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ENERGY AUDIT
OAO AUTOAGREGAT
IVANOVO
RUSSIA

Prepared for

US AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D C 20253

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QUALITY ASSURANCE STATEMENTS

The contents of this report include recommendations based on data provided by the client organization measurements made on site calculations and engineering judgement The conclusions reached were based on a limited engagement of less than ten days duration at the enterprise and not an exhaustive engineering analysis Hagler Bailly Services Inc certifies that this report conforms to the level of best commercial practice for industrial energy audits of similar level of effort, as conducted in the United States This report has been prepared under the guidance of a registered Professional Engineer, licensed to practice in the United States

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SECTION 1

EXECUTIVE SUMMARY

Cost-effective energy efficiency measures can result in large savings for an industrial enterprise thus releasing money spent on energy for other important uses by the management of the enterprise These cost savings can help to make the enterprise stronger, more productive and more competitive

One of the programs sponsored by the United States Agency for International Development (USAID) is the Energy Efficiency and Market Reform Project for Russia (Contract No CCN-0020-C-00-152-00) As part of this project, a team of engineers from East West Energy Agency in Moscow, led by Hagler Bailly carried out site activities at the OAO Autoagregat facility in the Ivanovo Region Their objectives were to work with the enterprise personnel and technical personnel from Ivenergo and to identify opportunities for improvements in energy efficiency of the various industrial processes at OAO Autoagraget

During the site visit, a vast amount of data was collected on the operating characteristics of the facility the equipment installed, and the energy usage Metering and measurements were done at key locations to determine the energy usage levels and operating efficiencies of the equipment All of this information was then analyzed by the energy efficiency experts and evaluated for areas of potential improvements These evaluations resulted in some recommendations for implementing cost-effective modifications to improve the energy efficiency of the enterprise

Based on the recommendations, the estimated overall savings for all energy efficiency measures for five measures is 2,092 million rubles per year Table 1 is a summary of these recommendations The table shows each recommended measure and includes the estimated costs and benefits, together with the simple payback for implementing these

The management of OAO Autoagregat should review these energy efficiency measures and the costs and benefits of each A decision on the measures to be implemented and the determination of the financing for these should occur as soon as possible Following that, the specifications for equipment and business plans for implementation will be written These will be used in determining the financing arrangements Once approved, the energy efficiency measures will be procured and installed

Systems, units, parts and spare parts for cars are main products of the enterprise Till the year 1996 AZLK factory (Moscow) was the major consumer of the products manufactured by the enterprise

Requirements in steam and hot water for technological purposes as well as heat load of the heating and hot water supply systems are met by the enterprise's own boiler house

While making the calculations related to the efficiency of using various measures the following assumptions were made

1 The calculations of the estimates of energy saving amount were done in natural terms While using the saving percentage during the implementation of a specific measure the estimates were done against the 1996 level of consumption

2 The following tariffs for energy resources were used in estimating the costs and savings in the study

- Electricity 450 rubles per kWh
- Natural gas 289,177 rubles/thousand m^3 of natural gas
- Water consumption 300 rubles/m^3

3 An exchange rate of 5,700 rubles per U S dollar was used in the calculations of costs and savings

4 During the calculation of tons of reference fuel into thousands of m^3 of natural gas it was assumed that natural gas heating value was at the level of 8000 Ccal/m^3 of natural gas (reference fuel has heating value of 7000 Ccal/kg)

5 During the calculation of heat losses in the heat supply system expressed in Gcal into thousands of m^3 of natural gas it was assumed that boilers efficiency was at the level of 90%

Table 1
Recommended Energy Efficiency Measures

No	Description Of Measure	Units Of Measure	Annual Energy Savings	Annual Savings in Rubles	Cost of Measure	Simple Payback in Years
1	Installation of Metering on major energy users	Kwh Gcal M^3	1,065 3 13 897 102 8	479 4 558 2 30 8	478 3	< 6 months
2	Rehabilitation of Condensate Recovery System	Gcal	3 304	132 7	500	3 8 years
3	Installation of Steam Traps (1)	M^3	2 288	661 5	34 2	< 1 month
4	Pipeline/Stop Valve Inspection & Repair (1)	M^3	60	17 4	2 9	2 months
5	On-going Combustion Analysis & Adjustments	M^3	733 4	212 1	17 1	< 1 month
	Total for all Measures (2)	Kwh Gcal M^3	1 065 3 17 201 3 184 2	479 4 690 9 921 8 2 092 1	1,032 5	6 months

(1) The energy savings and costs reflect a single measure There are numerous points throughout the facility where these measures are appropriate, hence the costs, and savings, will be much greater
(2) The total reflects only a single measure as described in (1), the totals will be greater as more measures are accomplished

Section 2

Introduction

The purpose of conducting the energy audit at OAO Autoagregat was to collect and analyze appropriate data and information about the enterprise and the energy usages within the facility, then use this information to make recommendations on cost-effective measures to increase the efficiency level of the plant The process involved the collection of historical use of electricity, gas, coal and other fuels and their associated costs It also involved some metering and measurements of key energy using equipment at the facility This was done using the most current and sophisticated energy auditing equipment available

Section 3

Enterprise Description and Energy Consumption

In order to better understand the overall situation with the enterprise and it=s energy use, it is important to look at the characteristics, operations, processes and energy requirements This section provides the description of the enterprise, followed by a description of the facility itself and then a description of the energy uses and requirements After that is a description of the data collection from the measurements and metering that was done during the energy audit

A Enterprise Description

The Joint Stock public company AO "Avtoagregat" was set up in 1992 and is a legal successor of Kineshma works Avtoagregat that was a part of a system of the automobile production concern Moskvich It is one of major enterprises of machine-building sector of Russia that manufactures units, parts and spare parts for cars Moskvich, GAZ, LUAZ, UAZ, VAZ Its product line includes brake systems, body fixtures, front and rear mounting, fastening parts, metallic fluorine plastic tape and bearers made of it

The enterprise has almost all types of modern machine-building production casting, thermal, forging and pressing, mechanical assembly, welding, mechanical processing, instrumentation, painting, etc Automated lines, digital control machine-tools, high-tech equipment manufactured by western firms from Italy, Belgium, Germany, Japan and other countries are widely used

AO Avtoagregat has its own water distribution system, water treatment facilities, a boiler house, a power supply system, a transportation shop, a construction facility, etc

There is a town created around the enterprise, the assets of the enterprise include a housing complex, a children's center, a policlinic, a hospital, a sports center, a subsidiary farm etc

Currently, the enterprise is nearly idle due to a lack of orders for its products The situation has been aggravated over the recent years As is known, the Moscow Works AZLK which is the parent enterprise of the concern has been facing a lot of difficulties related to the sales of its product - cars "Moskvich' In the past Avtoagregat formed part of AZLK and had a stable sale of its products, i e components and spare parts for cars Moskvich A change in the form of ownership and economic independence of Avtoagregat from AZLK accompanied by serious economic problems allowed AZLK to gradually refuse to support the enterprise, including its help in a package of orders development Hoping to develop in a stable way, combining its production work with the work of AZLK, the enterprise conducted active construction until recently but had to mothball it by 1996 For example the construction of a new iron-pig and casting shop and a mechanical assembly shop was started and practically completed (the buildings were constructed, but the equipment was not installed) At the moment the construction has been mothballed A modern warehouse with a computerized system of accounting was not commissioned A planned construction of a new boiler house related to the planned expansion of the major production has been suspended for an indefinite period

B Facility Description

The major organizational and administrative subdivisions of the enterprise are as follows

- Mechanical shop #1

- Mechanical shop #2
- Administrative general purpose building #1 (AGB-1)
- Administrative general purpose building #2 (AGB-2)
- Casting shop
- Neutralization station
- Boiler house
- Filtration and flotation station
- Recycled water supply station
- Metallic fluorine plastic tape shop (MFPT)
- Main 110/10 kV step-down station
- Compressor house #1
- Compressor house #2
- Heavy oil facility
- Department of Capital Construction
- Garage
- Sport complex
- Freezing station
- Warehouses
- Social sphere a policlinic, a technical school, a hostel, a hotel, a housing complex (microdistrict) a pig farm, etc

Product Output

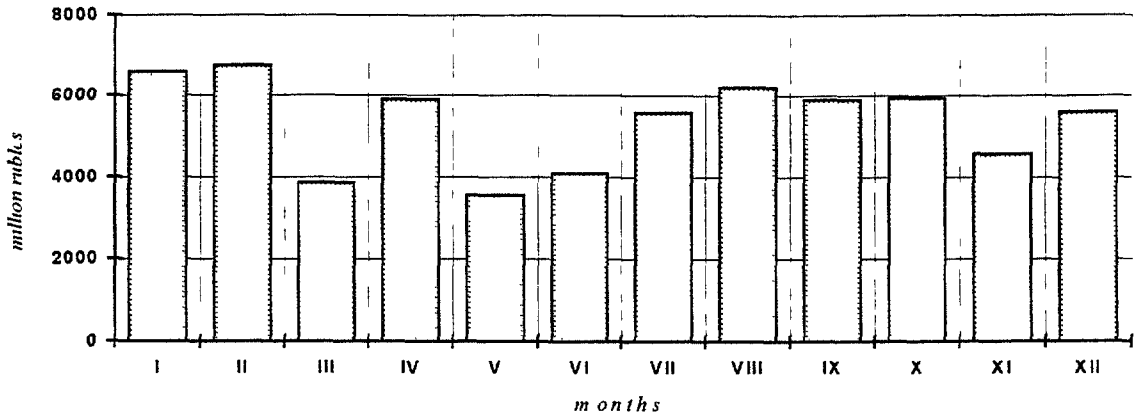
The product output volume, by months of 1996, is presented in Table 2 and in Figure 1 There were 64,227 million rubles worth of products manufactured in 1996 The production in prior years was 60,315 8 million rubles in 1994 and 115,13 million rubles in 1995 If the State Statistical Agency data is used as a basis, the inflation index in 1995 was about 2 relative to 1994, and it was 1 4 in 1996 relative to 1995 Therefore, it is possible to state that the decline in production in 1996 against 1994 was 2 8 It appears that the current production output of the enterprise is only 15-20% of the design capacity

In addition to this it is necessary to pay attention to a lack of rhythmical operation of the enterprise, decline in production amounted to 50% in certain months A significant number of employees receive minimal salaries without coming to work at all

Table 2 Product Output in the Enterprise in 1996

Product Type	Unit	Output Volume in 1996												
		1	2	3	4	5	6	7	8	9	10	11	12	year
Marketable product	mln rub	6587	6762	3872	5901	3536	4083	5587	6211	5897	5938	4561	5592	64227

Figure 1 Product Output by the Enterprise by Months of 1996 ã



C ENERGY CONSUMPTION

The enterprise AO Avtoagregat is a major fuel and energy consumer Table 3 presents data on consumption of boiler and furnace fuel, electricity and city water consumption by the enterprise over the period of 1994-1996

Table 3 Energy Resources Consumption by the Enterprise in 1994-1996

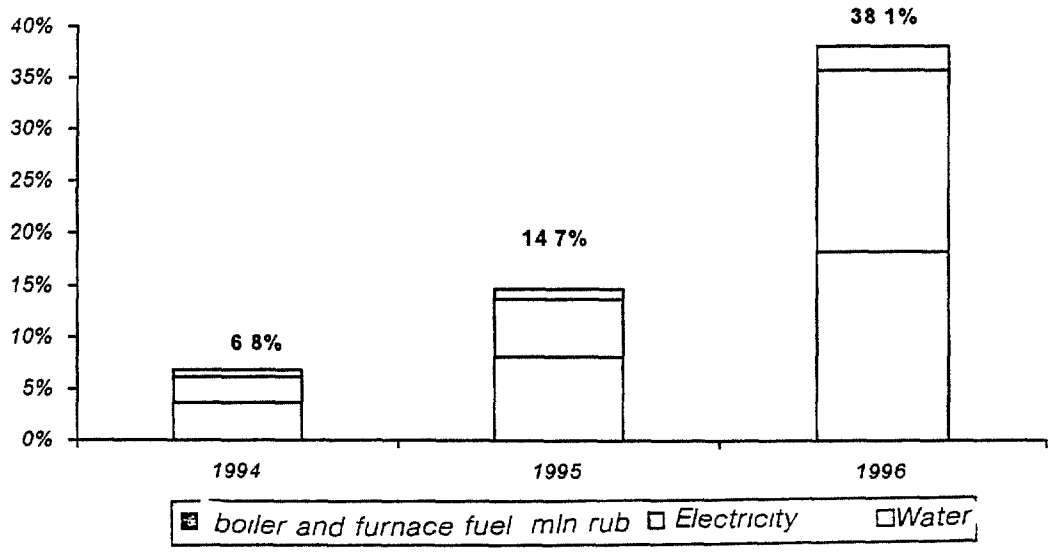
Item	Unit	1994	1995	1996
Fuel consumption	thousand tons of standard fuel	54 710	46 664	41 907
Electricity consumption	MWh	59 106	51 783	37 684
Water	Thousand m^3	1 392	1 339	1 027

Table 4 and Figure 2 present data on energy resources consumption in cost terms, in this case the share of costs per each energy resource is calculated as regards the total volume of the product output (over 1994-1996)

Table 4 Energy Resources Consumption by the Enterprise in Cost Terms in 1994-1996

Item	Unit	1994	% 1994	1995	% 1995	1996	% 1996
Product output	ml rub	60 315 8	100	115 134	100	62 227	100
Boiler and furnace fuel	ml rub	2 238	3 7	9 373	8 1	11 685	18 2
Electricity consumption	ml rub	1 428	2 4	6 448	5 6	11 320	17 6
Water	ml rub	432 5	0 7	1 125 8	1 0	1 515 6	2 3
Total energy resources	Mln rub	4 098 5	6 8	16 946	14 7	24 520 6	38 1

Figure 2 Data on the Energy Resources Consumption in Cost Terms (for 1994-1996)



As is clear from the data presented, the share of energy resources did not only increase continuously (it is characteristic in the industry as a whole due to the growth of tariffs over the recent years) but it may have increased more than it should This may be explained by a considerable decline in production and a significant share of relatively fixed costs for energy supply of the enterprise It is typical for major enterprises (especially, of enterprises with a town around it), Avtoagregat is one of such enterprises large production, auxiliary and residential premises require heating, ventilation and lightning (though in less degree) regardless of the load mode of major production facilities It becomes even more sensitive for enterprises that were accustomed to a calm existence in the conditions with no competition on the market for their products

Boiler-Furnace Fuel Consumption

In 1996, 41,907 tons of reference fuel (natural gas and heavy oil) were consumed by the enterprise for technological purposes and the boiler house operation The boiler house and heating furnaces of the precise casting shop, thermal and instrumentation shops are major consumers of natural gas Fuel oil is used as a backup fuel for the boiler house

Tables 5 and 6 present data on major fuel consuming units of the boiler house and the production accordingly

Table 7 presents data on the consumption of boiler and furnace fuel in 1996 by months Some data (for example, consumption of boiler and furnace fuel in November of 1996) causes some doubts, that is why they were omitted during the analysis

Table 5 Fuel Consuming Equipment of the AO Avtoagregat Boiler House
INFORMATION ABOUT THE EQUIPMENT AND OPERATION OF THE BOILER HOUSE
Primary Fuel natural gas
Backup Fuel fuel oil

Type of the Unit	Amount	Capacity t/h		Pressure kgf/cm² Operating (actual)	Gross Efficiency data after tests	Annual Fuel Consumption thousand reference units	Annual Heat Supply Gcal/ton	Standard Fuel Consumption to Generate 1 Gcal of heat	Comment
		Design	actual						
Steam boilers									
DKVR20/13	3	20	20	13(9)	92			158 kg r f /Gcal	gas-fuel oi
DE10-14GM	1	10	10	13(9)	89 4			159 8 kg r f /Gcal	fuel oil
Hot water boilers									
PTVM-30 #1	1	30	25 5	20 (12)	86			166 1 kg r f/Gcal	gas-fuel oi
PTVM 30 #2	1	30	26 5	20 (12)	88 6			161 2 kg r f/Gcal	gas fuel oi
PTVM-30 #5	1	30	25 5	20 (12)	91			160 kg r f /Gcal	gas fuel oi
TOTAL									
steam boilers						18 368	102 707		
hot water boilers						18 425	113 454		

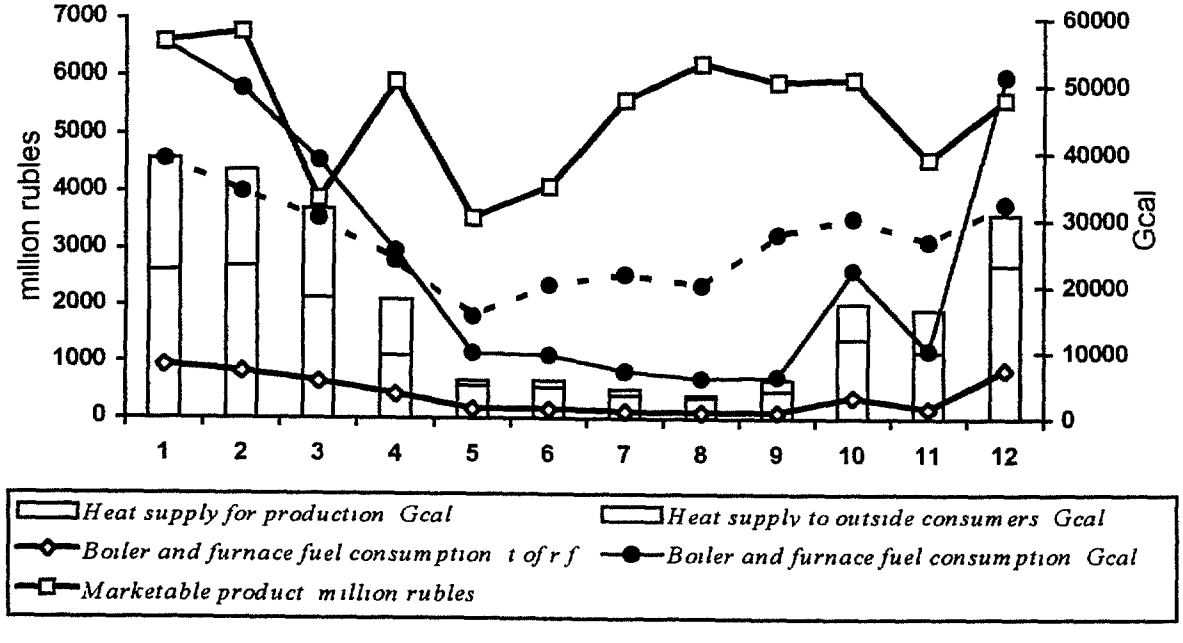
Table 6 Production Fuel Consuming Equipment of AO Avtoagregat
FUEL CONSUMING UNITS PERFORMANCE

#	Unit Type Brand Purpose	Amount	Capacity		Specific Fuel Consumption	Installed Capacity of Electric Drive
			Unit	amount		
	Precision casting shop					
1	Unit 695	2	kg/h	100-350	123 kg r f /tn	0 6 kW
2	Unit for roasting casting and cooling 675	2	kg/h	450	579 9	2 2 kW
3	Endogenerator EN-60	3	m³/h	55 8	0 093 kg r f /m³	35 kW
4	Parts normalization furnace	3	kg/h	250	104 kg r f /tn	1 7 kW
5	Stand for drying ladles and kilns	3	m³/h	10-12	11 9 kg r f /ladle	
6	Kiln for drying sand	2	kg/h	6000	12 3 kg r f /tn	10 kW
7	Machine for centrifugal casting	2	Unit	10	2 6 kg r f /cast mold	4 kW
	Thermal shop					
8	Furnace for heating rods for springs 16	1	kg/h	900	71 3 kg r f/t	14 kW
9	Furnace for tempering springs	1	kg/h	900	42 9 kg r f /t	31 kW
10	Furnace for heating stabilization bar	1	kg/h	1200	51 2 kg r f /t	11 kW
11	Slot furnace Interteck"	1	kg/h	400	106 9 kg r f /t	
12	Furnace for tempering stabilization bars	1	kg/h	1200	18 4 kg r f /t	7 5 kW
13	Unit EN-60	7	kg/h	55 8	0 093 kg r f /m³	35 kW
	Bar stabilization line Reno-Industriale					
14	Heating furnace	1	kg/h	720	69 8 kg r f /t	33 kW
15	Tempering furnace	1	kg/h	720	31 6 kg r f/t	43 kW
	Spring line Reno-Industriale					
16	Heating furnace	1	kg/h	3400	40 5 kg r f /t	33 kW
17	Tempering furnace MFPT	1	kg/h	3400	37 9 kg r f /t	36 kW
18	Endogenerator MK-2	2	m³/h	55 8	0 093 kg r f /m³	35 kW
19	Deguss furnace ISC	1	m³/h	60		22 9 kW
20	Heating furnace	2	m³/h	120	236 kg r f /tn	35 kW

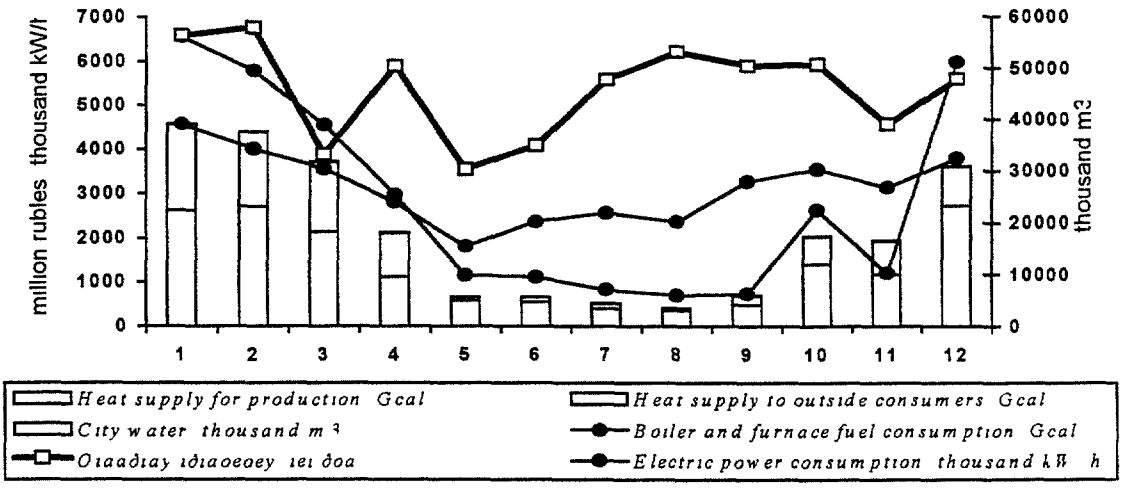
Table 7 Consumption of Energy Resources by Months of 1996 (data submitted by the enterprise)

Item	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	T
Boiler and furnace fuel	Tons of reference	8035 8	7093 7	5566 4	3632	1418 7	1362	1021 5	861 3	900 6	3209	1475 5	7331 8	41
Boiler and furnace fuel	Gcal	56251	49656	38965	25424	9931	9534	7151	6029	6304	22463	10329	51323	293
Electricity	Thousand kWh	4569 8	4002 7	3544 3	2797 2	1805 6	2360 1	2551 0	2356 7	3254 6	3531 9	3127 4	3782 6	376
City water	Thousand m3	106 6	100 2	75 5	71 7	55 2	56 1	75 3	86 6	106 1	98 7	96 0	99 8	102

Figure 3 Marketable Product Output (in mln rubles) by Months of 1996 and a) Consumption of Boiler and Furnace Fuel (tons of reference fuel) and Heat Supply (Gcal) b) Consumption of Electric Power (thousand kW/h) and City Water (thousand m^3)



a)



b)

Generation of Heat Power and Heat Supply to Consumers

The enterprise has its own boiler house with installed steam boilers and hot water boiler units The boiler house has four steam boilers and three hot water boilers

- Three boilers of DKVR-20/13 type with a nominal steam generation capacity of 20 tons/hour and 0 9 MPa operating pressure of saturated steam at the exhaust
- One boiler of DE-10/14GM type with a nominal capacity of 10 tons/hour and a 0 9 MPa operating pressure of saturated steam at the exhaust
- One boiler of PTVM-30 type with a nominal capacity of 30 Gcal/hour under design surplus pressure of 1 2 MPa
- One boiler of PTVM-30M type with a nominal capacity of 40 Gcal/hour under design surplus pressure of 1 2 MPa
- One boiler of TVGM-30 type with a nominal capacity of 30 Gcal/hour under design surplus pressure of 1 2 MPa

All of the boilers, except for DE-10/14GM, are equipped with gas and heavy oil burners Heavy oil is used as a backup fuel in case of interrupted natural gas supply or in the event the limit of gas consumption at the enterprise is exceeded The boiler DE-10/14GM fires only heavy oil

Hot water boilers provide the heating and hot water supply system of the enterprise, and supply heat to outside consumers A list of equipment that consumes heat (steam and hot water) at the enterprise is presented in Table 8

Table 8 Characteristics of the Units that Consume Heat (steam hot water)

#	Unit Type Brand Energy Resource type	Number	Installed Capacity of Electric Drive kW	Specific Consumption of Heat per One Unit of Output Gcal	% of Condensate Recovery behind the Unit	Comments
1	Washing machines	20	40		0	
2	Galvanic baths	162			0	
3	Melting baths	1	3		0	

In 1996, 138,974 Gcal of heat were supplied to meet the demand of the enterprise

In addition to its own uses, the enterprise supplies heat to outside consumers The Houses construction company (which was idle when the study was conducted) buys heat in the form of steam Heat for heating and hot water supply (with delivery water) is delivered to the following consumers

- Residential microdistrict (around 30 thousand residents)
- Sport complex
- Vocational school # 13
- Corrective prison
- Construction and installation agency
- Policlinic
- Hospital complex Sadko
- House construction company

In 1996, 77,187 Gcal of heat were supplied to outside consumers

The heat generation by the enterprise boiler house in 1996 is presented in Table 9 In total, 138,974 Gcal were supplied for technological purposes, including 77,187 Gcal provided to outside consumers

Table 9 Generation of Heat by the Enterprise Boiler House by Months of 1996 (Gcal)

Item	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Production purposes	22425	23100	18300	9560	4995	4699	3520	3064	4093	11988	10030	23200
Outside consumers	16692	14411	13382	8495	680	971	880	436	1802	5397	6436	7605
Total	39117	37511	31682	18055	5675	5670	4400	3500	5895	17385	16466	30805

Electric Power Consumption

The electric power consumption, in 1996, is shown in Table 7 and amounted to 37,684 Mwh

The boiler house, metal processing equipment and electrical heating furnaces of the mechanical shops, ventilation system and air conditioning in the production shops are major consumers of electric power

A central step-down 110/10 kV station, transformer substation for the residential microdistrict belong to the enterprise The over-the-fence supply of electricity amounted to 16,373 MWh in 1996

An automated system KTS TsT-5000 has been installed to meter electricity in the entrance feeders of the main

step-down station and the outside consumer feeders

At the present time, the installed capacity of the enterprise is 35 MW But due to decline in production, the current actual load is about 7 MW plus 1 MW for the boiler house during the winter period and 0 270 MW during the summer period In this case, the capacity of the ventilation and air conditioning system is estimated at 1 MW

City Water Consumption

The total consumption of city water amounted to 1,027 8 thousand m^3 in 1996 Data on city water consumption in 1996 by months is given in Table 7

Metering Energy Resources Consumption

To conduct commercial metering of the natural gas consumption, a diaphragm device that records gas supply to the boiler house and gas supply for technological purposes is installed at the gas distribution station To meter natural gas consumption by each boiler, DMI meters are installed at each boiler, but because of overdue calibration checks and certain faults of the devices, the accuracy of their readings is very doubtful

Commercial electric power metering is implemented at the enterprise by means of an automated system KTS Ts-500 On-site metering at the enterprise is conducted using a calculation method

Metering of heat power generated by the enterprise's boiler house is conducted by a calculation method

D Measurements and Results

There is some consistency between the schedule for the product output by the enterprise and the consumption of some energy resources only as regards electric power consumption and city water consumption

Figure 4 Marketable Product Output and Electric Power and City Water Consumption by the Enterprise by Months of 1996

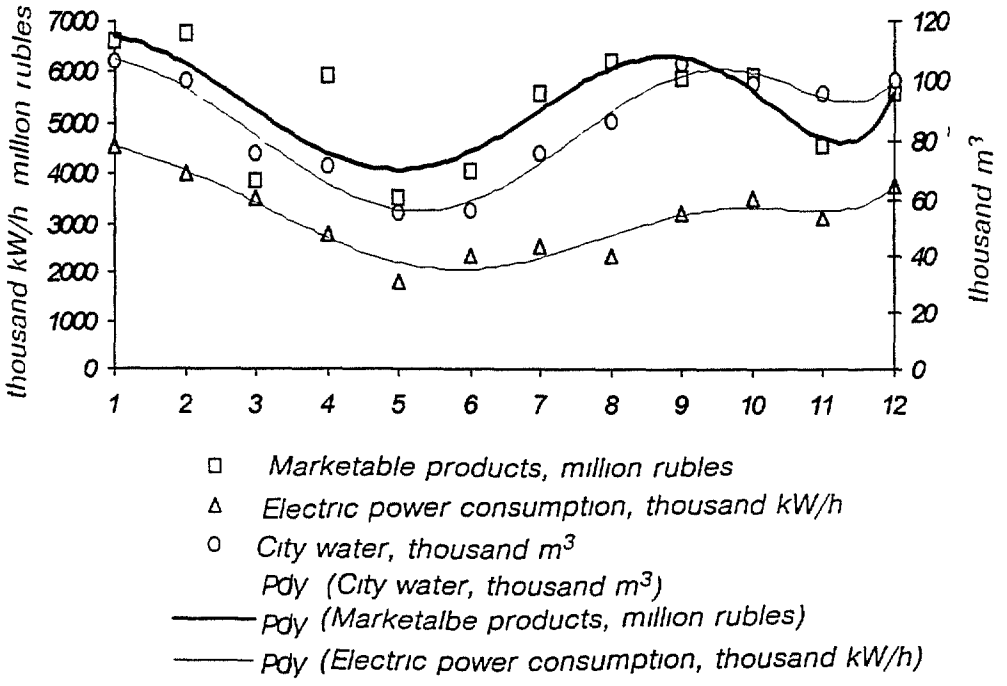
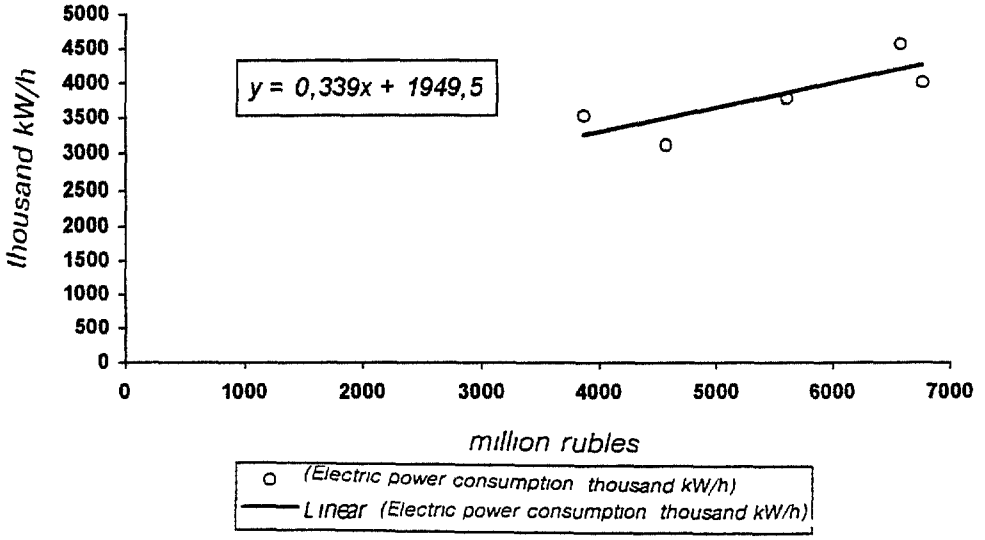
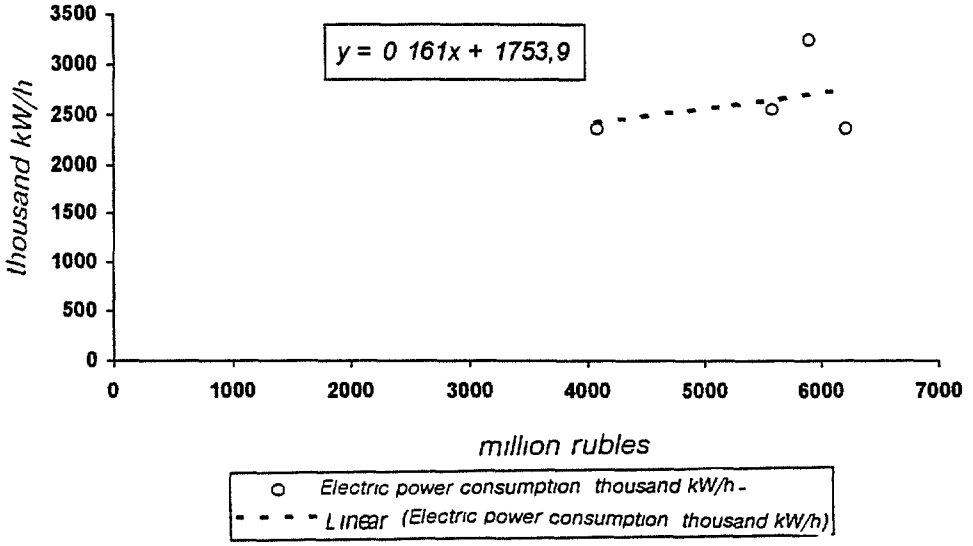


Figure 5 Electric Power Consumption as the Function of Product Output in 1996 in
a) Winter Months (January, February, March, November December)
b) Summer Months (June, July August, September)



a)



b)

The data obtained, provides information to identify a fixed component in the schedule of electric power consumption with a breakdown by summer[1] and winter months of 1996

- Winter 1950 thousand kW/h per month
- Summer 1754 thousand kW/h per month

[1]The dependence of electric power consumption on the product output by the enterprise in summer months of 1996 does not have a clear character which apparently, indicates the predominance of non-production component in the electric power consumption It is an evidence of an extremely low load of the enterprise production capacities

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Given the available error of approximation of dependence between the electric power consumed and the amount of product manufactured, it is possible to identify annual consumption of electric power in the form of a fixed component at the level of 20,000 thousand kWh while the total consumption of electric power at the enterprise is 37,684 thousand kWh This fixed component amounts to about 53% of the total

Over recent years, during checks and studies of numerous industrial enterprises, non-proportional decreases in the product output and electric power consumption was identified The rate of decrease in the electric power consumption is twice as low as the rate of decline in the product output due to availability of a fixed component of the electric power consumption that sometimes reaches 70! AO Avtoagregat fits organically the group of these enterprises and the problems that it is facing are stipulated by the following reasons

- Incomplete workload of major energy consuming technological equipment (electric furnaces presses, machine-tools, automated lines, etc) and an increase in losses related to heating and maintenance of energy consuming technological equipment in operation conditions

- Low level of automation (for example, a lack of possibility to adjust the capacity of the compressor and pump equipment when the compressed air and water consumption decreases)

- A necessity to maintain relevant temperature mode in the shops in the conditions of their partial load and forced idle work during interruptions in the technological sequence of operations related to the product output (it refers to lightning of the production shops in less degree)

This study focuses on the following factors

1 The main buildings of the enterprise have an area of around 10 000 m^3 and more, at the same time they are equipped with the single ventilation system and single heating system

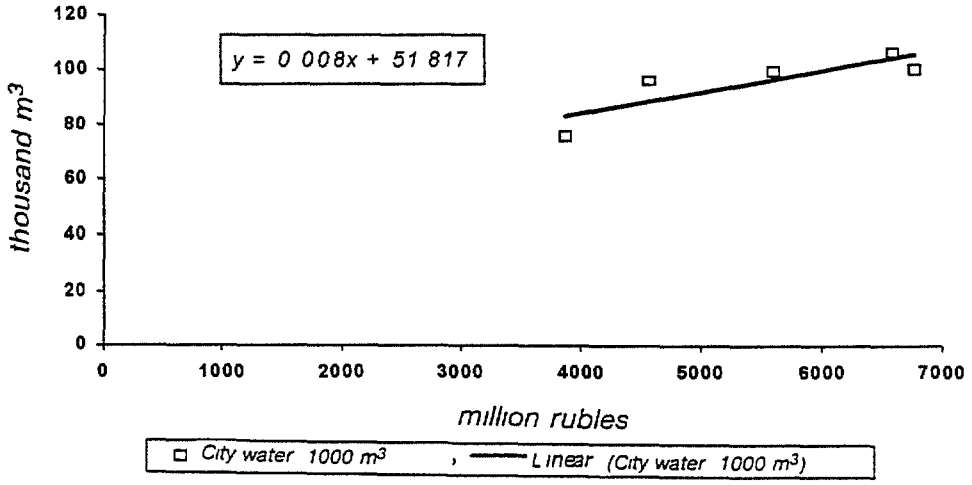
2 The shops electric supply schemes are loopbacked, that is, they have multiple feeds from the service entrance

3 The lighting system is divided into sections (in most cases DRL lamps are used), that include considerable spans of the shop, turning on and turning off the light in the sections is manual

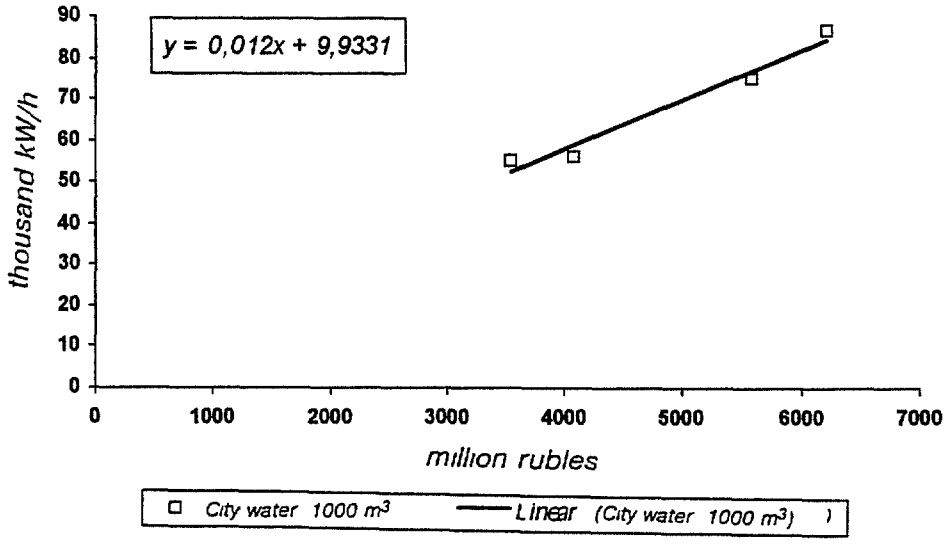
The situation at the enterprise is complicated because of mothballed buildings, a warehouse of manufactured products that is not used, and the costs for energy resources at these facilities is inefficient

An attempt to identify a fixed component as regards the city water consumption has given the following results

Figure 6 City Water Consumption as the Function of Product Output in 1996 in a) Winter Months (January February March November December) b) Summer Months (June July August September)



a)



b)

The data obtained gives a possibility to identify a fixed cost component in the schedule of city water consumption with a breakdown by summer[2] and winter months of 1996

- Winter 151 8 thousand m^3/month or 70 8 m^3/h
- Summer 9 9 thousand m^3/month or 13 5 m^3/h

[2] ~~The dependence of electric power consumption on the product output by the enterprise in summer m~~onths of 1996 is not very clear which probably means that the non-production component predominates in the electric power consumption It is an evidence of an extremely low load of the enterprise production capacities

Or the av. age annual consumption is more than 40 m^3/h [3]

The balance of the city water consumption by the enterprise in 1996 is as follows

TOTAL CONSUMPTION	1027 8 thousand m^3
Including	
⇒ fixed component	370 2 thousand m^3 (36%)
⇒ variable component	657 6 thousand m^3 (64%)

According to the data provided by the personnel, the steam supplied to an outside consumer (house building company) amounts to 10 tons/h on average The amount of steam supplied for the auxiliary production section's electric power consumption of which is not related directly to the product output does not exceed 5 tons/h Taking into account that there is no condensate recovery from these steam consumers forced water distribution for the generation of this steam (without accounting for steam losses in the chemical treatment facility) will amount to up to 15 m^3/h on average It seems that the balance (40-15=25 m^3/h) is the steam supplied to auxiliary subdivisions and water consumption by the administrative general purpose buildings In our opinion, water consumption for these purposes may be lowered by at least by 30%, or 65 7 thousand m^3/year

The full-scale work aimed at identifying reserves for saving city water in the whole enterprise was not included into the program of the energy audit The work can be done independently by the enterprise itself provided there is complete background statistical information on water consumption by specific city water consumers, no matter how large they are That is why, before starting this work, it is necessary to install a system of metering energy resources consumption at the enterprise as a whole, and metering city water consumption, in particular

It in not only the consumption of boiler and furnace fuel by the enterprise as a whole that is not directly related to the production load of the enterprise but the same may be said about heat consumption at the enterprise (without outside consumers of heat)

[3] An assumption according to which the winter and summer periods are equal (six months) has been made

Figure 7 Boiler-Furnace Fuel Consumption Heat Supply for Technological Purposes and Product Output by the Enterprise by Months of 1996

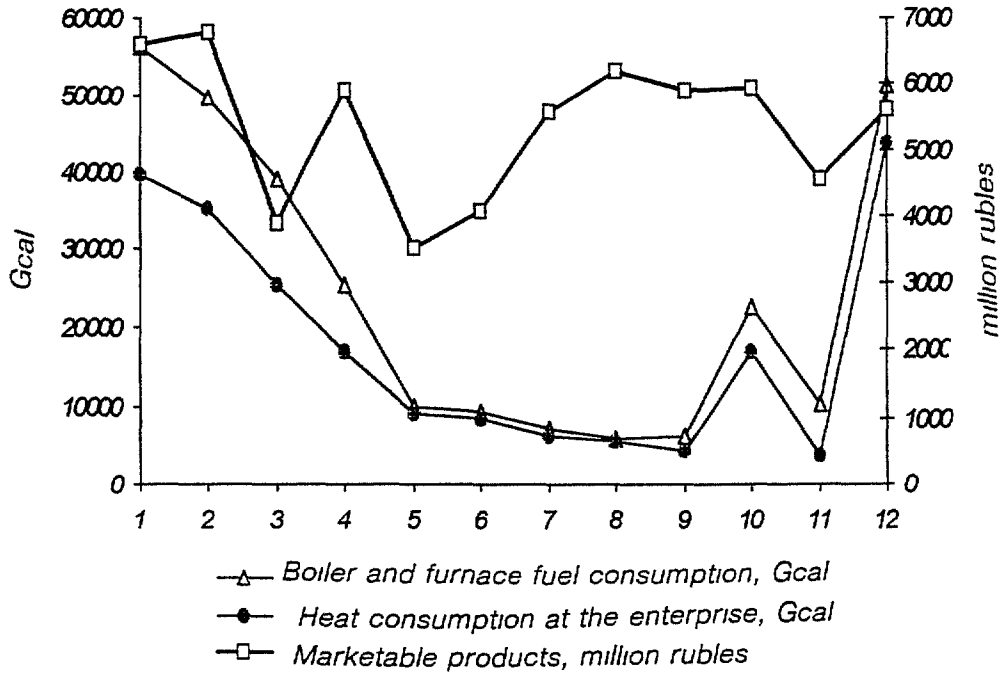
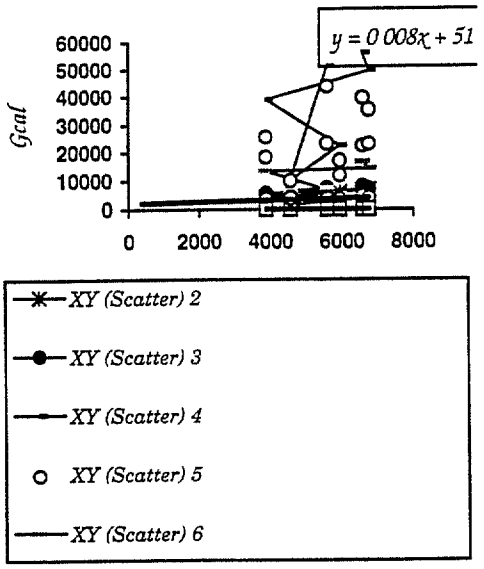
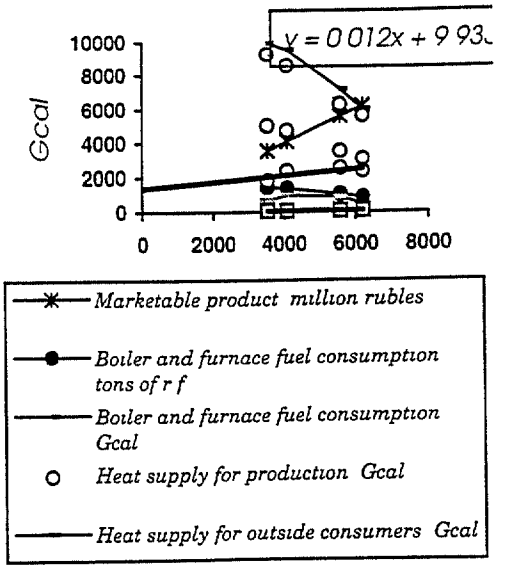


Figure 8 Heat Supply for Technological Purposes as the Function of Product Output of the Enterprise by Months in Winter (a) and Summer (b) Periods of 1996



a)



b)

The analysis of the chart that shows heat supply for technological purposes in summer months (Figure 8 b) gives reasons to believe that the more products were manufactured in the summer of 1996, the less heat was supplied for technological purposes (or vice versa Two explanations may be given to this fact

1 It is not heat consumption in the production by the heat consuming technological equipment that accounts for the major part of heat supplied for technological purposes but the heating system, heat consumption by auxiliary shops and sections, losses

2 A considerable share of costs for boiler and furnace fuel consumed for technological purposes is passed on to the outside consumers of heat

During the audit, only a few of the technological consumers of power were operating At the present time, the mode of product output by the enterprise is not only characterized by a partial operation of production equipment, by also by its very irregular operation This results in a lack of rhythmical and an intermittent operation of the major equipment As a result, it brings about increased non-production expenditures (losses) during the start-ups/stoppages, increased specific costs for manufacturing one unit of output that become especially high in case of partial load of the equipment due to non-proportionally quickly increasing specific losses of energy in this case

Thermal Technical Equipment

The Boiler House and Communication Lines

Four steam boilers and three water boilers are installed in the boiler house

- Three boilers of DKVR-20/13 type with a nominal steam generation capacity of 20 tons/hour and 0 9 MPa operating pressure of saturated steam at the exhaust
- One boiler of DE-10/14GM type with a nominal capacity of 10 tons/hour and a 0 9 MPa operating pressure of saturated steam at the exhaust
- One boiler of PTVM-30 type with a nominal capacity of 30 Gcal/hour under design surplus pressure of 1 2 MPa
- One boiler of PTVM-30M type with a nominal capacity of 40 Gcal/hour under design surplus pressure of 1 2 MPa
- One boiler of TVGM-30 type with a nominal capacity of 30 Gcal/hour under design surplus pressure of 1 2 MPa

All boilers except for DE-10/14GM are equipped with gas and heavy oil burners Heavy oil is used as a back up fuel in case of interrupted natural gas supply or in the event of an excess over limit of gas consumption at the enterprise The boiler DE-10/14GM fires only heavy oil Water boilers operate for the heating and hot water supply systems of the enterprise, and to supply heat to outside consumers

Boiler tests were conducted in April of 1997 Three boilers - # 2, 3, 4 were operating Measurements of the content and temperature of waste flue gases were made with the help of a portable electronic flue gases analyzer FYRITE 4 The results of boiler DKVR-20/13 #4 testing are given in Table 1 of the Appendix

It was impossible to adjust the combustion mode by changing the gas-air ratio as during the boiler survey a crack in the brick lining of the boiler was found which did not give a possibility to adjust the combustion mode The results of testing boiler DKVR 20/13 #3 are shown in Table 2 of the Appendix The tests were conducted in two modes steam load of 11 2 tons/h and 18 2 tons/h

With the steam load being 18 2 tons, the mode photography was made when the air flow corresponded to 15 mm of water according to the readings of a U-manometer, the optimal result was at 10 mm of water

The results of the testing boiler TVGM-30 #2 are given in Table 3 of the Appendix The tests were conducted during one mode water load of 15 2 Gcal/h with gas flow of 2627 m^3/h

Boiler #2 has been upgraded recently and no adjustment tests have been conducted yet, that is why the mode chart is old The column "Mode Photography" corresponds to the mode that the operator maintained at the moment of the tests performance The column "Mode Photography' corresponds to the mode established in accordance with the old mode chart During measurements taken to set an optimal combustion mode the operators were decreasing air surplus in the burners from the control panel In case of small load, the setting of a required air pressure before the burners (and its maintenance, which is the most important thing) is difficult

During the testing of the boilers DKVR 20/13, measurements behind the economizers were not accomplished due to a lack of flue gas sampling points

It is possible to make the following conclusions based on the results of the tests conducted

- Main losses in the boilers are connected with too high values of the surplus air ratio which is stipulated by availability of air suction along the flue gases duct and uneconomical mode of natural gas burning (gas-air ratio) A decrease in this ratio in the experiments conducted allowed to increase boiler #3 efficiency (without taking into account the economizer) by 3-3 5 %

- It is necessary to conduct re-adjustment of the boilers with preparation of new mode charts, the use of old and overdue mode charts is inadmissible

- It is necessary to use such indicators of air flow to the burners that it is possible to establish a required flow in case of low loads (at the moment it is necessary to set pressure of the air before the burners which is around several mm of water on the 100 mm water scale)

Heat Consumers

The major consumers of heat power as of April 24, 1996 are presented in Table 10

Table 10 Major Consumers (as of April 20 1996)

#	Consumer	Steam			Delivery Water
		Consumption t/h		Possible % of Condensate Recovery	Consumption t/h (Gcal)
		Min	Max	%	
1	House building company		40	0	50-60 Gcal
2	Heavy oil facility and deaerator [4]	4	5		-
3	Residential microdistrict		-		531/485[5] t/h
4	Mechanical shop # 2		8	60%	440 t/h (290 and 150 two connections)
5	AGB-2*	-	-	-	56 t/h (27 t/h - heating 29 t/h hot water supply)
6	AGB-1*	-	-	-	29 5/28 5 t/h
7	Sport complex	-	-	-	73 5/73 5 t/h
8	Mechanical shop # 1	3	6	50%	262 t/h (105 and 157 two connections)
9	Neutralization station*		0 5	-	-
10	Floatation station*	0	3	-	-
11	Casting shop	3	7	50%	-
12	CMFT		0 5	100%	-
	TOTAL	59	70		

The enterprise supplies heat power to the residential microdistrict of the town Kineshma with a total population of 30 000 residents Until recently the enterprise continued the construction of houses for its employees as well as the construction of relevant infrastructure (shops, policlinics, libraries, etc) Because of difficulties of the last two years the enterprise has reduced the scope of housing construction and the allocation of funds to maintain/repair the residential sector

With the objective of verification of the data submitted by the enterprise (and checking the installed flow meters) on the delivery water consumption and checking the balancing of the on-site system, measurements were taken of the delivery water flow in the main pipelines on the territory of the enterprise The protocols of the measurements taken are given in the Appendix (Table 5)

The said work was performed by the request of the enterprise Measurements were taken of the on-site heating system/hot water supply During the measuring process possibilities of modern ultrasonic measuring devices of the contact type (that do not need tie-ins) were demonstrated

During the measuring process a considerable excess of the delivery water consumption for the on-site requirements was identified It is connected with the fact that during the winter period the personnel maintains increased delivery water consumption for heating the enterprise because of the fear 'to de-freeze" the heating system (water air heating radiators used for heating the production shops is a bottleneck) Measurements were taken in April 23-24, 1997, i e at the end of the heating season, when the air temperature was above the zero, but the air heating radiators continued working in the "winter" operation mode It resulted in an increased temperature of the delivery water in the return line Due to a lack of computerized metering devices, the personnel did not even suspect that the operation mode of the on-site heating was inefficient As a result of the

[4]* In this Table and further in the text * indicates auxiliary subdivisions energy consumption of which is not related directly to the product output

[5] In this Table and further in the text numbers in the fractions correspond to flows in the direct (numerator) and the reverse (denominator) directions that were measured during the audit

measurements it became possible to prepare balances of flows and temperatures and calculate accurate value of the surplus flow The work was performed independently by the personnel of the enterprise with the use of the measurements results As result of this, it was possible to reduce the delivery water consumption for on-site purposes by 40% (around 400 t/h)

The measurements taken during the on-site work showed again a necessity for installation of the automated system for energy resources flow control

Electrical Technical Equipment

As has been stated previously, the boiler house, metal-working equipment and electric heating furnaces of the mechanical shops, the system of ventilation and air conditioning in the production shops are major consumers of the electric power

The central 110/10 kV step-down transformer substation for the residential micro-district belongs to the enterprise

The characteristic features of the transformer substations are presented in the Table

Production Shop # of the Substation	Number of Transformers	Capacity kVa		Voltage high/low kV
		Each	total	
Central step-down substation 110/10	2	15 000 20 000	35 000	110/10
Mechanical shop #1				
KTP-6	2	1000	2000	10 kV/0 4 kV
KTP-7	1	1000	1000	
KTP-8	1	1000	1000	
KTP 9	1	1000	1000	
KTP 10	2	1000	2000	
KTP 11	2	1000	2000	
KTP 12	1	1000	1000	
KTP-13	1	1000	1000	
KTP-42	1	1000	1000	
Mechanical shop #2				
KTP 14	2	1600	3200	10 kV/0 4 kV
KTP 15	2	1600	3200	
KTP 17	2	1600	3200	
KTP 18	2	1600	3200	
KTP 19	2	1600	3200	
KTP-67	2	1600	3200	
Casting shop				
KTP-2	1	1000	1000	10 kV/0 4 kV
KTP-3	1	1000	1000	
KTP-4	2	1000	2000	
KTP-5	1	1000	1000	
Neutralization station				
KTP-31	2	400	800	10 kV/0 4 kV
Flotation station				
KTP-30	2	400	800	10 kV/0 4 kV
Pig farm				
TP 29	2	630	1260	10 kV/0 4 kV
Recycled water station				
TP-29	2	1000	2000	10 kV/0 4 kV
Metallic fluorine tape shop				
KTP 21				
KTP 22	1	1000	1000	10 kV/0 4 kV
	1	1000	1000	
Boiler house				
TP 20	3	1000	3000	10 kV/0 4 kV
Second lift station				
KTP 32	2	400	800	10 kV/0 4
Microdistrict				
TP 1 -TP 13	24		7780	10 kV/0 4 kV

The compressor equipment installed at the enterprise has the following features

Compressor type	Amount	Capacity m^3/min	Pressure kgf/cm^2	Capacity of Electric Drive kW	Average Annual Electricity Consumption 1000 kWh
K 250-61 2	20	250	8	1600	68550
VP-2M-1050/8	20	20	8	125	195
2VP-10-63-9	1	63	8	320	499

There are no air flow meters in any of the compressors

Energy and technological modes in most of the production processes are interrelated, at the same time maximal productivity of the technological equipment with minimal specific electric power consumption corresponds to optimal energy modes

It should be noted that due to a lack of on-site metering of electric power consumption at the enterprise it is very difficult to obtain the actual balance of electric power consumption Therefore, it is nearly impossible to determine the electric power expenditures by specific items of revenues and expenditures (for each type of production, lightning, ventilation, transport losses in the networks, losses in the transformers, etc

A high priority task to help increase the efficiency of electric power consumption is the installation of a computerized system of electric power metering at the enterprise This will provide the data to analyze the electric power consumption at the enterprise and obtain objective data to make the following decisions

- Optimal load of the equipment installed in specific shops and sections
- Regulation of the enterprise load during peak hours
- Lowering customer contract demand with the control of the consumption during the peak hours, without allowing the demand to exceed the set figure which will allow to exclude the payment of penalties

A lack of rhythmical use of equipment results in lower overall load factor for the enterprise During the audit, only a few of the technological consumers of power were operating At the present time, the mode of product output by the enterprise is not only characterized by a partial operation of the production equipment, by also by its very irregular operation

Section 4

Recommended Energy Efficiency Measures

A Potential Energy Efficiency Measures

The energy auditors investigated as many potential efficiency measures as possible in the time budgeted for the project Subsequent to this, the most cost-effective measures are recommended for implementation by the enterprise Some of the potential energy efficiency measures are not reasonable because of the long payback period, or very high initial cost Those measures in the recommended list consist of actions that have simple paybacks of less than 3 years Given the economic conditions in Russia, this seems like the most reasonable maximum time period for the measures to be paid for by the savings

B Recommended Cost-Effective Measures

The following are the recommended energy efficiency measures for AO Autoagret to undertake to reduce its energy costs and improve the efficiency of the enterprise

PROJECT 1 THE INSTALLATION OF COMPUTERIZED SYSTEM OF COMPLEX ENERGY RESOURCES METERING ON THE BASIS OF THE TECHNICAL EQUIPMENT COMPLEX (TEC) "ENERGIA"

The Purpose of the Project — Organization of Commercial and On-site Metering of Energy Resources Consumption

Justification

At the moment the enterprise pays its bills for energy resources consumed in the following way

- Electricity based on the readings of the electrical meters
- Natural gas based on the readings of the gas meter with a differential pressure gage DP-7780
- City water based on the readings of water meter

On-site and shop metering of generation and consumption of fuel and energy resources is nearly unavailable

The installation of the system of commercial metering of received energy resources, consumed electricity, heat with steam and hot water, city water, compressed air will allow the enterprise to considerably increase the possibility for analyzing the consumption of fuel and energy resources, make decisions on the optimal load of specific shops and sections, lower customer contract demand for electricity and control its consumption during peak hours without allowing it to exceed the customer contract demand and through this measure exclude payment of penalties

The metering of generation and consumption of steam for technological purposes of the enterprise will allow to conduct analysis of heat consuming units operation, efficiency of their operation, identify places of losses

Given the fact that the boiler house of the enterprise supplies steam and cogeneration water to over-fence

consumers and in spite of this, it cannot meet all requirements of an expanding residential complex the installation of the computerized metering of cogeneration and city water consumption is an urgent task for the enterprise

The specialists of OAO "IVELEKTRONALADKA' performed the study to identify an estimated cost of the TEC system 'Energia' which must be compatible with the TEC TsT-500 installed at the enterprise and designed for metering electricity at the substation 110/10 kV

We propose the installation of 380/220 B electrical meters for the on-site metering of electric power consumption - 20 units, installation of the equipment to get information on the steam flow in the summer and winter pipe run, gas flow in the boiler house and for technological purposes, development of commercial gas metering system in the gas distribution station

As far as the boiler house is concerned, it is planned to install computerized system of metering raw water consumption, make-up water consumption, water flow through water boilers, steam consumption with the breakdown by all consumers, steam generation by boilers from #1 to #7, control over pressure and temperate of the heat carrier in the system of the heat supply of the enterprise and the residential microdistrict

Estimated costs for the development of a complex system of metering energy resources were prepared by the specialists of OAO 'IVELEKTRONALADKA (see Supplements)

Capital Investments

A complex of works to install the system is estimated at the level of 478 3 million rubles (83 9 thousand $USA)

Energy Resources Savings

In the world practice, computerized systems of metering consumption are not looked upon as direct energy saving measures In the modern world, it is difficult to conduct reasonable (planned, economically justified etc) energy saving policy without having complete background information about the facility as a whole, and about its energy consuming subdivisions in particular Therefore, the availability of this system must be looked upon as an obligatory condition for a normal operation of the enterprise At the same time, experience related to the installation of analogous systems at other facilities allows an analyst to forecast the saving of energy resources For example, at the moment it is impossible to separate "day' consumption of electricity from the "night consumption from the point of view of commercial metering At the same time it is impossible to perform analysis of on-site electricity consumption to justify a transfer of specific subdivisions/sectors of the enterprise to a night operation (it is an urgent issue especially for powerful electric furnaces)

During a subsequent analysis of information which the system will collect, a development of a policy for lowering energy consumption at the enterprise that would be justified from the technical point of view and, which is more important, from the economic point of view

It is important to note that the system as such does not save energy resources it is an instrument that in skillful hands allows to significantly lower (up to 50% in known cases) energy consumption

As regards to this enterprise, an evaluation of the efficiency of the system installation (one year) can be made at the following level

- Electric power up to 5% of electric power consumption by the enterprise proper (1,065 3 thousand kWh/479 4 million rubles/84 1 thousand $USA)

- Heat power up to 10% of heat consumption at the enterprise in the terms of natural gas consumption (13,897 Gcal/1,930 thousand m^3 of gas/ 558 2 million rubles/97 9 thousand $USA)

- Water up to 10% of total consumption (102 8 thousand m^3/ 30 8 million rubles/5 4 thousand $USA)

TOTAL, all energy resources 1187 4 million rubles/187 4 thousand $USA

Period of Capital Repayment (in relative terms) Less than six months

PROJECT 2 Rehabilitation of the System of Condensate Recovery at the Enterprise

The Purpose of the Project — Lowering Heat Power Consumption for Pre-Heating of the City Water to Recover Losses of Condensate in the Boiler House Steam Cycle

Justification

At the moment there is no system of the condensate recovery at the enterprise The system was included into the project of the factory, it was partially installed, but it was not completed by the time of the major production buildings commissioning At a later stage while new production facilities were added, the system of condensate recovery was "forgotten' Now it is completely dismantled (stolen)

Now all condensate is discharged to the sewage system, that is why there are steam losses around practically all drain shafts

A lack of the condensate recovery system results in the situation when in order to recover its losses, it is necessary to intake city water and subject it to chemical treatment in the chemical treatment facility at the boiler house In case of the condensate recovery, its temperature would be around 90°C Fresh city water has an average annual temperature at the level of 8°C Consequently, the recovery of the condensate losses with fresh water results in additional energy consumption to heat the latter from 8° to 90°C (the temperature of recovered condensate)

Capital Investments

As the issue was not developed as a project, we shall take capital costs to rehabilitate the system of the condensate recovery at the estimated level

500 million rubles (87 7 thousand $USA)

Energy Resources Savings

In accordance with the data submitted by the personnel, steam supply for technological purpose is estimated at the following level

- In winter up to 8 t/h
- In summer up to 15 t/h

Average annual steam supply for technological purpose will amount to around 11 5 t/h

The city water comes at the average annual temperature of 8°C We assume that the recovered condensate would have the temperature of around 90°C In the opinion of the personnel of the enterprise, the recovery of the condensate is possible at the level of 40-50% We shall take the value of 40% for our calculations We shall neglect losses in the line of the chemical treatment facility

Excessive electric power consumption will amount to

11 500 kg/h x 40% x (90-8)°C x 1 Ccal/(kg °C) 24 h/day x 365 days/year = 3304 Gcal, which in the terms of natural gas consumption (90% of boilers efficiency, heating value of gas being 8000 Ccal/m^3) will amount to

3304 Gcal/90%/8000 Ccal/m^3=
458 9 thousand m^3 of natural gas/132 7 million rubles/23 3 thousand $USA

Period of Capital Repayment Three years and ten months

PROJECT 3 Installation of Steam Traps in the Steam Consuming Equipment

The Purpose of the Project — Lowering Heat Losses with Flying Steam at the Steam Consuming Equipment (boilers, kilns)

Justification

During the performance of works to conduct the energy study, a complete lack of steam traps at the steam consuming units was identified Galvanic baths and boilers of heating and hot water supply systems may be referred to major steam consuming units Not a single unit has a steam trap In connection with this, certain part of steam is not used in the units properly and "flies' through them, without giving its full thermal potential Such losses are inadmissible and should be liquidated

There is no condensate recovery at the enterprise as the condensate is discharged to the sewage system The presence of the flying steam in the condensate is confirmed in part by a high steam losses of the drainage shafts on the territory of the enterprise

Capital Investments

30 steam traps are required to be installed As the installation of the steam traps can be conducted using the funds of the enterprise itself, the amount of capital investments equal the cost of purchased equipment and is estimated at the level of

34 2 million rubles (6000 $USA)

Energy Resources Saving

Accurate estimation of the flying steam share is impossible During the estimation of this measure efficiency we proceeded from the losses of the condensate at the level of 10% A breakthrough of the steam and its subsequent 10% loss results in excessive consumption of fuel to generate it at the level of 25%

In accordance with the data submitted by the personnel, steam supply for technological purposes is estimated at the following level

- In winter up to 8 t/h
- In summer up to 15 t/h

Average annual steam supply for technological purpose will amount to around 11 5 t/h

In the terms of natural gas consumption possible savings (steam pressure in the units is 4 bars efficiency of boilers is 90%, heating value of gas is 8000 Ccal/m^3) will amount to

11 500 kg/h x 654 Ccal/kg x 25% x 24 h/day x 365 days/year/90%/8000 Ccal/m^3=
2 288 thousand m^3 of natural gas/ 661 5 million rubles/116 1 thousand $USA

Period of Capital Repayment Less than one month

PROJECT 4 Inspection of Pipelines and Stop Valves of the Thermal Technical Equipment of the Enterprise, Liquidation of Identified Leaks and Defects

The Purpose of the Project — Determination of Conditions of Pipelines and Stop Valves of Thermal Technical Equipment with the Aim of Finding Defects (Developing a Plan for Valves Replacement)

Justification

During the survey of the enterprise steam leaks were identified in the steam collector near the galvanic baths location in mechanical shop # 2, in the connecting pipelines of the baths, in the inlet of the steam pipeline in mechanical shop # 1 Given a present state of affairs at the enterprise, much attention has to be devoted to steam transportation and use Presence of direct leaks from the steam pipelines is inadmissible In addition to this, taking into account that steam pipelines load is much less that the design load, steam transportation is linked with increased specific heat losses That is why not permitted steam flows are inadmissible The above said is referred to the network water used in the system of heating and hot water supply to a less degree We think that it is necessary to conduct a large-scale inspection of all pipelines and stop valves of the thermal technical equipment of the enterprise

Capital investments

Based on our estimates, in order to conduct a large-scale inspection of all thermal technical equipment of the enterprise, it is necessary to use the services of specialized firms that have diagnostics equipment A multipurpose ultrasonic device 'ULTRAPROBE 2000" one of the functions of which is identification of leakages of the stop valves is a very suitable device for these purposes

Estimated labor costs are as follows one specialist with a device is to work during three days

2 9 million rubles (500 $USA) is a maximal cost

Energy Resources Savings

Inspection as such will result in an energy saving effect only as regards the liquidation of direct leakages to the atmosphere Visually we estimate steam leakages identified during the survey at the level of 300 kg/h

In the terms of natural gas consumption, possible saving will amount (steam pressure in the units was assumed to be 4 bars, efficiency of the boilers was assumed as 90%, heating value of the steam was assumed as 8000 Ccal/m^3) to
300 kg/h x 654 Ccal/kg x 25% x 24h/day x 365 days/year/90%/8000 Ccal/m^3=
60 thousand m^3 of natural gas/17 4 million rubles/3 0 thousand $USA)

In addition to this, based on the results of the inspection, it will be possible to develop a program for repairing/replacing the stop valves, the implementation of which will allow to liquidate non-production consumption of heat power

Period of Capital Repayment Two months

PROJECT 5 Higher Efficiency of Combustion by Periodical Control of the Combustion Mode with the Help of the Portable Gas Combustion Analyzer

The Purpose of the Project Lowering Heat Losses that Result from Changes in the Characteristics of Boiler Units in the Operation and Inaccurate Preparation of Operation Charts Availability of the device gives the personnel the possibility to make diagnostics of the boilers and take timely measures to liquidate defects

Justification

It has been established that due to available suctions of air along the path as well as due to inefficient combustion modes, at the moment the content of oxygen in the waste gases of the boilers exceeds significantly optimal values It is connected, firstly, with a lack of adjustment of the gas-air ratio during the organization of the fuel combustion process, and secondly, with increased suctions of air in the boilers

During the survey it was established that boiler DKVR-30/13 # 4 was operated in the mode under which gas losses together with waste (q_2) amounted to 28% against 11% in the mode chart An attempt to adjust the gas-air ratio failed the oxygen content practically did not change when the operator tried to adjust it In order to find what caused it, a detailed survey of the boiler unit was conducted An all through crack in the brick line (up to 70 cm long) was found in the upper part of the frontal wall of the furnace (practically over the furnace)

The operation of the boiler unit in these conditions is not permissible

During the adjustment process at boiler DKVR 30/13 # 3, we managed to lower losses with waste gases by 3-3 5% through optimizing the combustion mode

Fine adjustment of the combustion process in case of which the struggle to save 1-3% of fuel is waged is impossible without the use of modern accurate diagnostics devices Portable gas combustion analyzers allow to implement accurate measuring of the content of smoke gasses optimize the combustion mode and keep account of the boilers conditions during the operation

In order to increase the fuel combustion efficiency, we recommend to equip the boiler house with such a device

Capital Investments

The purchase of a portable multicompoment analyzer (O_2, CO, NO, t, efficiency) that is 3000 $USA is suggested for the boiler house

Capital investments amount to 17 1 million rubles (3000 $USA)

Energy Resources Saving

Estimated potential for saving is up to 2% of the fuel consumed which in the terms of natural gas consumption is

733 4 thousand m^3/year of natural gas, or 212 1 million rubles/year (37 2 thousand $USA)

Period of Capital Repayment Less than one month

5 APPENDICES

Table 1 Results of Testing Boiler DKVR- 20/13 # 4

Item	Mode Chart	Photography of the Mode
Temperature of the air on the burner °C		9
Temperature of exhaust gases from the boiler °C	250	325
O_2 content in %	2 8	12 8
CO_2 content in %	10 2	4 6
CO content in ppm		0
NO_x content in ppm		44
Ratio of air surplus behind the boiler	1 15	2 56
Losses with exhaust gases in %	11 0	28 2

Table 2 Results of Testing Boiler DKVR 20/13 # 3

Item	Mode Chart (11 2 t/h)	Photography of the Mode	Optimal Mode	Mode Chart (18 2 t/h)	Photography of the Mode	Optimal Mode
Temperature of the air on the burner °C		9	9		9	9
Temperature of exhaust gases from the boiler °C	290	305	286	345	331	317
O_2 content in %	6 8	9 0	6 9	4 2	7 0	4 5
CO_2 content in %	9 4	6 7	7 9	9 4	7 8	9 2
CO content in ppm	0	0	9	0	0	100
NO_x content in ppm		65	64			64
Ratio of air surplus behind the boiler	1 43	1 75	1 48	1 22	1 5	1 27
Losses with exhaust gases in %	14	18 9	15 4	17 2	18 0	15 0

Table 3 Results of Testing Boiler TVGM 20/13 # 2

Item	Mode Chart (11 2 t/h)	Photography of the Mode	Photography of the Mode	Optimal Mode
Temperature of the air on the burner °C		9	9	9
Temperature of exhaust gases from the boiler °C	190	135	137	135
O_2 content in %	3 2	3 7	4 7	4 0
CO_2 content in %	10 0	9 6	9 1	9 5
CO content in ppm	0	1866	2	48
NO_x content in ppm		59	76	78
Ratio of air surplus behind the boiler	1 16	1 21	1 28	1 23
Losses with exhaust gases in %	8 4	5 9	6 3	6 0

PUBLIC JOINT STOCK COMPANY
"IVELEKTRONALADKA"

153002, Ivanovo, ul Kainina, d 5, tel 37-44-26, 32-83-84, fax 32-83-84
INN 3729003630, settlement account in the Ivanovo Saving Bank of the RF MFO 42406608, correspondent account 600164908 (cor account in Ivanovo and the Ivanovo region 164508)

#	Equipment and Type of Work	Amount	Cost of one Unit	Total Cost	Completion Period
1	Technical audit and development of the working project for the computerized system for metering electric power and heat	1	24 000 000	24 000 000	2 months
2	General work Cost of equipment				
	Personal computer				
	Input board	1	5 000 000	5 000 000	
	Uninterrupted power supply	3	1 200 000	3 600 000	
	Software	1	2 000 000	2 000 000	
	TEC Energia version 5				
	DE 443	1	5 000 000	5 000 000	
	Graphics ADS	1	1 000 000	1 000 000	
	TOTAL general work	1	3 000 000	3 000 000	
				19 600 000	
3	Metering electric power				
3 1	Cost of equipment				
	Data collection device E44M1	4	1 800 000	7 200 000	
	Electric meters 3-phase	20	600 000	12 000 000	
	UFI	55	250 000	13 750 000	
	Terminal blocks SK-20			1 000 000	
	Cables (in m)				
	KVVG 4x1 5	900	400	3 600 000	
	KVVG 7x1 5	900	7000	6 300 000	
	KVVG 19x1 5	100	15 800	1 580 000	
	wire PV1x1 5	300	623	186 900	
	Cost of equipment			45 616 900	
3 2	Installation work				
	Installation of UFI in the meters				
	Meters installation				
	USD installation				
	Cable laying				
	Installation work total			30 000 000	1 month
3 3	Checkout works				
	Meters checks				
	Installation checks				
	Software tuning				
	Checkout works total			20 000 000	1 month
	TOTAL metering electric power			95 616 900	
4	Metering heat				

4 1	Cost of equipment				
	USD E443	10	2 500 000	25 000 000	
	Sapfir 22DD	26	3 500 000	91 000 000	
	Sapfir 22DI	14	2 300 000	32 200 000	
	Sapfir 22DA	3	2 500 000	7 500 000	
	Thermal resistance	25	300 000	7 500 000	
	Regulating transducer	25	800 000	20 000 000	
	Protection equipment	25	100 000	2 500 000	
	Power supply BP-36	20	800 000	16 000 000	
	Cases	2		2 000 000	
	Auxiliaries for instrumentation installation				
	Cables (in m)			5 000 000	
	KVVGe 4x1 5				
	KVVGe 19x1 5	1 100	5 644	6 208 400	
	Cable PV 1x1 5	1 400	17 120	23 968 000	
	Cost of equipment	300	623	186 900	
				239 063 300	
4 2	Installation works				
	Cases fabrication				
	Installation of USD power supply units regulating transducers secondary commutation				
	Installation of primary transducers				
	Cable laying				
	Installation works total				
				50 000 000	2 moths
4 3	Checkout work				
	Laboratory checking of primary transducers				
	USD BP SH-900 resistance thermometers				
	USD programming				
	Checking installation quality				
	Primary transducers connection				
	Software tuning				
	Checkout works total			50 000 000	1 month
	TOTAL metering heat			339 063 300	
	TOTAL			478 280 200	

Leading specialist Shevtsov V V

Table 4 Protocols for Conducting Gas Combustion Analysis with the Help of the Device FYRITE 4

BACHARACH INC
FYRITE 4 - E
****
COMBUSTION ANALYZER
REVISION - 0 5
ID BACHARACH INC
SER NO 0000000000000

TIME
DATE
TEST NO 14

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 135
AMBIENT TEMP<C> 23
% O2 4 0
% CO2 9 5
PPM CO 48
PPM CO(UNDIL) 59
PPM NO (ONVD) 78
PPM NOX(UNDIL) 95
LAMBDA 1 23
qA 6 0

TIME
DATE
TEST NO 12

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 135
AMBIENT TEMP<C> 23
% O2 3 6
% CO2 9 7
PPM CO 1129
PPM CO(UNDIL) 1354
PPM NO (ONVD) 68
PPM NOX(UNDIL) 81
LAMBDA 1 20
qA 5 9

TIME
DATE
TEST NO 13

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 135
AMBIENT TEMP<C> 22
% O2 3 5
% CO2 9 7
PPM CO 813
PPM CO(UNDIL) 975
PPM NO (ONVD) 69
PPM NOX(UNDIL) 82
LAMBDA 1 20
qA 5 8

TIME
DATE
TEST NO 11

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 135
AMBIENT TEMP<C> 22
% O2 3 7
% CO2 9 6
PPM CO 1866
PPM CO(UNDIL) 2257
PPM NO (ONVD) 59
PPM NOX(UNDIL) 71
LAMBDA 1 21
qA 5 9

TIME
DATE
TEST NO 10

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 137
AMBIENT TEMP<C> 23
% O2 4 7
% CO2 9 1
PPM CO 2
PPM CO(UNDIL) 2
PPM NO (ONVD) 76
PPM NOX(UNDIL) 97
LAMBDA 1 28
qA 6 3

TIME
DATE
TEST NO 9
mB Press 32

TIME
DATE
TEST NO 8

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 317
AMBIENT TEMP<C> 26
% O2 4 5
% CO2 9 2
PPM CO 100
PPM CO(UNDIL) 126
PPM NO (ONVD) 64
PPM NOX(UNDIL) 81
LAMBDA 1 27
qA 15 0

TIME
DATE
TEST NO 7

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 318
AMBIENT TEMP<C> 26
% O2 4 2
% CO2 9 4
PPM CO 1037
PPM CO(UNDIL) 1296
PPM NO (ONVD) 53

LAMBDA 1 25
qA 14 9

PPM NOX(UNDIL) 66

TIME
DATE
TEST NO 6

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 331
AMBIENT TEMP<C> 25
% O2 7 0
% CO2 7 8
PPM CO 0
PPM CO(UNDIL) ----
PPM NO (ONVD) 79
PPM NOX(UNDIL) 118
LAMBDA 1 50
qA 18 0

TIME
DATE
TEST NO 5

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 286
AMBIENT TEMP<C> 25
% O2 6 9
% CO2 7 9
PPM CO 9
PPM CO(UNDIL) 13
PPM NO (ONVD) 64
PPM NOX(UNDIL) 94
LAMBDA 1 48
qA 15 4

TIME
DATE
TEST NO 4

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 280
AMBIENT TEMP<C> 23
% O2 5 0
% CO2 8 9
PPM CO 2246
PPM CO(UNDIL) 2942
PPM NO (ONVD) 27
PPM NOX(UNDIL) 35
LAMBDA 1 31
qA 13 6

TIME
DATE
TEST NO 3

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 305
AMBIENT TEMP<C> 21
% O2 9 0
% CO2 6 7
PPM CO 0
PPM CO(UNDIL) ----
PPM NO (ONVD) 65
PPM NOX(UNDIL) 113
LAMBDA 1 75
qA 18 9

TIME
DATE
TEST NO 2
mB Press - 55

TIME
DATE
TEST NO 1

FUEL NGAS
PRIMARY TEMP<C> 9
STACK TEMP <C> 325
AMBIENT TEMP<C> 12
% O2 12 8
% CO2 4 6
PPM CO 0
PPM CO(UNDIL) ----
PPM NO (ONVD) 44
PPM NOX(UNDIL) 112
LAMBDA 2 56
qA 28 2

TEST PERFORMED BY

_____

COMMENTS

Table 5 Protocols for Conducting Gas Combustion Analysis with the Help of the Device FYRITE 4

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/10 16 18
Par Record
Meas Point No 1 23-04
Pipe
Outer Diameter 89,0 mm
Wall Thickness 3,5 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 65 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance -8 mm
Damping 10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 5
\DATA
-29 85
-29 05

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/10 53 37
Par Record
Meas Point No 4 23-04
Pipe
Outer Diameter 159 0 mm
Wall Thickness 4 5 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 20 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 39 mm
Damping 10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 5
\DATA
-29 14
-28 95

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/10 39 31
Par Record
Meas Point No 3 24-04
Pipe
Outer Diameter 89 0 mm
Wall Thickness 3 5 mm
Roughness 0,5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 65 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance -8 mm
Damping 10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 6
\DATA
27,22
25 93

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/11 03 29
Par Record
Meas Point No 5 23-04
Pipe
Outer Diameter 159 0 mm
Wall Thickness 4 5 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 20 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 39 mm
Damping 10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 4
\DATA
37 34
37,22

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/11 25 38
Par Record
Meas Point No 5 23-04
Pipe
Outer Diameter 314 0 mm
Wall Thickness 7 0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 90 C Trancducer Type
M02-018
Sound Way Reflection
Transd Distance 161 mm Damping
10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 1
\DATA
37 5

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/11 37 18
Par Record
Meas Point No 6 23-04
Pipe
Outer Diameter 314 0 mm
Wall Thickness 7 0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 90 C Trancducer Type
M02-018
Sound Way Reflection
Transd Distance 161 mm Damping
10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 7
\DATA
-290,86
-290,09

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/11 40 51
Par Record
Meas Point No 7 23-04
Pipe
Outer Diameter 314 0 mm
Wall Thickness 7 0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 90 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 161 mm
Damping 10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 5
\DATA
-290,35
-290 86

\DEVICE ADM6402-00000250
\MODE STORED
\START 23 04 97/11 52 06
Par Record
Meas Point No 8 23-04
Pipe
Outer Diameter 214,0 mm
Wall Thickness 7 0 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 20 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 79 mm
Damping 10 s
Storage Rate 00 00 10 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 3
\DATA
-43,66
-43,54

```
\DEVICE                    ADM6402-00000250
\MODE                      STORED
\START                     23 04 97/12 13 56
Par Record
Meas  Point No    9 23-04
Pipe
 Outer Diameter      314 0 mm
 Wall Thickness            7 0 mm
 Roughness                         1 0 mm
 Pipe Material             Steel Normal
lining                     WITHOUT LINING
Medium                     Water
 Medium Temperat           70 C
Trancducer Type   M02-018
Sound Way                  Reflection
Transd  Distance            162 mm
Damping                           10 s
Storage Rate               00 00 05  s
Physic  Quant              Mass Flow
Unit Of Measure   [t/h]
Numb Of Meas Val             14
\DATA
      -530,31          61 0            42,8
      -532,09          61 0            42 9
```

```
\DEVICE                    ADM6402-00000250
\MODE                      STORED
\START                       23 04 97/12 16 37
Par Record
Meas  Point No            10 23-04
Pipe
 Outer Diameter            314 0 mm
 Wall Thickness             7 0 mm
 Roughness                         1 0 mm
 Pipe Material             Steel Normal
lining                     WITHOUT LINING
Medium                     Water
 Medium Temperat             70 C
Trancducer Type   M02-018
Sound Way                  Reflection
Transd  Distance            162 mm
Damping                           10 s
Storage Rate               00 00 05  s
Physic  Quant              Mass Flow
Unit Of Measure   [t/h]
Numb Of Meas Val             21
\DATA
      484,76           62,1            37 8
      485 02           62 1            37 6
-----------------------------
END OF TRANSMIS            23 04 97/12 54 08
```

```
\DEVICE          ADM6402-00000250
\MODE            STORED
\START           24 04 97/09 37 47
Par Record
Meas  Point No    1 24-04
Pipe
 Outer Diameter      520,0 mm
 Wall Thickness       10 0 mm
 Roughness            1,0 mm
 Pipe Material    Steel Normal
lining          WITHOUT LINING
Medium          Water
 Medium Temperat        70 C
Trancducer Type   M02-018
Sound Way        Reflection
Transd  Distance      316 mm
Damping               10 s
Storage Rate     00 00 05  s
Physic  Quant    Mass Flow
Unit Of Measure   [t/h]
Numb Of Meas Val        13
\DATA
 1068 06
 1071 60
```

```
\DEVICE          ADM6402-00000250
\MODE            STORED
\START           24 04 97/09 44 28
Par Record
Meas  Point No    2 24-04
Pipe
 Outer Diameter      520 0 mm
 Wall Thickness       10 0 mm
 Roughness            1,0 mm
 Pipe Material    Steel Normal
lining          WITHOUT LINING
Medium          Water
 Medium Temperat        70 C
Trancducer Type   M02-018
Sound Way        Reflection
Transd  Distance      316 mm
Damping               10 s
Storage Rate     00 00 05  s
Physic  Quant    Mass Flow
Unit Of Measure   [t/h]
Numb Of Meas Val        39
\DATA
 -996,67
 -995,26
```

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/09 54 55
Par Record
Meas Point No 2 24-04
Pipe
Outer Diameter 520,0 mm
Wall Thickness 10,0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 70 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 316 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 19
\DATA
1059 58
1060,99

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/10 02 27
Par Record
Meas Point No 3 24-04
Pipe
Outer Diameter 89 0 mm
Wall Thickness 3,5 mm
Roughness 0,5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 70 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance -7 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 10
\DATA
17 07
17,09

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/10 22 30
Par Record
Meas Point No
Pipe
Outer Diameter 89 0 mm
Wall Thickness 3 5 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 70 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance -7 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 12
\DATA
-22 13
-22 40

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/10 33 51
Par Record
Meas Point No 4 24-04
Pipe
Outer Diameter 210 0 mm
Wall Thickness 5 0 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 20 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 75 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 15
\DATA
26,35
26 58

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/10 47 22
Par Record
Meas Point No 5 24-04
Pipe
Outer Diameter 58 0 mm
Wall Thickness 4 0 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 20 C
Trancducer Type M02-018
Sound Way Face-To-Face
Transd Distance 20 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 35
\DATA
-0,90
-0 78

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/14 00 10
Par Record
Meas Point No 7 24-04
Pipe
Outer Diameter 89,0 mm
Wall Thickness 4 0 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 70 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance -7 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 11
\DATA
29 63
29 42

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/13 58 28
Par Record
Meas Point No 6 24-04
Pipe
Outer Diameter 89,0 mm
Wall Thickness 4 0 mm
Roughness 0,5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 70 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance -7 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 9
\DATA
-28 94
-28 66

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/14 11 58
Par Record
Meas Point No 8 24-04
Pipe
Outer Diameter 160,0 mm
Wall Thickness 5 0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 50 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 45 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 9
\DATA
-73 67
-73 41

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/14 13 23
Par Record
Meas Point No 9 24-04
Pipe
Outer Diameter 160 0 mm
Wall Thickness 5 0 mm
Roughness 1,0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 50 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 45 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 10
\DATA
72 91
72 84

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/14 33 31
Par Record
Meas Point No 11 24-04
Pipe
Outer Diameter 219 0 mm
Wall Thickness 8 0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 60 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 91 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 20
\DATA
-156,95
-156 60

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/14 23 58
Par Record
Meas Point No 10 24-04
Pipe
Outer Diameter 219 0 mm
Wall Thickness 8 0 mm
Roughness 1 0 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 60 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 91 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 12
\DATA
104 63
104 98

\DEVICE ADM6402-00000250
\MODE STORED
\START 24 04 97/14 44 19
Par Record
Meas Point No 12 24-04
Pipe
Outer Diameter 159 0 mm
Wall Thickness 4 0 mm
Roughness 0 5 mm
Pipe Material Steel Normal
lining WITHOUT LINING
Medium Water
Medium Temperat 20 C
Trancducer Type M02-018
Sound Way Reflection
Transd Distance 38 mm
Damping 10 s
Storage Rate 00 00 05 s
Physic Quant Mass Flow
Unit Of Measure [t/h]
Numb Of Meas Val 9
\DATA
-24 30
-24,43

```
\DEVICE          ADM6402-00000250
\MODE            STORED
\START           24 04 97/14 47 37
Par Record
Meas  Point No     12 24-04
Pipe
 Outer Diameter       159 0 mm
 Wall Thickness         4 0 mm
 Roughness              0 5 mm
 Pipe Material     Steel Normal
lining           WITHOUT LINING
Medium           Water
 Medium Temperat        20 C
Trancducer Type    M02-018
Sound Way          Reflection
Transd  Distance        38 mm
Damping                 10 s
Storage Rate       00 00 05  s
Physic  Quant      Mass Flow
Unit Of Measure    [t/h]
Numb Of Meas Val         6
\DATA
  -22 69
  -22 50
----------------------------------
END OF TRANSMIS    24 04 97/15 18 44
```