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ENERGY EFFICIENCY AUDIT REPORT
TARTU DISTRICT HEATING PLANT - ROPKA STATION
TARTU, ESTONIA

JULY 1992

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QUALITY ASSURANCE STATEMENTS

The contents of this report include recommendations based on data provided by the client plant, measurements made on site, calculations, and engineering judgement. The conclusions reached were based on a limited engagement of only about one week's duration in the plant, and not an exhaustive engineering analysis. RCG/Hagler, Bailly, 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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FINAL ENERGY AUDIT
ROPKA Station, TARTU DISTRICT HEATING
TARTU, ESTONIA

I. ACKNOWLEDGEMENTS:

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J.Pärl - manager of Tartu Energy Authority
A.Ivanainen - manager of 1-st thermalk district
M.Tammerg - senior foreman
O.Tammekivi - foreman
V.Môtus - foreman of automation
Mrs. Olli Tammekivi - computer division

II. EXECUTIVE SUMMARY

A team of engineers from RCG/Hagler, Bailly, Inc. made up of Messers. Barry G. Tunnah and Eduardo S. Maal, Messrs. Vladimir Marchenkov, Heinrich Suik and Prof.Dr.Sc. Arvo Ots from Tallinn Technical University (TTU) and TERMOX's Messers. Aare Kivilo, Mr. K Jugesman and translator, carried out Preliminary Energy Auditing site activities at ROPKA Station from Dec 2-4, 1991 to work together with ROPKA Station staff to identify and implement improvements to energy efficiency.

A review of operations shows that the performance of the boilerhouse itself is already good and therefore the savings potential here is believed to be small. The largest savings are clearly to be made at the users installations. However, a major problem is the lack of metering outside the boilerhouse: with few exceptions, consumptions of hot water and steam are unknown and billings are based on assumed allocations, which originally may have been based on design data but have not been verified.

In addition, two typical consumers were visited. RAHU 5 and 7, two residential apartment blocks, where one specific project, ECO F-3 (Heat meters for two buildings and thermostatic radiator controls), was selected for USAID financing and the Desurek sporting goods manufacturer, where some areas requiring additional study were identified.

RCG/HB has based it's work on consumption in 1989 and 1990 and energy prices in US $. This has been done due to the severe devaluation of the Estonian/Russian RUBLE at the time of the visit and the fact that Estonia will have to pay "world, free economy" prices for fuels.

Based on 1989 and 1990 figures, RCG/HB estimates total yearly energy costs for 1992 at ROPKA Station as:

Yearly Electricity use in MWh	2,796	
Yearly Fuel use in Tons of Mazout	55	
Yearly TOTAL Natural Gas use in GJ	674,172	
Yearly BOILERS Natural Gas use in GJ	133,388	
Yearly value of Elect. at US$ 50.00/Mwh	$ 139,780	6%
Yearly value of Mazout at US$ 70.00/Tn	$ 3,815	0.18%
Yearly value of TOT Nat Gas at US $3/GJ	$2,022,517	93%
Yearly value of TOTAL Energy	$2,166,112	

The bases for the Energy savings identified in this report, which cannot always be considered additive, have been broken down as follows:

GENERAL AND ENERGY MANAGEMENT IMPROVEMENTS.
IMPROVEMENT FROM USAID FINANCED EQUIPMENT PURCHASES

RCG/Hagler, Bailly conservatively estimates that the potential for energy efficiency improvement without major process changes, at ROPKA Station, is substantial. ROPKA Station can and should start to implement these measures immediately.

For the medium to long term, it is strongly recommended that, to encourage interest and awareness in energy efficiency and to provide an incentive for improving energy efficiency, better methods for charging consumers according to actual energy use should be developed. Implementation will require significant investment in metering, of course, but direct charging rather than continuing to apply artificial allocations based on design factors or estimated consumption rates is essential to achieve improved energy efficiency.

As a result of the survey performed, the RCG/Hagler, Bailly team recommends purchase of the equipment required to implement the energy efficiency projects listed below. ROPKA Station has agreed to pay for installation and other costs necessary to implement the recommended projects and to make full use of any equipment to be supplied by USAID. The details for the recommended USAID financed equipment purchases are:

<u>ECO F-1: Energy and production management computers</u>

TOTAL COST = $6,000

Portable Computer with Printer
LOTUS 123, software with ALLWAYS

ECO F-2: Portable efficiency monitoring instruments

TOTAL COST = $11,500

Electronic Combustion Gas Analyzer
FLUKE Temperature Indicator & probes
Electronic, Total Dissolved Solids meter
Infra-red pyrometer
Ultrasonic Steam Trap Tester
Electric Survey Meter

ECO F-3: Heat meters for two buildings and thermostatic radiator controls

TOTAL COST = $16,000

Set up two total energy load monitoring systems in 2 identical residential blocks and install control (manual and/or thermostats) valves on each radiator of one block -- monitor and compare resulting heat loads over a complete heating season.

The total cost for the recommended USAID financed equipment purchases is $29,500.

III. INTRODUCTION

3.1. Background

Tartu Heat Energy Enterprise (THEE) is a part of Estonian Republic Association "Estonian Domestic Heat Energy". The 1st thermal district is a part of THEE. Operationally THEE is managed by Tartu Energy Authority.

In future THEE will be changed to stock company "Tartu Soojus Ltd". This enterprise is managed by director T.Elken. Under his supervision are working chief engineer, planning department, construction department, accounting department and 3 thermal districts.
The 1-st thermal district is managed by A.Ivanainen who is also boilerhouse manager. Under his supervision are working senior foreman, foreman on electrical and automatics equipment and also chemical engineer.

ROPKA is responsible for the supply to all consumers with heat energy for 335 days per year. Maintenance period is 30 days usually in July. Their obligation is:

to supply heat energy to 41 industrial enterprises incl. 10 enterprises, which are supplied also with process steam.

to supply heat energy for heating of 38 state living houses, 4 cooperativ living houses, 23 private living houses, 2 schoolhouses and 3 kindergartens.

ROPKA's Operational and Management staff:

5	managment
11	boiler operations
5	watercleaning plant workers
13	maintenance
6	pipeline workers

Steam and hot water supply to the town of Tartu are generally provided by centralised boilerhouses. This applies to steam used for process purposes as well as for steam and hot water for space heating and domestic water uses. The Ropka Station of the Tartu Energy Adminstration supplies both steam and hot water to a part of the town to the south east of the centre: about half the load is for industrial consumers and half for residential customers.

3.2. Plant Description

3 steam boilers DKBP-20-13
2 steam boilers DE-25-13, modified in 1990 to hot water boilers.
2 heat exchangers (steam/water), type PSV-200;(heating surface area 200 sq m
6 heat exchangers 05 OST 34-531-68 (heating surface area 63 sq m)
Reserve fuel is mazout (3 tanks with capacity 400 tons each).

Design Capacity:

Total capacity of steamboilers is 3 x 11.32 = 33,96 Gcal/h
Total capacity of hot water boilers 2 x 16 = 32 Gcal/h
Hot water for heating has a design water outlet temperature of 130 C, and return temperature of 70 C.

IV. ENERGY USE ANALYSIS

4.1. Energy Use

The largest savings are clearly to be made through efficiency improvement in the distribution and transmission of steam and condensate as well as accuracy in the accounting of heat. However, a major problem is the lack of metering outside the boilerhouse: with few exceptions, consumptions of hot water and steam are unknown and billings are based on assumed allocations, which originally may have been based on design data but have not been verified. Some consumer plants installed, at their own cost, metering for energy supply and condensate return. This reportedly has reduced some energy bills by as much as 50 percent. It is not clear if this reduction is due to real energy use reductions or to the inaccuracy of previously assumed consumption figures.

Clearly, metering energy use will have benefits for some consumers who actually consume less than the estimates made by the Ropka boilerhouse accounting department, but logically there must be some customers who consume more than estimated. These customers will presumably be reluctant to accept metering. However, until a fairer system of charging on the basis of actual energy consumption is put into place, there will be little incentive for any customer to save energy, and certainly no solid basis with which to evaluate capital investments for energy conservation. Without a firm base on which to make savings estimates, it will be unclear whether or not any proposed action requiring investment is justifiable, and whether or not an investment already made has proved economically sound. This uncertainty will provide no stimulus to improved energy efficiency.

A clear incentive for energy efficiency seems to be a need for the boilerhouse to cut hot water and steam loads, or at the very least to minimise their growth rate, so that new construction or commissioning of extra boilers (and thus the corresponding expenditure) can be deferred. For this reason, it is recommended that portable instruments be supplied to the boilerhouse in order to set up a "unit" who who would provide advice and services to their customers, as described in another section of this report.

The direct relationship between FUEL/ENERGY consumption and HEAT production is further graphically corroborated by the straight line seen on Appendix A. For a plant with good energy management, such as ROPKA, these graphs are usually a straight line, with more energy used for a higher level of production. The TOTAL HEAT produced on a monthly basis is shown on Appendix B and the TOTAL Fuel/Energy use is shown on Appendix C.

During our visit to the Ropka heating station, simplified system drawings were prepared and

boilerhouse operations reviewed. Spot readings were taken of key parameters and boiler efficiencies estimated. Operations were discussed with local staff. In addition, two typical consumers were visited -- the Desurek sporting goods manufacturer and a residential apartment block.

4.2. Boilerhouse

The hot water and steam generation and distribution systems were reviewed. The main facilities operated by the Ropka plant, consisting of three steam boilers and two hot water boilers, together with a comprehensive hot water and steam distribution network in the south eastern sector of Tartu. All boilers can fire natural gas or heavy fuel oil ("mazout"). The usual fuel is gas, although there is a reserve of fuel oil for use in severe winter conditions when the availability of gas can be affected. During 1990, very little fuel oil was actually burned.

The three steam boilers are similar units: each has a capacity of 20 tonnes per hour of 13 bar saturated steam and is fitted with a conventional economiser. Combustion air is provided by a forced draft fan and there is an induced draft fan at each boiler outlet.

Each of the two hot water boilers operates in parallel on the water side with its economiser (the gas side is conventional). The hot water boilers are also fitted with forced and induced draft fans.

Water is obtained from the town system and passes through a water treatment plant at the boilerhouse. This water is then used both for steam raising and for the circulating district heating system.

Within the boilerhouse, instrumentation is excellent. Most water/steam/fuel gas flows, temperatures and pressures are measured and displayed. Most flows are recorded on strip charts. Daily log sheets are comprehensive, although the log sheets themselves do not include fuel gas flows (these are recorded elsewhere). The accuracy of meters is unknown: balances attempted on the basis of spot readings during our visit were not always correct.

Listed below are some general comments applicable to the ROPKA Boilerhouse operation:

- In the boilerhouse daily reports there is no mention made of combustion or system efficiency.

- The work area in the boilerhouse was noted to be clean and tidy.

- The standard of insulation on piping is generally good.
- There are few steam or water leaks in the system.
- Heat loss from the boiler structures appears quite acceptable, with surface temperatures typically around 50-60 deg C. However, a number of hot spots were noted at which the outside surface temperature reached as high as 210 deg C. These hot spots are indicative of internal refractory brick failure, leading to high heat losses and ultimately to mechanical damage to the boiler structures.

General Recommendations:

- The brickwork should be repaired on hot water boilers 4 and 5 and on steam boiler 3 at the first opportunity.

4.3. DESUREK SPORTING GOODS FACTORY (USER)

4.3.1. Plant Description:

A short visit was made to the Desurek sporting goods factory, which makes 15,000 tennis rackets per month. The plant is profitable (about 500,000 roubles/month). The percentage of manufacturing cost represented by energy is not known by management but is thought to be around 10 percent. The plant is part of a manufacturing group with two other factories in Tallinn which make laminated wood and synthetic resin skis.

Plant operations include much sawing and cutting of wood. There is a large ventilation air load, with many hoods and scoops over equipment, drawing air into ducts through which the dusty air is vented (through cyclones) to atmosphere. There is no heat recovery from this exhaust air.

4.3.2. Energy Use:

The biggest problem in evaluating plant energy uses is the total lack of meters. No measurements are made of steam or hot water flows,and air flows around the ventilation system are not known. Almost no temperature

measurements are made, temperatures inside the building are not recorded, and the temperature of hot air in the ducts is unknown.

Energy is used for process purposes and space heating. Steam is consumed for the drying of

wood in 4 drying chambers. Air is blown into the dryer and circulated by fan, passing over steam coils within the dryers. Humidity within the dryer is monitored and a small amount of warm air is vented to atmosphere during the drying process. The steam coils have steam traps fitted outside the dryers but it is not known when these were last replaced. No condensate is returned to the boilerhouse because the line has ruptured through corrosion. The insulation of drying chambers seems quite good as the walls were not hot on the one dryer in operation. Steam is also used for drying glued racket frames in a small drying chamber.

Hot water is produced by steam in a heat exchanger (calorifier). Steam also used for heating air which is circulated into the works by two large fans. The fans are controlled by time switches only; there is no temperature control or measurement of temperatures inside the heated buildings. The temperature inside the main fan room was quite high with system not running and it appears the steam supply is difficult to turn off. Some steam traps fitted but again there is no indication if they have ever been maintained. One trap was clearly not working in the area of the hot water calorifier.

4.3.3. Areas to be studied further:

A possible problem at the Desurek plant is the diversity of sources and intermittent nature of their operation. Not all the machines work all the time or when heating of the premises is needed. For example, some preheating of the premises will be needed early in the morning before the workers arrive. Most of the exhaust air is dusty and needs to be cleaned before passing over heat exchange surfaces (for example, finned tubes would become clogged). The precise location of exhaust vents needs review, as these seem to be scattered around the plant, making collection of warm exhaust air and installation of central heat exchangers a costly proposition.

Heat recovery from the multiple air outlets shoul be considered after further quantifying studies. The complexity of the system and multiplicity of outlets from many different parts of the plant may make this expensive.

Wood offcuts, bark, sawdust, wood chips and shavings are not used within the plant but are sent to the local cooperative pig farm. The plant should consider seriously installing a wood stove for heat generation for simple space heating.

4.4. RESIDENTIAL CUSTOMER (USER)

4.4.1. Physical Description:

A short visit was made to a typical residential area to look at elements of the district heating system such as supply of hot water for domestic water use and for space heating. Several blocks are identical in Rahu St. -- blocks 5A and 7A for example -- each having 30 apartments on 6 floors, with identical construction, orientation, painting, general level of maintenance, materials of construction, etc. We visited one block. The hot water pipe from Ropka boilerhouse travels about 4 km underground to the area. Our temperature readings showed the water was leaving the boilerhouse at about 77 deg C and arriving at Rahu St. at 72 C. The return temperature from the building was 50 C at the time. Inlet and outlet pressures were 3.5 and 3.0 bar respectively.

4.4.2. Energy Use:

The equipment installed in the building basement consists of a heat exchanger for heating domestic hot water (cold water from the town system is heated). The water temperature is controlled using a control valve which allows more or less hot water from the boilerhouse to flow through the double pipe exchanger, as required.
Although insulation of the system was not particularly good, at least an attempt had been made to provide basic insulation around most of the pipes. The main valves and the control valves appeared to be in good order, with appropriate lubrication. No leaks were seen.

As usual, there was no metering of the heat input to the building. Inlet and outlet temperatures can be measured by glass thermometers, none of which were broken.

4.4.3. Recommendations:

It is suggested that two identical blocks be taken and supplied with heat meters on the inlet and outlet to establish the total energy used by each block. Assuming more or less the same occupancy levels, we would expect the energy use of the 2 blocks to be about the same. An experiment could then be run in one block, in which hand operated valves and bypasses could be introduced on radiators. At a later date, it may be possible to install heat flux metering in individual apartments (evaporative type) to monitor relative heat uses, together with thermostatic controls.

4.4.4. Expected Results:

- Installation of better controls in residential blocks.

- Making decisions on future methods of billing residential consumers for energy use (will heat metering schemes be practical, will they work effectively and give acceptable results?)

- Providing a basis for further work and tests on energy saving (e.g. better insulation of walls, other energy saving measures such as sealing of gaps around windows, double glazing) by providing a reliable measurement of actual heat loads.

- Developing better estimation methods for heat loads.

V. RECOMMENDATIONS FOR ENERGY EFFICIENCY IMPROVEMENTS

Recommendations have been divided into two areas:

GENERAL AND ENERGY MANAGEMENT IMPROVEMENTS.
IMPROVEMENT FROM USAID FINANCED EQUIPMENT PURCHASES

The financial circumstances of the plant suggest that improvements in the first category should be undertaken as quickly as possible, concurrent with or before, those financed by USAID. RCG/HB didn't, at this time, consider IMPROVEMENTS REQUIRING MAJOR CAPITAL INVESTMENTS due to the current economic situation in Estonia and at Tartu.

5.1. GENERAL AND ENERGY MANAGEMENT IMPROVEMENTS

5.1.1. Boiler House Operation Control Improvement

Current Conditions:

With respect to the present operation of the boilerhouse equipment, readings were taken on December 3 and efficiencies estimated. The boilerhouse staff do not take such readings but use an outside group (Pintor, from Tallinn) to make an evaluation from time to time.The last check was made in April 1991 and this reported boiler efficiencies around 91 percent based on net calorific values, after adjusting operations to minimum excess air conditions.

Readings were also taken for hot water boilers #4 and #5. Key parameters were:

		#4	#5
Gas fired	M3/h	980	880
Water inlet	deg C	52	52
Water outlet	deg C	87	90
Combustion air inlet	deg C	23	29
Stack gas before econ	deg C	180	180
Stack gas after econ	deg C	90	90
Stack gas CO2	pct vol	7.5	9.5
Excess air	pct	56	23
Estimated efficiency (based on gross CV)	pct	86.7	87.5

Recommended Action:

It is recommended that the plant monitors a number of key parameters and ratios which represent system or equipment efficiencies, such as:

- Steam boiler efficiency, represented by tonnes of steam produced per M^3 of fuel gas fired (or per tonne of mazout), calculated for each boiler separately if possible Hot water boiler efficiency, expressed as the heat output (in kilocalories) per M^3 of gas fired, for each boiler separately if possible.

- Heat supplied for district heating purposes, calculated as kilocalories supplied per month and accumulated over the heating season. In addition, the number of degree days of heating should also be calculated each month from ambient temperature data and assuming a base temperature below which heating is necessary (e.g. 15 deg C). The cumulative heat supplied should be plotted against the cumulative degree days to monitor the effectiveness of the heat supply system.

- The excess air on boiler #4 is high and should be adjusted to the same level as boiler #5:

Expected Results:

This should give an increase in efficiency of at least 1 percentage point.

5.1.2. Boiler Refractory/Insulation

Current Conditions:

Heat loss from the boiler structures appears quite acceptable, with surface temperatures typically around 50-60 deg C. However, a number of hot spots were noted at which the outside surface temperature reached as high as 210 deg C. These hot spots are indicative of internal refractory brick failure, leading to high heat losses and ultimately to mechanical damage to the boiler structures.

Recommended Action:

The brickwork should be repaired on hot water boilers 4 and 5 and on steam boiler 3 at the first opportunity.

Expected Results:

The benefits received from these modifications are more related to improved safety and reliability in operations. The economic benefits are not easily quantified but can be in the range of 1-3% of boiler fuel use.

5.1.3. Combustion Efficiency Improvement

Current Conditions:

A check of combustion air intakes showed that the hot water boilers had air intakes inside the boilerhouse and the combustion air temperatures were 23 and 29 deg C, while the steam boiler air intake was open mainly to the outside and the air was only 14 deg C. It was said that drawing all the combustion air from inside the building would result in too much cold air entering and would cause the boilerhouse temperature to be too low for the operators comfort. However, the best place for taking combustion air is at the warmest position, and the highest temperature observed inside the building was 33 deg C (near the roof level).

Recommended Action:

The plant should therefore review the position of air intakes and use the hottest air available. No new ducts are needed as the intake position can be varied using existing ducts.

Expected Results:

A difference in inlet air temperature of say (33-14) or 19 degrees represents an increase in boiler efficiency of 1 percentage point.

5.1.4 Boiler Feed-Water Tank Insulation

Current Conditions:

Our examination of boiler feed water and blowdown water showed that the boiler drum water was at 2500 ppm, which is well within the limit of about 3500 ppm normally suggested for a boiler operating at 10 bars. The condensate collection tank was seen to be completely uninsulated. The tank contents are about 100 degrees C, while the surface temperature was measured at 98 deg C. The heat loss from the tank was estimated to be

about 12 kW, equivalent to about 28 M^3/h of natural gas.

Recommended Action:

If the tank were insulated, the collected condensate might boil off faster and returned condensate lost as steam. It may thus be necessary to put a small flow of cold water into the tank to keep the temperature below 100 deg C. The hot water outlet temperature is set according to a standard graph and often this leads to overheating in buildings, especially during mild weather, which leaves occupants no option but to open the windows to reduce inside temperatures.

It is suggested that the plant conduct tests and reduce the water temepratures by say 2-3 degrees below the figure given by the graph. Customer reaction must be carefully monitored and, if the heat supply is not adversely affected, the graph could be modified.

Expected Results:

The approximate saving in boilerhouse fuel would be 3-4 percent for a reduction in 1 degree C, assuming a typical supply/return difference of 20-25 degrees. In the longer term, the possibility of saving electricity by reducing the hot water circulation rate during periods of mild ambient temperatures should be investigated. This will require the installation of some type of motor controls on the circulating pump motors (e.g. frequency control) and could prove costly: benefits are not easily estimated and the idea requires further investigation.

5.2. USAID FINANCED EQUIPMENT PURCHASES

Taking into account the findings of the brief audit made at ROPKA Station and the needs expressed by plant management, it is recommended that the following equipment be supplied to the plant to assist in making energy efficiency improvements in the short term:

5.2.1. ECO F-1, Energy and production management computers

Existing conditions:

ROPKA collects a vast amount of information every day, but has no way of organizing this data and using it for production and energy management control.

Recommended action:

Provide two IBM-PC 386 equivalent computers with printers and Lotus 1-2-3 software, together with the spreadsheets of production and energy developed by RCG/Hagler, Bailly, Inc. ROPKA will obtain training in Lotus locally.

Estimated cost of equipment:

$6,000

Estimated cost of installation and training:

$1,000

Estimated benefits, energy savings (and economic savings):

The equipment, with the proper software, can serve as the basis of an energy management information and control system. The introduction of a management information system, with control actions taken in response to conditions identified in the plant, can achieve energy savings of 5-10%. Based on savings of at least 1% of energy costs, benefits are estimated as $48,000 per year, not including productivity or quality benefits.

Estimated payback period:

0.1 year

5.2.2. ECO F-2, Portable efficiency monitoring instruments

Existing conditions:

In tests of combustion efficiency at ROPKA, excess air was found to be 100% on one steam boiler, which is too high. Boiler water quality (total dissolved solids) was measured, and TDS was found to be too high. Some areas of inadequate insulation were observed, and heat loss from steam and hot water distribution systems is substantial. Further optimization would be possible with advanced instrumentation and efficiency teams.

Recommended action:

It is recommended that the boilerhouse be provided with some portable energy auditing instruments for checking their own performance regularly and to help a "customer service group" which should be set up. Even in the absence of incentives for consumers to improve their energy efficiency, the Ropka plant can offer advice and assistance to customers, building their own experience and establishing credibility. Pending the arrival of methods of charging consumers on the basis of their actual consumption, the plant may still be able to persuade consumers to reduce energy use, provided no major investment is required. Good customer relations take time to build anyway, and the promotion of energy awareness is a worthwhile objective in itself.

Customer help can be given in the areas of combustion control and improved operation of steam systems.

Estimated cost of equipment: $11,500 consisting of:

combustion kit	4,000
TDS meter:	500
thermocouple:	1,000
infrared:	1,000
ultrasonic (air/solid)	4,000
electric survey meter	1,000

Estimated cost of installation:

none

Estimated benefits, energy savings (and economic savings):

Based on boiler efficiency at time of audit, combustion efficiency improvements of 3-5% are possible. Avoidable losses in the distribution system are estimated as 1-3%. The estimated annual savings of the energy efficiency teams is 2%, or $200,000 per year. The savings potential for the "consumers" derived from use of such equipment is impossible to calculate. We can only cite the approximate savings potential of the sports goods factory that was visited. At that plant, savings of at least 20 percent of heat load appear readily achievable through rationalisation of the heating and ventilating systems, and better steam trapping on wood drying chambers (some investment will be necessary).

Estimated payback period:

Less than 0.1 year.

5.2.3. ECO F-3, Heat meters for for two buildings and thermostatic radiator controls.

Existing Conditions:

Several residential apartment blocks are heated by ROPKA and are identical in Rahu St. -- blocks 5A and 7A for example -- each having 30 apartments on 6 floors, with identical construction, orientation, painting, general level of maintenance, materials of construction, etc. We visited one block. The hot water pipe from Ropka boilerhouse travels about 4 km underground to the area. Our temperature readings showed the water was leaving the boilerhouse at about 77 deg C and arriving at Rahu St. at 72 C. The return temperature from the building was 50 C at the time. Inlet and cutlet pressures were 3.5 and 3.0 bar respectively.

The equipment installed in the building basement consists of a heat exchanger for heating domestic hot water (cold water from the town system is heated). The water temperature is controlled using a control valve which allows more or less hot water from the boilerhouse to flow through the double pipe exchanger, as required.

Although insulation of the system was not particularly good, at least an attempt had been made to provide basic insulation around most of the pipes. The main valves and the control valves appeared to be in good order, with appropriate lubrication. No leaks were seen.

There was no metering of the heat input to, and outlet of the building. Inlet and outlet temperatures can be measured by glass thermometers, none of which were broken.

Recommended Action:

It is suggested that two identical blocks be taken and supplied with heat meters on the inlet and outlet to establish the total energy used by each block. Assuming more or less the same occupancy levels, we would expect the energy use of the 2 blocks to be about the same. An experiment could then be run in one block, in which hand operated valves and bypasses could be introduced on radiators. At a later date, it may be possible to install heat flux metering in individual apartments (evaporative type) to monitor relative heat uses, together with thermostatic controls. Even with hand valves, however, the heat meters would allow

- Validation of actual heat loads and comparison with the values currently used for

billing by energy allocation

Comparison of the heat loads for the two identical blocks, after advising the occupants of one block how to reduce energy consumption by using the valves.

Residents could be given a small fee to take part in the experiment, with an additional incentive based on the level of energy reduction actually achieved.

Expected Results:

The results of this experiment would give a basis for further action by the Tartu Energy Administration in various areas, such as:

Installation of better controls in residential blocks.

Making decisions on future methods of billing residential consumers for energy use (will heat metering schemes be practical, will they work effectively and give acceptable results?)

Providing a basis for further work and tests on energy saving (e.g. better insulation of walls, other energy saving measures such as sealing of gaps around windows, double glazing) by providing a reliable measurement of actual heat loads.

Developing better estimation methods for heat loads.

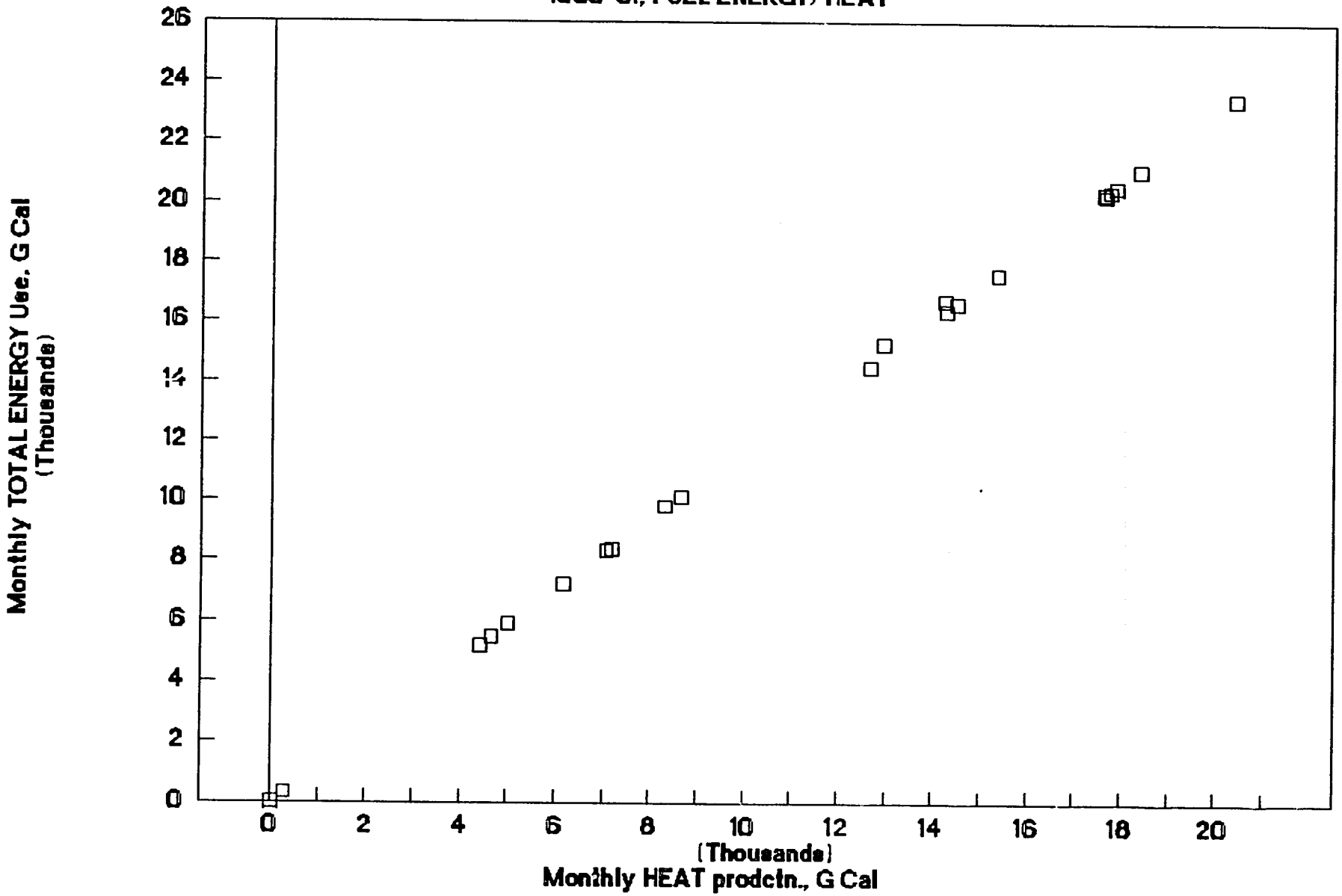
APPENDICES
GRAPHICAL PRESENTATION OF HISTORICAL ENERGY, PRODUCTION AND CLIMATIC MONITORING DATA

ROPKA Station, TARTU DISTRICT HEATING

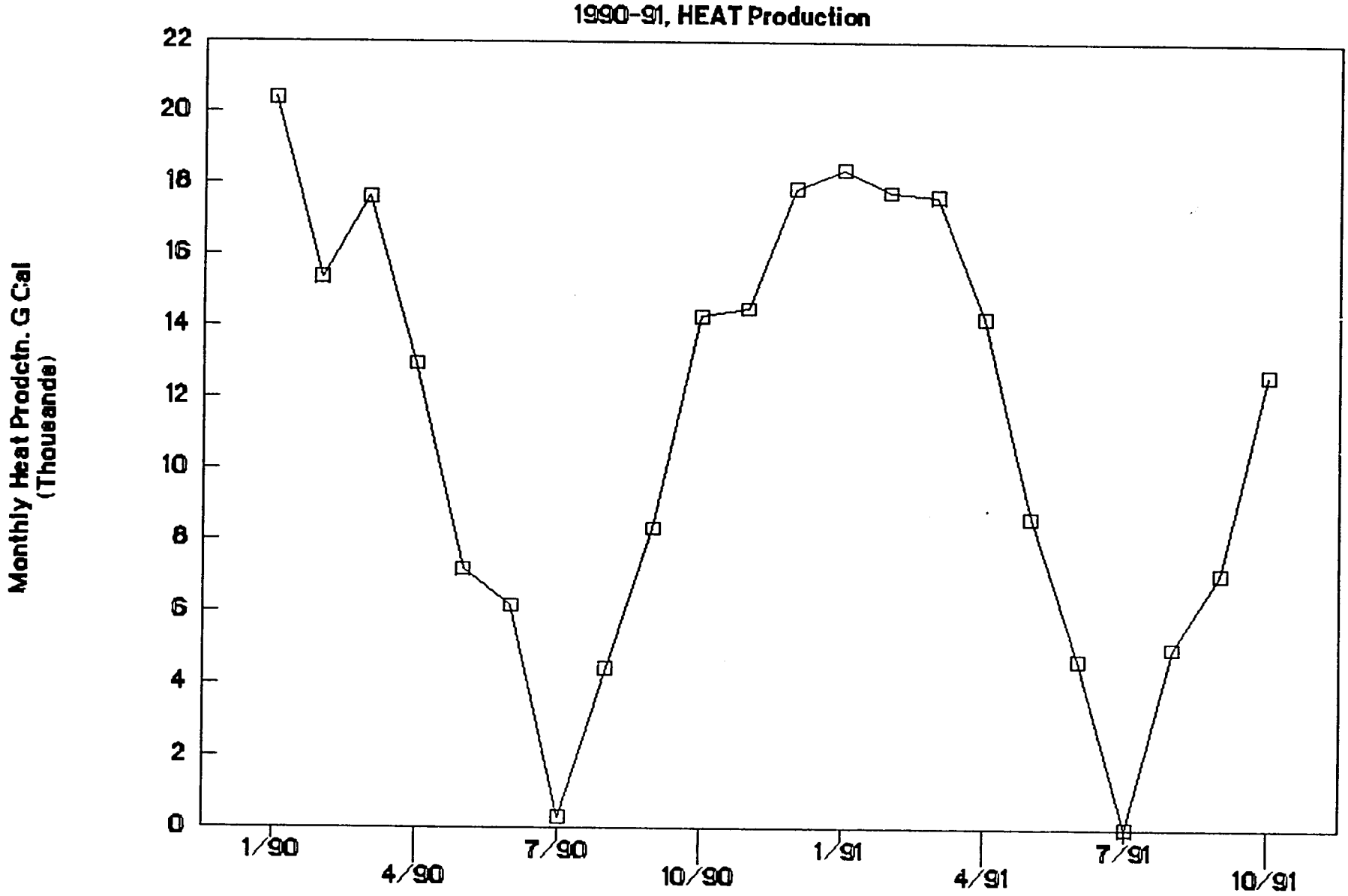
APPENDI:

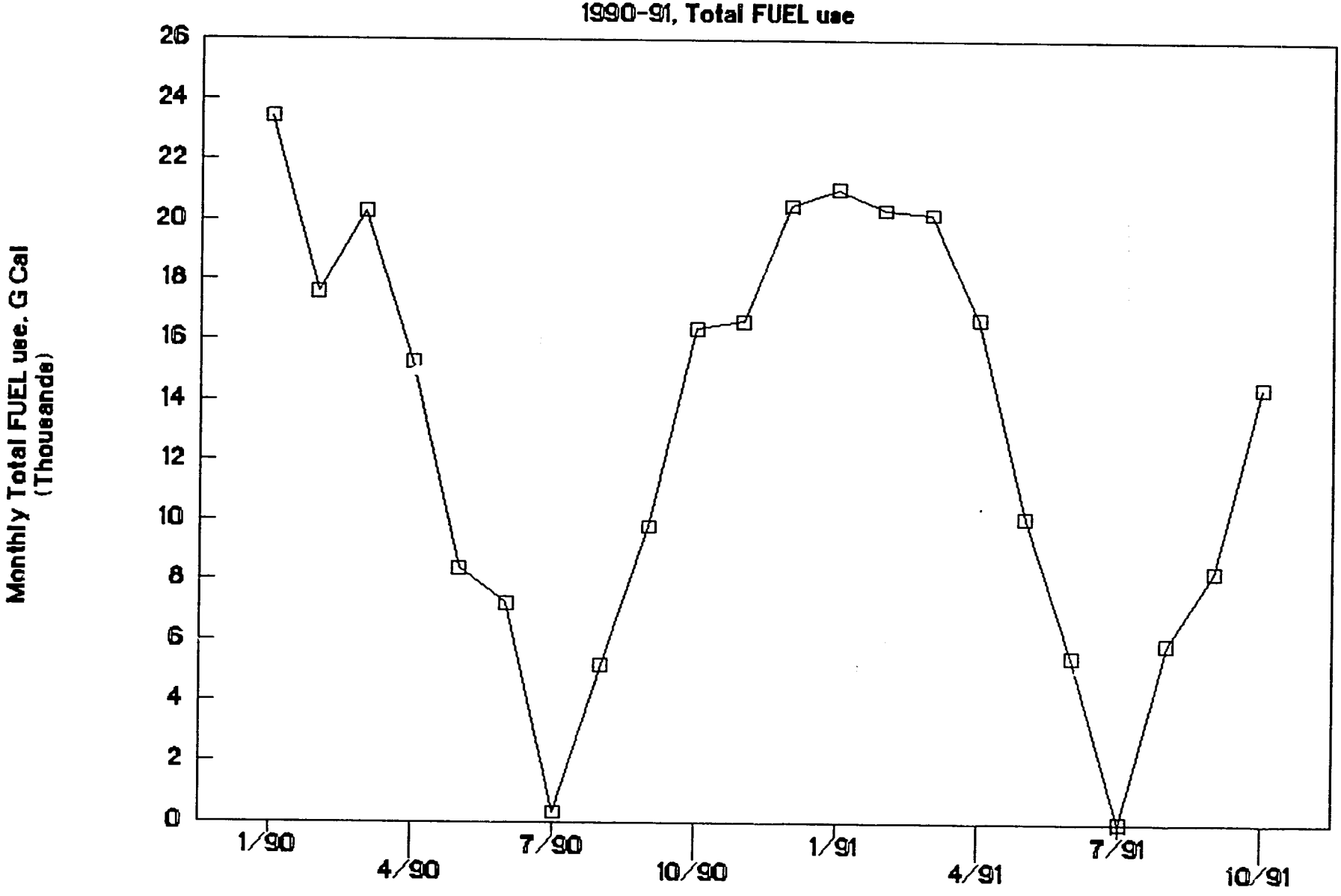
TARTU HEATING DISTRICT - ROPKA STATION

1990-91, FUEL ENERGY/HEAT



TARTU HEATING DISTRICT - ROPKA STATION



APPENDIX

TARTU HEATING DISTRICT - ROPKA STATION