PN. ACD-428

ENERGY AUDIT

# ZVEZDA PUBLISHING AND PRINTING COMPANY

## Perm Oblast
## RUSSIA

*Prepared for*

US AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D C 20253

*Prepared by*

**Hagler Bailly Services, Inc**
1530 Wilson Boulevard, Suite 900
Arlington, VA 22209-2406
(703) 351-0300

and

**East West Energy Agency**
Moscow, Russia

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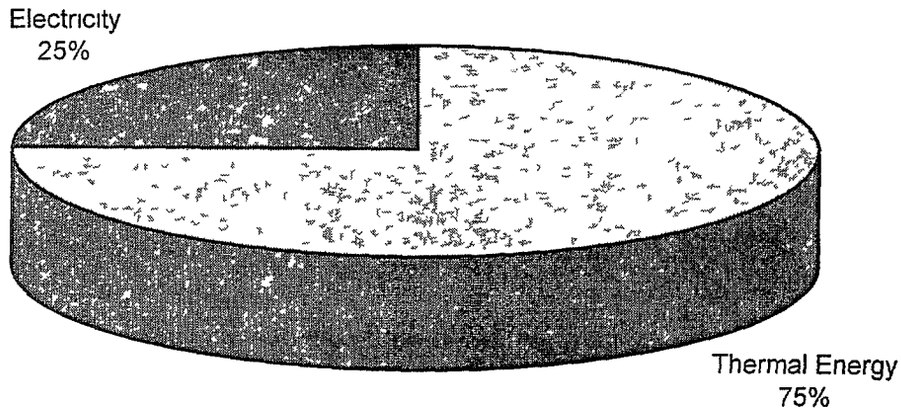
## 1 Executive Summary

This report presents the results of the energy audit carried out at the State Unitary Enterprise "Zvezda Publishing and Printing Company" (PPC) in March- May 1998 The work was done in close contact with the management of the energy department and the operating personnel of the company Experts from the energy efficiency laboratory of AO Permenergo and the technical laboratory of the Gosenergonadzor enterprise made an important contribution to this work

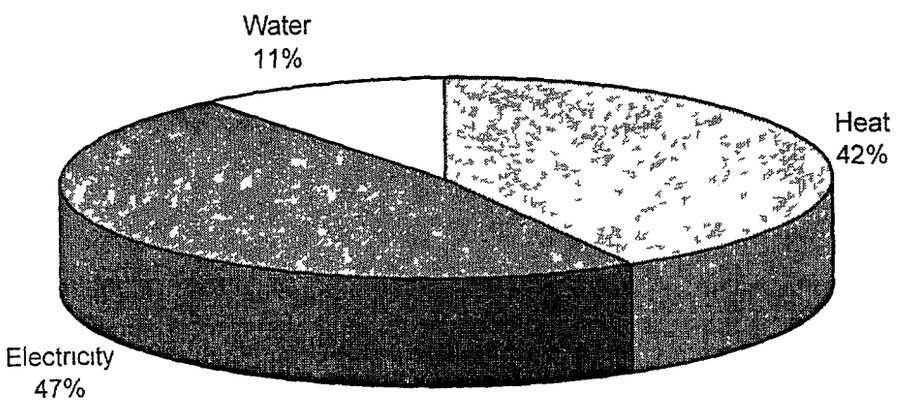
A graphic representation of the general structure of energy consumption by the Zvezda PPC is given in Diagram 1 1, where the quantity of different energy resources consumed is expressed as the power equivalent The input data were the data on energy consumption in1997 The Diagram shows that the Zvezda PPC uses just two types of energy resources heat and electricity

**Diagram 1 1 Energy Consumption Structure**



Along with the energy consumption structure, it is very important to know the structure of payments for energy resources Diagram 1 2 shows Zvezda's energy payment structure, where fuel oil accounts for the majority of payments Payments for thermal energy make up 42% and for water supply – about 11% (including water consumption and disposal)

**Diagram 1 2 Energy Payment Structure**



Based on the results on the energy audit, the following energy efficiency measures can be recommended

**Table 1 Energy Efficiency Measures**

| № | Description | Energy Savings | | Project Costs, rubles | Payback Period, months |
|---|---|---|---|---|---|
| | | GJ | ths rubles ($US) | | |
| No-cost and low-cost measures | | | | | |
| 1 | Elimination of the inefficient use of the lighting equipment | 28 8 | 2,160 (350) | 0 | 0 |
| 2 | Replacement of the HWS pump | 67 5 | 5,100 (835) | 3,000 (490) | 7 |
| 3 | Insulation of pipes in the heating and HWS systems | 3,710 | 137,828 (22,595) | 6,920 (1,135) | 1 |
| High-cost measures | | | | | |
| 4 | Installation of hot water boilers | -- | 650,000 (106,560) | 600,000 (98,360) | 11 |
| **TOTAL** | | **3,806 3** | **795,088 (130,342)** | **609,920 (99,987)** | **10** |

The numbers in the TOTAL row reflect the general effect of the implementation of all the measures

The proposed measures make it possible to decrease the total amount of energy consumed in 1997 by 12 4% and to reduce payments for energy resources and water by 44% The proposed substantial reduction in payments for energy resources will result from the installation of two gas-fired hot water boilers on the territory of the enterprise

Upon implementation of the proposed energy efficiency measures, the enterprise will still have much potential for energy saving Primarily, this has to do with the organization of efficient work of energy-using equipment, including lighting and technological equipment

## 2 Introduction

The energy audit was carried out by a group of engineers of the East-West Energy Agency in Moscow as part of the project "Energy Efficiency and Market Reform Project for Russia"(Contract # CCN-0020-C-00-152-00) The purpose of this project was to analyze the use of energy resources by the company and their cost, to identify places of inefficient use and to develop a set of energy-saving measures

During its visit to the company, the group obtained a great amount of information on the power and technological equipment, operating conditions of the equipment, the state of the power supply distribution systems, etc These data were systematized to be presented in this report

The data were collected by means of direct measurements, for example, capacities of power-consuming equipment, and also by means of calculations based on design plans and specifications and on information supplied by the operating personnel For direct measurements, up-to-date portable instruments of western manufacture were used The collected data were processed with the help of spreadsheets, which make data processing very fast and provide a graphic representation of results

## 3 Description of the Enterprise and the Technological Process

### 3 1 General Description of the Enterprise

The state unitary enterprise "Zvezda Publishing and Printing Company" is located in the city of Perm and is one of the city's leading book and newspaper producers The company was established in 1922

Besides the central territory where the main technological lines are located, the enterprise also has premises in another part of the city the central warehouse and the cardboard shop, which has not functioned since October 1997

The company owns a kindergarten and a children's summer camp

The types of products and monthly outputs in 1997 are given in Attachment 1

Table 3 1 1 demonstrates changes in annual output and payroll in 1994 – 1997

**Table 3 1 1 General Data**

| № | Name | Unit of Measurement | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|
| 1 | Volume of services | million rubles | 7453 0 | 16303 1 | 21038 6 | 25913 1 |
| 2<br>2 1 | Output, including<br>Main products<br>Newspapers<br>Cased books<br>Paperback books | <br><br>ths 4-page copies<br>ths copies<br>ths copies | <br><br>135600<br>4022 3<br>1646 3 | <br><br>113899<br>1344 7<br>1441 5 | <br><br>111538<br>566 5<br>2136 8 | <br><br>144121 3<br>1426 3<br>624 2 |
| 2 2 | Additional products<br>Graphics<br>Labels<br>Miscellaneous | <br>ths prints<br>ths prints<br>ths prints | <br>5235 1<br>15794 4<br>2284 8 | <br>3568 2<br>11220 3<br>1328 0 | <br>9289 9<br>3143 6<br>779 4 | <br>6430 6<br>5795 4<br>701 1 |
| 3 | Payroll | men | 697 | 619 | 567 | 505 |

The table shows a considerable decline in the output of all the products, except for newspapers and graphics, as compared with 1994 This is caused by a number of reasons, particularly by stronger competition at the printing market, which stems from the fast development of small printing houses The Zvezda PPC is a large enterprise designed for serial production of large sheet size publications with wide circulation In the present situation, when the number of publications grows but their circulation falls, Zvezda's small-circulation publications cost a little more than similar publications by small printing houses

In recent years the company switched over from the labor-consuming and obsolete letterpress printing to the modern method of offset printing, which improved the quality of printing and substantially reduced the cost of products

Table 3 1 2 demonstrates the product cost structure for 1997

**Table 3 1 2 Product Cost Structure by Cost Element**

| № | Cost Elements | Share, % |
|---|---|---|
| 1 | **Material costs, including** | **32 4** |
| | Raw materials | 20 7 |
| | Heat | 5 3 |
| | Electricity | 6 4 |
| | Water | 1 0 |
| 2 | **Labor costs** | **40 3** |
| 3 | **Deductions for social needs** | **15 5** |
| 4 | **Depreciation costs** | **6 0** |
| 5 | **Other expenses** | **5 7** |
| | **TOTAL** | **100** |

## 3 2 Description of Production

### 3 2 1 Description of the Enterprise's Shops

The chart of the enterprise (see Figure 3 2 1) shows the layout of the production premises, the transformer substations (TS), the compressor houses and the central heating station (CHS)

**Figure 3 2 1 Chart of the Enterprise**

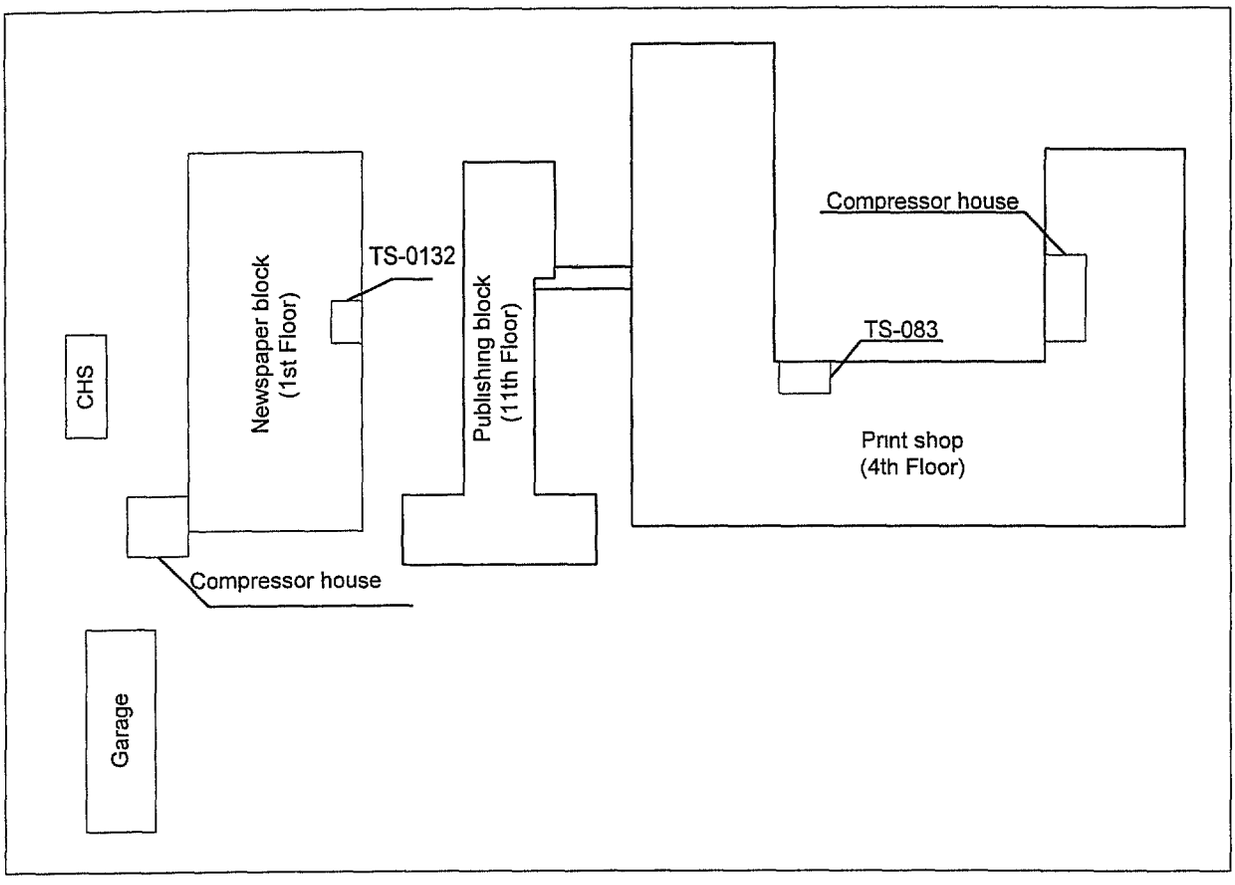



Table 3 2 1 indicates the area of the enterprise's main buildings

**Table 3 2 1 Area of the Enterprise's Main Departments**

| № | Departments | Area, $m^2$ |
|---|---|---|
| 1 | Print shop | 16,339 |
| 2 | Publishing block | 5,987 |
| 3 | Newspaper block | 6,505 |
| 4 | Underground garage | 2,412 |

The main technological equipment is concentrated in two buildings the newspaper shop and the print shop

On the ground floor of the print shop there is a paper preparation section, a maintenance and machine shop and a secondary materials shop On the first floor there is an offset

printing shop, on the second floor – a bookbinding shop, on the third floor – a composing room, and on the fourth floor – an offset shop

In the publishing block, newspapers' editorial offices, administrative offices and service rooms are located

In the newspaper shop, computer make-up is done and newspapers are printed

All the shops, except for the newspaper shop, operate in one shift – from $8^{00}$ to $15^{30}$ The newspaper shop operates 24 hours a day the maintenance teams work the first shift, while the second and third shifts do printing preparation work and print newspapers Printing takes place at night, approximately from $20^{00}$ to $8^{00}$, depending on the size of an order

Table 3 2 2 demonstrates the use factor of the enterprise's production capacities, characterizing the operating conditions of each of the shops in 1997

**Table 3 2 2 Use of Production Capacities in 1997**

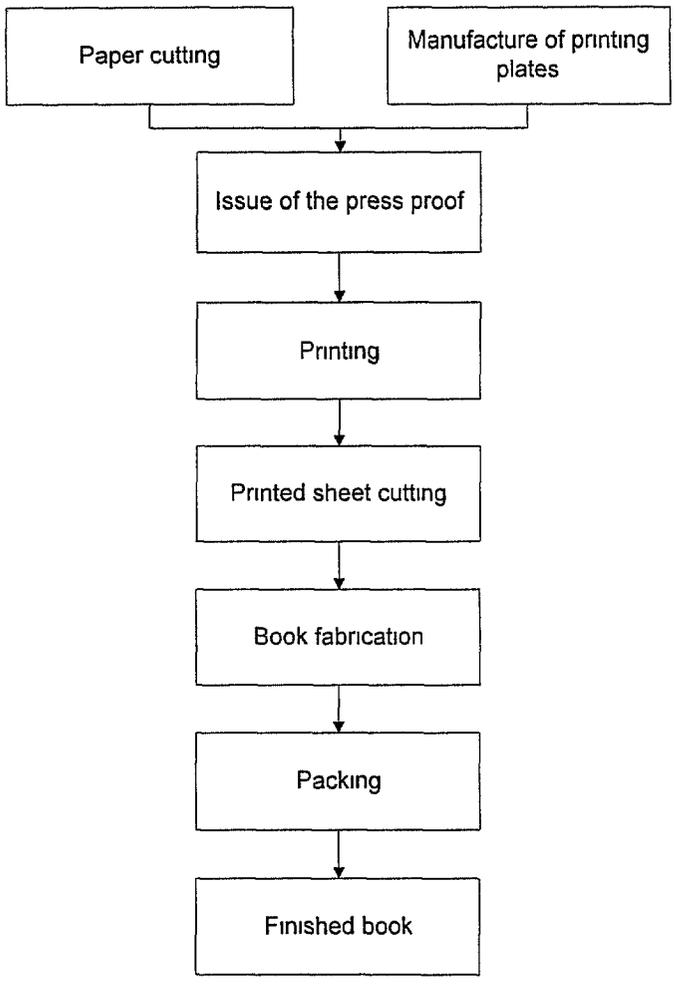
| № | Name of Equipment | Capacity, million prints | Output, million prints | Use Factor |
|---|---|---|---|---|
| 1 | Relief printing – total | 38,0 | 1,8 | 4,7 |
| | including roll rotaries | 25,4 | 0,0 | 0,0 |
| | flat-bed printing machines | 12,6 | 1,8 | 14,3 |
| 2 | Offset printing | 108,6 | 89,5 | 82,4 |
| 3 | POG-168 newspaper rotaries | 149,5 | 143,6 | 96,1 |
| 4 | POG-60 newspaper rotaries | 6,3 | 2,8 | 44,4 |
| | **TOTAL** | 302,4 | 237,7 | 78,6 |

### 3 2 2 Description of the Technological Process

The materials used at the enterprise include paper of different grades and various materials for printing paint, glue, binder board, etc

Figure 3 2 2 presents a simplified diagram of the book production technological process

**Figure 3 2 2 Technological Process Diagram**




The enterprise uses computer-based newspaper composition and make-up

Energy-using equipment is used at all the stages of the technological process Since the load curve of the entire enterprise is mainly determined by the load of the technological equipment, Attachment III provides a list of main equipment by department

At the book production stage and in the newspaper presses, compressed air is used

Compressed air is also used for blasting and cleaning the technological equipment in different sections

Water consumption for technological needs is quite small Water is used for paper moistening

The bookbinding shop has a one-pump vacuum processing system with a 7 5-kW drive The system is sectionalized, i e if one of the vacuum-using lines is idle, the corresponding section of the vacuum pipes can be disconnected from the main line in order to avoid losses

The enterprise has an energy-intensive pneumatic transport system that services the bookbinding, offset and printing shops The purpose of the system is to remove paper trimmings that result from the cutting machines' operation The system consists of 4 sections that service different technological lines and machines Each section has its own 15-kW fans (see the Attachment III) The fans are switched on and off manually from the control desk located in the secondary materials shop

## 4 Characteristics of Energy Consumption by the Enterprise

### 4 1 Description of Equipment and Operating Conditions of the Energy Using Systems

*Power Supply System*

Power to the buildings on the main grounds of the PPC is supplied through two transformer substations (TS) TS-083 located in the print shop and TS-0132 located in the newspaper block

Two 630-kVA transformers are installed at TS-083, and TS-0132 has two 560-kVA transformers Each substation is powered from one transformer, whereas the other is in the energized stand-by mode

The substations are equipped with reactive power compensation units TS-083 has three capacitors with a total capacity of 345 kVAr One of the units (144 kVAr) has an automatic switching device Reactive power is controlled manually by switching on or off stages of the capacitor banks The operating personnel of TS-083 switch on the capacitors at the beginning of a shift and switch them off at the end

The capacitors at the TS-0132 have a total capacity of 43 kVAr The unit operates 24 hours a day

The TS-083 supplies power to the print shop The other facilities – the newspaper shop, the publishing block, the CHS and the garage - are powered from TS-0132

For metering active and reactive power, at the transformer substations there are electricity meters SA4U-I672M and SR4U-I673M Because of different electricity rates, the enterprise keeps separate accounting of power consumption by the canteen and by the electric boiler for hot water preparation (which is used in the summertime for hot water supply) according to the CA4U-I672M meters

Electricity consumed by the subcustomers – the children's summer camp, the kindergarten and others – is measured with the installed meters

*Lighting*

The shops are lighted with different types of lamps The following lamps are used in the production shops LB-40, LB-20, LDT-40 and LDT-80 There are no incandescent lamps at the enterprise Table 4 1 shows the total capacity of the installed lighting fixtures by department

**Table 4 1 1 Installed Lighting Load of the Departments**

| № | Department | Lamp Type | Capacity, kW |
|---|---|---|---|
| 1 | Recycled material shop | NSP-60, NSP-200, DRL-250 | 4 09 |
| 2 | Offset shop | LB-40, LB-80 | 47 2 |
| 3 | Bookbinding department | LB-40, LB-80 | 20 0 |
| 4 | Composing room | LB-40, LB-80 | 34 8 |
| 5 | Newspaper shop | LB-40, LB-80 | 39 86 |
| 6 | Underground garage | LB-40, LB-80 | 4 8 |
| 7 | Publishing block | LB-40, LB-80 | ≈ 100* |
| | **TOTAL** | | ≈ 250 |

* - Since the data were not available, the number was obtained through analysis of consumed capacity

The general lighting system in the shops is sectionalized by row Most of the machines have individual lighting

*Air Supply System*

The technological lines in the offset, bookbinding and newspaper shops use compressed air The enterprise has two compressor houses located in the offset and newspaper shops The air supply system of the newspaper is connected with the air supply system of the print shop by means of an air duct In normal operations, the link is not used

Table 4 1 2 gives a list of the installed air compressors

**Table 4 1 2 List of Air Compressors**

| | Compressor Type | Installa-tion | No of units | Capacity, $m^3$/min | Pressure, kgs/$cm^2$ | Drive Capacity, kW | Cooling System |
|---|---|---|---|---|---|---|---|
| *Compressor house of the print shop* | | | | | | | |
| 1 | 4V-U1-5/9M2 | 1985 | 1 | 5 0 | 9 | 37 | air |
| 2 | KSE-5M | 1979 | 1 | 5 0 | 8 | 40 | air |
| 3 | 1-VV-10/8 | 1965 | 1 | 10 0 | 8 | 50 | water |
| *Compressor house of the newspaper block* | | | | | | | |
| 1 | S416-UHL-4,2 | 1991 | 1 | 1 0 | 8 | 10 | air |
| 2 | 155-2 | 1970 | 1 | 1 0 | 4 | 1,5 | air |
| 3 | E-3500 | 1965 | 1 | 1 75 | 9 | 22 | air |

At the outlet of the print shop's compressor house there are 3 receivers, 7 $m^3$ each Air pressure in the system is 5-6 5 atm When the pressure becomes higher, a relief valve shuts Only one compressor of the C416-UHL-4 2 type has an automatic switch that responds to pressure in the air supply system When the POG newspaper press is in operation, either the C416-UHL-4 2 or the E-3500 compressor is switched on

In normal operating conditions, the print shop's air demand is met by the 4B-U1-5/9M2 compressor alone The compressor is switched on at the beginning of a shift and switched off at the end

*Ventilation System*

Since the technological processes at printing plants require very good ventilation, the enterprise's shops have a powerful system of exhaust and forced ventilation

The exhaust ventilation system consists of about 250 fans The ventilation system is switched on and off at the beginning and at the end of a shift accordingly

It should be mentioned that the introduction of the computer technology at the enterprise has eliminated the need for a great amount of ventilation equipment

The ventilation system in the newspaper shop operates in three shifts

The forced ventilation system is adjusted to the temperature of the air coming out of the air heaters

*Heat Supply System Heating, Ventilation and Hot Water Supply (HWS)*

Heat is supplied from the heat-supply system to the central heating station (CHS) where there is an electromagnetic heat recorder complete with electromagnetic flow meters (Eris VT-100) installed on the straight and return lines and with a energy controller (IM-2300)

Since the heat recorder was installed in September 1996, heat costs have decreased by nearly 50%

Heat is used for heating, ventilation and hot water supply Boilers for warming up heating-system water are installed in the CHS, which is located in a separate building on the main grounds of the enterprise

To ensure water circulation, the system has two K90/55 pumps, which, as a rule, operate simultaneously The water flow rate is 90 m3/hour, head – 55 m, the drive's capacity – 15 kW

There is no individual heating load control in separate buildings or rooms, which diminishes the effectiveness of quality control at the boiler

Water is fed to the air heaters of the forced ventilation system from the heating circuit

In the summertime, heat is used only for the HWS purposes

Water for the HWS system is supplied from the city water pipelines with cold water intake pumps From the pump, a portion of cold water for the HWS system goes to the HWS boiler and then to the customer The boilers do not have automatic controls

*Water Supply*

The enterprise takes city water for its needs with a K-45/30 pump that ensures the required head to supply water to the multi-storey building of the publishing block The water flow rate is 45 $m^3$/hour, head – 30 m, the drive's capacity – 11 kW There are no automatic controls The operating personnel switch on the pump at the beginning of a shift and switch it off at the end

Payments to the water supplying organization are effected according to the meter readings Waste is piped by gravity

## 4 2 Analysis of Energy Consumption and Costs

The Zvezda PPC uses thermal energy, electricity and water

Table 4 2 1 demonstrates changes in energy consumption by the enterprise in 1994-1997

**Table 4 2 1 Energy Consumption in 1994 – 1997**

| Energy Sourcec | Units of Measurement | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|
| Heat | Gcal | No data | No data | 10,479 | 5,754 |
| Electricity | MWh | 3 091 | 2 519 | 2 723 | 3 288 |
| City water | $m^3$ | No data | No data | 33920 | 32191 |

The considerable decline in thermal energy consumption in 1997 results from the installation of a heat recorder at the CHS

The table in Attachment II provides data on energy consumption by the shops in 1997 by month

Bar chart 4 2 1 demonstrates energy consumption related to output in 1997 Energy consumption and output are expressed in conventional units, as against January 1997

**Bar Chart 4 2 1 Energy Consumption Related to Output in 1997**

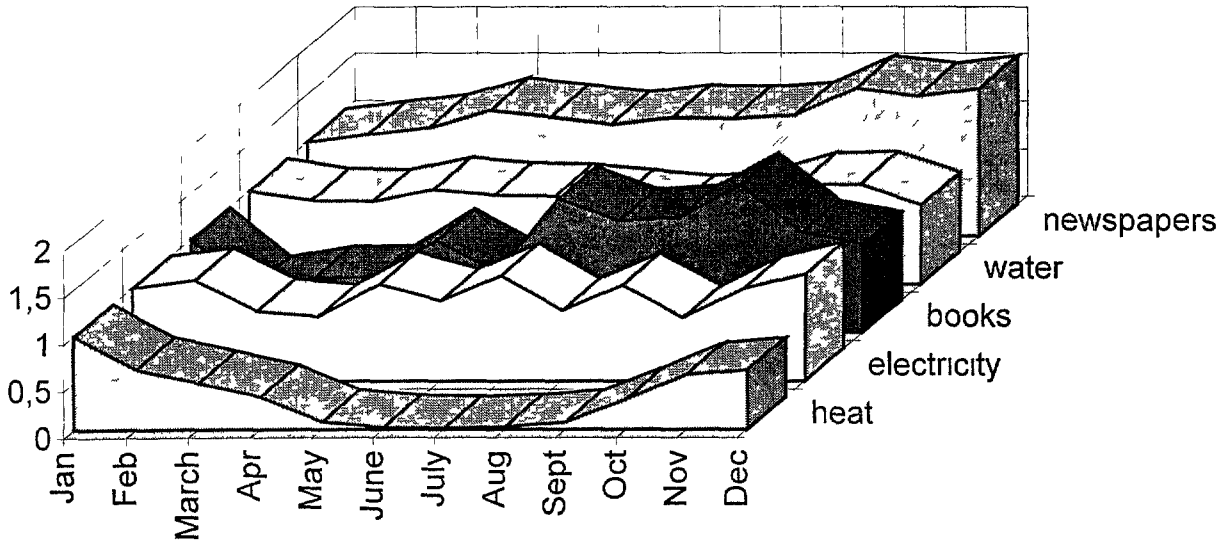



Table 4 2 2 below shows the old tariffs for energy resources that were effective in 1997 and the new tariffs that took effect in March 1998 The analysis of the energy efficiency measures' effectiveness is based on the new rates

**Table 4 2 2 Energy Resource Tariffs in 1997-1998**

| № | Energy Source | Unit | Tariff, rubles | |
|---|---|---|---|---|
| | | | 1997 | From 03 01 1998 |
| 1 | Electricity<br>basic rate<br>additional rate | <br>kW<br>kWh | <br>66<br>0 192 | <br>69,1<br>0,2703 |
| 2 | Heat | Gcal | 137 | 155 65 |
| 3 | City water<br>consumption<br>discharge | <br>$m^3$<br>$m^3$ | <br>3 96<br>2 324 | <br>3 96<br>2 32 |

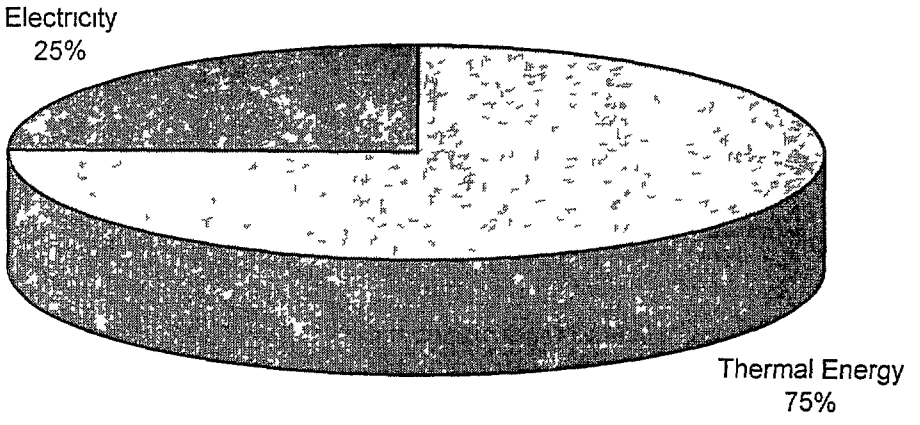
Table 4 2 3 provides data on the total energy consumption in 1997 expressed in the power equivalent units

**Table 4 2 3 Energy Consumption and Payments in 1997**

| Energy Source | Unit | Consumption | Energy | | Cost | |
|---|---|---|---|---|---|---|
| | | | GJ | % | ths rubles | % |
| Heat | Gcal | 5,485 | 22,964 6 | 75 2 | 751 45 | 41 8 |
| Electricity | MWh | 2101,7 | 7,566 1 | 24 8 | 853 9 | 47 6 |
| City water | ths $m^3$ | 32,191 | -- | -- | 190 2 | 10 6 |
| Total | | | 30,530 7 | 100 | 1,795 6 | 100 |

Diagrams 4 1 and 4 2 below demonstrate the structure of energy consumption expressed in the power equivalent and the structure of payments for energy resources used by the main facilities of the enterprise

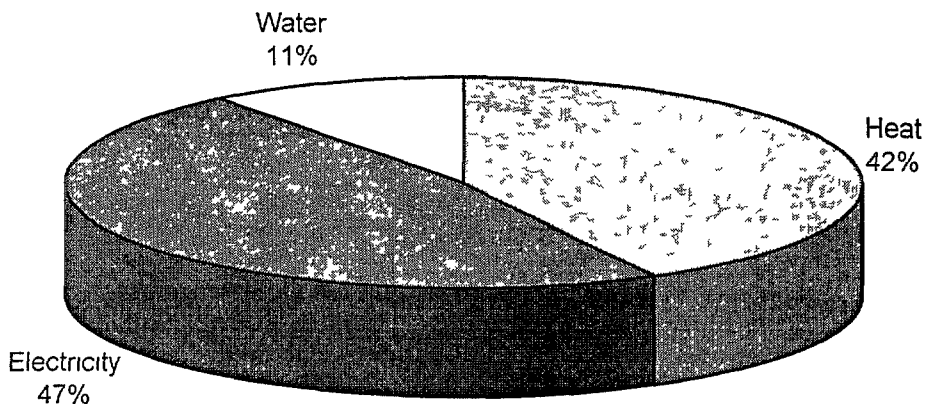
**Diagram 4 1 Energy Consumption Structure**




As the diagram shows, electricity accounts for 62% of the payments for energy resources According to its agreement with the power supplier – Permenergo, the enterprise pays for electricity at a two-part tariff The Permenergo personnel estimate monthly declared capacity on the basis of the enterprise's electricity consumption according to the existing methodology Payments for reactive power consumed are charged when the established quota is exceeded Along with the above payments, the Zvezda PPC pays for losses in the high-voltage transmission line and in the transformers owned by the enterprise

Diagram 4 2 represents the structure of payments for electricity

**Diagram 4 2 Energy Payment Structure**




The main load at the enterprise is the lighting equipment

Thermal energy accounts for nearly 42% of the payments for energy resources The enterprise uses heat for heating, HWS and ventilation

Water accounts for a small portion of the payments (11%) The reason is that no water is used for technological needs

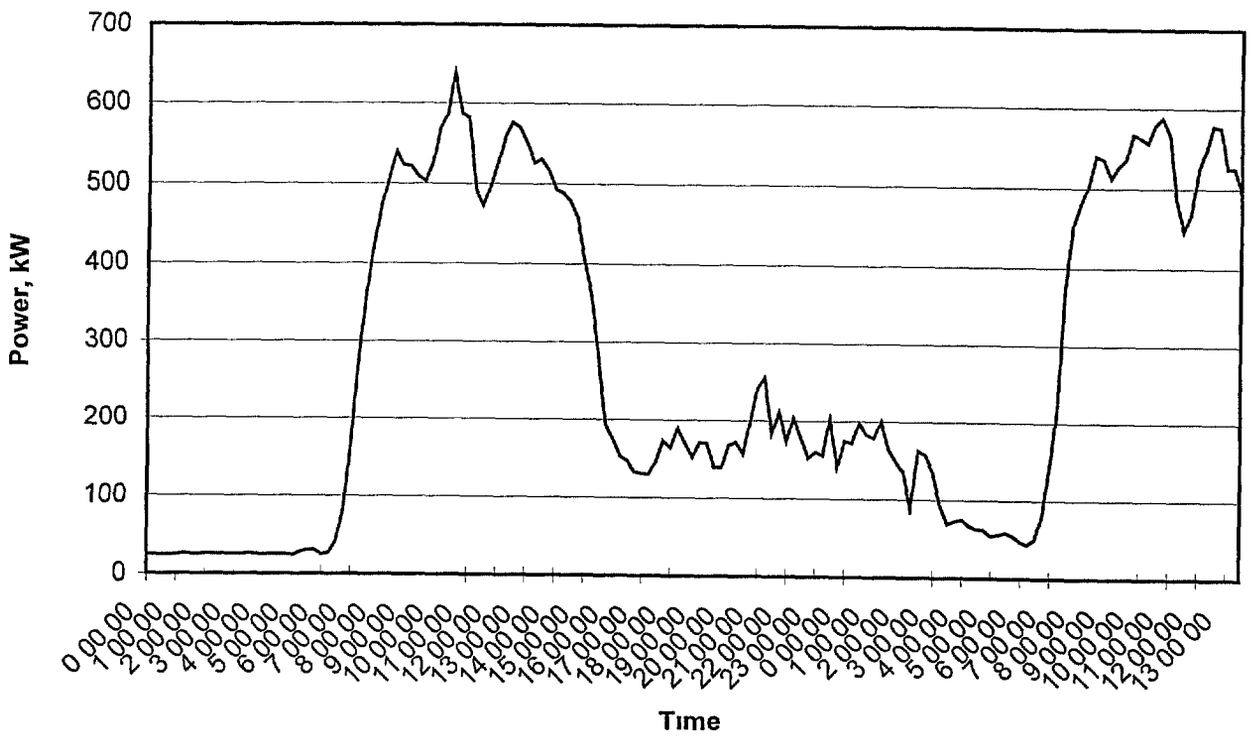
## 5 Energy Efficiency Measures

### 5 1 Results of Measurements Taken at the Enterprise

In the analysis of power consumption, power recorders, Energy and Elite, and a Fluke multi-meter were used For the purposes of the energy audit, power recorders were set on the two electricity meters Additionally, in order to obtain a daily load curve, analogous instruments were installed at the feeder of the lighting and ventilation loads in the print shop, at the feeder of the loads in the publishing block and the POG168 newspaper presses as the largest loads in the newspaper shop The obtained load curves are given in Attachment IV Parallel to the recording of the load curve with the Energy and Elite loggers, once-only measurements of power consumed were taken at the majority of the functioning loads in order to put together an energy balance of the enterprise

Figure 5 1 1 demonstrates the enterprise's load curve on May 18-19, 1998, which was obtained by adding up power consumption at both transformer substations The separate load curve of each TS are shown in Attachment IV

**Figure 5 1 1 Aggregate Load Curve on May 18-19, 1998**




Based on the measurement results, an energy consumption balance of the enterprise was put together Please not that the measurements were taken when the heating season was

over and the forced ventilation system and the heating system pumps were not functioning

Table 5 1 1 Energy Balance

| № | Load | Electricity Consumption,% |
|---|---|---|
| 1 | **Lighting** | 43 6 |
| | Print shop | 18 |
| | Publishing block | 12 9 |
| | Newspaper block | 7 8 |
| | Garage | 4 9 |
| 2 | **Heat Supply, including** | 2 5 |
| | Hot and cold water supply pump | 2 5 |
| 4 | **Technology, including** | 27 |
| | Offset shop | 13 5 |
| | Newspaper shop | 4 9 |
| | Bookbinding department | 6 2 |
| | Maintenance shop | 1 2 |
| | Composing room | 1 2 |
| 5 | **Ventilation** | 2 5 |
| 6 | **Air Supply** | 6 3 |
| 7 | **Outside loads and losses** | 1 7 |
| | **TOTAL** | 83 6 |

*Air Supply System*

During the energy audit, an experiment was held to identify leakage in the compressed air distribution system of the print shop At the end of a working shift, when all the compressed air services stopped functioning, a pressure of 6 5 atm was applied in the system During the control time period, the pressure in the system was falling After that, the compressors were started, and the pressure in the system was restored According to the compressors' working time, the volume of leakage in the control time period was determined During the experiment, the entire compressed air system was examined (the gate valves of the separate divisions were open – these are the operating conditions of the first shift)

Date 15 April 1998
Time $15^{40}$

| # | Section of the system | Control time, min | Pressure fall in the system atm | Working time of the compressors min | Leakage | |
|---|---|---|---|---|---|---|
| | | | | | $m^3$ | %* |
| 1 | Entire system (the first shift) | 4 | 2 1 | 2 33 | 11 65 | 33 7 |

*- Leakage in per cent was calculated in the following way
the ratio of the leakage in $m^3$ (11 65) to the total amount of air consumed during the experiment time (6 33 min) at the rated capacity of the compressor ($5m^3$/min)

During the visual examination of the compressed air distribution system, leakage was detected in the locking fittings of the air ducts and of the end-use services connected to the system

The air temperature in the discharge line is 120°C

*Heating System*

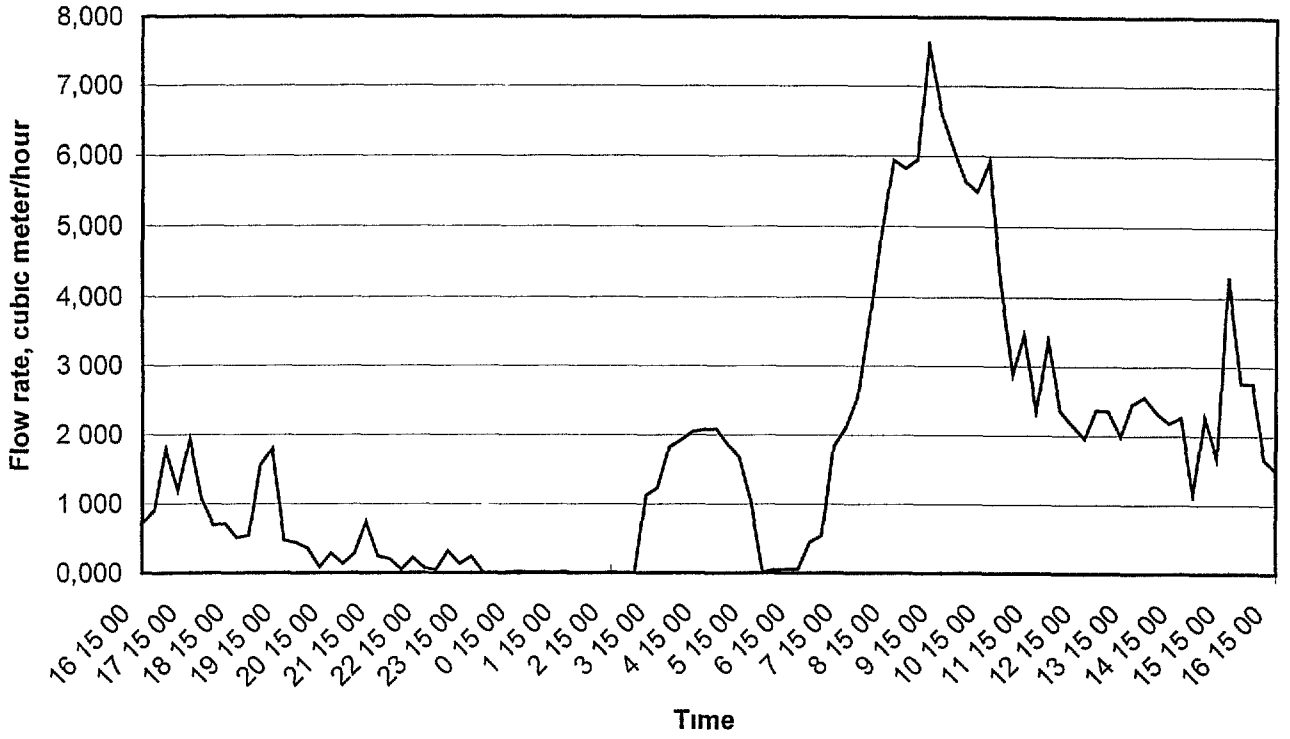
The visual examination and the measurements taken showed the absence of insulation coating on large sections of the heating and hot water pipes The total length of the un-insulated pipes is about 1170 meters, which leads to substantial heat losses The data on the location, diameters and temperature of the naked sections of the pipes are given in Attachment VI

At the time of the energy audit, the heating system was switched off because the heating season was over

*Hot Water Supply (HWS) System*

In order to identify the daily water consumption profile, a Panametrics ultrasonic flow meter was used Figure 5 1 3 demonstrates a daily water consumption curve

Figure 5 1 3 Water Discharge for HWS Needs on May 18-19, 1998




Daily water discharge was about 41m$^3$
During the measurement period, the readings of the cold water meter were registered
Daily cold water consumption was 101m$^3$

**5 2 Possible Energy-Saving Measures**

The survey and instrumental measurements have revealed possibilities for improving energy efficiency at the enterprise

*Lighting System*

The main electric loads at the enterprise are the lighting fixtures Better control and a system of measures to eliminate the non-efficient use of the lighting equipment will make it possible to substantially reduce electricity costs The economic effect of the recommended energy-saving measure (#1) does not fully reflect all potential energy savings in the lighting system, because the input data include the results of the visual examination of only one block (the print shop), where we revealed unjustified use of lighting fixtures with a total capacity of 4 kW

*Air Supply System*

The air compressors account for nearly 6% of all energy consumed by the enterprise, though compressed air demand is not high The big energy consumption by the compressors is explained by the fact that the compressor with a capacity of 5 $m^3$/min works non-stop during a whole shift Since the compressor capacity cannot be adjusted, excess air is from time to time released into the atmosphere Even if the leakage revealed during the survey is eliminated, this will not save energy unless the compressor is changed To achieve considerable energy savings in the air supply system, a new compressor with a wide control range and a capacity of 3-4 $m^3$/min, but due to the small use factor of the compressor, the compressor substitution project will have a rather long payback period Yet, upon a more careful analysis of the operating costs relating to the existing compressor, we can recommend a substitution of a modern spiral compressor

There is another option to reduce electricity consumption for air production use of the small compressors installed in the shops, which supply compressed air to separate units and which are currently either out of service or used as a backup In the bookbinding department, where the main compressed air services are located, a new small compressor to supply compressed air to a few technological units may be required The proposed decentralization of the air supply system will make it possible to avoid leakage in the distribution system and to coordinate the operation of the compressors and the compressed air services to a maximum possible extent

*Pneumatic Transport System*

There is a possibility to reduce energy consumption in the pneumatic transport system At present, the fans operate during a whole shift, including lunch breaks, while the equipment that the system services stands idle The system could be operated more efficiently if the fans were automatically switched on and off when the technological equipment was started and stopped

*Ventilation System*

One of the options to reduce the enterprise's ventilation heat load is to use exhaust air heat for warming up incoming air After analyzing the operating conditions of the exhaust and forced ventilation systems, we selected the largest existing exhaust ventilation systems, whose heat could be used for warming up incoming air on the basis of specialized heat exchange equipment (see Attachment V) As a result, we examined options providing for the installation of heat exchangers in the air pits in the right and left wings of the print shop In the left wing, 104,445 $m^3$/hour of exhaust air were to be used to warm up 74,960 $m^3$/hour of incoming air The numbers for the right wing were 56,290 $m^3$/hour of exhaust air and 67,280 $m^3$/hour of incoming air Provided the temperature of exhaust air is 16°C, one thousand cubic meters of air cooled down to 6°C (steam condensation heat not included) can generate about 3 5 kW of thermal energy Our calculations prove that the installation of heat exchangers will result in annual savings of 672 MWh or 580 Gcal, which under the existing heat tariffs is equal to 90,300 rubles ($14,800) Despite the great energy and money savings, this measure has a long payback period due to great capital costs (about $120,000) involved in the installation of

expensive foreign heat exchange equipment The implementation of this project can be economically justified when the market offers cheaper Russian equipment

*Heat Supply System*

With relatively small heat consumption at the enterprise, the share of payments for thermal energy is rather big because of high tariffs for heat To reduce payments for heat, we suggest the installation of two fully automatic gas-fired hot-water boilers, which will completely satisfy the enterprise's demand for heat needed for heating, ventilation and HWS The boiler capacity was selected on the basis of the heat consumption data for 1997 The installation of new boilers will not require any cardinal changes in the heat supply system, which reduces the total project costs The economic analysis of the project shows that the discounted payback period is less than two years (see Attachment VII), proving the advisability of the project implementation To determine the sensitivity of the project to possible increments in capital costs and to changes in operating cost reduction, we carried out an analysis, which is given in Attachment VII

Heat insulation of the distribution pipes of the HWS and heating systems can bring about considerable savings (see Project 3)

Taking into consideration that the buildings of the enterprise have a great number of windows, we recommend lagging the windows in the administrative offices and the service rooms to reduce heat losses through the window openings According to our estimate, this measure can reduce the total heat losses in the buildings

The existing system of water supply to the production and administrative buildings has great potential for electricity savings through changing the cold and hot water pumps The measurements taken show that the maximum daily hot water discharge does not exceed 8 $m^3$/hour However, on the hot and cold water supply line there is a KM45/30 pump with a capacity of 45 $m^3$/hour The pump is needed because the pressure in the city water pipelines is not enough to supply water to the multi-storey publishing block The substitution of a smaller pump proposed in Project 2 may not be the best option, and the installation of a small pump directly in the publishing block needs to be examined This option can save about 35 thousand kWh of electricity a year

## 5 3 Recommended Energy Efficiency Measures

Project 1

**Elimination of the Inefficient Use of the Lighting Equipment**

1 Savings

| | | |
|---|---|---|
| Annual electricity savings | 8,000kWh | 2,160 rubles ($350) |
| Total savings | | 2,160 rubles ($350) |

2 Costs

| | |
|---|---|
| Total costs | 0 rubles ($0) |

3 Payback period

**Recommendations**
To eliminate the inefficient use of the lighting equipment

**Description**
Currently, the enterprise inefficiently uses the lighting equipment during lunch breaks and during the second shift Switching the lamps off at lunchtime and using individual or sectionalized lighting in the production shops (especially during the second shift) will lead to substantial reduction in electricity costs

**Expected savings**

Under the existing electricity rate, the expected annual savings of 8,000 kWh are equivalent to 2,160 rubles ($350)

**Investment requirements**

This measure is not capital-intensive

**Implementation schedule**
The project can be implemented immediately

**Technical risks related to changes in the quality or quantity of products**
In this project there are no such risks

**Input data and calculations**

The visual inspection of the print shop revealed the use of excessive lighting equipment with an aggregate capacity of 4 kW Rational lighting arrangements will save about 8,000 kWh of electricity a year

## Replacement of the HWS Pump

| | | |
|---|---|---|
| 1 Savings | | |
| Annual electricity savings | 18,750 kWh | 5,100 rubles ($835) |
| Total savings | | 5,100 rubles ($835) |
| 2 Costs | | |
| Pump unit | | 3,000 rubles ($490) |
| Total costs | | 3,000 rubles ($490) |
| 3 Payback period | | |

**Recommendations**
To replace the pump in the cold and hot water supply system

**Description**
To decrease hot and cold water discharge, we suggest the substitution of a K20/30 pump for the existing KM-45/30 pump The dismantled pump can be used in another place

**Expected savings**
Under the existing electricity rate, the expected annual savings of 18,750 kWh are equivalent to 5,100 rubles ($835)

**Investment requirements**
The cost of a pump with a motor is about 3,000 rubles ($490) (including VAT)

**Payback**
The payback period will be 7 months The scale of the project does not require an estimation of the internal rate of payback

**Implementation schedule**
The project can be implemented immediately

**Technical risks related to changes in the quality or quantity of products**
In this project there are no such risks

**Input data and calculations**
The substitution of a smaller capacity pump for the existing HWS pump will reduce electricity consumption by 18,750 kWh a year, which under the existing electricity rates will be equal to 5,100 rubles ($835) The selection of a new pump was based on the results of measuring daily hot and cold water consumption The electricity savings were estimated on the basis of the measurements of capacity consumed by the pump

## Insulation of the Hot Water Pipelines and the Hot Water Tank

1 Savings

| | | |
|---|---|---|
| Annual heat savings | 885 5 Gcal | 137,828 rubles ($22,595) |
| Total savings | | 137,828 rubles ($22,595) |

2 Costs (VAT included)

| | |
|---|---|
| Mineral wool and asphalt sheathing paper | 4,320 rubles ($708) |
| Insulation assembly | 2,600 rubles ($427) |
| Total costs | 6,920 rubles ($1,135) |

3 Payback period

**Recommendations**
Insulation of the uninsulated distribution pipes in the heating and HWS systems

**Description**
To reduce heat losses from the uninsulated sections of the distribution pipes and the locking fittings, which will save 885 5 Gcal of heat

**Expected savings**
Under the existing heat tariffs, the expected savings of 885 5 Gcal of heat are equivalent to 137,828 rubles ($22,595)

**Investment requirements**
About 10 m3 of mineral wool will be required for the insulation of the uninsulated sections of the heating and HWS pipes with a total length of 1170 meters The estimated cost of insulation materials (mineral wool and asphalt sheathing paper) and of assembly works is 6,920 rubles ($1,135), including VAT

**Payback**
The payback period will be 1 month The scale of the project does not require an estimation of the internal rate of payback

**Implementation schedule**
The project can be implemented immediately

**Technical risks related to changes in the quality or quantity of products**
In this project there are no such risks

**Input data and calculations**
The input data included the measurements of the length, diameter and temperature of the surface of the uninsulated pipes in the heating and HWS systems (see Attachment VI)
The total heat losses from the uninsulated pipes are 163 4 kW

The economic insulation thickness for such pipes is about 30 mm When insulation is in place, losses through the insulated pipes will be about 22 7 kW

Thus, insulation will save about 140 7 kW, which is 1 029 7 MWh a year or 885 5 Gcal or, in terms of money, 137,828 rubles ($22,959)

Calculations of heat losses through the uninsulated sections of the pipes and determination of the economic insulation thickness were based on reference tables

## Installation of Hot Water Boilers

1 Savings

| | |
|---|---|
| Total money savings | 650,000 rubles ($106,560) |

2 Costs (VAT included)

| | |
|---|---|
| Installation and contract supervision of the boilers | 600,000 rubles ($98,360) |
| Total costs | 600,000 rubles ($98,360) |

3 Payback period

**Recommendations**
To install two hot water boilers manufactured by the Buderus company in the central heating station

**Description**
To reduce annual expenditures on purchasing heat from the city heating system, we suggest the installation of hot water boilers in the CHS

**Expected savings**
Under the existing heat tariffs, heat generation by the enterprise's hot water boilers will save about 650,000 rubles ($106,560)

**Investment requirements**
Capital costs involved in the installation of two 1 6-MW hot water boilers, their assembly, adjustment and additional equipment installation (including a stack) are about 6000,000 rubles ($98,360) This sum includes expenses on gas supply arrangements

**Payback**
The payback period will be 11 months The project evaluation according to the net present value method and the sensitivity analysis are given in Attachment VII

**Implementation schedule**
The project can be implemented immediately

**Technical risks related to changes in the quality or quantity of products**
In this project there are no such risks

**Input data and calculations**
The annual heat consumption for heat supply to the main grounds in 1997 was 5,485 Gcal In the 1998 prices for heat from the city heat supply system, this makes up 850,175 rubles

When imported hot water boilers (for example, boilers of the Buderus company) are installed, annual costs involved in generating so much thermal energy will be 200,000 rubles This amount includes payment for gas - 190,000 rubles and annual maintenance costs – 10,000 rubles

**Attachment 1 Zvezda PPC's Output in 1997**

| | Product Type | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | За год |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4-page newspapers, sheet size A-2 | ths copies | 9,392 | 10,132 | 10,797 | 2,444 | 11,783 | 11,109 | 11,732 | 11,626 | 11,963 | 14,626 | 13,868 | 14,647 | 144,121 |
| 2 | Books | | | | | | | | | | | | | | |
| 2 1 | cased | ths copies | 91 4 | 31 8 | 85 0 | 54 0 | 92 0 | 62 9 | 203 0 | 150 6 | 128 5 | 232 1 | 173 7 | 121 3 | 1426 3 |
| 2 2 | paperback | ths copies | 83 8 | 51 0 | 16 4 | 48 4 | 80 3 | 48 0 | 48 0 | 58 8 | 86 9 | 43 3 | 14 1 | 45 2 | 624 2 |

## Attachment II Fuel and Energy Consumption by Zvezda in 1997

| № | Energy Source | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | **Electricity** | | | | | | | | | | | | | | |
| 1 | *paid capacity* | kW | 276 | 535 | 483 | 267 | 258 | 547 | 530 | 500 | 438 | 439 | 469 | 469 | -- |
| | tariff | rub/kW | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | -- |
| | payment for 1997 | ths rubles | 18 216 | 35 310 | 31 878 | 17 622 | 17,028 | 36 102 | 34 980 | 33,000 | 28 908 | 28 974 | 30 954 | 30 954 | *343,926* |
| 2 | *electric energy* | | | | | | | | | | | | | | |
| 2 1 | Print shop | MWh | 95 | 107 | 72 | 65 | 77 | 50,101 | 75 | 76 | 99 | 69 925 | 126 28 | 133 651 | **1045 958** |
| 2 2 | Publishing block | MWh | 31 65 | 42 079 | 34 372 | 32 18 | 34 001 | 44 92 | 42 926 | 36 349 | 42 103 | 24 809 | 43 107 | 53 935 | **462,431** |
| 2 3 | Newspaper block | MWh | 30 | 33 | 25 | 24 | 22 | 16 | 27 | 27 | 26 | 18 | 48 | 41 | **337,00** |
| 2 4 | Garage | MWh | 6 | 5 | 6 | 6 | 5 | 5 | 6 | 6 | 4 | 6 | 4 | 4 | **63,00** |
| | Payment for Items 2 1-2 4 | ths rubles | -- | -- | -- | -- | -- | -- | -- | - | -- | -- | -- | -- | **366,41** |
| 2 5 | EPZ 100 | MWh | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **29,316** |
| | Payment for Item 2 5 | ths rubles | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **24,100** |
| 2 6 | Canteen | MWh | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **164,000** |
| | Payment for Item 2 6 | ths rubles | -- | -- | -- | -- | -- | -- | - | -- | -- | -- | -- | -- | **49,690** |
| | **Main grounds*** | **MWh** | **162,7** | **187,1** | **137,4** | **127,2** | **138** | **116** | **151** | **145,3** | **171,1** | **118,7** | **221,4** | **232,59** | **2101,705** |
| | **Payment for main grounds** | **ths rubles** | -- | -- | -- | - | -- | -- | - | -- | -- | -- | -- | -- | **440,183** |
| 2 7 | Paperboard shop | MWh | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | **20,00** |
| 2 8 | Central warehouse | МВтч | 85 | 60 | 30 | 15 | 120 | 90 | 110 | 38 | 82 | 15 | 30 | 25 | **700,00** |
| | Payment for Items 2 7-2 8 | ths rubles | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | - | **218,16** |
| | **Industrial area*** | **MWh** | **249,7** | **249,1** | **169,4** | **144,2** | **260** | **208** | **263** | **185,3** | **254,1** | **134,7** | **252,4** | **258,59** | **2821,71** |
| | **Payment for industrial area** | **ths rubles** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **658,34** |
| 2 9 | Kindergarten | MWh | 7 | 8 | 7 | 6 | 8 | 6 | 4 | 6 | 5 | 7 | 7 | 6 | **77,00** |
| 2 10 | Health center summer camp | MWh | 15 | 10 | 19 | 8 | 50 | 65 | 68 | 128 | 86 | 116 | 50 | 20 | **343,00** |
| | Payment for Items 2 9-2 10 | ths rubles | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **163,80** |
| 2 11 | Subcustomers | MWh | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **466,30** |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Payment for Items 2 11 | ths rubles | - | - | -- | -- | | - | -- | -- | -- | -- | -- | -- | 81,36 |
| **TOTAL** | **MWh** | **295,2** | **312,6** | **229,7** | **201,2** | **339,8** | **303,3** | **348,6** | **338,0** | **369,7** | **306,2** | **326,0** | **337,5** | **3708,01** |
| **TOTAL PAYMENT** | **ths rubles** | -- | -- | -- | -- | -- | - | - | -- | -- | -- | -- | -- | **903,79** |

| № | Energy Source | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Transformer losses | MWh | 7 88 | 8 04 | 7 47 | 7 57 | 7 86 | 7 67 | 7 9 | 7,58 | 7 90 | 7 52 | 7,93 | 8,12 | **93,40** |
| | tariff | rubles/ kWh | 0 76 | 0 75 | 0 65 | 0 65 | 0 84 | 0 77 | 0 80 | 0 72 | 0 79 | 0 67 | 0,71 | 0,71 | |
| | плата | ths rubles | 6 02 | 5 99 | 4 88 | 4 89 | 6 60 | 5 87 | 6 32 | 5 45 | 6 21 | 5,07 | 5 63 | 5 75 | **68,68** |
| | transmission losses | MWh | 0 46 | 0 58 | 0 44 | 0 50 | 0 38 | 0 44 | 0 47 | 0 48 | 0 50 | 0 47 | 0,58 | 0 40 | **5,68** |
| | tariff | rub/kWh | 0 192 | 0 192 | 0 192 | 0 192 | 0 192 | 0 192 | 0,192 | 0 192 | 0 192 | 0 192 | 0 192 | 0,192 | |
| | | ths rubles | 0 09 | 0 11 | 0 08 | 0,10 | 0 07 | 0 08 | 0 09 | 0 09 | 0 10 | 0 09 | 0,11 | 0,08 | **1,09** |
| 4 | Reactive power consumption | kVAr/h | 62970 | 82650 | 67860 | 67860 | 67860 | 67860 | 67860 | 67860 | 67860 | 67860 | 67860 | 67860 | **824220** |
| | **Total for electricity Main grounds** | ths rubles | -- | -- | -- | -- | -- | -- | -- | - | -- | -- | -- | -- | **853,88** |
| | **Industrial area** | ths rubles | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | **1072,04** |
| | **Enterprise** | ths rubles | -- | -- | -- | -- | -- | -- | -- | - | -- | -- | -- | -- | **1317,49** |

| № | Energy Source | Unit | Jan | Feb | March | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II | **Heat – enterprise** | **Gcal** | **1942** | **1255** | **967** | **679** | **160** | **48** | **26** | **62** | **154** | **623** | **1138** | **1236** | **8290** |
| | Print shop | Gcal | 700 | 455 0 | 286 0 | 220 0 | 63 0 | 16 0 | 8 0 | 22 0 | 60 0 | 189 0 | 374 0 | 476 0 | 2869 |
| | Publishing block | Gcal | 257 | 167 | 105 0 | 81 0 | 23 0 | 6 0 | 3 0 | 8 0 | 22,0 | 69 0 | 137 0 | 174 0 | 1052 0 |
| | Newspaper block | Gcal | 279,00 | 181 00 | 114 0 | 88 0 | 25 0 | 6 0 | 3 0 | 9 0 | 24 0 | 75 0 | 149 0 | 189 0 | 1142 0 |
| | Garage | Gcal | 103 00 | 67 00 | 42 0 | 33 0 | 9 0 | 2 0 | 1 0 | 3 0 | 9 0 | 28 0 | 55 0 | 70 0 | 422 0 |
| | **Heat – main grounds** | **Gcal** | **1339,0** | **870,0** | **547,0** | **422,0** | **120,0** | **30,0** | **15,0** | **42,0** | **115,0** | **361,0** | **715,0** | **909,0** | **5485,0** |
| | tariff | rub/Gcal | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 | 137 0 |
| | **Payment – main grounds** | **ths rubles** | **183,4** | **119,2** | **74,9** | **57,8** | **16,4** | **4,1** | **2,1** | **5,8** | **15,8** | **49,5** | **98,0** | **124,5** | **751,4** |
| | Paperboard shop | Gcal | 60 00 | 40 00 | 25 0 | 18 0 | 5 0 | 1 0 | 2 0 | 3 0 | 4 0 | 16 0 | 32 0 | 42 0 | 248 0 |
| | Central warehouse | Gcal | 387 00 | 210 00 | 268 0 | 151 0 | 0 0 | 0 0 | 0 0 | 0 0 | 0 0 | 151 0 | 270 0 | 285 0 | 1722 0 |
| | Kindergarten | Gcal | 156 | 135 | 127 | 88 | 35 | 17 | 9 | 17 | 35 | 95 | 121 | 0 | 835 0 |
| | **Payment – enterprise** | ths rubles | 266,054 | -- | -- | -- | -- | - | -- | -- | -- | -- | -- | -- | **1030,610** |
| III | **City water** | **$m^3$** | **3161** | **2857** | **2951** | **3300** | **3131** | **3091** | **2913** | **2774** | **2955** | **3676** | **3673** | **2930** | **37412,0** |
| | Print shop | $m^3$ | 1398 | 1265 | 1273 | 1419 | 1281 | 1307 | 1249 | 1165 | 1229 | 1517 | 1531 | 1196 | 15830 0 |
| | Publishing block | $m^3$ | 512 | 464 | 467 | 520 | 469 | 479 | 458 | 427 | 450 | 556 | 561 | 438 | 5801 0 |
| | Newspaper block | $m^3$ | 557 | 504 | 507 | 565 | 510 | 521 | 497 | 464 | 489 | 604 | 610 | 476 | 6304 0 |
| | Garage | $m^3$ | 207 | 186 | 188 | 209 | 189 | 193 | 185 | 172 | 183 | 223 | 226 | 178 | 2339 0 |
| | Paperboard shop | $m^3$ | 164 | 49 | 16 | 17 | 27 | 26 | 22 | 31 | 44 | 44 | 46 | 43 | 529 0 |
| | Central warehouse | $m^3$ | 33 | 103 | 79 | 162 | 248 | 161 | 107 | 84 | 112 | 92 | 95 | 112 | 1388 0 |
| | Kindergarten | $m^3$ | 290 | 286 | 421 | 408 | 407 | 404 | 395 | 431 | 448 | 640 | 604 | 487 | 5221 0 |
| | **Water – main grounds** | **$m^3$** | **2674** | **2419** | **2435** | **2713** | **2449** | **2500** | **2389** | **2228** | **2351** | **2900** | **2928** | **2288** | **30274,0** |
| | tariff for consumption | rub/$m^3$ | 3 96 | 3 96 | 3 96 | 3 96 | 3,96 | 3 96 | 3 96 | 3 96 | 3 96 | 3,96 | 3 96 | 3 96 | 3 96 |
| | payment – main grounds | rubles | 10589 | 9579 | 9643 | 10743 | 9698 | 9900 | 9460 | 8823 | 9310 | 11484 | 11595 | 9060 | 119885 |
| | payment – enterprise | rubles | 12518 | 11314 | 11686 | 13068 | 12399 | 12240 | 11535 | 10985 | 11702 | 14557 | 14545 | 11603 | 148152 |
| | tariff for discharge | ruble/$m^3$ | 2 324 | 2 324 | 2,324 | 2 324 | 2 324 | 2,324 | 2 324 | 2 324 | 2,324 | 2,324 | 2 324 | 2 324 | 2 324 |
| | payment – main grounds | rubles | 6 214 | 5 622 | 5 659 | 6 305 | 5 691 | 5 810 | 5 552 | 5 178 | 5 464 | 6 740 | 6 805 | 5 317 | 70 357 |
| | payment – enterprise | rubles | 7 346 | 6 640 | 6 858 | 7 669 | 7 276 | 7 183 | 6 770 | 6 447 | 6 867 | 8 543 | 8 536 | 6 809 | 86 945 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **total – main grounds** | ths rubles | **16,80** | **15,20** | **15,30** | **17,05** | **15,39** | **15,71** | **15,01** | **14,00** | **14,77** | **18,22** | **18,40** | **14,38** | **190,242** |
| **total – enterprise** | ths rubles | **19,86** | **17,95** | **18,54** | **20,74** | **19,68** | **19,42** | **18,31** | **17,43** | **18,57** | **23,10** | **23,08** | **18,41** | **235,097** |

**Attachment 3 List of Main Energy-Using Equipment by Department**

## OFFSET SHOP

| № пп | Name of Equipment | No of units | Installation | Installed capacity, kW | Drive capacity, kW |
|---|---|---|---|---|---|
| 1 | Proof printing press KB-123-64 | 1 | 1983 | 3 5 | 1 5 |
| 2 | Proof printing press KF-123-G4 | 1 | 1986 | 3 5 | 1 5 |
| 3 | Broadsheet assembling machine ' Kuromat" | 1 | 1987 | 7 | no data |
| 4 | "Rotory" | 1 | 1975 | 5 6 | no data |
| 5 | Gilding press | 1 | 1976 | 4 5 | no data |
| 6 | Varnishing machine «Gulamat" | 1 | 1980 | 28 | 7 (21) |
| 7 | 2-camera photographic equipment LNC 565 | 1 | 1982 | 14 | lamps 6 kW |
| 8 | Pile lifts | 6 | 1979-86 | 1 1 | no data |
| 9 | Folding machine 580, 5090 | 2 | 1970, 85 | 6 3 | 1 1 |
| 11 | 2-color machine P-24, P-71 | 2 | 1977, 81 | 28 | 2 6/ 13 |
| 13 | "Super-Varimat' | 1 | 1982 | 100 | 16 5/90 |
| 15 | «Seipa" | 2 | 1985, 86 | 7 7 | no data |
| 17 | «Duofan" | 1 | 1970 | 37 7 | 6 2 (1 5) |
| 18 | 4-color machine S-102-V | 1 | 1991 | 57 5 | main motor 2 9/2 9 |
| 19 | 4-color machine | 1 | 1989 | 93 | main motor 8 25/45 |
| 20 | Die-cutting | 1 | 1990 | 3,5 | no data |
| 21 | Banding | 1 | 1987 | 2,5 | no data |
| 22 | Printing frame | 1 | | 5,2 | lamp 3 kW |
| 25 | Drier | 1 | | 6,1 | no data |

## RECYCLED MATERIAL SHOP

| № | Name of Equipment | No of Units | Year of Installa tion | Installed Capacity, kW | Electric Motor, type |
|---|---|---|---|---|---|
| 1 | Waste paper press | 3 | 1986 | 12 2 | 4A 152 M4UZ<br>4AM80A4UZ<br>4AA50V2 |
| 2 | Hydraulic press | 5 | 1985 | 4,0 | 4AM100L4UZ |
| 3 | Drilling machine | 1 | 1988 | 0,55 | AIR71A4UZ |
| 4 | Lift | 1 | 1985 | 2,2 | AO2-31-4M100 |
| 5 | Electric telpher, load carrying capacity – 1 ton | 1 | 1987 | 2,47 | KG 168-6<br>EKT 120-M6 |
| 6 | Exhaust fan | 1 | 1986 | 2,2 | 4AM100L6UZ |
| 7 | Crane jib, load lifting capacity - 500 kg | 1 | 1985 | 3 74 | 2×AOL 12-4,<br>AOLB 31-4<br>AOP 51-6 |
| 8 | Pneumatic transport fan single-knife cutting machine | 2 | 1984 | 15 | 2×4AM160S4 |
| | Single and three-knife cutting machines | 1 | 1984 | 15 | 4AM160S4UZ |
| | Wolenberg line | 1 | 1984 | 15 | 4AM160S4 |
| | Book line | 2 | 1984 | 15 | 4AM160S4<br>4AM160S4UZ |
| | Single-knife cutting machine | 1 | 1985 | 15 | 4AM160S4 |

## COMPOSING ROOM

| № | Name of Equipment | No of Units | Year of Installation | Installed Capacity kW | Electric Motor, type |
|---|---|---|---|---|---|
| 1 | Two-color offset press 2POL-71 2№1 | 1 | 1989 | 34,5 | CLS 345/4-5 17 kW |
| 2 | Platen "Graphopress" | 2 | 1983 | 1,5 | AOL-32-4 |
| 3 | Gilding press BPC-75 | 1 | 1987 | 2 | no data |
| 4 | Platen press PT-1 | 1 | 1973 | 1,7 | no data |
| 5 | Flat-bed press "Victoria 820 | 1 | 1971 | 9 | CLS 315/6-4 5,5 kW |
| 6 | Flat-bed press "Victoria 1040" | 2 | 1978, 79 | 15 | CSL 242/9-4 7,5 kW |
| 7 | Flat-bed pressing machine PS-5 | 1 | 1960 | 3 | AO-42-4 |
| 8 | Paper-cutting machine "Sieka 132" | 1 | 1978 | 7,7 | № D 624 5,5 kWт |
| 9 | Folding machine BFA-2 | 1 | 1962 | 3 | no data |
| 10 | Folding machine BFA-2 Model 434 | 1 | 1972, 80 | 4 | no data |
| 11 | Block pressing machine BTC-1,5 | 3 | 1978-82 | 1 | AO-32-7 |
| 12 | Line casting machine KSN | 2 | no data | 3,2 | no data |
| 13 | Line casting machine N-140 | 2 | no data | 3,8 | no data |
| 14 | Line casting machine 2N-140 | 1 | no data | 4 | no data |
| 15 | Large type size machine | 2 | no data | 4 | no data |
| 16 | Line spacing automatic printer ALP | 1 | no data | 2,8 | no data |
| 17 | Semi-automatic printer SLB-2 | 1 | no data | 4,5 | no data |
| 18 | Proof printing machine FAT-525 | 2 | no data | 0,8 | no data |
| 19 | Line cutting machine HCK, ZDE | 2 | no data | 0,27 | no data |
| 20 | Processing machine «Reproplas" | 1 | no data | 3 | no data |
| 21 | Drilling machine HC-12A | 2 | no data | 0,6 | AOL-11-4 |
| 22 | Drilling machine 2 H 0112 | 2 | no data | 0,4 | no data |
| 23 | Lead-and-rule cutter MRC | 2 | no data | 2,8 | AO-32-4 |
| 24 | Bevelling machine KB-M6 | 1 | no data | 1,5 | KMER-90 1,5 |
| 25 | Milling machine MFT | 1 | no data | 1,7 | no data |
| 26 | Vertical miller HRR | 1 | no data | 0,6 | no data |
| 27 | Casting machine SLH-2 | 1 | no data | 12,4 | AOL-21-4 0,27 kW |
| 28 | Lathe 1A-616 | 1 | no data | 2,8 | no data |
| 29 | Type height setting machine SF-2 | 1 | no data | 4,5 | no data |

## NEWSPAPER SHOP

| № | Name of Equipment | No of Units | Year of Installation | Installed Capacity kW | Electric Motor, type |
|---|---|---|---|---|---|
| 1 | Newspaper press POG 168 | 2 | 1994 | 320 | main motor 4PFM-280MGUHLI, 145 kW |
| 3 | Flushing machine FVF65 | 1 | 1979 | 16 | 4A90LGUZ 3 kW, 100Б 12 kW |
| 4 | Unit for thermal treatment of zincographic prints FMT-53 | 1 | 1990 | 10 | heater 44A |
| 5 | Exposure unit FEF-65 | 1 | 1981 | 3,1 | 4AA56B2У3 0,27 kW LIFT-66 0,66 |
| 6 | Offset press POG-60 | 1 | 1983 | 6,3 | 2PF132MGU4 4 kW |
| 7 | Photographic camera AVZI-56 | 1 | 1990 | 6 | 2 LHA lamps 4501 |
| 8 | Etching machine FOR50M | 1 | 1981 | 7,5 | heater HVSG |
| 9 | Thermal treatment flow line FMT-120 | 1 | 1990 | 28,5 | AOL2-12-2 1,1 kW, 28 lamps KTT220-1000 |
| 10 | Photographic camera AVZ-565 | 1 | 1987 | 6 | 2×LHA 4501 |
| 11 | Automatic bundling machine MSP | 6 | 1981 | 3 | AOLЭ2-31-61,5 kW |
| 12 | Drilling machine C 115 | 1 | 1960 | 0,27 | AOL-11-4 |
| 13 | Drilling machine HC-12-A, 2M112 | 2 | 1963, 72 | 0,6 | AOL-11-4 |
| 15 | Lead-and-rule cutter MRP | 3 | 1966 | 1,7 | AOL 2-22-6 |
| 16 | Electric hot water boiler KEN 100M | 3 | 1994 | 4 | heater 100 |
| 17 | Vertical centrifuge FCV-66 | 2 | 1975 | 2,7 | П-11 0,3 kW |
| 18 | Lathe DIP200 | 1 | 1962 | 4,5 | AOA2-20-4 |
| 19 | Lathe 1M63 | 1 | 1970 | 13 | AO2-20-4 |
| 20 | Paint pump | 3 | 1970 | 2,8 | AK-32-6 |
| 21 | Emery | 3 | 1972 | 0 6 | AOL2-2 |
| 22 | Newspaper conveyer TGM | 4 | 1969 | 2,2 | PZ2 |
| 23 | Computer composing unit SKU | 4 | 1994 | 3 | 4AM80AUUZ 1,1 kW |
| 24 | Plate processing line 2FPP120 | 2 | 1997 | 11 | 4AMH90LUUZ 2,2 kW |
| 25 | Printing frame SPME 1214 | 3 | 1990 | 3 | RGTI-3000 |
| 26 | Electric booiler EPZ-100 | 1 | 1990 | 100 | |

## Attachment 4 Daily Load Curves of Zvezda's Main Loads

**Figure IV-1 Load of TS-0132 on May 18-19, 1998**

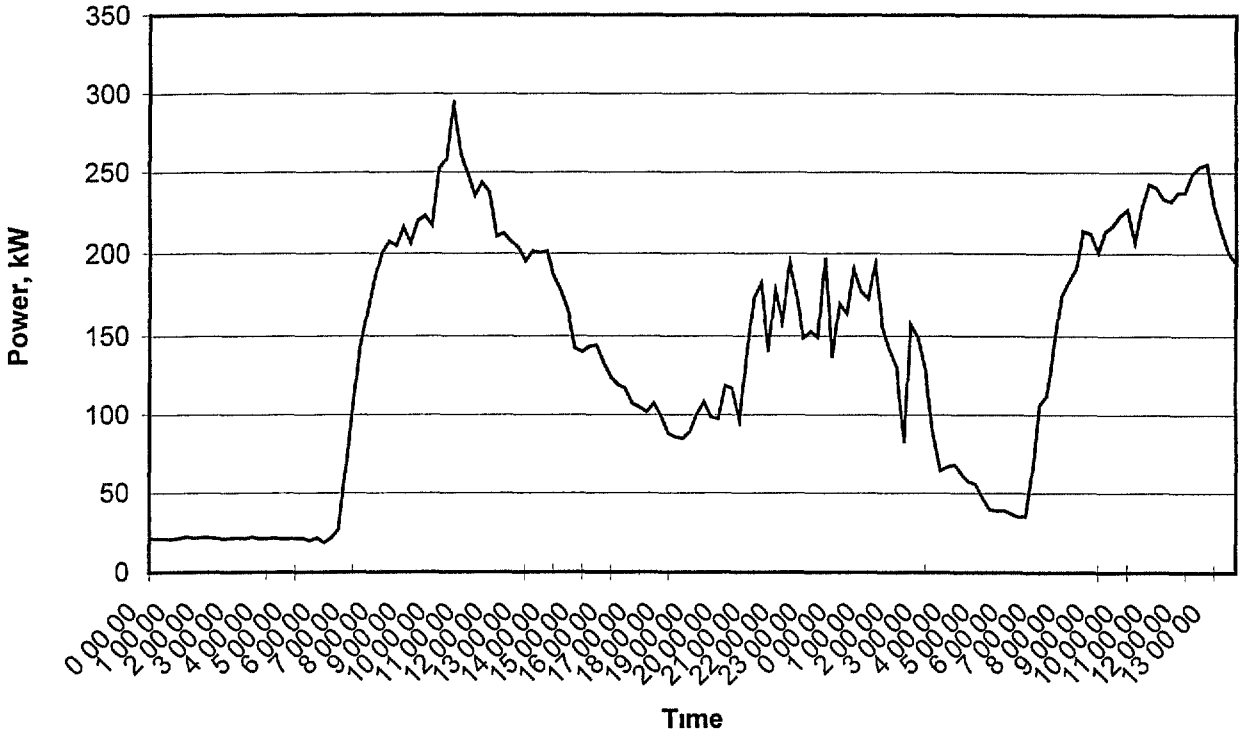


**Figure IV-2 Load of TS-083 on May 18-19, 1998**

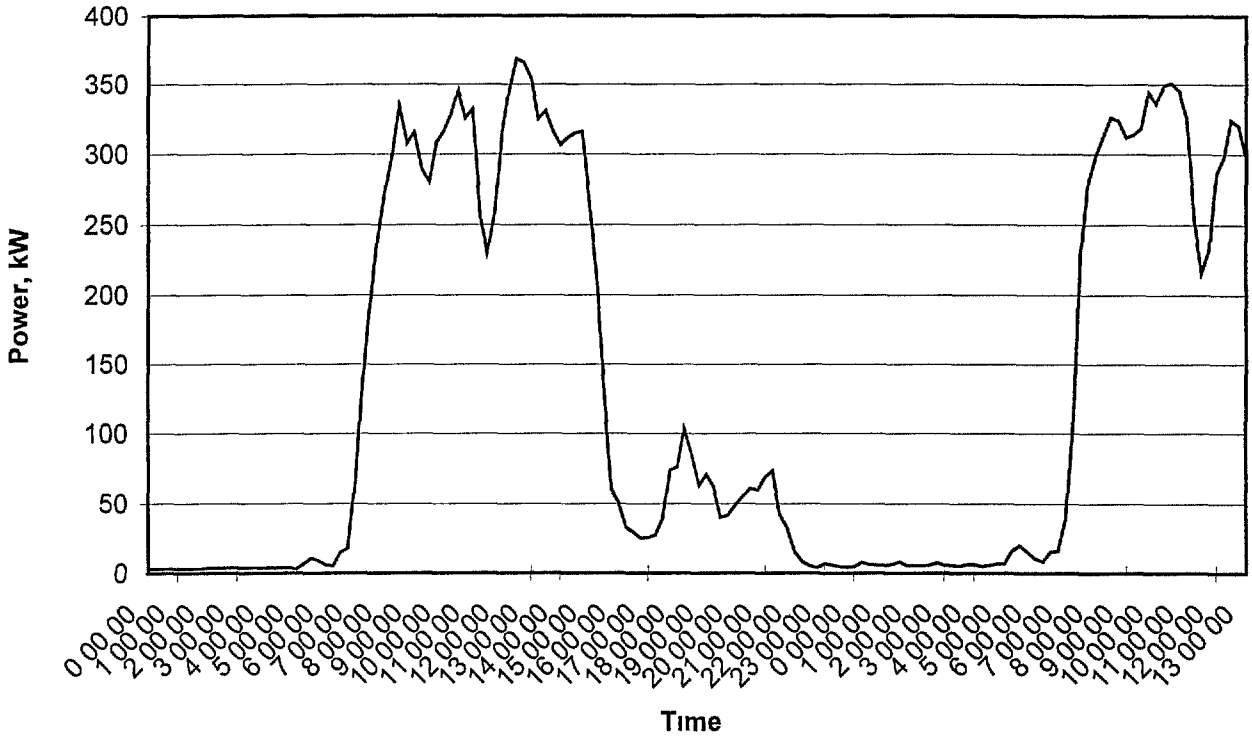


**Figure IV-3 Electricity Consumption by the POG Machines on May 18-19, 1998**

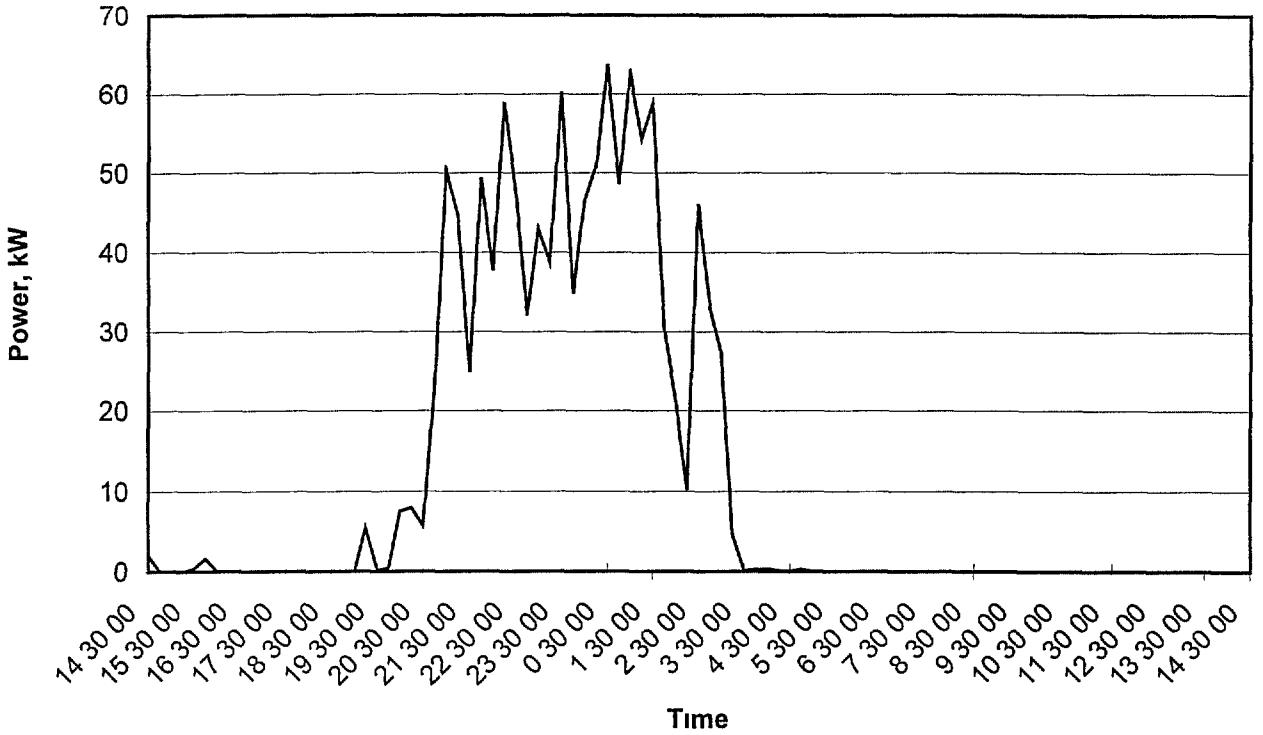


**Figure IV-4 Electricity Consumption by the Publishing Block on May 18-19, 1998**

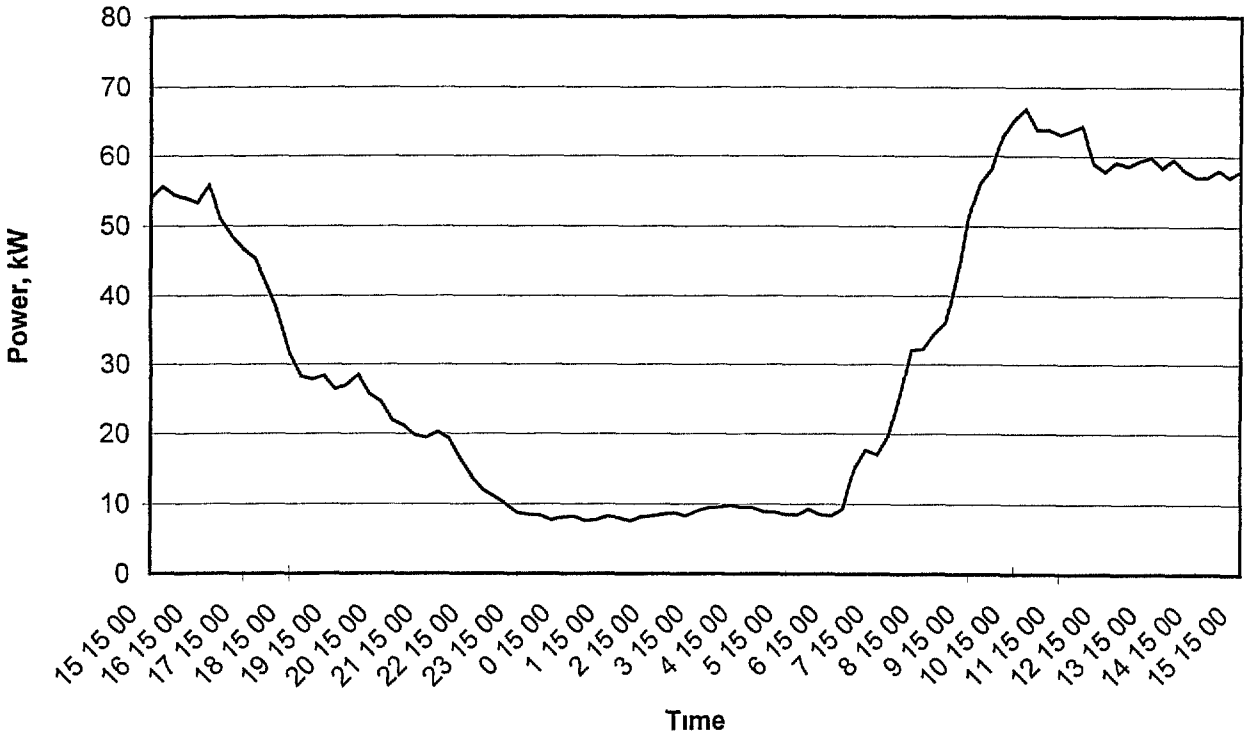


Figure IV-5 Aggregate Lighting Load of the Print Shop on May 14-15, 1998

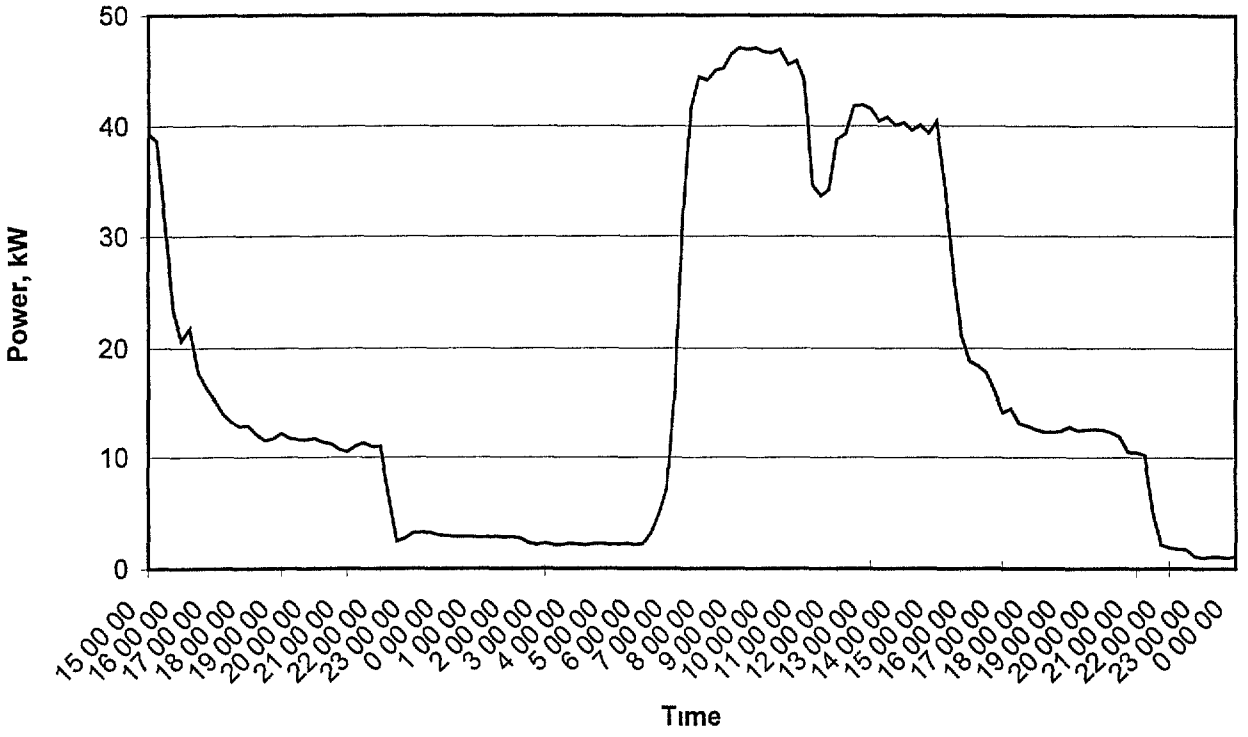
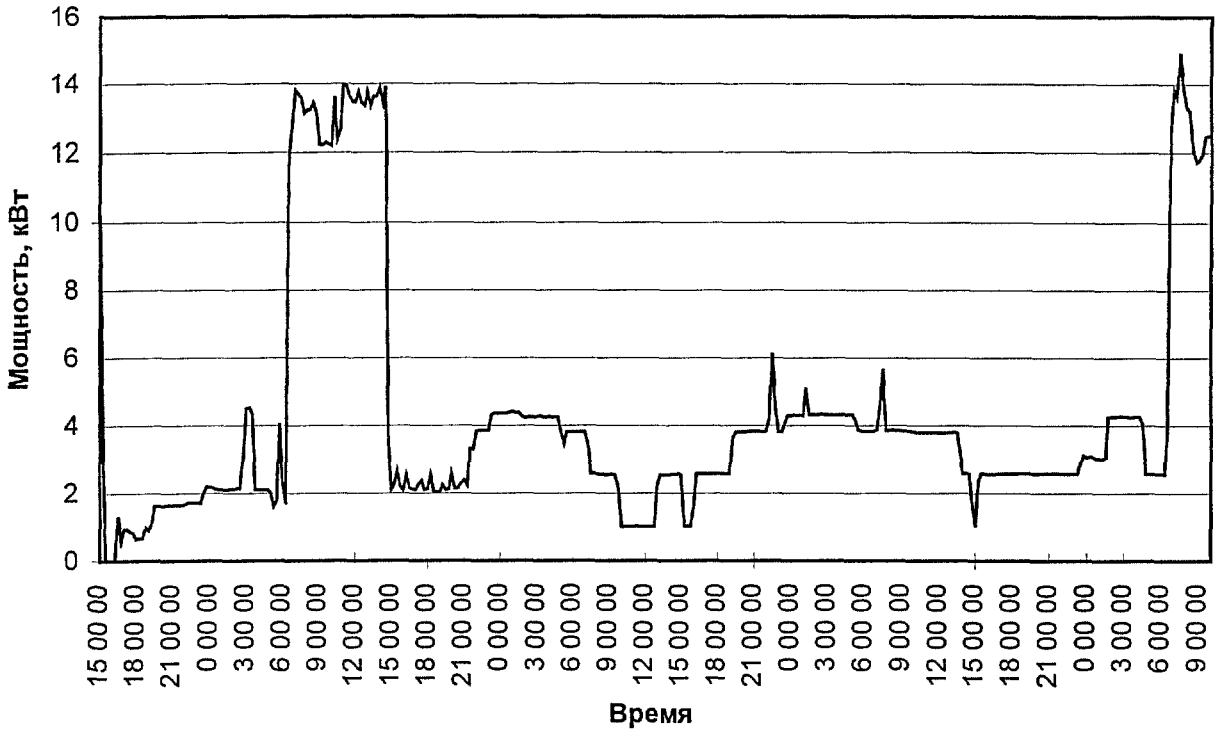


**Figure IV-6 Ventilation Load of the Left Wing of the Print Shop**



**Attachment 5 Ventilation Systems in the Print Shop**

| № | Department | № of Fans C4-70 | Revolutions per Minute | Volume of Exhaust Air $m^3/h$ | Serviced Premises and Equipment |
|---|---|---|---|---|---|
| *Exhaust ventilation systems* | | | | | |
| B 6 | bookbinding | 5 | 1420 | 4800 | «Rodina" section |
| B 19 | offset | 3 | 1440 | 1300 | photography room |
| B 24 | offset | 3 | 1440 | 1320 | photo laboratory |
| B 27 | print shop | 5 | 1420 | 4900 | shower room |
| B 26 | offset | 3 | 1420 | 1350 | photography room |
| B 28 | offset | 3 | 1420 | 1300 | retouching room |
| B 30 | composition | 5 | 1440 | 4900 | line casting room |
| B 36 | bookbinding | 6 | 1440 | 6800 | perflation |
| B 39 | offset | 6 | 1440 | 6850 | «Buzar" ultraplan |
| B 39a | offset | 6 | 1440 | 6850 | «Buzar" ultraplan |
| B 40 | offset | 6 | 1440 | 6820 | bath washing |
| B 44 | print shop | 3 | 1420 | 1350 | cloak room |
| B 46 | offset | 6 | 1440 | 6810 | 1st floor |
| B 47 | composition | 5 | 1420 | 4850 | hand composition |
| B 49 | bookbinding | 5 | 1420 | 4800 | perflation |
| B 54 | offset | 5 | 1420 | 4900 | color matching |
| B 55 | offset | 8 | 950 | 9880 | perflation |
| B 56 | printing | 5 | 1420 | 4900 | perflation, 3rd floor |
| B 57 | printing | 6 | 1440 | 6800 | perflation, 3rd floor |
| B 59 | bookbinding | 6 | 1440 | 6810 | «Book" line |
| B 60 | offset | 8 | 950 | 9800 | perflation, 4th floor |
| B 62 | printing | 6 | 1440 | 6820 | perflation |
| B 63 | bookbinding | 5 | 1420 | 4800 | drying drum |
| B 67 | bookbinding | 5 | 1420 | 4900 | sewing section |
| B 68 | bookbinding | 5 | 1420 | 4850 | cloth cutting |
| B 69 | paper preparation | 5 | 1420 | 4900 | perflation |
| B 71 | paper preparation | 5 | 1420 | 4900 | perflation |
| B 76 | printing | 6 | 1440 | 6805 | rotary |
| B 80 | bookbinding | 8 | 950 | 9820 | perflation |
| B 81 | bookbinding | 5 | 1420 | 4850 | perflation |
| **TOTAL** | | | | **∑160735** | |

**Attachment VI Heat Losses from Naked Pipes and in the Distribution System**

| № | Pipe Location | Pipeline Length, m | Pipe Diameter m | Surface Temperature, °C | Heat Losses, kW |
|---|---|---|---|---|---|
| *HWS* | | | | | |
| 1 | Ground floor of the print shop | 30 | 0 053 | 60 | 2 4 |
| 2 | Basement of the publishing block | 21 | 0 089 | 60 | 2 8 |
| 3 | Ground floor of the print shop | 340 | 0 100 | 60 | 49 3 |
| **TOTAL IN THE HWS SYSTEM** | | | | | **54 5** |
| *Heating System* | | | | | |
| 1 | Newspaper block | 20 | 0 027 | 65 | 1 1 |
| 2 | Basement of the publishing block | 30 | 0 042 | 65 | 2 4 |
| 3 | Ground floor of the print shop | 219 | 0 062 | 65 | 23 7 |
| 4 | Ground floor of the print shop | 168 | 0 076 | 65 | 22 3 |
| 5 | Basements of the publishing block and of the CHS | 104 | 0 080 | 65 | 14 6 |
| 6 | Basement of the publishing block | 208 | 0 100 | 65 | 35 2 |
| 7 | Basement of the publishing block | 16 | 0 139 | 65 | 4 3 |
| 8 | CHS | 14 | 0 200 | 65 | 5 3 |
| **TOTAL IN THE HEATING SYSTEM** | | | | | **108 9** |
| **GRAND TOTAL** | | | | | **163 4** |

**Attachment VII Analysis of Project 4 According to the Net Present Value Method**

| **Project analysis** | *Installation of hot water boilers* | | | | | |
|---|---|---|---|---|---|---|
| **Base case** | | | | | | |
| **Discount rate, %** | 10 | | | | | |
| **Numbers are given in $US** | | | | | | |
| Years | 0 | 1 | 2 | 3 | 4 | 5 |
| Capital investment | 98360 | | | | | |
| Energy savings | | 0 | 0 | 0 | 0 | 0 |
| Operating costs | | 106560 | 106560 | 106560 | 106560 | 106560 |
| Depreciation charges | | -4900 | -4900 | -4900 | -4900 | -4900 |
| Profit before tax | | 101660,0 | 101660,0 | 101660,0 | 101660,0 | 101660,0 |
| Profit tax (35%) | | -35581,0 | -35581,0 | -35581,0 | -35581,0 | -35581,0 |
| Profit after tax | | 66079,0 | 66079,0 | 66079,0 | 66079,0 | 66079,0 |
| Net cash flow | | 61179,0 | 61179,0 | 61179,0 | 61179,0 | 61179,0 |
| Discount coefficient | | 0,909090909 | 0,82644628 | 0,751314801 | 0,68301346 | 0,620921323 |
| Discounted cash flow | | 55617,3 | 50561,2 | 45964,7 | 41786,1 | 37987,3 |
| Payback period | | 1,9 | | | | |
| Net present value | | -42742,7 | 7818,4 | 53783,1 | 95569,2 | 133556,5 |
| Internal rate of return (5 years), % | | 55 | | | | |

**Sensitivity analysis of Project 4 (Changes in the internal rate of return in response to changes in operating cost reduction or in the proposed amount of capital costs)**

| Operating Cost Reduction | Capital Costs | | | |
|---|---|---|---|---|
| | 0 | +10% | +20% | +30% |
| +10% | 63 | 56 | 50 | 45 |
| 0 | 55 | 49 | 43 | 38 |

| | | | | |
|---|---|---|---|---|
| -10% | 47 | 41 | 36 | 31 |
| -20% | 39 | 34 | 29 | 24 |
| -30% | 31 | 27 | 22 | 17 |