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ENERGY EFFICIENCY AUDIT REPORT
KEDZIERZYN NITROGEN WORKS

Zaklady Azotowe Kedzierzyn
Kedzierzyn-Kozle, Poland

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LIST OF ACRONYMS/ABBREVIATIONS

A.I.D.	U.S. Agency for International Development
IRG	International Resources Group, Ltd.
kv	kilo volt
kWh	kilowatt hours
LHV	low heating value
MJ	mega - joule
MT	metric tons
MPa	milli Pascute - measure of pressure
MW	mega - watts
nm^3	normal cubic meters
ppm	parts per million
PSI	pounds per square inch
t	tons
TJ	
ZAK	Zaklady Azotowe Kedzierzyn, the Kedzierzyn Nitrogen Works

ACKNOWLEDGEMENTS

The IRG Industry Audit Team for Poland wishes to express sincere thanks to the plant management and technical personnel for the valuable time and effort spent in preparing for the audit visit. The cooperation shown by the plant facilitated the communication and exchange of ideas and experiences in the area of energy management. IRG also would like to thank the U.S. Agency for International Development, European Development Resources, Office of Energy and Infrastructure, for coordinating the entire project.

It is the hope of the Industry Audit Team that the exchange established through this initiative be maintained and expanded in the future.

PREFACE

In the wake of the political and economic collapse of the Soviet Union, the nations of Central and Eastern Europe confront an energy situation for which there is no historical precedent. Overnight long-standing supply agreements for oil, natural gas and electricity supplies from the Soviet Union have been curtailed or discarded with attendant dramatic increases in the prices of these commodities. In addition, as the veil of secrecy has been lifted in these nations, the devastating legacy of years of neglect of coal and other fossil fuel pollution and an aging, largely unsafe, and unregulated nuclear power industry are vital issues that need to be addressed in light of the fundamental structural reform of these Central and Eastern European economies. Democracy for these countries means change amidst great political and economic uncertainly.

To support the transition from Soviet-based dependence to democracy, based on free market principles, the United States, in 1989, instituted a program to assist the countries of Central and Eastern Europe with humanitarian aid, technical assistance and direct economic aid. The U.S. focused initially on Poland and Hungary, where this transition was in its most advanced stages. Since that initial commitment to Poland and Hungary, the U.S. has expanded its focus to include Czechoslovakia, Bulgaria, Romania and Yugoslavia as technical assistance recipients in Eastern and Central Europe. In the future, large scale assistance is likely to be given to the Baltic States, Estonia, Latvia and Lithuania, as well as the republics of the former Soviet Union -- and possibly Albania.

Grants and other assistance to Central and Eastern Europe already account for a U.S. commitment of $1.5 billion since 1989. In Fiscal Year 1991, alone, grant assistance to the region totaled about $450 million. Many of these special assistance grants were funded through the U.S. Agency for International Development, with implementation assistance by various U.S. agencies and private sector organizations.

One important initiative under the U.S. technical assistance program was the U.S. Agency for International Development Emergency Energy Program for Eastern and Central Europe, Component #1: Industrial Energy Efficiency Improvement. This program was designed to address regional energy sector problems on a short-term basis and to identify and implement energy efficiency initiatives. This effort combined in-plant, on-the-job training with identification and implementation of energy management practices and low-cost measures to be implemented during the period of the contract work. This report outlines the activities of the Industrial Energy Efficiency Improvement project in one plant in Poland.

The purpose of the Industrial Energy Efficiency work was to improve in the short-term the efficiency of energy use by industry. Specific objectives included:

1) fostering improved management of energy use in industrial plants by identifying and implementing immediately cost-effective "low cost/no cost" energy efficiency improvements;

2) transferring energy auditing and management techniques including financial and economic analysis techniques; and

3) providing equipment to implement low-cost options, to improve monitoring and energy management, and to identify additional energy efficiency opportunities.

To accomplish these objectives the following actions were undertaken:

1) Eight industrial facilities were selected as target plants for audits. The plants were selected on the basis of:

- potential for significant energy savings;
- the likelihood that the plants will continue operating in the new economic climate;
- applicability of results to similar plants in Poland to which the energy conservation measures developed in this program could be applied.

2) Two Audit Teams went to Poland on two separate occasions, each Team visiting four or five plants to perform energy audits and conduct training.

3) The Teams identified, specified, and procured energy efficiency equipment to be used by the plants to implement short-term energy efficiency improvements.

4) Representatives of the Audit Teams returned to the plants in October 1991 to assist in implementation of the audit recommendations, and to monitor the energy improvements actually achieved.

5) The Teams presented a wrap-up workshop for plant managers and technical staff of the participant plants and other similar plants throughout the country. The seminar was held in Warsaw October 8-9, 1991.

The Industry Audit Team audited four plants (**Figure 1**):

Huta Ostrowiec, Steel Plant - Ostrowiec-Swietokrzyska
Zaklady Azotowe Wloclawek, Nitrogen Plant - Wloclawek
Zaklady Azotowe Kedzierzyn - Kedzierzyn-Kozle
Cement Plant Wierzbica - Wierzbica

The Audit Team collected data at every plant on the costs of producing steam and electricity, primarily using plant records, audit measurements, and interviews with plant officials. In some cases, the Audit Team counselled the plants in the establishment of systems for cost accounting in the plant, particularly where it related to energy costs per unit of output. The Industrial Energy Efficiency activities had tremendous success and generated letters of support from several plant managers.

Program Rationale

While this program was clearly a logical starting point for improved energy use patterns, it is only a beginning. Although all activities under the Industrial Energy Efficiency project were conducted using a relatively small budget for equipment purchases, the energy savings results

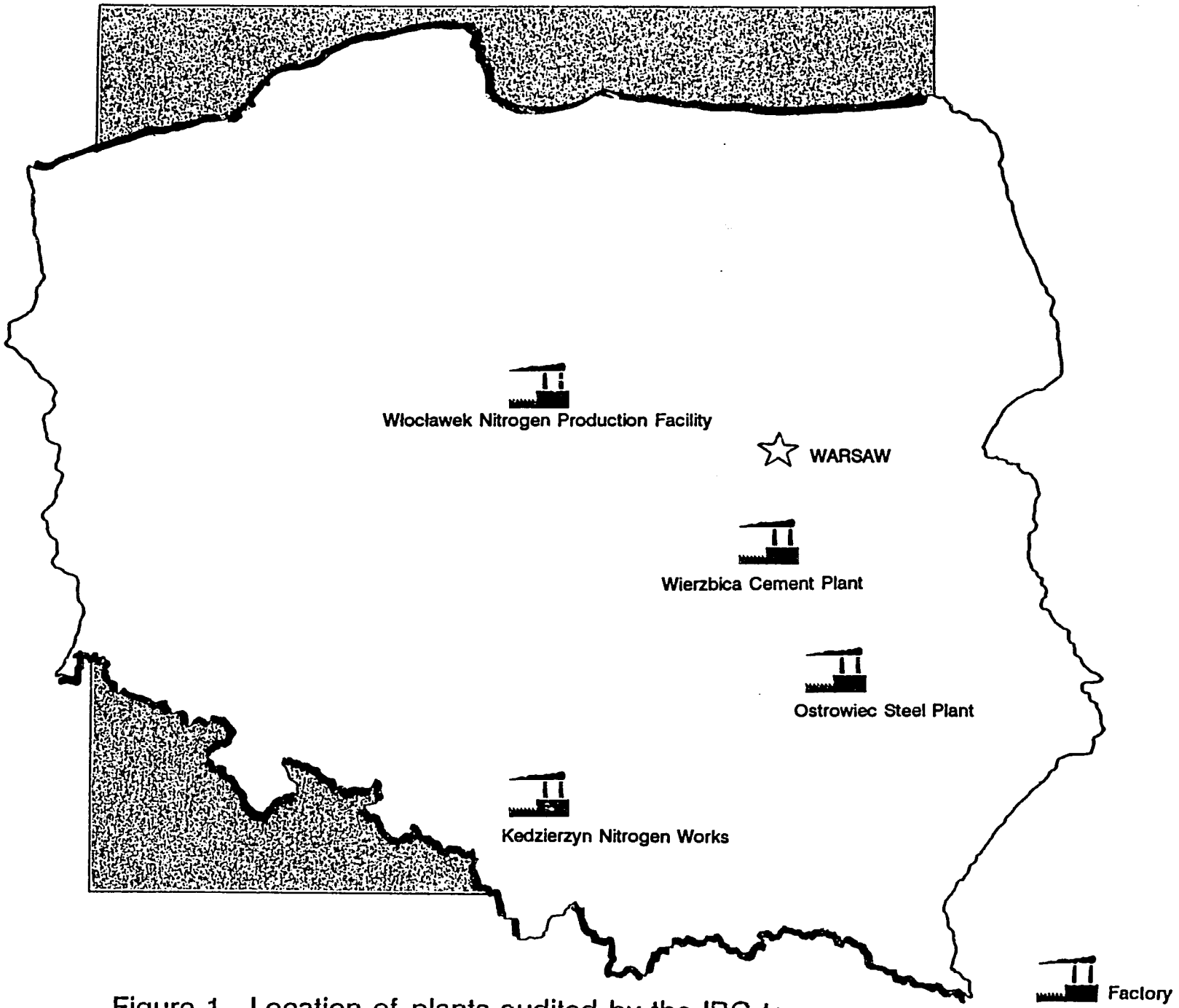

Figure 1. Location of plants audited by the IRG team.

were significant. Thus, the program demonstrated the tremendous potential for energy savings through low cost and no cost mechanisms. Moreover, these programs represented important energy savings initiatives that were implemented on a timely basis, within a matter of months.

These initiatives should serve as a cornerstone for a new way of approaching energy savings in Poland. They represent the lowest cost and most readily implemented energy savings initiatives available. Furthermore, the energy savings techniques/measures identified and implemented in this Emergency Energy Program should be applicable to other similar facilities and process units throughout Poland. As a result, these low cost techniques for improving energy efficiency, and thereby improving economic efficiency in industrial facilities, should serve as a model for restructuring energy use in the Polish industrial sector.

The project also highlighted a number of issues that fundamentally affect the ability of industrial entities to solve energy problems. Basic issues such as industrial energy pricing, environmental regulation, legal reforms, corporate organization and management structure, personnel training, and the overall economic environment all affect the ability of industrial concerns to implement energy savings opportunities. Thus, the Industrial Energy Efficiency Improvement project attempted to address issues of micro-level plant organization and management, training, and economic evaluation at each of the plants. In addition, the IRG Team has outlined key macro-level issues which must be addressed by the Government of Poland before comprehensive energy efficiency initiatives are enacted. These issues are addressed in this report as well as in Industrial Profile Report and the Policy and Institutional Analysis Report for Poland, both prepared as part of the Industrial Energy Efficiency Improvement project.

Ultimately, the IRG Team is convinced that the overwhelming potential for energy and cost savings in the Polish industrial sector will provide sufficient incentive for plant managers and industrial executives to actively promote the need for reforms that encourage energy conservation and improved economic efficiency.

1. EXECUTIVE SUMMARY

As part of the U.S. Agency for International Development (A.I.D.)-funded, Emergency Energy Program for Eastern and Central Europe, the International Resources Group (IRG) Industry Audit Team visited Poland in April 1991. During this time, the Team conducted an energy efficiency audit of the Nitrogen Works at Kedzierzyn, in Kedzierzyn-Kozle, Poland. The overall purpose of the audit was to assist the plant in identifying low-cost or no-cost opportunities for energy saving, and in training key plant personnel in modern methods of energy management as practiced in the United States (see **Appendix I** for a detailed list of activities).

To accomplish this, members of the IRG Industry Audit Team collected data at each plant visited to make informed decisions regarding opportunities for improving energy efficiency. Data were accumulated from several sources, including plant instrumentation, field measurements (using a portable ENERAC 2000 stack-gas analyzer purchased for the project), plant records, independent reports, and interviews of plant operating personnel. Information regarding measurements taken during the audit and general plant statistics is included in **Appendix II.**

The Kedzierzyn Nitrogen Works was included in the Industrial Energy Efficiency Improvement project based on assessments by the project definitional team, which included IRG Vice President Charles Ebinger and IRG Team Leader Gerald Decker. The Team evaluated the following issues before deciding which plants to include:

- potential for energy savings from low- or no-cost activities;
- overall economic status (ie. would the plant survive removal of price subsidies and/or privatization?); and
- replicability of the project activities and experiences at similar plants throughout Poland.

Following the April visit, the Team returned to the U.S. and arranged the procurement of equipment to be used by Kedzierzyn to implement the low-cost/no-cost energy efficiency initiatives identified. Once the equipment was ordered, the Team returned to Poland in October 1991 to learn what progress had been made in implementing their recommendations and to provide additional advice on equipment installation and key energy-management issues.

1.1 Plant Background

Kedzierzyn Nitrogen Works is a relatively old facility, built after World War II on the ruins of a German chemical plant. Commercial nitrogen fertilizer production began at this facility in 1954, and it is now the second largest chemical production complex in Poland. It is comprised of more than 50 varied production plants, and has aproximately 5,300 employees. Production includes industrial grade gases (hydrogen, oxygen, and argon), ammonia, nitric acid, saltpetres, saltmag, formalin, urea, resins and adhesives, oxo-alcohols, phthalic and maleic anhydrides, fatty alcohols, and amines.

In 1990, the facility consumed more than 940.842 million kilowatt hours (kWh) of electricity, of which 319.546 million kWh were generated by the cogeneration plant located within the complex. However, because the cost to produce electricity within the complex is 220 zł/kWh, the plant purchased most of its electricity from the grid prior to 1991, for only 207 zł/kWh, lower than the cost of generating electricity on site.

Other energy sources consumed at the plant include coal, process tail gas, and heavy oil. The consumption of coal alone comprises 93.7% of total fuel consumption at the facility, with annual consumption of coal in 1990 at 504,000 metric tons (MT).

Low-cost oportunities for energy conservation identified by the IRG Industry Audit Team principally involved improvements in process and load controls, waste heat recovery, combustion efficiency, and the use of thermal energy. In addition, the Team recommended strategic, operational and management changes -- including product diversification -- that could improve the plant's overall economic status.

1.2 Results of the Emergency Energy Program:

As part of the audit process, the Team recommended several pieces of equipment be purchased. These included:

- Infrared Thermometer
- Steam Traps
- In-Situ Oxygen Analyzer
- Load Management Personal Computer

These recommendations are summarized below in **Table 1**; this table also summarizes estimated energy savings for each item, a key criterion used in recommending the purchase of specific equipment. Given the need for high impact energy savings results, all equipment purchased had a payback period of one year or less. In addition, special attention was given by the IRG Team to procuring equipment that would produce energy savings results which could be easily replicated in plants throughout Poland.

Table 1. Equipment Procured under the A.I.D. Emergency Energy Program

Equipment Item	Cost	Annual Savings	Type of Savings	Payback Period (yrs)	Coal (tons)
Infrared Thermometer	$427	$1,743	steam	.24	83
Steam Traps	$2,619	$33,603	steam	.08	n/a
In-situ O_2 Analyzer	$25,484	$73,500	combustion	.35	3500
Load Management Personal Computer	$4,445	$10,000	process/ electrical	.44	n/a
TOTAL	$32,975	$118,846		.28	3583

Unlike many other technical assistance projects, this was an action-oriented initiative, designed to demonstrate the potential for energy savings in Poland by actually implementing energy efficiency projects in selected facilities. This report is intended to provide the reader with a background against which to view actions implemented under this project. Thus, this report outlines the observations, comments, and recommendations of the Audit Team gathered during the initial plant audit in April 1991, and from subsequent discussions with plant managers.

To allow a more comprehensive evaluation of the results of this initiative, results will be presented in the summary reports for the project. This report specifically focuses on the costs, benefits, and problems associated with each energy efficiency option. In addition, the report briefly outlines management, training, policy, and institutional factors that affect the ability of plants to achieve improvements in energy efficiency.

2. PLANT PERSPECTIVE

2.1 Background Information

Zaklady Azotowe Kedzierzyn (ZAK), the Kedzierzyn Nitrogen Works, is an older plant, tracing its history to World War II and the German era. It was erected on the ruins of a German chemical factory destroyed during the war, owned at that time by IG Farben Industries. The Polish government decided to rebuild the plant shortly after World War II, and initial commercial production of nitrogen fertilizers at Kedzierzyn began in 1954.

The Kedzierzyn facility is the second largest chemical production complex in Poland today, and is comprised of more than 50 varied production facilities and auxiliary units built on 2,000 acres of land. The facility employs approximately 5,300 people.

Production activities of the Kedzierzyn Nitrogen Plant can be divided into the following areas:

- Industrial grade gases (hydrogen, oxygen and argon) and ammonia;
- Nitric acid, saltpetres and saltmag;
- Formalin, urea, resins and adhesives;
- Oxo-alcohols;
- Phthalic and maleic anhydrides; and
- Fatty alcohols, amines, and others.

Annual sales in 1990 reached US $185 million, with 43% of total revenue derived from export earnings. Total profits reported in 1990 were US $22 million.

2.2 Plant Statistics

A cogeneration plant within the complex is more than 30 years old, and has a capacity of 123 MW. This coal-fired plant has nine boilers with a capacity of 100 tons/hour and one with a capacity of 60 tons/hour, as well as seven steam turbines (1 - 16.6 MW; 1 - 14.7 MW; 3 - 14.6 MW; 2 - 24 MW). This plant has the capacity to provide the necessary steam/hot water required for chemical processing, 40% of the heating requirements for the town of Kedzierzyn, and 30% of the electric power for the entire complex.

The network distributes steam at the following pressures (at turbine extraction points):

0.6 MPa	41.2%
1.5 MPa	34.8%
1.0 MPa	20.6%
7.0 MPa	3.4%

Schematic representation of the cogeneration plant flow diagram is presented in **Figure 4 of Appendix IV.**

In 1990, the facility consumed 940.842 million kWh of electricity, of which 319.546 million kWh were generated by the cogeneration plant. These figures indicate that the average power output of the cogeneration plant in 1990 was 36.5 MW, and give a clear indication of under-utilization of the cogeneration capacity of 135 MW.

The cost to produce electricity at Kedzierzyn is 220 zł/kWh, whereas the cost of power purchased from grid was only 207 zł/kWh in 1990. It was, therefore, to Kedzierzyn's advantage to produce only sufficient electric power necessary to satisfy steam and hot water demands in the plant.

It is anticipated that with continued commitment by the Government of Poland to removing price subsidies in the energy sector, the cost of electric power from the grid will increase to 250 zł/kWh in 1992. After the cost of electricity from the grid exceeds the cost of cogenerated electricity from the facility's plant, only then will it be advantageous for the plant to increase its generation of electricity.

The supplies of chemical energy (fuel, raw material, and electricity) at the plant are broken down in **Figure 2 of Appendix IV**. Of the fuel used at the Nitrogen Works, 93.7 percent is coal, 5 percent is process tail gas and 1.3 percent is heavy oil. The annual consumption of coal by the plant was 582,000 metric tons (MT) in 1989 and 504,000 MT in 1990.

Although the boilers are designed for burning coal with 23.0 MJ/kg (LHV) and less than 18% of ash, coal with lower heating value (19.5 to 20.5 MJ/kg) and additional ash (20 to 30%) has been used through a program of economic optimization **(Appendix V)**.

Waste heat recovery from exothermic reactions and waste gas recovery from processing the focal points of energy efficiency at this plant prior to the April 1991 audit. Steam generated from these two sources totalled 27% of the steam demand. (refer to **Figure 2 of Appendix IV**).

The cost of production computed from the above figures is approximately 1,513 x 10^9 zł, or US $161 million at the exchange rate of 9,400 zł = US $1. If a profit of US $22 million is added, the total revenue is close to the $185 million figure previously mentioned. Total energy costs as a percentage of production costs were found to be 27.34%; this figure includes natural gas as a raw material for the ammonia plant. Without natural gas as a feedstock for the ammonia plant, the total cost of energy as a percentage of production costs would be reduced to 12.5%.

The most significant set of numbers related to energy efficiency are the specific energy and raw material consumption figures. These are given in a table in item 24 of the questionnaire **(Appendix III)**.

2.3 Electric Power Tariff (as of Feb. 1991)

As previously stated, the average cost of electricity in 1990 from the grid was 207 zł/kWh. The cost to generate electricity at Kedzierzyn's cogeneration plant through condensing turbines and cooling towers was 220 zł/kWh; the anticipated average electricity cost from the grid in 1991 will be 250 zł/kWh. Consequently, electricity from the cogeneration plant will become increasingly economically competitive as the price of grid electricity increases.

Contract demand	120,000 zł/kW/month
15 minute demand	18,000 zł/kW/month
Usage charge	
on peak (8 am to 11 pm)	260 zł/kWh
off peak	160 zł/kWh
night	90 zł/kWh

2.4 Operating Status of the Plant

At the time of April 1991 audit, Team members observed that, in general, plant equipment and instrumentation were very old; consequently, collection of energy data and key energy-efficiency measurements was inconsistent.

Infrared thermometers used by the Team detected numerous places where insulation on steam pipes was in poor condition. In general, however, the pipe insulation was in good condition compared to other plants audited.

Nonetheless, the plant's production and overall cost figures suggest that, despite these problems, the plant has consistently operated as a profitable enterprise. Considering that more than 40% of plant revenues and subsequent profits are derived from export earnings, it appears that the plant is highly competitive in the international marketplace. In fact, the plant is in such a solid financial state that it has begun construction of a new ammonia plant, despite the serious recession that has pervaded the entire country during the last two years. Improvements in energy efficiency would only add to the plant's competitiveness and profitability.

3. ENERGY MANAGEMENT

3.1 Energy Management Program

A fairly strong energy management program exists at Kedzierzyn Nitrogen Works. High-level management strongly supports the program and encourages broad-based participation in activities initiated through the program. There is also a formal energy committee at the plant, which consists of the Vice Director of Production, Director of the Department of Technology and Energy, head of each production department, Director of the Office of Design, and head of the Department of Automatics.

Energy measurements in the plant are taken by the engineers group in the Department of Automatics. Energy balances, audits, verification, documentation, information management, and plant load and fuel optimization information are the responsibility of the Department of Technology and Energy, which is associated with the cogeneration power plant. Due to the poor quality of the measuring instruments, however, measurementsoften have been unreliable. The purchase of reliable energy measurement equipment will ensure the audit and data collection results are used most efficiently to promote optimal energy use at the facility.

The Department of Technology and Energy also researches and implements projects to improve the energy efficiency of the plant. Given the inevitability of price increases for electricity, fuel, and raw materials (natural gas) in the near future, the Department of Technology and Energy has been working to reduce specific energy consumptions in the plant.

Cost accounting, which includes accounting for the cost of fuels, electric power and raw materials, and economic analyses are jointly performed by the Department of Technology and Energy and the Office of Design. These groups also address environmental issues while evaluating various projects .

3.2 Future Requirements/Recommendations

Future requirements for Kedzierzyn include:

- Developing an economic model for project evaluations and economic forecasting; and
- Designing benchmarks/targets of achievement in terms of energy/fuel costs reduction per unit of production, and estimating a time schedule for each project.

4. ENERGY EFFICIENCY IMPROVEMENT OPTIONS

Several options for improvement in energy efficiency were discussed with management staff and engineers during the energy audit. Maior options at this facility were primarily associated with plant or process modernization projects. Audit Team/plant management discussions concentrated on the findings of a 1989 report on energy efficiency improvement options at the Kedzierzyn facility, written by two members of the Energy Management Committee, Mr. Chmielewski and Mr. Nawrot (**Appendix IV**).

These opportunities were identified either as a result of test work, plant inspections, or through personnel awareness. Listed below are a variety of options for improving energy efficiency use within the plant. Clearly, all these practices and projects will help conserve energy in the facility. However, given the reality of scarce resources for implementing these projects, the IRG Industry Audit Team recommended some be given priority; this prioritization is included in **Section 5**. This section outlines the wide variety of options available for energy efficiency improvement. The ultimate decision regarding implementation of alternative options will depend upon criteria set by the plant management -- including acceptable payback periods -- and upon the overall corporate strategy. Equipment the Audit Team recommended for purchase under the Emergency Energy Program is detailed in **Appendix XII**; in addition, justifications for the purchase of these items and calculations for return on investment are presented in **Appendix XIII**.

4.1 Short-Term/Low Cost/No-cost Options

For the purposes of this report, "short-term" options refer to items which will not require hard currency, but may require small-scale local currency investments, as well as items which may require limited amounts of hard currency. Each should be possible within the existing framework of plant expenditures (ie. zloty purchases, small hard currency purchases, improved maintenance, and housekeeping), and all will have rapid payback periods.

- **Thermal Leak Detection**

  In many places, insulation on the steam/hot water pipelines is either missing or damaged. An infrared thermometer can be used to detect those heat leaks; such a thermometer was used by the engineers from Energopomiar to demonstrate these results on an insulated turbine housing.

- **Boiler Combustion Analysis**

  All boilers at the cogeneration plant need oxygen or flue gas analyzers to enable operators to improve the combustion efficiency.

  A portable gas analyzer, Enerac-2000, was used to make several measurements on the exhaust end of one boiler. It demonstrated that simple instrument can be used to improve the combustion efficiency of the boilers by evaluating them one at a time.

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- **Plant Load and Fuel Cost Optimization**

  Not only will the prices of electricity, fuel, and natural gas be increased in the future, but pricing structures will also become more complicated. Kedzierzyn has been attempting to vary the plant load, maintenance schedule, and turnover period, to minimize overall electricity, fuel, and natural gas costs. There is a real need for a dedicated personal computer to calculate the optimal plant load and fuel selections and to conduct economic analyses of various energy efficiency projections.

  Given the size of Kedzierzyn's energy consumption bill, with 500,000 MT of coal, 940 million kWh of electricity, and 326 million nm^3 of natural gas consumed annually, this optimization program should pay for itself in a few months.

4.2 Medium-Term/Medium Cost Options

- **Steam Trap Replacement Program**

  This is an ongoing project; thus far 500 new traps have been installed (including Armstrong model 1810), but there are still 1,500 more to be put into operation. It was estimated that by the end of next year, all old steam traps will be replaced.

- **Steam to Hot Water Conversion**

  This is an ongoing project as well; all building heating systems should be converted from steam to hot water by the end of 1991. Yearly savings have been estimated to be 50 TJ of delivered heat, and 80,000 m^3 of treated water.

- **Steam Pipe Insulation Program**

  Through this ongoing program, additional insulation (thickness) will be added to steam pipes when they are overhauled or repaired. The anticipated fuel price increases will justify the thicker insulation. A study to optimize insulation thickness on pipes is suggested.

- **Installation of Heat Meters**

  The heat demand of large buildings will be measured with meters to make the energy conservation program more accountable. Total heat delivered to buildings in 1990 was estimated at 1,100 TJ, approximately 1.8% of the total energy cost (including natural gas as raw material).

4.3 Long-Term/Capital Intensive Options

Since many chemical technologies and equipment at the Kedzierzyn Nitrogen Works are old, energy inefficient, and environmentally unsound by modern industrial standards, there are several long-term modernization plans crucial to long-term sustainable operations.

A study conducted for the World Bank addressed a number of these modernization plans; a copy of this study was given to the energy audit team to be used as reference **(Appendix XI)**.

- **New Nitric Acid and Fertilizer Plant**

  This project is badly needed not only for energy efficiency, but more critically, for eliminating a serious air pollution source. The new process will generate sufficient heat from the exothermic reactions to support the fertilizer production. The estimated energy savings will be about 1,500 TJ yearly. Currently, two stacks are emitting yellow flue gas that contains 2,000 parts per million (ppm) of nitrogen oxide (NO_x), which can be seen miles away.

  Kedzierzyn has been fined for these environmental violations, but not severely enough to stop the operation. On the other hand, the facility does not have sufficient funds (US $90 million) to build a new plant; this is the biggest concern facing current management.

- **New Cogeneration Plant**

  The existing power plant is too old to implement any permanent energy efficiency or desulfurization measures. As such, it would be optimal to build a new cogeneration plant with new combustion controls and flue gas cleaning facilities.

  This project was already included in the World Bank study **(Appendix XI)**. A fluidized bed boiler, was mentioned as a viable alternative to the pulverized coal boiler, with an estimated cost of US $120 million. Detailed discussion of this project will be presented later in this report.

- **New Oxygen Plant**

  The purpose of this project is to replace the existing plant with a new one based on the latest technology. The estimated cost is US $32 million.

4.4 Large Capital Intensive Modernization Projects (underway)

1. Change Feedstocks to Ammonia Plant

   - 1979 gave up coke base process
   - 1990 gave up coke oven gas

- Reduced energy and raw material consumption by 6,600 TJ/yr

2. Modernization of Nitro Chalk Plant

   - Reduced energy consumption by 620 TJ/yr

3. New Oxo-alcohol Plant

   - 1986 start up
   - The new plant (Union Carbide license) became a showcase for energy efficiency. Specific energy consumptions: 139.45 kWh/MT, and 8.9 GJ/MT of steam (ref. #24 of questionnaire).

4. Modernization of Ammonia Synthesis Plant

   - Start up to be within one year
   - Estimated saving in energy and natural gas could reach 4,400 TJ/yr.
   - Cost of this project is about (US) $80 million.

5. CONCLUSIONS AND RECOMMENDATIONS

Since the Nitrogen Works at Kedzierzyn was operating under relatively efficient conditions, the IRG Industry Audit Team recommended a number of changes to the energy management program and the cogeneration facility designed to help the plant build on its strengths. Listed below are conclusions and recommendations made by the Team as a result of the initial audit visit in April 1991, its return visit in October 1991, and in subsequent discussions with managers at the plant.

5.1 Energy Management Program

Considering the outdated equipment and technology used at the plant, the management staff of the Nitrogen Works at Kedzierzyn have done a commendable job addressing energy efficiency problems. The energy management program is well in place, and the energy management team has addressed most major aspects of standard energy-efficiency programs.

Graphs and statistics are displayed in the production administration building to demonstrate the progress made in energy efficiency over the years. However, these graphs and statistics were not expressed in terms of energy consumption per unit of product. Adding statistical analysis of energy consumption per unit of product would greatly improve the energy management.

Most "housekeeping" energy-saving practices have already been completed under the existing energy management program. All the hallways in the plant appear to use the minimum required lighting, and room lights are invariably switched off when they are vacated. In light of the plant load and fuel optimization results, compiled without a dedicated computer, the plant management appears extremely determined to survive by cutting energy costs without affecting production.

5.2 Under-utilization of Cogeneration Plant

The average power output of the cogeneration plant in 1990 was 34 MW, although the installed capacity of the cogeneration plant is 135 MW. As such, the cogeneration capacity was significantly under-utilized.

Without the benefit of process steam or hot water sales to the district heating system, electric power from the cogeneration plant cannot compete with the electricity purchased from the grid at a lower price. The low grid price is actually an artificial price for electricity set by the government; consequently, the cogeneration potential will not, and should not, be exploited until electricity subsidies are substantially reduced or removed.

5.3 Combination of District Heating System and Cogeneration Plants

The low load factor of the cogeneration plant at Kedzierzyn is one of the main energy efficiency problems that must be addressed in the immediate future. Many factors have

contributed to this low load factor, but unrealistic electricity and fuel prices are the major contributors. However, the situation is changing.

The projected future electricity price will be in the range of 250 zł/kWh to 480 zł/kWh in 1992, once most electricity price subsidies are removed. Adjustment, as such, will definitely offer additional economic incentive to increase the utilization rate of Kedzierzyn's cogeneration plant. The cogeneration plant is so old, however, it must be replaced with new boilers and turbines very soon. In the aforementioned report to the World Bank, modernization of the cogeneration plant was one of three top priorities recommended for the Kedzierzyn facility. According to managers, an order of two fluidized bed combustion boilers and one turbine has been placed already. The total cost of stage I of this modernization process was estimated at $75 - $126 million, depending on if domestic or foreign suppliers were used.

The cogeneration plant already supplies 40% of the heating demand for the district heating system of the City of Kedzierzyn. There is also the Blachownia power plant 10 km away, an older cogeneration plant that supplies a small amount of industrial process steam to a nearby chemical plant. Blachownia is used currently for peaking capacity only.

It makes sense to combine the three systems into one modern cogeneration plant. By shutting down the Blachownia plant and boilers of the district heating system, fuel savings, pollution reductions, and operation and maintenance efficiency improvements will result in a short payback period for the new investment and a cleaner environment for local residents. The new plant would be built solely based on Kedzierzyn's economic merit. In the meantime, the old boilers of the district heating system and Blachownia power plant should remain in operation, despite their inefficiencies. Consequently, if the combination project is delayed or abandoned, money will be wasted through inefficiency, and there will be no relief in environmental pollution.

This issue was emphasized in the Audit Team's discussions with plant managers. The initiative by the Wloclawek plant and the recently published Kracow Environmental Project by United Energy Partners were cited as examples that the scope of a project should be extended beyond the physical boundary of the plant. The total merits of a comprehensive project must be evaluated with the economic, environmental, and social benefits of the entire region, and not simply the economic benefits to one plant.

To accomplish this, a new approach is needed at all levels of Polish decision-making. More importantly, support for new initiatives is needed from both domestic and international sources. The financial institutions (domestic or foreign) who are funding modernization projects are in an ideal position to promote appropriate integrations. It is hoped that the goals of these projects will be in agreement with those of World Bank, USAID, and other donor agencies.

5.4 Gas Fired Combined-Cycle Cogeneration Plants

At the closing session, the IRG Team Leader, Mr. Jerry Decker, indicated that long-term energy policy for Poland will be centered around coal. In the long-term, coal gasification appears to be a viable option for future Polish electric power plants. In the near-term, Team members recommend Poland adopt the use of combined-cycle, gas turbine cogeneration power plants.

The primary justifications for this policy are:

- Combined-cycle gas turbines can be converted to burn coal gas when necessary at a later time;
- Combined-cycle gas turbine have the highest fuel efficiency rate of all other fossil fuel powered options;
- Poland already has the district heating systems in place to take advantage of thermal energy outputs from these cogeneration plants;
- The technologies for gas-fired and coal gas-fired combined-cycle cogeneration power plants have existed for years -- as such, the technology risk is minimal; and
- Kedzierzyn is located in the Silesian coal mining region and has the advantage of being near the mine mouth. In addition, a coal storage/handling facility and ash management program already exist. These programs will be helpful when the turbine fuel is switched from natural gas to coal gas.

Currently, all natural gas is imported from the format USSR. However, the World Bank is cooperating with Polish authorities on developing domestic resources. Alternative sources of imported gas, from Norway and Algeria, are also seen to be important future sources of natural gas for Poland. Gas prices are imposed by the Ministry of Finance. Future adjustment of gas prices are projected in **Appendix VI**.

Management staff of the Nitrogen Works informed the Audit Team that a Swedish firm completed a feasibility study on a coal gas power plant for the facility. To construct a 160 MW coal gas plant, the cost was estimated to be US $900 million. The IRG Team considered this cost too high to be economically recovered within an acceptable payback period.

Another proposal is to build a combined-cycle gas fired cogeneration plant to replace both cogeneration plants. In addition to the economic benefits of high efficiency (both energy and labor), the environmental benefits of this project are significant: more than 1.5 million MT of coal per year will not be burned in this highly polluted area due to this project.

The management is very interested in looking into this proposal further in conjunction with the fluidized bed combustion boiler study included in the report to the World Bank.

5.5 Privatization

Kedzierzyn is in the process of being privatized, although the transition has been slow. At the present time, management cannot give further details about the privatization other than to indicate the plant is disengaging from a number of local subsidy obligations.

The plant staff are excited about the prospect of becoming a private enterprise and understand that operations must remain competitive on an international scale for the facility to attract investment money. However, they also recognize it will not be easy to remain competitive with old technology and equipment.

5.6 Discussion of Options

1. Zirconia O_2 analyzer - The eight probe oxygen (O_2) analyzer is meant for the cogeneration plant, to cover as many as eight boilers. The boiler house is 230 meters long, and the control room is in the middle. The probe cable is 450 meter long.

   At this stage, Kedzierzyn is in the process of modernizing the cogeneration plant. Two fluidized-bed combustion boilers (FBC) are scheduled to be installed in the near future; each FBC will be responsible for delivering 230 tons of steam per hour. After that, two more FBC boilers will be installed; and ultimately, all old boilers will be retired.

   The 0.7% improvement in fuel efficiency expected as a result of the installation of the O_2 analyzer system, as estimated in IRG report (**Appendix XII**), is in agreement with Kedzierzyn projections for efficiency improvement.

2. Steam traps - Kedzierzyn is already familiar with Armstrong inverted bucket steam traps; it started its own program for steam trap replacement two years ago. In that time over 600 Armstrong steam traps were installed; by next year, they will have completed the entire steam trap replacement program (1,500 traps).

   According to estimates by management, each steam trap will save 4-5 kg of steam per hour, and 30 to 40 tons of steam per year. At an estimated steam cost of $11.00 per ton, the payback for an $110 steam trap is about 3.5 months.

3. Desktop computer - The annual coal consumption at Kedzierzyn was over 500,000 MT in 1990. The Power Department had attempted to optimize the coal purchased according to price, shipping cost, heating values, sulfur content, and other criteria. The lack of a dedicated computer facility limited the results in the past, suggesting the installation of the computer will dramatically improve plant efficiency.

   At a electricity cost of 300 zł/kWh, Kedzierzyn is paying $1.4 million per month for electric power. The contract demand charge is about 22 million zł per MW per month. Mr. Nawrot intends to have an off-line load management and optimization program with the help of this computer. For every MW demand eliminated by this program, Kedzierzyn can save $23,000 each year.

   Kedzierzyn was paying $2.0 million each month for natural gas (mostly as a raw material for ammonia production). If a scheduling and optimization program can be formulated with this new computer tool, there will be significant savings in gas demand charges.

   The personal computer purchased for this location is a high speed computing tool (386 CPU and 33 Mhz) with tremendous memory capacity (100 Mb hard disk). In addition to

uses mentioned above, it will not only perform engineering and technical computations, but also business, finance, accounting, and information management functions.

APPENDIX I

AUDIT ACTIVITIES
April 1991

First Day (4/8)

1. Introduction of industry team, US AID program, goals and objectives, and auditing schedule.

2. Presentation of ZAK Energy Management Program:

   History of plant
   Productions, Sales, Management, organization
   Energy demands, raw material sources
   Cogeneration plant statistics
   Statistics of energy consumptions
   Auditing procedure, results, records, documentation
   Energy management practice, energy price increase forecast
   Modernization plans, plant load and fuel optimization
   privatization

Second Day (4/9)

1. Plant tours
2. Cogeneration Plant walk through
3. Discussion on US AID questionnaire

Third Day (4/10)

1. Continued discussion on US AID questionnaire
2. Economic justifications on short term options
3. Discussions on potential energy savings projects
4. Measurements of stack gas compositions with portable gas analyzer, ENERAC 2000.
5. Measurement of surface temperatures on insulated steam pipelines, and turbine housings.

Fourth Day (4/11)

1. Discussions on the results of gas analyzer measurements and the IR thermometer measurements with Energopomiar technical people
2. Prepare draft of audit report

Fifth Day (4/12)

1. Training seminar of Energy Management by team leader, Mr. Jerry Decker.
2. Presentation of Industry Team's audit report
3. Discussion on potential energy saving projects
4. Conclusion by team leader

APPENDIX II

PARTICIPANTS IN OFFICIAL MEETINGS
April 1991

Zaklady Azotowe Kedzierzyn

Konstanty Chmielewski	General Manager (M. Sc.)
Adam Gurgul	Production Director (M.Sc. Chem Engr.)
Henryk Nawrot	Chief Power Engineer. (M.Sc.)
Janusz Cieslar	Chief Technology Engineer. (M.Sc.)
Adam Golonka	Lead Power Engineer. (M.Sc.)
Eustachy Sieja	Assistant Chief Tech. Engineer. (B.Sc.)
Jerzy Kowalik	Mgr Project Engineering (M.Sc. Mech Engr)
Stanislaw Wardas	Consultant, Chem Engineer. (M.Sc. Chem Engr)

International Resources Group

Gerald L. Decker	Team Leader
Tadeusz J. Swierzawski	Engineer
Frank Wang	Engineer

Energopomiar

Edward Magiera
Marian Warachim

Kompekon Consulting

Boguslaw Pieczyski	President

APPENDIX III

ANSWERS TO IRG QUESTIONNAIRE

ENERGY AUDIT QUESTIONNAIRE

A. Identification

1. Nitrogen Establishments "Kędzierzyn"

2. Address: ZAŁADY AZOTOWE KĘDZIERZYN
47-220 Kędzierzyn-Kozle, Poland

3. In energetics part: Henryk Nawrot
in technical part: Janusz Cieslar

4. General Power Engineer
General Technology Engineer

5. 121-93

6. Fax: 12999, 13099; Telex:039331, 039332 pl

7. Chemicals

8. The dates of factory commissioning are different depending on the production line: from the year 1954 - manure production line, up to 1986 - alcohols-OXO production line

9. 5,300 employees

10. 24 hours/day: 364-365 days/year

11. Nitrogen establishments are multiplant company, in which are conducted many chemical syntheses. On the base of such simple raw materials like: natural gas, methanol, propylene, naphthalene and fatty acids, products are manufactured, finally prepared in various processing degrees.

All plants of company are self-sufficient if you take into account steam and water procurement but not power. Electric energy is brought particularly from Company's own Power and Heat Plant.

Raw materials are brought to the Company mainly by pipelines and railways but in some degree only - by autocisterne/carcis terns.

Company has its own maintenance services dealt with mechanical, electrical and measurement equipment.

B. Processing Activities

12. Scheme of connections with Company - see Figure 3.

13. Below are the main production units of the Company:

Ammonia production

- oxygen plant
- pressurized semi-combustion of natural gas at 4.0 and 0.07 MPa level
- compression of gas
- final cleaning
- ammonia synthesis

Manure production

- nitric acid plant
- magnesium-nitro-chalk plant / salmag
- ammonia saltpetre plant, nitro-chalk plant

Production of formaldehyde-urea resins

- urea plant
- formalin plant
- resin plant

Production of OXO-alcohols and ftal-softeners

- synthesized gas plant, and hydrogen plant
- OXO-alcohols plant
- ftal-anhydride plant
- ftalous plant

Production of fatty alcohols and aminos

Production of auxiliary medicines

Power and Heating Plant

- boilerhouse
- turbine room
- header of hot water for Company and town heating
- water treatment plant

Compressed air installation for measurement purposes

Chemical apparatus production plant

Auxiliary divisions: car and railway transport

Magazines

14. Heating consumption in the year 1990:

- steam, 0.6 MPa, 513,202 GJ
- hot water 560,670 GJ

Electricity consumption for lighting in the year 1990:

1,466.6 MWh

C. Raw Materials and Products

15.

Raw Material	Quantity Consumed	Origin	Mode of Transport	cost (million) zl
natural gas	326.76 million m^3	country pipenet	pipeline	223.35
methanol	42.295 Mg	nitrogen plant -Chorzow	railway	55.24
propoylene	86.101 Mg	Plock Refinery, import	cisterns	215.62
naphthalene	12,933 Mg	Chemical Plant -Blachownia	car cisterns	44.50
O-xylene	17,660 Mg	Chemical Plant -Plock	railway cisterns	58.1

16. These are re-used materials:

- outlet gases after ammonia synthesis / purge gas, 27.16 million m^3/year, is re-used to argon production
- methanol after resin processing, 1.969 Mg/year, is re-used to formalin production

17. Some by-products, like catalysts, are sold off.

18. Major products:

products	unit	plant capacity	annual production	value of sales
ammonia	Mg	369.000	295.007	intermediate production for manure
nitrogen acid	Mg	480.000	350.760	
nitro chalk	Mg	225.000	103.150	66.15 ml zł
salmag	Mg	330.000	255.540	220.51 ml zł
ammon salt-petre	Mg	220.000	122.390	92.34 ml zł
urea	Mg	181.440	150.250	97.68 ml zł - partially for further processing
silakol	Mg	146.000	81.948	152.33 ml zł
OXO-alcohols	Mg	133.500	118.816	419.43 ml zł - partially to further processing
ftal ahydride	Mg	46.000	28.500	47.10 ml zł - partially to further processing
formalin	Mg	57.300	34.740	intermediate production for glue
fatty alcohols	Mg	6.560	4.480	44.04 ml zł partially for further processing

Note: for intermediate products above point out value "of goods" not "of sales"

D. Energy Supplies

19. Energy products used in the plant: coal, natural gas, coke - oven gas, fuel oil, electricity

20. They are brought to the plant:

- coal - by railway,
- natural gas and coke-oven gas - by pipeline
- fuel oil - by railway cisterns
- electricity - by 220 and 110 Kv transmission lines

21. These are the prices of energy products in 1990:

687.370 zł/thousand cubic meters of natural gas
450.000 zł/thousand cubic meters of natural coke-oven gas
97.360 zł/metric ton of coal
819.940 zł/kWh of electricity

22. Below are relevant specifications for each:

- coal: calorific value: 19,500-20,500 kJ/kg
  ash content: 20-30%
  sulphur content: below 1%

- natural gas: calorific value: 35,000 kJ/m^3
  pressure: 1.0-4.0 MPa

- coke-oven gas: calorific value: 17,500-18,000 kJ/m^3
  pressure: 0.2 MPa

- fuel oil: calorific value: 41,600 kJ/kg

23. For chemical processing heat available:

steam: 7.0 MPa, 400°C; 1.5 MPa, 270°C; 1.0 MPa, 180°C; 0.6 MPa, 160°C; 0.15 MPa, 130°C

hot water: 135/70°C

Heat consumption depends on production level and a season of the year: 900-1800 GJ/h.

Coke-oven gas demand: 1500 m^3/h.

E. Energy Utilization

24. The major consumers of different type of energy are:

Process	Type of energy	Quantity per product unit	Efficiency
ammonia	natural gas steam electricity by product: steam waste gas	979 m^3/Mg 3.57 GJ/Mg 967.8 kWh/Mg 6.87 GJ/Mg 92 m^3/Mg	31.4 MCF/MT
nitrogen acid	electric energy thermal energy by product: steam	194.2 kWh/Mg 0.28 GJ/Mg 4.5 GJ/Mg	
nitro-chalk	electric energy steam	41.4 kWh/Mg 2.69 GJ/Mg	
salmag	electric energy steam	71.9 kWh/Mg 2.55 GJ/Mg	
urea	electric energy steam	213.6 kWh/Mg 3.6 GJ/Mg	
OXO-alcohols	electric energy steam	139.45 kWh/Mg 8.9 GJ/Mg	
Ftal-ahydride	electric energy steam gas by product: steam	1068.2 kWh/Mg 8.0 GJ/Mg 149.8 m^3/Mg 1.4 GJ/Mg	
formalin	electric energy steam	86.46 kWh/Mg 1.18 GJ/Mg	

25. Approximately, energy costs represented 27.34% in relation to total production costs in the year 1990.

26. In boilers it is possible to exchange coal to natural gas or to coke-oven gas up to 30% of boilers output, without any modification. Increased gas utilizing above that level required some modifications.

27. In heating buildings it was used about 1,000,000 GJ in the year 1990.

28. For mechanical handling and transport within the plant is used 0.06% of total electric energy consumption.

29. Oil tanks are heated by steam with hand-operated valves.

30. The plant encounters energy demand constraints according to State regulations - decision no. 208 of The Cabinet in 19.12. 1990.

F. Energy Consumption Data

31. The latest annual consumption data in the year 1990:

Fuel Type	Units	Current Price (zł)	Quantity Consumed	Total Cost million (zł)
coal	ton	97,360	504,000	49,070
natural gas	10^3m^3	687,370	326,760	224,605
coke-oven gas	10^3m^3	450,000	506,62	22,778
heat	GJ	9,664	8,956,167	86,552
electric energy	MWh	207,000	940,842	195,588
fuel oil	ton	818,940	516	0.422

32. The overall ratio of energy consumption per plant output value is equal of 14.374 GJ/mln zł. This value contains natural gas applied as chemical raw material.

33. See answer to number 24.

G. <u>Electricity Consumption</u>

34. Total installed capacity of motors: 327,500 kW
Voltage levels utilized: 220 kV, 110 kV, 30 kV, 6 kV, 0.9 kV, 0.23 kV

35. Yes, electricity is generated at the plant.

36. The ratio of electricity consumption is: 0.536 MWh per 1 mln zł of the plant output value.

37. There are installed steam turbosets.

38. The self-generating capacity: 123,100 kW

39. In the year 1990 there was generated 319,546 MWh.

40. Fuels used for self-generation:

Fuel Type	Units	Quantity Consumed	Heat Content of Fuel
coal	ton	118.896	20.297
waste gases	GJ	129.088	-
combustible waste products	GJ	25.410	-
fuel oil	ton	122	41.598

41. Self-generation capacity will not increase. Its quantity depends on steam demand to chemical processing.

42. There are available every hour readings of electricity consumption.

43. Electricity demand: peak - 165 MW
average: - 120 MW

44. The average power factor for the plant is 0.93 if connected with country network.

H. Combined Heat and Power Generation/Cogeneration

45. Yes, at the plant the cogeneration system is installed.

46. The basic data. See scheme, figure 4.

Energy Source	Level of Heat Production /GJ/hr	Level of Steam and Electric Production /kW/
steam boilers	810	30,000

47. The system was installed within the period of years: 1954-68, together with Company development.

48. The cogeneration output power is closely dependent on chemical production. Due to tendency of decreasing heat consumption it is foreseen to decrease cogeneration system capacity, too.

I. Boilers

49. Basic data:

Makers: 1. Simmering Graz-Panker, Austria - 5 units;
2. Prvni Bruenska, Czechoslovakia - 4 units;

Capacity: 100 t/h - each
Steam Pressure: 7.2 MPa
Temperature: 500°C
Normal Consumption of Coal: 18-24 t/h each
Fuels Used: 1. pulverized coal, gas
2. pulverized coal

Average efficiency: 83%

50. The source of boiler feed water is own water treatment plant.

51. Water treatment is based on ion exchangers, CO desorption, desiliconizing, de-aeration and met requirements sufficient for boiler as above in question 49.

52. Condensate is used in 27%.

53. Consumption rate of water is about 3 million m^3 per year.

54. The peak demand for steam is 650 t/h.

J. Energy Management and Conservation

5. Below is presented the brief overview of positions and responsibilities.

Production, distribution and energy management is coordinated within the department of Vice Director of Company - for production affairs. Under his dependence are five production plant power and heating plant and the Office of Technology and Energy. The Heads of individual plants are responsible on overall supervisory, specially concerning production, its costs and energy consumption. For the production of whole Company, different types of energy auditing and calculation of specific consumption rates of energy per products are carried out at he office of Technology and Energy. Individual plants carry out such Auditing, each for its own production only. In the Company, the General Power Engineer is responsible for energy management. He is a member of the Office of Technology and Energy.

56. Yes, the Company has the energy conservation program - see enclosures.

57. See enclosure

58. Responsibility for energy management results as a duty of position. It is mentioned above in question 55.

59. Yes, there is "energy committee".

60. Some energy conservation measures identified in enclosure. The special task are:

- exchanging drain devices in steam distribution network

- reconstruction building heating; exchange steam heaters on water type ones
- build in the meters of water and heat capacity

61. Instruments available to conduct energy audit work:

    - electric energy: counters of active power and worthless power

      power consumption recorders

    - thermal energy: flow fluid meters, pressure and temperature meters

62. Yes, the Company has its own Information Center of Technics and Economy.

63. Energy consumption per each product is examined and controlled as a routine matter - monthly.

64. Analysis of energy consumption, for high energy-consuming products, is carried out everyday, at each individual installation. For other products, analysis is carried out periodically. In the Department of Production, analysis of all specific consumption rates including energy, is carried out every month.

65. There are used the units of measurement as written in question 31.

66. Yes, the analysis includes also study of the relation between energy used and level of production.

67. The present extent of record-keeping of energy consumption is as follows:

    - electric energy: there is recorded total energy consumption in the Company, consumption by major consumers /above 0.2 MW/ and total consumption by little installations and arrangements.

    - thermal energy: on one side - there is recorded steam and heat production in boiler-house and utilized boilers, which is going to steam and heat network of company. One the other side - the consumption of technological centers or installations is also recorded. These data are used to examine a quality of energy management at board of Directors. Individual installations are provided with additional record and meters of steam and heat consumption. The range of instruments depends on commissioning time of the installation.

68. Yes, such comparisons are carried out.

69. Yes, specific energy consumption rates are set for each product individually.

70. Due to the high energy-consuming of majority of production, energy data are considered very important in overall manager information system.

71. Personnel dealt with operation and supervisory of energetic and electric equipment are graduated of additional, professional qualification.

72. Yes. The formal system of preventive maintenance provides current, middle, and general overhaul of individual installations and machines, according to approved schedule. Overhauls are carried out and supervised by a special service of Gene Mechanic Engineer within the Department of Technical Manager.

U.S. EMERGENCY ENERGY PROGRAM FOR EASTERN AND CENTRAL EUROPE

Component #1
Industrial Energy Efficiency

Energy Audit Questionnaire

A. Identification

1. Name of Company/Plant:
2. Address:

3. Name of Person Interviewed/Completing Form:
4. Title/Position:
5. Telephone:
6. Fax (or Telex):

7. Industry in which the factory is classified:

Mining	Construction Materials	Paper
Textiles	Mechanical/Electrical	Chemicals
Oil Refining	Food Processing	Steel
Other		

8. Date of factory commissioning:

9. Number of Employees:

10. How many hours/day does the plant operate (average)? Days per year (average)?

11. Please provide details on plant operation (eg., procurement, fabrication, scheduling, inspection, packaging, storage, shipping).

B. Processing Activities

12. Provide a flow sheet of the plant indicating major operations.

13. List the different process units (manufacturing stages), eg., boiler, electricity generation, oxygen plant, compressed air.

14. Provide a materials and energy balance for such non-process functions as lighting, heating, ventilation, air conditioning (if any), and materials handling.

C. Raw Materials and Products

15. List all major raw materials consumed:

Raw Material	Quantity Consumed	Origin	Mode of Transport to the Plant	Cost

16. List and quantify any recycled or re-used materials.

17. Are by-products or waste products of this plant utilized elsewhere?

18. List all major products:

Product	Units of Production	Plant Capacity	Actual Annual Production	Value of Sales

E. Energy Utilization

24. What process units/departments are the major consumers of each type of energy?

Process Unit	Type of Energy	Quantity	Efficiency

25. What percentage, approximately, do energy costs represent in relation to total production costs?

26. List any alternative fuels that could be used with or without modification of the plant.

27. How much energy is used in heating/cooling buildings?

28. How much energy is used for mechanical handling and transport within the plant?

29. Are fuel oil tanks heated? If so, how are they heated and how is the system controlled?

30. Does the plant encounter energy time of day or seasonal energy demand constraints (especially for electric power and natural gas)?

F. Energy Consumption Data

31. Give the latest annual consumption data:

Fuel Type	Units	Current Price	Quantity Consumed	Total Cost

Electricity	Current Price	kWh Consumed	Total Cost
Purchased:			
Self-Generated:			

32. What is the overall ratio of energy consumption per unit of plant output (eg., GJ/product unit)?

33. Give specific energy consumption ratios for different fuels used (eg., million metric tons of fuel oil/product unit).

G. Electricity Consumption

34. What is the total installed capacity of motors and other equipment (kw)? Specify voltage levels utilized.

35. Is electricity generated at the plant?

36. What is the ration of electricity consumption per unit of plant output (eg., kWh/product unit)?

37. If yes, what type of generator is installed (eg. diesel, gas turbine, steam turbine, waste heat boilers)?

38. What self-generating capacity is installed? (kw)

39. How much electricity was generated by the plant last year (kWh)?

40. Fuels used for self-generation:

Fuel Type	Units	Quantity Consumed	Heat Content of Fuel

41. Is self-generation capacity to be increased?

42. Are there data available on daily and seasonal variations in electricity consumption? Is there a daily load curve available?

43. Give electricity demand: peak and average.

44. What is the average power factor for the plant?

H. Combined Heat and Power Generation (Cogeneration)

45. Is there a cogeneration system installed at the plant?

46. If yes, provide the following:

Energy Source.	Level of Heat Production (GJ/hr)	Level of Steam and Elec. Prod. (kw)

47. When was the system installed?

48. Are there plans to install cogeneration systems or to increase the capacity of an existing system?

I. Boilers

49. Provide data for each boiler:

Maker:

Type/Model:

Capacity:

Steam Pressure:

Temperature:

Normal Consumption of Fuel:

Fuels Used:

Average Efficiency:

50. What is the source of boiler feed water?

51. What water treatment is used? What is the water quality after treatment?

52. What percentage of condensate is re-used?

53. What is the consumption rate of water?

54. What is the peak demand for steam?

J. Energy Management and Conservation

55. Provide an organizational chart and brief overview of positions, responsibilities, management policy directives, internal accounting policy, and quality assurance policy.

56. Does the plant currently have an energy conservation/savings program?

57. If yes, what does this program consist of? What are the energy savings?

58. Who is responsible for energy management?

Name:
Position:
Full Time/part time?
Qualifications, Experience?

Is there an "energy team"? If so, how many?

59. Is there an "energy committee"? If yes, list the members of the committee and their titles. What are the tasks and responsibilities of the energy committee?

60. What energy conservation measures have been identified to date?

61. What instruments/equipment are currently available to conduct energy audit work?

62. Does the plant have adequate information and literature concerning energy conservation and audit procedures?

63. How is energy consumption examined and controlled?

-- by senior management only? by each plant within the company?

-- as a routine matter, or from time to time?

-- when was the last complete review performed?

64. What analysis of energy consumption is carried out?

-- According to department (eg., offices, process plant, maintenance)?

-- By major equipment (eg., furnaces, boilers, electrostatic fillers)?

-- By end-use (eg., lighting, process heat, rotating equipment)?

-- By major product line?

-- By total monthly consumption?

65. What units of measurement are used? Are the consumption patterns of different forms of energy converted into a common unit of measurement?, eg., kilocalories, BTU, or kWh?

66. Does the analysis include study of the relation between energy used and level of production?

67. Describe the present extent of record-keeping of energy consumption for all forms of energy consumed. Are records available of the energy consumed in the different parts of the plant? By major individual consuming equipment? By department?

68. Is the current energy consumption compared with energy consumed in previous periods, or with other similar plants? Are adjustments to energy consumption made for variations in products quality, in the quality or type of raw materials, in climatic conditions, in capacity utilization?

69. Are specific, quantitative objectives set by management?

-- for total energy consumption?

-- for specific energy consumption?

-- for energy savings (eg., percentage reduction)?

-- for improvements in specified processes or manufacturing stages?

70. Are energy data considered important in the overall management information system?

71. What action has been taken to educate personnel in energy conservation procedures?

72. Is there formal system of preventive maintenance? (Give details).

APPENDIX IV

THE PROBLEMS OF OPTIMAL ENERGY MANAGEMENT AT ZAKLADY AZOTOWEC KEDZIERZYN

A REPORT BY K. CHMIELEWSKI AND H. NAWROT

Konstanty Chmielewski
Henryk Nawrot
Zakłady Azotowe "KĘDZIERYZN"

ABSTRACT

The rational energy management at a big chemical factory has been presented in this paper, based on the example of the "KĘDZIERZYN" Nitrogen Works.

Examples are given on how the energy consumption to produce ammonia, nitrogenous fertilizers and some organic products has been reduced.

Some pending projects have been presented, as well as some of those planned, to lower energy/consumption.

In addition, those problems have been discussed, which will need to be solved in consequence of the expected rise in prices of energy-delivering raw materials.

INTRODUCTION

When a chemical factory offers many products in various degrees of processing, it consumes a lot of energy in various forms. For this reason, such a factory faces the problems of rational energy management irrespective of the decisions made by its administration.

Rational energy management covers all fields of energy utilization, i.e. its production, distribution, and consumption. When following the progress of technology, one finds that the best results were obtained within the field of consumption, what reads in manufacturing processes. Minor changes, though also appreciable, refer to the remaining two fields.

The above mentioned processes were also reflected, in the activities of our Nitrogen Works that will be discussed later in this paper.

THE STRUCTURE OF THE "KĘDZIERZYN" NITROGEN WORKS AS REGARDS PRODUCTION AND ENERGY CONSUMPTION

The "Kędzierzyn" Nitrogen Works comprise many plants/units to manufacture basic and auxiliary products to carry out repairs, and to supply services to the main units. There are numerous interdependences regarding raw materials, cooperation etc. which connect separate units. The following basic production lines can be distinguished within our Works:

- natural-gas based and coke-oven gas based production of ammonia:
- production of nitrogenous fertilizers based entirely on our own intermediate products such as ammonia, nitric acid, and carbon dioxide:
- a line to produce OXO-alcohols, composed of:
  * a unit to generate syn-gas from hydrogen and natural gas; and
  * a unit to produce octyl and butyl alcohols to begin with propylene as a feedstock;
- production of phthalic and maleic anhydrides coming out of naphthalene, o-xylene and benzene
- production of phthalic softeners, du-butyl and di-octyl phthalates based on our own intermediate products of phthalic anhydride, and butyl and octyl alcohols;
- a line to convert methanol to give formalin and to produce urea-resin adhesives from formalin and urea;
- production of fatty alcohols from fatty acids of both animal and vegetable origin; and
- a number of small- and medium-scale products; such as auxiliary agents for textile industries and auxiliaries to produce paints and lacquers, paper, waxes, etc.

Our demands for steam and various grades of water are covered by our thermal-electric power station. It operates 10 pulverized-coal steam boilers capable of producing about 100 tons of steam per hour. The generated steam is of 7 MPa and 500°C. It is then expanded in turbines to the pressure of 1.5 MPa, 0.6 MPa, and 0.15 MPa, according to the specific application needs.

There are 7 turbines installed with a combined power output of 125 MW. Among these, 2 turbines are equipped with condensation members.

Approximately 70% of our electric energy requirements are delivered by the power grid, while 30% are our own production.

Our total power installed amounts to 325 MW, our power input is between 130 and 170 MW.

There are 2 heating systems:

- to deliver heat for our Works and for a housing estate nearby - its power output is 83 MW; and

- to deliver heat for parts of the town of Kędzierzyn - its power output is 76 MW.

We also have factory networks to distribute steam of 0.6 and 1.5 MPa as well as a network to distribute heat just for heating needs. In addition, there exists a local network of 1.0 MPa steam to serve our plants producing nitric acid and saltpeter fertilizers.

Apart from heat-carrying agents, our Power Engineering Department supplies the factory networks with various grades of water (industrial water, drinking water, demineralized and/or partly-demineralized water) as well as with compressed instrument air.

To meet process and heating requirements, we utilize the following energy carriers: coal, natural gas, coke-oven gas, and electricity.

In 1989, our Works delivered a total 30,141 TJ of energy, broken down as follows:

coal	-	582,000 Mg
natural gas	-	385,000,000 m^3
coke-oven gas	-	126,000,000 m^3
electricity	-	849,000 MWh
gas fractions, oils	-	215 TJ

We sold almost 621 TJ of energy in various forms, of that figure 476 TJ were consumed to heat the town. Hence, the net energy consumption amounted to 29,520 TJ.

Our thermal-electric power station processed fuels yielding 12,368 TJ, where coal amounted to 92.6%, gaseous wastes 6.0%, and solid wastes and oil 1.6%. More than 10,120 TJ of thermal energy were produced. Of that, 74% was passed on to be utilized as heat, and the remaining 26% was converted into electricity.

Our factory network distributed 8,322 TJ in the form of steam, in which 73% was composed of steam generated in our thermal-electric power station, and 27% of steam generated by heat recovery from our production plants.

Our steam network distributed the following grades and shares of steam:

0.6 MPa	-	41.2%
1.5 MPa	-	34.8%
1.0 MPa	-	20.6%
7.0 MPa	-	3.4%

Specification for supplies of energy-delivering materials is shown in **Figure 1**, and the general energy balance for 1989 is presented in **Figure 2**.

THE PROJECTS PUT INTO PRACTICE AND AFFECTING ENERGY CONSUMPTION

Coke Replaced by Natural Gas as a Feedstock to Produce Ammonia

Within this project, hydrogen to produce ammonia is no longer generated in a coke-based line. This process has been replaced by using pressure semi-combustion of methane in the air-oxygen mixture. The semi-combustion plant output is sufficient to produce 1,000 Mg of ammonia per day.

figure 1

figure 2

This project enabled steam, raw materials, and electricity consumption of about 6,600 TJ, providing a savings of some 20% of the total energy consumption in our Works. On the basis of those savings, we could develop production of other goods with no need to intensify our energy-delivering systems.

Modernization of the Nitro-chalk Plant

This plant has been operating since 1955. High degrees of exploitation of both the buildings and process equipment, as well as the need to improve the quality of our product, made us decide to shut-down the old plant and to build a new one. The new plant has modern units for neutralization and a mechanical granulation method has been employed rather than tower granulation; how the plant needs only one-half the energy previously necessary.

At the same time, the Urea Plant I cooperating with the Nitro-chalk Plant was shut-down. Those 2 stopped plants provided a heat savings of about 620 TJ per year. Moreover, amounts of gas effluents and of waste water were significantly reduced.

Together with the new Nitro-chalk Plant, a new plant to purify waste condensates through ion-exchange materials was designed and erected according to our own engineering. This plant has been operating at its full capacity for 2 years now and delivers about 60 - 80 m^3/h of water, the quality of which meets the requirements for boiler water. It also delivers several hundred tons a year of ammonia, previously sent to our sewage system.

Starting the OXO-alcohols Production

A new plant to produce OXO-alcohols which was built in our Works employs a UNION CARBIDE low-pressure process. This technology is an example of significant progress in the reduction of energy consumption in manufacture of OXO-alcohols.

This process can be compared with that of the "Oświęcim" Chemical Works, where old plants were employed to produce the same alcohols. The plants are no longer in operation. Energy consumption was 2.5 to 3 times higher than that of our Works now. So, starting up our new plant gave reduction in energy consumption in the national scale. Apart from that, design solutions were introduced to lower energy consumption within the "Kędzierzyn" Nitrogen Works itself. For example, we have an additional boiler to utilize all our liquid and gaseous wastes and to generate 3.0 MPa steam to drive one of our compressors. Though investment costs were higher than first planned, the necessary steam does not have to be sent from our thermal-electric power station 3 km away, where the wastes were planned to be utilized. In this manner, we have reduced steam losses to compensate for investment costs.

Steam Heating Replaced by Water Heating

For many years we have had 2 systems of central heating:

- **water system** -- mainly for the buildings close to our thermal-electric power station, and for those newly erected; and
- **steam system** -- for the remaining ones.

Losses of steam (for the latter system), losses of condensate and no possibility to control heating made us decide to eliminate steam heating. Step by step, for a few years we have been supplying more and more buildings from our water heating system. In the beginning, we built a central heating station, with its capacity being 83 MW to cover all needs in our Works. This project will take a few years to complete since new delivering pipelines have to be built and heating systems inside buildings have to be changed. Moreover, we can do that only from May to September, i.e. when there is no need to operate the heating system. In 1987, the water system delivered 38% of the required heat, while in 1989 as much as 54%. Yearly savings are estimated to reach 50 TJ of heat and 80,000 m^3 of water.

Modernization of the Ammonia Synthesis

A new synthesis unit is currently under construction; it will have an output of 1,500 Mg/day and will replace the old plant composed of 17 separate (which as been in operation since the mid-1950s).

This project, together with the line to produce syn-gas, will enable recovery of the reaction heat, lower electric energy demand, and will lower consumption of natural gas.

Savings are estimated to reach 4,400 TJ/year, orsome 15% of the Works' total energy consumption.

Modernization of the Process to Produce Nitric Acid and Fertilizers

The next project contributing to the decrease in energy consumption covers replacement of the atmospheric process for the pressure process to produce nitric acid. Moreover, project are being designed to produce MG-nitro-chalk instead of the saltpetre fertilizers and to have a unit for mechanical granulation. The increased acid concentration together with the new granulation unit will make the whole line of fertilizers self-supporting in its heat requirements.

Planned energy savings are expected to reach 1,500 TJ/year.

Modernization of Our Thermal-Electric Power Station

Our boilers and turbines have been exploited to a high degree. Moreover, we face the problem of environment protection. That made us start the feasibility study to choose the best method for modernization of our thermal-electric power station.

We are considering 2 variants:

- fluidized-bed atmospheric boilers, e.g. type P200 offered by ABB; and
- fluidized-bed atmospheric boilers with their beds circulating.

The following advantages are expected after implementation of either of the above:

- increased of thermal efficiency compared with that of the old pulverized-coal boilers;

- increase of the steam pressure up to 10 or even 12 MPa to improve the electric energy output from the expanding turbines; and

- significant reduction of emissions of SD_2 and NO_x.

PRESENT AND FUTURE POSSIBILITIES WITHIN THE FIELD OF RATIONAL ENERGY MANAGEMENT

It can be clearly seen from the examples presented above that energy savings are sought and achieved in manufacturing processes. This will also be a principle to follow in our Works. Yet, apart from technology, there is a group of problems that have recently become more and more significant, especially considering the rising prices of energy-delivering materials.

Some of those problems have already been solved. Still, there are such problems that it would be unprofitable to put their solutions into practice.

Below examples of the energy management problems are listed as subjects of interest for individual departments within our Works.

Reduction of Heat Losses in Pipelines

Steam networks in chemical factories comparable to the "Kędzierzyn" Nitrogen Works can reach the length of tens of km in all. Thus, it is obvious that even relatively small heat losses (3 - 4%) will cause large amounts of lost heat; those amounts can be comparable to quantities consumed by some separate production plants. The main reasons for such losses are: poor insulation, and/or inefficient steam traps. The problem of steam traps has been successfully solved in our Works. We recently purchased more than 500 steam traps, types Gestra BK 15 and Armstrong model 1810, and installed them on main pipelines at first. In time, steam receiving units will also be equipped with such traps. The problem of insulation is more complex since the insulation thickness is a middle course between the insulation costs and heat losses. The energy prices are expected to go up to reach the prices calculated by the rest of the world. Hence, reasonable insulation thicknesses will be changed too. Insulation replacement can be carried out together with the general overhauls of pipelines. Thermovision equipment is very useful to estimate the condition of insulation and to locate places where heat is being lost. However, the equipment itself is very expensive, as is having the pipelines tested; for this reason utilization of this method is limited to vital cases only.

Water Economics

Low prices of the consumed water as well as relatively mild limits regarding the allowed amounts of water were the reasons for the fact that water economics was not the main problem in factories. The last price increase in July 1990, together with the shortage of surface and underground water suitable for further conditioning, generated a completely new approach to the following sides of the question:

- proper quality of water circulating in cooling systems must maintained (chemical composition and suspended matter);

- the make-up water stream must be controlled and adjusted according to salinity;
- additional components should be introduced to prevent corrosion, formation of deposits etc.;
- steam condensates must be subject to recovery and contaminated condensates must be cleaned and subject to conditioning; and
- new and more efficient methods for water conditioning should be chosen.

Waste Heat Recovery

A chemical factory has large amounts of waste heat which are at too low a temperature to be directly utilized.

Temperatures are as follows:

- water from cooling systems 30 - 40°C, and
- waste condensates and process vapors 80 - 100°C.

These temperatures would have to be increased through of heat pumps or heat transformers to be reasonably utilized. We have considered the application of 2 types of such systems: (1) compression type, and (2) absorption type; their power installed being of the order of a few MW.

With the present prices of energy and prices of such appliances, this investment does not for itself. Yet, we estimate that this problem will have to be considered again before long.

The most reasonable way of utilizing of the water from the cooling systems would be supporting our heating water systems. Waste condensates and vapors could be used to generate low pressure steam.

Installing Meters at Receiving Units

In our Works, central heating covers over 200 buildings and heat consumption is calculated in relation to the size of a given object.

The only way to force a user to save energy is to install a heat meter. However, no heat meters are produced in Poland. Comparison of the prices of energy and the prices of imported meters gave us no reason to buy and install any meters, especially in case of small energy users.

Complex Diagnostics of Appliances and Units

It is important for rational energy management to analyze carefully such problems as:

- location and range of heat losses;
- proper selection of specific energy carriers to operate specific manufacturing processes;

- selection of outputs for basic and auxiliary appliances to reach the desired productivity; and

- effective methods to better the present condition of affairs.

Such services can be offered to factories by existing companies, but only on a limited, specialized scale (e.g. steam boilers, compressors, reactors, etc). In chemical processes, however, a broader view on a problem and/or the ability to put a problems together to be solved as a set is needed.

Adjusting Production Processes Outputs to Match the Scale of Charges for Energy Carriers

The scale of charges for electricity and natural gas comprise factors which can fluctuate based on a season of the year or even a day (electricity). Skillful adjustments of the productivity, and thus of energy consumption, to match the charges can provide substantial cost savings.

This rule is followed in our Works; we adjust the load of our plants at the highest charge time and at night. The scale of charges can also influence the dates planned for some plant repairs.

Taking full advantage of such possibilities requires a system to observe the actual productivity, energy consumption, feasibility of changing the load, etc. This will be possible when computer control systems become more popular and commonly used.

Control of Combustion Processes

Gas-fired industrial furnaces are utilized in some manufacturing processes. To reach higher combustion efficiency and economize on energy, one has to employ new control systems. They must be sensitive to instantaneous changes in the raw material temperature, in fuel composition, air, etc. These requirements can be met only when applying microprocessor-based control systems. But the decision to replace conventional systems and to apply the above must be supported by economical analysis.

SUMMARY

This short survey of the projects already put into practice and of those to be accomplished prove that rational energy management in a chemical factory must be a continuous process. Separate projects comprise a few goals to achieve, but improvements in energy management are not always the among first. Yet, the problem of energy must always be considered.

Economical factors and prices of energy carriers like coal, natural gas, and electricity, exert strong pressure on which problems of reasonable energy consumption to consider and solve first.

For the last few decades, prices of the basic energy carriers were kept far below world prices. This made many projects in the field of energy consumption unprofitable. Reaching step by step the normal level of those prices will force the consumers to accomplish projects previously neglected.

Figures 3 and 4 outline other major plant operating characteristics that should be considered in an energy management program.

Figure 3. Z A KĘDZIERZYN Major S Operations Flow Sheet

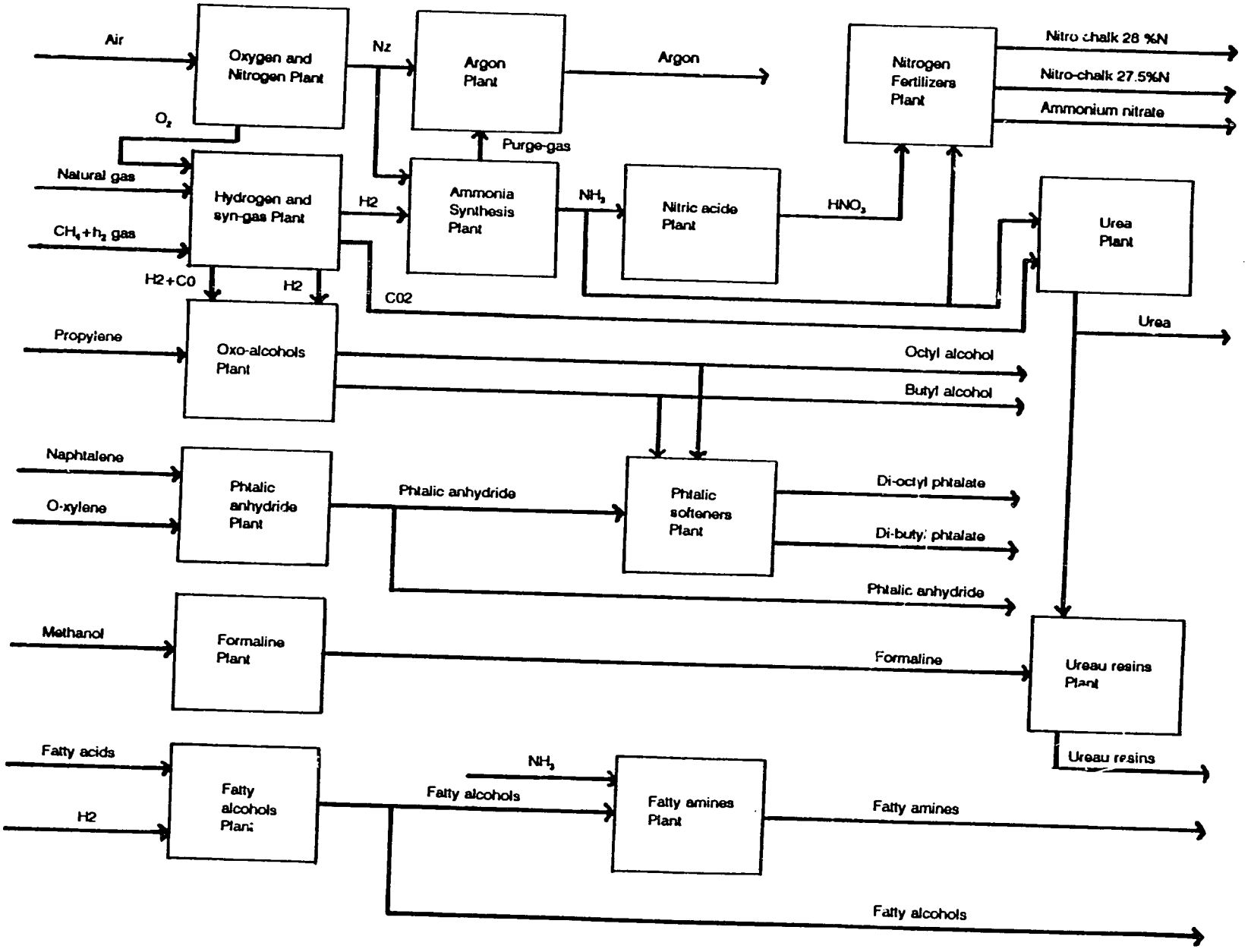
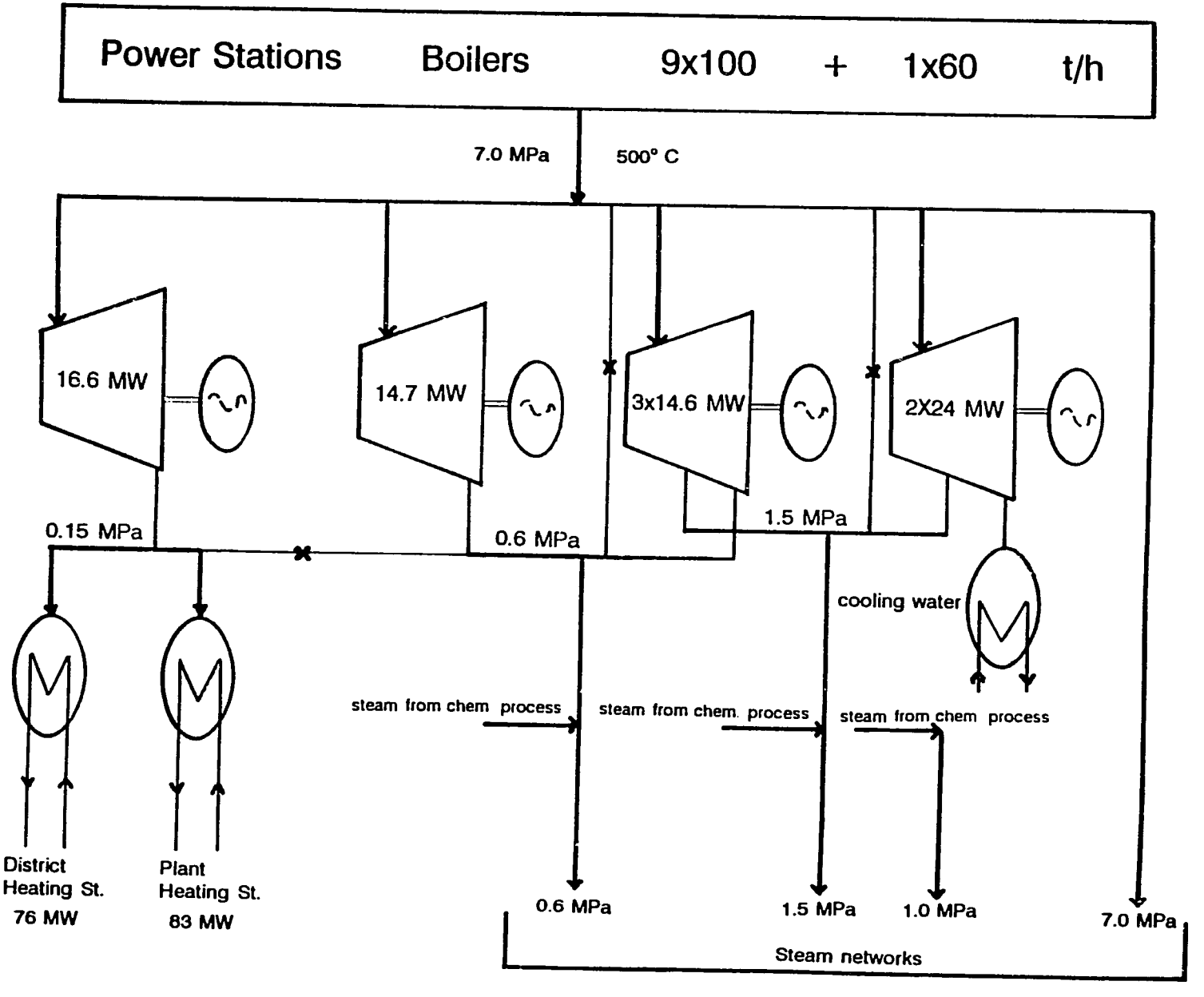


Figure 4. Steam and Heat Distribution Flow Sheet



APPENDIX V

COAL PRICES AND SPECIFICATIONS

COAL PRICES AND SPECIFICATIONS

ZAKUP I TRANSPORT								
Kopalnia		Knurow fakt.	Gaz koks	Knurow	Knurow	Debiensko	Rymer	Rymer
Klasa wegla		19/30/1.2	10/30/1.2	20/25/1	25/15/0.6	21/19/1	21/25/1	29/7/1
Zawartosc popiclu	%	28	0	25	15	19	25	7
Wartosc opalowa	MJ/kp	20.500	17.200	20.000	25,000	21,000	21.000	29,000
Ilosc wegla zuzyta w roku	Mg	504,000	579,497	516,600	403,440	486,072	492,000	347,793
Energia chemiczna	GJ	10,332,000	9,967,341	10,332,000	10,086,000	10,207,518	10,332,000	10,086,000
Sprawnosc przemiany	%	82	85	82	84	83	82	84
Cieplo uzyskane w parze	GJ	8,472,240	8,472,240	8,472,240	8,472,240	8,472,240	8,472,240	8,472,240
Cena wegla	zl/Mg	121,800	175,000	145,100	257,200	153,000	198,800	426,100
Koszt wegla	tys zl	61,387,200	101,411,902	74,958,660	103,764,768	74,369,060	97,809,600	148,194,641
Koszt transportu	zl/Mg	31,820	0	31,820	31,820	33,000	35,000	35,000
Koszt loco ZA Kedzierzyn	tys zl	77,424,480	101,411,902	91,396,872	116,602,229	90,409,446	115,029,600	160,367,400
KOSIT DOSTARCZENIA WEGLA DO KOTLA								
Koszt en. elektrycznej	zl/kWh	250	250	250	250	250	250	250
Jedn. zuzycie en. przy rozl	kWh/Mg	5	0	5	5	5	5	5
Jedn. zuzycie en. w mlynie	kWh/Mg	17	0	17	17	17	17	17
Zuzycie en. wagon - kociol	kWh	11,088,000	0	11,365,200	8,875,680	10,693,590	10,824,000	7,651,448
Koszt energii	tys. zl	2,772,000	0	2,841,300	2,218,920	2,673,398	2,706,000	1,912,862
KOSZT KORZYSTANIA ZE SRODOWISKA								

APPENDIX VI

PROJECTED NATURAL GAS PRICES

PROJECTED NATURAL GAS PRICES

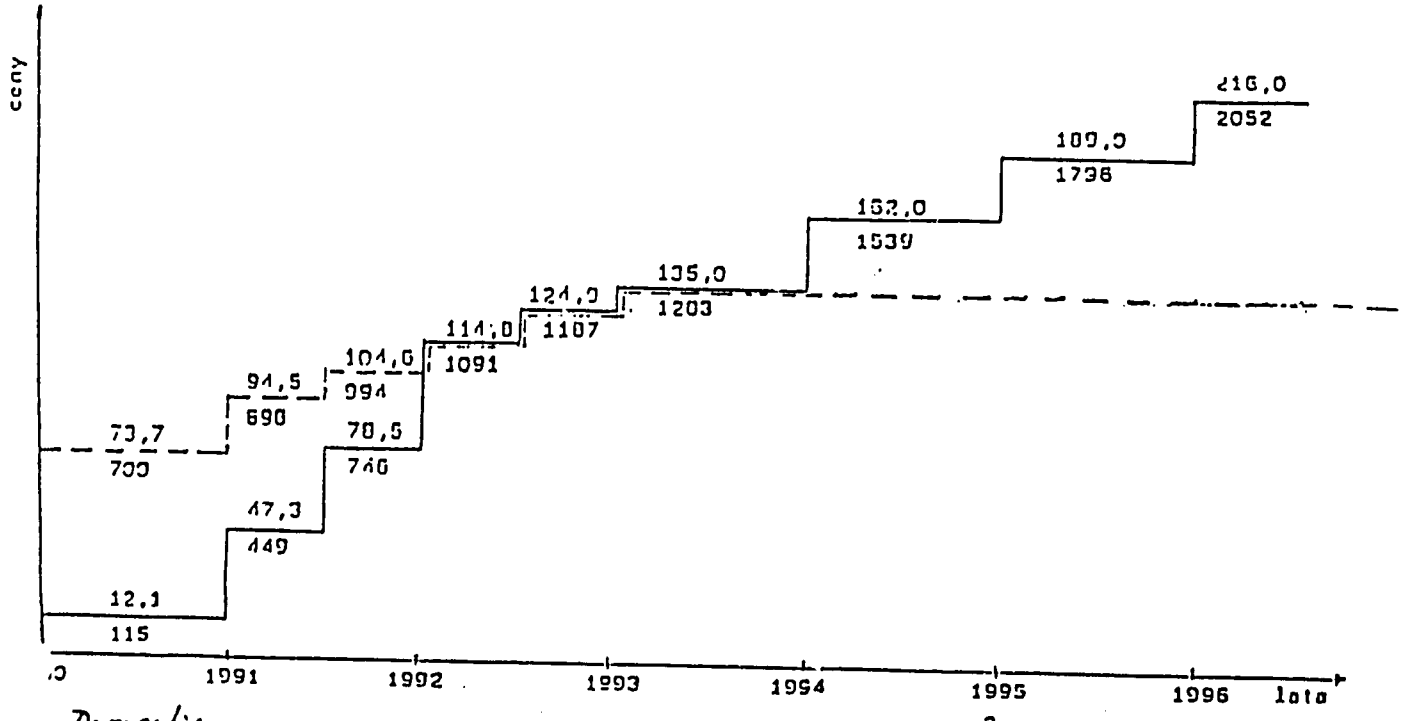
Zawartosc siarki	%	1.2	0	1	0,6	1	1	1
Emisja SO_2	Mg	5097	0	4354	2040	4096	4146	2931
Oplata jednostkowa	zl/kg	680	680	680	680	680	680	680
Oplata za SO_2	tys. zl	3,465,960	0	2,960,508	1,387,209	2,785,561	2,819,531	1,993,117
Emisja NOx	Mg	697	801	714	558	672	680	481
Oplata jednostkowa	zl/kg	680	680	680	680	680	680	680
Oplata za NOx	tys. zl	473,960	473,960	485,809	379,394	457,101	462,675	327,064
Ilosc popiolu w wegiu	Mg	141,120	141,120	129,150	60,516	92,354	123,000	24,346
udzial zuzla	%	25	25	25	25	25	25	25
ilosc zuzla	Mg	35,280	35,280	32,288	15,129	23,088	30,750	6,086
Ilosc popiolu lotnego	Mg	105,840	105,840	96,863	45,387	69,265	92,250	18,259
Sprawnosc odpylania	%	98	98	98	98	98	98	98
Pyl do atmosfery	Mg	2,785	2,785	1,927	908	1,385	1,845	365
Oplata jednostkowz	zl/kg	180	180	180	180	180	180	180
Oplata za pyl	tys. zl	501,300	501,300	348,705	163,393	249,355	332,100	65,733
Wsk. emisji pylu	p/GJ	269.6	269.6	137.5	90.0	135.7	178.6	36.2
Odpady na skladowisko	Mg	138,335	138,335	127,213	59,608	90,968	121,155	23,980
Oplata jednostkowa	zl/Mg	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Oplata za skladowanie	tys. zl	1,383,350	1,383,350	1,272,128	596,083	909,684	1,211,550	239,803
Jedn. koszt skladowania	zl/Mg	15,500	15,500	15,500	15,500	15,500	15,500	15,500
Koszt skladowania	tys. zl	2,144,193	0	1,971,798	923,928	1,410,011	1,877,903	371,695
Proj. nowego skladowiska	Mg	320,000	320,000	320,000	320,000	320,000	320,000	320,000
Koszt przyg. nowego sklad.	tys. zl	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Udzial kosztu nowego skl.	tys. zl	8,645,938	0	7,950,797	3,725,516	5,685,527	7,572,188	1,498,771
Razem koszt KOBZTY REMONTOW	tys. zl	16,614,700	544,957	14,989,744	7,175,523	11,497,238	14,275,946	4,496,183
Naklady na rem. biez. i sr.	tys. zl	5,500,000	0	5,057,795	3,300,000	3,616,773	4,816,948	2,750,000
KOSZTOGOLEM	tys. zl	102,311,180	101,956,858	114,285,711	129,296,672	108,196,855	136,828,494	169,526,445
JEDNOSTKOWO	zl/GJ	9,902.4	10,229.1	11,061.3	12,819.4	10,599.7	13,243.2	16,808.1
Roznica w koszcie w por. do stanu obecnego	tys. zl	0	(354,322)	11,974,531	26,985,492	5,885,675	34,517,314	67,215,265
Stosunek kosztu jednostkowego w por. do stanu obecnego	%	103.3%	100.0%	111.7%	129.5%	107.0%	133.7%	169.7%

APPENDIX VII

GAS ANALYZER MEASUREMENTS

Tabl.1.3 Wariantowe przyjęcie cen nośników bez podatku akcyzowego /tys.zł/
Wskaźniki relacji cen energetyczne oraz indeksów cen paliw na rynkach światowych w latach 1991-1996

Rodzaj a-energetyka b-przemysł c-gospodarstwa domowe	Jednostka miary	Wskaźnik relacji cen	Cena i koszt zakupu dla energetyki w tys.zł (10,25 $/GJ)					
			1991	1992	1993	1994	1995	1996
Węgiel energetyczny.....b	tona	1.00	100.00	127.65	229.37	255.63	355.31	414.52
c	tona	3.63	435.00	742.67	836.23	1233.24	1443.34	1732.30
Węgiel koksujący.....	tona	1.23	303.00	274.45	381.21	437.25	501.30	642.35
Olej opałowy.....a	tona	1.37	241.00	421.52	522.16	722.29	843.24	923.28
b	tona	1.40	353.65	455.47	647.21	755.32	881.34	1052.26
Lekki olej opałowy.....b	tona	2.03	553.00	844.50	1121.00	1427.55	1665.00	1929.26
c	tona	2.08	646.52	924.78	1233.64	1543.31	1840.55	2152.21
Olej napędowy L.....	litr	2.31	0.60	0.83	1.11	1.40	1.71	2.03
Benzyna silnikowa.....	litr	2.00	0.65	0.90	1.31	1.63	1.90	2.21
Gaz ziemny wysokometanowy.....a	a)	0.93	0.10	0.27	0.38	0.45	0.53	0.62
b	a)	1.02	0.21	0.44	0.59	0.73	0.87	1.07
c	a)	3.22	0.50	0.87	1.16	1.45	1.74	2.03
Gaz ziemny zaazotowany.....a	a)	0.53	0.12	0.18	0.24	0.35	0.36	0.42
b	a)	1.02	0.20	0.32	0.46	0.58	0.69	0.78
c	a)	3.22	0.33	0.56	0.73	0.88	1.10	1.30
Gaz koksowniczy.....a	a)	0.95	0.08	0.13	0.18	0.22	0.27	0.31
b	a)	1.02	0.15	0.22	0.29	0.36	0.44	0.51
c	a)	3.22	0.21	0.43	0.58	0.72	0.87	1.01
Energia elektryczna.....b	kWh	2.33	0.14	0.21	0.27	0.34	0.41	0.48
c	kWh	10.33	0.26	0.38	0.48	0.58	0.68	0.82



Domestic ceny gazu dla gospodarstw domowych — w USD/1000m³ / w tys.zł/1000m³

Industrial ceny gazu dla odbiorców przemysłowych — w USD/1000m³ / w tys.zł/1000m³

APPENDIX VIII

MEETING NOTES

Within the scope of this point of the program, a visit at the Nitric Plants was organized. The representatives of the management discussed the following production installations when presenting particular plants:

1. **The installation for Ammonia Synthesis which is at present being completed.** This installation has been designed by Putauy Institute of Fertilizers and B.P. ZAK.

   Ammonia synthesis takes place in a big reactor which weighs 260 tons. This is an adiabatic reactor with gas injection into the catalytic bed (reactor diameter - 3m). Synthesis gas H_2 and N_2 is generated by the pressurized, incomplete combustion of natural gas. In incomplete combustion, oxygen of the following parameters is used 40 atm, 450 °C. About 100 ton/hour of steam (its parameters: 500 °C, 80 atm) are recovered from this process.

2. **Two production lines of nitric acid (the so-called pressure-free method).** The Nitric Plants are faced with problems concerning environment protection. These problems are connected with big concentrations of nitric oxides which are ejected through stocks of these installations in the form of colorful smokes in the air. On the installations, sodium nitrate and nitrate are generated which results in the decrease in the amount of nitric oxides ejected through stacks. Waste gas includes nitric oxides whose concentration is about 2000 pem, still a big value. The plant's level of modernization is not good. Turbosets from the late 50's are the newest equipment. Modernization plans comprise a gradual exchange of boilers for fluid pressure-free ones (the cost of 2 boilers of this sort is estimated at abt. 50 mln USD). The modernization would start in this five-year period and by the end of 1995 it would be possible to begin construction of new units. Turbosets and other equipment of the heat and power generating plant are old and worn out.

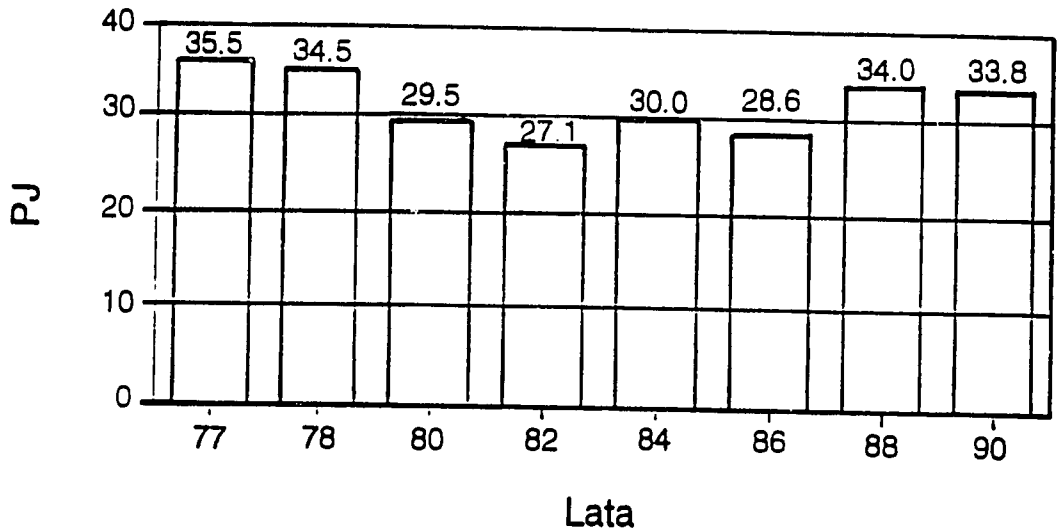
   In addition, Production management presented the arrangement of particular technological lines at site tho basis of a mock-up - model of the Nitric Plants.

   Privatization: At present in the Nitric Plants, as are the majority of Polish plants, steps are being undertaken to prepare the plants for privatization. Director Chmielemski supposes that only this year will the Nitric Plants become a one-man company with public funding. At the same time, the Nitric Plants are leading talks with possible foreign contractors who claim to be interested in buying the shares of the plant.

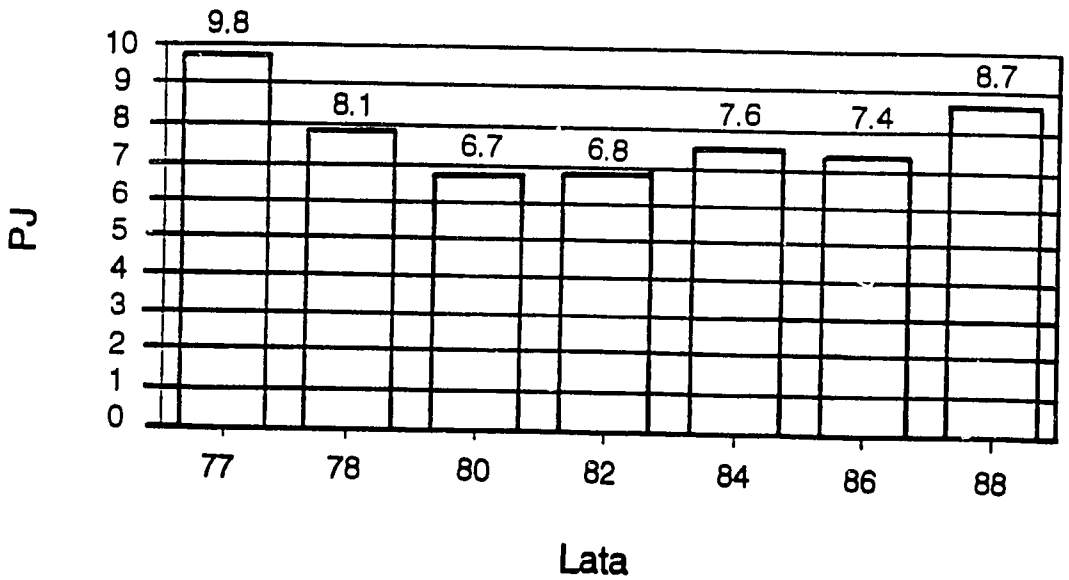
APPENDIX IX

ENERGY CONSUMPTION STATISTICS

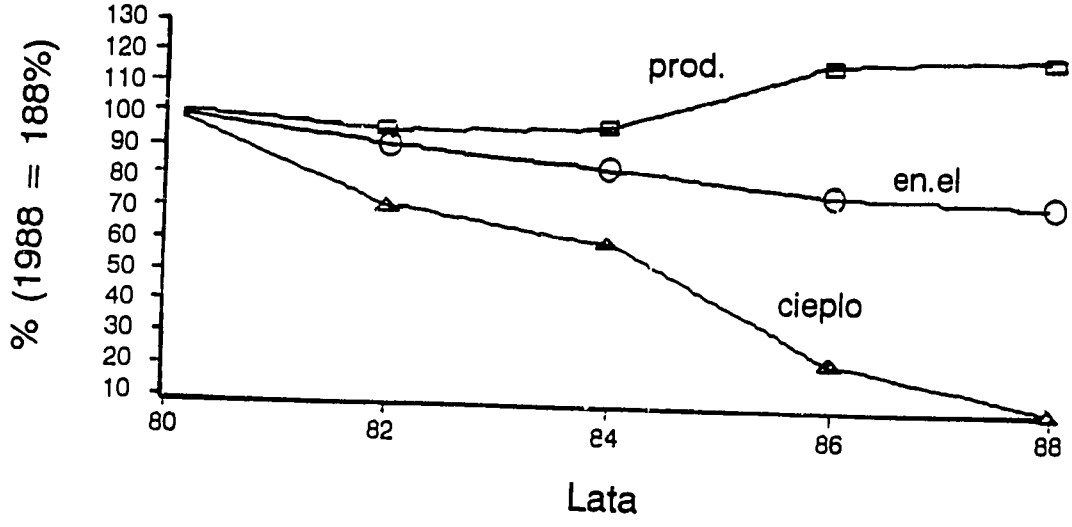
Globalne zuzycie energii
w ZA Kedzierzyn



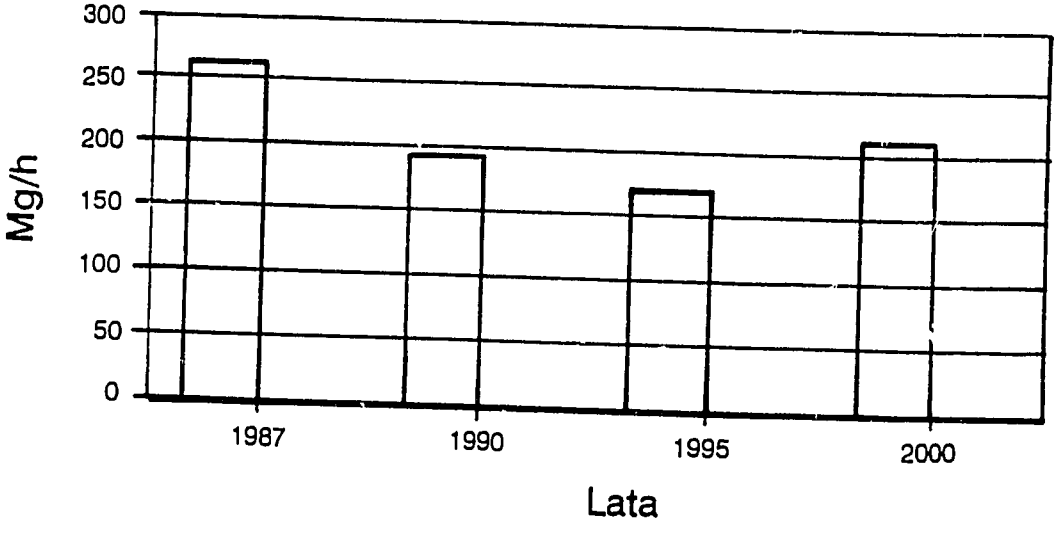
Zuzycie ciepla do celow technol
w ZA Kedzierzyn



Produkcja i wskazniki zuzycia ciepla i en.el dla bezwodnika ftalowego



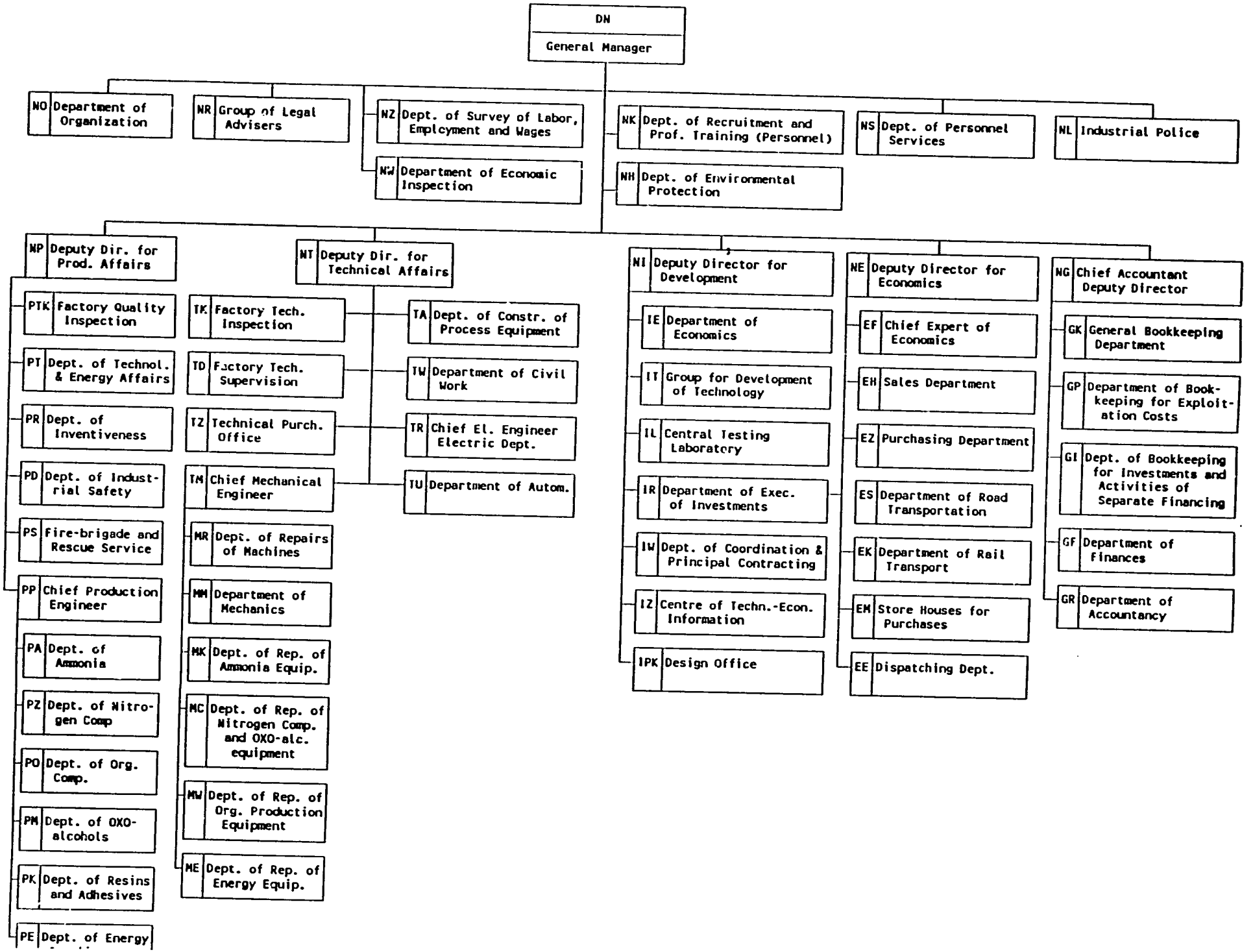
Przewidywane zapotrzebowanie pary do celow technologicznych w MG/h)



APPENDIX X

ORGANIZATIONAL CHART

ORGANIZATION STRUCTURE



APPENDIX XI

REPORT TO WORLD BANK, OCTOBER 1990

This Information comprises three parts:

Part I	■	Quantitative information about our Works
Part II	■	Concise qualitative and descriptive specifications of our Works
Part III	■	Information about 3 investment undertakings within the rational energy management, recognized to fulfil the conditions for external financing

Table 1

General Information

Name of the enterprise:	"KĘDZIERZYN" Nitrogen Works
Postal address:	47-220 Kędzierzyn-Koźle
Telephone No.:	120-00, 130-00
Telex No.:	039-331, 039-216
Telefax No.	129-99, 130-99

Name and telephone number of the person responsible for gathering and preparing the information contained herein:

Elżbieta Rutkowska, MSc., 122-64, 136-51

"KĘDZIERZYN" NITROGEN WORKS

INFORMATION

for WORLD BANK

concerning the World Bank Project

"Energy Supplies and Efficient Energy Consumption"

October 1990

Table 1: Sales by Product Group

Product Group	Year	Domestic Sales		Exports to Eastern Countries		Other Exports		Total 2	
		Q	V	Q	V	Q	V	Q	V
Product Group 1	1988	835	28,456	-	-	27	2,407	862	30,863
	1989	770	66,946	-	-	87	16,024	857	82,970
	1990	225	156,293	-	-	77	85,941	302	242,234
Product Group 2	1988	159	9,536	-	-	7	510	166	10,046
	1989	157	22,802	-	-	8	2,189	165	24,991
	1990	45	90,254	-	-	5	10,000	50	100,254
Product Group 3	1988	78	14,778	33	5,188	61	17,696	172	37,662
	1989	99	75,713	24	8,746	40	43,552	163	128,011
	1990	8	125,725	11	16,581	55	284,943	74	427,249
Product Group 4	1988	55	1,002	-	-	-	-	55	1,002
	1989	49	2,282	-	-	-	-	49	2,282
	1990	22	13,328	-	-	-	-	22	13,326
Product Group 5	1988	49	11,466	-	-	-	-	49	11,466
	1989	50	26,915	-	-	-	-	50	26,915
	1990	31	68,477	-	-	-	-	31	68,477

Table 2: Production

Product Group	Unit	1988		1989		1990 Jan-June	
		Q	V	Q	V	Q	V
1. Nitrogenous fertilizers and others nitric products	thousands t mln zl	862	30,844	855	82,767	315	252,79
2. Adhesive resins	thousands t mln zl	166	10,041	165	24,930	52	104,62
3. Organic products	thousands t mln zl	172	37,641	163	127,698	77	445,88
4. Technical gases	thousands t mln zl	55	1,002	49	2,276	23	13,90
5. Residual products and energy	thousands t mln zl	49	11,460	50	26,849	13	71,40
Total	thousands t mln zl	1.304	90,988	1.282	264,520	480	888,68

PART I

Quantitative information about our Work

Table 3: List of Products

Product Group 1	Product Group 2	Product Group 3	Product Group 4	Product Group 5
Nitrogenous Fertilizers Sodium nitrate Sodium nitrite Ammonia liquid Nitric acid conc. Nitroso compounds	- Adhesive resins	- oktanol - n-butanol - izo-butanol - butyl acetate - dibutyl phthalate - dioctyl phthalate - phthalic anhydride - maleic anhydride	- Argon liquid - nitrogen liquid - carbon dioxide liquid	- Fatty alcohols - stearin - fatty amine - others organic products - textile auxiliaries

Table 4: Inputs by Product Group

January - June 1990

	Product Group 1	Product Group 2	Product Group 3	Product Group 4	Product Group 5
In material inputs					
Natural and coke-oven gas	339,572	-	-	-	-
Methanol	-	503,711	-	-	-
Propylene	-	-	1,200,206	-	-
Orthoxylene	-	-	306,329	-	-
Benzene	-	-	101,555	-	-
Other inputs					
Energy	69,310	373,610	350,614	16,862	1,609,803
Pay/labor	114,361	213,980	477,732	306,966	392,635
Depreciation	57,180	106,990	238,866	31,748	196,317
Other Costs	30,497	57,062	127,395	16,932	104,702
	91,489	171,185	382,186	50,796	314,108
Total	762,409	1,426,538	3,184,883	423,304	2,617,565

Table 5: Sources of the Main Inputs

January - June 1990

Input Groups	Unit	Loc:		Imports from Eastern Countries		Imports from Other Countries		Total	
		Q	V	Q	V	Q	V	Q	V
Propylene	t mln zl	27,813	73,199	18,942	19,217	-	-	46,755	92,416
Natural and coke-oven gas	"	191,683	125,869	-	-	-	-	191,683	125,869
Methnaol	"	21,137	26,193	-	-	-	-	21,137	26,193
Orthoxylene	"	8,861	23,587	-	-	-	-	8,861	23,587
Benzene	"	3,236	7,819	-	-	-	-	3,236	7,819

Table 6: The comparison of the economic dates for 1985-1989

(in thousands of zls)

	Specification	1985	1986	1987	1988	1989
1.	Sale	26,442,347	34,369,185	51,877,980	95,009,196	269,334,40?
2.	Cost	25,047,364	32,293,626	48,488,578	83,453,388	206,062,74?
3.	Profit before taxes	1,402,052	2,313,813	5,791,866	15,788,180	96,457,66?
4.	Taxes and others charges	734,801	1,216,954	3,060,798	6,355,381	32,271,15?
	- income tax	734,801	1,216,954	3,029,772	5,690,390	26,216,91?
	- stabilization tax	0	0	0	138,128	
	- remuneration increase tax	0	0	31,026	556,863	
	- dividend	0	0	0	0	6,054,24?
5.	Net profit	667,251	1,096,859	2,731,068	9,402,799	64,186,50?
6.	Part in profit others units	97	98	99	3,862	2,336,77?
7.	Profit for partition	667,348	1,096,957	2,731,167	9,406,661	66,523,27?
8.	Partition of the profit at:					
	- reserve found	66,735	113,040	198,748	607,637	
	- introduce found	0	3,699	11,055	67,362	
	- found of factory staff	213,972	305,898	481,628	1,837,716	13,785,33?
	- found of development	380,641	631,320	2,019,736	6,850,734	52,493,48?
	- others objects	6,000	43,000	20,000	43,212	244,45?

Table 7: Energy Balances

Year: 1989

Energy Carriers	Specific Unit	MJ	Purchase			Production			Consumption	
			Q	Unit Price	V	Q	Unit Price	V	Q	Unit Price
Hard coal	t	20,491	27,3000	77,035	2,102,1000	-	-	-	273,000	77,035
Natural gas	thousands m^3	34,571	15,3120	715,000	109,480,800	-	-	-	153,120	715,000
Coke-oven gas	thousands m^3	17,585	38,563	425,000	16,389,300	-	-	-	38,563	425,000
Electric energy	MWh		30,0359	1,828,145	54,909,975	186,274	96,750	18,020,338	484,844	150,000
Fraction of Hydrolysis	thousands m^3	31,318	4,340	651,000	2,825,340	-	-	-	4,340	651,000

Table 8: Environmental Impact

	Unit	1986	1987	1988	1989	1990
Emissions						
NO_x	Mg/Year	15,664	12,692	10,077	7,937	5,600*
SO_2	"	7,187	8,181	6,584	6,271	6,150*
CO	"	7,997	7,163	8,164	8,705	5,740*
NH_3	"	1,299	1,064	860	556	800*
HF	"	-	-	-	-	-
SiF_4	"	-	-	-	-	-
Dust of power industry	Mg/Year	10,790	9,770	7,973	5,134	3,140*
Ammonium nitrate	"	1,375	943	672	514	730*
Phthalic anhydride	"	646	769	508	523	330*
Liquid discharge						
Organic compounds	Mg/Year	9,798	9,143	8,585	8,329	5,350*
ChZT	"	3,934	4,263	3,525	3,634	3,000*
Ammonia nitrogen	"	316	605	593	448	58 *
Nitrate nitrogen	"	1,432	1,805	1,212	1,408	940*
Suspension						
Solid discharge						
T o t a l	Thousands Mg/Year	230.9	256.4	242.8	240.9	214.3*
Ash and slag from thermal-electric power station	"	227.2	252.9	239.4	238.1	211.1*
Solid wastes (Phthalate's and amino resins' production/	"	3.7	3.5	3.4	2.8	3.2*

* = Forecasting

1. History of the Works

A decision to build the "KĘDZIERZYN" Nitrogen Works was made in 1948. The area where the German company IG Farben Industries had once its factory was found to be the best site due to convenient communication and the main resources of raw materials being just near by,

The first plants of the ammonia/fertilizers line, the so-called "Azot I", were started up in 1954. New lines to produce ammonia and saltpetre fertilizers ("Azot II") were put in operation in 1957. Then another plants began their production of: crystalline urea, concentrated nitric acid and mixed nitric and sulphuric acids.

At the same time the first plants of the organic products complex were commissioned. In 1955 the production of phthalic anhydride began as well as the production of waxes, aniline resins for textile industry and synthetic fatty acids.

In the 60's our own thermal-electric power station began its operation and new productions were started: sodium nitrite and sodium nitrate, formalin, urea-formaldehyde resin adhesives and phthalic anhydride and a plant to produce maleic anhydride were commissioned. The following years gave us another lines to produce formalin and argon as well as a plant to produce fatty amines.

In 1970, a plant to produce fatty acids was put in operation and the production of argon began. In 1973, plants to produce phthalic anhydride and a plant to produce maleic anydride were commissioned. The following years gave us other lines to produce formalin and argon as well as a plant to produce fatty amines.

1979 was a very important year for our Works. We commissioned a plant to produce syn-gas for manufacture of ammonia. This meant that coke was replaced for natural gas as our raw material.

PART II

Concise qualitative and descriptive specifications

of our Works

3. Manufacturing Directions

Characterization of manufacturing processes: continuous processes, three-shift work.

3.1. Basic Products:

data on manufacturing processes, their specifications, volume of production, quality of products, technical condition of plants.

Ammonium Nitrate

The process of GIAP-Moscow (USSR) of 1957. Process equipment -- domestic. The process consists in continuous concentration of the ammonium nitrate solution. A three-step evaporation system is employed to give the final concentration of minimum 99.7%. This melt is then granulated in a tower.

Production capacity: 220,000 tons/year

Volume of Production: 1987 - 211,810 t 1988 - 183,320 t
1989 - 177,260 t

Working time: 1987 - 281 days 1988 - 261 days
1989 - 249 days

Ammonium nitrate meets the domestic requirements.
Strength of granules and mesh analysis cannot compete with those obtainable at modern plants. This production is declining.

Nitro-chalk

This is a process updated in 1972 at the "KĘDZIERZYN" Nitrogen Works.
Process equipment - domestic.
This process consists in continuous concentration of ammonium nitrate (as above) and mixing the melt with powdered dolomite.
Then granulation in a tower follows.

Production capacity: 205,000 tons/year

Volume of production: 1987 - 178,960 t 1988 - 198,570 t
1989 - 220,270 t

In the 80's we shut down some obsolete and environmentally noxious plants (Phthalic Anhydride I in 1981, Nitro-chalk I in 1987 and Urea I in 1988). On the other hand, despite some difficulties, we built and put in operation some new plants, e.g. a plant to produce urea adhesives applying a continuous manufacturing process (in 1985).

In late 1986 we started to erect a new plant of OXO alcohols. New plants to produce syn-gas and purified hydrogen were commissioned, too. This grade of hydrogen could be used in our production of organic chemicals.

In summer 1987 a plant was put in operation to produce magnesium nitro-chalk, a new loose product which would not agglomerate.

Simultaneously the work was carried on to build our biological sewage-treatment plant. Its first stage was part and parcel of the erection of our OXO alcohols plant. Its final form is to be commissioned this year.

Right now we go on with the work to modernize our ammonia synthesis plant.

The process equipment for neutralization and evaporation delivered by Metalchem/Poland, machines - by KSB and Demag/Germany; equipment for granulation - by Deutsche Babcock Anlagenbau/Germany. The whole dates back to 1985. A new plant is planned to be built.

Urea

The process of Toyo-koatsu/Japan of 1962.
The process equipment comes from Germany and G. Britain.
Ammonia and carbon dioxide react at 25 MPa to give urea.
The unprocessed raw materials are recycled. Then concentration of the solution, crystallization, drying and granulation take place.

Production capacity:	181,440 tons/year	
Volume of production:	1987 - 174,670 t 1989 - 187,060 t	1988 - 172,700 t
Working time:	1987 - 310 days 1989 - 327 days	1988 - 310 days

Product quality - meets the requirements of the Council for Mutual Economic Aid standards.

The process equipment and machines delivered by Esslingen and by Hallberg/Germany, by Worthington and by Babcock -- Eilcox/G. Britain and by Escher - Wyss/Switzerland, of 1963. In operation - 26 years. Technical condition - satisfactory, some modernization needed to ensure better environmental protection.

Nitric Acid, commercial grade

The process of Prosynchem/Poland and GIAP/USSR of the 50's. Ammonia is oxidized with air on a Pt-Rh catalyst. Nitrogen oxides are then absorbed in water and spent oxides in a soda solution. No elevated pressure is applied in both stages.

Production capacity: 480,000 tons/year

The process equipment is domestic, machines of the 50's come from France and (of that time) German Democratic Republic. In operation - 32 years. New units must be build to lower energy consumption and to protect the environment.

Ammonia

Natural gas is converted to give syn-gas: the process of 1978 worked out by the "KĘDZIERZYN" Nitrogen Works and by H. Topsoe/Denmark.

Synthesis of ammonia: the process of Prosynchem/Poland and of "KĘDZIERZYN" Nitrogen Works dates back to the 50's - 60's. Natural gas is subjected to semi-combustion on a Ni catalyst in the presence of air and oxygen. CO is converted at high and low temperatures. CO_2 is then washed out with water and potassium carbonate, while the remaining CO is washed out with copper lye. Synthesis - at 30 MPa.

Production capacity: 437,000 t/year

The process equipment and machines are domestic, from USSR and Czechoslovakia. All dates back to the 50's.

The semi-combustion and CO_2 wash-out units - domestic, from USSR and Czechoslovakia (Skoda) and from Germany (Babcock, Borsig, Hallberg) of mid 70's.

A new line for synthesis and modernization of CO_2 wash-out are just under construction.

Urea-Formaldehyde Resin Adhesives

The process of the "KĘDZIERZYN" Nitrogen Works comes from 1985. The process equipment was delivered by Chemieanlagenbau Leipzig/(of that time) GDR.

Urea and formaldehyde are continuously condensed under elevated pressure, the mixture is vacuum concentrated, and then further condensation, homogenization and cooling take place.

Production capacity: 146,000 tons/year

Volume of production: 1987 - 104,680 t 1988 - 126,560 t
1989 - 128,530 t

Working time: 1987 - 285 days 1988 - 310 days
1989 - 314 days

The volume of production is as high as there is a call for it. The product quality enables the production of chipboards of the emission grade El and E2.

The process equipment and machines come from the mid '70s and were delivered by various companies of (at that time) GDR. In operation - 5 years. The plant is in good technical condition. Required updating of the product coding system.

Formalin

The process of the "KĘDZIERZYN" Nitrogen Works, of 1975. The process equipment comes from Germany and is domestic. The methanol-water mixture is oxidized and dehydrogenated at one step on a Ag catalyst. Gaseous formaldehyde is then absorbed in water.

Production capacity: 55,000 tons/year in terms of 100% formaldehyde.

Product quality - according to Polish Standard, grade I.

The process equipment - domestic, of the 70's; machines - of mid. 80's, delivered by Aerzen/Germany. In operation - 15 years. Technical condition - good, the cooling system needs some modernization.

OXO Alcohols

The process of Union Carbide/USA, of 1981.
The process consists in the low-pressure hydroformulation of propylene. A homogeneous Rh catalyst complex is used. The produced aldehydes are then processed by means of aldol condensation and hydrogeneration to give 2-ethylhexanol. Butyric aldehydes are also hydrogenated to give butanols.

Production capacity: 133,450 tons/year

Volume of production: 1987 - 78,750 t 1988 - 118,445 t
1989 - 111,130 t

Working time: 1987 - 227 days 1988 - 310 days
1989 - 265 days

The plant was started up in 1987. Its volume of production is limited by availability of propylene.

Product quality - meets the requirements of world standards. The process equipment of Metalchem/Poland and Standardkessel/Germany. Machines of KSB and Borsig/Germany dating back to early 80's. The plant is in operation for 4 years. Modernization of the plant as well as increase of its productivity are planned.

Anhydrides

Phathalic Anhydride

The process of the "KĘDZIERZYN" Nitrogen Works, of 1960.
The process equipment is domestic. We have got 2 production lines.
The process consists in oxidation of naphthalene and/or o-xylene with air on a V catalyst.

Production capacity: 46,000 tons/year (total for 2 lines)

Volume of production: 1987 - 39,200 t 1988 - 41,370 t
1989 - 41,880 t

Product quality - meets the requirements of Polish Standard, grade I.

The plants are exploited out, they need modernization.

Maleic Anhydride

The process of the "KĘDZIERZYN" Nitrogen Works, of 1970.
The process equipment is domestic.
The process consists in oxidation of benzene on a V-Mo catalyst.

Production capacity:	6,000 tons/year	
Volume of production:	1987 - 5,100 t 1989 - 5,555 t	1988 - 5,800 t

In operation - 17 years. The plant needs modernization.

Phthalic Plasticizers

The process of the "KĘDZIERZYN" Nitrogen Works, of 1987.
Phthalic anhydride is continuously esterificated with 2-ethylhexanol what takes place in the cascade of reactors (3 reactors). The product is then neutralized, washed, refined and filtered.

Production capacity:	70,700 tons/year	
Working time:	1987 - 333 days 1989 - 346 days	1988 - 334 days

Product quality - comparable with foreign products.

Ammonium Nitrate and Nitro-chalk

The process equipment and machines date back to mid. 50's produced by various companies from Poland, Germany and Czechoslovakia. In operation for over 30 years. The plants to be shut down when the production of Salamag is increased.

Salmag

The process to prepare the melt of ammonium nitrate worked out in the "KĘDZIERZYN" Nitrogen Works; granulation - delivered by Babcock/Germany - 1987.

The process equipment produced by Metalchem/Poland and Babcock/Germanu, machines delivered by KSB and Demag/Germany. The process consists in neutralization of ammonia with nitric acid followed by concentration to reach - 7.5%.

This solution is fed into the processes to produce ammonium nitrate and nitro-chalk. Its remaining part is concentrated to reach 95%, mixed with powdered dolomite and subjected to two-roller granulation.

Production capacity:	330,000 tons/year	
Volume of production:	1987 - 92,720 t 1989 - 244,750 t	1988 - 257,710 t

Working time: 1987 - 135 days 1988 - 300 days
1989 - 288 days

Note:

1. the production of saltpetre fertilizers is limited by the production capacity of the nitric acid plant.

2. the salmag plant was started up in 1987.

Product quality - meets the requirements of world standards.

Volume of production: 1987 - 55,100 t 1988 - 57,900 t
1989 - 58,070 t

Working time: 1987 - 350 days
1989 - 327 days

The volume of production is adjusted to the demand. Product quality - grade I according to domestic standards. The process equipment is domestic, dates back to the 70's and 80's. In operation (after making the process continuous) - 4 years. The plant is just under further modernization.

Fatty Alcohols

The process of Lurgi/Germany, of the "KĘDZIERZYN" Nitrogen Works and of ICSO-"Blachownia"/Poland. It comes from 1970. Direct high-pressure hydrogenation of natural fatty acids on suspended catalysts to give saturated and unsaturated alcohols.

Production capacity: 6,550 tons/year

Volume of production: 1987 - 5,140 t 1988 - 6,130 t
1989 - 5,840 t

Working time: 1987 - 273 days 1988 - 300 days
1989 - 278 days

The volume of production is limited by availability of fatty acids.
The process equipment is domestic and German, of mid. 60's. The plant was completed by Lurgi/Germany. In operation in the "KĘDZIERZYN" Nitrogen Works - 20 years. Its technical condition is regular.

Fatty Amines

The process of ICSO-"Blachownia"/Poland and of the "KĘDZIERZYN" Nitrogen Works, dating back to 1978.
The process equipment is domestic and comes from Germany. Continuously operated ammonolysis of fatty acids gives nitriles which are batchwise hydrogenerated to give fatty amines. A suspended Ni catalyst is employed.

Volume of production: 1987 - 720 t 1988 - 954 t
1989 - 756 t

3.2 Supplies of Basic Raw Materials and Energy Consumption

Natural Gas

Amount needed to cover full demand: 480,000,000 m^3/year
Supplier: All-Poland system of gas distribution networks (GOZG-Zabrze)
Type of transport: pipeline
The gas quality meets our requirements. The delivered amounts of gas happen to be limited in winter.
Consumption (in thousand m^3/year):
1987 - 335,740 1988 - 364,400 1989 - 384,640

Methanol

Amount: 70,000 tons/year
Supplier: "CHORZÓW" Nitrogen Works/Poland
Type of transport: railway tank cars
Comments: continuity of supply is satisfactory
Consumption:
1987 - 59,712 t/y 1988 - 63,930 t/y 1989 - 60,350 t

Propylene

Amount: 100,000 t/year
Supplier: MZRiP-Plock (Refinery)/Poland, chemical factory "Boehlen"/(of that time) GDR
Type of transport: railway tank cars
Consumption (in tons/year):
1987 - 63,815 1988 - 88,811 1989 - 81,944

Fatty Acids

Amount: 10,000 tons/year
Supplier: "Pollena"-Nowy Dwór Mazowiecki/Poland and "Strem"-Strzemieszyce/Poland
Type of transport: railway tank cars

Stearin

The process of the "KĘDZIERZYN" Nitrogen Works, of IChp-Warsaw/Poland and of ICSO-"Blachownia"/Poland. It dates back to 1983.
Fatty acids are hydrogenated (hardened) on a suspended Ni catalyst.

Volume of production: 1987 - 3,260 t 1988 - 3,680 t
1989 - 2,350 t

Working time: 1987 - 236 days 1988 - 282 days
1989 - 210 days

Fatty amines and stearin are alternately produced on the same plant. The particular volume of production depends on the demand for a given product.
The process equipment is domestic and comes from Germany. It dates back to mid. 70's. Machines come from Germany. In operation - 12 years. Technical condition - good. A new separate plant to produce stearin is just under construction.

4. Management

The managing agencies of our Works are as follows:

1. General Conference of Delegates
2. Council elected by employees
3. General Manager

Comments: continuity of supply is satisfactory right now.
Consumption (in tons/year):
1987 - 9,150 1988 - 12,230 1989 - 9,680

Hard Coal to Cover Energy Demands

Amount: 600,000 tons/year
Supplier: commercial Center for Coal Industry
Type of transport: railway cars
Comments: continuity of supply is provided
Consumption (in tons/year):
1987 - 626,500 1988 - 598,063 1989 - 582,000

Electric Energy

Total amount: 1,200 GWh/year
Supplier: all-Poland power network (Zakład Energetyczny - Opole)
and our own thermal-electric power station
Type of transport: power grid
Comments: continuity of supply is provided
Total consumption (in GWh/y):
1987 - 1,194 1988 - 1,235 1989 - 1,177

in these figures the following amounts were purchased from the all-Poland network:
1987 - 870,2 1988 - 912,2 1989 - 848,8

"Purchase of some complete appliances and replacement of machines". Its share in the whole costs amounts up to 18%. This undertaking is fully covered by the funds of our Works. The significance of this undertaking is a result of respectively fast wearing out of our durable goods as well as a result of the fast progress in the chemical technology nowadays compared to the long history of our Works.

The share of such purchases in our expenses grows up and up.

The investment costs of 1990 amounting to 211,310,6 mln zł will be in 68% covered by the banking credit. This will only be "Modernization of the syn-gas unit, etc.". The remaining part will in general be our own funds.

5. Investment Program to Accomplish in 1990

In the enclosed table, the investment program for 1990 is shown together with the results expected after the program is accomplished. During the past 9 months of this year, the accomplishment of this program went on smoothly. There seem to be no threat for any position of the program not to be completed on schedule.

From the point of view of the expected results and of the investment costs, the most important projects are as follows:

A. Fertilizer line: a project "Modernization of the syn-gas unit, of the ammonia synthesis unit and of the central cooling unit".
This undertaking is planned to be finished in the last 3 months of 1991. This is our only project covered this year by a banking credit (the credit part is 95% of the costs).

B. Organic production line: "Realization of a pilot plant to produce stearin, production capacity 5,000 tons/year" as well as "Realization of a distillation unit for fatty alcohols".
The Both projects are covered this year by our own means. They are the investments of comparatively low investment costs and short pay off periods.

C. Technical infrastructure: "Modernization of 2 electro-filters", "Execution of the railway terminals No. 111, 113 and 115", "Storage yard for distillation residue for the Department of Anhydrides".
Those projects are to be finished this year.
The Environmental Protection Fund granted us some subsidy in 1990 to accomplish the modernization of our electro-filters and in 1989 to build a storage yard for distillation residue. But the share of this subsidy in the whole costs was not significant.

Planned Projects for Modernization and Development for 1990

Pos.	Specification	Date to finish start quarter of year	Investment costs in mln zł prices of 1990		Expected results after completion of a project
		finish quarter	Total / Civil	In 1990	
	A. Fertilizer line				
1.	Modernization of the syn-gas unit, ammonia synthesis unit and central cooling unit	IV.87 / IV.91	914,292.2 / 174,258.1	150,205.0 / 71.833.0	1) Reduction of the consumption of the so-called primary energy per 1 Mg NH_3 from the present 11.5 GCal/Mg down to the expected 8.5 GCal/Mg; in the effect - release of - 125,000 Mg of the theoretical standard fuel a year. 2) Environmental improvement by reduction of the amounts of the emitted impurities, the example being the reduction of the emitted ammonia by 4 times. 3) Reduction of the amounts of wastes disposed in waters. If the changes rise 10 times in 1990, and if decrease of the amounts of waste water reaches 5,840 Mg of chemical oxygen demand, the savings will reach 11,680 mln zł a year. 4) Improvement in labour conditions by application of modern and integrated units and plants, and especially of control systems. This should cause reduction of our working personnel and increase of skills of our staff.
2.	Modernization of Urea II	IV.89 / I.92	21,000.0 / 6,400.0	2,700.0 / 1,720.0	1) Reduction of emissions to atmosphere of -90 Mg/year of ammonia and -60 Mg/year of urea. 2) Improvement of waste water management; - 300 Mg/year of ammonia and - 900 Mg/year of Urea will no longer be disposed to waste waters. 3) The plant operation will become more smooth and failure-free since new ammonia pumps will be installed. 4) Reduction of energy and raw materials consumption factors.
3.	Modernization of the railway loading platform	I.89 / II.90	3,597.3 / 3,420.7	3,000.0 / 2,900.0	Rationalization of fertilizers loading capacity and throughout.
4.	Installation of fuel gas compressors in building. 359	I.90 / III.90	400.0 / 300.0	400.0 / 300.0	Settlement of accounts for the costs of 1990. The realization was stopped since the delivery of coke-oven gas was broken.
5.	Installation of 2 crushers in building 421/1	III.89 / III.90	332.6 / 52.0	320.0 / 50.0	Improvement of labour safety conditions by ssilencing and warning of the control room; the production of dolomite what reads of Salmag will become continuous.
	Total (1 - 5)		939,622.1 / 184,430.8	156,625.0 / 76,803.0	

Pos.	Specification	Date to finish start quarter of year	Investment costs in mln zł prices of 1990		Expected results after completion of a project
		finish quarter	Total Civil	in 1990	
B.	Organic production line	III.85 / III.90	4,682.6 / 1,105.5	2,108.1 / 960.5	
1.	Pilot plant to produce stearin, production capacity 5,000 tons/year				Increase of the production of stearin by 5,000 tons/y starting from IV quarter of 1990. If the price and the costs are close to those values obtained in 1990 for tallow stearin (price = 10,857.000 zł, costs = 8,000,000 zł/t) our gross profit will be = 14,285.0 mln zł.
2.	Modernization of the plant	III.89 / III.90	768.9 / 367.0	400.0 / 220.0	The process to produce di-octyl phthalate will become more up-to-date after employis a new type of a catalyst (Titanates). This will improve the quality of our product to increase our exports to western countries. The price is expected to go up by some $50/ton. For the export figures of 15,000 tons/year, our income will be 750,000 $/year. Simultaneously, we will reduce the amount of the disposed waste water and reduce the charges resulting therefrom - savings - 500 mln zł/y (assuming the unit charge is going up 10 x this year. In the future we will be able to base our whole production on litanate catalysts.
3.	Construction of a plant for a dish-washer "Garsil"	III.89 / IV.90	454.5 / 354.7	300.0 / 250.0	We will get a new production of a dish-washer "GARSIL" production capacity 5,. The average price for 4 months of 1990 is 5.8 mln zł/t, the costs are 3,1 mln zł so our gross profit will be 1,350 mln zł/y.
4.	Construction of a distillation unit for fatty alcohols	I.90 / IV.90	2,500.0 / 1,750.0	2,500.0 / 1,750.0	The production capacity of the distillation unit will be increased by 15,000 of saturated alcohols. The need to implement this project is the reason of the increase of the production of Dept. of Hydrogenation. So, the distillation unit becomes a "bottle neck". Assuming that the distilled product will be just all tallow stearin, which price is 10,857,000 zł/t and the unit costs are 7,306.24 our gross profit will be increased by 53,300 mln zł/year.
Total (1 - 4)			8,406.0 / 3,577.2	5,308.1 / 3,180.5	

Pos.	Specification	Date to finish start quarter of year / finish quarter	Investment costs in mln zł prices of 1990 / Total / Civil	Investment costs in mln zł prices of 1990 / In 1990	Expected results after completion of a project
	C. Technical infrastructure				
1.	Modernization of electro-filters No. 11, 12; finishing the filter No. 10.	1989 / 1990	6,700.0 / 4,864.0	6,700.0 / 4,864.0	The results for 3 electro-filters will be: reduction of the dust emission by 1,500 tons/y. And resulting from the above, we will pay smaller charges for air pollution and will pay smaller fines for excessive emissions. In all, it will be about 200 mln zł/y (we assume increase of charges by 10 times).
2.	Welding workshop for regeneration of parts of machines and facilities, building 678	I.90 / IV.90	497.0 / 303.0	497.0 / 303.0	Results: we will be able to carry on the begun project to regenerate the part of our machines and facilities; what will be based on the existing equipment. Our spendings to buy spare parts will be reduced, our imports of spares will be reduced, new methods to regenerate machine parts could be introduced.
3.	Modernization of oil management in our thermal-electric power station	III.89 / IV.90	315.4 / 265.4	300.0 / 250.0	Improvement of the industrial safety conditions and reduction of fire hazard. The order of the Prevention Serice, No. 37/PO-1-3; will be implemented.
4.	Water intake and incorporating the wells R-3 and 7b into our factory network	I.86 / IV.90	470.7 / 399.4	354.0 / 300.0	The water supply conditions for all Depts. will be improved. This applies both to process water and boiler feed water.
5.	Storage yard for distillation residue, building 859/1	IV.88 / III.90	1,392.9 / 1,338.7	1,250.0 / 1,200.0	No toxic waste water coming from the distillation residue of anhydrides will into the soil. Storage capacity - 300 m³.
6.	Modernization of the sanitary sewage system, constr. of fecal matter on our housing estate	II.85 / III.90	1,015.3 / 1,004.6	452.5 / 452.5	Results in ecology - fecal matter will be treated, sanitary conditions of our housing estate will be improved, no waste water will be disposed into the state "Bisty Lug".
7.	Modernization of social rooms for the Dept. of Anhydrides, building 680	III.89 / III.91	500.0 / 460.0	214.0 / 204.0	Improvement in social and hygienic conditions for the staff of the Dept. of Anhydrides.
8.	Execution of railway terminals No. 111, 113 and 115	I.90 / IV.90	2,250.0 / 2,250.0	2,250.0 / 2,250.0	Both road and rail transport will become more efficient. The turnout will be the ground nearby will be even and hardened, safety of the traffic will be increased.
9.	Cleaning the vent gases, removal of chronium tannins dust	III.90 / II.91	120.0 / 80.0	60.0 / 34.0	Results in ecology: reduction of the mission of chronium units to atmosphere.

PRODUCTS' PROFITABILITY FOR 1985-1989

1985

PRODUCTS	SALE /zl/	QUANTITY /t./	UNIT PRICE (2/3) /zl/t./	UNIT COST /zl/t./	UNIT PROFIT (LOSS) (4-5) /zl/	PROFITABILITY (6/5) %	PROFITABILITY (6/4) %
1	2	3	4	5	6	7	8
ARGON(thousands of litres)	368,423,809	4,514	81,618	69,523	12,095	17.40	14.82
AMMONIA	464,249,150	20,523	22,511	19,019	3,492	16.36	15.51
SODIUM NITRITE	425,591,933	14,865	28,630	16,427	12,203	74.29	42.62
SODIUM NITRATE	202,396,244	10,671	16,967	13,137	3,830	29.30	20.19
SODIUM NITRATE-LIQUID	162,462,327	11,604	14,001	16,263	(2621)	(11.84)	(1.87)
SALETRIAK,SALMAG 6M 27,5ZN	743,441,183	66,482	11,183	10,221	952	9.30	8.51
SALETRIAK 28ZN	3,667,205,820	358,870	10,219	9,931	288	2.90	2.82
AMMONIUM NITRATE 34ZN	2,561,735,540	214,780	11,927	11,779	148	1.26	1.24
UREA GRANULAR 46ZN	2,163,772,721	130,632	16,564	15,941	623	3.91	3.76
UREA RESIN ADHESIVE	2,567,928,771	75,646	33,947	31,635	2,312	7.31	6.81
SILEKOL N-1	564,489,287	21,342	26,450	21,194	5,256	24.80	19.87
BUTYL ACETATE	771,049,761	5,303	92,864	90,152	2,712	3.01	2.92
DIBUTYL PHTHALATE	839,821,621	8,523	98,536	97,523	1,013	1.04	1.03
DIOCTYL PHTHALATE	3,216,418,267	30,185	106,557	103,215	3,342	3.24	3.14
PHTHALIC ANHYDRIDE	1,488,793,888	18,801	79,187	75,345	3,842	5.10	4.85
MALEIC ANHYDRIDE	398,314,807	3,652	109,068	103,667	5,401	5.21	4.95
OKTANOL	0	0	0	0	0	0.00	0.00
n-BUTANOL	0	0	0	0	0	0.00	0.00
iso-BUTANOL	0	0	0	0	0	0.00	0.00

1986

PRODUCTS	SALE /zl/	QUANTITY /t./	UNIT PRICE (2/3) /zl/t./	UNIT COST /zl/t./	UNIT PROFIT (LOSS) (4-5) /zl/	PROFITABILITY (6/5) %	PROFITABILITY (6/4) %
1	2	3	4	5	6	7	8
ARGON(thousands of litres)	443,982,356	4,541	97,772	79,546	18,224	22.91	18.64
AMMONIA	582,754,997	22,349	26,075	28,435	(2,360)	(8.30)	(9.05)
SODIUM NITRITE	637,407,141	14,617	43,607	22,492	21,115	93.88	48.42
SODIUM NITRATE	284,783,252	11,414	24,949	24,271	678	2.79	2.72
SODIUM NITRATE-LIQUID	250,509,439	12,144	20,628	20,408	220	1.08	1.07
SALETRIAK,SALMAG 6M 27,5ZN	750,596,407	46,420	16,170	13,976	2,194	15.70	13.57
SALETRIAK 28ZN	4,847,302,559	365,946	13,246	12,803	443	3.46	3.34
AMMONIUM NITRATE 34ZN	3,330,059,973	217,298	15,325	14,688	637	4.34	4.16
UREA GRANULAR 46ZN	2,577,451,467	123,223	20,917	19,680	1,237	6.83	6.29
UREA RESIN ADHESIVE	1,252,342,934	31,246	40,078	41,154	(1,076)	(2.62)	(2.69)
SILEKOL N-1	3,155,592,666	105,106	30,023	27,223	2,800	10.29	9.33
BUTYL ACETATE.	1,001,415,185	8,662	115,344	114,440	904	0.79	0.78
DIBUTYL PHTHALATE	1,173,235,714	9,230	127,111	128,869	(1,758)	(1.36)	(1.38)
DIOCTYL PHTHALATE	3,822,343,266	28,641	133,457	135,071	(1,614)	(1.19)	(1.21)
PHTHALIC ANHYDRIDE	2,371,739,260	22,967	103,267	88,748	14,519	16.36	14.06
MALEIC ANHYDRIDE	604,045,018	4,816	125,422	113,724	11,701	10.29	9.33
OKTANOL	0	0	0	0	0	0.00	0.00
n-BUTANOL	0	0	0	0	0	0.00	0.00
iso-BUTANOL	0	0	0	0	0	0.00	0.00

1987

PRODUCTS	SALE /zl/	QUANTITY /t./	UNIT PRICE (2/3) /zl/t./	UNIT COST /zl/t./	UNIT PROFIT (LOSS) (4-5) /zl/	PROFITABILITY (6/5) %	PROFITABILITY (6/4) %
1	2	3	4	5	6	7	8
ARGON(thousands of litres)	523,868,395	3,995	131,131	108,514	22,617	20.84	17.25
AMMONIA	1,463,766,867	43,048	34,003	34,475	(472)	(1.37)	(1.39)
SODIUM NITRITE	971,842,652	13,340	71,776	27,269	44,507	163.21	62.01
SODIUM NITRATE	351,467,164	9,953	35,313	25,494	9,819	38.51	27.80
SODIUM NITRATE-LIQUID	263,334,795	11,379	23,318	22,643	675	2.98	2.89
SALETRZAK,SALMAG GR 27,5%N	2,580,012,054	107,516	23,997	21,439	2,558	11.93	10.66
SALETRZAK 28%N	4,998,107,016	276,543	18,074	17,750	324	1.82	1.79
AMMONIUM NITRATE 34%N	4,483,206,856	211,386	21,208	21,118	90	0.43	0.43
UREA GRANULAR 46%N	3,271,434,127	115,388	28,352	26,947	1,405	5.21	4.95
UREA RESIN ADHESIVE	1,344,994,619	23,704	56,741	52,984	3,757	7.09	6.62
SILEKOL N-1	4,071,758,590	108,502	38,222	38,151	81	0.21	0.21
BUTYL ACETATE	1,225,390,251	8,152	149,584	147,865	1,719	1.16	1.15
DIBUTYL PHTHALATE	1,541,240,490	9,625	160,129	143,814	16,315	11.34	10.19
DIOCTYL PHTHALATE	7,925,407,924	45,525	174,177	138,678	35,499	25.60	20.38
PHTHALIC ANHYDRIDE	2,036,120,545	16,512	123,312	103,296	20,016	19.38	16.23
MALEIC ANHYDRIDE	624,461,563	3,976	157,058	149,299	7,759	5.20	4.94
OKTANOL	3,849,655,863	34,699	110,944	119,406	(8,462)	(7.09)	(7.63)
n-BUTANOL	875,072,339	5,953	146,997	119,697	27,300	22.81	18.57
iso-BUTANOL	576,484,470	6,987	82,508	80,343	2,165	2.69	2.62

1988

PRODUCTS	SALE /zl/	QUANTITY /t./	UNIT PRICE (2/3) /zl/t./	UNIT COST /zl/t./	UNIT PROFIT (LOSS) (4-5) /zl/	PROFITABILITY (6/5) %	PROFITABILITY (6/4) %
1	2	3	4	5	6	7	8
ARGON(thousands of litres)	839,882,996	4,391	191,274	192,994	(1,720)	(0.89)	(0.90)
AMMONIA	2,897,138,329	54,537	53,103	57,218	(4,115)	(7.19)	(7.75)
SODIUM NITRITE	1,558,266,364	13,822	112,738	49,303	63,435	128.66	56.27
SODIUM NITRATE	573,667,474	9,859	58,187	44,578	13,609	30.53	23.39
SODIUM NITRATE-LIQUID	409,005,949	11,760	34,779	41,394	(6,615)	(15.98)	(19.02)
SALETRZAK,SALMAG GR 27,5%N	9,785,319,891	257,560	37,978	32,196	5,782	17.96	15.22
SALETRZAK 28%N	5,681,188,885	196,661	28,888	29,260	(372)	(1.27)	(1.29)
AMMONIUM NITRATE 34%N	6,082,876,050	183,512	33,147	33,358	(211)	(0.63)	(0.64)
UREA GRANULAR 46%N	4,098,762,743	92,463	44,329	43,234	1,095	2.53	2.47
UREA RESIN ADHESIVE	2,333,350,188	26,914	86,697	89,026	(2,329)	(2.62)	(2.69)
SILEKOL N-1	7,552,430,430	125,039	60,401	63,236	(2,835)	(4.48)	(4.69)
BUTYL ACETATE	2,384,128,703	10,017	238,008	219,983	18,025	8.19	7.57
DIBUTYL PHTHALATE	2,036,153,616	8,225	247,557	206,326	41,231	19.98	16.66
DIOCTYL PHTHALATE	13,951,766,800	49,463	282,065	189,462	92,603	48.88	32.83
PHTHALIC ANHYDRIDE	3,174,418,829	19,281	164,640	142,746	21,894	15.34	13.30
MALEIC ANHYDRIDE	930,254,125	4,276	217,552	216,851	701	0.32	0.32
OKTANOL	13,608,180,525	59,870	227,295	159,664	67,631	42.36	29.75
n-BUTANOL	1,518,745,263	6,622	229,348	162,537	66,811	41.11	29.13
iso-BUTANOL	2,935,473,993	13,996	209,737	113,201	96,536	85.28	46.03

1989

PRODUCTS	SALE /zl/	QUANTITY /t./	UNIT PRICE (2/3) /zl/t./	UNIT COST /zl/t./	UNIT PROFIT (LOSS) (4-5) /zl/	PROFITABILITY (6/5) %	PROFITABILITY (6/4) %
1	2	3	4	5	6	7	8
ARGON(thousands of litres)	1,959,981,412	4,280	457,706	339,905	117,801	34.66	25.74
AMMONIA	3,165,691,991	29,712	106,546	119,917	(13,371)	(11.15)	(12.55)
SODIUM NITRITE	6,244,002,772	14,390	433,913	147,236	286,677	194.71	66.07
SODIUM NITRATE	2,299,386,573	9,753	235,762	129,756	106,006	81.70	44.76
SODIUM NITRATE-LIQUID	1,486,791,036	12,412	119,787	107,879	11,908	11.04	9.94
SALETRZAK,SALMAG GR 27,5%N	23,268,993,695	245,559	94,759	83,243	11,516	13.83	12.15
SALETRZAK 28%N	18,792,287,724	222,934	84,295	79,491	4,804	6.04	5.70
AMMONIUM NITRATE 34%N	16,663,725,376	177,253	94,011	88,890	5,121	5.76	5.45
UREA GRANULAR 46%N	13,110,100,908	105,270	124,538	111,458	13,080	11.74	10.50
UREA RESIN ADHESIVE	1,603,667,933	10,478	153,051	145,621	7,430	5.10	4.85
SILEKOL N-1	20,988,626,557	128,005	163,967	153,442	10,525	6.86	6.42
BUTYL ACETATE	7,532,076,097	10,269	733,477	538,579	194,898	36.19	26.57
DIBUTYL PHTHALATE	8,755,166,958	11,316	773,698	445,946	327,752	73.50	42.36
DIOCTYL PHTHALATE	51,862,277,300	46,529	1,114,623	463,904	650,719	140.27	58.38
PHTHALIC ANHYDRIDE	5,759,667,720	17,107	336,685	336,002	683	0.20	0.20
MALEIC ANHYDRIDE	1,858,527,132	4,054	458,443	490,079	(31,636)	(6.46)	(6.90)
OKTANOL	32,226,357,633	51,315	628,010	437,443	190,567	43.56	30.34
n-BUTANOL	4,251,214,532	6,375	666,857	388,656	278,201	71.58	41.72
iso-BUTANOL	8,276,383,909	13,541	611,209	353,802	257,407	72.75	42.11

7. **Present Situation**, the effect of the implemented economical program on our Works.

In order to adjust the Works to the rules of the market controlled economy, we are just reorganizing our internal structures. We organize our own marketing; we strengthen our economic sections. Our investment sections will be turned into development sections. Their objectives will be not only investing but also giving directions for changes in the range of production, working on new processes as well as taking care for fast implementation of these processes.

On the level of our Works and the Council elected by our employees, a Committee was formed for changes in ownership. The Committee is to prepare a plan for further activities in this respect.

8. **Medium- and Long-Term Plans**

Apart from finishing the following investment projects within the infrastructure:

- biological-mechanical sewage-treatment plant,
- system for monitoring the background for air-borne contaminations inside and outside our Works,
- installation of electro-filters in our thermal-electric power station,
- storage yard for wastes,

during the coming 5 years we want to modernize the following production lines:

- synthesis of ammonia,
- nitric acid plant,
- phthalic anhydride plant.

In order to increase our competitive potential and to increase our export sales, we want to:

- modernize our OXO alcohols plant and increase its production capacity up to 200,000 tons/year,
- increase the quality of our anhydrides and phthalates,
- add new organic products, e.g. to build a new plant to produce acrylic acid and acrylates.

The main projects to improve our energy management and to protect environment will refer to the modernization of:

- ammonia plant,
- nitric acid plant,
- phthalic anhydride plant,

as well as to installation of the fluidized-bed boilers in our thermal-electric power station.

PART III

Information about 3 investment undertakings

within the rational energy management, recognized

to fulfil the conditions for external financing

9. Other Comments

Our plans for further development of our Works are firmly bound up with the "Poludnie" Refinery-Petrochemical Complex which is expected to be built in our region.

From the point of view of the financial possibilities to modernize and to enhance our production, it is clear that we absolutely need some foreign capital involved. If based on our own means and some banking credit, we are not in the position to cover all the investment plans.

The efficient development of our Works would be accelerated if we could get some modern processes together with financial means for their implementation.

Information about the rational energy consumption with regard to the project: "Modernization of the syn-gas unit, of the ammonia synthesis unit and of the central cooling unit"

1. Objectives and Expected Results:

the production of ammonia in our Works is based on natural gas. The ammonia plant consists of 3 basic units: a syn-gas unit (pressure - 40 bars), a synthesis unit (pressure - 300 bars) and a central cooling unit.

The planned modernization of our ammonia plant will comprise as follows:

- In the syn-gas unit, the semi-combustion of methane with air and oxygen will be replaced for the process applying oxygen only. The high energy consuming units for water-wash and copper-wash will be shut down. Instead, there will be a low-temperature conversion introduced followed by wash-out of CO_2 with propylene carbonate and by methanation.

- One synthesis unit will be built (its production capacity being 1,500 tons/day) instead of the existing 17 small units. Full utilization of the process heat will be provided.

- In our central cooling unit, 11 small piston compressors driven by electric motors will be replaced for 2 turbocompressors driven by the counter-pressure turbines supplied with steam generated in the heat utilization boilers.

- a big isothermal tank will be built to store 15,000 tons of liquid ammonia. This is bound to improve the operation of our units to produce fertilizers.

- We are going to improve the environmental conditions in the whole Works. Among others, a biological sewage-treatment plant and a storage yard for wastes will be built, and a network will be organized for monitoring the emission of contaminations all around our works.

As a result of the above, we expect to achieve:

a) consumption factor for natural gas will be lowered from 970 m_3 (NIP conditions)/1 ton of NH_3 down to 885 m^3 (NIP conditions)/1 ton of NH_3,

b) consumption of the so-called primary energy for a unit production will be lowered from 45 GJ/t down to 34 GJ/t; for the expected volume of production of 370,000 tons NH_3/year, this should give us the savings of - 140,000 t/year of the theoretical standard fuel,

c) quality of our ammonia will be improved significantly (it will be oil-free) to lower the ammonia consumption factor in further processing to give fertilizers; we will also save up on our Pt catalyst,

d) ammonia effluents to atmosphere will be significantly reduced; so will be the amounts of waste condensates and of solid wastes to improve the environmental conditions,

e) better working conditions; working hazard will be eliminated which always goes together with the operation of the exploited out high-pressure appliances, fittings and pipelines; the accepted control system will cause decrease of employment and will enable optimization of production.

Information about the rational energy consumption with regard to the project: "Nitric acid plant IV, production capacity 1,400 tons/day"

1. Objectives and expected results:

At present we produce nitric acid of 42 - 44 % w/w.
The process equipment operates at atmospheric pressure and its production capacity amounts to 480,000 tons/y. It dates back to the 50's. This nitric acid of such a low concentration is then processed to produce saltpetre fertilizers.

The employed technology together with technical condition of the plant force us to shut down the plant.

In its place we plan to build a new plant, applying a pressure process, with its production capacity being 1,400 tons/day - 462,000 tons/y in terms of 100 % HNO_3.

The following results are expected after realization of this project.

a) reduction of energy consumption for the production of ammonium nitrate by ~ 53,135 tons of the theoretical standard fuel. 1 ton of the theoretical standard fuel = 29.3 GJ. the existing neutralization plant (NH_3 + HNO_3) is supplied with nitric acid (~ 42 stet 44 %) and has to use steam to evaporate the solution. After the planned modernization, this plant will generate steam 0.45 MPa to be used somewhere else. This will be possible if nitric acid 60% is applied. Such a grade of nitric acid will be produced in the new plant IV.

b) substantial reduction of the amounts of NO_x blown out to atmosphere.
For the existing nitric acid plant:
Present emission of NO_x (in terms of N_2O_5) amounts to 7,456 tons/day (this is as of 1989)

2. Investment Costs [1)]

Table 9

Pos.	Specifications	Foreign [2)] Exchange (in million zł)	Local Currency (in million zł)	Total (in million zł)	Comments
1.	Engineering studies and supervision				see pos. 5.
2.	Equipment	179,916.944	225,649.010	405,565.954	
3.	Construction and civil works	60,727.527	116,685.389	177,412.916	
4.	Taxes				see pos. 5
5.	Others	20,134.874	40,552.559	60,687.433	
6.	Total	160,779.345	382,886.958	643,666.303	

1) means necessary to finish the project

2) foreign currency was converted with the rate $ 1 = 9,500 zł

3. Inter-relations between the proposed project and other projects:

When the modernization of our ammonia plant is finished, our production of NH_3 will be the least energy consuming production of NH_3 in the whole country.

Our NH_3 will be mainly consumed to produce nitro-chalk 27.5% since it is easy to export this product. This production, however, is limited by re-construction of our production capacity for nitric acid. We just think of erecting a new plant capable of producing some 1,400 tons/day (in one or two lines). That would be based on "know-how" and the process equipment delivered by the best world-famous companies. We have already started gathering offers.

4. Progress achieved for the definition of the investment project:

The "KĘDZIERZYN" Nitrogen Works have got the completed detail engineering. The realization of this project is advanced at over 30%.

5. Further steps:

The "KĘDZIERZYN" Nitrogen Works seek for a cheap long-term credit to help us in bringing this project to its end.

Modernization of our thermal-electric power station. Application of fluidized bed boilers

1. Objectives and expected results:

The objective of this project is to modernize the basic four plants of our thermal-electric power station:

- boiler house
- turbine house
- water treatment plant
- coaling plant.

The planned modernization consists in replacement of the existing pulverized-fuel boilers for the fluidized bed ones. Old turbines would be replaced, too. The water treatment plant and the coaling plant would be updated.

When the realization of this project is completed, we expect the following results:

1.1 Replacement of the existing boilers and turbines (in operation for over 30 years) and application of some modern equipment.

Present situation

Boiler house

We have got 5 boilers, type Panker, output of 100 tons of steam/hour each. they were built in 1956-61.
4 other boilers, type I brneńska, output as above, were installed in 1963-66.
1 more boiler, type Panker, output of 60 tons/hour, was installed in 1955.
The specification for the produced steam is: 7.2 MPa and 495 °C.

So big amounts of nitrogen oxides are the reason for the fact that the allowable concentration of NO_x in the protected areas far away from the "KĘDZIERZYN" Nitrogen Works is exceeded. When a new plant is built, the emission of NO_x to atmosphere will be lowered down to 370 tons/y (in terms of N_2O_5). So, the emission will be reduced some 20 times.

2. Investment costs:

	Foreign [x] Exchange (in million zł)	Local Currency (in million zł)	Total (in million zł)
Total	500,000	300,000	800,000

[x] foreign currency was converted with the rate
$ 1 = 9,500 zł

3. Inter-relations between the proposed project and other projects:

The project related to the investment project in question is erection of the mechanical granulation plant for the production of Salmag 27.5%.

Our works have already been producing Salmag 27.5%. Because of its quality, its exporting is pretty easy. If we build a new plant, our export sales will increase. This will mean increase in efficiency of our production of fertilizers. The "KĘDZIERZYN" Nitrogen Works will be the only Polish producer of Salmag 27.5%.

4. Progress achieved for the definition of the investment project:

The "KĘDZIERZYN" Nitrogen Works have already got a preliminary report. A feasibility study is planned to be prepared by the end of 1991, i.e. when a plant delivering company is chosen. So far, we have got no assurance of any financial means for the realization of this undertaking.

5. Further steps:

We are just trying to find a foreign partner and to gain some foreign capital.

Turbine House

1 counter-pressure turbine 0.15 MPa, power 16.6 MW, in operation since 1958
1 counter-pressure turbine 0.6 MPa, power 14.7 MW, in operation since 1955
3 counter-pressure/extraction turbines 1.5/0.6 MPa, power 14.6 MW, in operation since 1960-64
2 condensing/extraction turbines 1.5/0.6 MPa, power 24 MW, in operation since 1958.

Future situation

Boiler house

Version I

We plan to install 6 fluidized bed boilers with their furnaces operating at atmospheric pressure, type OPF-140, output of 140 t/hour. They would be delivered by Raciborska Fabryka Kotłów/Poland. In the I stage, only 2 such boilers would be installed.

Version II

In this version we intend to install 4 pressure-operating fluidized bed boilers, type P 200, output of 200 t/hour. They would be delivered by ABB/Sweden. In the I stage, only 1 boiler would be installed.

Turbine house

For both versions, 3 counter-pressure/extraction turbines are planned to be installed, power 32 MW each. They would be delivered by ZAMECH-ABB/Poland.

The inspection of the technical condition of our basic equipment shew that it could be in operation for up to 10 - 12 years at best. Our Works need to have continuous supplies of steam and electricity. So, this equipment must absolutely be replaced.

1.2. Reduction of environmental pollution

The expected degree of reduction is shown below:

Component	Unit	Present situation		Modernization	
		winter	summer	version I	version II
SO_2	kg/h	2,497	1,561	339.6	138
N_2O_5	kg/h	1,992	1,245	169.0	193.6
dust	kg/h	3,110	2,473	172.2	24.3

After the implementation of this project, we will meet the requirements for the allowed air pollution figures to be in force after 1998. The presently operated boilers and their effluents cleaning equipment would not be able to meet those requirements.

The above shown reduction of the environmental pollution is as important to us as the technical problems discussed herein.

1.3. Improvement of thermal efficiency by some 3 - 5%, depending on the chosen version. The savings of coal resulting therefrom would be of the order of 12,000 - 20,000 units of the theoretical standard fuel.

1.4. More efficient process of water treatment for the needs of energy production as well as for the chemical production processes. The water throughput of this plant would be increased to reach 850 m^3/h.

The modernized water treatment plant will cover the future needs of our Works regarding conditioned water.

1.5. The ash is expected to have better properties to enable its utilization in other branches of industry.

All our ash is now stored on a storage yard. Yet the volume of the yard is limited, so we have to look for some other ways to utilize the ash.

2. Investment costs

The carried out preliminary study gave us the costs given in the table below.

All figures are in thousand $ (USA):

The data for the I stage only.

Specification	Version I	Version II
Investment range	2 boilers OPF-140 1 turbine	1 boiler P 200 1 turbine
Documentation and supervision	8,385	11,700
Equipment, accessories and civil work in boiler and turbine houses	49,187	89,087
Appliances and supplementary systems	5,034	4,788
Other	11,974	21,125
Total, I stage	74,580	126,700
Total modernization	216,580	348,316

For the version I, all basic equipment, i.e. boilers and turbines, will be domestic.

For the version II, a boiler P 200 together with a gas turbine must be delivered by ABB, while some sub-assemblies can be executed in our country.

3. Inter-relations between the proposed project and other projects

The modernization of our thermal-electric power station seriously affects 2 problems of the development of our whole Works:

- it ensures supplies of steam, heat, conditioned water and electricity for the coming 20 - 30 years,
- it reduces the environmental pollution in the region of high degree of pollution. Improvement in this field is necessary not only for our Works but for the adjacent town as well.

These are the basic two points which should be ensured before starting any further projects.

From among the particular undertakings, it should be mentioned that we are just modernizing our coaling system (wagon tipplers) and we are getting things ready before starting the modernization of our water treatment plant.

4. Progress achieved for the definition of the investment project

Within the project in question we managed to carry out:

4.1. We have got a report for the modernization of our thermal-electric power station.

It was prepared in April 1990.

The report discusses technical and economical problems of the present situation as well as of the suggested versions.

4.2. Two opinions (co-reports) have also been prepared.

4.3. We have sent our inquiry to ADB/Sweden and have got their offer concerning the boiler, type P 200.

4.4. We placed a preliminary order with Raciborska Fabryka Kotłów/Poland concerning the boiler, type OPF-140, and we stay with them in permanent contact.

5. Future steps

- The versions should be estimated and one of them should be chosen for realization by the end of 1990.
- For the chosen version, brief fordesign should be elaborated.
- Financial means should be sought and the contracts for boilers and turbines should be signed with their producers.

APPENDIX XII

EQUIPMENT SPECIFICATIONS AND JUSTIFICATIONS

The recommended equipment is listed in order of priority. All equipment supplied must be in metric units, 220 volts/50 hertz, with a two year supply of consumable and critical parts (spares). In addition, two operating and maintenance manuals and appropriate batteries and/or chargers must also be provided. Complete units with all parts for operation to be supplied for use in Bulgaria. All required equipment to be provided, instrument air at 6.5 Bar (Dry) available and delivered to user at 20 PSI. Quotations should provide a complete installation sketch and description of all equipment supplied.

1. **Portable flue gas and emissions analyzer.** ENERAC 2000 or equivalent, to determine volume % (dry basis) CO_2, CO (to 0.2 % or preferably higher), O_2, SO_2, NOx, soot and combustible hydrocarbons. Unit to indicate, and if possible to print out, results. Also to indicate temperature to at least 1,100 °C and to serve as a draft gauge, reading to plus and minus 100 mm of water relative to atmospheric pressure. Must be durable.

2. **Portable temperature indicator for reading skin and internal temperature** to approximately 1,600 °C. Accuracy 99.8 % over entire range.

3. **Infrared Thermometer.** Davis Instruments or equivalent capable of reading surface temperatures, in order to identify heat losses.

Details on the energy and cost savings associated with these items are included on the following page.

Name of Company: Kedzierzyn Nitrogen Works Location: Kedzierzyn-Kozle, Poland Type of Industry:					Total Energy Savings
I. LOW-COST EQUIPMENT	COST	ANNUAL SAVINGS	PAYBACK PERIOD (YRS)	TYPE OF SAVINGS	GAS (m^3) COAL (tons) ELECTRIC (kwh)
Emissions Gas Analyzer	$11,697	$230,000	0.05	combustion/heat loss	20,000.00
IR Thermometer (savings est. w/temp indic.)	$ 892			combustion/heat loss	
Portable Temperature Indicators	$1,942	$5,520	0.43	combustion	48,000.00
EQUIPMENT TOTAL	$14,531	$235,520	0.06		204,480.00

(ENERGY COST ASSUMPTIONS)
Natural Gas - 1725 leva/1000 m^3
15 leva = $1 US

APPENDIX XIII

EQUIPMENT LIST FOR ZAKLADY AZOTOWE KEDZIERZYN

1. One set of O2 analyzers by Johnson Yokogawa which contains:

   - eight (8) probes with zirconian cell, #Z021D-L-100-A*U
   - eight (8) probe protectors, #Z021R-L-100-A*U
   - one averaging converter, #AV8G-87BD-AE*A
   - one system recorder,#4177-500-71/BU;

2. IBM compatible personal computer, Model ASY 386SX-33 MHZ, 2MB mem,w/2FD(1-1.2; 1-1.44); AT I/O, 101 KB,100 MB Conners IDE HD; SVGA Color Monitor(1024 RES); Alps printer/6 ft cable, 24 pin,132 col wd, LQ; op & M/S manuals; and Lotus 123 software ver 3.1;

3. Ten medium-sized steam traps by Armstrong Iron Works;

4. Five larger steam traps by Armstrong;

5. One infrared thermometer, Cyclops 3 by Davis Instrument.

The current staff at Kedzierzyn does not have all the requisite experience or skills required to take full advantage of the new desktop computer right away. However, an introductory course and practical workshop on desktop computers, tailored to plant-specific needs would enable plant personnel to learn all necessary uses of the equipment.