activity or due to force majeure. Baseline takes into account uncertainties and uses conservative assumptions.

Justification of the methodology

This baseline approach is used for the following reasons:

1. It is based on an approved CDM methodology and therefore incorporates a level of scientific rigour which has already been approved by the UNFCCC methodology panel
2. It meets the conditions of applicability of AM0034/Version 03 since:
    a. The facility was established before 31st December 2005
    b. The facility has no existing N_2O abatement technology, hence, no impact on the work of it could be done by the project activity
    c. The project will not affect the plant's nitric acid production levels
    d. There are no requirements in the host country to reduce N_2O emissions
    e. There is no N_2O abatement technology installed at the plant
    f. The project activity will not increase NO_x emissions
    g. There is no non-selective catalyst installed for the reduction of NO_x
    h. The project will not lead to any material change in other greenhouse gas emissions within the project boundary
    i. Continuous monitoring of the N_2O concentration and tail gas flow has been installed for the duration of a campaign for the measurement of baseline emissions, and thereafter

In the Identification of the baseline scenario we list first barriers named in the AM0028 methodology and we specifically mark cases (n/a), when some of these barriers do not apply to the project.

Identification of the baseline scenario

For identification of the baseline scenario the procedure of the CDM methodology AM0028/Version 04.1 has been used, in accordance with the suggestion of the CDM methodology AM0034/Version 03

Step 1a

Step 1a of a baseline scenario identification includes listing of all technically feasible alternatives to the given project. The principal theoretical alternatives to the project are:
- Continuing to operate the plant as is
- Switch to alternative production method not involving ammonia oxidation process
- Alternative use of N_2O such as:
  - Recycling of N_2O as a feedstock for the plant
  - The use of N_2O for external purposes
- Installation of Non-Selective Catalytic Reduction (NSCR) De-NO_x system
- Installation of N_2O abatement not as a JI project
- Installation of an N_2O destruction or abatement technology:
  - Tertiary measure for N_2O destruction
  - Primary or secondary measures for N_2O destruction or abatement

Step 1b

This step includes all possible technically feasible options to handle NO_x emissions. Non-Selective De-NO_x units cause also reduction of N_2O and thus it is necessary to elaborate also on this technical option. Possibilities regarding NO_x emissions are as following:
- Continuation of the current situation, whether either De-NO_x units is installed or not
- Installation of new Selective Catalytic Reduction De-NO_x unit
- Installation of a new Non-Selective Catalytic reduction (NCSR) De-NO_x unit
- Installation of a new tertiary measure that combines NO_x and N_2O emission reduction

Step 2

Eliminate baseline alternatives that do not comply with legal or regulatory requirements

There are no regulatory requirements in Romania regarding N_2O emissions. NO_x emissions are regulated by the Approval of Integrated Pollution Prevention and Control. Azomures has installed at all 3 nitric acid plants a Selective Catalytic Reduction De-NO_x units:

All alternatives could comply with relevant legal regulations.

Step 3

Eliminate baseline alternatives that face prohibitive barriers (barrier analysis)

Step 3a

On the basis of the alternatives that are technically feasible and in compliance with all legal and regulatory requirements establish a complete list of barriers that would prevent alternatives to occur in the absence of JI. Barriers include, among others:

- Investment barriers, *inter alia*:
  - Debt funding is not available for this type of innovative project activity
  - Debt funding is not available due to no project return without JI
  - No access to international capital markets due to perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented (n.a.)

- Technological barriers, *inter alia*:

- o Technical and operational risks of alternatives
- o Technical efficiency of alternatives (e.g. N_2O destruction, abatement rate)
- o Skilled and/or properly trained labour to operate and maintain the technology is not available and no education/training institution in the host country provides the needed skill, leading to equipment disrepair and malfunctioning (n.a.)
- o Lack of infrastructure for implementation of the technology (n.a.)

- Barriers due to prevailing practice, *inter alia*:
  - o The project activity is the "first of its kind": No project activity of this type is currently operational in the host country or region

Since Romania is the EU Member State with corresponding level of industrial development we have used for elimination of possible alternatives mainly technical and operational risks of alternatives and technical efficiency of alternatives criteria (i.e. there is no barrier in form of no access to international capital markets, lack of infrastructure or lack of skilled personnel as Azomures is capable of implementing and operating a de-N_2O project).

Nitric acid production in industrial facilities such as Azomures plant is not possible to be changed in a way not involving the ammonia oxidation process.

Alternative use of N_2O is neither technologically nor economically feasible. It is not possible to recycle N_2O in order to use it for the nitric acid production, neither it is technically and economically feasible to use N_2O for external purposes.

Installation of NSCR is also not feasible from technological and economic points of view due to high energy costs, high gas temperatures required, emissions of CO_2 and hydrocarbons to the air. N_2O emission levels are also higher than with Selective Catalytic Reduction (SCR) and it is a very expensive abatement technology both in terms of investments and operation costs. The Azomures plant has installed selective catalyst reduction system which reduces NO_x emission level below the limits of 500 mg/Nm^3 established by Azomures' IPPC permit. Actual NOx emissions are below the IPPC ELV defined in the IPPC permit and are online published on the Azomures web site (www.azomures.com) under Oxidi de azot section of the website in the ppmV unit.

Since reduction of N_2O represents significant investments for installation, burner modifications and following costs of operation of the De-N_2O system it is not economically feasible to implement a De-N_2O project without use of financing provided through JI.

Tertiary De-N_2O reduction is not economically feasible in the Azomures plant as it would require principal changes to complete design of nitric acid production lines and NO_x emissions abatement is handled by installation of Selective Catalytic reduction unit.

Recent level of the ammonia oxidation catalyst development does not allow to implement de-N_2O project using primary catalyst as the De-N_2O reduction component.

It is important to note that Azomures by implementation of the de-N_2O project contributes to environmentally friendly innovativeness of the chemical industry, nitric acid production specifically.

At the time of start of the project in the year 2006 there were no operational secondary catalyst de-N2O projects in the region and there was no experience with operation of secondary catalyst inside the oxidation burners.
By August 2009 there have been published on the UNFCCC website (http://ji.unfccc.int/JI_Projects/Verification/PDD/index.html) in total 16 de-N_2O projects, which have

proceeded into the PDD publication stage. In Romania specifically there have been 2 de-N2O projects under implementation, i.e. Azomures project and then Donauchem project.

Step 3b
Based on the reasons listed in the Step 3a above we have eliminated in this step following alternatives:

- Switch to alternative production method not involving ammonia oxidation process
- Alternative use of N_2O such as:
  o Recycling of N_2O as a feedstock for the plant
  o The use of N_2O for external purposes
- Installation of Non-Selective Catalytic Reduction (NSCR) De-NO_x system
- Installation of N_2O abatement not as a JI project
- Installation of an N_2O destruction or abatement technology:
  o Tertiary measure for N_2O destruction
  o Primary measures for N_2O destruction or abatement

Only remaining alternative achieving N_2O emission reduction, other than continuation of Status Quo, is secondary catalytic reduction of N_2O in existing reaction chambers of ammonia oxidation reactors.

Step 4
Identify the most economically attractive baseline scenario alternative
Implementation of installation of the secondary De-N_2O catalyst, itself does not generate any financial profit. Since it is only alternative left after elimination of other alternatives in steps 2 and 3, it is not necessary to conduct further simple cost analysis, which would otherwise appropriate to this alternative.

Step 5
Re-assessment of Baseline Scenario in course of proposed project activity's lifetime

Sub-step 5a
Azomures nitric acid plant has installed a Selective Catalytic Reduction De-NO_x units in order to comply with existing NO_x regulations in Romania. SCR De-NOx unit leads to higher N_2O formation and its intensification would lead to higher emission reductions. Thus change in the NOx regulations would not necessitate re-assessment of the Baseline Scenario, because it would actually increase its level of required conservativeness.

Sub-step 5b
In case of introduction of either concentration or mass limits of N_2O emission the Baseline Scenario would be re-assessed according to new regulations.

Note on variation on AM0034 for application on this project

1.   Multiple plants
The plant actually consists of 3 separate plants comprising four production units of burner (NA2 has 3 burners), one absorption tower, De-NO_x system, and tail gas turbine. The emissions from the tail gas turbines are led to stack bars individual for each plant and emitted to the air.

Because of this, baseline emissions are measured separately from each plant and a separate baseline factor is calculated for each plant. Similarly, project emissions are recorded for each plant. The number of emissions reductions of the project is the sum of emission reductions for each separate plant.

2. Overlapping of consecutive campaigns

AM0034 requires that the baseline factor should be established through measuring emissions during an entire campaign. The plant has three separate lines, and the timing of the campaigns of these lines is staggered.

N2O emissions monitoring system has been installed on all three lines in March 2007.

Baseline campaign used for calculation of the baseline emission factor on line NA2 started in July 2007 at the beginning of a campaign and was completed in October 2008.

Baseline campaign used for calculation of the baseline emission factor on line NA3 started in March 2007 at the beginning of a campaign and was completed in July 2008.

Baseline campaign used for calculation of the baseline emission factor on line NA4 started in July 2007 during course of then campaign, which started in September 2006. Production of nitric acid from date of installation of N_2O monitoring (July 2007) until end of then campaign (March 2008) was 124,081 tHNO3. Baseline measurements then continued from beginning of following campaign, which started in March 2008 and by August 2009 was not completed yet. Nitric acid production from March 2008 until installation of secondary catalysts in August 2008 reached 92,197 $tHNO_3$. NA4 baseline emissions factor was thus calculated using data from two campaigns and total quantity of nitric acid produced during this overlapped baseline campaign was 216,278 $tHNO_3$, i.e. less than NA4 historic campaign length of 275,871 $tHNO_3$. This approach is called overlapping. By overlapping data from two consecutive campaigns with materially same operating conditions it was possible to establish baseline factor and install secondary catalysts in August 2008.

3. Use of the default factor
In case of failure to get the measured baseline emissions factor verified the project will use as the default emission factor the IPCC default factor of $4.5 kgN_2O/tHNO_3(100\%)$, if this factor will be lower than the factor resulting from actual measurements.

B.2.   Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

This section provides proofs of the project additionality, i.e. proofs demonstrating importance of the JI project implementation for greenhouse gas reduction that would not have been achieved in the business-as-usual scenario. *"Tool for the demonstration and assessment of additionality"* (version 04) is used as a reference for proving attractiveness of chosen JI project alternative in front of other possible alternatives.

Step 1
Identification of alternatives to the project activity consistent with current laws and regulations
As suggested by the CDM methodology AM0034 Step 1 has been omitted because B.1 section identifying and describing baseline scenario has already identified continuation of the Status Quo as the only realistic alternative to the chosen project scenario, which is also consistent with mandatory laws and regulations of Romania.

Step 2
Investment analysis
Investment analysis is the next step undertaken in order to prove the necessity of ERUs revenues for the project implementation that otherwise would not be financially attractive.

As described in section "Identification of the baseline scenario", in the absence of the JI project, there is no installation of any equipment which would reduce N_2O emissions, and the business continues as usual. This means that there is no reduction of N_2O emissions and they would remain at recent level.

Step 2b
Simple Cost Analysis
In terms of simple cost, implementation of proposed JI project would mean significant cost for the project owner. JI project directed on installation of N_2O abatement system in Azomures plant will incur the costs of secondary catalyst installation in all eleven ammonia oxidation reactors of 3 plants. Besides catalyst design and transportation costs the plant will have to carry the costs of ammonia oxidation reactors' modification. The plant will have to pay for use of secondary catalysts plus the costs of catalyst replacement and maintenance. Equipment for monitoring baseline N_2O emissions and emissions of N_2O after the project implementation requires additional costs for its design, transportation, maintenance, servicing and certification in accordance with the CDM methodology AM0034 requirements. Total cost of implementation of this project for Azomures during the crediting period is estimated at €11.8 million. There is no other income of the project other than sale of ERUs. Revenue from sale of ERUs is estimated at €62.9 million under assumption of ERUs total generation in the region of 8 million ERUs in total. Value of the project is determined by value of emission credits on the carbon market and it is not possible to estimate it exactly.

Step 3
Barrier analysis
Step 3 is omitted because the *"Tool for the demonstration and assessment of additionality"* (version 04) allows the use of alternatively Step 2 or Step 3 for the proof of additionality.

Step 4
Common practice analysis
This step allows to double check for the previous proofs of the project additionality demonstrating that besides being the only plausible alternative from financial point of view the project also introduces innovative practice in the industry of the region regarding greenhouse gas abatement activity.

Introduction of N_2O abatement technology is not common practice for nitric acid industry mainly because there are no incentives for N_2O abatement due to the absence of regulation imposing N_2O emission limits. In case of Romania, in particular, high costs of project implementation and absence of N_2O emission limiting regulation make N_2O abatement activity to be not attractive for local nitric acid production industry. On the other hand N_2O abatement activity is known to be widespread practice among nitric acid plants implemented as CDM or JI projects, which proves this activity to be rather attractive in a framework of Kyoto Protocol project flexibility instruments.

Conclusion
Implementation of the N_2O abatement project in the JI framework is the only way to make the introduction of N_2O abatement technology financially feasible for the plant. Installation of the secondary N_2O abatement catalyst is state-of-art technology, hence, not widely spread among nitric acid production plants. Because of its modernity this technology is quite costly and it does not represent for the plant any financial benefit. The only advantage of N_2O abatement is reduction of this potential greenhouse gas in order to introduce climate change mitigation measures. Given that national/local regulations do not foresee N_2O emission limits the JI project implementation and the use of ERUs sale proceeds is the only possible solution for reducing N_2O emissions at the nitric acid plant of Azomures.

B.3.	Description of how the definition of the <u>project boundary</u> is applied to the <u>project</u>:

Project boundary encompasses all anthropogenic emissions by sources of GHGs which are under the control of project participants, are reasonably attributable to the project and are significant. Project

boundary and greenhouse gas sources relevant for the project implementation are individuated in accordance with the Approved Consolidated Methodology AM0034 "Catalytic reduction of N_2O inside ammonia burner of nitric acid plants".

According to the methodology the project boundary shall cover the facility and equipment for the complete nitric acid production process. The following diagram identifies the borders where N_2O emission reduction project will take place in 3 nitric acid plants (one single diagram demonstrates project boundary for all 3 nitric acid plants taking into account only difference between them is number of burners in NA2 comparing to NA3 and NA4). The chart below shows major stages of the nitric acid production, points where gas analysers are installed in order to monitor baseline emissions of nitrous oxide, and placement of secondary catalysts applied for N_2O abatement. The process of nitric acid production and N_2O abatement is identical on two production lines. The inlet of ammonia into the ammonia oxidation reactors of both lines is the first point in the project boundary and the gas emission from the stacks is the last point in the nitric acid production process included into the project boundary.

Primary catalyst
N2O abatement cat.
Monitoring point
Sampling pipes
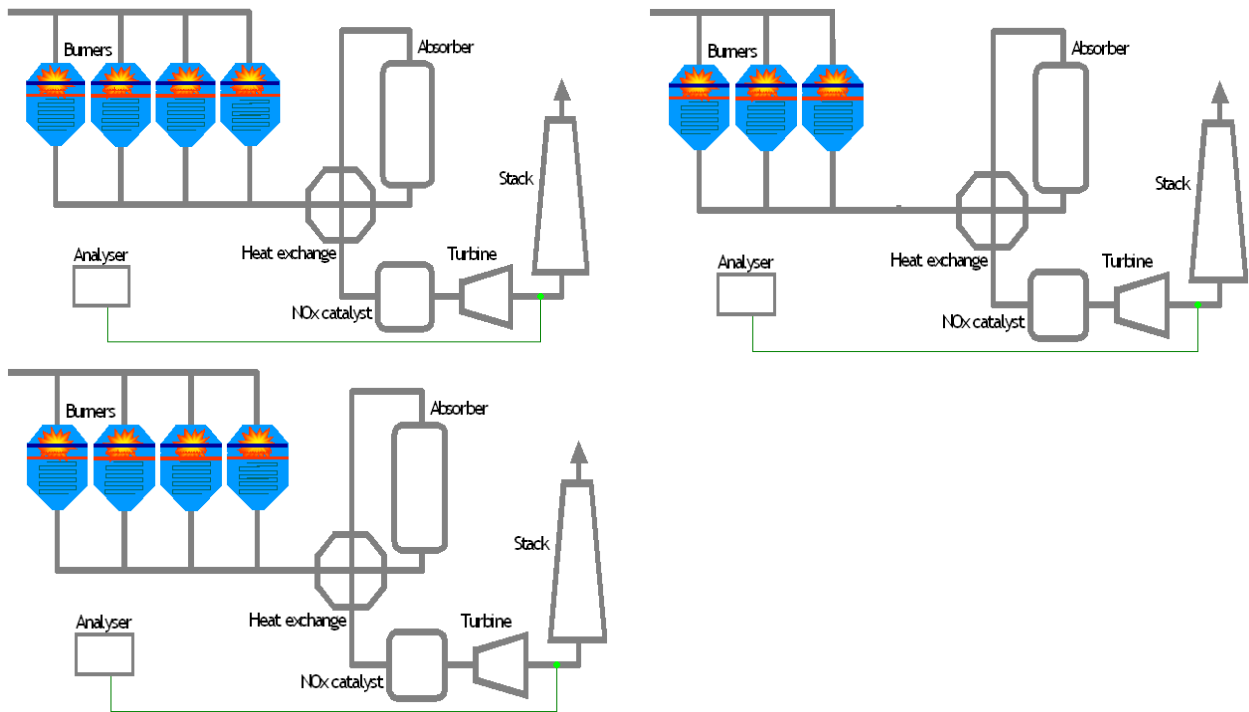
The only greenhouse gas to be considered in the implementation of the N_2O abatement project at the nitric acid plant is the N_2O.

	Source	Gas	Inclusiveness	Justification /Explanation
Ba se l	Nitric Acid Plant (Burner inlet to stack)	CO_2	Excluded	N_2O abatement project does not lead to any change in CO_2 and CH_4 emissions
		CH_4	Excluded	

Project activity		N₂O	Included	
	Nitric Acid Plant (Burner inlet to stack)	CO_2	Excluded	N₂O abatement project does not lead to any change in CO_2 and CH_4 emissions
		CH_4	Excluded	
		N_2O	Included	
	Leakage emissions from production, transport, operation and decommissioning of the secondary catalyst.	CO_2	Excluded	No leakage emissions are expected.
		CH_4	Excluded	
		N_2O	Excluded	

B.4.	**Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:**

>>
Baseline has been set for line NA2 from July 2007 through October 2008, for NA3 from March 2007 through July 2008 and for NA4 from July 2007 through August 2008.

Contact person	Ioan Soleriu
Company	Azomures
Project participant	Yes
Address	Gh. Doja street 300, Târgu Mures
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SECTION C.   Duration of the project / crediting period

C.1.	**Starting date of the project:**

September 20, 2006

C.2.	**Expected operational lifetime of the project:**

The project is expected to operate beyond 31st December 2012.

C.3.	**Length of the crediting period:**

The period of claim on Emission Reduction Units (ERUs) is 4 years and 6 months starting from July 24, 2008, when first emission reductions were generated and lasting until 31 December 2012.

SECTION D.	Monitoring plan

D.1.	Description of monitoring plan chosen:

In order to establish a definitive baseline, N_2O measuring instruments were installed in the lines in the plants NA2, NA3 and NA4. Continuous measurements were made. To ensure the integrity of the data from these measurements and the suitability of the data for inclusion in the Baseline Study within the Project Design Documentation, the measurements will be validated by an Accredited Independent Entity - respected and experienced validator in the field of Joint Implementation.

N_2O emissions monitoring system consists of the measurement devices part and data processing and storage part. Detailed description of the monitoring system as defined in the methodology AM0034 (i.e. N_2O analyser and tail gas flow meter) and other monitoring devices used for calculation of baseline emission factor and project emission reductions (i.e. oxidation pressure, oxidation temperature, ammonia flow, air flow, HNO_3 mass flow meters) can be found in the Annex 3 Monitoring plan of the PDD. Azomures' N_2O monitoring system is operated in accordance with the Quality Assurance Manual "Monitoring of the N2O emissions from the nitric acid plant" complying with requirements of the EN14181. Based on this document Azomures executes weekly calibrations of the N2O analysers, weekly maintenance of the tail gas flow meters and other related monthly and annual maintenance.

Raw emissions data are monitored, recorded, archived and sent on monthly basis by Azomures to Vertis.Vertis is responsible for preparation of emission reductions calculation model and monitoring report which are subject to verification.

D.1.1.	Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
P.1	$NCSG_{2,3,4}$ N_2O concentration in	N_2O analyser MIR9000	mgN_2O/m^3 (converted from ppmV)	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting	

	the stack gas for particular plant						period	
P.2	$VSG_{2,3,4}$ Volume flow rate of the stack gas for particular plant	Gas volume flow meter ABB	m^3/h	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting period	
P.3	$PE_{n, 2,3,4}$ N_2O emissions of nth project campaign for particular	Calculation from measured data	tN_2O	c	After every project campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
P.4	$OH_{2,3,4}$ Operating hours for particular line (l=A, B)	Monitoring system	Hours	m	Daily, compiled for entire campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
P.5	$NAP_{2,3,4}$ Nitric acid production (100% concentrate) for particular line (l=A, B)	Monitoring system	$tHNO_3$	m	Daily, compiled for entire campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
P.6	$TSG_{2,3,4}$ Temperature of stack gas for particular line (l=A, B)	Thermocouple sensor	°C	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting period	
P.7	$PSG_{2,3,4}$	Foxboro transducer		m	Every 2 seconds	100%	Electronic and paper for at least	

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	Pressure of stack gas for particular line (l=A, B)						2 years after end of the crediting period	
P.8	$EF_{n, 2,3,4}$ Emission factor calculated for n^{th} campaign for particular line (l=A, B)	Calculated from measured data	$tN_2O/tHNO_3$	c	After end of each campaign		Electronic and paper for at least 2 years after end of the crediting period	
P.9	$EF_{mn,a, 2,3,4}$ Moving average emissions factor for particular line (l=A, B)	Calculated from campaign emissions factors	$tN_2O/tHNO_3$	c	After end of each campaign		Electronic and paper for at least 2 years after end of the crediting period	For the first campaing EF and EF_x will be equal
P.12	$CL_{n, 2,3,4}$ Campaign length for particular line (l=A, B)	Calculated from nitric acid production data	$tHNO_3$	c	After end of each campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
P.13	$EF_{p, 2,3,4}$ Emissions factor used to determine emissions reductions for particular line (l=A, B)	Determined from campaign emissions factors	$tN_2O/tHNO_3$	c	After end of each campaign		Electronic and paper for at least 2 years after end of the crediting period	Determined from campaign emissions factors
P.14	$EF_{min, 2,3,4}$ Minimum	Determined from campaign emissions factors	$tN_2O/tHNO_3$	c	After end of 10th campaign		Electronic and paper for at least 2 years after end	Determined from campaign emissions factors

	emissions factor after 10 campaigns for particular line (l=A, B)						of the crediting period	

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO$_2$ equivalent):

Over the duration of the project activity, N$_2$O concentration and gas volume flow in the stack of the nitric acid plant as well as the temperature and pressure of ammonia gas flow and ammonia-to-air ratio on all 3 nitric acid plants have been measured continuously.

Estimation of campaign-specific project emissions
The monitoring system was installed using the guidance document EN 14181 and provides separate readings for N$_2$O concentration and gas flow volume for every hour of operation. Error readings (e.g. downtime or malfunction) and extreme values are automatically eliminated from the output data series by the monitoring system. Same statistical evaluation that was applied to the baseline data series will be 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$_2$O in the stack gas for the project campaign (mgN$_2$O/m^3)
PE$_n$	Total N$_2$O emissions of the nth project campaign (tN$_2$O)
OH	Is the number of hours of operation in the specific monitoring period (h)

Derivation of a moving average emission factor

In order to take into account possible long-term emissions trends over the duration of the project activity and to take a conservative approach a moving average emission factor will be estimated as follows:

Step1: campaign specific emissions factor for each campaign during the project's crediting period will be estimated by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign.

For example, for campaign n the campaign specific emission factor would be:

$EF_n = PE_n / NAP_n$ (tN$_2$O/tHNO$_3$)

Step 2: moving average emissions factor to be calculated at the end of a campaign n will be estimated a as follows:

$EF_{ma,n} = (EF_1 + EF_2 + \ldots + EF_n) / n$ (tN$_2$O/tHNO$_3$)

This process will be repeated for each campaign such that a moving average, $EF_{ma,n}$, will established over time, becoming more representative and precise with each additional campaign.

To calculate the total emission reductions achieved in a campaign in formula below, the higher of the two values $EF_{ma,n}$ and EF_n shall be applied as the emission factor relevant for the particular campaign to be used to calculate emissions reduction s (EF_p). Thus:

If $EF_{ma,n} > EF_n$ then $EF_p = EF_{ma,n}$
If $EF_{ma,n} < EF_n$ then $EF_p = EF_n$

Where:

Variable	Definition
EF_n	Emission factor calculated for a specific project campaign (tN$_2$O/tHNO$_3$)
$EF_{ma,n}$	Moving average (ma) emission factor of after nth campaigns, including the current campaign (tN$_2$O/tHNO$_3$)
n	Number of campaigns to date
EF_p	Emissions factor that will be applied to calculate the emissions reductions from this specific campaign (i.e. the higher of EF_x and EF_n) (tN$_2$O/tHNO$_3$)

Minimum project emission factor

A campaign-specific emissions factor will be used to cap any potential long-term trend towards decreasing N_2O emissions that may result from a potential built up of platinum deposits. After the first ten campaigns of the crediting period of the project, the lowest EF_n observed during those campaigns will be adopted as a minimum (EF_{min}). If any of the later project campaigns results in a EF_n that is lower than EF_{min}, the calculation of the emission reductions for that particular campaign will use EF_{min} and not EF_n.

Where:

Variable   Definition
EF_{min} Is equal to the lowest EF_n observed during the first 10 campaigns of the project crediting period ($N_2O/tHNO_3$)

Project Campaign Length
a. Longer Project Campaign
If the length of each individual project campaign CL_n is longer than or equal to the average historic campaign length CL_{normal}, then all N_2O values measured during the baseline campaign can be used for the calculation of EF.

b. Shorter Project Campaign
In practice this means that, if the assumption that platinum deposits do have a reducing effect on N_2O emissions is correct, then an increasing adoption of EF_{min} instead of EF_n should be experienced as the project progresses through its crediting period.

If $CL_n < CL_{normal}$, EF_{BL} will be recalculated by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_n.

Leakage
No leakage calculation is required.

D.1.1.3. Relevant data necessary for determining the <u>baseline</u> of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use*	Data variable	Source of data	Data unit	Measured (m), calculated (c),	Recording frequency	Proportion of data to be	How will the data be	Comment

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numbers to ease cross-referencing to D.2.)				estimated (e)		monitored	archived? (electronic/ paper)	
B.1	$NCSG_{BC, 2,3,4}$ N_2O concentration in the stack gas for particular plant	N_2O analyser MIR9000	mgN_2O/m^3 (converted from ppmV)	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.2	$VSG_{BC, 2,3,4}$ Volume flow rate of the stack gas for particular plant	Gas volume flow meter ABB	m^3/h	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.3	$BE_{BC, 2,3,4}$ Total N_2O for baseline campaign for particular plant	Calculation from measured data	tN_2O	c	At least once after baseline campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.4	$OH_{BC, 2,3,4}$ Operating hours for particular plant	Monitoring system	Hours	m	Daily, compiled for entire campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.5	$NAP_{BC, 2,3,4}$ Nitric acid (100% concentrated) over baseline campaign for particular plant	Monitoring system	$tHNO_3$	m	Daily, compiled for entire campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	

B.6	$TSG_{2,3,4}$ Temperature of stack gas for particular plant	Thermocouple sensor	°C	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.7	$PSG_{2,3,4}$ Pressure of stack gas for particular plant	Foxboro transducer	hPa	m	Every 2 seconds	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.8	$EF_{BL, 2,3,4}$ Emission factor for baseline period for particular plant	Calculated from measured data	$tN_2O/tHNO_3$	c	At the end of the baseline campaign		Electronic and paper for at least 2 years after end of the crediting period	
B.9	$UNC_{2,3,4}$ Overall measurement uncertainty of the monitoring system	Calculation of the combined uncertainty of the applied monitoring equipment	%	c	Once after monitoring system is commissioned		Electronic and paper for at least 2 years after end of the crediting period	
B.10	$AFR_{2,3,4}$ Ammonia gas flow rate to the AOR for particular plant	Flow meters as defined in the monitoring plan	$kgNH_3/h$	m	Continuously	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.11	$AFR_{max, 2,3,4}$ Maximum ammonia flow rate for particular plant	Plant operation manual	$kgNH_3/h$	m	Once	100%	Electronic and paper for at least 2 years after end of the crediting period	

B.12	$AIFR_{2,3,4}$ Ammonia to Air ratio for particular plant	Calculated	%	mc	Every hour	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.13	$CL_{BL,\,2,3,4}$ Campaign length of baseline campaign for particular plant	Calculated from nitric acid production data	$tHNO_3$	c	After end of each campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.14	$CL_{normal,\,2,3,4}$ Normal campaign length for particular plant	Calculated from nitric acid production data	$tHNO_3$	cm	Prior to end of baseline campaign		Electronic and paper for at least 2 years after end of the crediting period	
B.15	$AIFR_{max,\,2,3,4}$ Maximum ammonia to air ratio for particular plant	Plant operation manual	%	mcm	Once	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.16	$OT_{h,\,2,3,4}$ Oxidation temperature for each hour for particular plant	Temperature meter as defined in the monitoring plan	°C	m	Every hour	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.17	$OT_{normal,\,2,3,4}$ Normal operating temperature for particular plant	Plant operation manual	°C	m	Once	100%	Electronic and paper for at least 2 years after end of the crediting period	

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B.18	$OP_{h, 2,3,4}$ Oxidation pressure for each hour for particular plant	Pressure meter as defined in the monitoring plan	Pa	m	Every hour	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.19	$OP_{normal, 2,3,4}$ Normal operating pressure for particular plant	Plant operation manual	Pa	m	Once	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.20	$GS_{normal, 2,3,4}$ Normal gauze supplier for the operation condition campaigns for particular plant	Invoices		m		100%	Electronic and paper for at least 2 years after end of the crediting period	
B.21	$GS_{BL, 2,3,4}$ Gauze supplier for baseline campaign for particular plant	Invoices		m	Once	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.22	$GS_{project, 2,3,4}$ Gauze supplier for the project campaigns for particular plant	Invoices		m	Each campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	

B.23	$GC_{normal, 2,3,4}$ Gauze composition during the operation campaign for particular plant	Invoices		m	Each campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.24	$GC_{BL, 2,3,4}$ Gauze composition during baseline campaign for particular plant	Invoices		m	Once	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.25	$GC_{project, 2,3,4}$ Gauze composition during baseline campaign for particular plant	Invoices		m	Each campaign	100%	Electronic and paper for at least 2 years after end of the crediting period	
B.26	EF_{reg} Emissions level set by incoming policies or regulations	Azomures personnel responsible for legislation					Electronic and paper for at least 2 years after end of the crediting period	

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO$_2$ equivalent):

The baseline for both Azomures nitric acid production lines NA2, NA3 and NA4 has been established separately through continuous monitoring of both N_2O concentration and gas flow volume in the stacks.

The schematic of the procedure is as follows:

1. Determination of the permitted operating conditions of the nitric acid plant to avoid overestimation of baseline emissions:
In order to avoid the possibility that the operating conditions of the nitric acid production plant are modified in such a way that increases N_2O generation during the baseline campaign, the normal ranges for operating conditions have been determined for the following parameters:

- (i)   oxidation temperature;
- (ii)   oxidation pressure;
- (iii) ammonia gas flow rate;
- (iv)   air input flow rates.

		NA2		NA3		NA4	
		minimum	maximum	minimum	maximum	minimum	maximum
Oxidation temperature	˚C	800	880	800	860	800	860
Oxidation pressure	bar G	2.5	4.0	0.0	2.6	1.8	3.0
Ammonia gas flow rate	Nm3/h	7,800	12,000	8,000	12,500	8,000	13,800
Air inputes rate	Nm3/h	68,000	106,000	60,000	116,000	70,000	121,000
Ammonia to air ratio	%	11.1%	12.5%	9.0%	11.5%	9.0%	11.5%

Because prior to implementation of JI project there were no requirements and no need from the plant operation point of view to store data on operating conditions, the "permitted range" for oxidation temperature and pressure has been determined, in accordance with the AM0034 methodology, using the range stipulated in the plant operation manual.

ii. Ammonia gas flow rates and ammonia to air ratio input into the ammonia oxidation reactor (AOR):
Parameters monitored are the following:
AFR   Ammonia gas flow rate to four AORs in one line (tNH_3/h)
AFR_{max} Maximum ammonia gas flow rate to four AORs in one line (tNH_3/h)
AIFR   Ammonia to air ratio (%)
$AIFR_{max}$ Maximum ammonia to air ratio (%)

The upper limits for ammonia flow and ammonia to air ratio has been determined using calculation of maximum permitted ammonia gas flow rates and ammonia to air ratio as specified in the plant operation manual.

Permitted ranges for pressure, temperature, ammonia flow rate and ammonia to air ratio determined are within the Operating Manual for nitric acid production process.

2. Determination of baseline emission factor: measurement procedure for N_2O concentration and gas volume flow
N_2O concentration and gas volume flow are monitored on all 3 Azomures nitric acid plants NA2, NA3 and NA4 throughout the baseline campaign. The monitoring system installed complies with requirements of the European Norm 14181 (2004).

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. Error readings (e.g. downtime or malfunction) and extreme values are automatically eliminated from the output data series by the monitoring system.

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 plant 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 for that period. The overall uncertainty of the monitoring system shall also be

determined and the measurement error will be expressed as a percentage (*UNC*). The N_2O emission factor per tonne of nitric acid produced in the baseline period (EF_{BL}) shall then be reduced by the estimated 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.

Since there are not in Romania any national or regional regulations for N_2O emissions, the resulting EF_{BL} is used as the baseline emission factor.

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. In case of oxidation temperature measurements, where measurements , as the case can be, can be influenced for example by slightly different location of thermocouples in each of 4 burners, the average hourly value of 4 oxidation temperature readings is used as the oxidation temperature value to be checked against the permitted range. Any N_2O baseline data that have been measured during hours where the operating conditions are outside the permitted range are eliminated from the calculation of the baseline emissions factor.

In order to further ensure that operating conditions during the baseline campaign are representative of normal operating conditions, statistical tests will be performed to compare the average values of the permitted operating conditions with the average values obtained during the baseline measurement period.

Impact of regulations:
Should N_2O emissions regulations that apply to nitric acid plants be introduced in Romania (host country), such regulations will be compared to the calculated baseline factor for the project (EF_{BL}), regardless of whether the regulatory level is expressed as:
• An absolute cap on the total volume of N_2O emissions for a set period;
• A relative limit on N_2O emissions expressed as a quantity per unit of output; or
• A threshold value for specific N_2O mass flow in the stack;

In this case, a corresponding plant-specific emissions factor cap (max. allowed $tN_2O/tHNO_3$) will be derived from the regulatory level. If the regulatory limit would be lower than the baseline factor determined for the project, the regulatory limit would serve as the new baseline factor, that is:

if $EF_{BL} > EFr_{eg}$, then the baseline N_2O emission factor shall be EF_{reg} for all calculations.

where:

Variable **Definition**
EF_{BL} Baseline emissions factor ($tN_2O/tHNO_3$)
EF_{reg} Emissions level set by newly introduced policies or regulations ($tN_2O/tHNO_3$).

Such EF_{reg} would be determined according to the nature of the regulation (e.g. in terms of absolute emission, by-product rate, concentration in stack gas), as described in the approved methodology AM0028.

The composition of the ammonia oxidation catalyst:
Azomures uses various types of oxidation catalysts. Composition of oxidation catalysts depends on latest technical knowledge of oxidation catalyst manufacturers as well as actual price of precious metals.

It is not possible to commit to using identical composition of oxidation catalysts during entire duration of the project because of several reasons.

Such commitment would put supplier of oxidation catalysts into monopoly situation. This would have negative impact on freedom of Azomures to choose best offered oxidation catalysts in terms of price, lease terms and conditions and also latest scientific developments as composition of oxidation catalysts may change from time to time based on most recent scientific knowledge of oxidation catalysts suppliers.

Furthermore, as it can be seen in secondary catalyst supply negotiations it is usual industry practice that suppliers of de-N_2O secondary catalysts condition abatement ratio guarantees provided by use of their oxidation catalysts and they offer higher level of performance security by linking supply of oxidation and secondary catalysts together. Choosing one single supplier of both oxidation and secondary catalyst could be a reasonable decision taking into account this approach of catalyst suppliers.

Flexibility in using various compositions which are usual industry practice for nitric acid plants of oxidation catalysts is a principal issue. It can be clearly demonstrated, that this flexibility is motivated by sound operational and economic reasons, there is not existent any other reason such as manipulation with the

N2O emissions, because there is no knowledge developed on impact of various oxidation catalyst compositions on level of N2O formation. Flexibility in using standard oxidation catalyst compositions will not impact environmental integrity of the project.

In order to demonstrate, that composition of primary catalysts has not been chosen with regard to N_2O formation Azomures will provide relevant verifier verifying the monitoring report with statement from primary catalysts suppliers on impact of those specific primary catalysts on N_2O formation, if such statement will be available. In case of a material decrease in generation of N2O the baseline campaign needs to be repeated or a conservative default factor applied.

In case of change of composition of a primary catalyst in future Azomures will demonstrate to a verifier:
- commercial – price, lease contract tenure, other terms and conditions Etc.
- technical – NO yield, operating parameters, impact on N_2O formation., and
- composition – conformity with industry standards

reasons justifying such eventual change within the JI project framework.

Parameters monitored for composition of the catalyst are as follows:

GS_{normal} Gauze supplier for the operation condition campaigns
GS_{BL} Gauze supplier for baseline campaign
$GS_{project}$ Gauze supplier for the project campaign
G_{normal} Gauze composition for the operation condition campaigns
GC_{BL} Gauze composition for baseline campaign
$GC_{project}$ Gauze composition for the project campaign

Campaign Length
In order to take into account the variations in campaign length and its influence on N_2O emission levels, the historic campaign lengths and the baseline campaign length have been determined and compared to the project campaign length. Campaign length is defined as the total number of metric tonnes of nitric acid at 100% concentration produced with one set of gauzes.

Historic Campaign Length
The average historic campaign length (CL_{normal}) defined as the average campaign length for the historic campaigns (in case of all three plants the previous four campaigns for which HNO_3 production data are available), has been used as a cap on the length of the baseline campaign.

Baseline Campaign Length (CL_{BL})
If $CL_{BL} \leq CL_{normal}$

all N_2O values measured during the baseline campaign can be used for the calculation of EF_{BL} (subject to the elimination of data that was monitored during times where the plant was operating outside of the "permitted range").

If $CL_{BL} > CLnormal$
N_2O values that were measured beyond the length of CL_{normal} during the production of the quantity of nitric acid (i.e. the final tonnes produced) are to be eliminated from the calculation of EF_{BL}.

D. 1.2. Option 2 – Direct <u>monitoring</u> of emission reductions from the <u>project</u> (values should be consistent with those in section E.):

This option was not used

D.1.2.1. Data to be collected in order to monitor emission reductions from the <u>project</u>, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.1.2.2. Description of formulae used to calculate emission reductions from the <u>project</u> (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

Not applicable

D.1.3. Treatment of <u>leakage</u> in the <u>monitoring plan</u>:

Due to nature of the project there is no leakage calculation required by the AM0034.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

Not applicable

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

The emission reductions for the project activity over a specific campaign are 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:

$ER = (EF_{BL} – EF_P) * NAP * GWPN_2O$ (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.
EFB_L	Baseline emissions factor (tN_2O/tHNO_3)
EF_P	Emissions factor used to calculate the emissions from this particular campaign (i.e. the higher of $EF_{ma,n}$ and EF_n)

Nameplate capacity of nitric acid plants NA2, NA3 and NA4 is defined in the plant contracts signed at time of start of these plants. NA2 nameplate capacity is 241,425 tHNO_3(100%) per year (333 operational days). NA3 nameplate capacity is 240,000 tHNO_3(100%)/year and NA4 nameplate capacity is 247,500 tHNO_3(100%)

This template shall not be altered. It shall be completed without modifying/adding headings or logo, format or font.

Emission reductions estimates are based on preliminary calculations from the baseline data and preliminary observations of abatement ratios measured during measurements following the installation of secondary catalysts.

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

Since N_2O is not a pollutant regulated by national legislation, it does not have any negative impact on an environment in vicinity of its point of emitting and it does not have any significant and attributable impact on population living in the plant's vicinity, it is not required to carry out the environmental impact study.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	**Uncertainty level of data (high/medium/low)**	**Explain QA/QC procedures planned for these data, or why such procedures are not necessary.**
P.1, B.1 $NCSG_{BC, 2,3,4}$ N_2O concentration in the stack gas for particular plant	Low	N_2O analyser MIR9000 QAL1 suitability calculations carried, QAL2 test carried out, QAL3 procedures carried out at the plant
P.2, B.2 $VSG_{BC, 2,3,4}$ Volume flow rate of the stack gas for particular plant	Low	Gas volume flow meter ABB QAL1 certified, QAL2 test carried out
P.6, B.6 $TSG_{2,3,4}$ Temperature of stack gas for particular plant	Low	Regular calibration and control according to existing measurement requirements
P.7, B.7 $PSG_{2,3,4}$ Pressure of stack gas for particular plant	Low	Regular calibration and control according to existing measurement requirements

This template shall not be altered. It shall be completed without modifying/adding headings or logo, format or font.

B.9 $UNC_{2,3,4}$ Overall measurement uncertainty of the monitoring system	Low	Regular calibration and control according to existing measurement requirements
B.10 $AIFR_{2,3,4}$ Ammonia gas flow rate to the AOR for particular plant	Low	Regular calibration and control according to existing measurement requirements
B.16 $OT_{h,\,2,3,4}$ Oxidation temperature for each hour for particular plant	Low	Regular calibration and control according to existing measurement requirements
B.18 $OP_{h,\,2,3,4}$ Oxidation pressure for each hour for particular plant	Low	Regular calibration and control according to existing measurement requirements

D.3.   Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

Monitoring plan shall be implemented in accordance with plant operation manual, national requirements for emission measurements, specific requirements of the EN14181 norm and requirements of this JI project using methodology AM0034.

D.4.   Name of person(s)/entity(ies) establishing the monitoring plan:

Mr. Laszlo Pasztor

Vertis Finance Kft. (not a project participant)
Alkotas u. 39/c

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Hungary

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SECTION E.   Estimation of greenhouse gas emission reductions

E.1.   Estimated project emissions:

987,957 tCO$_2$e in total

E.2.   Estimated leakage:

No leakage

E.3.   The sum of E.1. and E.2.:

987,967 tCO$_2$e in total

E.4.   Estimated baseline emissions:

9,185,133 tCO$_2$e in total

E.5.   Difference between E.4. and E.3. representing the emission reductions of the project:

8,197,176 tCO$_2$e in total

E.6.   Table providing values obtained when applying formulae above:

Year	Estimated project emissions in tCO$_2$e/year	Estimated leakage in tCO$_2$e/year	Estimated baseline emissions in tCO$_2$e/year	Estimated emission reductions in tCO$_2$e/year
2008	109,773	0	1,020,570	910,797
2009	219,546	0	2,041,141	1,821,595
2010	219,546	0	2,041,141	1,821,595
2011	219,546	0	2,041,141	1,821,595
2012	219,546	0	2,041,141	1,821,595
Total in tCO$_2$e	**987,957**	**0**	**9,185,133**	**8,197,176**

SECTION F.   Environmental impacts

F.1.   Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

Since N$_2$O is not a pollutant regulated by national legislation, it does not have any negative impact on an environment in vicinity of its point of emitting and it does not have any significant and attributable impact on population living in the plant's vicinity, it is not required to carry out the environmental impact study.

F.2.   If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to supporting documentation of an

environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

This type of project does not require to carry the EIA study.

SECTION G.   Stakeholders' comments

G.1.   Information on stakeholders' comments on the project, as appropriate:

This type of project does not require to carry the EIA study, neither requires public stakeholders involvement.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

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Annex 2

BASELINE INFORMATION

Baseline campaign used for calculation of the baseline emission factor on line NA2 started in July 2007 at the beginning of a campaign and was completed in October 2008.

Baseline campaign used for calculation of the baseline emission factor on line NA3 started in March 2007 at the beginning of a campaign and was completed in July 2008.

Baseline campaign used for calculation of the baseline emission factor on line NA4 started in July 2007 during course of then campaign, which started in September 2006. Production of nitric acid from date of installation of N_2O monitoring (July 2007) until end of then campaign (March 2008) was 124,081 tHNO3. Baseline measurements then continued from beginning of following campaign, which started in March 2008 and by August 2009 was not completed yet. Nitric acid production from March 2008 until installation of secondary catalysts in August 2008 reached 92,197 $tHNO_3$. NA4 baseline emissions factor was thus calculated using data from two campaigns and total quantity of nitric acid produced during this overlapped baseline campaign was 216,278 $tHNO_3$, i.e. less than NA4 historic campaign length of 275,871 $tHNO_3$. This approach is called overlapping. By overlapping data from two consecutive campaigns with materially same operating conditions it was possible to establish baseline factor and install secondary catalysts in August 2008.

As a result of these baseline measurements following baseline emission factors have been estimated. These figures are estimates only. Final baseline emission factor calculation will be subject to verification during first periodic verification.

	NA2	**NA3**	**NA4**
Baseline measurements start	July 27, 2007	March 3, 2007	July 16, 2007
Baseline measurements end	October 19, 2008	July 13, 2008	August 10, 2008
Baseline $tHNO_3$ production	207,307 $tHNO_3$	217,950 $tHNO_3$	216,278 tHNO3
Baseline emission factor	11.83 $kN_2O/tHNO_3$	9.37 $kgN_2O/tHNO_3$	6.11 $kgN_2O/tHNO_3$

Annex 3

MONITORING PLAN

In order to establish a definitive baseline, N_2O measuring instruments were installed in the lines in the plants NA2, NA3 and NA4. Continuous measurements were made throughout the duration of one production campaign in all 3 plants. To ensure the integrity of the data from these measurements and the suitability of the data for inclusion in the Baseline Study within the Project Design Documentation, the measurements will be validated by an Accredited Independent Entity - respected and experienced validator in the field of Joint Implementation.

N_2O emissions monitoring system consists of the measurement devices part and data processing and storage part.

MONITORING SYSTEM DESCRIPTION NITRIC ACID 2 PLANT
A. 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.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. N$_2$O 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$_2$O 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 N$_2$O 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.

MONITORING SYSTEM DESCRIPTION NITRIC ACID 3 PLANT
A. 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.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. 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.

K. 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 N_2O 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.

MONITORING SYSTEM DESCRIPTION NITRIC ACID 4 PLANT

A. 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.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. N2O 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 N_2O 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.