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ENERGY EFFICIENCY AUDIT REPORT
P.V. BUDAFOKI PAPER PLANT
BUDAFOK, HUNGARY

APRIL 1992

PREPARED BY: RCG/HAGLER, BAILLY, INC.
Arlington, VA

and

EGI CONTRACTING/ENGINEERING
Budapest, Hungary

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

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR EUROPE
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The contents of this report include recommendations based on data provided by the client plant, measurements made on site, calculations, and engineering judgment. 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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The enthusiastic assistance of plant personnel in a number of departments contributed greatly to this brief energy audit of the P.V. Budafoki Papirgyar plant. In particular, we wish to acknowledge the major participation of Messrs Pusztai and Farkas of the Energy Supply Department who provided much of the basic data, guided us around the plant and participated in test work. We also wish to express our thanks to Mrs. Lizicska (Production Manager) for information provided, and to Messrs. Moncz (boiler operations) and Ormos (electrical department) who provided information and carried out various tests themselves using the portable instruments brought to the plant.

EXECUTIVE SUMMARY

ACTIVITIES

The Budafok paper plant is the only plant in Hungary which makes cardboard for boxes and packaging. There are 460 employees at the plant. At present the plant is state-owned but discussions are in progress with a view to privatisation.

Single and multilayer board are produced, with about 80 percent of raw materials being waste paper and 20 percent purchased pulp. Production of saleable board in 1990 was almost 35000 tonnes from the three conventional lines and one line for hand made board. The latter contributed only about 4 percent of 1990 production and is expected to cease operation soon.

ENERGY USAGE

Energy supplies to the plant consist of electricity purchased from the grid, steam purchased from the nearby Buszesz plant, and natural gas for raising steam in the paper plant boilers. Occasionally warm water is also purchased from Buszesz but this is expected to cease shortly. Quantities of warm water purchased in 1990 were relatively small, amounting to around 1200 M3 per day on average for the first quarter only.

Energy consumptions (excluding warm water) in 1990 were:

	Basic units of consumption		Energy content GJ	pct	Cost ** 1000 Ft	pct
Electricity *	28300	Mwh	319945	48.7	133066	52.0
Natural gas	8024500	M3	272699	41.4	88350	34.5
Purchased steam	24674	tonnes	65337	9.9	34544	13.5
TOTALS			657981	100.0	255960	100.0

* Conversion to GJ uses a factor of 2700 kcal/kwh, the estimated equivalence of primary fuels used for electricity generation.

** Cost figures are based on current prices (April 1991).

The total energy consumption is currently equivalent to an average of about 7500 Ft. per tonne of paper produced. Based on an average paper price of say 38000 Ft., energy thus represents about 20 percent of the selling price of the product.

With respect to specific energy consumptions (the energy consumed per unit of production), the plant data for 1990 indicate the following:

Electricity consumed by board machines	755	kwh/t paper
Total electricity consumption	830	kwh/t paper
Steam consumed by board machines	2.73	tonnes/t paper
---- equivalent to	6.74	GJ/t paper
Total steam consumption	9.5	GJ/t paper

These figures suggest that the energy efficiency of the Budafok plant compares with typical practice for board mills using the technology of the mid to late 1970"s.

PLANT EVALUATION

A review of plant energy records and reporting systems was carried out from April 3-9, 1991, and various tests of equipment performance were conducted in the plant using data obtained from existing plant instrumentation and from portable energy audit instruments.

The main findings were as follows:

(1) Energy related data are collected daily and reports produced regularly by the Energy Supply Department. In these reports, a number of efficiency ratios are presented. However, the reports do not appear to be fully utilised for energy management purposes.

(2) Metering of major energy consumptions is adequate although some new electricity, gas and steam meters would be useful.

(3) As noted above, in terms of energy efficiency, overall plant performance is up to the standard expected for mills designed in the late 1970's.

(4) Boiler performance is generally good, with excess air maintained at acceptable low levels.

(5) The quality of water sent to the boilers and that of the water in the boilers was below the standards for Total Dissolved Solids normally expected for package boilers producing saturated steam at 8-9 bars.

(6) Boiler heat losses from radiation and convection are quite low.

(7) Lines to steam traps and condensate return lines often lack adequate insulation.

(8) In general, steam traps require repair or replacement. Of the traps tested, about 85 percent were found defective.

(9) In particular, it is believed that significant steam losses are occuring through defective traps on the board machines. This is partly due to the wrong type of trap being installed.

(10) The marginal cost of steam generated in the plant is about 950 Ft/tonne, compared with a stated total cost of 1100 Ft/t and a cost of purchased steam of 1400 Ft/t from the nearby Buszesz plant.

(11) The steam heated space heating system is not efficient.

(12) Some motors are clearly oversized for their present duties but others were found properly sized.

(13) The cleaning of lighting fixtures could be improved.

MAIN RECOMMENDATIONS

Bearing in mind that the plant has little funding available for capital investment projects and that the ownership structure may change later this year, our principal recommendations are therefore the following:

(1) Improve the format and content of regular reports, and increase the efficiency of report preparation by introducing a computer. Carry out data analysis with the routine figures collected and develop the relationship of production to energy use.

(2) Operate the boilers with a higher blowdown and recover additional heat by installing more heat exchange surface.

(3) Maintain a good combustion efficiency by regular checking of excess air levels.

(4) Install a few additional gas, electricity and steam meters to improve monitoring and control of major energy users.

(5) Improve the insulation of certain steam and condensate lines.

(6) Repair or replace all defective steam traps in the plant on general steam and condensate system applications..

(7) Replace all traps on the drying cylinders of the board machines.

(8) Convert the space heating system to circulating hot water.

(9) Check the load on the larger motors and replace oversized motors where economically justified.

(10) Modify operating procedures for the hydropulpers if possible, to reduce the amount of "idle" time.

(11) Review the contract for steam purchases from Buszesz and renegotiate the contract to reflect more realistic steam production prices.

SAVINGS, COSTS AND PAYBACKS

The anticipated savings, corresponding investments and calculated paybacks are summarised in Exhibit A. The overall energy savings amount to about 7 percent of current energy bills and recommended actions have an average payback of 6 months.

RECOMMENDED EQUIPMENT PURCHASES

Support from USAID for the purchase of selected equipment and instruments is recommended as part of this project. These purchases are:

Steam traps for the board machines		US $ 20,000
Computer, printer, Lotus software		5,000
Sonic steam trap tester		1,300
Electrical system survey instrument		6,000
Combustion analyser		3,000
Water quality TDS meter		300
	Total	35,600

EXHIBIT A

SUMMARY OF SAVINGS OPPORTUNITIES

No.	Item	Savings Ft	Savings US $	Cost Ft	Cost US $	Payback months
	Energy Management					
1.1	Reports, balances	--	--	--	--	---
1.2	Additional data	--	--	--	--	---
1.3	Maintenance costs	--	--	--	--	---
1.4	Monthly review	--	--	--	--	---
1.5	Computer, software	1300000	18000	365000	5000	3.3
1.6	Electricity meters	650000	9000	123000	1680	2.2
1.7	Elec survey inst'mt	560000	7700	438000	6000	9.3
1.8	Gas/steam meters	880000	12000	1340000	18400	18.4
	Boilerhouse					
2.1	Combustion analyser	870000	12000	220000	3000	3.0
2.2	Blowdown heat rec.	1160000	15900	790000	11100	8.4
2.3	Economiser	920000	12600	1500000	20500	19.5
	Steam & condensate lines					
3.1	Replace traps	365000	5000	365000	5000	12.0
3.2	Line drainage, traps	--	--	--	--	---
3.3	Sonic trap tester	235000	3200	95000	1300	4.9
3.4	Cond line insulation	--	--	--	--	---
	Steam purchases					
4.1	Review contract	--	--	--	--	---
	Board machines					
5.1	Replace traps	7700000	105500	1460000	20000	2.3
5.2	Flash steam rec	--	--	--	--	---
5.3	Hood ht rec system	--	--	--	--	---
5.4	Insulate cyl. ends	1980000	27000	1980000	27000	12.0
5.6	Minimise grade changes	--	--	--	--	---
	Space heating					
6.1	Convert to hot water	935000	12800	--	--	---
6.2	Insulate lines	--	--	--	--	---
	Electrical					
7.2	Replace a/c motors	112800	1550	300000	4100	31.8
7.3	Dual spd h/p motor	163600	2200	241000	3300	18.0
7.4	Improve lighting	20000	550	73000	1000	21.8
	Totals	17851400	245000	9290000	127380	6.2

Total savings equivalent to about 7 percent of present energy expenses.

1 INTRODUCTION TO THE PLANT

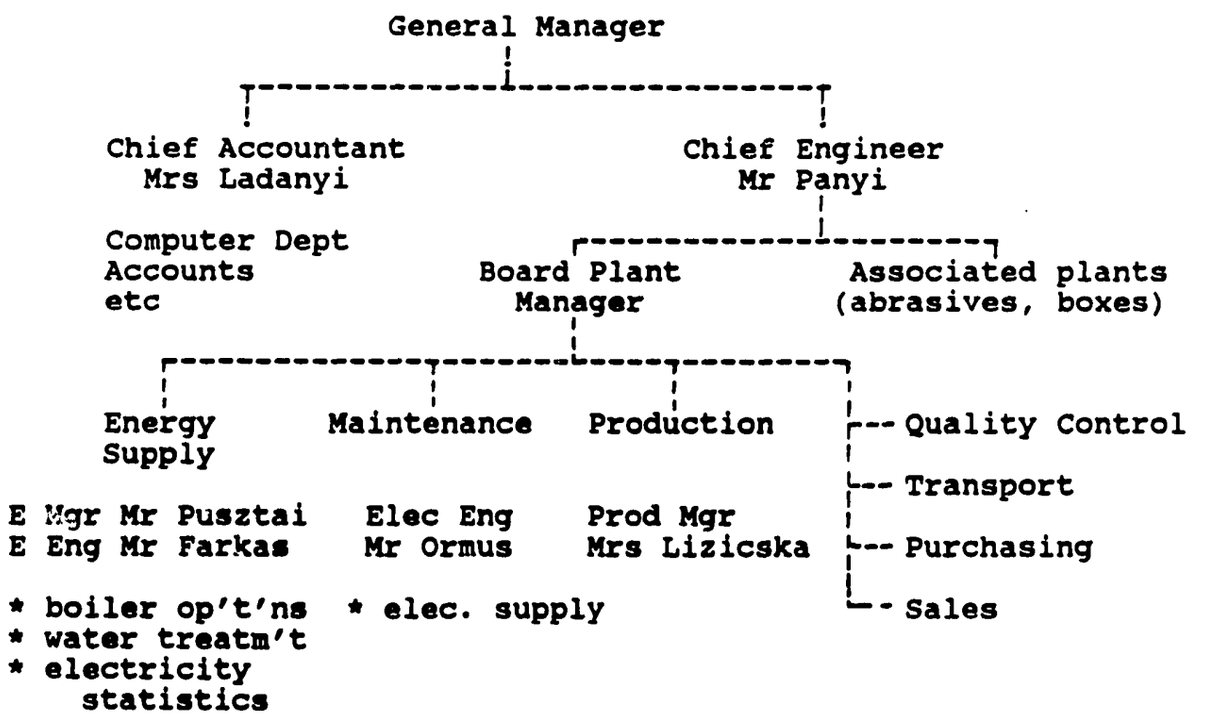
1.1 PLANT ACTIVITIES

The PV Budafoki Papirgyar plant is the only one in Hungary currently making board for packaging. Single and multilayer boards are produced in a wide range of qualities, thicknesses and cut sizes. The board is made in three lines of conventional board making machines, together with a small line for hand made board. Production in 1990 was about 34100 tonnes, of which only 1460 tonnes (4.3 %) were hand made. Raw materials are purchased pulp and recycled waste paper, the latter amounting to about 80 percent on average. The raw materials are broken down in a slurry of water in the materials preparation section.

In addition to the main production facilities, the plant includes various utility supply sections, such as the boilerhouse, a water treatment plant and air compressors: these are described below.

1.2 MANAGEMENT STRUCTURE

The management structure of the plant may be summarised as follows:



The Energy Supply Department reports through the Chief Engineer and is responsible for operating the boilerhouse and water treatment plants, as well as maintaining energy consumption records and preparing routine reports on energy use. This extends to electricity statistics, although the responsibility for electricity systems lies with the Maintenance Department.

1.3 ENERGY AND UTILITY SUPPLY SYSTEMS

The main energy sources for the plant are electricity, natural gas and purchased steam. The electricity is obtained entirely from the grid as the plant does not generate any of its own electricity. The supply is provided along two 10 kilovolt feeders, one of which is used while the other is kept as standby. The contracted maximum load is 6.2 MW, although the maximum demand rarely exceeds 5.4 MW. Power factor correction to a level of about 0.94 by distributed capacitors ensures the plant receives a premium in the monthly electricity bills.

Natural gas is purchased for use in the plant boilers to raise steam. A small amount of natural gas is also used in the process itself. The calorific value of the gas normally varies in a narrow range from 33.9 to 34.1 MJ/nM3.

Steam is supplied from the plant boilers and through purchases from the nearby Buszesz power plant. Although the Buszesz plant operates a cogeneration system, the price charged for steam is higher (at 1400 Ft/t) than the cost of self-generated steam (1100 Ft/t), and therefore the paper plant generally runs one or two of its own boilers for base load steam demand and draws on Buszesz to provide peak demands. This is of course the reverse of the situation which Buszesz would like but is a consequence of the relative pricing and of the unreliability of the Buszesz steam supply. In fact, the plant wishes to negotiate an amended contract.

The plant has four locally made, gas fired boilers installed in their boilerhouse which date from about 1972. Saturated steam at 9 bars is produced, although the steam is actually used at about 3-4 bars (the pressure reduction being performed through a simple let-down valve). The boiler capacities and minimum loads are as follows:

	Boiler 1	2	3	4
Maximum capacity (t/h)	11.0	12.0	12.0	10.5
Minimum load (percent)	50	30	30	30

Each boiler has a small heat recovery system connected to the continuous boiler blowdown line and an internal system for heat recovery from the combustion gases into the boiler feed water. There are no air preheat systems fitted. Condensate recovery is stated to be about 80 percent, some of which is returned to Buszesz and the remainder to the boilers.

Water for various uses in the plant is obtained from wells and from the Danube River. Waste water is returned to the Danube after treatment at the plant, which includes filtration and clarification. Water for the boilers is treated in an ion exchange unit.

From time to time, the plant receives warm water at around 40 deg.C from the Buszesz plant. During the first quarter of 1990, the maximum quantity was approximately 3000 M3/day and the average was 1200 M3/day.

Compressed air at 6-7 bars is provided for general plant use (e.g. presses, operation of paper guides on the machines, pneumatic actuators) by two air compressors rated at 780 nM3/h each. Each is

fitted with a 100 kw motor. Demand is such that both compressors are normally running at near full capacity. In fact, the compressors were originally two cylinder machines and have been modified for single cylinder operation. Oil free dry instrument air is provided from a separate installation with two compressors.

At present, there is heat recovery at the air compressor outlet but the recovered heat is discarded as warm water to drain.

1.4 ENERGY CONSUMPTION

Energy consumption by the plant during 1990 (excluding warm water) was as follows:

	Basic units of consumption		Energy content GJ	pct	Cost ** 1000 Ft	pct
Electricity *	28300	Mwh	319945	48.7	133066	52.0
Natural gas	8024500	M3	272699	41.4	88350	34.5
Purchased steam	24674	tonnes	65337	9.9	34544	13.5
TOTALS			657981	100.0	255960	100.0

* Conversion to GJ uses a factor of 2700 kcal/kwh, the estimated equivalence of primary fuels used for electricity generation.

** Cost figures are based on current prices (April 1991).

Details of energy consumptions are given in Appendix A. In summary, some key parameters recorded for 1990 are:

* Board produced (net saleable)	34129	tonnes
* Average ratio, net to gross production	0.824	
* Electricity consumed by board machines	755	kwh/t product
* Total electricity consumption	830	kwh/t product
* Total purchased steam	24647	tonnes
* Self generated steam	90966	tonnes
* Total steam	115613	tonnes
* Estimated boiler efficiency (average)	82	percent
* Equivalent to	11.5	t steam/1000 M3 gas
* Equivalent to	87.3	M3 gas/t steam
* Steam consumed by board machines	2.7	tonnes/t product
* Equivalent to	6.7	GJ/t product
* Total plant steam consumption	9.5	GJ/t product
* Total energy cost	7543	Ft/t product
* Energy cost as percent of product price (based on typical price of 38000 Ft/t)	20	percent

The performance of the plant may be compared with figures in published reports for the industry in other countries. For example, energy costs in the UK are typically 15 to 20 percent of overall production costs in a paper or board mill: the figure for the Budafok plant of 20 percent of typical board price is thus consistent. In terms of energy consumption, the plant appears to be close to typical European standards of the late 1970's or early 1980's. This is to be expected due to the age of the basic plant design:

	Budafok plant	EEC data(1)	UK data(2)	
Thermal energy	9.5	8.3	11.2	GJ/t product
Electricity	830	-	750	kwh/t product

(1) From Energy Audit #3, "Pulp, Paper and Board Industry of the European Economic Community", data for 1981/2
(2) From Energy Audit Series # 14, The Paper and Board Industry, UK Dept. of Energy and Dept of Industry, data from 1978.

A modern design of mill would probably show an improvement of about 20 percent on the older figures.

2 FINDINGS AND RECOMMENDATIONS

2.1 ENERGY MANAGEMENT

2.11 Findings

The Energy Supply Department produces routine daily, monthly, quarterly and annual reports of energy consumption. In these reports, a number of efficiency ratios are presented, such as specific energy consumption of the board machines in kwh per tonne of saleable product. All the reports are produced by hand calculation and this is a time consuming exercise every day. In addition, manual calculation is always prone to error (although it must be stated that very few minor discrepancies were found in our analysis of the records).

It is our impression that the data collected and presented in the regular reports are not fully utilised for energy management purposes. Indeed, we do not believe the daily differences in plant performance are analysed by production staff or management, or that changes in plant parameters are made with a view to improving efficiency. As is typical for many plants, the focus is almost entirely on production and therefore the economics of production (including energy consumption) do not receive high enough attention. This is not to say that expenditures are not checked: rather, the cost effectiveness of changes in plant operation or in changes in maintenance procedures, for example, are not evaluated and decisions are not always based on proper analysis of cost-effectiveness. Trends in energy efficiency, either towards better

or worse performance, are not monitored and corrective actions, where necessary, are unlikely to be made on the basis of efficiency changes.

Our analysis of the routine data collection and reporting procedures suggests that improvements in both content and format of the reports are desirable, and that the efficiency of report preparation can be improved significantly. These actions would result in more useful, accurate and timely reports being available to management. In addition, time currently spent by technical staff on tedious hand calculations could be utilised for more productive work, such as the analysis of plant performance and energy efficiency, and the development of practical recommendations to improve profitability. The proposed measures have been discussed with the staff involved and some of the proposed procedures demonstrated (for example, see Appendix A). There is a high level of interest in the Energy Supply Department in making improvements in energy management procedures.

2.12 Recommendations Concerning Energy Management

Specific recommendations with respect to energy management are therefore as follows:

1 Organise the preparation of all routine reports, from daily to annual, through the use of Lotus spreadsheet software (or equivalent). Examples of the procedure and typical reports are given in Appendix A.

2 Change the report formats to present data for corresponding periods side by side. For example, daily reports for one entire month could be put onto one page, with the figures for each day filling one vertical column. In this way, the data are more easily compared from one day to the next, changes in key parameters can be seen more easily, and management can focus more quickly on apparent discrepancies or adverse trends.

3 Review the current parameters reported and add key data and ratios which will assist in improving energy management. The example reports in Appendix A include a number of parameters and ratios which are not usually shown in the current reports. For example, gross production should be reported together with the ratio of net (or saleable) production to gross (or total) production. The level of product wastage and costly reprocessing is readily measured by this ratio, which is apparently as low as 0.73 on occasion (that is, about 27 percent of production is rejected as being of unsaleable quality or is "lost" during changes of board thickness or grade, and is recycled for total reprocessing).

4 Extend the energy consumption reporting procedure to include the calculation of water/condensate/steam balances and an electricity balance every month. A start can be made on these balances using the available data, but establishing reliable balances may need the installation of some additional meters. In fact, the development of the balances can contribute to the definition of additional metering needs.

5 As part of the routine monthly energy report, present selected parameters in graphical format. The use of graphs to present data can make the report more interesting, more easily understood, and can show the development of trends more clearly than simple tabular information. Graphs are already kept by the Energy Supply Department but are not included in routine reports.

6 Provide the necessary hardware and software for computerising the energy reporting systems. At present, the Energy Supply Department does not have a computer and therefore it is recommended that a computer, printer and relevant software be purchased within the scope of this project. Immediately on receipt of these items, a brief period of training and assistance to implement the new procedures is suggested.

By improving the energy management system and ensuring that the relevant data are available, it should be possible to improve the basis for costing products by grade and quality, as well as reducing the consumption of energy throughout the plant.

2.2 METERING

2.21 Findings

It is a fundamental principle of energy management that you cannot manage what you cannot measure. A number of major energy consumptions are metered already by the plant. It is thus possible to monitor the electricity and steam consumed by each board machine line. Electricity consumption by several departments is known (water treatment, boilerhouse). Estimates are however necessary for providing figures for lighting and use by storage and maintenance workshops. Electricity consumed for air compression and for raw material preparation are not known independently.

With respect to natural gas consumption, this is only known as a total boilerhouse consumption and the use by each boiler is not known. Steam production by each boiler is metered and it would therefore be useful to have fuel gas meters on each boiler, enabling a rapid check of boiler efficiency to be made by comparing steam produced against gas consumed. Figures obtained from the plant records indicate significant variations in boiler efficiency in the range 70.8 to 90.8 percent (corresponding to the range 9.8 to 12.8 tonnes of steam per 100 M3 of natural gas). Boiler efficiency should be monitored closely and the reasons for these apparent wide variations should be found.

With respect to steam consumption, it is important to know the quantities used for space heating and heating domestic water. It is doubtful if the steam used for these purposes is known with confidence.

2.22 Recommendations on Metering

The following recommendations are therefore made:

1 Purchase for the plant a portable instrument for conducting power consumption surveys and conduct a comprehensive survey of electricity loads and consumptions.

2 Install electricity meters for the main operating departments such as the raw material preparation section and the compressed air section. Specific metering locations should be determined using the results of the survey mentioned above.

3 Install natural gas meters for each boiler.

4 Install steam meters on the distribution lines to major users to ensure that reasonable steam balances can be drawn up each month. By measuring most of the steam consumptions around the plant, it should be possible to reduce the amount of steam shown each month as "losses", whose real nature is not currently known.

2.3 OVERALL PLANT ENERGY PERFORMANCE

2.31 Findings

Data given in Appendix A show the plant performance for 1990 and for the first two months of 1991. Variations in the figures suggest further investigations of many items are justified. For example:

1 Net to gross production ratio varies from machine to machine and from month to month for any given machine. The average ratio for machine 21, which supplies almost 70 percent of production, is the lowest while energy consumption on that machine is higher than that of the other two conventional lines:

	Ratio Net/Gross	Elec. use, kwh/t	Steam, GJ/t
Machine 21	0.777	805	2.73
Machine 22	0.986	486	2.23
Machine 23	0.873	723	2.29

(Note: Variations in the net/gross ratio are sometimes so large that it is suspected there are errors in the production figures reported.)

Limitations in the use of each machine to make specific products may well require machine 21 to operate the most, and indeed the number of grade changes on machine 21 may be one of the causes of high energy consumption and low saleable product ratio. However, the differences in performance of the machines should be checked and the production plans for the plant should be reviewed to ensure that the most efficient and lowest cost machines are being utilised fully.

2 Monitoring electricity consumption closely may allow the reasons for the large variations to be found. For example, the specific electricity consumption was recorded as 576 kwh/t in July 1990 and 1126 kwh/t in August. In this case, there was a two week shutdown in August and the high electricity use is attributed to start up operations during which production was at a low level.

3 Boiler efficiency, which is also discussed in detail later, was calculated to be in the range 70.8 to 90.8 percent. This is a rather large variation, with the highest efficiency figures perhaps too high. The reliability of the figures should be checked.

Based on current energy cost data, the average cost of energy per tonne of product is seen to exceed 7500 forint, which corresponds to about 20 percent of the typical selling price of the products. This high percentage illustrates the value of a good energy monitoring system, coupled with a routine management review procedure in which the performance figures are studied promptly at the end of each month.

Prompt analysis of results is essential to ensure that any corrective action is taken as soon as possible and adverse conditions are not allowed to continue longer than absolutely necessary. A monthly senior management review of energy consumption performance is strongly recommended.

2.32 Recommendations

Resulting from our analysis of overall plant performance, the following recommendations are made:

1 Management should monitor energy and corresponding production data immediately following the end of each month. Prompt action should be taken to correct deficient performance or to investigate discrepancies.

2 The Energy Supply Department should develop data relating the energy consumption of major energy users in the plant to the production level or "activity" of the equipment concerned. This should be done by drawing graphs of energy use against production or activity, e.g. production of compressed air. These graphs are typically straight line graphs, the slope and y-axis intercept revealing the extent of energy consumption that is truly related to production and the amount of energy that is "fixed" and independent of production. The nature of the energy - production graphs can assist in defining priorities for investigating energy inefficiencies. Examples of graphs for the plant are given in Appendix B.

3 In addition, develop graphs of specific energy consumption against production (or activity). These can be used to monitor equipment performance at any production level and to set energy efficiency improvement targets for sections of the plant and for the plant as a whole (see Appendix B).

4 As a general recommendation, give maintenance of facilities more attention. For example, steam traps appear to receive almost no attention at all. In addition, repair of insulation should be done on many steam and condensate lines.

2.4 BOILER PERFORMANCE

2.41 Introduction

The plant boilerhouse has four boilers installed. These are locally made package boilers, constructed around 1972. The combustion air fan is mounted on top of each boiler: there is no air preheat system. Boiler feedwater is preheated in a small heat exchanger through which the hot continuous blowdown passes. The boilers are used to raise saturated steam at about 8 to 9 bars.

The performance of the plant boilers was evaluated using portable instruments for combustion gas analysis, temperature measurement and boiler water dissolved solids content. The plant itself has no equipment for regular checking of combustion efficiency, although the boilers are checked and adjusted at least once per year (see below).

The existing control system on each boiler consists of a conventional mechanical linkage between the fuel gas control and the air flow dampers. When the steam demand rises, the steam pressure drops and a signal is sent to increase the gas flow to the boiler. The air flow is increased in step with the gas by means of the mechanical linkage. The exact air to fuel ratio is set by the dimensions of the linkage and the ratio can be adjusted by altering the shape of a cam profile. Boiler performance is checked thoroughly once per year by an outside agency, at which time the cam profile is adjusted to keep the correct air to fuel ratio over the full boiler load range. The boiler was checked and adjusted in November 1990.

2.42 Combustion Tests

Performance checks were done on three of the four boilers. Tests on Boiler II were done by the audit team and the use of the combustion gas analyser was demonstrated to the boiler operators who conducted tests on Boilers III and IV. The tests on Boiler II included switching to manual control and adjusting the air rate downwards: in this way, it was possible to achieve a reduction in the excess air rate from about 30 percent to 25 percent (representing an improvement in combustion efficiency of about 0.5 percent at full load).

The results of the tests are shown in Appendix C. In summary, we found the excess air rates and the levels of carbon monoxide to be acceptable on all boilers. Stack gas exit temperatures were quite low, resulting in combustion efficiencies around 80 percent. Some reduction in excess air could be made if the plant were able to trim the boilers using a combustion gas analyser. The expected improvement would be about 1 to 2 percentage points.

2.43 Water Tests

The boiler feed water includes recycled condensate. The plant stated that the condensate return rate is typically 80 percent, although not all condensate is returned to the plant boilers. It was stated that condensate equivalent to all the steam purchased from Buszesz is returned and only the balance is recycled within the plant. On this basis, the boiler feed water should comprise 60 to 70 percent condensate. Samples of condensate, feed water and boiler water (blowdown) were checked for total dissolved solids. Results were:

Condensate	50 ppm TDS
Boiler make up	720 ppm TDS
Boiler water	5500 ppm TDS

Because of the importance of good water quality on boiler and steam system performance, the plant was asked to check their records and to repeat the TDS tests over a period of several days. It appears the boiler water is normally in the range 4000 to 4200 ppm TDS and that the sample taken on our visit had an unusually high TDS.

However, even taking the lower figures, we can see that the TDS level of the make up water is quite high, suggesting that there may be some problem in the water treatment system. The high level is a major factor in the high TDS content of the boiler water (and, in turn, in the condensate). The TDS value for the condensate is certainly rather high. In theory, the condensate should be free of dissolved solids (good quality steam being pure water vapor): a level of a few ppm would be acceptable. In any case, a condensate recovery of 80 percent overall is not consistent with the water quality observed.

The TDS level in the boiler blowdown is also considered too high. For a boiler operating at 8-9 bars, we would normally recommend a maximum of 3500 ppm, at which level there is minimum risk of boiler water foaming and carryover of water with a high level of solids into the steam system. The presence of solids in the steam system can lead to deposits on heat exchange surfaces and resulting deterioration of the heat transfer coefficient, as well as corrosion in the steam piping, valves, condensate return, heat exchangers and steam traps.

To reduce the TDS level in the boiler water, it is necessary to increase the blowdown rate. With the high TDS make up water, the blowdown rate to maintain 3500 ppm in the boiler is over 2 tonnes per hour, a rather high figure representing almost 20 percent of the boiler feed water. This is costly, in part because the water consumption will rise and this is an added cost. In addition, the discarding of a large quantity of hot blowdown is an energy loss.

The blowdown outlet temperature of the existing blowdown/make up water heat exchanger on Boiler II was found to be about 40 deg C for the existing boiler conditions. The continuous blowdown at that time was measured and found to be approximately 250 to 300 kg/h (under these conditions, the boiler water TDS was 5500 ppm). The blowdown was then increased to about double the flow and the temperature rose to about 76 deg C. A check of the boiler water TDS after two hours showed that the TDS level had been reduced to 5000 ppm, at which time the test was discontinued.

To maintain a lower level of TDS in the boiler, it will be necessary to increase the blowdown. To reduce energy losses, it is recommended that a larger make up water/blowdown heat exchanger be installed on each boiler. The present exchangers are small (1.2 M2 area) and unable to provide adequate heat recovery. The cost of new exchangers was estimated and compared with the value of the heat saved to ensure that the new exchangers are cost effective. A payback period of 0.7 years was estimated (Appendix D).

Another alternative would be to consider improving the quality of the boiler feed water by installing more comprehensive water treatment facilities. This could be costly but the economics should be verified by the plant. A further option may be the purchase of higher quality water from a nearby plant such as Buszesz (or the retention of condensate normally returned to Buszesz).

To assist the plant in maintaining the correct water quality in their boiler system, it is recommended that a simple conductivity meter be purchased for the boilerhouse operators to use regularly on each shift to adjust blowdown rates.

2.44 Boiler Heat Losses

The heat losses from the outer surfaces of Boilers II and III were calculated from surface temperature measurements. A brief temperature survey was carried out using a contact probe and an infrared pyrometer. The heat losses are estimated to average about 0.3 percent of boiler input at full load which is fully acceptable.

Heat recovery from stack gases may be considered although the stack temperatures are rather low at 180 to 210 deg C. An economiser designed to reduce the stack temperature to say 135 deg C would give savings of 1 million Ft/year for an investment of 1.5 million Ft at each boiler. The payback would thus be about 1.5 years (see Appendix D).

2.45 Cost of Steam

The overall boiler efficiency was calculated to be 80 percent based on the lower heating value of fuel gas. This figure includes the estimated blowdown losses and losses from radiation and convection, both of which are small. Based on this efficiency, the marginal cost of steam was calculated to be 950 Ft/tonne. This compares with 1400 Ft/t for steam purchased from Buszesz and a total cost of 1100 Ft/t for plant steam, as quoted by the plant.

2.46 Summary of Recommendations for the Boilerhouse

In summary, the following recommendations are made:

1 Purchase a combustion gas analyser for the boilerhouse operators to use for routine checking of performance and tune ups. Through regular use of gas analyses, the plant should be able to improve boiler efficiency by 1 to 2 percentage points.

2 Institute a higher blowdown rate to reduce the present high level of TDS in the boiler water. This in itself will increase the energy loss in the blowdown unless additional heat recovery is achieved through installing additional heat exchange surface. The cost effectiveness of this must be checked (initial estimate of payback 0.7 years: see Appendix D).

3 As an alternative to operating with an increased blowdown rate (and with additional heat exchange surface), evaluate the economics of installing a new water treatment process. This would reduce the blowdown rate needed to maintain boiler water TDS levels around 3000-3500 ppm.

4 As another option, explore the availability of high quality water from Buszesz (including retention and reuse of condensate currently returned to Buszesz). The quantity of water required should of course be estimated in two ways, firstly under current conditions of high plant boiler loads and minimum purchases from Buszesz, and secondly with low self generation of steam and high levels of steam purchases from Buszesz.

5 Purchase a conductivity meter for the plant boilerhouse to enable water qualities to be monitored regularly.

6 Evaluate the costs and benefits of installing an economiser to recover heat from stack gases in boiler feed water (initial estimate, payback 1.6 years: see Appendix D).

7 Finally, as there was no time to check the boiler feed water pump capacities and head, check the present situation. Many plants still have the original pumps fitted and these may not be properly sized for the current throughput and be fitted with motors that are too large. The plant should check the situation and evaluate the economics of pump/motor replacement where necessary.

2.5 STEAM DISTRIBUTION AND CONDENSATE RETURN SYSTEMS

2.51 Findings

In the old plant, the boilerhouse used to be in a central position. The present boilerhouse is at one side of the plant and steam lines tend to be quite long. In fact, the plant has been considering constructing a new boilerhouse in the old central position (although the economic justification for this is somewhat unclear). While many of the steam lines are long, they seem well insulated, with much of the insulation looking new. However, there appear to be few drain points and steam traps to remove condensate from the lines. Water could therefore build up in the lines and water hammer could result. In addition, excess water in the system can have an adverse effect on the heat transfer rate in heating equipment, resulting in slower drying.

One steam trap was found on the main steam line to the board machine area. This was checked and found to be passing steam continuously. This trap should be repaired or replaced as soon as possible. The steam trap on the steam line from Buszesz was also seen to be passing a large amount of steam: this too needs attention.

It was noted that there was often a lack of insulation on the lines to traps and to the main condensate recovery lines. The flash steam recovery system on machine 21 for supplying steam to the first three cylinders lacked insulation.

There is a condensate system in operation which is stated to recover around 80 percent of the available condensate. However, there is a steady plume of steam released to atmosphere from the main condensate collecting tank, in spite of cold treated water being passed into the tank. The plume is believed to amount to at least 1.5 tonnes/hour.

The problem is believed to be an excessive flow of steam into the condensate system from leaking steam traps on the outlet of steam heated cylinders (the board machines). Traps were checked on machine 21 with a sonic steam trap tester and 17 out of 20 traps were found passing steam continuously. Thus for the 105 traps on the machines, the steam passing through could easily exceed 1 t/h, much of which is immediately vented to atmosphere. In addition to the direct steam loss, the machine drying performance is adversely affected.

The reason for the steam traps being defective is primarily the fact that an incorrect trap type is fitted. Thermodynamic traps are not suitable for use where there is a back pressure and should be replaced by inverted bucket traps (e.g. Armstrong Series 1810) which should work well provided they are installed correctly in a vertical position.

2.52 Recommendations Concerning Steam Distribution and Condensate

Recommendations relating to the steam distribution and condenste return systems are:

1 Repair or replace all traps on these systems, installing the appropriate type of trap in each case.

2 Check the drainage of all major steam lines and install traps if necessary.

3 Purchase a sonic steam trap tester and develop a routine steam trap monitoring and maintenance procedure.

4 Check all condensate return lines and ensure that adequate insulation is installed. Check the insulation on condensate collecting tanks.

2.6 PURCHASE OF STEAM FROM BUSZESZ PLANT

2.61 Findings

The records show that only about 20 percent of the plant steam requirements were met in 1990 through purchases from Buszesz. In the first two months of 1991, the contribution of purchased steam has dropped to 11 percent. The relatively low level of purchases is primarily a function of the high price charged by Buszesz compared with the cost of self generated steam but is also due to the unreliable nature of the Buszesz supply. The high price of purchased steam is

perhaps surprising because the steam supplied by Buszesz is produced in a cogeneration system, which is normally the most efficient way to produce both electricity and steam. There appears to be an opportunity to negotiate a more favorable contract price with Buszesz which could be attractive to both parties.

If such a contract could be agreed, the operating "mode" could be revised. At present, the plant meets base load steam demand with its own steam and purchases steam from Buszesz to meet peak demands. This is of course the reverse of the situation that would help Buszesz to operate at the highest efficiency.

2.62 Recommendations Regarding Steam Purchases

1 Discuss a new contract with Buszesz and compare the cost of steam offered with that for self generation. It is suggested that a new contract include penalties for non delivery of steam by Buszesz.

2 Review the problems of reliability with Buszesz and assist in any study of measures to improve reliability. EGI could assist in this study.

2.7 BOARD MACHINES

2.71 Findings

The problem of excessive flow of steam into the condensate system from defective steam traps on the board machines has already been mentioned. On machine 21, use of a sonic steam trap tester showed 17 out of 20 traps tested were passing steam continuously. It is suspected that most of the steam traps on the machines are in similar condition. In other words, it is probable that 85 percent of steam traps are defective. For the 105 traps on the machines, the steam passing through could easily exceed 1 t/h, much of which is immediately vented to atmosphere. In addition to the direct steam loss, the heat transfer rate in the drying cylinders is adversely affected and drying is hampered. To achieve the required product moisture content, it is thus necessary to use excessive steam.

The reason for the poor state of the steam traps was indicated above. Because there is a back pressure on the traps, the thermodynamic traps fitted are considered not suitable. Any steam passing through one trap will affect the performance of the others and cause them to pass steam also. The steady passing of small amounts of steam can soon cause damage to the disks in the traps and large steam leakages are the result. Thermodynamic traps were originally installed about 5 years ago; some of the existing traps are believed to be around 18 months old. The thermodynamic traps should be replaced by inverted bucket traps. There are suitable traps made by Armstrong (Series 1810) which could be installed between the existing flanges and should work well provided they are installed correctly in a vertical position.

During our visit to the plant, the flash steam recovery system for supplying low grade steam to the first three cylinders on the board machine was never seen in operation. The system should be used as much as possible to reduce steam use in the rest of the machine.

There is a large heat recovery system installed on machine 21 (and similar ones on the other machines). A hood is fitted to collect hot wet air from the drying cylinders and this is passed through two heat exchangers (each 600 M2) to preheat dry incoming air. There is also another steam heated exchanger to further preheat the incoming air if necessary. The dry air is then distributed under the drying cylinders and a small portion is blown under the roof space to prevent condensation in that area.

It appears that the efficiency of the heat recovery system is not checked against design conditions. Thermometers are understood to be ineffective because they do not screw into the wells provided. It is recommended that the system be evaluated and the level of heat recovery determined and compared with design. The distribution of hot dry air should also be checked to ensure that excessive air is not being wasted in the roof space.

The drying cylinders on all machines have bare end caps with no insulation. This is conventional practice in many mills. However, tests with insulated cylinder ends shows that savings of 3 to 5 percent of steam demand are readily obtained. This should be considered by the plant. The insulation may be made in sections that clip on to the cylinders and are easily removed for maintenance access. The thickness of insulation will be limited by the size of the gap between the rotating cylinder ends and the fixed structure of the machine.

An attempt was made to check the surface temperature of several rotating cylinders. A non-contact infrared pyrometer was used for this purpose. The problem is determining the emissivity of the surfaces, which are highly polished and thus have a low emissivity. In this case, a small error in the emissivity setting will result in a large error in the temperature reading. However, the relative temperatures are a reasonable indication of any differences in surface temperature. The results of temperature scans on two cylinders on machine 21 showed thefollowing temperature profiles:

(1)	Deg C --	109	135	148	129	122	118
(2)	Deg C --	75	77	79	78	78	77

(Each 3.6 meter width, readings approximately every 0.7 meters)

The extent of edge drying for the higher temperature cylinder may be worth checking. To obtain acceptable final product moisture levels, it is sometimes found that additional steam is needed to dry the edges while the centre of the roll becomes overdried, thus wasting energy. The machines in this mill have automatic moisture content measurement with automatic adjustment of the steam rate to drying cylinders. There does not appear to be a problem of uneven drying but it may be worth the plant rechecking this. To correct uneven drying, some mills have installed small radio frequency or microwave edge dryers to complete the drying of edges without over use of steam.

Utilisation of the "white water" removed from the stock by the board machines was not checked. The plant should recycle as much of this water as possible to the raw material preparation section.

Finally, it was noted that the production plans for the machines often include a relatively high number of grade or quality changes. The machines are frequently required to change board thickness or even change the board material composition once per day on average over a four or five day period. Changing the thickness usually results in the loss of one roll of board (say 5 tonnes) as adjustments are made to achieve the new thickness, while a change of stock composition requires a complete machine shutdown, with corresponding heat losses as well as extra broke being lost on start up.

On the assumption that about 5 tonnes of paper are lost for every change, this suggests a waste of at least 5 percent of the energy. Based on an energy cost of 7500 Ft/tonne of product, the loss is thus around 37500 Ft per day. It is understood that the reason for frequent quality changes is to meet orders without storing product, as the company is short of working capital and storage of products obviously has a cost. The cost, in terms of interest paid at 40 percent per year on the value of 1 tonne of product (assumed to average 38000 Ft/t) is estimated to be 1270 Ft per month for each tonne stored. Compared with losses of 7500 Ft per day for reprocessing rejected board, it is possible that storage of products and operation of the board machines for long runs at optimum conditions could be more profitable for the plant. This matter should certainly be examined by plant management.

2.72 Recommendations Relating to Board Machine Performance

The following recommendations are made:

1 Replace all thermodynamic traps on the board machines with inverted bucket traps (Armstrong Series 1810 or equivalent). Ensure the correct installation of these traps in a vertical position. The plant has provided details of the existing traps, capacities, pipe diameters and distances between flanges (see Section 3.3).

2 Check the traps and insulation on the flash steam recovery system and ensure the system is operated as much as possible.

3 Install thermometers in the hood heat recovery systems and check performance against design. Ensure minimum loss of hot dry air into the roof space.

4 Consider insulation of the end caps of cylinders on all machines. Carry out a cost benefit analysis.

5 Check the temperature profiles on cylinders and check the differences between moisture contents of the edge of board and the centre. If excessive differences are found, consider the use of supplementary drying of the edges using microwave or RF drying.

6 Check the recycling of white water to the raw material preparation section.

7 Check the comparative costs of storing products and frequent quality changes on the board machines.

2.8 STEAM FOR SPACE HEATING

2.81 Findings

The quantity of steam apparently consumed for space heating amounts to almost 10 percent of the annual steam demand for the whole plant. This is a large consumption. The use of steam for space heating is often costly: a circulating hot water system would undoubtedly be much less expensive to operate. Conversion to such a system should be considered seriously by the plant. As part of the evaluation of steam traps which was done, one of the traps fitted on a branch of the space heating system was examined. We believe it is not operating correctly and the improper operation of steam traps on a steam heated system is of course a serious problem which leads immediately to a large and expensive waste of steam.

The energy consumed for any space heating system should be monitored regularly against the climate conditions, that is, against heating degree days. Discepancies in energy use per degree day can be used to identify energy waste.

The condition of insulation on lines to the locations where space heating is operated should be checked and repairs made as necessary.

2.82 Recommendations Relating to Space Heating

Recommendations are as follows:

1 Determine the cost effectiveness of converting the present space heating system from steam to a circulating hot water system. It is likely that a closed loop hot water system will prove economically justified.

2 Ensure that all outside lines associated with the space heating system are properly insulated.

3 Monitor energy use for space heating against actual climatic conditions (heating degree days) to identify discrepancies in energy consumption.

2.9 ELECTRICAL SYSTEM

2.91 Findings

The maximum electrical demand is about 5.4 MW compared to the contracted maximum of 6.2 MW. The power factor is compensated and is normally around 0.94 which results in the plant receiving a premium each month from the electric utility company.

Occasionally there are some minor problems in the cabling systems. During our visit, there was a slight overheating of some wiring. It also appears that the main transformer buss bars sometimes overheat at connections. This suggests that a regular survey of electrical wiring, the switch rooms and transformers should be carried out using thermal

imaging equipment: EGI has such equipment and the plant should therefore discuss the matter with them.

There are a number of large motors installed in the plant, most being for raw material preparation and board machine drives. A list of motors of 100 kW and above is given in Appendix E. The opportunity was taken to check the load on three motors using the portable Esterline electrical survey equipment, and it is recommended that this type of equipment be provided for the plant to carry out its own testing over an extended period.

One of the motors on the air compressors was checked first. Both machines are fitted with 100 kW motors, the same size as originally fitted to the compressors when they were two cylinder machines. Although the compressors are now single cylinder, the motors have not been changed. As might be expected, the 100kW motor was found to be underloaded. Over a period of about two hours, we found the load reasonably steady at 50 to 52 kW.

It is therefore recommended that consideration be given to switching to a smaller motor, say 60 kW, to operate consistently with a higher motor load and thus a higher efficiency. A saving of about 4 percent of the present energy consumptionis expected: for a motor replacement cost of 150,000 Ft, this gives a payback of 2.5 to 3 years, which is not particularly attractive but the prices and motor characteristics should be checked to verify this.

It was noted that th re appeared to be no waste heat recovery from the hot air compressor exhaust gases. The plant stated that there is a system but the recovered hot water is not used and is discarded to drain.

One of the hydropulper motors, also 100 kW, was then tested. The hydropulpers are used to prepare stock for the board machines by grinding up waste paper in a slurry of water. Depending on the product properties, part of the raw material can be composed of new pulp which is thoroughly mixed with the waste material. The hydropulper is gradually filled with water and paper/pulp: the fibers are separated by "grinding" with blades in the base of the equipment, one set driven by the 100 kW motor and another set stationary. After the hydropulper has been filled with the stock (or slurry), the stock is transferred to a storage tank which is kept agitated by a stirrer (fitted with a 30 kW motor). It is then pumped to one or more of the board machines.

It appears that the hydropulpers are frequently filled up with stock and then kept agitated while the stock tanks are emptied to the machines. We were told that around 50 percent of the hydropulper motor running hours were "idle", that is, the motors were kept running to keep the fibers suspended in the water rather than to break down the waste paper or pulp. It was thought that a variable speed motor might be fitted to reduce the waste of electricity.

We checked the load on one hydropulper motor as the vessel was filled (our test started at the 50 percent level). The load was found to be reasonably steady at 55 to 60 kW. After filling, the stock was maintained agitated and the motor load appeared to remain constant.This suggests the 100 kW motor could be changed for a 70 to 75 kW motor to

save a little electricity. A more comprehensive check of motor loading at all stages of an operating cycle is recommended.

It is also recommended that a study be made of the operating and idle hours on all hydropulpers. It is possible that significant savings could be achieved by more accurate scheduling of the start of each machine, ensuring the minimum idle time and the maximum use of the storage capacity in which the stirrers are powered by smaller (30 kW) motors. In addition, the excessive action on the fibers would be reduced (too much cutting by the hydropulper blades shortens the fibers).

Replacement of the 100 kW motors by dual speed motors was also considered. In this case, the lower speed would be used for the simple stirring action, i.e. the idle time. The power required could be greatly reduced. Our initial estimates suggested a payback in the region of 1.5 years.

One of the largest motors was also checked. This was a 160 kW motor fitted to a "grinding" machine and this was found to be operating with a load between 144 and 148 kW. There is little opportunity for savings for this particular motor.

The plant should use an electrical load survey instrument to check loads on all motors, starting with the largest ones. Where motors are significantly oversized, the economics of replacement with smaller motors should be determined and motors replaced where justified.It may be possible to save money by replacing oversized motors with existing smaller motors from the plant spare motor stocks or with existing motors from another machine, moving motors from one location to another and only buying a few new motors in the smallest sizes.

It was noticed that lighting fixtures in many locations need cleaning. The level of lighting was adequate throughout the plant but clean luminaires can contribute to savings because their light output is significantly greater: it should therefore be possible to obtain the same lighting level with lower rated bulbs or tubes. In some locations, properly cleaned luminaires might allow one quarter to one half of the fittings to be switched off.

2.92 Recommendations Relating to Electricity

The recommendations are as follows:

1 Check the economics of replacing the two 100 kW motors on the main air compressors with 60 kW motors which are more closely matched to the actual loads. Initial estimates suggest a payback of 2.5 to 3 years for an investment of 150,000 Ft per motor.

2 Check the hydropulper operations. Recheduling machine start up times would appear to offer useful savings. If this is not possible, consider the economics of fitting dual speed motors of 75 kW each.

3 Purchase an electrical survey instrument for the plant electrical department to do their own checking of the actual service load of all motors sized over 100 KW. Where motors are significantly oversized, evaluate the economics of replacement with new motors

sized for the current duty and change where justified.

4 Discuss with EGI the initiation of regular electrical system surveys using their Thermovision equipment to identify potential problem areas in good time.

5 Improve the standard of lighting maintenance, ensuring regular cleaning of light fittings and replacing luminaires when cleaning is not adequate.

6 Check lighting levels after cleaning the luminaires, switching off lights where and when possible. Consider installing extra switches to allow selected areas to be controlled independently and consider photoelectric controls in some areas of the plant.

3 SUMMARY OF ENERGY SAVING OPPORTUNITIES

3.1 List of Recommendations

Exhibit 3.1 lists those measures that require capital investments together with estimated savings and paybacks. The total savings listed are equivalent to about 7 percent of the present energy bills. A complete list of the recommendations made in this report is as follows:

(1) Energy Management and Metering

(1.1) Organise report preparation using spreadsheet software; improve report formats; add key parameters to be monitored; develop reporting procedure to include water/condensate,steam and electricity balances.

(1.2) Develop data relating energy consumption to production levels and monitor plant performance closely and regularly.

(1.3) Ensure energy costs of inadequate maintenance are documented

(1.4) Adopt monthly review of energy perforamnce by senior management.

(1.5) Purchase a computer, printer and Lotus software to accomplish item (1.1); provide training and implementation assistance.

(1.6) Install electricity meters for main operating departments

(1.7) Purchase portable electricity survey meter for checking motor loads and sizes.

(1.8) Install three natural gas meters on boilers and steam meters (say 5) on lines to major users.

(2) Boilerhouse

(2.1) Purchase combustion analyser for closer combustion control.

(2.2) Operate with higher blowdown rate and monitor TDS levels.

(2.3) Evaluate alternatives to high blowdown and heat exchangers, such as a new water treatment plant or purchase of water from Buszesz (or other nearby plants).

(2.4) Consider installation of an economiser for heating boiler feed water with stack gases.

(2.5) Check the boiler feed water pumps and motors; replace if economically justified.

(3) Steam and Condensate Systems

(3.1) Repair or replace all traps, using the appropriate type of traps for the specific service required. Outside the board machines, there are about 35 traps on various systems. Based on tests in the plant, it is likely that at least 25 will need replacing.

(3.2) Check the drainage of main steam lines and install traps if necessary.

(3.3) Purchase a sonic steam trap tester and establish a routine trap testing and maintenance program.

(3.4) Maintain or replace insulation on condensate lines.

(4) Steam Purchases

(4.1) Study and compare the options for steam supply, including purchase from Buszesz or self generation.

(4.2) Study the problem of reliability of steam supply from Buszesz and develop recommendations for improvement.

(5) Board Machines

(5.1) Replace all thermodynamic traps on the board machines with inverted bucket traps.

(5.2) Check traps and insulation on the flash steam recovery system and use this system as much as possible.

(5.3) Install thermometers on the moist air heat recovery system and monitor performance.

(5.4) Obtain cost estimates for insulation of cylinder end caps and implement project if economically justified.

(5.5) Check moisture in board edges and centre, and install supplementary RF or microwave edge drying if necessary.

(5.6) Check the cost of frequent grade changes on the board machines and compare with the cost of storing products.

(6) Space Heating

(6.1) Determine the cost effectiveness of converting the present steam heated system to a circulating hot water system. If economically justified, modify the current system.

(6.2) Ensure outside lines of the space heating system are properly insulated.

(6.3) Monitor space heating energy against heating degree days.

(7) Electricity Systems and Consumers

(7.1) Discuss with EGI the initiation of regular electrical system surveys using the EGI Thermovision camera.

(7.2) Replace both 100 KW motors on the air compressors with 60 KW motors as the present motors are clearly oversized.

(7.3) Investigate options for the hydropulper system, including rescheduling of operations, additional stock storage with low HP stirrrer, and fitting of a 75 kW dual speed motor.

(7.4) Check lighting levels after luminaire cleaning and switch off where possible; install extra switches to improve ability to control lighting loads in future; set up routine lighting maintenance program.

3.2 Potential Savings

3.3 Possible Projects for USAID Support

A number of the recommendations are suitable for funding support by USAID as they provide the plant with the tools for further efforts to improve energy efficiency. In addition, assisting the plant to replace inappropriate steam traps should result in short term energy savings measurable using the present energy consumption reporting system. This should therefore serve as a demonstration project and should encourage other plants in Hungary to adopt a similar measure at relatively modest cost.

The specific recommendations for USAID support are as follows:

(1) Replace steam traps on the board machines

Estimated cost for 105 traps $ 20,000
Anticipated savings $ 122,000 per year
Payback period 2 months.

The above cost is for equipment only: it is assumed the plant will provide the necessary labor for installation.

The items to be purchased are as follows:

Number of steam traps	Steam pressure bars g	Nominal pipe diameter inches	mm	Dimensions mm Between flanges	Flange bolt circle dia.
Machine 21					
-predrying					
38	3	3/4	20	150	75
1	3	1	25	195	85
2	8	1 1/4	32	195	100
-final drying					
15	4	1	25	195	85
2	4	1 1/4	32	195	100

58					
Machine 22					
25	3	1	25	195	85
Machine 23					
19	3	1	25	195	85
3	3	3/4	20	150	75

22					

Total 105 traps

All traps to be Armstrong inverted bucket type (Series 1810) or similar.

(2) <u>Purchase computer, printer and software</u>

Estimated cost $ 5,000
Anticipated savings say $ 18,000 per year
Payback under 4 months.

The items to be provided are:

* Desk top computer with 386 processor, IBM compatible, minimum 40 MB hard disk and 1 MB RAM, VGA color monitor, dual 3.5 and 5.25 FDD. Keyboard standard US version.

* Printer should be 24 pin dot matrix with 142 character wide carraige.

* Computer and printer to be supplied for use on 220 v/50 Hz power supply.

* Lotus 123 software, US version can be supplied but manual must be supplied in Hungarian.

The cost indicated above does not include the recommended training and implementation assistance.

(3) Purchase sonic steam trap tester

Estimated cost $ 1300
Anticipated savings say $ 6600 per year
Payback period under 3 months

The equipment should be the UE Systems Ultraprobe 500C or similar.

(4) Purchase electrical survey equipment

Estimated cost $ 6000
Anticipated savings at least $ 8000 per year
Payback period under 9 months

The equipment should be the Esterline Angus with current transformers (or similar).

(5) Purchase combustion analyser

Estimated cost $ 3000
Anticipated savings $ 12,000
Payback period 3 months

The equipment should be the Enerac 2000 Combustion Analyser or similar, with extra printer paper.

(6) Purchase TDS meter

For improved control of boiler water (Myron L meter or similar).

The total cost of the six items is $ 35,600. The items are listed in order of priority in case the budget for all six items is not available. A reduced budget can also be accomodated by modifying the first item to include only the traps on Machine 21 (58 traps) which would reduce the cost by about half.

Consideration should be given to providing spare parts and operating supplies for all equipment sent to Hungary.

EXHIBIT 3.1

SUMMARY OF SAVINGS OPPORTUNITIES

No.	Item	Savings Ft	Savings US $	Cost Ft	Cost US $	Payback months
	Energy Management					
1.1	Reports, balances	--	--	--	--	---
1.2	Additional data	--	--	--	--	---
1.3	Maintenance costs	--	--	--	--	---
1.4	Monthly review	--	--	--	--	---
1.5	Computer, software	1300000	18000	365000	5000	3.3
1.6	Electricity meters	650000	9000	123000	1680	2.2
1.7	Elec survey inst'mt	560000	7700	438000	6000	9.3
1.8	Gas/steam meters	880000	12000	1340000	18400	18.4
	Boilerhouse					
2.1	Combustion analyser	870000	12000	220000	3000	3.0
2.2	Blowdown heat rec.	1160000	15900	790000	11100	8.4
2.3	Economiser	920000	12600	1500000	20500	19.5
	Steam & condensate lines					
3.1	Replace traps	365000	5000	365000	5000	12.0
3.2	Line drainage, traps	--	--	--	--	---
3.3	Sonic trap tester	235000	3200	95000	1300	4.9
3.4	Cond line insulation	--	--	--	--	---
	Steam purchases					
4.1	Review contract	--	--	--	--	---
	Board machines					
5.1	Replace traps	7700000	105500	1460000	20000	2.3
5.2	Flash steam rec	--	--	--	--	---
5.3	Hood ht rec system	--	--	--	--	---
5.4	Insulate cyl. ends	1980000	27000	1980000	27000	12.0
5.6	Minimise grade changes	--	--	--	--	---
	Space heating					
6.1	Convert to hot water	935000	12800	--	--	---
6.2	Insulate lines	--	--	--	--	---
	Electrical					
7.2	Replace a/c motors	112800	1550	300000	4100	31.8
7.3	Dual spd h/p motor	163600	2200	241000	3300	18.0
7.4	Improve lighting	20000	550	73000	1000	21.8
	Totals	17851400	245000	9290000	127380	6.2

Total savings equivalent to about 7 percent of present energy expenses.

Notes -- bases for calculations

1.5 Better monitoring and quicker respons to problems. Savings 0.5 % of total energy bill (260 million Ft/yr) Cost estimate includes computer, printer and Lotus software.

1.6 Better monitoring. Savings 0.5 % of electricity bill (130 million Ft/yr). Cost estimated for 8 meters.

1.7 Replacement of large motors by smaller motors. Savings say 3 % on 10 x 100 kW motors, 4000 hrs/yr.

1.8 Better monitoring, reduction of steam demand. Savings say 1 % of natural gas fired by boilers (8 million Nm3/yr). Cost based on 3 turbine meters at 200,000 Ft and 5 orifice plates at 150,000 Ft.

2.1 Improved combustion control. Savings 1 % of boiler fuel.

2.2 See Appendix D. Equipment includes heat exchanger and TDS meter. Based on 2500 hrs/yr operation. Could be possible to arrange piping to allow one exchanger to serve more than one boiler and thus save on capital expense.

2.4 See Appendix D.

3.1 Assumes 25 traps replaced and payback is one year.

3.2 No data available; detailed survey needed.

3.3 Savings based on detection and replacement of at least 5 traps per month.

3.4 No data available; detailed survey needed.

5.1 Costs and savings based on 105 traps, with leakage currently say 10 kg/hr each for 7000 hr/yr.

5.2, 5.3 No data available; detailed survey needed.

5.4 Savings say 2 % of current steam use. Payback of 1 year assumed.

5.6 No data available; detailed survey needed. Savings could be significant.

6.1 No data available; detailed survey needed. Savings assumed to be at least 25 % of present system steam use.

6.2 No data available; detailed survey needed.

7.2 Savings say 4 % of present 50 kW load for 6000 hr/yr operation. New motor cost 150000 Ft each.

7.3 Savings 4 % of 60 kW load for 2000 hrs/yr, and 30 kW load saving 1000 hrs/yr. Cost of 75 kW dual speed motor 241000 Ft.installed.

7.4 Savings 10 % of current 85000 kWh per year used for lighting. Cost of improvements assumed to be around $ 1000.

APPENDICES

A Sample Energy Reports

B Energy-Production Graphs

C Boiler Combustion Test Results

D Economiser and Heat Recovery Calculation for Boilers

E Electric Motors of 100 kW and Above

BUDAFOK PAPER PLANT, PRODUCTION AND ENERGY DATA -- EXAMPLE REPORT FORMATS

EXAMPLE DAILY REPORT

Item	Average or Standrd	Day 1	2	3	Month to Date
Production net tonnes	*	605			
gross tonnes	*	713			
ratio net/gross		0.849			
Steam					
own generated - tonnes	*				
own generated - t/hour					
nat gas to boilers M3	*				
nat gas to boilers t					
nat gas to boilers t/h					
purchased steam t	*				
purchased steam t/hour					
total steam tonnes					
total steam t/hour					
spec steam con t/t net					
Boiler efficiency					
M3 gas/tonne steam					
tonnes steam/1000 M3					
Electricity					
total use kwh	*				
total use kwh/hour					
for water treatmt kwh	*				
for water treat. kwh/h					
spec elec con kwh/kg n					
Water Usage					
1 Raw water M3	*				
2 Humbold M3	*				
3 Filtered water M3	*				
4 Own use M3	*				
own use %	*				
5 Well water M3	*				
6 Warm water M3	*				
total 1+2+5+6 M3					
spec water con. filtered/kg net					

* report can include one complete month
* total "month to date" column can be extended easily to include averages as well as totals
* this report can be used as input to the corresponding monthly report

The data for each month are displayed in the vertical columns, allowing easy comparison of performance from one month to the next. Input data are identified by "I" in the second column and figures calculated by the computer programme are designated "C". In practice, the input data can be entered manually or (preferably) can be obtained automatically by the computer from the daily report program.

Parameters	I/C	1990 Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	1990 TOTALS	1991 Jan	Feb
Net production, tonnes																
machine 21	*	2052	2027	1948	2393	1925	1930	2452	1098	2371	2021	2489	46	22752	2393	1905
machine 22	*	734	609	369	473	375	611	674	294	245	527	618	1	5530	522	149
machine 23	*	474	450	576	443	373	291	320	195	354	422	418	70	4386	233	469
machine 26	*	146	163	146	129	92	144	123	54	145	106	174	39	1461	128	137
total net tonnes		3406	3249	3039	3438	2765	2976	3569	1641	3115	3076	3699	156	34129	3276	2660
Gross productn, tonnes																
machine 21	*	2725	2665	2716	2764	2695	2194	2929	1623	2942	2705	3255	55	29268	2964	2665
machine 22	*	744	621	372	499	360	612	677	353	226	538	607	1	5610	539	621
machine 23	*	595	472	609	497	501	272	450	224	350	497	471	84	5022	298	472
machine 26	*	185	164	135	136	91	135	152	54	132	133	176	47	1540	139	164
total gross tonnes		4249	3922	3832	3896	3647	3213	4208	2254	3650	3873	4509	188	41441	3940	3922
Ratio net t/gross t																
machine 21		0.753	0.761	0.717	0.866	0.714	0.880	0.837	0.677	0.806	0.747	0.765	0.830	0.777	0.807	0.715
machine 22		0.987	0.981	0.992	0.948	1.042	0.998	0.996	0.833	1.084	0.980	1.018	0.830	0.986	0.968	0.240
machine 23		0.797	0.953	0.946	0.891	0.745	1.070	0.711	0.871	1.011	0.849	0.887	0.830	0.873	0.782	0.994
machine 26		0.789	0.994	1.081	0.949	1.011	1.067	0.809	1.000	1.098	0.797	0.989	0.830	0.949	0.921	0.835
overall net/gross		0.802	0.828	0.793	0.882	0.758	0.926	0.848	0.728	0.853	0.794	0.820	0.830	0.824	0.831	0.678
		NOTE: Figures based on data provided by plant. Some discrepancies must exist, as the ratio should not exceed 1.00														
Number of changes of product grade or specification	*	-	-	(these data not collected) -	-	-	-	-	-	-	-	-	-	-	-	-
Electricity, Mwh																
machine 21	*	1606.0	1664.8	1844.6	1706.1	1748.9	1589.0	1303.9	1216.2	1622.5	1529.4	2083.2	411.4	18325.9	1238.2	1846.4
machine 22	*	210.4	218.1	241.6	223.5	229.1	324.6	229.5	205.5	222.3	237.0	293.4	52.2	2687.2	244.2	101.2
machine 23	*	316.6	328.3	363.7	336.4	344.9	204.3	205.7	188.4	222.3	258.5	322.7	81.2	3172.9	157.0	404.7
machine 26	*	128.9	133.7	148.1	137.0	140.4	152.1	97.3	102.8	155.6	129.2	234.7	34.8	1594.6	104.6	177.1
total Mwh		2261.9	2344.9	2598.1	2402.9	2463.2	2270.0	1836.4	1712.9	2222.6	2154.1	2934.1	579.5	25780.6	1744.0	2529.4
Sp Con. machines, kwh/t																
machine 21 net		783	821	947	713	909	823	532	1108	684	757	837	8944	805	517	969
machine 22		287	358	655	472	611	531	341	699	907	450	475	52180	486	468	679
machine 23		668	730	631	759	925	702	643	966	628	613	772	1160	723	674	863
machine 26		883	820	1014	1062	1526	1056	791	1903	1073	1219	1349	892	1091	817	1292
overall kwh/t		664	722	855	699	891	763	515	1044	714	700	793	3715	755	532	951
Total Electricity, Mwh																
machines		2261.9	2344.9	2598.1	2402.9	2463.2	2270.0	1836.4	1712.9	2222.6	2154.1	2934.1	579.5	25780.6	1744.0	2529.4
boilers	*	97.1	85.4	92.8	76.3	67.5	37.1	67.1	42.5	55.4	91.4	110.6	43.3	866.3	99.1	92.2
water treatment	*	131.4	106.9	107.9	101.5	98.6	99.3	116.1	62.4	108.9	119.6	127.9	15.2	1195.8	121.0	99.8
lighting	*	8.0	8.0	8.0	8.0	8.0	7.0	7.0	5.0	7.0	7.0	7.0	5.0	85.0	8.0	8.0
workshops	*	7.0	7.0	7.0	7.0	7.0	7.0	7.0	5.0	7.0	7.0	7.0	5.0	80.0	7.0	7.0
losses (est.)	*	25.9	26.3	29.0	26.8	27.3	24.9	20.4	18.9	24.8	24.5	32.8	7.0	288.6	20.5	28.3
miscellaneous	*	3.0	2.5	2.5	0.2	0.2	0.2	0.0	0.5	1.0	0.5	3.0	2.0	15.6	2.7	2.7
sold	*	0	0	0	0	0	0	0	0	0	0	0	0	0.0	-4.9	-4.2
total plant		2534.3	2581.0	2845.3	2622.7	2671.8	2445.5	2054.0	1847.2	2426.6	2404.1	3222.3	657.0	28311.9	1997.3	2763.1
Spec. Elec. Con. kwh/t		744	794	936	763	966	822	576	1126	779	782	871	4212	830	610	1039

APP. A

Parameters	I/C	1990 Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	1990 TOTALS	1991 Jan	Feb
Natural Gas, 1000 M3																
boilers	*	978.9	949.7	866.8	784.4	576.0	362.1	485.8	398.9	490.4	628.0	1152.5	264.2	7937.7	865.6	978.0
process	*	5.8	6.6	6.1	5.7	8.5	4.0	7.5	7.3	11.0	8.2	14.3	1.6	86.8	9.1	8.5
total 1000 M3		984.8	956.3	873.0	790.2	584.4	366.2	493.2	406.1	501.5	636.2	1166.8	265.8	8024.5	874.7	986.5
Gas heatg. value GJ/M3	*	34.3	34.3	34.0	33.9	34.1	34.0	33.8	33.7	33.8	34.0	33.9	34.0	34.0	34.0	34.0
Natural Gas, GJ																
boilers		33578	32573	29472	26592	19641	12312	16418	13441	16577	21352	39071	8982	269750	29430	33251
process		200	227	209	194	288	138	253	245	373	279	484	56	2949	310	289
total GJ		33778	32800	29681	26786	19929	12449	16671	13687	16950	21632	39555	9038	272699	29740	33540
Steam, tonnes																
purchased	*	2220	1209	631	1074	1733	3472	3647	1670	3202	2732	1646	1438	24674	1708	940
own	*	12491	10655	9948	8428	6653	3902	5696	3906	5940	7644	12890	2813	90966	10239	10847
total		14711	11864	10579	9502	8386	7374	9343	5576	9142	10376	14536	4251	115640	11947	11787
Heatg value GJ/t steam	*	2.469	2.432	2.433	2.454	2.475	2.420	2.494	2.597	2.455	2.488	2.457	2.486	2.472	2.455	2.440
Steam, GJ																
purchased		5879	3201	1671	2844	4589	9194	9657	4422	8479	7234	4359	3808	65337	4523	2489
own		30453	25977	24253	20547	16220	9513	13887	9523	14482	18636	31426	6858	221775	24963	26445
total GJ		36332	29178	25924	23391	20809	18707	23544	13945	22961	25870	35784	10666	287112	29485	28934
losses GJ	*	3108	6674	5299	6064	3511	2867	2463	3965	2227	2777	7853	2167	48975	4448	6783
Steam to mach., tonnes																
machine 21	*	6863	6711	6089	5458	5204	4360	4731	3071	5808	5594	8121	149	62159	5658	6064
machine 22	*	1346	1118	861	1118	917	1291	1157	759	834	1308	1597	0	12306	1097	395
machine 23	*	1382	1061	1277	1044	1007	442	689	449	756	902	878	152	10039	477	657
machine 26	*	861	978	898	748	534	768	582	324	899	583	1148	254	8577	720	822
total tonnes		10452	9868	9125	8368	7662	6861	7159	4603	8297	8387	11744	555	93081	7952	7938
Steam to mach., GJ																
machine 21		16945	16321	14815	13394	12880	10551	11799	7975	14259	13918	19951	369	153631	13890	14793
machine 22		3323	2719	2095	2744	2270	3124	2886	1971	2047	3254	3923	0	30416	2693	964
machine 23		3412	2580	3107	2562	2492	1070	1718	1166	1856	2244	2157	377	24812	1171	1603
machine 26		2126	2378	2185	1836	1322	1859	1452	841	2207	1451	2820	632	21200	1768	2005
total GJ		25806	23999	22201	20535	18963	16604	17855	11954	20369	20867	28851	1379	230058	19522	19365
Sp Steam Con. t/t net																
machine 21		3.34	3.31	3.13	2.28	2.70	2.26	1.93	2.80	2.45	2.77	3.26	3.23	2.73	2.36	3.18
machine 22		1.83	1.84	2.33	2.36	2.45	2.11	1.72	2.58	3.40	2.48	2.58	0.00	2.23	2.10	2.65
machine 23		2.92	2.36	2.22	2.36	2.70	1.52	2.15	2.30	2.[illegible]	2.14	2.10	2.17	2.29	2.05	1.40
machine 26		5.90	6.00	6.15	5.80	5.80	5.33	4.73	6.00	6.20	5.50	6.60	6.52	5.87	5.63	6.00
total steam t/t net		3.07	3.04	3.00	2.43	2.77	2.31	2.01	2.80	2.66	2.73	3.17	3.56	2.73	2.43	2.98
Sp Steam Con. GJ/t net																
machine 21		8.26	8.05	7.60	5.60	6.69	5.47	4.81	7.26	6.01	6.89	8.02	8.02	6.75	5.80	7.77
machine 22		4.53	4.46	5.68	5.80	6.05	5.11	4.28	6.70	8.36	6.18	6.35	0.00	5.50	5.16	6.47
machine 23		7.20	5.73	5.39	5.78	6.68	3.68	5.37	5.98	5.24	5.32	5.16	5.39	5.66	5.03	3.42
machine 26		14.56	14.59	14.96	14.23	14.37	12.91	11.80	15.58	15.22	13.68	16.21	16.21	14.51	13.81	14.64
		[illegible]	[illegible]	[illegible]	[illegible]	6.86	5.58	5.00	7.28	6.54	6.78	7.80	8.84	6.74	5.96	7.28

APP. A

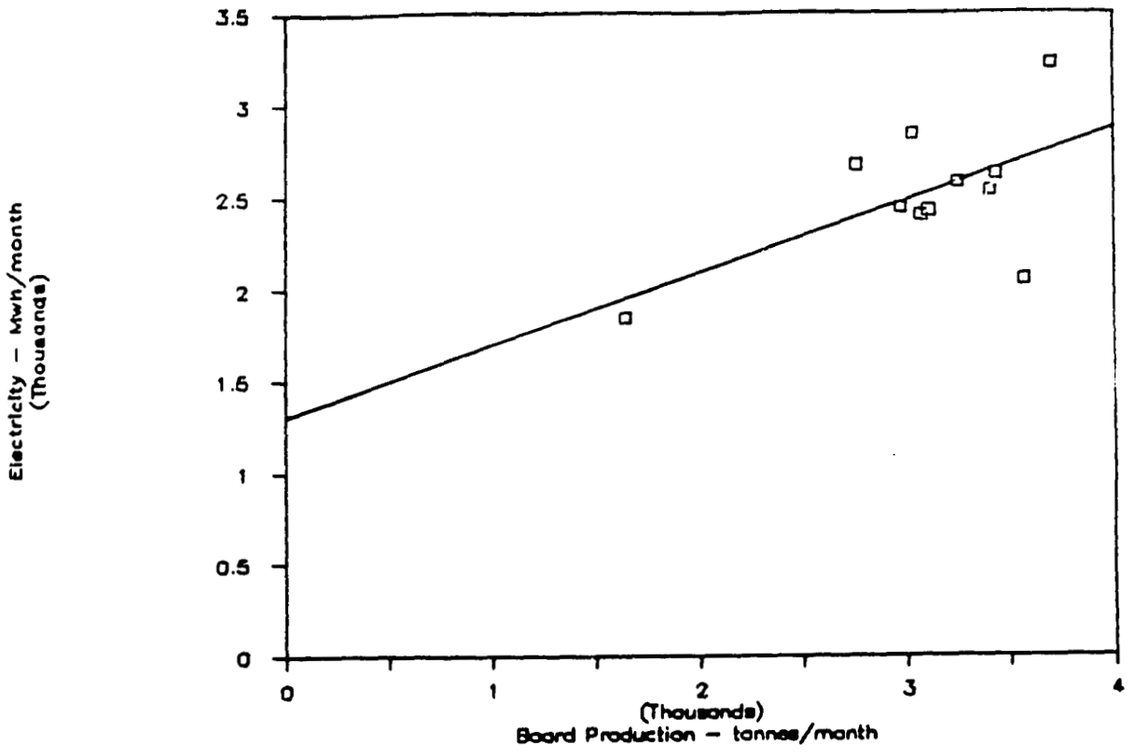
Total Steam, GJ																
machines		25806	23999	22201	20535	18963	16604	17855	11954	20369	20867	28851	1379	230058	19522	19365
space heating	*	9060	3583	2245	1521	0	0	0	0	884	3823	5690	8342	35148	8336	6032
domestic uses	*	500	500	500	500	500	500	500	500	500	500	500	300	5800	500	500
sales	*	459	409	438	427	753	194	4276	1697	162	301	457	462	10035	1561	3493
loss in B line	*	301	193	176	197	343	498	503	259	355	230	249	310	3614	205	185
boiler own use	*	457	388	363	308	242	142	209	142	215	279	468	102	3315	375	397
total steam		36583	29072	25923	23488	20801	17938	23343	14552	22485	26000	36215	10895	287970	30499	29972
total less sales		36124	28663	25485	23061	20048	17744	19067	12855	22323	25699	35758	10433	277935	28938	26479
equivalent rate t/h		48.6	42.7	34.3	32.0	26.9	24.6	25.6	17.3	31.0	34.5	49.7	14.0	31.7	38.9	39.4
total less space htg		27064	25080	23240	21540	20048	17744	19067	12855	21439	21876	30068	2091	242787	20602	20447
equivalent rate t/h		36.4	37.3	31.2	29.9	26.9	24.6	25.6	17.3	29.8	29.4	41.8	2.8	27.7	27.7	30.4
Sp Heat Con total GJ/t		10.61	8.82	8.39	6.71	7.25	5.96	5.34	7.83	7.17	8.35	9.67	66.88	8.14	8.83	9.95
Sp Heat Con w/o sp htg GJ/t net		7.95	7.72	7.65	6.27	7.25	5.96	5.34	7.83	6.88	7.11	8.13	13.40	7.11	6.29	7.69
Boiler efficiency %		90.7	79.7	82.3	77.3	82.6	77.3	84.6	70.8	87.4	87.3	80.4	76.4	82.2	84.8	79.5
t steam/1000 M3 gas		12.8	11.2	11.5	10.7	11.6	10.8	11.7	9.8	12.1	12.2	11.2	10.6	11.5	11.8	11.1
M3/t steam		78.4	89.1	87.1	93.1	86.6	92.8	85.3	102.1	82.6	82.2	89.4	93.9	87.3	84.5	90.2
Purch warm water M3	*	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	420000	3000	3000

SUMMARY OF KEY DATA																
Production net t		3406	3249	3039	3438	2765	2976	3569	1641	3115	3076	3699	156	34129	3276	2660
Production gross t		4249	3922	3832	3896	3647	3213	4208	2254	3650	3873	4509	187.95	41440.9	3940	3922
Ratio net/gross		0.802	0.828	0.793	0.882	0.758	0.926	0.848	0.728	0.853	0.794	0.820	0.830	0.824	0.831	0.678
Electricity Mwh		2534.3	2581.0	2845.2	2622.6	2671.8	2445.5	2054.0	1847.2	2426.6	2404.1	3222.2	656.99	28311.8	1997.3	2763.1
Nat Gas 1000 M3		984.78	956.28	872.97	790.16	584.44	366.16	493.23	406.14	501.47	636.23	1166.8	265.83	8024.50	874.7	986.47
Purch. steam t		2220	1209	631	1074	1733	3472	3647	1670	3202	2732	1646	1438	24674	1708	940
Purch warm water M3		35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	420000	3000	3000
Mach. elec con kwh/tn		664	722	855	699	891	763	515	1044	714	700	793	3715	755	532	951
Total elec kwh/t net		744	794	936	763	966	822	576	1126	779	782	871	4212	830	610	1039
Mach. steam use t/t n		3.07	3.04	3.00	2.43	2.77	2.31	2.01	2.80	2.66	2.73	3.17	3.56	2.73	2.43	2.98
Total steam t		36124	28663	25485	23061	20048	17744	19067	12855	22323	25699	35758	10433	277935	28938	26479
Total steam t/h		48.6	42.7	34.3	32.0	26.9	24.6	25.6	17.3	31.0	34.5	49.7	14.0	31.7	38.9	39.4
Steam w/o sp htg t		27064	25080	23240	21540	20048	17744	19067	12855	21439	21876	30068	2091	242787	20602	20447
Steam w/o sp htg t/h		36.4	37.3	31.2	29.9	26.9	24.6	25.6	17.3	29.8	29.4	41.8	2.8	27.7	27.7	30.4
Sp steam con GJ/t net		10.61	8.82	8.39	6.71	7.25	5.96	5.34	7.83	7.17	8.35	9.67	66.88	8.14	8.83	9.95
SSC w/o sp htg GJ/t n		7.95	7.72	7.65	6.27	7.25	5.96	5.34	7.83	6.88	7.11	8.13	13.40	7.11	6.29	7.69
Boiler efficiency %		90.7	79.7	82.3	77.3	82.6	77.3	84.6	70.8	87.4	87.3	80.4	76.4	82.2	84.8	79.5
Elec Ft/kwh avg	*	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Gas Ft/M3 avg	*	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01
Steam Ft/t	*	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Warm water Ft/M3	*	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Elec cost 1000Ft		11911	12131	13373	12327	12558	11494	9654	8682	11405	11299	15145	3088	133066	9388	12987
Gas cost		10842	10529	9611	8700	6435	4031	5430	4472	5521	7005	12847	2927	88350	9630	10861
Steam cost		3108	1693	883	1504	2426	4861	5106	2338	4483	3825	2304	2013	34544	2391	1316
Warm water cost		123	123	123	123	123	123	123	123	123	123	123	123	1470	11	11
Total energy cost (1000 Ft)		25984	24475	23990	22652	21541	20509	20313	15614	21532	22252	30418	8150	257429	21409	25164
Energy cost (Ft/net t paper)		7629	7533	7894	6589	7791	6891	5691	9515	6912	7234	8223	52246	7543	6535	9460
Paper cost Ft/t	*	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000
Energy cost as percent of paper cost		30.5	30.1	31.6	26.4	31.2	27.6	22.8	38.1	27.6	28.9	32.9	209.0	30.2	26.1	37.8

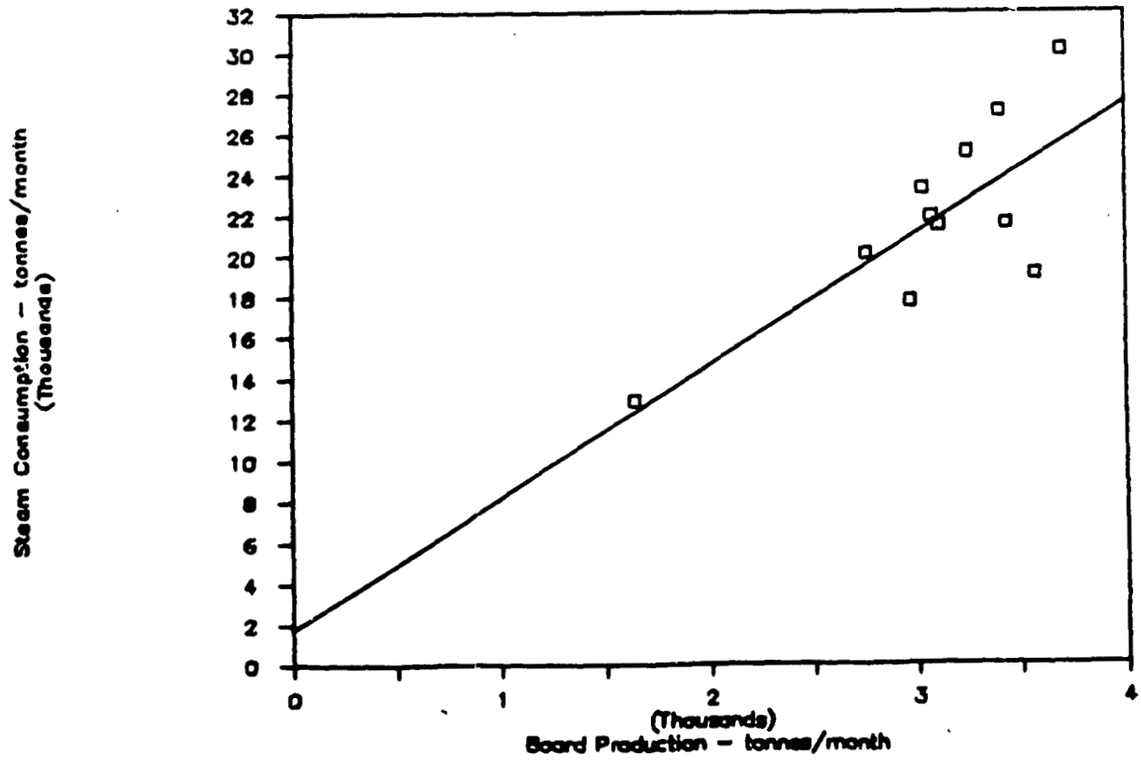
36

B

Electricity – Production Graph

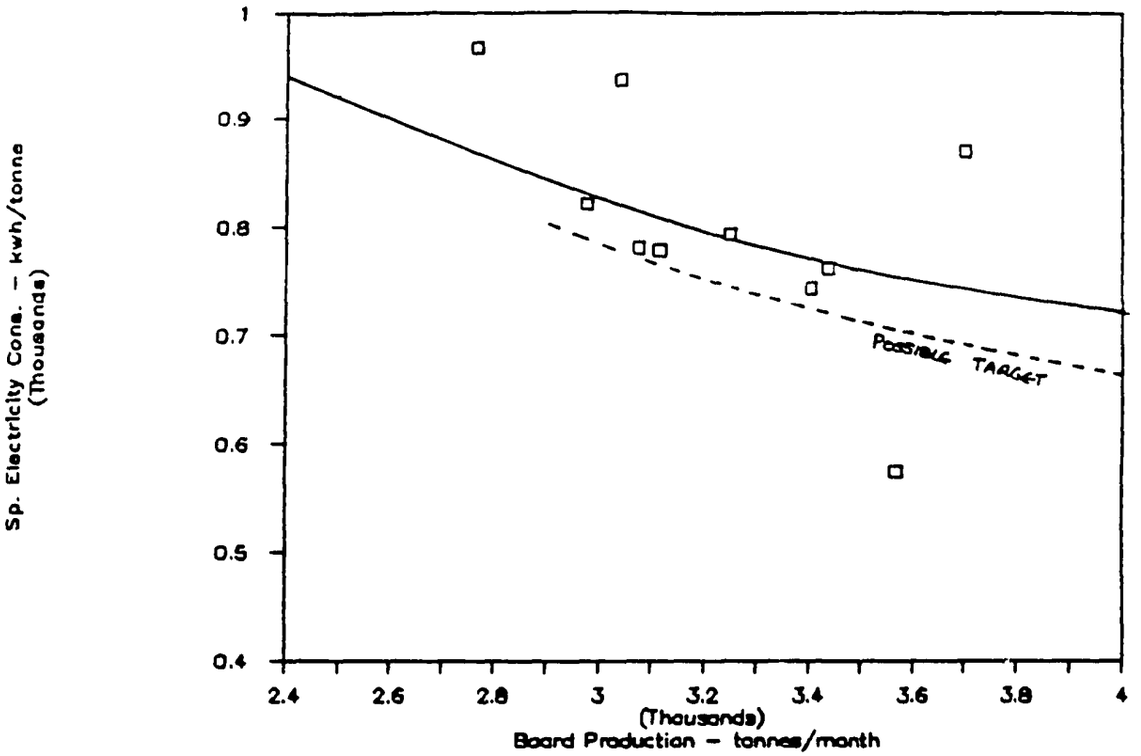


Steam – Production Graph

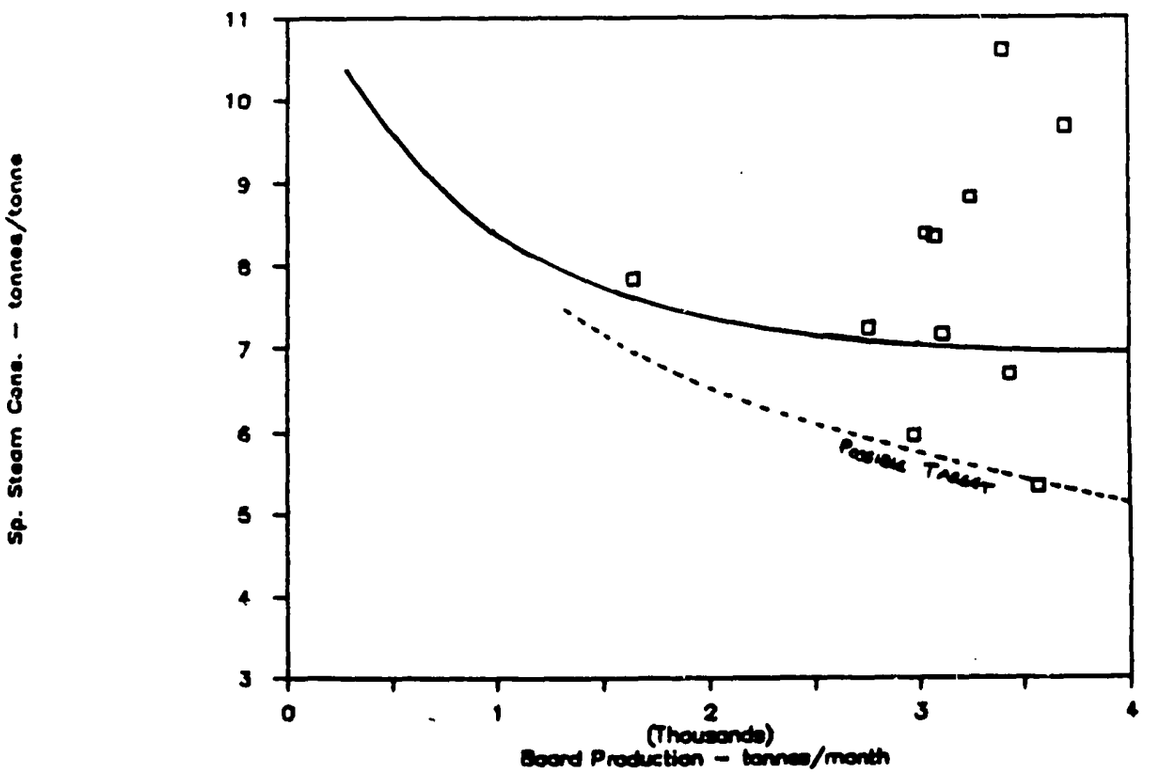


37

Spec. Electricity Consmptn – Production



Spec. Steam Consumption – Production



II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

~10%

TIME: 09:53:41
DATE: 04/05/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	80.0	%
AMBIENT TEMPERATURE:	34	°C
STACK TEMPERATURE:	211	°C
OXYGEN:	05.1	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	09.9	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	29	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:03:44
DATE: 04/05/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	80.3	%
AMBIENT TEMPERATURE:	36	°C
STACK TEMPERATURE:	210	°C
OXYGEN:	04.5	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	09.2	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	25	%
CARBON MONOXIDE ALARM:	50	PPM

II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

~9%

TIME: 10:08:54
DATE: 04/05/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	80.5	%
AMBIENT TEMPERATURE:	37	°C
STACK TEMPERATURE:	209	°C
OXYGEN:	04.4	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	09.3	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	25	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

I

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

~50%

TIME: 10:12:42
DATE: 04/05/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	82.1	%
AMBIENT TEMPERATURE:	38	°C
STACK TEMPERATURE:	154	°C
OXYGEN:	04.1	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	09.5	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	22	%
CARBON MONOXIDE ALARM:	50	PPM

II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

~30%

TIME: 10:15:25
DATE: 04/05/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	82.8	%
AMBIENT TEMPERATURE:	38	°C
STACK TEMPERATURE:	170	°C
OXYGEN:	03.1	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	10.0	%
COMBUSTIBLE GASES:	0.04	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	16	%

II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

~30%

TIME: 10:16:47
DATE: 04/05/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	82.7	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	172	°C
OXYGEN:	02.9	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	10.1	%
COMBUSTIBLE GASES:	0.05	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	15	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:19:22
DATE: 04/05/91

~30%

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	82.8	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	167	°C
OXYGEN:	02.8	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	10.2	%
COMBUSTIBLE GASES:	0.06	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	14	%
CARBON MONOXIDE ALARM:	50	PPM

II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:23:15
DATE: 04/05/91

~90%

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	80.1	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	200	°C
OXYGEN:	05.6	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	08.6	%
COMBUSTIBLE GASES:	0.05	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	33	%
CARBON MONOXIDE ALARM:	50	PPM

II

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:30:58
DATE: 04/05/91

~90%

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	79.1	%
AMBIENT TEMPERATURE:	40	°C
STACK TEMPERATURE:	205	°C
OXYGEN:	05.4	%
CARBON MONOXIDE:	3	PPM
CARBON DIOXIDE:	08.8	%
COMBUSTIBLE GASES:	0.12	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	32	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:34:57
DATE: 04/05/91

~90%

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	79.0	%
AMBIENT TEMPERATURE:	40	°C
STACK TEMPERATURE:	207	°C
OXYGEN:	05.3	%
CARBON MONOXIDE:	3	PPM
CARBON DIOXIDE:	08.6	%
COMBUSTIBLE GASES:	0.11	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	30	%
CARBON MONOXIDE ALARM:	50	PPM

Boiler III

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 07:40:56
DATE: 04/08/91

100%

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	80.6	%
AMBIENT TEMPERATURE:	37	°C
STACK TEMPERATURE:	212	°C
OXYGEN:	02.3	%
CARBON MONOXIDE:	6	PPM
CARBON DIOXIDE:	10.5	%
COMBUSTIBLE GASES:	0.04	%
STACK DRAFT (INCHES H20):	- 01.7	
EXCESS AIR:	11	%

II 8.50%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 07:44:26
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	81.4	%
AMBIENT TEMPERATURE:	37	°C
STACK TEMPERATURE:	197	°C
OXYGEN:	02.7	%
CARBON MONOXIDE:	6	PPM
CARBON DIOXIDE:	10.3	%
COMBUSTIBLE GASES:	0.05	%
STACK DRAFT (INCHES H20):	- 01.7	
EXCESS AIR:	13	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

4

BOILER III

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 08:40:16
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	81.2	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	187	°C
OXYGEN:	02.8	%
CARBON MONOXIDE:	11	PPM
CARBON DIOXIDE:	10.2	%
COMBUSTIBLE GASES:	0.12	%
STACK DRAFT (INCHES H20):	- 01.7	
EXCESS AIR:	14	%
CARBON MONOXIDE ALARM:	50	PPM

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 08:45:29
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	79.6	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	213	°C
OXYGEN:	02.3	%
CARBON MONOXIDE:	11	PPM
CARBON DIOXIDE:	10.5	%
COMBUSTIBLE GASES:	0.15	%
STACK DRAFT (INCHES H20):	- 01.7	
EXCESS AIR:	11	%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 08:48:05
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	81.3	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	182	°C
OXYGEN:	02.7	%
CARBON MONOXIDE:	8	PPM
CARBON DIOXIDE:	10.3	%
COMBUSTIBLE GASES:	0.14	%
STACK DRAFT (INCHES H20):	- 01.7	
EXCESS AIR:	13	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

BOILER IV

App C pg 3

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 09:10:26
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	80.7	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	199	°C
OXYGEN:	04.1	%
CARBON MONOXIDE:	6	PPM
CARBON DIOXIDE:	09.5	%
COMBUSTIBLE GASES:	0.06	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	23	%
CARBON MONOXIDE ALARM:	50	PPM

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 09:13:16
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	82.3	%
AMBIENT TEMPERATURE:	39	°C
STACK TEMPERATURE:	172	°C
OXYGEN:	03.0	%
CARBON MONOXIDE:	6	PPM
CARBON DIOXIDE:	10.1	%
COMBUSTIBLE GASES:	0.07	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	16	%
CARBON MONOXIDE ALARM:	50	PPM

SERIAL # 11001934

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TI[illegible] 1:55:42
DA[illegible] /08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	81.8	%
AMBIENT TEMPERATURE:	36	°C
STACK TEMPERATURE:	187	°C
OXYGEN:	04.2	%
CARBON	3	PPM
CARBON	09.4	%
COMB.	0.00	%
STA[illegible] H20):	+ 00.0	
EX[illegible]	22	%
	50	PPM

BOILER IV

15.100%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:05:18
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	81.7	%
AMBIENT TEMPERATURE:	38	°C
STACK TEMPERATURE:	155	°C
OXYGEN:	04.2	%
CARBON MONOXIDE:	11	PPM
CARBON DIOXIDE:	09.4	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	23	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

15.50%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 09:58:20
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	83.4	%
AMBIENT TEMPERATURE:	37	°C
STACK TEMPERATURE:	167	°C
OXYGEN:	02.1	%
CARBON MONOXIDE:	11	PPM
CARBON DIOXIDE:	10.5	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	10	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

15.30%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:07:41
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	83.1	%
AMBIENT TEMPERATURE:	38	°C
STACK TEMPERATURE:	166	°C
OXYGEN:	02.3	%
CARBON MONOXIDE:	11	PPM
CARBON DIOXIDE:	10.5	%
COMBUSTIBLE GASES:	0.05	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	11	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

15.50%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:02:20
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	83.3	%
AMBIENT TEMPERATURE:	38	°C
STACK TEMPERATURE:	164	°C
OXYGEN:	02.5	%
CARBON MONOXIDE:	16	PPM
CARBON DIOXIDE:	10.4	%
COMBUSTIBLE GASES:	0.03	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	12	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

15.30%

SERIAL # 11001934
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: RCG/HBI

TIME: 10:00:36
DATE: 04/08/91

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	83.0	%
AMBIENT TEMPERATURE:	38	°C
STACK TEMPERATURE:	159	°C
OXYGEN:	01.6	%
CARBON MONOXIDE:	26	PPM
CARBON DIOXIDE:	10.9	%
COMBUSTIBLE GASES:	0.10	%
STACK DRAFT (INCHES H20):	+ 00.0	
EXCESS AIR:	7	%
CARBON MONOXIDE ALARM:	50	PPM

MODE:PPM OXY_REF=TRUE%

APPENDIX D

ECONOMISER AND HEAT RECOVERY CALCULATION FOR BOILERS

Economiser

Natural gas heating value	34000	kJ/Nm3
Flue gas side		
Mass flow	18000	kg/h
Inlet temperature	190	deg C
Outlet temperature	135	deg C
Feed Water Side		
Mass flow	14300	kg/h
Inlet temperature	98	deg C
Outlet temperature	114.5	deg C
Heat Rate	280	kW
Heat recovered (10 % losses)	252	kW
Savings		
Natural gas	33.4	Nm3
Assumed boiler efficiency	80	percent
Operating hours	2500	hr/yr
Assumed fuel cost	11	Ft/Nm3
Value of savings	920,000	Ft/yr
Investment	1,500,000	Ft
Payback	1.6	years

Continuous Blowdown Heat Recovery

Boiler water side		
Mass flow	2300	kg/hr
Inlet temperature	175.4	deg C
Enthalpy	742.6	kJ/kg
Outlet temperature	45	deg C
Enthalpy	188.4	kJ/kg
Make up water side		
Mass flow	14300	kg/hr
Inlet temperature	30	deg C
Enthalpy	127.7	kJ/kg
Outlet temperature	51.5	deg C
Enthalpy	214.8	kJ/kg
Heat Rate	354	kW
Heat recovered (10 % losses)	318	kW
Savings		
Natural gas	42.1	Nm3
Assumed boiler efficiency	80	percent
Operating hours	2500	hr/yr
Assumed fuel cost	11	Ft/Nm3
Value of savings	1,160,000	Ft/yr
Investment	790,000	Ft
Payback	0.7	years

APPENDIX E

ELECTRIC MOTORS OF 100kW AND ABOVE

Machine 21

Vacuum pump motors	8 x 125 kW AC
Mixer	1 x 250 kW AC

Machine 22

Main machine drive	1 x 100 kW DC

Machine 23

Main machine drive	1 x 117 kW DC
Paper grinding	1 x 125 kW AC
	1 x 132 kW AC
Homogenising	1 x 125 kW AC

Material Preparation

Paper grinding	2 x 160 kW AC
Hydropulpers	6 x 100 kW AC
Grinding	7 x 125 kW AC
	3 x 250 kW AC (6 kV)
Pump	1 x 160 kW AC

APPENDIX 1. DETAILED RECOMMENDATIONS FOR ENERGY EFFICIENCY IMPROVEMENT

Recommendations by RCG/Hagler, Bailly for energy efficiency improvement have been grouped in two categories:

A. General and Energy Management

These projects are opportunities which are recommended for immediate action, and require little or no expenditure. These projects affect management systems and techniques, rather than process equipment. These projects are the primary focus of the USAID Emergency Energy Program for Hungary.

B. Low-cost, Short-term Improvements

These projects are low-cost improvements to process plant and equipment which are recommended for implementation in the short-term (in 1991). Because of the low cost and quick payback (less than one year), these projects could be implemented from the company's annual maintenance budget. Some of these projects may be of interest to the USAID Emergency Energy Program for Hungary.

Following is list of the recommended projects for Budafoki Papirgyar:

Action A.1: Improve plant energy management and accounting

Action A.2: Institute energy efficiency teams to reduce energy losses

Action B.1: Replace faulty steam traps

Each project listed above is presented in a stand-alone project form which provides all basic information to qualify the project. The data are provided at the "inventory" level (first order of magnitude approximation), and include the following:

- Description and rationale
- Calculation of savings (energy and others)
- Implementation cost
- Financial analysis limited to the pretax pay-back period
- Planning
- Technical risk and reference
- Back-up data and calculations.

ACTION A.1 - Improve Plant Energy Management and Accounting

1. PROCESS AREA

Overall plant energy management and accounting system.

2. STATEMENT OF RECOMMENDATION

Improve the monitoring and recording of energy consumption and production parameters throughout the plant. Use a portable PC computer to store and analyze this data on a regular basis (intially monthly, eventually weekly or daily). Among the tasks of the computer should be included the following:

- -- storage of daily and monthly data on consumption of total and submetered electricity, steam, and fuel; as well as production data by machine and total
- -- relationships (graphs) of energy consumption of major users relative to production (specific energy consumption)
- -- relationships (graphs) of specific energy consumption against production
- -- printout of monthly data and graphs in a consistent and clear format for review by technical management and overall management at the plant.

3. DESCRIPTION/RATIONALE

In this plant, energy accounts for nearly 20% of final product cost. With this high percentage, it is imperative that a good energy monitoring system coupled with management review be instituted. While some data on consumption and production is currently gathered, there is no analysis done. With the large amount of data available, a computer is the only way to ensure that the data can be consistently entered, organized, analyzed, and presented to management in a timely manner.

With the computer, a large number of operating parameters and efficiency indices can be evaluated at the same time, providing an excellent picture of plant efficiency. Eventually, the plant will want to enter more detailed (daily) data to obtain a much more immediate evaluation of operating efficiency; the computer is the only reasonable way to achieve this.

4. BENEFITS

4.1 Energy Savings

Energy savings are obtained as a result of management review of the analyzed data, and the resulting instructions to correct or improve

energy use. The very fact that the staff know this data is being monitored and analyzed regularly is already partial incentive to optimize operation. The installation of such and energy management/accounting system can be expected to bring anywhere from 0.5 to 3% reduction in energy consumption.

- Assuming 0.5% reduction in energy consumption:

$$0.5/100 \times 255{,}960{,}000 \text{ Ft/y} \times 1/70 \text{ \$/Ft} = \$18{,}300/\text{y}$$

5. IMPLEMENTATION COSTS

Equipment	Number	US$ Cost
Desktop computer/monitor/keyboard/DOS	1	4,200
Wide carriage printer	1	400
Spreadsheet software	1	400
TOTAL		5,000

In addition to the hardware and software costs, there will be some cost to set up the computer inputs for the monitoring system, train someone to use the computer, and ensure that correct data are obtained.

6. PAYBACK

The payback period for the purchase of the computer system is approximately 3 months.

7. SCHEDULE

Task 1 -- completion date: May 20, 1991

HBI prepares and addresses to Budfoki Papirgyar the specifications for the computer equipment.

Task 2 -- completion date: May 25, 1991

HBI gets quotations from US manufacturers. EGI obtains quotations from Hungarian companies.

Task 3 -- completion date: June 10, 1991

Budafoki reviews specifications and makes recommendations for selection of supplier.

Task 4 -- completion date: June 15, 1991

USAID gives clearance for equipment procurement based on HBI financial and economic study and evaluation of quotations.

Task 5 -- completion date: June 16, 1991

HBI sends purchase orders for equipment.

Task 6 -- completion date: August 10, 1991

Shipment of equipment arrives in Hungary.

Budafoki completes a workplan for the institution of a data collection, analysis, and reporting program using the computer system. All important parameters needed to be entered into the computer are identified. Any necessary training of staff is begun.

Task 7 -- completion date: August 31, 1991

Budafoki installs the computer system, and stores available detailed data from the last two years in the system. Preliminary analysis of this data is begun.

Task 8 -- completion date: September 10, 1991

HBI reviews Budafoki computer installation, and its use as the basis of a detailed energy management and monitoring program. Setting of monthly targets for parameters such as specific energy consumption is begun.

8. TECHNICAL RISK AND REFERENCE

There is no significant risk involved in the implementation of this project.

9. SPECIFICATION OF EQUIPMENT

- **central computer unit**
  IBM PC compatibe (MS DOS 3.3 minimum)
  80386 microprocessor
  4 MB RAM
  3 1/2" floppy disk drive (1.4 MB)
  5 1/4" floppy disk drive (0.7 MB)
  serial and parallel communication ports
  Hungarian characters EPROM (CWI)
  VGA 14" color monitor
  Hungarian keyboard

- **printer**
  24 pin dot matrix
  wide carriage (142 col)
  Hungarian characters EPROM (CWI)

- **software**

  spreadsheet: Lotus 123 + Allways, or QUATTRO PRO, or IMPRESS in Hungarian
  word processor: Wordstar or Wordperfect
  all user manuals to be in Hungarian

ACTION A.2 - Institute Energy Efficiency Teams to Reduce Energy Losses

1. PROCESS AREA

Portable instruments: to be used throughout the plant for combustion, steam and electrical systems.

2. STATEMENT OF RECOMMENDATION

Set up at least 3 energy efficiency teams to test and optimize equipment operation on a regular basis. Teams should be organized for the boilers, the steam system, and the electrical systems. Following are recommendations for the activities on each of these teams:

2.1 Combustion Efficiency Testing Program

Use an electronic combustion gas analyzer to monitor the exhaust O2 content and the combustion efficiency of all four boilers on a weekly basis. Use the combustion analyzer on-line to make necessary fuel/air adjustments in order to keep O2 levels at a minimum with CO less than 100 ppm.

2.1 Steam Trap Testing Program

Inventory all steam traps. Begin a regular testing program using the ultrasonic test instrument, ensuring that every trap is tested on a regular basis at least twice per year. Tag or otherwise identify each malfunctioning trap and schedule its repair or replacement as soon as possible.

2.2 Optimize Boiler Blowdown

Use the TDS or conductivity meter to monitor the boiler water dissolved solids content 3 times per day. Manually adjust the blowdown or change the bottom blowdown rate in order to maintain the solids concentration inside the boiler less than 3500 ppm (mg/l).

2.3 Reduce Peak Electrical Demand

Use an electric power analyzer to determine the variations in electrical demand for the bakery as a whole, and for the larger individual pieces of equipment. Analyze the results of these measurements to determine the peak demand period during the day, and to identify the equipment which most importantly contribute to this electrical demand. Develop a program for manual rescheduling of equipment operation, or shutoff of certain equipment during the peak demand period in order to reduce the peak demand.

3. DESCRIPTION/RATIONALE

Measurements performed during the audit showed the need for test instruments and their use in the plant, for example:

(a) tests on all four boilers showed that while the combustion efficiency was adequate, an additional 1 to 2 percentage points on the efficiency could be gained by a finer tuning based on precise measurement of exhaust gas composition

(b) steam trap tests showed that over 80% of the sample tested were leaking significantly; a regular testing program with proper testing instruments (ultrasonic) can immediately identify leaking traps; trap repair or replacement must then be scheduled as soon as possible

(c) electrical measurements on motors showed some to be significantly underloaded, and operating at lower efficiency; operation of others could be rescheduled to reduce startup times.

Use of portable instruments will allow the testing of steam traps, boiler water, and electrical equipment to ensure that equipment is operating in optimum condition. While the operation is generally good, the use of instruments provides a basis for an optimization of operation, offering energy savings of several percent. This amount of savings will pay for the investment in instruments and staff time many times over in one year. In addition, regular testing of plant equipment improves the staff knowledge and understanding of the equipment, and can serve as a basis for a better preventive maintenance program.

4. BENEFITS

4.1 Energy Savings

Energy savings are obtainable primarily by using the ultrasonic tester to identify leaking steam traps, and by using the electric power analyzer to identify possible electrical demand reductions.

- Combustion efficiency (conservatively assuming 1% average improvement)

88,350,000 Ft/y x 0.01 x 1/70 $/Ft = 12,600 $/y

- Leaking steam traps identified/repaired (assuming 10/y):

10/yr x 5 kg stm/h (loss) x 6000 h/y x 1.1 Ft/kg stm = 330,000 Ft/y = $4700

- Possible electricity consumption reduction (assuming average 0.25% reduction):

0.25/100 x 133,066,000 Ft/y x 1/70 $/Ft = 290,000 Ft/y = $4800

Total possible savings: $ 22,100

5. IMPLEMENTATION COSTS

Equipment	Number	US$ Cost
Electronic combustion gas analyzer	1	3,000
Ultrasonic tester	1	1,500
TDS meter	1	300
Electric power analyzer	1	6,000
TOTAL		10,800

6. PAYBACK

The payback period for the purchase of all four instruments is approximately six months.

7. SCHEDULE

Task 1 -- completion date: May 20, 1991

HBI prepares and addresses to Budafoki Papirgyar the specifications for the instruments.

Task 2 -- completion date: May 25, 1991

HBI gets quotations from US manufacturers.

Task 3 -- completion date: June 10, 1991

Budafoki reviews specifications and makes recommendations for selection of supplier.

Task 4 -- completion date: June 15, 1991

USAID gives clearance for equipment procurement based on HBI financial and economic study and evaluation of quotations.

Task 5 -- completion date: June 16, 1991

HBI sends purchase orders for equipment.

Task 6 -- completion date: August 10, 1991

Shipment of equipment arrives in Hungary.

Budafoki completes an operating procedure for the use of portable instruments, including who is responsible, where they will be stored, frequency of use for different applications, etc.

Task 7 -- completion date: August 31, 1991

Budafoki presents results of initial tests using the instruments. A list of steam traps tested and their operating condition,

recommended action, and implementation plan should be included. Initial measurements of electrical equipment and their contribution to electrical demand should also be available.

Task 8 -- completion date: September 10, 1991

HBI reviews Budafoki test procedures and results, and assists in making additional energy-saving recommendations based on the test results.

8. TECHNICAL RISK AND REFERENCE

Proper operation of the instruments presents no risk to the company. As part of the operating procedures mentioned in Task 6, instructions for instrument operation should be translated or adapted into Hungarian.

9. SPECIFICATION OF EQUIPMENT

9.1 Electronic Combustion Gas Analyzer

Type: Electronic microprocessor-based
Physical: Portable, self-contained with carrying case
Probe length min 12", sample line length minimum 6 ft
Silica gel sample dryer and condensate trap
Built-in thermal printer, with line feed button
Output LCD display, backlit, adjustable
- ambient temperature: 0-60 C
- stack temperature: 0-600 C
- O2: 0-21%, electrochemical cell
- CO: 0-1000 ppm, electrochemical cell
- NOx or NO: 0-2000 ppm
- SO2: 0-2000 ppm
- Combustibles: 0-2.5%, semiconductor sensor
- Stack draft: mmHg, peizoresistive sensor
- Computed values of CO2, excess air, combustion efficiency

Power: 6-12V battery, rechargeable; input 220V 50Hz
Accessories: memory for various fuels, with possibility to custom set
or Options: diagnostic messages
autozero on startup
Spares: O2 cell (1)
CO cell (1)
6 rolls printer paper
4 bottles silica gel

9.2 Ultrasonic Tester

Type: Ultrasonic detector
Physical: Pistol-type detector/stethoscope, with minimum 4" probe, extendable to 15"
Output: Analog meter on pistol and audible sound converter for use with earphones; 10/1 sensitivity calibration dial

Power: 9 V battery, optionally rechargeable
Accessories: lightweight plug-in headset, carrying case; tone-generator and rubber focusing extension optional

9.2 TDS Meter

Type: Conductivity meter
Physical: Integral measuring cup
Output: Analog meter, 0-5000 ppm in a minimum of 3 ranges
Power: 9V battery

9.3 Electric Power Analyzer

Type: Three-channel kW, kVAr, power factor recorder
Physical: Benchmount model, NEMA II drip-proof case
3-pen chart recorder
100% zero adjust
voltage and current leads (6 ft minimum)
Input: maximum 600 V, 1000 A AC
Output: power factor: 0.5 lag to 0.75 lead
kW, kVAr: 0-1200, minimum 6 ranges
kWh, kVArh counter, resettable to zero
max kW, kVAr demand: selectable 15, 30, 60 min periods
chart drive minimum 10 speeds in cm/hr and cm/min
Power: input 220V 50Hz
Accessories: 3 x 1000A:1A current transformers
Spares: fuses
3 x pens/cartridges and chart paper

ACTION B.1 - Replace Faulty Steam Traps

1. PROCESS AREA

Steam and condensate system for the paperboard machines.

2. STATEMENT OF RECOMMENDATION

Replace 105 thermodynamic-type steam traps on paperboard machines 21, 22, and 23 with inverted bucket-type traps.

3. DESCRIPTION/RATIONALE

During the audit, steam traps were identified as a primary cause of the large amount of steam (estimated at 1.5 t/h) lost from the condensate tank. A test of a sample of 20 traps yielded 17 faulty traps. A major reason for the defective traps is that an incorrect type of trap is being used in the system. The thermodynamic traps emptying into a line with back pressure do not perform adequately. Furthermore, as soon as one trap begins to blow steam, the back pressure in the whole line is increased, affecting the performance of the remaining traps. The only effective solution to this problem is the replacement of the existing thermodynamic traps with inverted bucket traps. These traps are hardy, are not affected significantly by back pressure, and are easy to test.

4. BENEFITS

4.1 Energy Savings

Energy savings are obtained by replacement of steam traps, eliminating the steam leakage through the traps. It is assumed that an average of 10 kg/h of steam are leaking through each trap. Total savings are estimated at $99,000.

- Replacement of 105 leaking steam traps:

105 x 10 kg/h (loss) x 6000 h/y x 1.1 Ft/kg stm = 6,930,000 Ft/y = $99,000/y

5. IMPLEMENTATION COSTS

Equipment	Number	US$ Cost
Inverted bucket steam traps (various sizes)	105	21,000

6. PAYBACK

The payback period for the purchase of all four instruments is approximately 2.5 months.

7. SCHEDULE

Task 1 -- completion date: May 20, 1991

HBI prepares and addresses to Budafoki Papirgyar the specifications for the instruments.

Task 2 -- completion date: May 25, 1991

HBI gets quotations from US manufacturers.

Task 3 -- completion date: June 10, 1991

Budafoki Papirgyar reviews specifications and makes recommendations for selection of supplier. Budafoki Papirgyar supplies whatever data possible on flows to steam traps in order to most closely approximate orifice size to be specified for the traps.

Task 4 -- completion date: June 15, 1991

USAID gives clearance for equipment procurement based on HBI financial and economic study and evaluation of quotations.

Task 5 -- completion date: June 16, 1991

HBI sends purchase orders for equipment.

Task 6 -- completion date: August 10, 1991

Shipment of equipment arrives in Hungary.

Budafoki Papirgyar completes a workplan for replacement of steam traps.

Task 7 -- completion date: August 31, 1991

Budafoki Papirgyar begins the trap replacement program and presents results of initial trap replacements.

Task 8 -- completion date: September 10, 1991

HBI reviews Budafoki Papirgyar trap installations as well as the overall performance of the condensate return system.

8. TECHNICAL RISK AND REFERENCE

There is no significant risk involved in the implementation of this project.

9. SPECIFICATION OF EQUIPMENT

Traps must be inverted bucket type.

Number of traps	Steam p bar g	Nom. pipe diam (in)	mm	Dimensions (mm) Between flanges	Flange bolt circle dia.

41	3	3/4	20	150	75
45	3	1	25	195	85
15	4	1	25	195	85
2	4	1 1/4	32	195	100
2	8	1 1/4	32	195	100

105					