PN-ABM-237
79205

ENERGY EFFICIENCY AUDIT REPORT
BALTIC SHIP REPAIRS
TALLINN, ESTONIA

JULY 1992

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WASHINGTON, D.C. 20253

USAID Contract EUR-0015-C-00-1007-00

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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 judgement. The conclusions reached were based on a limited engagement of only about one week's duration in the plant, and not an exhaustive engineering analysis. RCG/Hagler, Bailly, Inc. certifies that this report conforms to the level of best commercial practice for industrial energy audits of similar level of effort, as conducted in the United States. This report has been prepared under the guidance of a registered Professional Engineer, licensed to practice in the United States.

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FINAL ENERGY AUDIT
BALTIC SHIP REPAIRERS
TALLINN, ESTONIA

I. ACKNOWLEDGEMENTS:

USAID, ENPRO and RCG/Hagler, Bailly, Inc. gratefully acknowledge the assistance, and cooperation shown by USAID/Tallinn, Tallinn Technological University's (TTU) Messers. Vladimir Marchenkov, Heinrich Suik and Arvo Ots. We also gratefully acknowledge the personalized assistance and cooperation of the following BALTIC SHIP REPAIRERS individuals:

Mr. Valeri Kovalenko, Chief Engineer
Mr. Igor Novosyolov, Energy Manager
Mrs. Alexandra Galina, Accounting Department
Mr. Andrei Schelokov, Public Relations

II. EXECUTIVE SUMMARY

RCG/HB's Messrs Barry G. Tunnah and Eduardo S. Maal, together with Tallinn, Tallinn Technological University's (TTU) Messrs. Vladimir Marchenkov, Heinrich Suik and Arvo Ots and EnPro Engineers Bureau's Messrs. Sulev Soosar, anfd Hienar Nurste carried out Preliminary Energy Auditing site activities at BALTIC Station from Dec 8-10, 1991 to work together with BALTIC SHIP REPAIRERS staff to identify and implement improvements to energy efficiency.

The BALTIC SHIP REPAIRERS enterprise occupies 1 km of waterfront in northwest Tallinn, its main line of business being marine repair of vessels up to 20,000 DWT. BSR employs 2,000 workers and has launched joint ventures with West European partners for sandblasting, painting, and metal fabrication.

BSR is in the process of establishing several Stock companies, joint ventures, cooperatives. etc. These are being established (at least partially) when compatible with the various structures and resources of BSR. Some of the names provided were: BALDIW, EPSOS, Merge, Baltic Premator, ScanBal, Torvik, Arba, Madam Taira, Pako, Rechnik, Severo-Zapad, Ekologia, Sudoservice, LenBalt, Ahto. Unfortunately, the RCG.Hb Team was unable to obtain any more details about these companies.

BSR doesn't record production from it's many shops in tangible units. All production is recorded in "manhours" worked at the specific shops. Only Acetylene production is recorded in "bottles" of Acetylene.

RCG/HB has based it's work on consumption in 1990 and 1991 and energy prices in US $. This has been done due to the severe devaluation of the Estonian/Russian RUBLE at the time of the visit and the fact that Estonia will have to pay "world, free economy" prices for fuels.

Based on 1990 and 1991 figures, RCG/HB estimates total yearly energy costs for 1992 at BALTIC SHIP REPAIRERS as:

Yearly Electricity use in MWh	27,696	
Yearly Fuel use in Tons of Mazout	8,884	
Yearly value of Elect. at US$ 50.00/Mwh	$1,384,800	69%
Yearly value of Mazout at US$70/ton	$621,880	31%
Yearly value of TOTAL Energy in US $	$2,006,680	

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

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

From these potential savings figures, RCG/Hagler, Bailly conservatively estimates the total potential for energy efficiency improvement without process changes, at BALTIC SHIP REPAIRERS as 6-20 %.

The potential savings figures shown for GENERAL AND ENERGY MANAGEMENT IMPROVEMENTS reflect the importance and potential of these modifications, which BALTIC SHIP REPAIRERS can and should start to implement immeditely.

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

ECO B-1. Energy and production management computers

	TOTAL COST	YEARLY SAVINGS	SIMPLE PAYBACK
	$6,000	$21,661	0.2

Portable Computer
LOTUS 123, software with ALLWAYS

ECO B-2. Portable efficiency monitoring instruments

	TOTAL COST	YEARLY SAVINGS	SIMPLE PAYBACK
	$11,500	$40,000	0.4

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

ECO B-3. Demonstrate distributed, electric radiant heating systems

	TOTAL COST	YEARLY SAVINGS	SIMPLE PAYBACK
Electric Radiant Space Heaters	$16,000	$31,000	0.8

The total cost for the recommended USAID financed equipment purchases is $33,500 and the expected yearly savings are $93,000 with a simple payback of approximately 0.3 years.

III. INTRODUCTION

3.1. Background

The Baltic Ship Repairers (BSR) was founded as Russian-Baltic Shipbuilding Yard in 1912. It's principal business was repair and building of ships for the Russian Fleet for the Baltic and North Atlantic. BSR is situated on territory of 76 hectars in Tallinn suburbs (on Kopli peninsula). BSR has 2 kms of wharfs, 3 floating docks (12500, 8500, 4500 t) in Tallinn and one (8500 t) in Luanda (Angola). The company operates various quays and floating dry docks around two enclosed harbors and historically its main line of business has been to repair fishing vessels. The types of ship handled now also include bulk carriers, both Soviet and foreign, up to 20,000 DWT. BSR has three joint ventures with Swedish, Finnish and German firms for sandblasting, painting and the fabrication of metal structures. There are about 2000 workers employed by BSR.

Although BSR has previously carried out much of the work itself, there is an increasing reliance on contractors for specialized work: a number of workshops are leased to other firms and BSR supplies electricity, steam and hot water for space heating. BSR also operates a number of air compressors to supply the site. Premises are now offered for firms to set up unrelated operations such as the manufacturing of furniture, clothes and shoes.

3.2. Plant Description

BSR capabilities include all types of metal working, such as welding, machining, casting and forging, manufacture of metal structures, pressure vessels, heat exchangers (they have no ASME code stamp capabilities), as well as the repair and rebuilding of machinery of all types, from pumps to diesel engines. BSR has experience in repairing refrigeration systems, electricity generators, radio and navigation equipment, lifeboats, and most types of specialized shipboard machines. BSR also builds ships up to 50 meters in length, mainly small fishing vessels. BSR operates an air liquefaction plant for the production of oxygen which is supplied throughout Estonia to over 700 customers in bottles (and as liquid for some customers), and also produces acetylene from imported calcium carbide.

IV. ENERGY USE ANALYSIS

4.1. Energy Use

Energy has historically represented a low percentage of costs. The exact figure was not known by management but was thought to have risen to about 7 percent recently. Energy costs did not receive much attention. This situation is likely to change soon, as Estonia will have to pay hard currency for imported energy supplies such as fuel oils and natural gas, which will no doubt be priced at -- or close to -- world market prices.

Management recognizes that much of the equipment is old and inefficient, and the Energy Manager is developing a comprehensive energy conservation program which will be discussed in greater detail on section V. PREVIOUS ACTIVITIES IN ENERGY CONSERVATION.

Energy consumed at the BSR plant is electricity and mazout. The total electricity consumption is metered but only about 80 percent of this is measured by sub-metering in the various workshops. All electricity is purchased, except for a very small amount which is produced by ships generators when their equipment is under test. Electricity is purchased from Estonian electric company "Eesti Energia". Connection with city grid is by two 35 kV cables to 35/6 Kv substation. There are 6 Kv main transmission cables on the plant and twenty 6/0.4 Kv substations.

Average yearly heavy fuel oil (mazout) consumption in 1990-1991 was 8,800 tons. BSR has 7 (+1 under reconstruction) mazout tanks with capacity of 2,750 tons. Mazout is used in the boilerhouse to generate steam for direct use and for making hot water for space heating. Mazout is also used in furnaces in the forging and casting shops.

At the present time, the plant does not consume natural gas but a line is being constructed to connect the entire site with the natural gas network of Tallinn. Most mazout services are expected to convert to gas by the middle of 1992. BSR has made (preliminary) contract with Estonian natural gas supply company "Eesti Gaas" to purchase 15.8 million nm^3 of gas a year starting from 1992.

The Energy use and production data gathered at BSR shows very little relationship between FUEL/ENERGY consumption and production. Only Acetylene production is recorded in tangible units, "bottles" and there is no linear relationship between FUEL/ENERGY vs. Production, as seen on Appendices B, C, D. It was practically impossible to obtain "measured" data on actual production. BSR doesn't record production from it's many shops in tangible units. All production is recorded in "manhours" worked at the specific shops. See Appendix A,

BALTIC, Total Energy Used vs. Manhours Worked. A plant with good energy management, unlike BSR, show a fairly linear relationship between Energy use and Production.

4.2. Boilerhouse

Current Conditions:

Boilerhouse is situated near the edge of territory - distance to the farthest heat consumer is approx. 3 kms. Total number of centrally heated buildings is greater than 70, including more than 10 huge (and high) workshops.

Four mazout burning (steam) boilers installed. Have plans to install in 1992/93 two new boilers, modified from solid fuel to natural gas firing (mazout as the reserve fuel).

Most of the boilerhouse equipment is old and has been in operation for up to 40 years. Boiler number 1, built in 1970, was operating near maximum capacity during our visit, producing about 20 tons/hour of saturated 8 bar steam. The boiler was originally designed to fire oil shale but was modified to burn mazout. A space is being prepared to take a new boiler. This has apparently been purchased in Russia and is designed for coal firing: the equipment is being modified for gas burning.

Readings were taken around boiler #1 to assess the level of performance. Mazout temperature at the burner was 100 deg C but there was no meter to measure the quantity fired. Water entered the boiler from the deaerator at 102 deg C. The stack gas temperature after the economizer was 120 deg C and the carbon dioxide level 10 percent, corresponding to an excess air rate of almost 60 percent. Although the boiler is quite old, it

The combustion air intake is situated close to the outside of the boilerhouse and there is an ability to take outside air to the boilers. The air temperature was measured at 19 deg C, indicating that most of the air was being drawn from the boilerhouse itself (outside temperature 3 C, ambient temperature in the boilerhouse 25 C).

Heat loss from the boiler outer surface is estimated to be around 4 percent. There were a number of hot spots where the temperature peaked at 250 deg C, indicating poor condition of sections of refractory brickwork inside the boiler.

Water samples were taken. The feedwater was 1100 ppm total dissolved solids (TDS) and blowdown water 4900 ppm. The actual blowdown rate is not known but is calculated to be around 20 percent (which is rather high and leads to losses equivalent to 5 percent of the fuel fired. The TDS in condensate was measured at 100 ppm which is rather high,

suggesting carryover to the steam system. This may be a contributory factor to the large number of steam leaks observed around the entire steam network, which may be suffering serious corrosion problems.

It was noted that there are very few instruments in the boilerhouse and there is no routine checking of boiler performance using portable equipment -- the plant has no such testing equipment. There were several orifice plate meters fitted in the steam lines but these have been abandoned: there is now no measure of the steam production (or of the fuel used).

The estimated boiler efficiency is 85 percent (based on gross CV) which compares with the efficiencies of 87-90 percent reported in 1979.

Hot water for space heating is produced in four large vertical heat exchangers through which 8-10 bar steam is passed. Warm water is returned from the site and enters the exchangers at about 50-55 deg C: hot water leaves at about 60-70 deg C (or higher in the coldest time of winter). Steam condensate collects at the bottom of the exchangers and is drained through a hand valve to a condensate collection tank. There are no steam traps fitted. At the time of our visit, there was a substantial condensate leak from the outlet of one exchanger, the hot condensate being lost to drain.

The heat exchanger section has a separate log sheet on which all temperatures and pressures are recorded every two hours. The operators said that no one ever reads these log sheets but they are routinely filed for the record.

Mazout is stored in seven tanks located about 200 meters from the boilerhouse. The tanks are insulated and the contents are maintained at around 40 deg C by steam coils. The coils are fed with 2 bar steam but have no traps on the outlet ends. Condensate is drained from each coil through a manually controlled valve: at one point, four coils were being drained through 1 inch pipes and the flow of condensate was accompanied by a steady flow of live steam. There was no attempt to recover the condensate.

Most of the tanks have had new coils fitted. The original coils were located at the base of each tank but these have corroded and been taken out of service. They have been replaced by coils taken into the oil through the roof of each tank, leaving about 10 meters of pipe at the inlet (and a similar amount at the outlet) from which heat losses are thought to be significant, even though the pipes have some insulation. The layout of the new coils is such that condensation almost certainly occurs outside the tank and thus the amount of steam used for heating the oil is in fact excessive. Installing a steam trap on the coil outlet at ground level would not improve the situation.

Mazout is pumped from tanks to a double pipe heat exchanger in which the oil is heated

to about 120 deg C by steam. No steam trap is fitted on the steam side. There is no working temperature indicator on the oil outlet, but it appears the figure of 120 deg C may be correct. Insulation of the heat exchanger is poor, with most of the return bends uninsulated and much of the existing insulation damaged and ineffective due to being exposed to rainwater. From the heater, the mazout passes to the boilerhouse along an exposed piperack about 250 meters long, arriving at the burners at 100 deg C.

Recommended Action:

We recommend that appropriate repairs be made to the boiler brickwork at the first opportunity (i.e. the next major maintenance shutdown).

Second, combustion air should be taken from the hottest point available.

Third, boiler feed water treatment should be checked and water quality kept as high as possible so that blowdown can be as low as possible.

Maximum return of condensate should also be pursued by the plant to improve the TDS level of feed water (for example, the large leak of condensate from the piping at the base of one of the vertical hot water exchangers should be repaired promptly).

It is also recommended that new heating coils entering at the bottom of the Mazout tanks be installed.

Finally, the excess air to the boiler should be kept as low as possible. Reducing air may result in the production of smoke from the boiler stack: in that case, burner tips should be replaced and the steam atomization system checked.

Expected Results:

The air rate adjustment would increase the boiler efficiency by 1 percentage point. Condensate collection, and steam leak repairs could produce savings as large as 20-30%.

4.3. Steam and Hot Water Distribution Systems

Current Conditions:

There are steam and hot water distribution networks which serve essentially all the BSR facilities on the site, which measures about 1 km by 0.8 km. The steam lines range from 8 inches to 1/2 inch in diameter, distributing steam at about 4-5 bars. Condensate is only returned from one large workshop and this represents about 10 percent at most of the

steam production. Hot water lines, both supply and return, are routed to most of the workshops.

A wide area of the BSR site was covered during the audit visit. A large number of leaks were seen on the steam lines, often from corroded valves. No steam traps appear to be fitted anywhere in the system, and condensate is frequently drained through manual valves (together with varying quantities of live steam too). The plant has decided to make their own traps based on a drawing of an inverted bucket trap found in a Russian text book of 1953. The first traps are just finished and will undergo tests shortly. There is some doubt about the capacity of the traps to discharge condensate.

The condition of insulation on steam and hot water lines is somewhat variable. Sections of many lines are not insulated and other sections have the outer metal sheet coverings damaged, allowing rain to soak the insulating material (and thus destroy its insulating properties). A great deal of asbestos-based insulation is used, including asbestos rope.

Recommended Action:

All asbestos-based insulation used, including asbestos rope, where possible, should be carefully removed and replaced with safe materials.

Expected Results:

Based on the leakage seen, on the quantities of steam being discharged, and the general level of insulation observed, it is quite likely that significant steam savings could be achieved in the medium term, possibly of the order of 40-50 %.

4.4. Space heating Systems

Current conditions:

Most of the workshops and offices are heated using circulating hot water, either directly in radiators and pipes or indirectly, with warm air blown across finned tube coils and ducted through the workshops. At most of the workshop doors, warm air "curtains" are produced by blowing air across hot water coils. Many of the workshops are old structures and the roof height is perhaps 30 meters: much of the warm air in each shop will rise into the roof. There is no roof insulation installed and therefore it is believed that significant heat losses are occurring from the roof areas. The total volume of heated space is understood to be around 1 million M^3.

As is the usual situation, there is no way to control the temperature in the heated spaces:

the windows were open in some offices. The workshops were generally well heated, even though there were many bays unoccupied. There is of course no ability to heat only those parts of workshops which are occupied and in which work is being carried out. During lunchtime, we noted the temperatures at ground level in two large workshops were 18 and 19 deg C, with outside temperatures around -4 to 0 deg C. Since much of the heat supplied must be lost to the roof, the consumption of energy for space heating is believed to be excessive. A recent study by a Swedish group suggested that BSR is using about 12 liters of fuel oil per year per M^3 of heated volume, compared with a typical figure of 5-6 liters in a similar type of plant in Sweden.

A wide area of the BSR site was visited. A large number of leaks were seen on the steam lines, often from corroded valves. No steam traps appear to be fitted anywhere in the system, and condensate is frequently drained through manual valves (together with varying quantities of live steam too). As mentioned above, the plant has decided to make their own traps and plans to install about 10 prototypes soon for testing.

Recommended Action:

In future, the continuing use of circulating hot water for space heating needs careful reconsideration by management. Radiant heaters may be an option to save on energy costs: these can be electric heaters or fired by gas, as this fuel will become available to all the workshops in 1992 as part of the scheme to introduce natural gas to the site. Radiant heaters are usually much more efficient at directing heat where it is needed, at ground level where the work takes place. Installation and tests with a few radiant heaters are suggested as a demonstration project for the BSR site.

Expected Results:

Based on one building using about 10% of BSR heat, annual equivalent fuel costs for the building are 10% of total fuel costs, or $60,000. Radiant electric heating would preclude the need for steam lines to the building, thus distribution losses of 10% would be eliminated. The use of radiant heating would increase that building's heating efficiency by 40%. Overall savings for the building are thus estimated as 40% of $60,000 plus 10% of $60,000, or $31,000 per year. Electrical energy for pumping, boiler fans, etc. would also be reduced slightly, as would water treatment costs. Worker productivity has been improved by radiant heating systems in the US.

4.5. Lighting

Current conditions:

Although the type of lighting is generally acceptable (i.e. mercury vapor lamps in the open workshops and fluorescent tubes in most other places), it is apparent that many locations are being "over" illuminated unnecessarily. It is recommended that the plant install low level task lighting, closer to the bays in which work is actually carried out, and reduce the use of the lights mounted near the roof of most workshops.

Recommended Action:

A full survey of the lighting systems should be made and levels of illumination in the entire plant should be checked. Electricity can be saved by replacing much of the high level lighting (mercury vapor lamps) by lower level task lighting for illuminating individual bays where work is carried out. To ensure that savings are actually made, it will be necessary to check the existing switching arrangements so that unnecessary lights are capable of being switched off.

Expected results:

It is of course impossible to estimate the potential savings without comprehensive information of this type, but similar surveys and reorganization of lighting on large sites has often resulted in electricity savings for lighting of 50 percent or more.

4.6. Forging & Casting Shops

Current conditions:

In the forging shop, there are about 12 small mazout fired furnaces, to which only the most basic controls are fitted. There are no procedures for checking the combustion efficiency of the furnaces, and the exhaust gases pass directly to atmosphere with no attempt at heat recovery. Doors on some of the furnaces seen operating during the visit were leaking excessively. The overall efficiency of much of the old equipment in this workshop is believed to be low.

The casting operations were shut down during our visit and so no comments can be made.

Recommended Action:

Efforts should be made when converting furnaces to gas firing to rehabilitate them and to allow for heat recovery (e.g. for preheating incoming combustion air). It is understood that the plant does indeed intend to study heat recuperation.

Expected Results:

It would be unrealistic to "guesstimate" savings results with the amount of available data, however, based on past experience in similar situations, savings in the range of 5-10% can be easily achieved with minimum investments.

4.7. Galvanizing Plants

Current conditions:

Part of the galvanizing shop was visited in which there were 6 open tanks heated by immersed steam coils. No traps are fitted and the steam condensate is lost to drain. In the hot galvanizing workshop, an electric resistance furnace (500 Kw) was used for heat treating zinc coated pieces to 500 deg C. The furnace is insulated internally with refractory brick but the outside surface remained at a high temperature even after the heating cycle had been finished. An attempt had been made to insulate the furnace externally by draping strands of asbestos rope loosely across the top. This workshop was particularly untidy and a large amount of debris was strewn around the entire working area. There are no data available relating production to energy consumption.

4.8. Oxygen Plant

Current Conditions:

The oxygen plant was visited briefly and appeared to be in good working order. The cold box was well insulated with no sign of leakages. The equipment is quite old but maintenance seems good. There are no data available relating production to energy consumption.

4.9. Compressed Air

Current Conditions:

Most of the air compressors are very old, although one relatively new machine has been installed. This is cooled by circulating cooling water, which has an outlet temperature of 35 deg C. No attempt has been made to recover heat but there could be some potential for producing warm water or warm air for space heating purposes.

V. PREVIOUS ACTIVITIES IN ENERGY CONSERVATION

BALTIC SHIP REPAIRERS were the only enterprise visited which had a tentative ENERGY CONSERVATION PLAN which was developed by the plant Energy Manager. Not all items appear to be directly concerned with energy saving but the main proposals should contribute generally to improved efficiency of operation: these are as follows:

(1) Decrease the quantity of compressed air generated, mainly through rescheduling of operations to avoid working certain shifts.

(2) Utilize air compressors on the floating docks rather than the main plant distribution system when small air volumes are needed.

(3) Use portable air compressors during second shift and holiday working to avoid commissioning the entire plant system if possible.

(4) Repair air valves on ships and throughout the main system to cut down on losses.

(5) Assemble oxygen and acetylene gas cutting equipment in one centralized location.

(6) Reconstruct fresh water supply to vessels to avoid need to run pumps continuously.

(7) Rebuild sewage and water supply systems.

(8) Optimize loads and operating schedules for the heat treatment furnaces.

(9) Operate ventilation systems in workshops only when strictly necessary.

(10) Improve sealing around doors and windows to reduce air infiltration.

(11) Develop methods of reducing water consumption.

(12) Conserve electricity in lighting systems by using task lighting rather than high level lighting of entire workshops.

(13) Improve the insulation of steam and hot water distribution piping.

(14) Install steam traps where needed (the plant has had difficulty obtaining traps and has started making its own inverted bucket traps).

(15) Initiate a maintenance campaign to reduce losses through steam, compressed air, water and hot water leaks.

(16) Install meters in key positions around the plant (specific locations not yet defined).

(17) Develop improved space heating control procedures, such as closer control of hot water supply temperatures in accordance with ambient temperatures.

(18) Install thermostats to control internal building and room temperatures.

(19) Complete connection of the boilerhouse and forging/casting workshops to the natural gas supply line.

(20) Use bottled gas for cutting equipment.

(21) When testing shipboard electric generating equipment, feed the generated power into the plant system as much as possible.

(22) Substitute electric resistance furnaces by induction heating.

(23) Improve the circulating cooling water system at the air compressor house.

(24) Install water cleaning and recycling equipment at the galvanizing workshop.

(25) Renovate cable routings.

(26) Install electric water heating at workshops for domestic hot water.

(27) Change space heating systems from steam to hot water.

(28) Install two new boilers in the boilerhouse.

(29) Use portable electric tools in workshops rather than pneumatic tools.

(30) Monitor boiler efficiency more frequently.

(31) Improve energy awareness of BSR personnel.

Consideration is also being given to the application of heat recovery systems but no specific proposals have been made yet.

Although there remain many details to be worked out, the development of an energy conservation plan is clearly a very positive first step.

The Energy Department should continue to define these proposals, including the development of estimates for the costs involved, the value of the expected savings and some sort of Schedule/Implementation Plan.

A major difficulty in assessing the potential savings is the complete lack of metering in the plant at the moment: current energy consumptions by different workshops and for different functions are difficult to determine. It is suggested that a review be made of the overall plant consumption of all utilities and that the energy conservation plan be developed to take into account the potential impact of conversion of many fuel oil services to gas, the potential for heat recovery throughout the plant, and the opportunity that gas will provide for dispersed heating and domestic hot water systems (as opposed to the centralized systems currently used).

VI. RECOMMENDATIONS FOR ENERGY EFFICIENCY IMPROVEMENTS

Recommendations have been divided into two areas:

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

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

6.1. GENERAL AND ENERGY MANAGEMENT IMPROVEMENTS

- A vigorous effort should be made by the plant to clean up the site, many parts of which are covered in debris and old, rusting pipework and broken equipment. The hot galvanizing shop is an example of the cluttered and untidy nature of many working areas. Cleaning up is unlikely to save energy directly but is an important first step to instilling an awareness of the need for care by all personnel in doing their work. A clean and safe site is more likely to be an efficient and productive workplace.

- Greater attention should be paid to collecting relevant data on energy consumptions and corresponding activities (or production figures, where relevant). Each month, the plant produces a report with many figures for estimated energy consumptions: since almost nothing is measured on the thermal side (i.e. steam, mazout) and the accuracy of electricity metering is suspect, it is believed that the reported data are quite inappropriate for real energy management. By using allocations based on design data (or using various other assumptions) it is impossible to detect trends in energy efficiency and to detect deficiencies in equipment performance. The true cost of operations cannot be known with any certainty, and therefore the profitability of activities may be doubtful. It is well known that "if you cannot measure it, you cannot manage it".

- The condition of insulation of all steam, condensate return and hot water lines, both supply and return, should be checked and replaced where damaged. Sections of missing insulation should be restored.

- A survey of the steam system should be made and steam traps installed where

required. As there appear to be no steam traps at present, this may prove a major project and require significant investment. The inverted bucket traps being manufactured by the BSR themselves may prove suitable for some services, although it appears the plant has made only 10 traps to date and has not yet tested them.

- With respect to steam trapping, it is recommended that traps be supplied to the plant for installation on the four vertical exchangers used to produce circulating hot water. The traps should be installed with valves and pipework sufficient to isolate the traps when required and to allow the rate of condensate removal to be measured, with and without the traps in operation.

- As an integral part of the energy conservation plan, the energy department should carry out a comprehensive survey of the entire steam and hot water network. Sources of heat must be identified and the consumptions of energy determined by direct measurement (or by calculation). Sources of heat which might be suitable for heat recovery systems should be identified, and locations for the use of recovered heat (heat sinks) noted. For example, heat may be recovered from the stack gases of forging furnaces, although the operating hours of the furnaces need to be established, and possibly from the air compressors.

- The results of the various measures suggested above should be evaluated and the need for continuing operation of the existing boilerhouse reconsidered. By using dispersed heat sources for domestic hot water and for space heating, the need to operate a large boilerhouse and heat exchangers for providing hot water may be removed. If the site is converted to gas firing, there will be no need to have steam for mazout tank heating -- if mazout firing is needed in emergency situations, the small amount of fuel oil could be heated by electric resistance heaters.

The future need for a large boilerhouse should be considered carefully and major investments to upgrade steam and hot water production facilities re-evaluated. Through use of decentralized equipment, losses in the steam, condensate return and hot water lines would be eliminated, together with all the associated maintenance. Supplies of steam and hot water to new joint venture companies may be eliminated also, improving the efficiency of energy use throughout the BSR facilities. Efficient decentralized production of domestic hot water and space heating could lead to the shutdown of the entire boilerhouse, and therefore major expenditure on new boilers should be undertaken only after thorough reconsideration of the future energy needs of the site.

6.2. USAID FINANCED EQUIPMENT PURCHASES

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

6.2.1. ECO B-1, Energy and production management computers

Existing conditions:

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

Recommended action:

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

Estimated cost of equipment:

$3,500

Estimated cost of installation and training:

$1,000

Estimated benefits, energy savings (and economic savings):

The equipment, with the proper software, can serve as the basis of an energy management information and control system. A management information system, with control actions taken in response to conditions identified in the plant, can easily achieve energy savings of 5%. Based on savings of 1% of fuel oil and 1% of electricity, benefits are estimated as $20,000 per year, not including productivity or quality benefits.

Estimated payback period:

0.2 year

6.2.2. ECO B-2. Portable efficiency monitoring instruments

Existing conditions:

In tests of combustion efficiency at BSR, excess air was found to be 60% on boiler #1, which is excessive. Heat loss from steam distribution systems was observed to be excessive. Frequently no steam traps were used, and when existent, they were usually malfunctioning. Compressed air systems had many leaks. Insulation on steam and/or condensate lines was frequently in disrepair or missing. Electric motor and systems efficiency was NEVER checked. Further optimization would be possible with advanced instrumentation.

Recommended action:

Provide an energy efficiency test kit consisting of electronic oxygen sensor, electronic carbon monoxide sensor, thermocouple indicator and probe set, wet chemical combustion analyzer, boiler feed-water dissolved solids meter, infrared thermometer, and ultrasonic tester and an Electric Survey Meter. BSR to form efficiency teams to put the instrument to work as part of an energy management program.

Estimated cost of equipment: $9,000 consisting of:

combustion kit	4,000
TDS meter:	500
thermocouple:	1,000
infrared:	1,000
ultrasonic	1,500
electric survey meter	1,000

Estimated cost of installation:

none

Estimated benefits, energy savings (and economic savings):

Based on boiler efficiency and uncontrolled/monitored blow-down at time of audit, combustion efficiency improvements together with boiler feed-water quality improvement and the resultant blow-down reduction should result in a measurable energy savings of at least 4-5% of boiler total fuel use. Electric system efficiency improvements of 2-5% are possible when power factor is improved through proper sizing of motors and reduction of phase imbalance. Stem and air leak reductions also result in 1-2% energy savings. Reduction of thermal losses caused by faulty or missing insulation can also result in a measurable energy saving. Therefore we conservatively estimate a yearly savings of 2% of total energy use for BSR, or $40,000.

Estimated payback period: 0.3 year.

6.2.3. ECO B-3, Distributed, Radiant Space Heating Systems

Existing conditions:

The BSR plant, sprawling over 70 hectares, is heated by a centralized system with steam and hot water lines. The losses in transmitting heat could be avoided by using decentralized systems. Furthermore, BSR/s fuel oil consumption for large workshops in bays with high ceilings is TWICE (12 vs. 5 liters/M^3) what it is in similar buildings in industrialized, free market economies. In radiant systems, more of the heat is transferred directly to the workers, thus reducing the heating of high spaces needlessly without affecting worker comfort.

Recommended action:

A test should be conducted with electric and/or gas-fired radiant heaters in one of the large workshops. These heaters can be mounted about 3-5 meters above bays in the workshop to provide radiant infrared heating to the workers in the corresponding bays. There is no need to heat up the entire workshop and all the air contained in the premises, which at present takes a significant amount of energy in the form of circulating hot water.

Each bay should be heated with one or more heaters which can be turned off when not needed.

Estimated cost of equipment:
$20,000

Estimated cost of installation:
$5,000

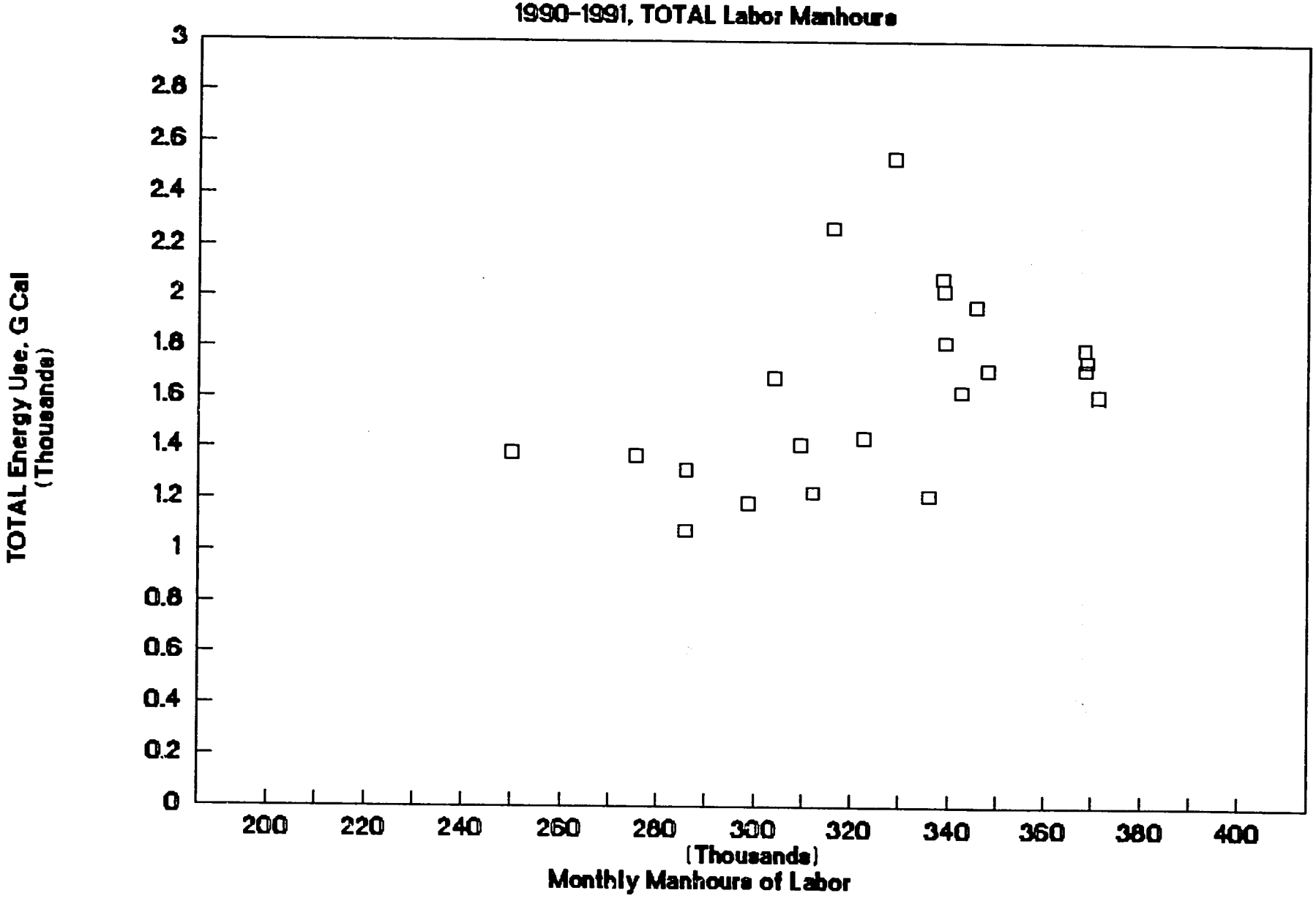
Estimated benefits, energy savings (and economic savings):

Based on one building using about 10% of BSR heat, annual equivalent fuel costs for the building are 10% of total fuel costs, or $60,000. Radiant electric heating would preclude the need for steam lines to the building, thus distribution losses of 10% would be eliminated. The use of radiant heating would increase that building's heating efficiency by 40%. Overall savings for the building are thus estimated as 40% of $60,000 plus 10% of $60,000, or $31,000 per year. Electrical energy for pumping, boiler fans, etc. would also be reduced slightly, as would water treatment costs. Worker productivity has been improved by radiant heating systems in the US.

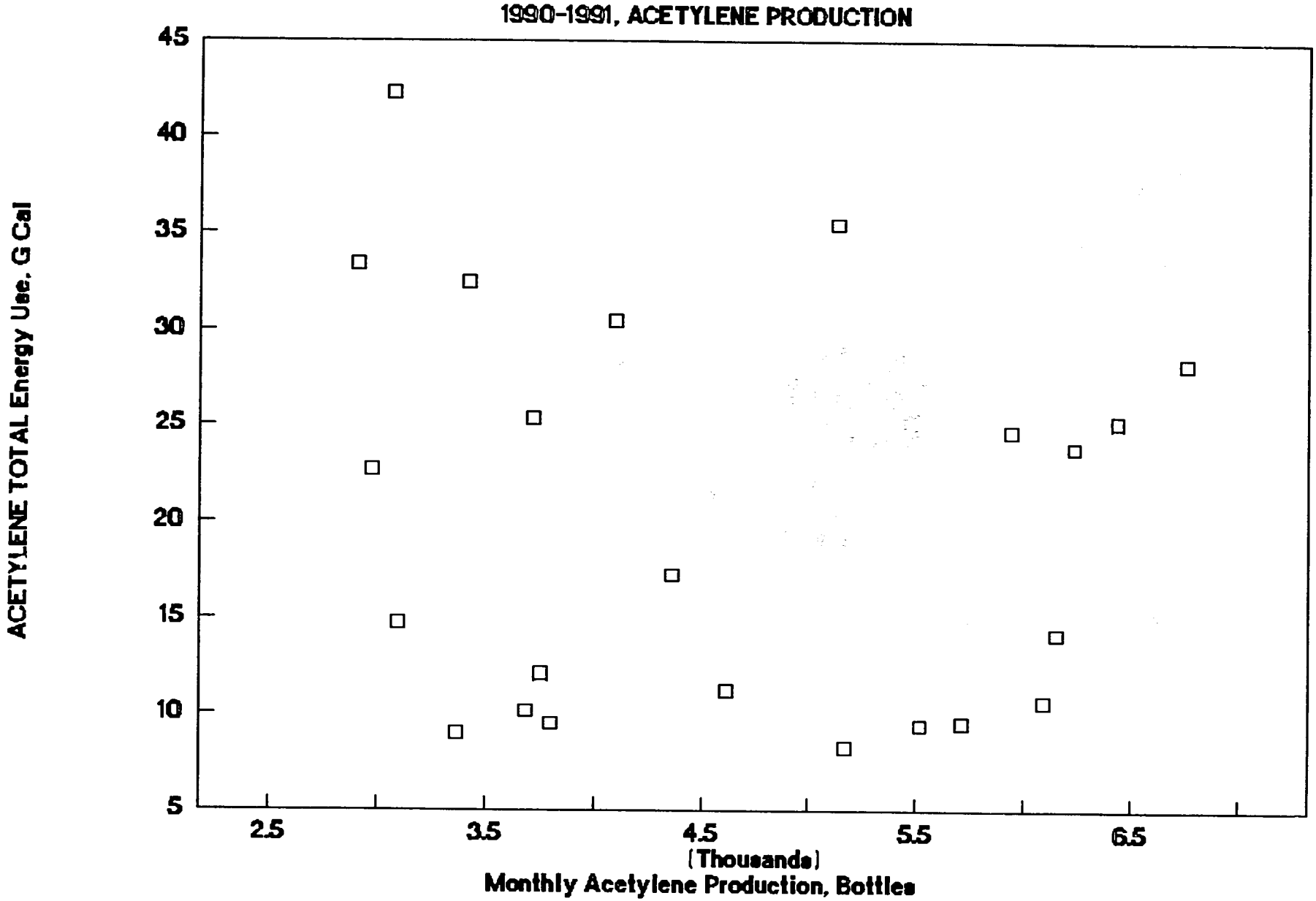
Estimated payback period: 0.7 year

APPENDICES
GRAPHICAL PRESENTATION OF HISTORICAL ENERGY AND PRODUCTION DATA

BALTIC SHIP REPAIRERS - ENERGY/MANHOURS

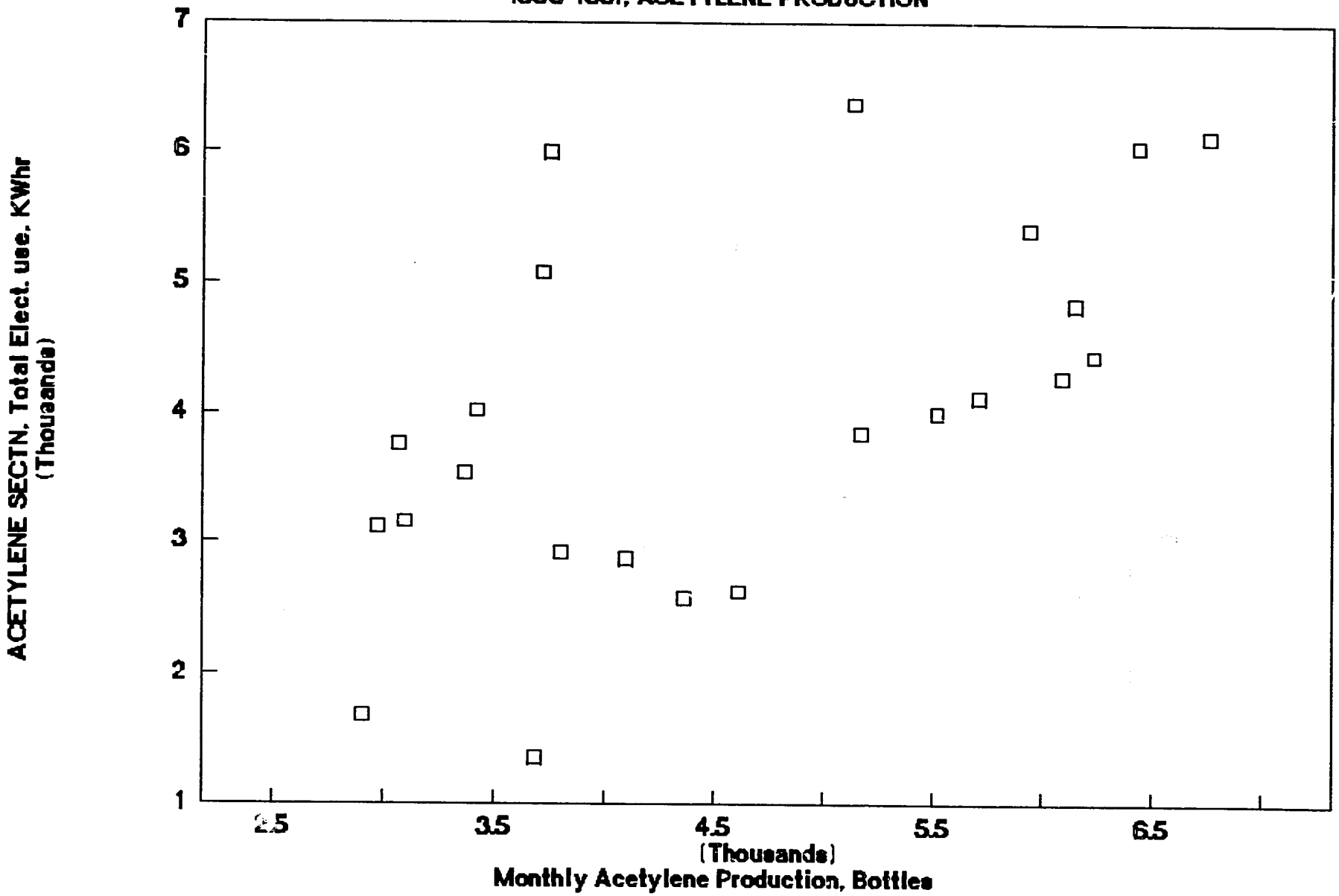


BALTIC SHIP REPAIRERS-ENERGY/ACETYLENE



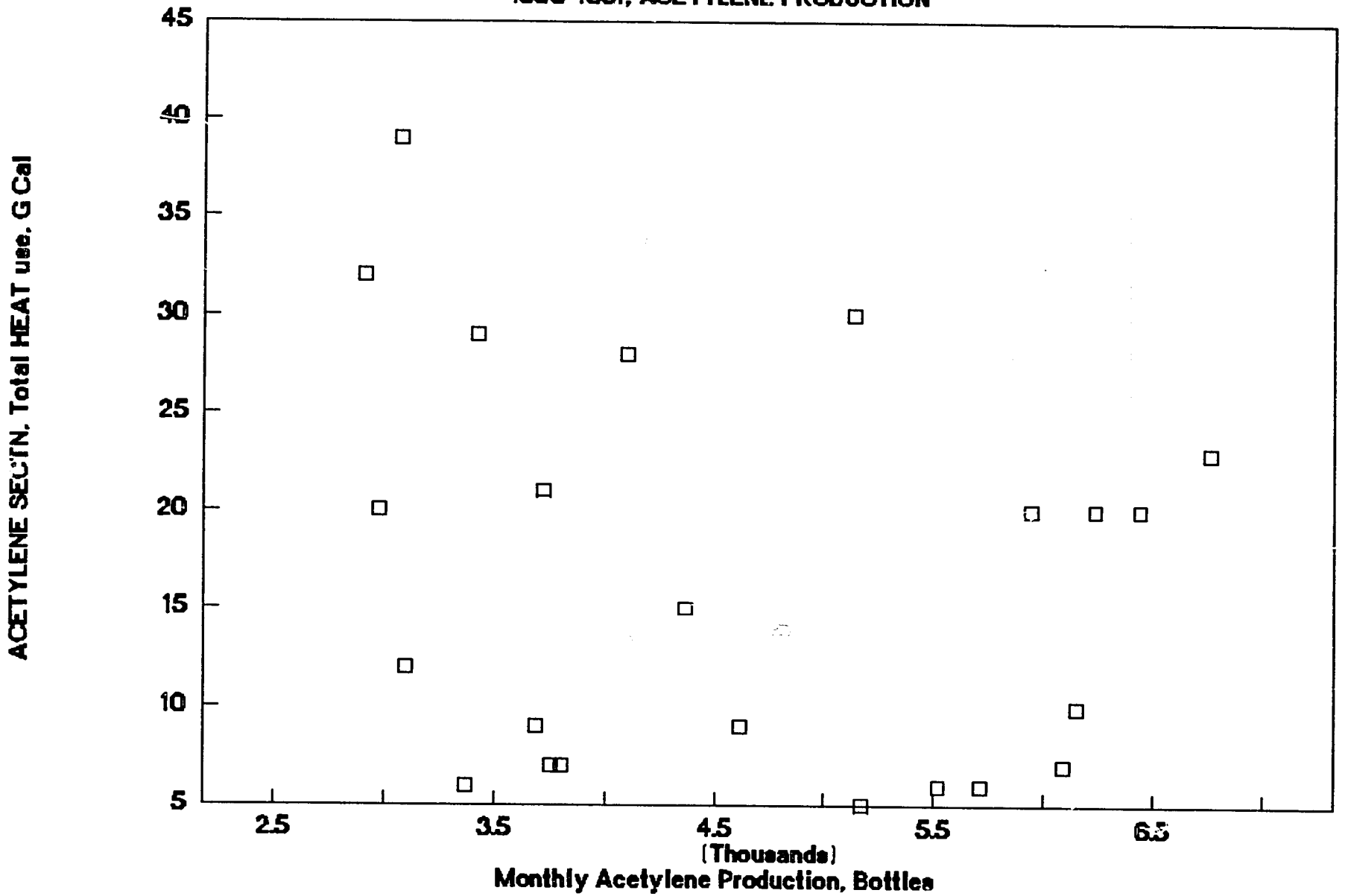
BALTIC SHIP REPAIRERS-ELECTR/ACETYLENE

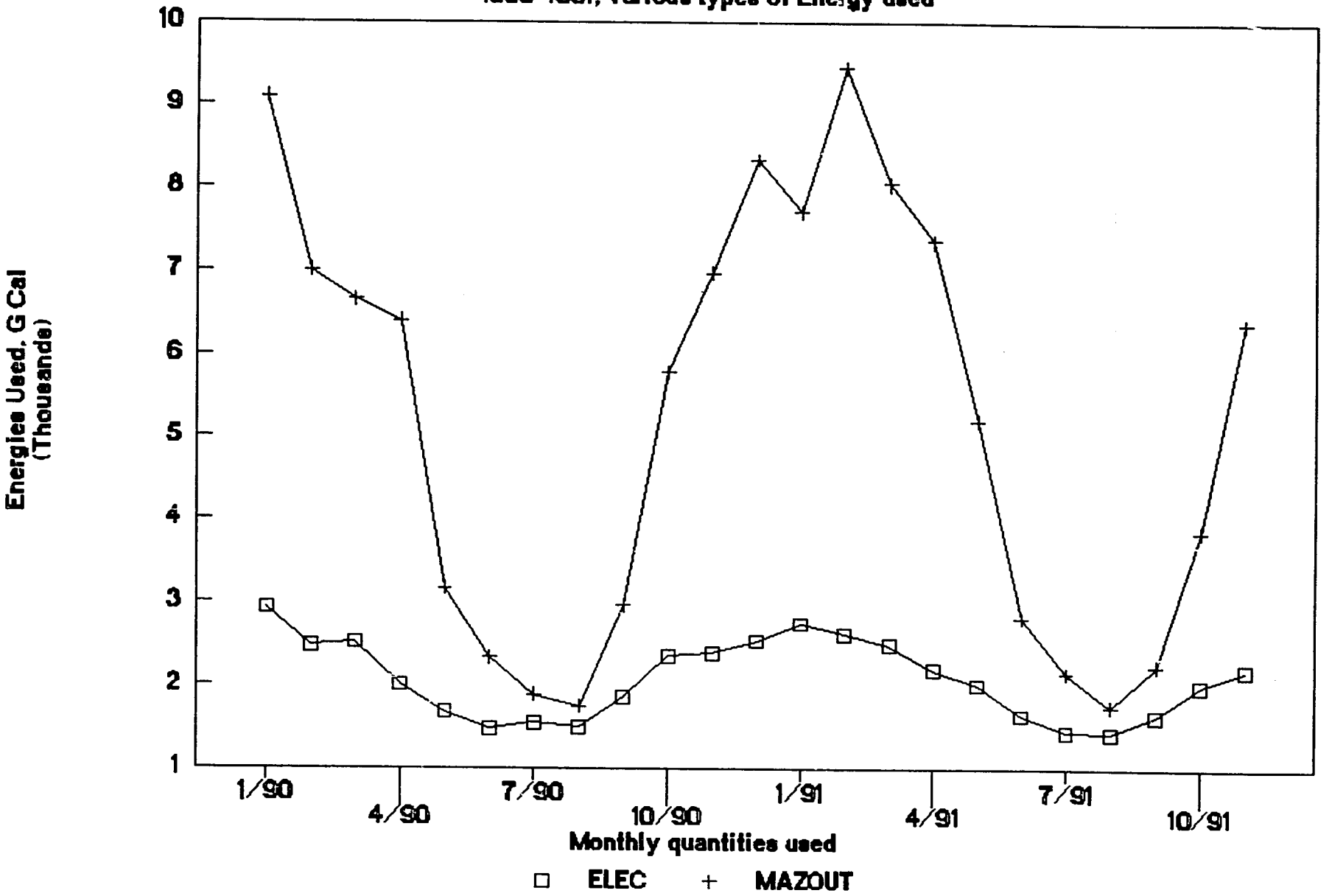
1990-1991, ACETYLENE PRODUCTION



BALTIC SHIP REPAIRERS - HEAT/ACETYLENE

1990-1991, ACETYLENE PRODUCTION



BALTIC SHIP REPAIRERS - ENERGY USED

1990-1991, Various types of Energy used