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BURNS AND ROE ENTERPRISES, INC.

Audit Report
STROJINDUSTRIA BUILDING MATERIALS PLANT
KIEV, UKRAINE

FINAL

August 1997

Prepared by:	**Foster Wheeler USA Corporation**
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FOSTER WHEELER USA CORPORATION
CLINTON, NEW JERSEY, U.S.A.

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Delivery Order #6:
Energy Efficiency and Reliability for the Ukraine
Task 3 - Industrial Energy Efficiency

STROJINDUSTRIA Building Materials Plant
KIEV, UKRAINE

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Preface

The work described in this report has been carried out by FOSTER WHEELER USA CORPORATION (FWUSA) of Clinton, New Jersey, within the framework of the U.S. Agency for International Development (USAID) Emergency Energy Program for the Newly Independent States (NIS), under contract with Burns and Roe Company; NIS Energy Efficiency and Market Reform Project, Contract Number CCN-0002-1-00-3154-00.

This is a working document published informally by FWUSA. This report has been prepared in a working document format, in the interest of timeliness, to present the results of the project with light review.

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1.0 EXECUTIVE SUMMARY

Introduction

As part of Delivery Order #6 of the NIS Energy Efficiency and Market Reform project, the United States Agency for International Development (USAID) sponsored a total of five industrial energy audits at large energy consuming industries in Ukraine. Two of the audits were completed by Foster Wheeler USA Corporation of Clinton, New Jersey (USA). The other three audits were conducted by Burns& Roe Enterprises and Resource Management Associates (RMA). This report details the findings of the Foster Wheeler energy audit performed at the Strojindustria Building Materials Plaint located in Kiev, Ukraine.

The five industrial audit sites were selected under previous activities within this Delivery Order. This selection process included working with Ukrainian agencies and the Ukrainian IDEA Staff to identify the largest and most intensive electrical energy consuming sectors. Plants typical of each sector were suggested for audits. Site visits to each plant were coordinated by the IDEA staff; team leaders from Foster Wheeler and RMA reviewed these facilities in order to select the five most appropriate sites. Each facility was evaluated using a numerical ranking form, and the five plants scoring the highest were selected. The chosen sites were then notified that they had been selected to participate in the energy audits and demonstration activity. In addition to the Strojindustria Building Materials Plant, the following four plants were selected: Kiev Artistic Glass Plant in Kiev; Zaporozhia Coke and Chemical Plant and Kommunar/ZAZ Car Plant both in Zaporozhia; and Donetsk Metallurgical Plant in Donetsk. Following notification, audit schedules were coordinated, and the audits conducted.

The Strojindustria Building Materials Plant located in Kiev, Ukraine is one of the leading plants for construction material in the Ukraine. It currently employs 1,200 people. The plant is leased from the state by the employees, who must make a profit for the plant to survive — a parastatal company. Located on the right bank of the Dnieper River, it occupies 50 hectares. The plant was established in 1954 by combining five separate existing plants which manufacture various building products.

The plant manufactures linoleum, fiberboard, roofing material, mineral wool insulation, and concrete pipe. In 1994, the plant operated at less than 40% of design capacity for the majority of its product lines. Finished products are typically shipped in railroad cars and sometimes in trucks. Currently, about 2% of the plant's linoleum production is exported to Russia. All other products are sold entirely in the Ukraine.

In the past, the plant has implemented several energy conservation measures. Each of these has been related to specific modifications to some of the processing schemes contained within the plant, rather than to the classic general measures typically

appropriate for all plants. In general, the plant finds it difficult to implement energy conservation projects due to a lack of hard currency and also due to difficulties arising from their lack of a full set of energy management procedures. The audit team has addressed these issues in discussions with plant personnel and in ECO #9.

Principal Findings

Several energy conservation opportunities (ECO's) were identified for short term no cost/low cost measures and for longer term higher cost investment measures. Fifteen (15) ECO's were identified and are summarized in Table 1. Thirteen ECO's have attractive paybacks, both on world and on local energy prices. Only, the electrical ECO # 14 and condensate collection ECO # 15 were unattractive.

ECO's #'s 01, 05, 10, and 11 all contain energy savings equipment and instrumentation related to combustion efficiency improvement and to electrical measurements. The audit team recommends that USAID assist the plant in starting its energy conservation program by purchasing for them the equipment and instruments contained within these four ECO's for an estimated cost of $ 100,000. Implementation of these four ECO's should save 178.7 billion Btu (188,500 GJ) or 5.5 million cubic meters of natural gas and 1,810,000 kWh of electricity annually. These ECO's will produce savings of $ 350,500 based upon local prices and $ 795,800 based upon world prices.

Please note that totals are not given for the columns in Table 1, because some of the numbers presented are included in more than one of the ECO's listed.

Table 1 Summary of Energy Conservation Opportunities (ECO's)

ECO #	DESCRIPTION	ANNUAL FUEL SAVINGS m^3/yr OF NATURAL GAS (ELEC-TRICITY)	ANNUAL ENERGY SAVED	ANNUAL COST SAVINGS (US $)		ESTIMATED PROJECT COST (US$)	SIMPLE PAYBACK WORLD ENERGY PRICES	SIMPLE PAYBACK LOCAL ENERGY PRICES
				WORLD ENERGY PRICES	LOCAL ENERGY PRICES			
01	Purchase Portable Boiler Efficiency Measurement Device	388,000	12 6 billion Btu (13,300 GJ)	28,700	31,000*	7,000	2 9 months	2 7 months
02	Inspect Boiler 2 for Air Leaks in the Preheater and Combustion Chamber, Adjust Burners	303,500	9 9 billion Btu (10,400 GJ)	22,500	24,300*	9,000	4 8 months	4 4 months
03	Identify and Repair Steam Leaks	5,746,000	186 6 billion Btu (196,900 GJ)	807,000	278,000	40,000	18 days	54 days
04	Install Automatic Flow Controllers on Large Users of Steam in Each of the Five (5) Plants	3,919,000	127.3 billion Btu (134,300 GJ)	550,400	189,700	158,300	3 5 months	10 months
05	Identify Where Steam Insulation is Deficient, Add Insulation or Fix	4,310,000	140 0 billion Btu (134,300 GJ)	605,000	208,500	15,830	10 months	2 5 years
06	Insulate the Four (4) Bitumen Storage Tanks to Conserve Steam Usage	1,269,000	41 2 billion Btu (43,500 GJ)	178,200	61,400	205,500	14 months	3 1 years
07	Recover Vent Steam from Dirty Condensate Receiver	239,000	7 8 billion Btu (8,200 GJ)	33,800	11,600	18,200	6 5 months	1 6 years
08	Install Continuous Carbon Monoxide and Oxygen Analyzers on the Melting Furnace	587,000	19 0 billion Btu (20,100 GJ)	43,400	46,900*	24,575	6 8 months	6 3 months

* Includes recently imposed tax of approximately U S $15 00 per 1,000 cubic meters

Table 1 Summary of Energy Conservation Opportunities (ECO's)

ECO #	DESCRIPTION	ANNUAL FUEL SAVINGS m^3/yr OF NATURAL GAS (ELEC-TRICITY)	ANNUAL ENERGY SAVED	ANNUAL COST SAVINGS (US $)		ESTIMATED PROJECT COST (US$)	SIMPLE PAYBACK WORLD ENERGY PRICES	SIMPLE PAYBACK LOCAL ENERGY PRICES
				WORLD ENERGY PRICES	LOCAL ENERGY PRICES			
09	Institute Improved Energy Management Procedures	5,235,000	170 billion Btu (179,400 GJ)	200,000	56,200	Negligible	Days	Days
10	Purchase Portable Electrical Analysis Instrument	(1,810,000 kWh)	1,810,000 kWh	90,500	28,100	15,100	2 0 months	6 4 months
11	Recover Heat from Mineral Wool Melting Furnace to Preheat Charge	481,500	15 6 billion Btu (16,500 GJ)	83,400	71,600	134,000	1 6 years	1 9 years
12	Increase Efficiency of Steam Used for Unloading Bitumen from Railroad Tank Cars	1,307,000	42 4 billion Btu (44,800 GJ)	104,000	63,200	73,000	8 4 months	1 2 years
13	Identify, Add or Replace Non-Operating Steam Traps	7,836,000	245.5 billion Btu (268,500 GJ)	499,200	379,400	71,700	1 7 months	2 3 months
14	Collect Additional Condensate and Recycle to Boilerhouse	1,176,000	38 2 billion Btu (40,300 GJ)	165,100	56,200	282,000	1 7 years	5 0 years
15	Install Capacitors to Improve Power Factor of Fiber Board Plant	(4,600,000 KVAR)	4,600,000 KVAR	27,500	3,100	24,100	0 9 years	7 8 years

2.0 PURPOSE OF AUDIT

The purpose of this audit is to investigate the large consumers of energy within the plant and to identify Energy Conservation Opportunities (ECO's) for short term no cost/low cost measures and for longer term higher cost investment measures. This will improve plant energy efficiency and reduce the current overall consumption of energy within the plant in its various forms.

The Strojindustria Building Materials Plant was selected as a critical energy intensive facility important to the economy of the Ukraine. It is recognized as having many opportunities to reduce energy consumption by improving efficiency of energy utilization.

The plant was selected in October of 1994 following a survey in which many different types of plants were visited throughout the Ukraine for the purpose of selecting the five best candidates.

3.0 FACILITY BACKGROUND

3.1 Description of Facility

The Strojindustria Building Materials Plant located in Kiev, Ukraine is one of the leading plants for construction material in the Ukraine. It currently employs 1,200 people. The plant is leased from the state by the employees who must make a profit for the plant to survive - a parastatal company. This parastatal plant located on the right bank of the Dnieper River occupies 50 hectares of area. It was established in 1954 by combining five separate existing plants which manufacture various building products. Each of these plants were originally designed by different design organizations which were Institutes of the former Soviet Union. Much of the original equipment was "lend-lease" equipment obtained from the United States after World War II. The oldest equipment was manufactured in America and has been in service since 1901.

The plant contains several dozen buildings. These consist of six industrial buildings for product manufacture of items such as linoleum, fiberboard, roofing material, mineral wool batts and concrete pipe. Other buildings present are mechanical and maintenance workshops, a quality control laboratory, and administration.

The facility also has two compressor stations, an electrical substation and a boilerhouse for the production and supply of the heating and process steam to internal users and for sale to offsite users.

3.2 Product Background

The Strojindustria Building Materials Plant manufactures a variety of building material products in five different manufacturing facilities at the site. The five facilities are as follows:

1. Mineral Wool Products Plant - This facility produces mineral wool insulating rolls and insulating batts. During 1994, insulation production averaged 4,100 cubic meters per month (m^3/mo). Maximum capacity of the plant is 49,500 m^3 per year.

3.0 FACILITY BACKGROUND

3.2 Product Background (continued)

2. Roofing Materials Plant - This unit manufacturers roofing cardboard, tar paper and water proof insulating material for pipes. During 1994, the plant manufactured 1,120,000 m^2/mo of these materials. Maximum capacity of the plant is 56.8 million m^2 per year of tar paper and water proof insulating material and 19,000 metric tons per year of roofing cardboard.

3. Linoleum Plant - This facility makes a full range of both insulated and uninsulated linoleum floor covering and its required glue. During 1994, production averaged 180,000 square meters/month (m^2/mo) of various linoleum products. Maximum capacity of the plant is 7.8 million m^2 per year.

4. Fiberboard Plant - This unit manufactures fiberboard for sound absorption and heat insulation. The plant also produces the insulation backing for the linoleum. During 1994, production averaged 60,000 m^2/mo. Maximum capacity of the plant is 4.55 million m^2 per year.

5. Preformed Concrete Plant - This facility manufactures preformed concrete pipe (600 to 1440 millimeter diameter) in five meter lengths and preformed building panels and structural pieces. During 1994, production averaged 2,000 items per month. Maximum capacity of the plant is 66,900 m^3 per year of concrete pipe and 10,000 m^3 per year of concrete plates.

In 1994, the plant operated at less than 40% design capacity for the majority of its product lines. Only the mineral wool plant operated at full capacity. The plant maintains a low inventory of completed products and operates to fill orders from customers as they are received. With the exception of the mineral wool plant that operates 24 hours a day, three (3) days per week, the plant typically operates five (5) days per week, with two (2), eight (8) hour shifts per day.

The finished products are typically shipped in railroad cars and sometimes in trucks, depending upon the size of the order. Currently, approximately two (2) percent of the plant's linoleum production is exported to Russia. All other products are sold entirely in the Ukraine.

3.0 FACILITY BACKGROUND

3.3 Viability of Facility

The plant makes of full range of Building Material Products including such items as linoleum, fiberboard, roofing material, mineral wool batts and concrete pipe. Almost all of these products are sold domestically in the Ukraine.

Last year the plant operated at less than 40% of its design capacity for most of its product lines. The mineral wool plant was the only plant that operated at full capacity. During the construction season the plant tends to operate at its highest capacity in order to fill orders. As a parastatal company, the plant is keenly aware of the need to produce a profit and thus manages the production of its facility with this as its primary goal.

The viability of the facility is currently good, but it would improve further if it could increase its export level above the current value of 2 percent which is currently applicable only to its linoleum products. In addition it should strive to increase domestic sales so that its overall operation can profitably function at or near the facility's design capacity.

3.4 Energy Conservation History

The plant has, in the past, implemented several energy conservation measures. Each of these has been related to specific modifications to some of the processing schemes contained within the plant, rather than to the classic general measures typically appropriate for all types of plants. In general, however, the plant finds it difficult to implement energy conservation projects due to a lack of hard currency and also due to difficulties encountered in their lack of a full set of energy management procedures.

The plant has a single individual who is responsible for energy conservation, but does not have a fully functioning energy conservation committee. The plant does not have any budget for energy conservation. It must make recommendations to a technical council. Even if approval is obtained from the technical council, the council cannot insure that funds will be provided for the project.

3.0 FACILITY BACKGROUND

3.4 Energy Conservation History (continued)

The plant has a criteria from making energy conservation investments which is based upon energy usage per quantity of product. It does not have a criteria which is based upon the more classical approaches, such as payback or discounted cash flow. Basic maintenance, such as the repair of steam leaks and the repair or replacement of faulty insulation, needs to be greatly improved.

3.0 FACILITY BACKGROUND

3.5 Facility Energy Use

3.5.1 Consumption

The types of energy used at the STROJINDUSTRIA Building Materials Plant are natural gas and electricity. The principal energy source is natural gas, much of which goes to make steam which is used in making the various products. See Tables 2 and 3 for the 1994 steam consumption per unit of product for mineral wool, linoleum, fiberboard and roofing cover materials. The wide variation in the steam consumption per unit of product indicates that improved control is needed in steam allocation and distribution throughput the various production areas of the plant.

Natural gas accounts for 88.1 percent of the energy usage in the plant and electricity accounts for 11.9%. This can be seen graphically on the pie chart on page 11. The total plant electrical consumption is approximately 9 megawatts. All of this electricity is purchased from Kievenergo.

The STROJINDUSTRIA Building Materials Plant consumed the following amounts of energy in 1994:

Electricity

18,073,007 kWh

Natural Gas

43,950 thousands of meters^3

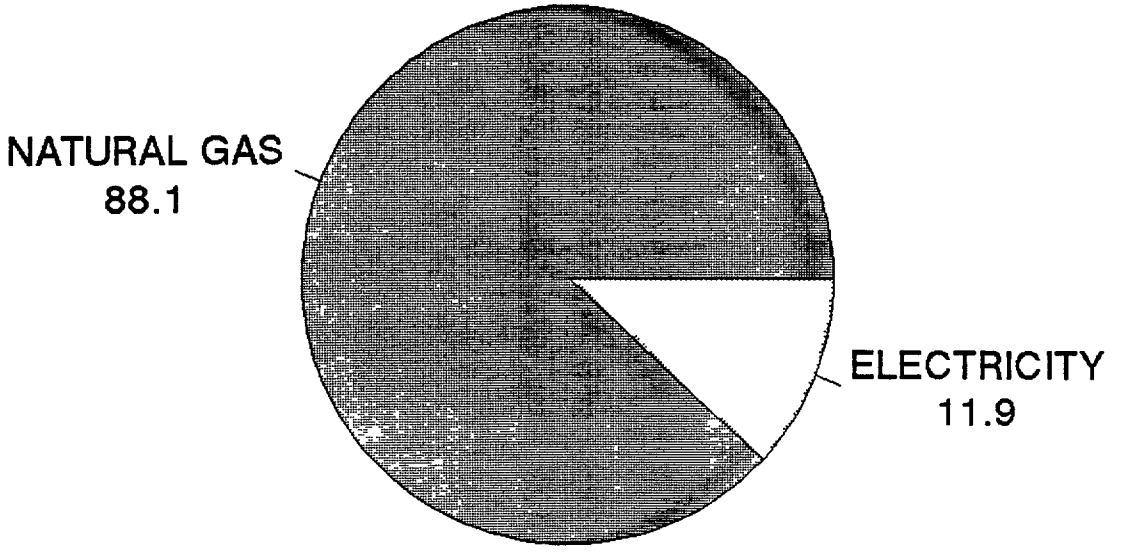
Appendix "C" shows that the highest consumption of natural gas in 1994 was in the months of November and December, when approximately 55 million meter^3 was consumed each month. The lowest consumption of natural gas was in May and June, when approximately 21 million meter^3 was consumed each month. This consumption profile does not bear a relationship to the quantities of the various products produced during these months. Thus, it would appear that the natural gas usage was more weather related than production related.

3.0 FACILITY BACKGROUND

3.5 Facility Energy Use

3.5.1 Consumption (continued)

Appendix "C" shows that the highest consumption of electricity in 1994 was in the months of December when 2.16 million kWh was consumed. The lowest consumption was in February when 0.9 million kWh was consumed. The reason for the high consumption in December is not apparent from the production data, but the low consumption in February is undoubtedly because of the shutdown of the roof covering materials plant and the concrete foundation blocks facility. Other plant facilities were also operating at low capacity, as well, during the month of February, 1994.



PERCENTAGE OF EACH ENERGY SOURCE USED IN 1994

3.0 FACILITY BACKGROUND

3.5 Facility Energy Use

3.5.1 Consumption (continued)

Table 2 1994 Steam Consumption Per Unit of Product: Mineral Wool and Linoleum

	Mineral Wool			Linoleum		
	Production, M^3	Steam, Tons	Tons Steam / M^3	Production, Thousands M^3	Steam, Tons	Tons Steam / 1000 M^2
Jan.	3,980	2,818	0.708	174.6	6,959	39.86
Feb.	2,274	570	0.251	69.3	3,803	54.88
June	1,133	260	0.2295	218.8	3,580	16.36
Sept.	5,550	N/A	-	233.0	4,745	20.36
Dec.	5,568	N/A	-	223.0	8,399	37.66

Table 3 1994 Steam Consumption Per Unit of Product: Fiberboard and Roofing

	Fiberboard			Roofing Cover Materials		
	Production, M^2	Steam Tons	Tons Steam / M^2	Production, Thousands M^2	Steam, Tons	Tons Steam / 1000 M^2
Jan.	51,000	2,649	0.0519	366.3	5,891	16.08
Feb.	19,000	838	0.0441	79.4	10,232	128.87
June	63,000	951	0.0151	882.4	6,637	7.52
Sept.	110,000	1,526	0.0139	2,266	11,481	5.07
Nov.	66,000	1,314	0.0199	1,923.1	15,341	7.98

3.0 FACILITY BACKGROUND

3.5 Facility Energy Use

3.5.2 Energy-Using Systems

Boilerhouse/Steam System

The production of steam in the boilerhouse is a large consumer of natural gas. There are four (4) boilers, each capable of producing 60 metric tons per of steam with a maximum outlet pressure of 13 bar. Currently the boilers each produce 2/3 of their maximum capacity or about 40 metric tons per hour at an outlet pressure of 6 to 7 bar. Three (3) of the boilers were built in America in 1948 and later modified. The boilers normally consume 87 normal meters^3 of natural gas per metric ton of steam produced. In distributing the steam throughput the plant, there is no system of automatic flow control to insure that the steam is properly distributed in accordance with the required amounts.

Compressor Stations

There are a total of seven (7) compressors in the main compressor station. Normally three (3) of the compressors are in operation and the others are on standby. Each compressor is 320 KW and can compress 50 normal meters^3 per minute of air. The compressor are two-stage piston type.

The compressors are shutdown during the evening. It normally takes 10 to 15 minutes to restart them the next morning. The largest user of the compressed air is the preformed concrete plant.

Mineral Wool Plant

The mineral wool plant has a furnace which is a large consumer of natural gas. The plant processes three (3) metric tons of product per hour and consumes 270 to 320 meters^3 of natural gas per ton of mineral wool product. The molten material is at a temperature of 1260 to 1320 °C. The stack gas temperature is typically 920 to 915 °C, after the preheater.

3.0 FACILITY BACKGROUND

3.5 Facility Energy Use

3.5.2 Energy-Using Systems

Mineral Wool Plant (continued)

A new project has been proposed to recover heat from the stack gas and use it to preheat the incoming feed.

3.5.3 Energy Costs

The plant indicated that the cost of energy was continuously increasing. They were not able to give us any information on projections for future cost, but did give us some information on the current and the previous costs of natural gas and electricity. The following information is for their current costs:

Utility	Current Plant Costs
Natural Gas	$ 80.00 U.S. per 1000 meter^3 which includes a recently imposed tax of approximately $ 15.00 per 1000 meter^3
Electricity	2,300 Ukrainian coupons/Kwh or $ 0.0155/Kwh* for 10,000 volts
	2,358 Ukrainian coupons/kWh or $ 0.0159/kWh* for 380 volts
	278,500 Ukrainian coupons per KW demanded or $ 1.88/KW demanded

Industrial enterprises with installed power of 750 KW and more pay for electricity in a 2-stage tariff.

That is:
1. Cost of electricity consumed.
2. Cost of electricity demanded.

* Based on current exchange rate of 148,000 Ukrainian Coupons, per U.S. dollar

3.0 FACILITY BACKGROUND

3.5 Facility Energy Use

3.5.3 Energy Costs (continued)

Note: In the case of higher power usage (that exceeds the demanded figure) which is checked within a 30 minute interval, the plant must pay 10 times more than the normal rate for every extra KW used. The hours of 8:00 to 11:00 and 17:00 to 21:00 are the hours in which the higher power usage will result in penalty payments.

As a means of comparison, world and local energy prices may be seen in Appendix "D".

4.0 SYSTEMS AUDITED - SHORT TERM RECOMMENDATIONS

4.1 Boilers

Strojindustria plant's process and heating steam is provided by four industrial boilers from a centrally located boilerhouse. Maximum steam generation capability of these boilers is 240 metric tons per hour (T/hr) when they are fired on natural gas and 200 T/hr when fired on mazut which is used only when natural gas is unavailable. At present, steam generation rate is at 50% capacity. Three identical boilers were manufactured for coal firing by Puget Sound Machinery in 1946; the fourth boiler is of local manufacture. The boilers were rebuilt and converted to use natural gas and mazut in 1961. Table 4 presents the boiler descriptions and operating parameters. Currently the fourth boiler is kept in reserve.

Table 4
Boiler Descriptions

Boiler Number	Steam Conditions			Feedwater Temperature (°C) Economizer in/out	Combustion Air Temperature (°C)	Fuel
	Flow (T/hr)	Pressure (bar)	Temperature (°C)			
1,2,&3	60	15 design 8-10 normal	300	103 130	300	Gas
4	60	39 design 13 normal	440 design 425 normal	103 130	300	Gas

With the exception of condensate return, the steam production cycle at Strojindustria is efficient. Measured boiler efficiencies were 91.3%, 86.3%, and 91.4% for Boilers 1, 2 and 3 respectively. Boiler 4 was not operating. Boiler feed water is treated in sulfidized coal ion exchangers with a total treatment capacity of 200 T/hr. The water is treated to less than 10 μg/kg hardness. The beds are regenerated with a NaCl brine. Treated water at 17 to 25 °C is sent to two atmospheric type deaerators (0.2 bar operating pressure) which operate at 103 - 104 °C. Venting of steam from these deaerators is minimal because the steam is recovered in a vent condenser. The boiler feedwater is pumped through an economizer which heats the water to 130 °C before entering the steam drum. The steam generated in the boiler

4.1 Boilers (continued)

is sent to a superheater. Additional heat is recovered from the boiler flue gas in a two-stage recuperator which heats the combustion air to 300 °C. The economizer is located between the two stages of the air preheater.

Continuous blowdown is high at 5% to 7% but heat is recovered to heat the raw feed water.

The boilers were equipped with automatic control systems and oxygen analyzers. During the visit the automatic controls were not in service. Plant personnel claimed that the steam production rates were too low. The plant no longer uses the oxygen meters because they were not reliable. These were located after the steam drum where flue gas temperature was 400 °C.

The boilerhouse operating staff were well-trained and operated the boilers effectively. For example, they shutdown boilers to maintain high steam loads in the operating boilers. Also, they shutdown the least efficient boiler.

The project team and plant identified two energy conservation opportunities (ECO) applicable directly applicable to the boilers. These consisted of the purchase of a portable efficiency measurement device, and repair of air leaks and burner adjustments on boiler 2. Both ECO's were low cost or no cost opportunities.

Energy Conservation Opportunity #1 — Purchase Portable Boiler Efficiency Measurement Device

Stack analyses show that excess air in the boilers may be reduced by about 1 % before excessive carbon monoxide appears. Unburned fuel losses become significant when carbon monoxide concentrations exceed 100 to 300 parts per million by volume. This device should provide better control of excess air because the boilers can be operated closer to this limit. Based upon fuel usage in 1994, the estimated fuel savings from use of this instrument is 12.6 billion Btu (13,300 GJ) annually. This provides $ 31,000 savings based upon local prices and $ 28,700 savings based upon world wide prices. The estimated cost of the instrument is $ 7,000. The calculations show a rapid

4.1 Boilers (continued)

payback for this instrument, 2.7 months based upon local prices and 2.9 months based upon worldwide prices. **The audit team recommends that USAID purchase this instrument — a Bacharach Model CA300NSX Combustion Analyzer — for the plant.**

See Appendix "A" for relevant calculations and supporting data.

Energy Conservation Opportunity #2 — Inspect Boiler 2 For Air Leaks in the Air Preheater and Combustion Chamber; Adjust Burners

Flue gas analyses show air leakage equal to about 40% of the combustion air requirements. The leakage comes from the low temperature section of the combustion air preheater located in this section. Also, excess oxygen in the combustion chamber can only be set to 5% before excessive carbon monoxide is produced. The appearance of excessive carbon monoxide at relatively high excess air may be caused by either air leakage into the boiler or poor mixing within the burners. Boiler 2 needs to be inspected to determine the source of the air leaks. Based upon the higher stack temperature, leakage of hot combustion air from the air preheater tubing is a probable cause of this leakage. Assuming a 2% recovery in efficiency, implementation of this energy conservation opportunity will save 9.86 billion Btu (10,400 GJ) annually. This provides $24,300 savings based upon local prices and $22,500 savings based upon world wide prices. The estimated cost of implementation is $9,000. The calculations show a rapid payback for this ECO, 4.4 months based upon local prices and 4.8 months based upon worldwide prices. This ECO should be implemented as soon as possible.

See Appendix "A" for relevant calculations and supporting data.

4.2 Steam System

The steam boilers described above provide steam to many different users of varying sizes throughout the complex. The largest users are the linoleum plant and the roof covering materials plant. The driers within these plants consume a large quantity of steam.

4.2 Steam System (continued)

Of the nominal 150 metric tons per hour of steam that is produced by the operating boilers, for the last six months of 1994 the monthly steam consumption of the four largest consumers within the plant is as follows:

TABLE 5 SECOND HALF 1994 STEAM CONSUMPTION, METRIC TONS

MONTH/ USER	July	August	September	October	November	December
Fiberboard	735	1,034	1,526	1,555	1,314	1,521
Linoleum	3,575	4,104	4,745	8,333	8,912	8,399
Roof Covering Material	4,980	10,915	11,481	11,774	15,341	14,808
Concrete Parts	270	310	290	130	1,400	800

In observing the lines and valves comprising the steam system, a very large number of leaks were observed throughout the plant. Especially large steam leaks were observed in the areas of Bitumen heating and Bitumen oxidizing. It is necessary to locate and to fix each of the many leaks which currently exist in the plant.

The steam flow to the various users, both large and small is not under a proper system of flow control. To improve efficiency in steam usage, we recommend the installation of automatic flow control valves on the large users of steam in each of the five (5) plants comprising the overall complex.

Many of the steam traps in the plant do not operate properly. The plant uses various types of traps, but plant personnel do not believe that the traps that they have operate efficiently. It is recommended that new traps be installed, as needed, to replace the older ineffective ones.

4.2 Steam System (continued)

It was noted in many part of the plant that hot steam pipes and other hot surfaces had faulty insulation that was in a state of disrepair or frequently had no insulation at all. As examples, the large steam line to the tar paper plant had broken insulation and had a surface temperature on the outside of the pipe which was measured to be 196°C. The four large Bitumen tanks which were each heated by steam coils to approximately 80°C did not have any insulation whatsoever and were each loosing an extremely large quantity of heat during cold weather.

Energy Conservation Opportunity #3 — Identify and Repair Steam Leaks

During a walking tour of the plant, the audit team observed numerous visible leaks from flanges, valve bonnets and other equipment. Identification and repair of these leaks will produce a significant reduction in steam consumption and fuel usage. Based upon previous experience, the audit team estimates that a 20% decrease in steam consumption is potentially available from a leak repair program. To take advantage of these savings, the plant needs to identify, tag, and catalog each leak by conducting a detailed survey of the steam system. Leaks can occur through valve glands and/or gaskets, piping flanges, poorly seated isolation valves, holes in piping and through pipe fittings. Steam traps are also a source of leaks but they are covered elsewhere. Each leak observed by the survey team should be catalogued in a logbook with the location, date found, and estimated size of the leak. The leak should be tagged with a metallic tag and the tag should remain until the leak is fixed. After the leak is fixed, the repair date should be noted in the log book.

Assuming 20% leakage, repair of steam leaks will decrease steam consumption by 91,500 T/yr. This is equivalent to 186.6 billion Btu (196,900 GJ) in fuel savings annually. Estimated annual savings are $ 278,000 based upon local prices and $ 807,000 based upon world wide prices for steam. The simple payout is 54 days based upon local prices and 18 days based upon world prices. This project should be implemented immediately due to its rapid payout.

See Appendix "A" for relevant calculations and supporting data.

4.2 Steam System (continued)

Energy Conservation Opportunity #4 - Install Automatic Flow Controllers on Large Users of Steam in Each of the Five (5) Plants

The use of automatic flow controllers on the large users of steam in the five (5) plants will greatly aid in directing the steam to its users in the proper quantities needed for efficient operation. It is estimated that 62,400 metric tons of steam is currently lost each year, due to insufficient utilization and distribution. This corresponds to $ 189,700, based upon local prices and $ 550,400, based upon worldwide prices. In terms of energy 127.3 billion Btu (134,300 GJ) is currently lost annually.

The estimated project cost to install the valves is $ 158,300. The simple payback, based upon local energy prices would be 10 months and based upon worldwide energy prices would be 3.5 months.

See Appendix "A" for relevant calculations.

Energy Conservation Opportunity #5 — Identify Where Steam Line Insulation is Deficient Add Insulation or Fix

During the walking tour of the plant, the audit team observed many uninsulated steam lines. There were areas of other lines where insulation had deteriorated. The team measured surface temperatures as high as 280 °C (536 °F) on some of these bare pipes. Identification of missing and deteriorated insulation followed by addition of insulation and repair of broken insulation will reduce steam consumption and conserve energy. To take advantage of these savings, the plant needs to identify, tag, and catalog insulation deficiencies by conducting a detailed survey of the steam system. This survey may be conducted simultaneously with the leak survey recommended in ECO#3. Each area of pipe observed to have an insulation deficiency by the survey team should be catalogued in a logbook with the location, date found, pipe size and the insulation specification - thickness, length and type required for the repair. The area should be tagged with a metallic tag and the tag should remain until the repair has been performed. After the repair is finished, the repair date should be noted in the log book.

4.2 Steam System (continued)

One portable infrared temperature measuring device — Wahl Model DHS-29XT infrared thermometer— should be purchased by USAID to help in the inspection and continuous maintenance of the steam system. This device may also be used to detect hot bearings on machinery, and minor energy-wasting short circuits in the electrical distribution system. The second device should be purchased by the plant.

Based upon the audit team's experience up to 15% savings in steam consumption is potentially available. A 15% saving will decrease steam consumption by 68,600 T/yr. This is equivalent to 140 billion Btu (147,700 GJ) in fuel savings annually. Estimated annual savings are $ 208,500 based upon local prices and $ 605,000 based upon world wide prices for steam. The simple payout, regardless of the absolute savings is 2.5 years based upon local prices and 10 months based upon world prices. This project should be implemented immediately due to its rapid payout.

See Appendix "A" for relevant calculations and supporting data.

Energy Conservation Opportunity #6 — Insulate the Four 94) Bitumen Storage Tanks to Conserve Energy

During the plant visit, the audit team observed that the four bitumen storage tanks are not insulated. These store bitumen feed material for the roofing plant at 70 °C to 80 °C (158 °F to 176 °F). Insulation of these tanks with mineral wool produced in the plant will decrease steam consumption and conserve energy. Insulation of the tanks will save 41.2 billion Btu (43,500 GJ) annually. This is equivalent to 20,200 metric tons of steam which costs $ 61,400 based on Ukrainian prices and $ 178,200 based on world wide prices. Simple payback is 3.3 years based upon Ukrainian prices and 13.8 months based upon world wide prices.

See Appendix "A" for relevant calculations and supporting data.

4.3 Condensate System

Because of the many existing steam traps that are not efficient and do not work properly, the amount of condensate that can presently be collected and recycled back to the boilers is very small. At present, the plant estimates that the maximum recovery of condensate that it is able to achieve is 20 percent. The remainder is going hot to the sewer. In the summer the amount of condensate recovered is essentially "zero".

The condensate that results from the condensation of steam in the presence of Bitumen produces a mixture of the two substances which results in a "Dirty" condensate which needs purification, before it can be reused. In addition, in this particular service, large quantities of steam are currently being vented to atmosphere. This steam needs to be recovered and reused.

Due to the low recovery of condensate, additional make-up water must be used. Associated with this are three additional expenses:

- The cost of the make-up water
- The cost of treating the make-up water
- The cost of heating the make-up water

Increasing the amount of condensate recovered is certainly a critical item in improving the efficiency of the entire system.

Energy Conservation Opportunity #7 — Recover Steam Vented From Dirty Condensate Receiver

A large continuous stream of steam vents from the dirty condensate receiver in the bitumen storage tank area. This stream should be recovered and used in an appropriate service such as heat tracing of the bitumen pipe lines. Project execution requires blocking of the vent, and addition of steam piping to convey the recovered still to the user. Recovery of this stream will reduce steam consumption in the bitumen tank area and conserve energy. An estimated 34,100 T/yr steam is vented annually. This is equivalent to 69.6 billion Btu (73,400 GJ) yearly. The vented steam is valued at $ 11,600 based upon local prices and $ 33,800 based upon world prices. Estimated simple payback is 1.59 years based upon local prices and 6.6 months based upon worldwide prices. Due to the rapid payout, this project should be implemented.

See Appendix "A" for relevant calculations and supporting data.

4.0 SYSTEMS AUDITED - SHORT TERM RECOMMENDATIONS

4.4 Compressed Air System

The compressed air system consists of two stations. In the main compressor station there are seven (7) air compressors. Each compressor is a two-stage piston-type machine.

The compressors are each 320 KW and each has the capacity to handle 50 normal meters^3 of air per minute. During normal operation three (3) air compressors are in operation providing a total of 150 normal meters^3 of air per minute to the various users. The largest user is the preformed concrete plant. The other four (4) compressors are on standby.

To conserve electrical energy, the compressors are all shutdown during the evening and the restarted the following morning. It takes, typically 10-15 minutes to restart the compressors.

4.0 SYSTEMS AUDITED - SHORT TERM RECOMMENDATIONS

4.5 Five Processing Plants

The overall plant consists of the following five (5) processing plants:

- Mineral Wool Products Plant
- Roofing Materials Plant
- Linoleum Plant
- Fiberboard Plant
- Preformed Concrete Unit

A brief description of each of these is given below:

Mineral Wool Products Plant

This the only plant in the entire complex that is operating at or near its design capacity. The furnace in the mineral wool plant is a large consumer of natural gas. It operates at high temperatures in which the molten material is at 1260 °C to 1320 °C and the stack gas at 920 to 915 °C. See Section 5.1, ECO-11, for an attractive method in which it is proposed to recover heat for the stack gas and use it to preheat the incoming feed.

Energy Conservation Opportunity #8 — Install Continuous Carbon Monoxide and Oxygen Analyzers on the Melting Furnace

Measurements showed high carbon monoxide and high excess oxygen in the stack gas of the melting furnace. Continuous monitoring will permit prompt adjustment to prevent carbon monoxide formation. Based upon the measurements melting furnace efficiency and assuming that high carbon monoxide is produced one third of the operating time, energy usage can be improved by as much as 5% by implementation of this ECO. Based upon 1994 production information, use of these analyzers will save 19.0 billion Btu (20,100 GJ) annually. This provides $ 46,900 savings based upon local prices and $ 43,400 savings based upon world wide prices. The estimated cost of implementation is $ 24,575. The calculations show a rapid payback for this ECO, 68 months based upon local prices and 6.3 months based upon worldwide prices. This ECO should be implemented as soon as possible.

See Appendix "A" for relevant calculations and supporting data.

4.5 Five Processing Plants (continued)

Roofing Materials Plant

The roofing materials plant is the largest consumer of steam in the complex. Its consumption is typically twice that of any of the other plants. Within this plant a large consumer of steam is the unloading of Bitumen from railroad cars. An improved method of Bitumen unloading is presented as ECO-12 in Section 5.2.

Linoleum Plant

In the linoleum plant three main components, PVC resin, talc and coal dust are combined to produce the product. The plant is a large consumer of steam and is second in steam consumption, after the roofing materials plant. During our visit the plant was using a moderate quantity of electricity ranging from approximately 0.8 to 1.3 MW.

Fiberboard Plant

The fiberboard processes wood into fiberboard though a series of steps involving operations such as grinding, slurring with water and drying in large steam heated driers. The steam consumption is moderate compared to some of the other plants in the complex. The electrical consumption during our stay was typically 2.0 MW with a low power factor, caused by the grinders, which was typically around 0.7.

Preformed Concrete Plant

This plant was not operating during the time of our visit. When in operation it is a fairly high user of steam.

4.6 Energy Management

In addition to the various areas of the plant that were audited in order to discover energy conservation opportunities, emphasize was also placed on learning about the energy management procedures used in the plant, in order to see if energy conservation opportunities could be discovered in these areas, as well.

4.0 SYSTEMS AUDITED - SHORT TERM RECOMMENDATIONS

4.7 Energy Management and Training (continued)

- The plant does not have a yearly budget which is set aside for energy conservation projects.

- It is extremely difficult to get approval from the "Ruling Body" for energy conservation projects.

- The plant has no criteria, such as payback or discounted cash flow, for making investments in the plant to conserve energy.

- Basic maintenance is performed, except where replacement parts are not available or where the implementation of the repair would be extremely costly.

- Employees have not received any training in the principles of energy conservation.

Based upon the above findings, we would like to recommend improvements in energy management procedures and in energy conservation training of plant personnel.

Energy Conservation Opportunity #11 - Institute Improved Energy Management Procedures

The establishment of improved Energy Management Procedures is vital in carrying out a proper energy conservation program.

A strong chairman should be appointed for the "Bureau for Energy Usage" who will be responsible to develop an appropriate agenda and proper planning for energy conservation implementation. The highest proprietary must be given to the establishment of a yearly budget for energy conservation. A criteria such as a 3 year payback or 15% discounted cash flow should be used for making decisions as to whether or not to invest in an energy conservation project and also to convince the "Ruling Body" of its merit.

4.0 SYSTEMS AUDITED - SHORT TERM RECOMMENDATIONS

4.7 Energy Management and Training (continued)

In addition, the "Bureau for Energy Usage" must work with plant personnel to:

EDUCATE all plant personnel on energy use awareness;
MOTIVATE all plant personnel to find energy conservation opportunities in their work areas;
REWARD all plant personnel for identifying potential savings and investment opportunities;
QUANTIFY each conservation opportunity, potential savings and investment payback;
PLAN and update a rolling 5 year energy management strategy to implement conservation;
SOLICIT funding for energy conservation projects;
IMPLEMENT conservation opportunities; both funded and no cost;
FOLLOW UP after implementation and quantify actual savings;
ADVERTIZE successful energy conservation projects and lessons learned; and
REPLICATE successful conservation projects to all parts of the plant.

It is estimated that a 10% improvement in efficiency could be achieved. This is based upon our experience over the past fifteen (15) years in similar industries in Egypt, South America and the Far East. Based upon local prices the overall yearly savings would be $ 718,000. For worldwide prices this would be approximately $ 2,000,000. The annual savings would be 0.38 trillion Btu (400,900 GJ).

The cost of the program would be negligible and the payout would be immediate.

See Appendix "A" for relevant calculations.

4.7 Electrical System

The plant consumes 9 MW normally. There are four main feeders from two Kievenergo substations serving 14 substations throughout the plant. The substations are rated from 400 kVA to 8,300 kVA. The total length of electric cables for 10 and 0.4 KVolts is 15,800 meters. During our visit, there was one main feeder in operation mode and another three were in reserve mode. This situation was due to some problems caused by a drop in frequency below the normal level of 50 cycles in the Electric Power System.

Electrical measurements in the fiberboard plant, showed that the power factor was very low, in the order of 0.66 to 0.73. The plant was not aware of this problem, because the permanently installed power factor meter did not operate properly, it always read 0.98. Most likely the low power factor is the result of the on and off operation of the eight (8) wood grinding machines. This low power factor needs improvement.

The power factors of all other currently operating units were measured and found to be adequate. The electrical consumption of the plant was measured during night-time hours and the consumption appeared to be abnormally high and characteristic of equipment being run when it should be shutdown. Plant management, however, explained why certain items had to be run at night and thus accounted for the electricity that was being consumed.

Energy Conservation Opportunity # 10 — Purchase Portable Electrical Analysis Instrument

As discussed above the very low power factor in the fiber board plant needs improvement. The power factor of all other currently operating units were measured and found to be adequate. However, measurements could not be made in the roofing plant and concrete plants which were not operating at the time of the audit. The electrical consumption of the plant was measured during night-time hours and the consumption appeared to be abnormally high and characteristic of equipment being run when it should be shutdown. Plant management, however, explained why certain items had to be run at night and thus accounted for the electricity.

4.7 Electrical System (continued)

A survey using a Dranetz 808A Power Analyzer to pinpoint exactly which items of equipment are running when they should be shutdown and to analyze the roofing and concrete plants for low power factor and waste from equipment that is not shutdown during the night will conserve energy. Based upon their experience the audit team estimates that a survey using the instrument will produce a 10% reduction in electrical energy consumption for the plant. This is 1,810,000 kWh. This corresponds to savings of $28,100 based upon local prices and $90,500 based on world prices. Purchase of an analyzer and execution of a survey results in a simple payback of 6.4 months based upon local prices and 2.0 months based upon world prices.

Based upon the rapid payback, the audit team recommends that USAID purchase a Dranetz Model 808A Power Analyzer for use in the plant.

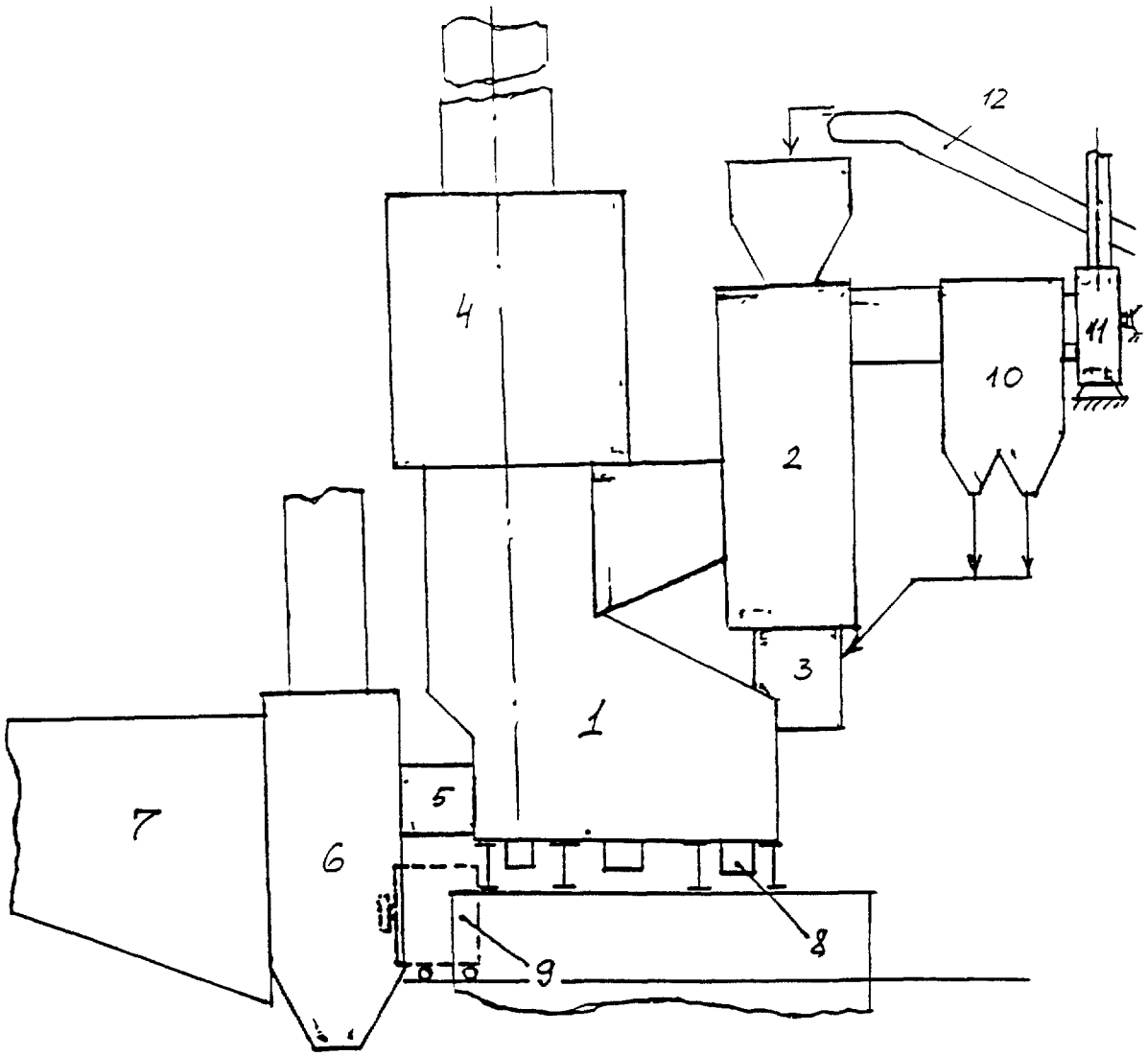
See Appendix "A" for relevant calculations and supporting data.

5.0 SYSTEMS AUDITED - LONG TERM RECOMMENDATIONS

5.1 Mineral Wool Plant

The Mineral Wool Products Plant produces mineral wool insulating rolls and insulating batts from basalt - a natural volcanic glass - blast furnace slag or limestone and a backing material. The process is energy intensive requiring 61.7 billion Btu (65,100 GJ) heat input and 1,700 MW electrical input. The manufacturing process starts with the crushed basalt/slag mixture which is fed to a proprietary design glass melting furnace developed by the National Academy of Sciences of Ukraine in collaboration with Strojindustria. This unique furnace uses advanced technology to melt the feed materials. Figure 1 shows an elevation view of the furnace and connected auxiliary equipment. A conveyor belt (Item 12) transports crushed basalt to the loading point where it drops into a charge hopper (Item 3). The crushed basalt is charged into the melting converter (Item 1) where it is melted and maintained in a molten bath at 1260 °C to 1320 °C. The melting converter features water-wall construction that permits rapid heating of the furnace from a cold starting condition. It also features submerged combustion. Natural gas is premixed with 360 °C to 400 °C preheated air (from Item 4) in a proprietary burner (Item 8). The burning gas mixture forms bubbles which continue to burn and release heat directly to the charge as they rise through the molten glass. This provides excellent heat transfer because combustion occurs within the melt and the rising bubbles produce strong convection currents which thoroughly mix the molten material. The furnace melts 3 metric tons per hour (3 T/hr) of feed material, requiring 17.4 GJ/hr (16.5 MMBtu/hr) heat input.

After a residence time of several hours, the molten glass discharges by gravity into a feed trough (Item 5) which conveys it to the fiber spinning machine (Item 9). A continuous stream of molten glass drops onto a water-cooled centrifugal spinning machine. The stream is stretched into multiple fine fibers which solidify rapidly. The fibers are blown into the fiber deposition chamber (Item 7). The fibers enter a machine which forms a felted pad of proper thickness. The machine sews a waterproof backing onto one side of the batt. It slices the batt in half and cuts the slices to a uniform length. The machine forms two rolls from the completed batts. These rolls are tied and manually removed from the machine by two workers.



Equipment List:

1. Melting Converter
2. Charge Preheater (New Addition)
3. Charge Hopper (Modified)
4. Air Preheater (Modified)
5. Joint for Melt Unloading (Molten Glass Transport Trough) (Modified)
6. Air Chamber (Modified)
7. Fiber Deposition Chamber
8. Burners
9. Centrifuge (Glass Filament Spinner)
10. Dust Collector (New Addition)
11. Induced Draft Fan (New Addition)
12. Transporter (Feed Conveyer) (Modified)

Figure 2. Schematic diagram of the Proposed Modifications to the Mineral Wool Plant Glass Melting Furnace and Auxiliary Equipment

5.0 SYSTEMS AUDITED - LONG TERM RECOMMENDATIONS

5.1 Mineral Wool Plant (continued)

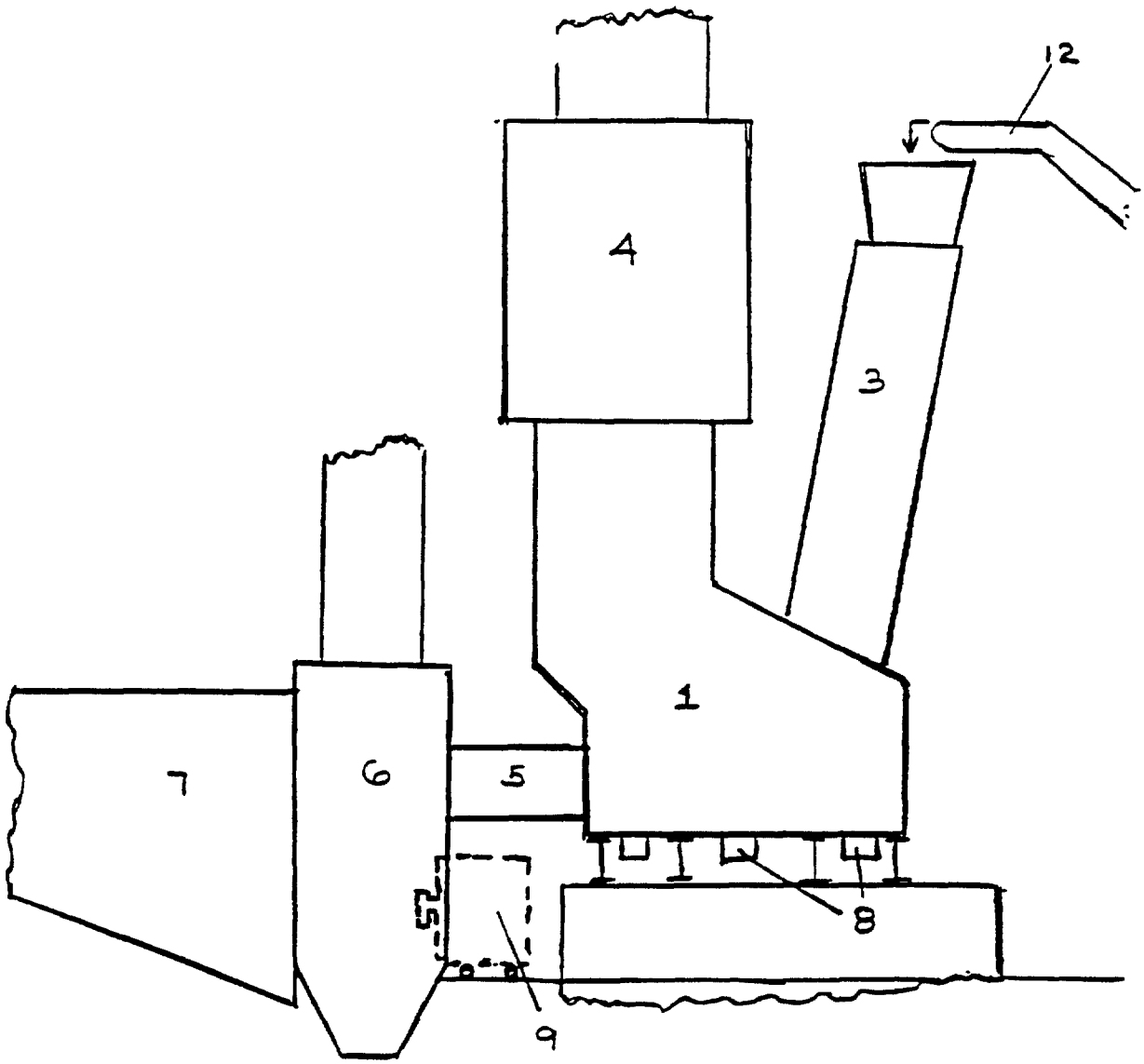
Energy Conservation Opportunity #11 — Recover Heat From Mineral Wool Melting Furnace to Preheat Charge

Currently, at 968 °C, the stack temperature of the melting furnace is very high. At this temperature almost 50% of the energy from the fuel leaves the system as sensible heat in the stack gases. The mineral wool plant is considering a project designed by the National Academy of Sciences of Ukraine to recover more heat by preheating the charge material before it enters the converter. Implementation of the project will increase heat recovery by 33% and decrease electrical use by 18%. Based upon calculations presented in Appendix A, the project will save up to 26.0 billion Btu (27,500 GJ) and 480,000 kw of electrical energy annually. At an estimated $134,000 total cost, this project has a simple payback of 1.9 years based upon local prices and 1.6 years based upon world prices using 1994 data. Electrical cost savings estimated by the National Academy of Sciences of Ukraine were higher. If these were used in the payback analysis, the project would have a simple payback of 1.6 years based upon local prices and 1.5 years based upon world prices. The joint proposal from the plant and the National Academy of Sciences of Ukraine is given in Appendix "H".

The audit team recommends that USAID support this project for the following reasons:

- **The payback is attractive.**
- **The project supports advanced technology, developed within the Ukraine.**
- **The project is a refinement of a successfully operating process and is not a development project.**
- **The project would be funded jointly by USAID and the plant. The plant would supply $59,500 and USAID would supply $74,900.**

The project to reduce energy consumption in the mineral wool plant involves modifications to the existing gas melting furnace shown in Figure 2. The largest energy savings will be produced by addition of a charge preheater (Item 2). Addition of this device requires redesign of the charge hopper (Item 3) to accommodate hot feed material. After the modifications, the flue gas path will be split. Part of the gas will pass through a new air preheater (Item 4) which replaces the current air preheater. The remainder of the flue gas will pass through the charge preheater (Item 2). After passing through the



Equipment List:

1. Melting Converter
3. Charge Hopper
4. Air Preheater
5. Joint for Melt Unloading (Molten Glass Transport Trough)
6. Air Chamber
7. Fiber Deposition Chamber
8. Burners
9. Centrifuge (Glass Filament Spinner)
12. Transporter (Feed Conveyer)

Figure 1. Schematic diagram of Mineral Wool Plant Glass Melting Furnace and Auxiliary Equipment

5.1 Mineral Wool Plant (continued)

charge preheater, the gases are laden with dust. The dust is removed in a mechanical dust collector (Item 10) and recycled to the charge hopper. An induced draft fan (Item 11) draws the flue gas through the charge preheater and provides the control to properly proportion flue gas between the air preheater and the charge preheater. Further energy savings are provided by the redesign of the molten glass transport trough (Item 5) and the air chamber (Item 6). The transport trough has been shortened to reduce heat loss from the molten glass. Hence, the furnace will be able to discharge glass at a lower temperature.

See Appendix "A" for relevant calculations. These calculations are based upon information from joint proposal presented by the plant and the National Academy of Sciences of Ukraine (See Appendix "H") and supporting data.

5.2 Bitumen Unloading System

Bitumen arrives at the plant in railroad cars. Four or five cars arrive each week. The cars usually have an annular space for steam jacketing the area surrounding the contained Bitumen to facilitate its removal from the car. The Bitumen will begin to flow when it is heated above a temperature of 40 °C. In the winter the Bitumen arrives as a very hard solid and exceedingly large quantities of steam are needed to help remove it from the railroad cars. To make the problem even worse, the steam jacketing area often has cracks which leads to large steam losses and the railroad cars are uninsulated which further inhibits the effectiveness of the steam. Plant personnel indicated that in the best case the Bitumen can be removed in 2 hours and in the worse case it can take as long as ten (10) days. A more effective procedure for removing the Bitumen from the railroad cars is clearly needed.

Energy Conservation Opportunity #12 - Increase Efficiency of Steam Used for Unloading Bitumen from Railroad Tank Cars

The installation of an enclosure will greatly aid in reducing the steam required to remove bitumen from the railroad cars. It is estimated that 20,800 metric tons of steam may be saved by installing the enclosure. This corresponds to $63,200, based upon local prices and $104,000, based upon worldwide prices. In terms of energy 42.4 billion Btu (44,800 GJ) is currently lost annually.

5.0 SYSTEMS AUDITED - LONG TERM RECOMMENDATIONS

5.2 Bitumen Unloading System (continued)

The estimated project cost to install the vales is $73,000. The simple payback, based upon local energy prices would be 1.2 years and based upon worldwide energy prices would be 8.4 months.

See Appendix "A" for relevant calculations.

5.3 Steam System

A description of the steam system has already been given above in Section 4.2. This will not be repeated here, except to point out that one of the recommended steam-related energy conservation opportunities is a long term one which will involve an investment in order for implementation to be achieved. This opportunity is described below:

Energy Conservation #13 - Identify, Add or Replace Non-Operating Steam Traps

It is recommended that the plant acquire approximately 100 new Inverted Bucket type steam traps. This will cover the steam traps that currently do not work. It is conservatively estimated that the new installation of 100 steam traps will properly condense and recover 20% of the current steam load or 30 metric tons/hr. On an annual basis this would be 124,800 metric tons. This corresponds to $ 379,400, based upon local prices and $ 499,200, based upon worldwide prices. The energy savings would be 254.5 billion Btu (268,500 GJ) per year.

The estimated project cost would be $ 71,700. The simple payback, based upon local prices would be 2.3 months and based upon worldwide prices would be 1.7 months.

See Appendix "A" for relevant calculations.

5.4 Condensate Steam

A description of the condensate system has already been given above in Section 4.3. This will not be repeated here, except to point out that one of the condensate-related energy conservation opportunities is a long term one which will involve an investment in order for implementation to be achieved. This opportunity is described below:

5.4 Condensate Steam (continued)

Energy Conservation #14 - Collect Additional Condensate and Recycle to Boilerhouse

To implement this ECO it is necessary that new equipment be installed, consisting of a condensate collection drum, a condensate pump and spare and a vent condenser to recover approximately 45 metric tons per hour of additional condensate. This will improve the total condensate recovery of the entire plant from 20% to 50%. On an annual basis an additional 187,200 metric tons would be recovered. This corresponds to $ 56,200, based upon local prices and $ 165,100, based upon worldwide prices. The yearly energy savings would be 38.2 billion Btu (40,300 GJ).

The estimated project cost would be $ 282,000. The simple payback, based upon local prices would be 5.0 years and based upon worldwide prices would be 1.7 years, based upon current economics, this ECO should not be pursued.

See Appendix "A" for relevant calculations.

5.5 Electrical System

A description of the electrical system has already been given above in Section 4.7. This will not be repeated here, except to point out that one of the electrical system related energy conservation opportunities is a long term one which will involve an investment in order for implementation to be achieved. This opportunity is described below:

Energy Conservation Opportunity #15 - Install Capacitors to Improve Low Power Factor of Fiberboard Plant

To improve the power factor of the Fiberboard Plant would require approximately 1,100 KVAC of correction. The estimated project cost is $24,100. Based on local costs the payback would be 7.8 years and based on worldwide cost 0.9 years. This ECO is not currently attractive, based on local costs.

See Appendix "A" for relevant calculations.

6.0 TRAINING ACCOMPLISHED

An objective of this project is to transfer as much information and hands on training of energy auditing techniques to local technical personnel so that they may continue this same work after the foreign consultants have completed their brief visit.

6.1 Local Engineer

The local engineer, Peter Garkun, was an experienced electrical engineer from the local electrical utility. Previous experience included work with the energy inspection agency (Energonadzor). He was familiar with energy conservation techniques and metering, but was able to benefit from interaction with the auditors during the audit.

His experiences during this audit included:

- discussion with plant energy management staff about the audit's purpose and anticipated results;
- participation in planning the audit;
- participation in obtaining plant energy consumption history;
- one-on-one training with audit equipment operation and potential uses;
- participation in conducting the audit to identify potential conservation measures;
- hands on utilization of electrical measuring equipment to quantify potential energy savings;
- discussions with plant staff to determine the feasibility of various conservation measures;
- participation in final "report out" meeting with plant Chief Engineer and Shop Managers;
- development of power factor savings in fiber board plant.

6.2 Plant Staff

Energy management personnel and staff from the boiler house, electrical and mechanical departments participated in the energy audit of the facility. As part of the plant audit, plant personnel took part in:

- discussion of audit purpose and anticipated results;
- setting up the audit plan and itinerary;
- one-on-one training with audit equipment operation and potential uses;
- conducting the audit to identify potential conservation measures;
- hands on utilization of audit equipment to quantify potential energy savings;
- training also included increasing the sensitivity of plant personnel to

steam losses from leaking valves, inoperative steam traps and lack of insulation;

- discussions of typical energy management practices in the US; and
- final "report out" meeting with plant Chief Engineer and Shop Managers.

7.0 IMPACT OF SAVINGS

The recommended Energy Conservation Opportunities (ECO's) and their potential savings represent a meaningful percentage of the total energy usage of the plant. The demonstration of technologies, such as stack gas heat recovery from the melting furnace, can lay the groundwork for additional savings from other projects that can provide substantial reductions in the plant's energy use. In addition, the ECO's recommended are not specific to the production of building materials. They are primarily related to control of energy consumption within a plant and will be applicable to many Ukrainian production facilities.

8 0 RESULTS OF FOLLOW UP VISIT

8 1 Visit Objectives

The objectives of the July 1997 equipment followup visit were to

- Assess energy conservation achievements in each plant in response to the 1995 audit.
- Assist the plants with the use of the newly arrived measuring instruments
- Identify and report problems for correction with any of the instruments
- Discuss equipment installation

8.2 Main Energy Conservation Opportunities (ECOs) during 1995

The chief ECOs identified during the 1995 audit were as follows

ECO #	Description	Estimated Savings (GJ)
01	Purchase Portable Boiler Efficiency Measurement Device	13,300
03	Identify and Repair Steam Leaks	196,500
05	Identify Where Steam Insulation is Deficient, Add Insulation or Fix	134,300
09	Institute Improved Energy Management Procedures	179,400
10	Purchase Portable Electrical Analysis Instrument	1,810 MWh
12	Institute Energy Conservation Training of Plant Personnel	200,500
15	Identify, Add or Replace Non-operating Steam Traps	268,500

An Enerac 2000 combustion analyzer was purchased to address ECO #1 A UCC Leakcheck Sonic leak detector was purchased to address ECOs #3 and #15 Purchase of steam traps has been recommended to address ECO #15 A Mikron M90B infrared thermometer was purchased to check

insulation (ECO #5), to aid detection of leaking steam traps (ECO #15), and to inspect rotating and electrical equipment for hot spots A Rustrak Power Logger RR-1233A-2-0-0 was purchased to help the plant reduce electricity use Mazut flowmeters were purchased to track use of fuel and bitumen

8 3 Status of Plant during July, 1997 Visit

Dr James P Stumbar and Mr Doug Presny visited Strojindustria on July 10, a scheduled visit on July 11 was canceled because the plant was not working The visit consisted of discussions with Mr Anatoly Vladimirovich Guzik, Chief Engineer - Vice Director, Mr. Eduard Mikhailovich Dolgiy, Vice Director, Mr Aleksandr Grigoryervich Markov, Heat Engineer; Mr Aleksandr Grigoryevich Prontenko Chief of Steam and Power Shop, and Mr Vladimir Nikolayevich Kuznetsov, Chief of Instruments. The manufacturing operations at the plant cover a four day week due to weak markets At the time of the visit, the roofing material and the fiberboard plants were operating at full capacity The linoleum and reinforced concrete panel plants were operating at partial capacity. The mineral wool plant was down for a one month maintenance period.

Strojindustria claims that the plant has been actively checking the steam lines for leaks and poor insulation and they have been repairing the leaks Plant personnel indicated that fuel consumption was reduced from 55 Gcal in the first six months of 1996 to 37 Gcal in the first six months of 1997 This reduction occurred with about the same product output of materials

8 4 Accomplishments during Visit

The plant has been using the instruments well Strojindustria is interested in using the instruments to help other plants achieve energy conservation credits They would like to obtain certification of the instruments for this purpose and for their own internal use

The results of the follow up visit to Strojindustria building materials plant are as follows

- Using the Enerac 2000 combustion analyzer, plant personnel demonstrated the manner by which they monitor the boilers After the plant made a measurement, the audit team asked the boiler operator to reduce air flow After a slight adjustment increased efficiency by a small amount from 83 5% to 83 7 A further adjustment produced carbon monoxide This showed that the plant was operating close to the optimal efficiency

- Strojindustria demonstrated the use of the sonic leak detector on a steam trap. The plant has unsuccessfully tried to use the instrument to locate leaks under the steam pipe insulation Consequently, they were not fully satisfied with the instrument for this purpose.

- Strojindustia has used the infrared thermometer to examine rotary equipment for hot bearings At present they have not found any problems.

- Strojindustria gave the audit team the following information showing lower percentage energy costs for manufacture of products The plant has been asked to modify this data to a basis of energy used per weight, volume or area of product

The attached photographs show monitoring activities conducted during the follow up visit

CONSUMPTION OF ENERGY RESOURCES IN STROJINDUSTRIA PLANT

(% COST FROM ENERGY TO PRODUCE UNIT OF PRODUCT)

	5 months 1996				5 months 1997		
	Fuel	Steam	Electricity		Fuel	Steam	Electricity
Product Name							
1) Mineral Wool	15.70%		10.00%		10.00%		7 30%
2) Roofing Material	2.50%	3 50%	2 10%		2 40%	3 30%	1 70%
3) Linoleum		6 10%	1 30%			5 80%	0 90%
4) Fiberboard		25 50%	17 40%			17 70%	11 30%
5) Concrete Products		5.30%	1 10%			4 00%	0.80%
Total Plant	5.20%	4 80%	2 50%		3 00%	4 50%	2 40%

8 5 Work Needed to Complete Implementation

Strojindustria's claims of energy reduction must be verified Strojindustria presented data to show significant improvements in energy usage in a table that compared relative energy costs for producing a unit of product before and after energy conservation measures were taken by the plant These units do not allow proper quantification of the actual savings Instead, the data should be supplied using cubic meters of gas or kW of electricity, or kg of steam divided by product output Units of product output may be kg, cubic meters, square meters

Strojindustria expressed concerns about proper applications of steam traps Application guidelines are supplied by many vendors, (i e Armstrong) Strojindustries claimed that they had a detailed program for monitoring and repairing steam traps, including a logsheet which shows how they track the inspections

For the Rustrak Ranger, male to female adapters for connection of intermediate current transformers (0 to 1000 amps) may be required.

Strojindustria was very interested in obtaining certification for the instruments. They would like to have the instruments certified by the Ukrainian authorities now and later

8 6 Lessons Learned

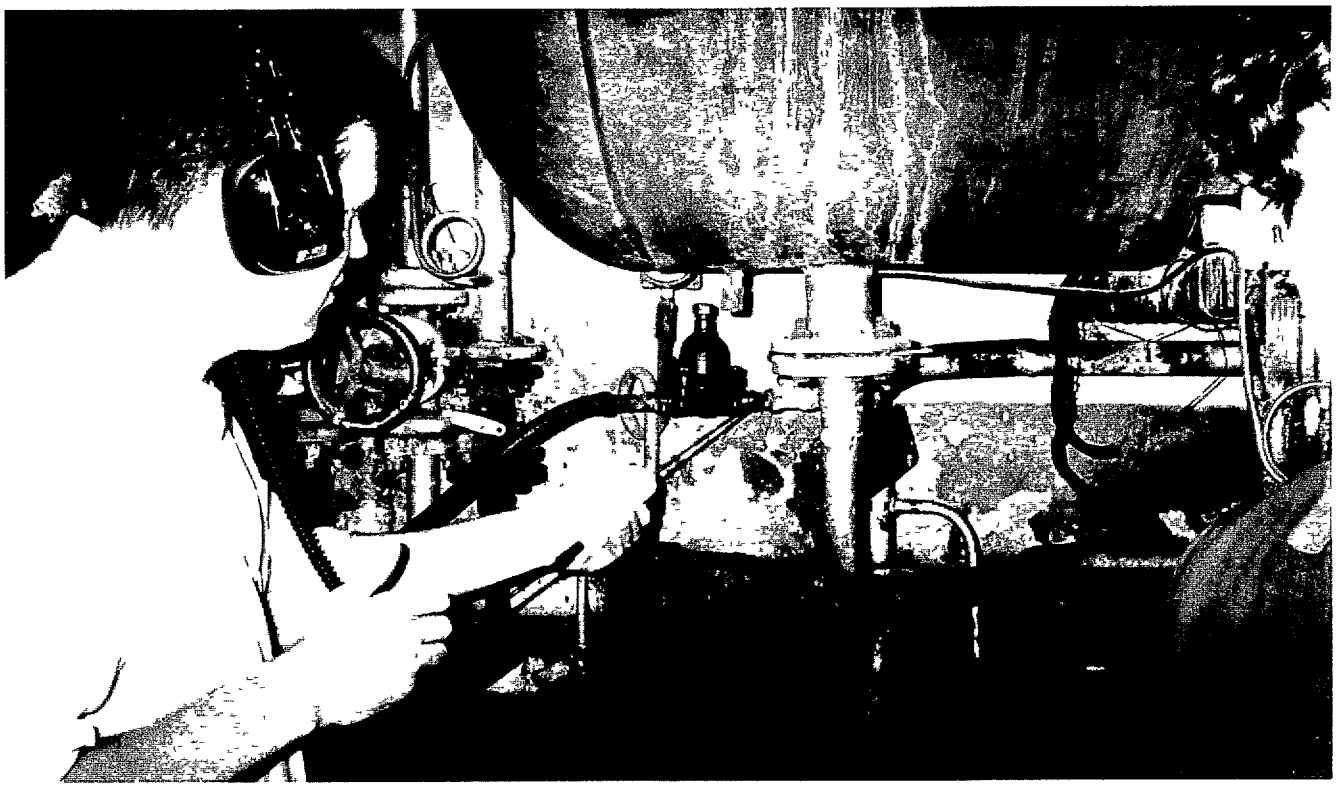
The effectiveness of future programs can be improved by addressing the following items discovered during the visits.

Future projects should consider purchase of Personal Computers (PCs) with Russian software A PC with an integrated software package such as Microsoft Office or Lotus Smart Suite would be a useful tool for tracking energy management in the plants Applications would include. steam trap leak detection and repair, steam system leak detection and repai, tracking of wasted electricity in various parts of the plant.

Purchased instruments should be checked for completeness and correctness of parts and for ability to operate as specified prior to shipment to the plants.

Issues of local certification of equipment should be addressed to ensure that the equipment can be used effectively

Equipment for proper calibration of supplied instruments should be provided to ensure long term usefulness of the instruments



Use of Sonic Leak Detector at Strojindustria Guilding Materials Plant

Use of Mikron Infrared Thermometer at Strojindustria Building Materials Plant

APPENDIX "A"

Energy Conservation Opportunities (ECO's), Savings Calculations, Implementation Costs, Specifications

ENERGY CONSERVATION OPPORTUNITY CALCULATION SECTION CONTENTS

ECO-01	Purchase Portable Boiler Efficiency Measurement Device
ECO-02	Inspect Boiler 2 for Air Leaks in the Preheater and Combustion Chamber; Adjust Burners
ECO-03	Identify and Repair Steam Leaks
ECO-04	Install Automatic Flow Controllers on Large Users of Steam in Each of the Five (5) Plants.
ECO-05	Identify Where Steam Insulation is Deficient, Add Insulation or Fix
ECO-06	Insulate the Four (4) Bitumen Storage Tanks to Conserve Steam Usage
ECO-07	Recover Vent Steam from Dirty Condensate Receiver
ECO-08	Install Continuous Carbon Monoxide and Oxygen Analyzers on the Melting Furnace
ECO-09	Institute Improved Energy Management Procedures
ECO-10	Purchase Portable Electrical Analysis Instrument
ECO-11	Recover Heat from Mineral Wool Melting Furnace to Preheat Charge
ECO-12	Increase Efficiency of Steam Used for Unloading Bitumen from Railroad Tank Cars
ECO-13	Identify, Add or Replace Non-Operating Steam Traps
ECO-14	Collect Additional Condensate and Recycle to Boilerhouse
ECO-15	Install Capacitors to Improve Power Factor of Fiber Board Plant

ECO-01

Purchase Portable Boiler Efficiency Measurement Device

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Analyses of stack gases with a portable analyzer showed that the boilers had high carbon monoxide emissions and high excess air.

DESCRIPTION OF PROPOSED MODIFICATIONS

Better control of excess air is needed promptly to conserve energy. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Based on the measurements the boilers averaged 89.7% efficiency. After trimming the boilers averaged 90.6% efficiency. A 0.9% efficiency improvement is forecast for this measure.

Average Steam flow:	111 metric ton/hr
Enthalpy added to steam:	
1322.1 Btu/lb superheated x 1.055 kJ/Btu x 2.205 kg/lb	= 3076 kJ/kg
182.0 Btu/lb saturated liquid at 100 °C x 1.055 x 2.205	= 423 kJ/kg
	= 2653 kJ/kg
Total heat input to steam:	
2653 kJ/kg x 111 T/hr (average steam load) x 1000 kg/T	= 294,500,000 kJ/hr
	= 294.5 GJ/hr
Heat input to boiler:	
294,500 GJ/hr/0.897 (efficiency) before implementation	= 328.3 GJ/hr
294,500 GJ/hr/0.906 (efficiency) after implementation	= 325.1 GJ/hr
Total estimated savings	= 3.2 GJ/hr
4160 hrs of operation 4160*3.2	= 13,300 GJ saved per year
	= 12.6 billion Btu per year
13,300 x 1,000,000/34,267	= 388,000 m^3/yr saved
388,000 x $80 US/1000 m^3 Ukrainian Price	= $31,000 USD/yr
388,000 x $74 US/1000 m^3 World Price	= $28,700 USD/yr

Project to purchase Portable Analyzer

ECO-01 (continued)

Cost of Recommended Bacarach Model CA 300NSX
Combustion Analyzer = $7,000 USD

Simple Payback Ukrainian Prices	=	Cost / Savings	=	7,000 / 31,000 x 12	=	2.7 Months
Simple Payback World Prices	=	Cost / Savings	=	7,000 / 28,700 x 12	=	2.9 Months

ECO-02

Inspect boiler 2 For Air Leaks in the Air Preheater and Combustion Chamber; Adjust Burners

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Analyses of stack gases with a portable analyzer showed that boiler 2 had high leakage of air in the location of the low temperature air heater. Carbon monoxide emissions also appeared at relatively high excess air.

DESCRIPTION OF PROPOSED MODIFICATIONS

Identification and repair of the air leaks in the air heater is needed to conserve energy. The appearance of carbon monoxide at relatively high excess oxygen indicates that boiler 2 either has excessive air leakage into the setting or that its burners need maintenance and adjustment. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Based on the measurements the boiler 2 had a 88.3% efficiency. Boiler 1 and boiler 3 operate at 91.3% and 91.4% efficiency respectively, about 3% higher efficiency than boiler 2. Assuming the repair of air leaks and/or the burner maintenance can recover two-thirds of the difference, successful execution of this ECO should provide a 2% efficiency improvement.

Average Steam flow:	111 metric ton/hr/3 boilers	= 37 metric ton/hr
Enthalpy added to steam:		
1322.1 Btu/lb saturated x 1.055 kJ/Btu x 2.205 kg/lb		= 3076 kJ/kg
182.0 Btu/lb saturated liquid at 100 °C x 1.055 x 2.205		= 423 kJ/kg
		= 2653 kJ/kg
Total heat input to steam:		
2653 kJ/kg x 37 T/h x 1000 kg/T		= 98,200,000 kJ/hr
		= 98.2 GJ/hr
Heat input to boiler:		
98.2 GJ/hr/0.883 (efficiency) before implementation		= 111.2 GJ/hr
98.2 GJ/hr/0.903 (efficiency) after implementation		= 108.7 GJ/hr

ECO-02 (continued)

Total estimated savings	= 2.5 GJ/hr
4160 hours * 2.5 GJ/hr	= 10,400 GJ saved per year
	= 9.86 billion Btu per year
10,400 x 1,000,000/34,267	= 303,500 m^3/yr saved
303,500 x \$80 US/1000 m^3 Ukrainian Price	= \$24,300 USD/yr
303,500 x \$74 US/1000 m^3 World Price	= \$22,500 USD/yr

Inspect boiler 2 repair air leaks and adjust burners for boiler 2

Labor	= \$3,000
Repair materials - sheet metal, packing, welding rods, burner parts	= \$6,000
Total Cost	= \$9,000

Simple Payback Ukrainian Prices $= \frac{\text{Cost}}{\text{Savings}} = \frac{9{,}000 \times 12}{24{,}300} = 4.4$ months

Simple Payback World Prices $= \frac{\text{Cost}}{\text{Savings}} = \frac{9{,}000 \times 12}{22{,}500} = 4.8$ months

B \ECO02 BMP

TABLE "A-1"

STROJINDUSTRIA BUILDING MATERIALS PLANT

KIEV, UKRAINE

BOILER STACK MEASUREMENTS

Boiler #	Time	Stack Temp Deg C	Excess Oxygen vol %	Carbon Dioxide vol %	Excess Air %	Efficiency %	Carbon Monoxide vppm	Nitrogen Oxides vppm	Sulfur Oxides	Comments
16-Mar-95										
1	10 13	105	9 8	6 2	82	94 3	2	137	0	Stack Gas Loss Add wall & blowdown
3	10 37	122	7 1	7 8	47	94 4	10	NA	0	Stack Gas Loss Add wall & blowdown
3	11:10	346	2 8	10 2	14	85 2 not appl	10	NA	0	After Boiler-Shows that mixing is adequate
1	11 21	331	3 5	9 7	18	85 5 not appl	2	185	0	Before fuel/air ratio adjustment
1	11 25	328	1 7	10 7	8	86 8 not appl	46	NA	0	After fuel/air ratio adjustment
1	11 30	NA	1 2	NA	6	87 1 not appl	100 to 200	NA	0	Lowest excess oxygen limit boiler 1
1	12 23	238	4 3	9 2	23	89.6 not appl	0	NA	0	Before Economizer
1	12 30	155	5 5	8 7	32	93 1 not appl	3	NA	0	After Economizer
3	12 45	155	5 7	8 5	34	93 0 not appl	10	98	0	After Economizer
Boiler # 20-Mar-95										
2	10 49	348	6 3	8 2	39	82 6 not appl	4	102	0	After Boiler
2	11:01	139	13 2	4 4	156	89 6	4	54	0	Stack Gas Loss Add wall&blowdown
2	11 14	140	11 2	5 4	105	91 3	60	58	0	After Burner Adjustment Excess O2 Limit
2	11 24	163	8 7	6 8	65	91 4 not appl	65	NA	0	After Economizer
2	11:33	197	8 3	7 1	60	89 4 not appl	130	NA	0	Before Economizer
2	11 58	343	4 9	9 0	28	84 1 not appl	116	95	0	After Boiler - Shows poor mixing

BOILER PLANT EFFICIENCY RESULTS

Boiler #	Time	Flue Gas Loss	Unburned CO Loss	Wall/Blowdown Loss	Total Losses	Net Efficiency
1	10.13	5 7%	0 0%	3 0%	8 7%	91 3%
3	10:37	5 6%	0.0%	3 0%	8 6%	91 4%
2	11.01	10 4%	0 0%	3.0%	13 4%	86 6%
2	11:14	8.7%	0 0%	3 0%	11 7%	88 3%

TABLE "A–2"
STROJINDUSTRIABUILDING MATERIALS PLANT
KIEV, UKRAINE
BOILER OPERATING MEASUREMENTS

Time	Gas Flow	Steam Flow	Steam Press.		Superheat Steam Temp	Air Preheat Temp		Combustion Chamber Press.	Press. After Boiler	Exhaust Temp.	Comments
			Drum	Outlet		Right	Left				
16–Mar–95	(m3/hr)	(T/hr)	(bar)	(bar)	(deg C)	(deg C)	(deg C)	(mm w.c.)	(mm w.c.)	(deg C)	
Boiler #1											
10:00	3300	47	10.5	6.8	249	215	210	–1.5	–100	106	
10:15	3300	47	10.5	6.8	249	213	208	–1 5	–100	105	
11:26	3300	47	10.5	6 6	249	205	202	–1.5	–100	103	Excess Oxygen Decreased.
Boiler #3											
10:00	3200	51	11.5	5 7	298	202	217	–1.5	–80	126	
10:15	3200	52	11.3	5.7	298	202	217	–1.5	–80	127	
20–Mar–95											
Boiler #2											
10:51	4200	60	10	8.9	310	210	200	–1.5	–297	120	
11:15	4200	68	9.7	8.5	310	222	215	–1.5	–275	124	After Firing Rate Adjustment
11:50	3975	69	9 1	8.1	308	225	217	–1.5	–270	125	
11:57	3975	69	9.1	8	308	225	217	–1.5	–247	125	After Final Adjustment

ECO-03

Identify and Repair Steam Leaks

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

During the plant visit, the audit team observed numerous visible leaks from flanges, valve bonnets, heat tracing, and other equipment.

DESCRIPTION OF PROPOSED MODIFICATIONS

Identification and repair of the steam leaks will reduce steam consumption and conserve energy. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Until the plant conducts an actual survey of the leaks, estimated savings are order of magnitude savings. Actual savings will be in proportion to those given in the calculations. The audit team estimates that repair of steam leaks can potentially save 20% of the plant's current steam production.

Average Steam flow: = 111 metric ton/hr

Estimated Potential Steam Savings

111 T/hr x 0.20 = 22 T/hr
22 T/hr x 16 hr/day x 5 days/week x 52 weeks/year = 91,500 T/yr

Approximate local price for steam is 450,000 Ukrainian coupons/metric ton or $3.04 per metric ton.

Current Annual Loss = $3.04 per metric ton x 91,500 T/yr = $ 278,000 USD
(Local Price)

Current Annual Loss = $4.00 per 1,000 lb x 91,500 T/yr
x 2.205 lb/kg = $ 807,000 USD
(World Price)

Latent Heat of Steam = 925 Btu/lb

ECO-03 (continued)

Estimated Yearly Energy Savings = 925 Btu/lb x 91,500 T/yr x 2,205 lb/T
= 186,600 MMBtu
= 186.6 billion Btu/yr
= 196,900 GJ/yr
= 5,746,000 m^3/yr

196,900 x 1,000,000/34,267

Estimated Project Cost to Repair Steam Leaks

Assume 200 leaks at $200 average cost per leak = $40,000 USD

Total Cost = $ 40,000

Simple Payback Ukrainian Prices = $\frac{\text{Cost}}{\text{Savings}} = \frac{40{,}000 \times 365}{278{,}000}$ = 54.4 days

Simple Payback World Prices = $\frac{\text{Cost}}{\text{Savings}} = \frac{40{,}000 \times 365}{807{,}000}$ = 18.0 days

ECO-04

Install Automatic Flow Controller on Large Users of Steam in Each of the Five (5) Plants.

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Currently all of the steam users in each of the five (5) plants are controlled manually. This method of control does not insure that the proper quantity of steam is being provided to each user and in most cases the quantity provided is too large.

DESCRIPTION OF PROPOSED MODIFICATIONS

It is recommended that for the largest users of steam in each of the five (5) plants, automatic flow controllers be installed to insure that the proper quantity of steam is, in all cases, delivered to the user.

It is assumed that five (5) new automatic controllers will be needed at this time, having the following dimensions:

Two	12 inch
Two	10 inch
One	8 inch

ENERGY SAVINGS CALCULATION

A 10% efficiency improvement in the utilization of steam is forecast for this measure.

10% of 150 metric tons per hour = 15 metric tons/hour
Annual steam savings = (15) (16) (260) = 62,400 metric tons

Annual Savings (Local Price)	=	(3.04) (62,400)	=	$ 189,700
Annual Savings (Worldwide Price)	=	(4.00) (62,400) $\frac{(2,205)}{(1,000)}$	=	$ 550,400
Yearly Energy Saved	=	(925) (62,400) (2,205)		
	=	127.3 billion Btu (134,300 GJ)		
134,300 x 1,000,000/34,267	=	3,919,000 m^3/yr		

ECO-04 (continued)

Estimated Project Cost to Purchase and Install Valves:

$ 158,300

Simple Payback Local Energy Prices	=	Cost / Savings	=	(158,300) 12 / 189,700	= 10.0 months
Simple Payback Worldwide Energy Prices	=	Cost / Savings	=	(158,300) (12) / 550,400	= 3.5 months

B \ECO04 BMP

ECO-05

Identify Where Steam Insulation is Deficient, Add Insulation or Fix

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

During the plant visit, the audit team observed many uninsulated steam lines. There were also parts of these lines where insulation had deteriorated. The team measured surface temperatures as high as 280 °C on some of these bare pipes.

DESCRIPTION OF PROPOSED MODIFICATIONS

Identification of missing and deteriorated insulation, addition of insulation and repair of broken insulation will reduce steam consumption and conserve energy. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Until the plant conducts an actual survey of the steam lines, estimated savings are order of magnitude savings. Actual savings will be in proportion to those given in the calculations. The audit team estimates that repair of steam leaks can potentially save 15% of the plant's current steam production.

Example Calculation for 6 inch diameter (150 mm diameter) steam line

Heat Loss per linear foot at 530 °F (277 °C) surface temperature (bare pipe)	= 3360 Btu/hr-linear ft
Heat Loss per linear foot at 130 °F (54 °C) surface temperature (insulated pipe)	= 155 Btu/hr-linear ft
Available savings	= 3205 Btu/hr-linear ft

Estimated energy savings:
The example given below is used to estimate simple payback. Total energy savings estimated on the following page.

A uninsulated pipe in the fiber board plant was approximately 450 ft (140 m) long.

450 ft x 3205 Btu/hr-linear ft/1,000,000	= 1.44 MMBtu/hr
1.44 MMBtu/hr x 1.055 GJ/MMBtu	= 1.52 GJ/hr

ECO-05 (continued)

16 hrs/day x 5 days/week x 52 weeks/yr x 1.44 MMBtu/hr	= 5,990 MMBtu/yr
	= 6,320 GJ/yr

Estimated Steam Savings for example:
Heat Content of Superheated Steam is approximately 1300 Btu/lb

5,990,000,000 Btu/yr/1300 Btu/lb/2.205 kg/lb/1000 kg/T	= 2,090 T/yr
2090 T/yr x 2205 lb/T	= 4,608,000 lb/yr
Current Annual Loss = $3.04 per metric ton x 2,090 T/yr (Local Price)	= $ 6,350 USD
Current Annual Loss = $4.00 per 1,000 lb x 2,090 T/yr x 2.205 lb/kg (World Price)	= $ 18,400 USD

Estimated Cost to Insulate this steam line.

The line requires 3 inch (76 mm) thick insulation. Assuming mineral wool lagged with aluminum, the estimated unit cost is $ 17.40 per linear foot.

Cost to insulate line = 450 ft x $ 17.40 per ft.	= $ 7,850 USD
Cost of two (2) Wahl Model DHS-29XT infrared thermometers	= 2 x $ 4,000
One infrared thermometer to be purchased by USAID	
	= $ 8,000 USD
Total Cost	= $ 15,850

Simple Payback Prices = $\frac{\text{Cost}}{\text{Savings}}$ = $\frac{15,830}{6,350}$ x 1 = 2.5 years Ukrainian

Simple Payback Prices = $\frac{\text{Cost}}{\text{Savings}}$ = $\frac{15,830}{18,400}$ x 1 = 0.86 years World = 10 months

Note: insulation or repair of insulation on other steam lines in the plant will have similar returns.

Potential cost of steam losses from poorly insulated lines

111 T/hr x 0.15	= 16.7 T/hr
16.7 T/hr x 16 hr/day x 5 days/week x 52 weeks/year	= 68,600 T/yr

ECO-05 (continued)

Approximate local price for steam is 450,000 Ukrainian coupons/metric ton or $3.04 per metric ton.

Current Annual Loss = $3.04 per metric ton x 68,600 T/yr = $ 208,500 USD
(Local Price)

Current Annual Loss = $ 4.00 per 1,000 lb x 68,600 T/yr (world price) x 2.205 lb/kg
= $ 605,000 USD

Latent Heat of Steam = 925 Btu/lb

Estimated Yearly Energy Savings =925 Btu/lb x 68,600 T/yr
x 2,205 lb/T = 140,000 MMBtu
= 140 billion Btu/yr
= 147,700 GJ/yr

147,700 x 1,000,000/34,267 = 4,310,000 m^3/yr

ECO-06

Insulate the Four (4) Bitumen Storage Tanks to Conserve Steam Usage

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

During the plant visit, the audit team observed that the four bitumen storage tanks were not insulated. These store bitumen feed material for the roofing plant at 70 °C to 80 °C (158 °F to 176 °F).

DESCRIPTION OF PROPOSED MODIFICATIONS

Insulation of the tanks with mineral wool produced in the plant will decrease steam consumption and conserve energy. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Assuming a 75 °C (167 °F) Bitumen storage temperature and an average daily temperature of 20 °C (68 °F) in summer and -12 °C (10 °F) in the winter. The average ambient temperature is 4 °C (39 °F). The heat losses from a bare tank and an insulated tank are as follows:

Heat transfer Coefficient U (Btu/hr ft^2 °F)
For an insulated tank

$$\frac{1}{U} = \frac{1}{h_i} + \frac{x}{k} + \frac{1}{h_o}$$

Where:
h_i = 20 Btu/hr ft^2 °F
k_a = 0.3 Btu-in/hr ft^2 °F
x = 4 inches insulation thickness
h_o = 2.0 Btu/hr ft^2 °F

$$\frac{1}{U} = \frac{1}{20} + \frac{4}{0.3} + \frac{1}{2.0}$$

$$\frac{1}{U} = 0.05 + 13.3 + 0.5$$

$$U = 0.072 \text{ Btu/hr ft}^2\ ^\circ\text{F}$$

ECO-06 (continued)

Heat/area = 0.072 x (167 - 39) = 9.2 Btu/hr ft^2

For a bare tank

$$\frac{1}{U} = 0.05 + 0.5$$

$$U = 1.81 \text{ Btu/hr ft}^2\ ^\circ\text{F}$$

Heat/area = 1.81 (167 - 39)	= 232 Btu/hr ft^2
Savings = 232 - 9	= 223 Btu/hr ft^2 surface area.

Surface area of the tanks
Tanks are 10 m (32.8 ft) high by 12 m (39.4 ft) diameter.

Sidewall area:	4 tanks x 3.1416 x 39.4 ft x 32.8 ft	= 16,200 ft^2
Roof area:	4 tanks x 3.1416/4 x 39.4 x 39.4	= 4,900 ft^2
Total surface area		= 21,100 ft^2

Yearly heat loss:

8760 hr/yr x 223 Btu/hr ft^2 x 21,100 ft^2/1,000,000	= 41,200 MMBtu/yr = 41.2 billion Btu/yr = 43,500 GJ/yr
43,500 x 1,000,000/34,267	= 1,269,000 m^3/yr

Steam savings 925 Btu/lb latent heat

41,200,000,000 Btu/yr/925 Btu/lb/2205 lb/T	= 20,200 metric T/yr
Current Annual Loss = $3.04 per metric ton x 20,200 T/yr (Local Price)	= $ 61,400 USD
Current Annual Loss = $4.00 per 1,000 lb x 20,200 T/yr x 2.205 lb/kg (World Price)	= $ 178,200 USD

ECO-06 (continued)

Estimated Cost to Insulate the tanks.

The line requires 4 inch (100 mm) thick insulation. Assuming mineral wool lagged with aluminum, the estimated unit cost is \$1.35 ft^2.

Cost to insulate tanks = 21,200 ft^2 x \$1.35 per ft.	=	\$ 28,600 USD
Labor	=	\$176,900 USD
Total	=	\$205,500 USD

Simple Payback Ukrainian Prices	=	Cost / Savings	=	205,500 / 61,400 x 1 yr	=	3.1 years
Simple Payback World Prices	=	Cost / Savings	=	205,500 / 178,200	=	1.15 years = 13.8 months

B \ECO06 BMP

ECO-07

Recover Steam Vented From Dirty Condensate Receiver

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

A large continuous stream of steam vents from the dirty condensate receiver in the bitumen storage tank area.

DESCRIPTION OF PROPOSED MODIFICATIONS

Close the vent, recover low pressure steam, use this recovered steam to supply energy to selected heat traced bitumen pipes in the storage tank area. Recovery of this steam will reduce steam consumption in the bitumen tank area and conserve energy. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Estimated Potential Steam Savings

Estimated velocity from vent line is 30 ft/sec.

Vent line diameter is 6 in or 0.5 ft (150 mm)
Volume of steam lost = 30ft/sec x 3.1416/4 x 0.5 ft x 0.5 ft x 3600 sec/hr = 21,200 ft^3/hr
Weight of steam lost = 21,200 ft^3/hr /10.5 ft^3/lb/2205 lb/T = 0.92 T/hr

0.92 T/hr x 16 hr/day x 5 days/week x 52 weeks/year = 3,830 T/yr

Approximate local price for steam is 450,000 Ukrainian coupons/metric ton or $3.04 per metric ton.

Current Annual Loss = $3.04 per metric ton x 3,830 T/yr = $ 11,600 USD
(Local Price)

Current Annual Loss = $4.00 per 1,000 lb x 3,830 T/yr x 2.205 lb/kg = $ 33,800 USD
(World Price)

ECO-07 (continued)

Latent Heat of Steam	= 925 Btu/lb
Estimated Yearly Energy Savings	
= 925 Btu/lb x 3,830 T/yr x 2,205 lb/T	= 7,800 MMBtu/yr
	= 7.8 billion Btu/yr
	= 8,200 GJ/yr
8,200 x 1,000,000/34,267	= 239,000 m^3/yr

Estimated Project Cost to Repair Steam Leaks

Assume 200 ft of 6 in (150 mm) diameter line, one block valve, 4 inches (100 mm) insulation

Total Estimated Cost = $18,200 USA

Simple Payback Ukrainian Prices = $\frac{\text{Cost}}{\text{Savings}} = \frac{18{,}200 \times 365}{11{,}600}$ = 1.6 years

Simple Payback World Prices = $\frac{\text{Cost}}{\text{Savings}} = \frac{18{,}200 \times 365}{33{,}800}$ = 0.54 years = 6.5 months

ECO-08

Install Continuous Carbon Monoxide and Oxygen Analyzers on the Melting Furnace

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Analyses of stack gases with a portable analyzer showed that the glass melting furnace had high carbon monoxide emissions.

DESCRIPTION OF PROPOSED MODIFICATIONS

Better control of excess air is needed promptly to conserve energy. The quantity of energy that is currently being lost is estimated in the calculations given below.

ENERGY SAVINGS CALCULATION

Based on the measurements the furnace had unburned fuel losses of 15.3% and losses from the sensible heat in the stack gases (968 °C, 5.7% excess oxygen) of 49.9% plus an estimated wall loss of 24%. This yields a net efficiency of 14.5%. After readjusting the fuel/air ratio, the unburned fuel loss was zero. Use of continuous oxygen and carbon monoxide analyzers will permit the operators to eliminate unburned fuel losses and increase furnace efficiency to 29.8%.

Average glass melted:	= 3.0 metric ton/hr
Enthalpy added to glass:	
0.2 Btu/lb °F x (2350 °F temp. difference) x 1.055 kJ/Btu x 2.205 lb/kg	= 1093.3 kJ/kg
100 kcal/kg heat of fusion x 4.184 kJ/kcal	= 418.4 kJ/kg
	= 1511.7 kJ/kg
Total heat input into glass:	
1512 kJ/kg x 3 T/h x 1000 kg/T	= 4,540,000 kJ/hr
	= 4.54 GJ/hr
Heat input to furnace:	
4.54 GJ/hr/0.145 (efficiency) before implementation	= 31.3 GJ/hr
4.54 GJ/hr/0.298 (efficiency) after implementation	= 15.2 GJ/hr

ECO-08 (continued)

Total estimated savings	= 16.1 GJ/hr
3 days/week x 24 hrs/day x 52 weeks x 16.1 GJ/hr x 0.33 estimated time CO is present	= 20100 GJ/yr
	= 19.0 billion Btu/yr
20,100 x 1,000,0000/34,267	= 587,000 m^3/yr
587,000 x \$80 US/1000 m^3 Ukrainian Price	= \$46,900 USD/yr
587,000 x \$74 US/1000 m^3 World Price	= \$43,400 USD/yr
Project to purchase Portable Analyzer	
Cost of Recommended Oxygen and NDIR Carbon Monoxide Analyzers	= \$24,575 USD

Simple Payback Ukrainian Prices = $\frac{\text{Cost}}{\text{Savings}}$ = $\frac{24{,}575}{46{,}900}$ x 12 = 6.3 Months

Simple Payback World Prices = $\frac{\text{Cost}}{\text{Savings}}$ = $\frac{24{,}575}{43{,}400}$ x 12 = 6.8 Months

TABLE "A-3"
STROJINDUSTRIA MELTING FURNACE COMBUSTION LOSSES

Carbon Monoxide (CO) losses
Volume flue gas/volume of natural gas = 10 5 ft3/ft3 at stoichiometric Combustion

On March 15, 1995, The melting furnace was operating with 3334 vppm or more CO
Flue gas Volume in Boiler 3

3 T/hr molten basalt * 2205 lb/T		6615 lb glass/hr
0 2*(2410 – 60) + 180 Btu/lb latent		649 9 Btu/lb added to basalt
6615 lb glass/hr * (649 9 Btu/lb)		4299089 Btu/hr into glass
4 30 MMBtu/hr/0.145 (Efficiency)		29648886 Btu/hr firing rate
29 6 MMBtu/hr/983 Btu/SCF		30162 SCFh natural gas
30200 SCFh*(10 5+9 5*0 375 excess air)		424148 SCFh flue gas
424,000 SCFh*3334 vppm CO/1000000		14141 SCFh carbon monoxide
14100 SCFh CO* 321 Btu/SCF		4539291 Btu/hr combustion loss
Instrument Saturated	>	15 3% Combustion loss (minimum)

Efficiency = 0 501 (Bacharach) – 0 153 Combustion loss – 0 201 Wall losses = 0 145

3 T/hr molten basalt * 2205 lb/T	6615 lb glass/hr
0 2 Btu/lb–deg F*(2410 – 60) deg F + 180 Btu/lb latent heat	649 9 Btu/lb added to basalt
6615 lb glass/hr * (649 9 Btu/lb)	4299089 Btu/hr into glass
4 30 MMBtu/hr/0.298 (Efficiency)	14426471 Btu/hr firing rate
14.4 MMBtu/hr/983 Btu/SCF	14676 SCFh natural gas
14676 SCFh*(10 5+9 5*0 375 excess air)	206381 SCFh flue gas
206,400 SCFh*33 vppm CO/1000000	68 SCFh carbon monoxide
68 SCFh CO* 321 Btu/SCF	21862 Btu/hr combustion loss
	0 2% Combustion loss

Efficiency = 0 501 (Bacharach) – 0 0 Combustion loss – 0 201 wall losses = 0 298

'(30162–14676) SCFh saved	15486 SCFh saved
15486 SCFh/35.31 * 24 hr/day * 3 days/week * 52 weeks/yr	1642000 m3/yr saved

Estimated Savings

'1,642,000 US * $80/1000 m3	$131,360 Ukrainian
'1,642,000 US * $74/1000 m3	$121,508 World

ECO-09

Institute Improved Energy Management Procedures.

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

- The plant has a single individual who is responsible for energy conservation, but does does not have a fully functioning energy conservation committee.

- The plant does not have a yearly budget which is set aside for energy conservation projects.

- The plant must make recommendations to a Technical Council to receive approval for an energy conservation project. Even if approval is obtained from the Technical Council, the council cannot insure that founds will be provided for the project.

- The plant has no criteria, such as payback or discounted cash flow, for making investments in the plant to conserve energy. Their only criteria for making energy conservation investments is based upon energy usage per quantity of product.

- Basic maintenance, such as the repair of steam leaks and the repair or replacement of faulty insulation, needs to be greatly improved.

DESCRIPTION OF PROPOSED MODIFICATIONS

A fully functioning energy conservation committee must be put place under the direction of the single individual who is currently responsible for energy conservation. The committee will be responsible for developing an appropriate agenda and proper planning for energy conservation implementation. The highest proprietary must be given to the establishment of a yearly budget for energy conservation. A criteria such as a 3 year payback or 15% discounted cash flow should be used for making decisions as to whether or not to invest in an energy conservation project. High priority must be given to improving basic maintenance.

ENERGY SAVINGS CALCULATION

We predict an overall efficiency improvement of 10% in the overall utilization of energy, if these recommendations are implemented.

Given below is the actual yearly cost for 1994, based on local prices, for the following types of energy:

	Ukrainian Coupons	U.S. Dollars
Natural Gas	60,400,000	408,100
Electricity	22,800,000	154,100
Total	83,200,000	562,200

ECO-09 (continued)

If there is a 10% improvement in efficiency, the overall savings, based upon local prices, would be $ 56,200. For worldwide prices this would be approximately $ 200,000.

The annual energy savings would be:

1.7 trillion Btu/hr x 10% = 0.17 trillion Btu/hr (179,400 GJ)

179,400 x 1,000,000/34,267 = 5,235,000 m^3/yr

The cost of the program would be negligible and the payout immediate.

B \ECO09 BMP

ECO-10

Purchase Portable Electrical Analysis Instrument

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Currently, the measured power factor in the fiber board plant is very low — 0.66 to 0.73. This low power factor needs improvement. The power factor of all other currently operating units were measured and found to be adequate. However, measurements could not be made in the roofing plant and concrete plants. The electrical consumption of the plant was measured during night-time hours and the consumption appeared to be abnormally high and characteristic of equipment being run when it should be shutdown. Plant management, however, explained why certain items had to be run at night and thus accounted for the electricity.

DESCRIPTION OF PROPOSED MODIFICATIONS

Purchase a Dranetz 808A Power Analyzer to pinpoint exactly which items of equipment are running , when they should be shutdown and to analyze the roofing and concrete plants for low power factor and waste from equipment that is not shutdown during the night.

ENERGY SAVINGS CALCULATION

Use of the Dranetz 808A Power Analyzer should reduce electricity consumption by 10%.

Electricity Savings:

18,073,007 kWh (1994 consumption) x 0.10	= 1,810,000 kWh

Annual Estimated Cost Savings:

Local Prices — 1,810,000 kWh x $0.0155 per kWh	= $28,100 USD
World Prices — 1,810,000 kWh x $0.05 per kWh	= $90,500 USD

Instrument Cost:

Dranetz 808A Power Analyzer	= $14,100 USD
Survey Cost	= $1,000 USD
Total Cost	= $15,100 USD

ECO-10 (continued)

Simple Payback	=	Cost / Savings	=	15,100 / 28,100	x 12	= 6.4 months Ukrainian Prices
Simple Payback	=	Cost / Savings	=	15,100 / 90,500	x 12	= 2.0 months World Prices

ECO-11

Recover Heat From Mineral Wool Melting Furnace to Preheat Charge

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Currently, at 968 °C the stack temperature of the melting furnace is very high. At this temperature almost 50% of the energy in the fuel is wasted. The mineral wool plant is considering a project designed by the National Academy of Sciences of Ukraine to recover more heat by preheating the charge material before it enters the converter. Implementation of this project will increase heat recovery by 33%.

DESCRIPTION OF PROPOSED MODIFICATIONS

Modifications to the melting furnace and auxiliaries are shown in Figure 2. A charge preheater (Item 2) will be added to the furnace. The charge hopper (Item 3) will be redesigned to feed hot charge material to the converter. The flue gas path will be split. Part of the gas will pass through a new air preheater (Item 4) and the remaining gas will pass through the charge preheater (Item 2). After passing through the charge preheater, the gases are laden with dust. The dust is removed in a mechanical dust collector (Item 10) and recycled to the charge hopper. The flue gas is transported through the charge preheater by the suction created with an induced draft fan (Item 11). To reduce heat loss from the molten glass, the molten glass transport trough will be replaced by a shorter one (Item 5) and the air chamber (Item 6) will be redesigned.

ENERGY SAVINGS CALCULATION

Based on the measurements the melting furnace operates with losses from the sensible heat in the stack gases (968 °C, 5.7% excess oxygen) of 49.9% plus an estimated wall loss of 24%. This yields a net efficiency of 26.1%. After the charge preheater is added the furnace efficiency will increase to 34.8%. Losses then will consist of 45.1% sensible heat and 20.1% wall loss. The energy savings from this project are presented below.

Average glass melted:	= 3.0 metric ton/hr
Enthalpy added to glass:	
0.2 Btu/lb °F x (2350 °F temp. difference)x 1.055 kJ/Btu x 2.205 lb/kg	= 1093.3 kJ/kg
100 kcal/kg heat of fusion x 4.184 kJ/kcal	= 418.4 kJ/kg
	= 1511.7 kJ/kg

ECO-11 (continued)

Total heat input into glass:

1512 kJ/kg x 3 T/h x 1000 kg/T	= 4,540,000 kJ/hr
	= 4.54 GJ/hr

Heat input to furnace:

4.54 GJ/hr/0.261 (efficiency) before implementation	= 17.4 GJ/hr
4.54 GJ/hr/0.348 (efficiency) after implementation	= 13.0 GJ/hr
Estimated fuel savings	= 4.4 GJ/hr
3 days/week x 24 hrs/day x 52 weeks x 4.4 GJ/hr	= 16500 GJ/yr
	= 15.6 billion Btu/yr
16,500 x 1,000,0000/34,267	= 481,500 m^3/yr
481,500 m^3 x $80 US/1000 m^3 Ukrainian Price	= $ 38,500 USD/yr
481,500 m^3 x $74 US/1000 m^3 World Price	= $ 35,600 USD/yr

Electrical Savings:

6 kw/m3 x 50,000 m3 x 0.0155 $US/kw Ukrainian Price	= $ 4,700 USD/yr
6 kw/m3 x 50,000 m3 x 0.050 $US/kw World Price	= $ 15,000 USD/yr

Net Savings

$38,500 fuel + $4,700 electrical (Ukrainian Price)	= $ 43,200 USD/yr
$35,600 fuel + $15,000 electrical (World Price)	= $ 50,600 USD/yr

NOTE: The current plant work week is short. Therefore, energy savings for the project are also calculated based upon a 5 day week, 24 hour/day operation as follows.

5 days/week x 24 hrs/day x 52 weeks x 4.4 GJ/hr (full load factor)	= 27,500 GJ/yr

Fuel Savings 5 days/week

27,500 x 1,000,000/34,267	= 802,500 m^3/yr
802,500 m^3 x $80 US/1000 m^3 Ukrainian Price	= $ 64,200 USD/yr
802,500 m^3 x $74 US/1000 m^3 World Price	= $ 59,400 USD/yr

ECO-11 (continued)

Electrical Savings 5 days/week

6 kw/m3 x 50,000 m3 x 5/3 x 0.0155 $US/kw Ukrainian Price	= $ 7,400 USD/yr
6 kw/m3 x 50,000 m3 x 5/3 x 0.050 $US/kw World Price	= $ 24,000 USD/yr

Net Savings

$64,200 fuel + $7,400 electrical (Ukrainian Price)	= $ 71,600 USD/yr
$59,400 fuel + $24,000 electrical (World Price)	= $ 83,400 USD/yr

Project to add charge preheater to Melting Furnace

Total Estimated Cost: (See attached english translation of proposal - Appendix "H")
= $ 134,000.

This estimated cost does notinclude addition of an oxygen analyzer and portable gas analyzer listed in the proposal - (Appendix "H"). Although these were included in the proposal, Foster Wheeler does not consider the analyzers to be critical for the success of the project. Addition of an oxygen analyzer is estimated to cost $8,000 USD. The cost of the portable analyzer has been included in ECO #1.

Simple Payback 3 day work week:

$$\text{Simple Payback} = \frac{\text{Cost}}{\text{Savings}} = \frac{134{,}000}{43{,}200} = 3.1 \text{ Yr. Ukrainian Prices}$$

$$\text{Simple Payback} = \frac{\text{Cost}}{\text{Savings}} = \frac{134{,}000}{50{,}600} = 2.6 \text{ Yr. World Prices}$$

Simple Payback 5 day work week:

$$\text{Simple Payback} = \frac{\text{Cost}}{\text{Savings}} = \frac{134{,}000}{71{,}600} = 1.9 \text{ Yr. Ukrainian Prices}$$

$$\text{Simple Payback} = \frac{\text{Cost}}{\text{Savings}} = \frac{134{,}000}{83{,}400} = 1.6 \text{ Yr. World Prices}$$

ECO-12

Increase Efficiency of Steam Used for Unloading Bitumen Charge.

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Bitumen arrives at the plant in railroad cars. Four or five cars arrive each week. The cars usually have an annular space for steam jacketing the area surrounding the contained Bitumen to facilitate its removal from the car. The Bitumen will begin to flow when it is heated above a temperature of 40 °C. In the winter the Bitumen arrives as a very hard solid and exceedingly large quantities of steam are needed to help remove it from the railroad cars. To make the problem even worse, the steam jacketing area often has cracks which leads to large steam losses and the railroad cars are uninsulated which further inhibits the effectiveness of the steam. Plant personnel indicated that in the best case the Bitumen can be removed in 2 hours and in the worse case it can take as long as ten (10) days. A more effective procedure for removing the Bitumen from the railroad cars is clearly needed.

DESCRIPTION OF PROPOSED MODIFICATIONS

Install a heated enclosure of concrete block sides with a precast slab roof, containing 3 inches of mineral wool insulation. The enclosure is to be large enough to service one railroad car containing Bitumen at a time. We estimate this to be approximately 5 meters in height by 5 meters in width and 13 meters in length. The enclosure will be designed to have an inside temperature of 80 °F (27 °C), when the ambient temperature is 0 °F (-18 °C), via steam heating.

ENERGY SAVINGS CALCULATION

We estimate that the newly built inclosure will save an average of 5 metric tons/hr.

Annual Steam Savings	=	(5) (16) (260)	=	20,800 metric tons
Annual Savings (Local Price)	=	(3.40) (20,800)	=	$63,200
Annual Savings (Worldwide Price)	=	(5.00) (20,800)	=	$104,000
Yearly Energy Savings	=	(925) (20,800) (2,205)	=	42.4 billion Btu (44,800 GJ)

ECO-12 (continued)

44,800 x 1,000,000/34,267 = 1,307,000 m^3/yr

Estimated project cost:

$73,000

Simple Payback Local Energy Prices	=	Cost / Savings	=	73,000 / 63,200	=	1.2 years
Simple Payback Worldwide Prices	=	Cost / Savings	=	73,000 / 104,000	=	8.4 months

ECO-12 (continued)

Estimated project cost:

$73,000

Simple Payback Local Energy Prices	=	Cost Savings	=	73,000 63,200	=	1.2 years
Simple Payback Worldwide Prices	=	Cost Savings	=	73,000 104,000	=	8.4 months

ECO-13

Identify, Add or Replace Non-Operating Steam Traps.

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

The steam system nominally handles 150 metric tons per hour of steam, as produced by the operating boilers. Much of the steam is used in condensing services which should employ properly functioning steam traps. However, at present, many of the steam traps do not work properly. The plant uses various types steam traps which they now believe do not work efficiently.

DESCRIPTION OF PROPOSED MODIFICATIONS

It is recommended that the plant acquire approximately 100 new Inverted Bucket type steam traps. This will cover the steam traps that currently do not work.

ENERGY SAVINGS CALCULATION

We conservatively estimate that the new installation of 100 steam traps will properly condense and recover 20% of the current steam load or 30 metric tons/hr.

Annual Steam Savings	=	(30) (16) (260)	=	124,800 metric tons
Annual Savings (Local Price)	=	(3.04) (124,800)	=	$ 379,400
Annual Savings (Worldwide Price)	=	(4.00) (124,800)	=	$ 499,200
Yearly Energy Savings	=	(925) (124,800) (2,205)	=	254.5 billion Btu (268,500 GJ)
268,500 x 1,000,000/34,267			=	7,836,000 m^3/yr

ECO-13 (continued)

Estimated project Cost to Purchase and Install 150 Steam Traps:

$ 71,700

Simple Payback Local Energy Prices	=	Cost / Savings	=	(71,700) (12) / 379,400	=	2.3 months
Simple Payback Worldwide Prices	=	Cost / Savings	=	(71,700) (12) / 499,200	=	1.7 months

ECO-14

Collect Additional Condensate and Recycle to Boilerhouse.

At present, only 20% of the condensate produced in the plant is recovered and the remainder goes to the sewer as hot water. In terms of flow quantities, of the 150 metric tons per hour ton of steam that is produced by the boilers, 30 metric tons per hour is recovered as condensate and 120 metric tons per hour is lost.

DESCRIPTION OF PROPOSED MODIFICATIONS

Of the 120 metric tons per hour that is lost, some of it is not condensed and thus can not be recovered. We will assume that it is possible to recover an additional 45 metric tons per hour. This will give us a total recovery of 50% or 75 metric tons per hour.

In addition to some new piping, the new equipment that would be needed is the following:

- Condensate Collection Drum
- Condensate Pump and Spare
- Vent Condenser

ENERGY SAVINGS CALCULATION

45 metric tons per hour of condensate recovered would represent the following annual savings:

$$(45)\ (16)\ (260) = 187{,}200 \text{ metric tons/year}$$

Condensate is typically valued at 10% of the steam price. This corresponds to:

Local Condensate Price	=	(0.1) (3.04)	= 0.30 $/metric ton
Worldwide Condensate Price	=	(0.1) (4.00)	= 0.40 $/1000 lbs.
Annual Savings (Local Price)	=	(0.30) (187,200)	= $ 56,200
Annual Savings (Worldwide Price)	=	(0.40) (187,200) $\frac{(2{,}205)}{1{,}000}$	= $ 165,100
Yearly Energy Savings	=	(10%) (925) (187,200) (2,205)	= 38.2 billion Btu (40,300 GJ)

ECO-14 (continued)

40,300 x 1,000,000/34,267 = 1,176,000 m^3/yr

Estimated Project Cost to Purchase and Install System:

$ 282,000

Simple Payback Local Energy Prices	=	Cost / Savings	=	282,000 / 56,300	= 5.0 years
Simple Payback Worldwide Prices	=	Cost / Savings	=	282,000 / 165,100	= 1.7 years

ECO-15

Install capacitors to improve power factor of fiberboard plant.

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

When taking electrical measurements of the fiberboard plant, it was observed that the power factor was very low, in the order of 0.66 to 0.73. The plant was not aware of this problem, because the permanently installed power factor meter did not operate properly, always read 0.98. Most likely the low power factor is the result of the on and off operation of the eight (8) wood grinding machines. This low power factor needs to be improved by the addition of capacitors.

DESCRIPTION OF PROPOSED MODIFICATIONS

Our calculations have shown that the power factor in the fiberboard plant can be significantly improved from its current average valve of approximately 0.7 to a value of approximately 0.90 through the addition of 1,100 KVAR of capacitors.

ENERGY SAVINGS CALCULATION

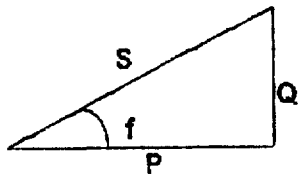
		17.03.95	10:22		
P	=	1822	KW	For PF = 1.0	For PF = 0.9
Q	=	2075	KVAR	add. Q = 2075KVAR	add Q = 1193KVAR
S	=	2762	KVA		
PF	=	0.66			

		17.03.95	10:29		
P	=	1814	KW	For PF = 1.0	For PF = 0.9
Q	=	1959	KVAR	add. Q = 1959KVAR	add Q = 1080KVAR
S	=	2670	KVA		
PF	=	0.68			

ECO-15 (continued)

		17.03.95	10:44		
P	=	2242	KW	For PF = 1.0	For PF = 0.9
Q	=	2078	KVAR	add. Q = 2078KVAR	add Q = 992KVAR
S	=	3057	KVA		
PF	=	0.73			

Calculation were provided by formula addQ = Q - P *TAN(ACOS(0.9))



PF=COS(f)

Additional capacitors to be added are 1100 KVAR.

The worldwide cost of reactive power is $0.006/KVARH

The local cost of reactive power is $0.00068/KVARH

1,100x260x16x0.006	=	$ 27,500 per year, worldwide cost
1,100x260x16x0.00068	=	$ 3,100 per year, local cost

1,100 KVAC arranged in a bank of 11 x 100 KVAC units, is estimated as $24,100 installed. The payoff period is 7.8 years based on local costs and 0.9 years based on worldwide costs.

The annual energy savings is 4.6 million KVAR.

This ECO is moderately attractive.

B \ECO15 BMP

BASIS OF ESTIMATED INVESTMENT COSTS

The following forms the basis of the estimated Investment Costs contained in this section:

- Current day instant execution philosophy with no forward escalation.
- Normal 40-hour work week with no premium time. Construction assumed to be performed by plant personnel.
- Contingency has not been included.
- Costs have been adjusted to reflect the Ukraine location. It is assumed that the rate of currency exchange is negating the effect of local inflation.
- These estimates have an accuracy of ±30%.

Please note the following qualifications regarding, ECO-12.

- It is assumed that all utilities will be provided to the building by others.

- It has been assumed that the railroad track will have to be removed during the construction.

APPENDIX "B"

Photographs of Facility and Equipment

List of Photographs:

1. Entrance to Plant

2. Display of Products

3. Exit of Mineral Wool Furnace

4. Mineral Wool Production (Packaging)

5. Bacharach Portable Combustion Analyzer

6. Stack From Mineral Wool Furnace

7. Boiler Instrument Panel

8. Boiler Burners

9. Burner Peephole Looking Into Boiler Firebox

10. Boiler House Stack

11. Electrical Measurements at Substation Using Dranetz Electrical Analyzer

12. Electrical Measurements at Substation

13. Production of Linoleum

14. Production of Linoleum and Its Backing

15. Bitumen Unloading From Railroad Cars

16. Bitumen Area Steam Leaks

17. Steam Vent From Dirty Condensate Receiver

18. Uninsulated Bitumen Storage Tanks

19. Air Compressors

20. Air Compressor

21. Stockpile of Wood For Fiber Board Production

22. Ground Wood Slurry For Fiber Board Production

List of Photographs: (continued)

23. Fiber Board Processing Machine

24. Cutting of Fiber Board With Water Jet Cutter

25. Fiber Board

26. Energy Conservation Sign in Russian

27. Storage of Completed Concrete Pipe

28. Presentation of Findings to Plant Management

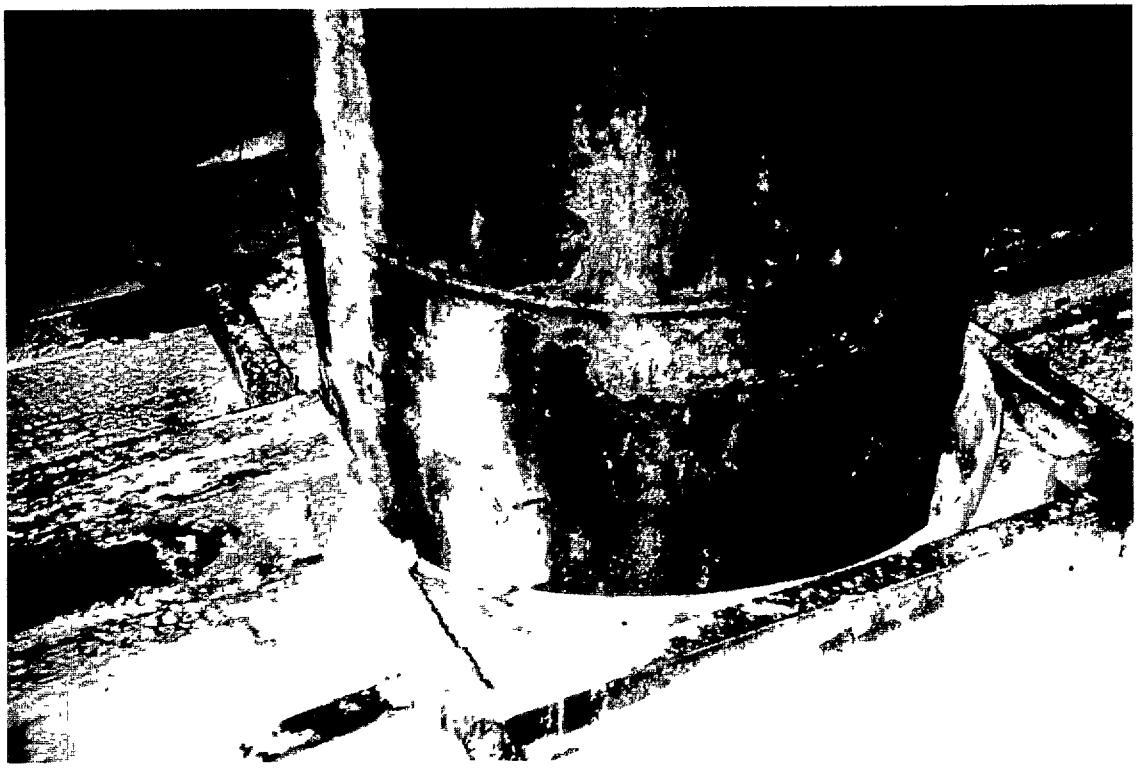
1. Entrance to Plant

2 Display of Products

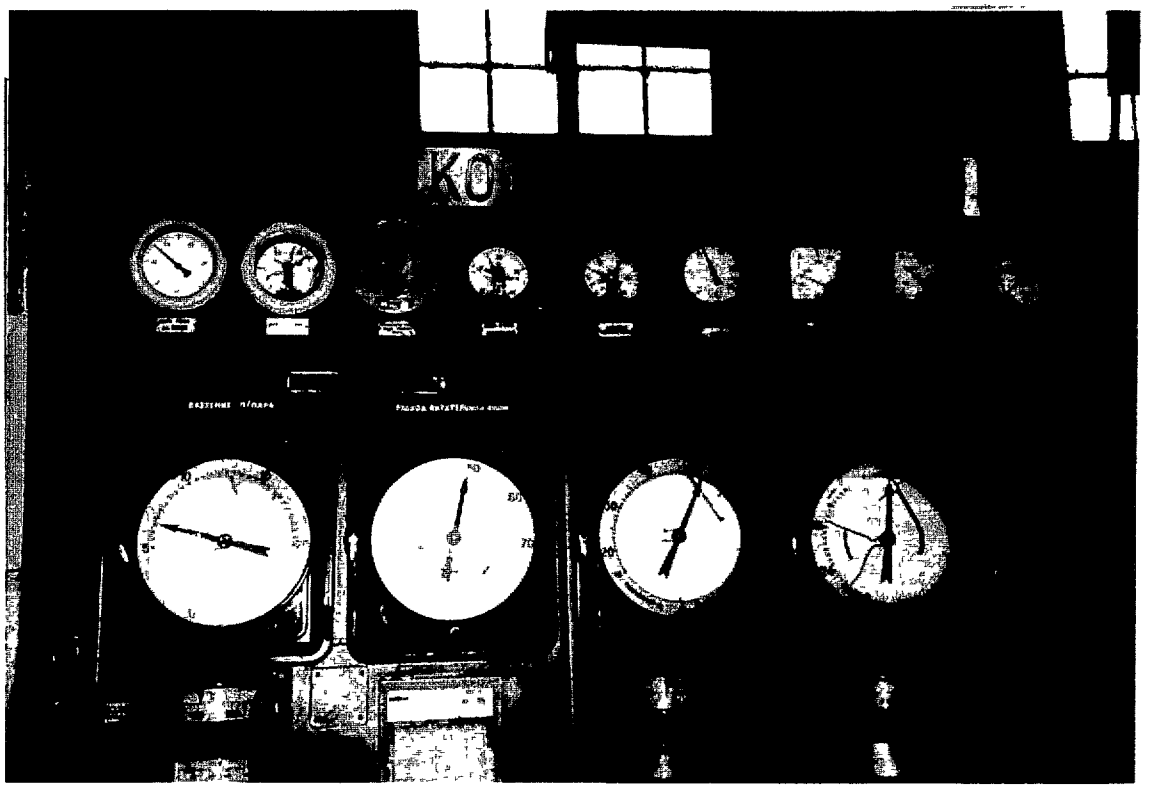
3. Exit of Mineral Wool Furnace

4 Mineral Wool Production (Packaging)

5. Bacharach Portable Combustion Analyzer



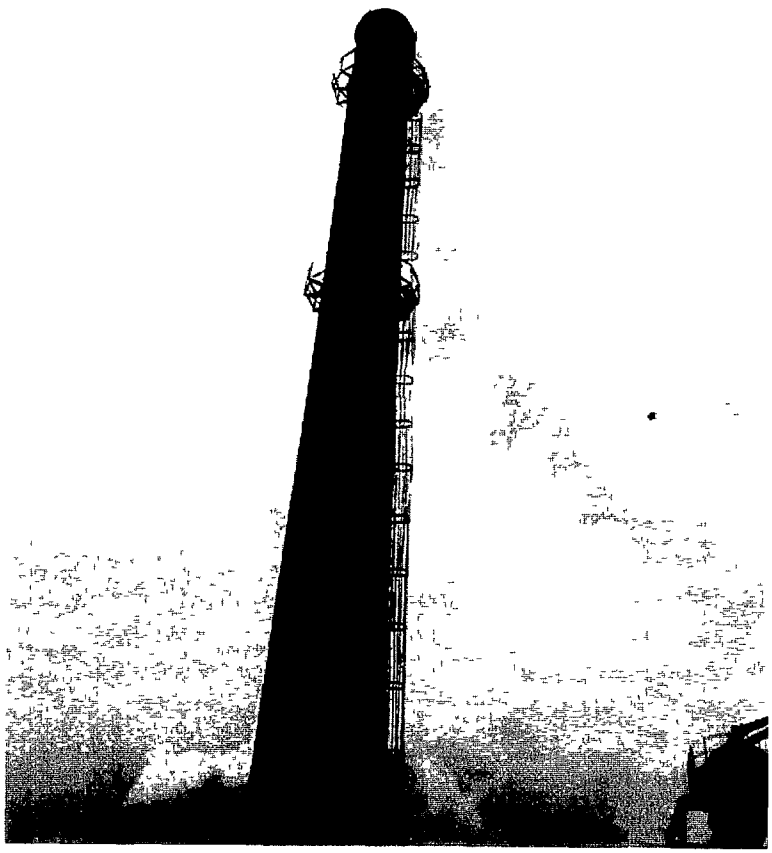
6 Stack From Mineral Wool Furnace



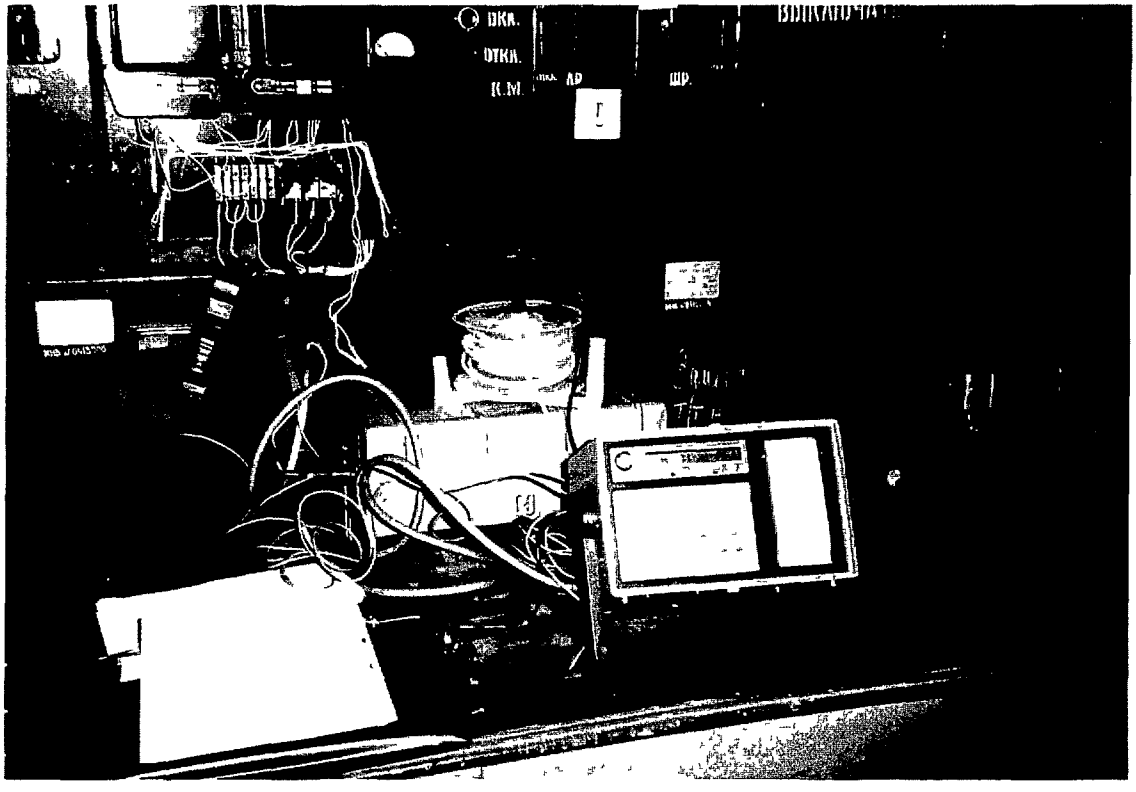
7. Boiler Instrument Panel

8 Boiler Burners

9 Burner Peephole Looking Into Boiler Firebox

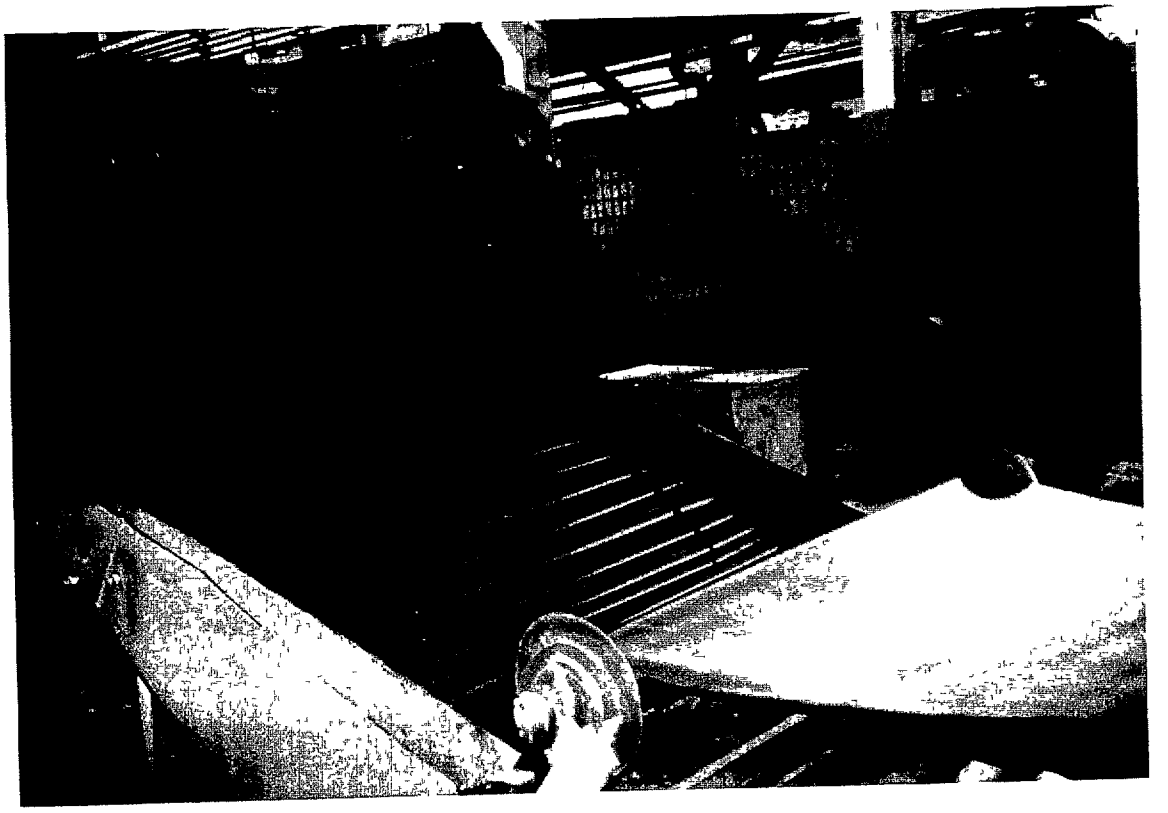


10. Boiler House Stack

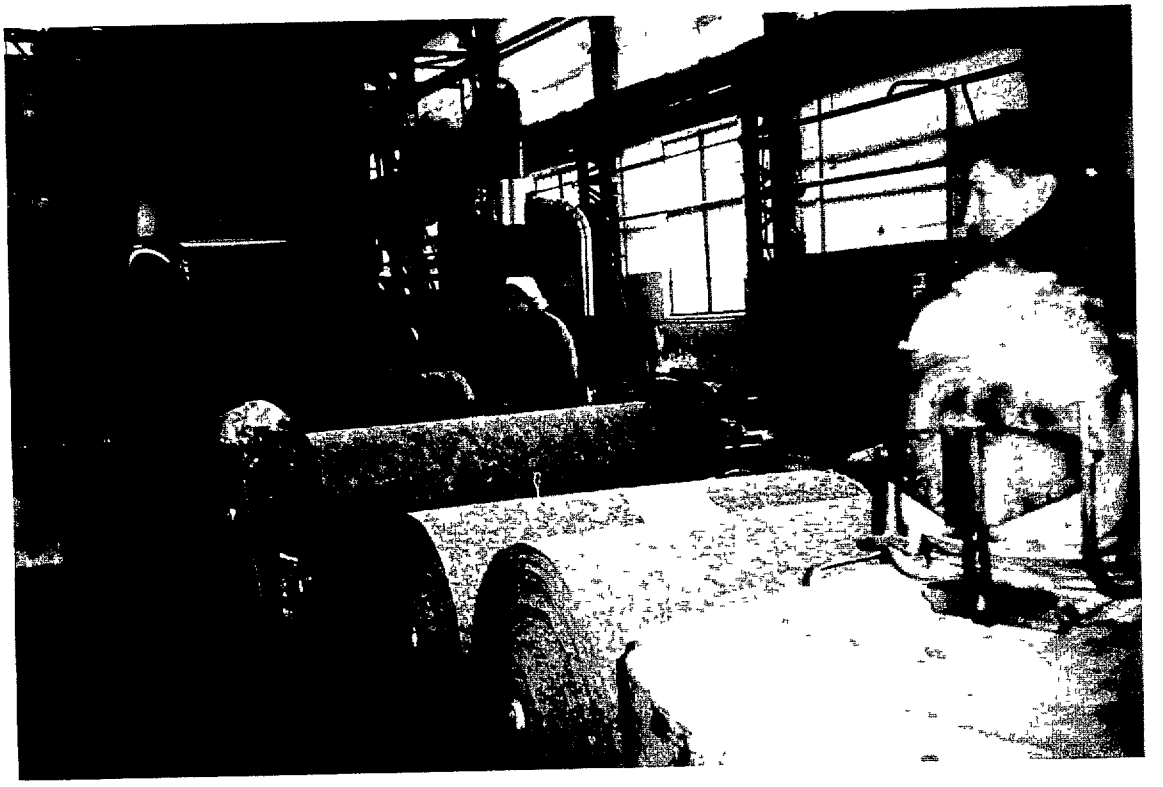


11. Electrical Measurements at Substation Using Dranetz Electrical Analyzer

12 Electrical Measurements at Substation

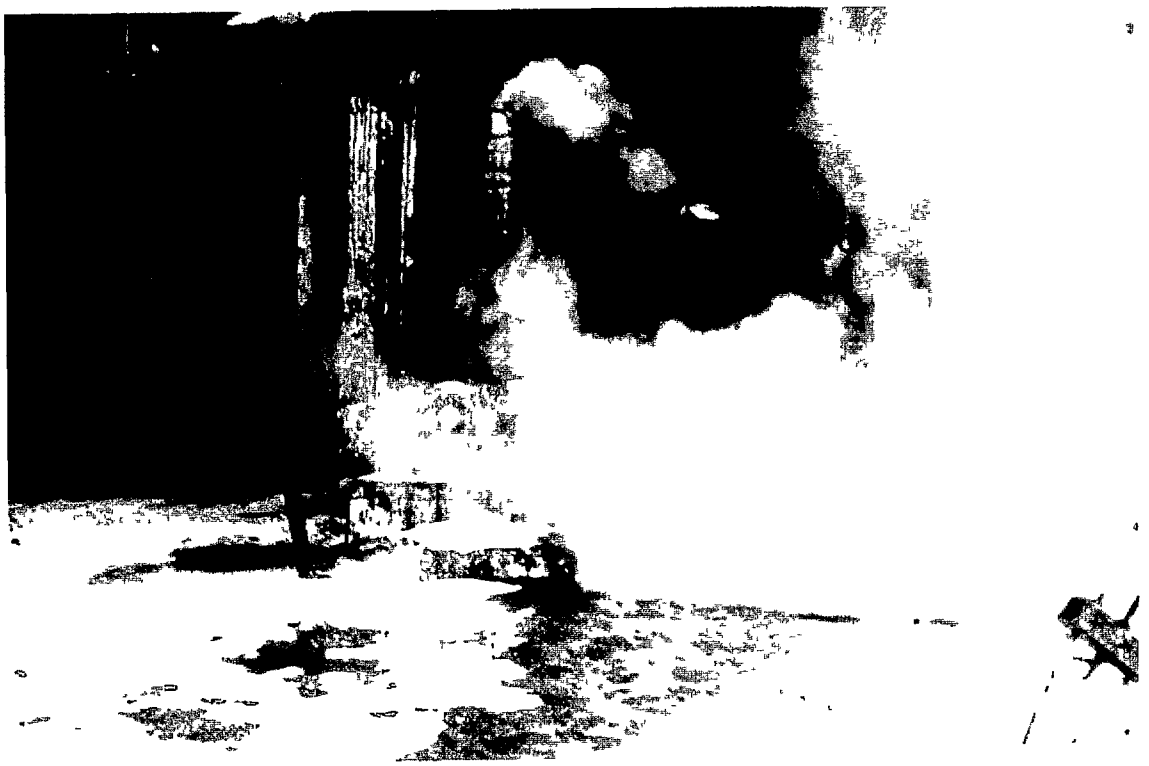


13. Production of Linoleum



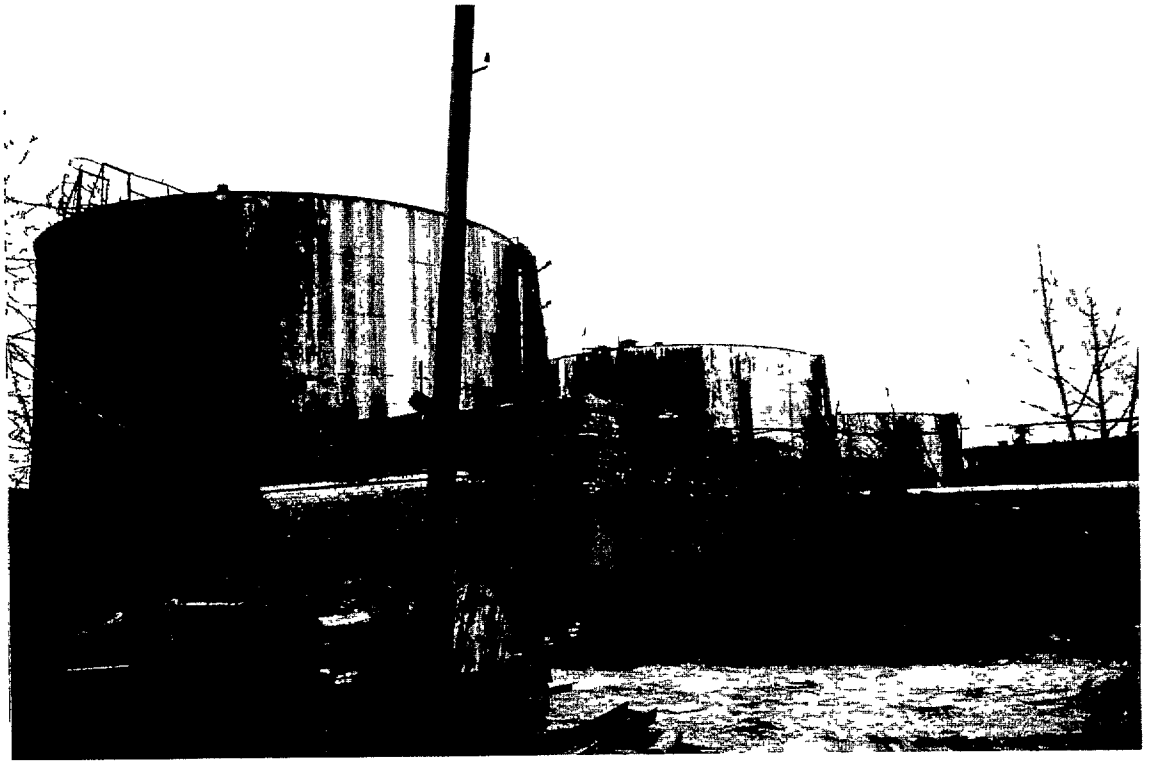
14. Production of Linoleum and Its Backing

15. Bitumen Unloading From Railroad Cars



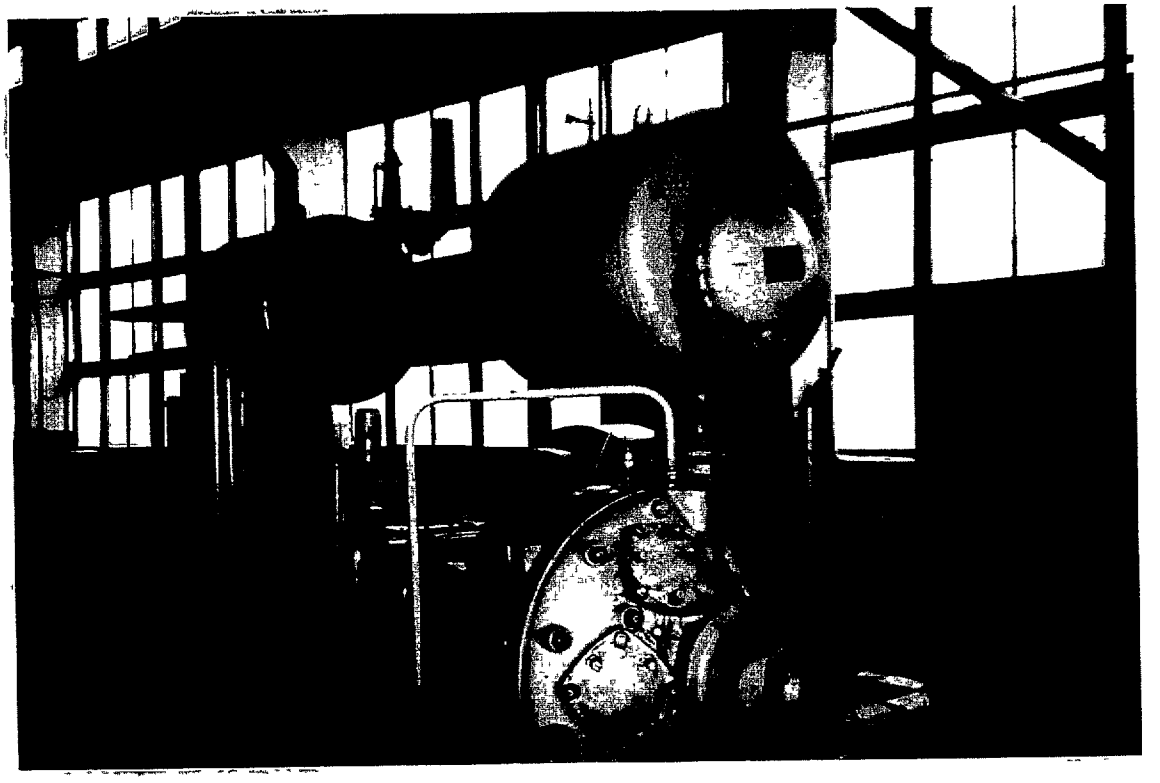
16. Bitumen Area Steam Leaks

17. Steam Vent From Dirty Condensate Receiver

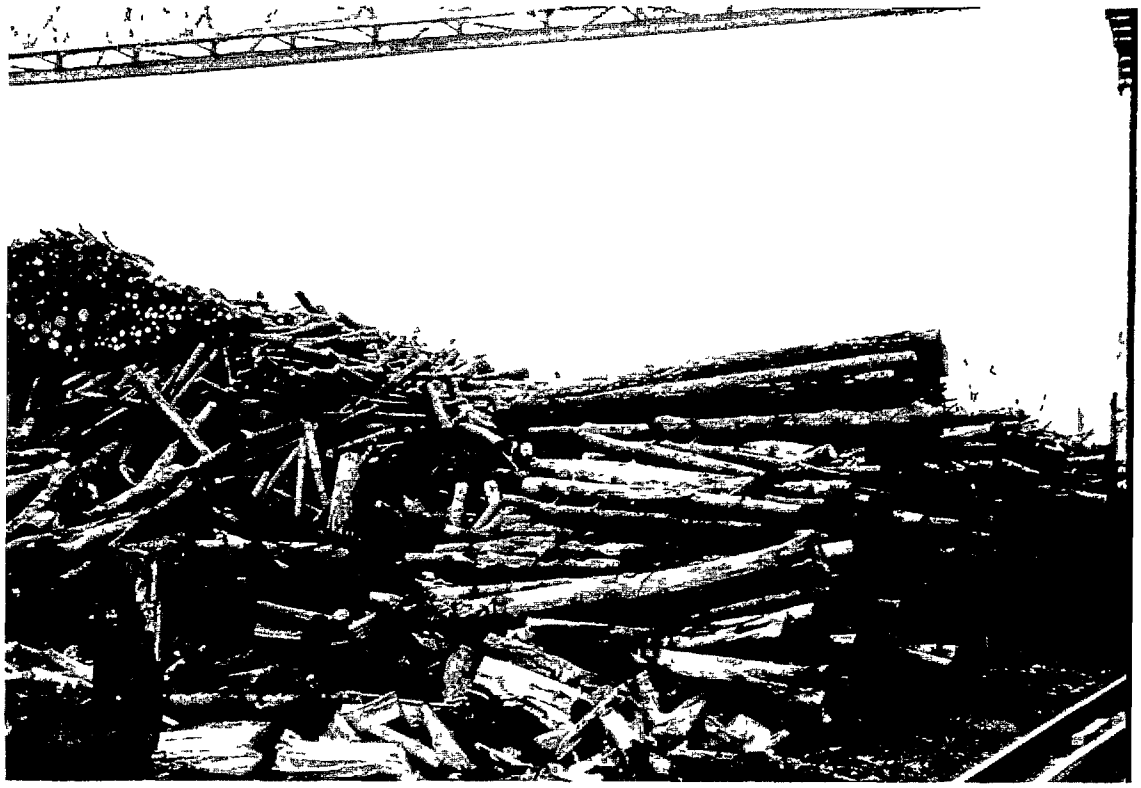


18. Uninsulated Bitumen Storage Tanks

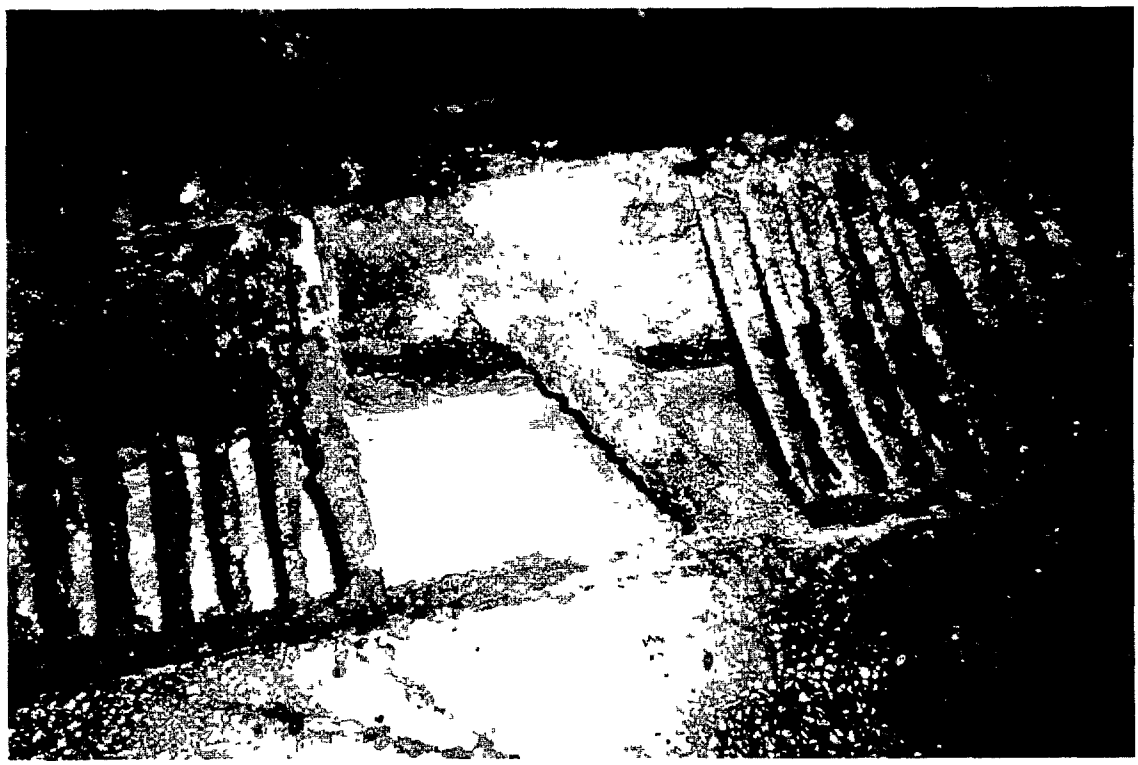
19 Air Compressors



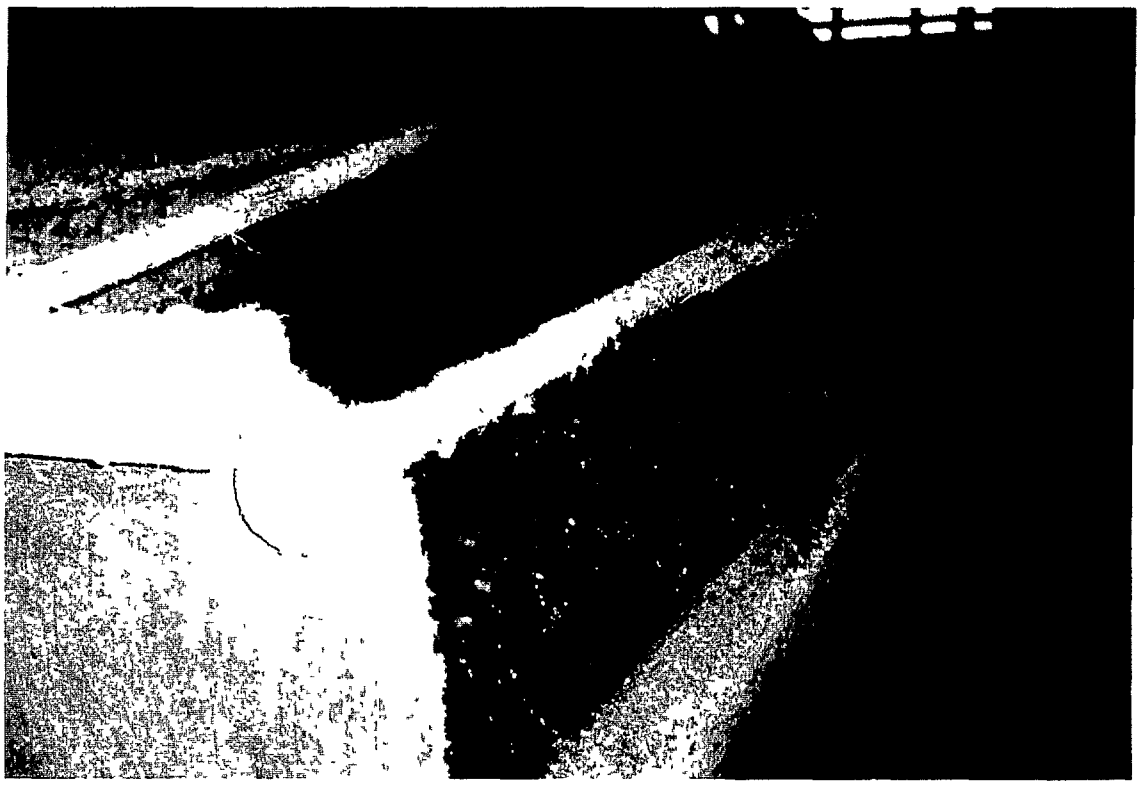
20. Air Compressor



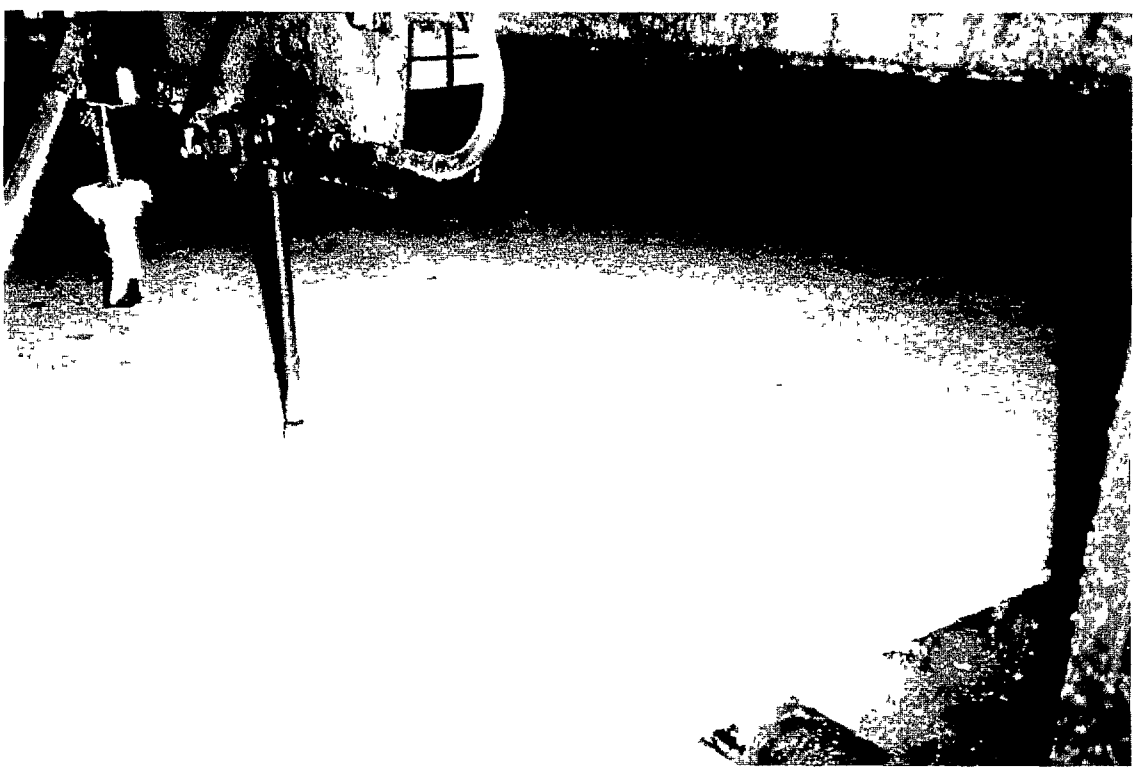
21. Stockpile of Wood For Fiber Board Production



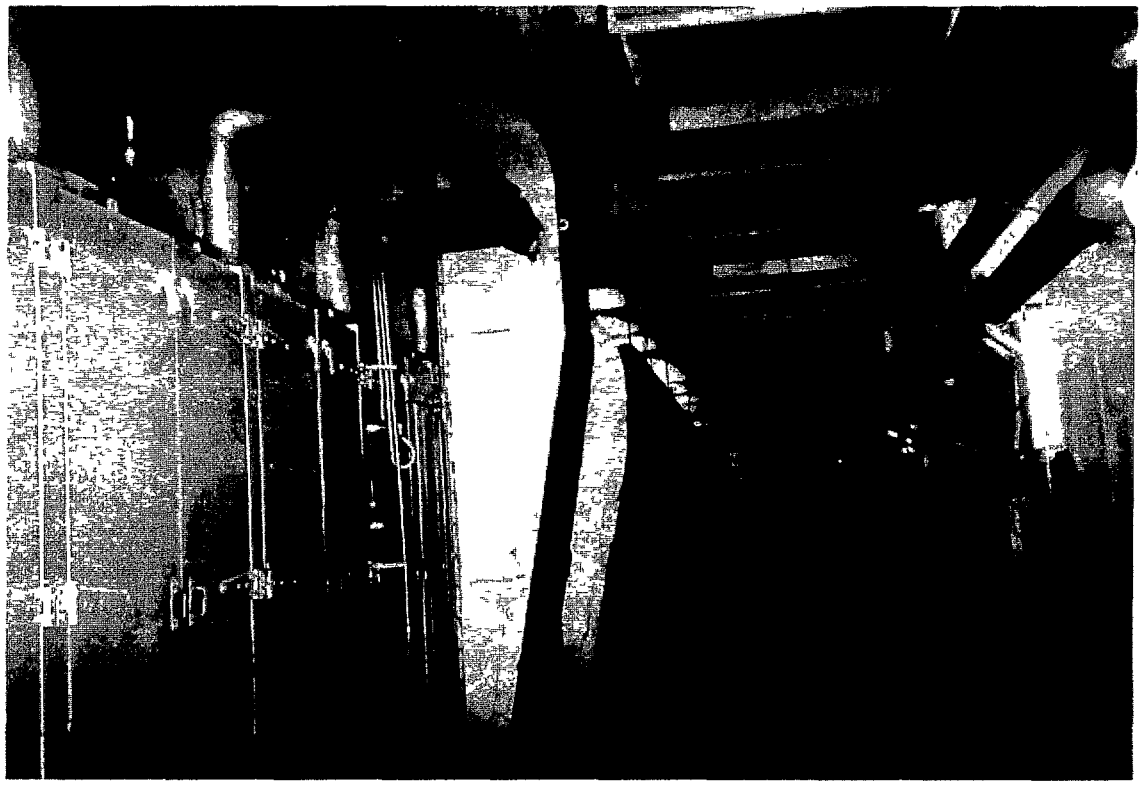
22 Ground Wood Slurry For Fiber Board Production



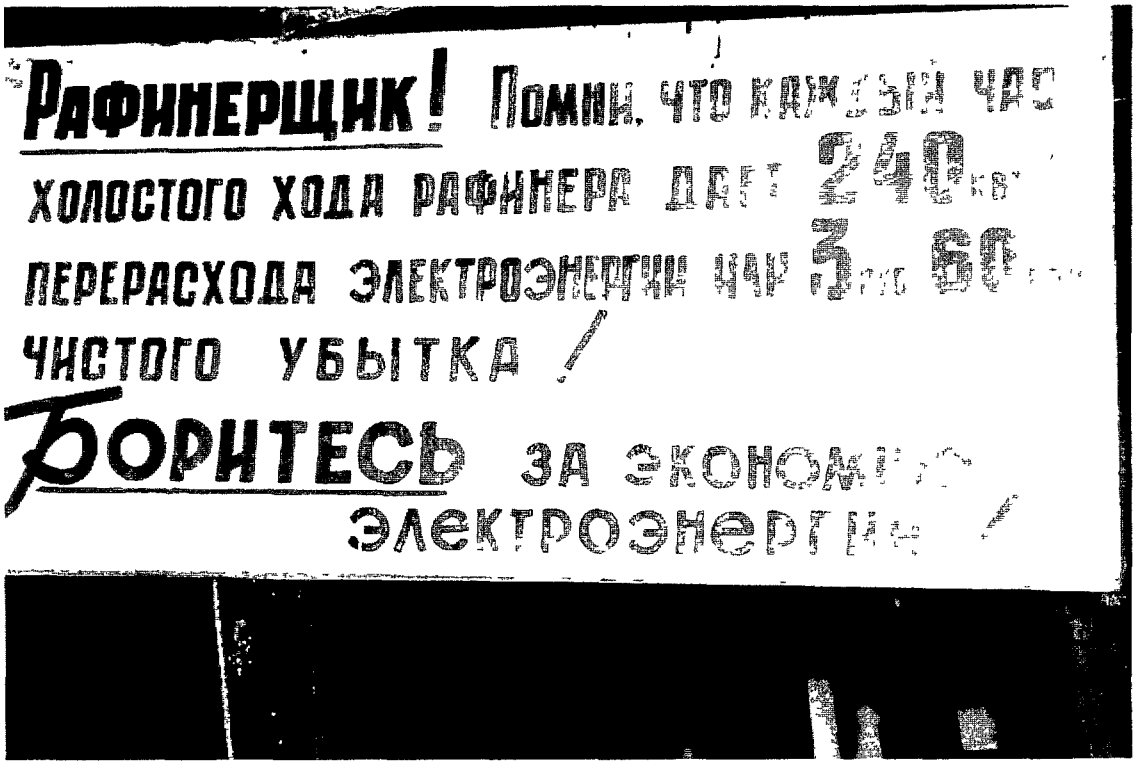
23. Fiber Board Processing Machine



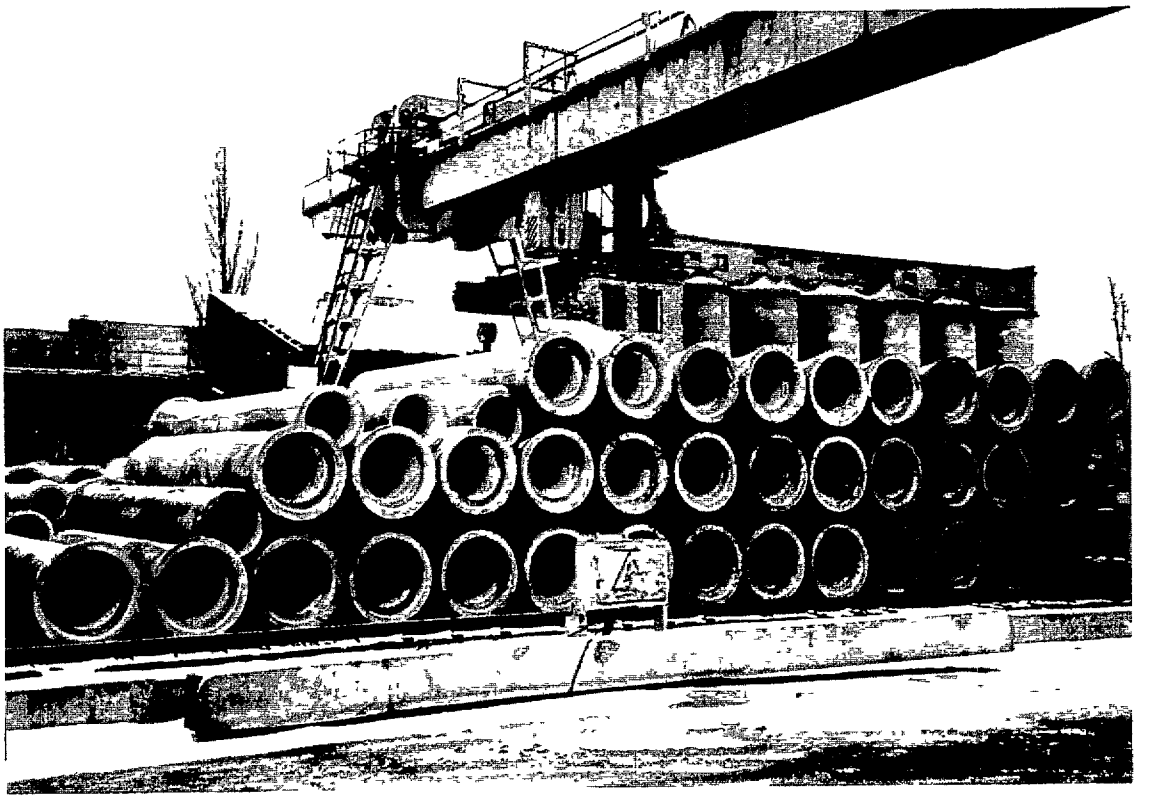
24 Cutting of Fiber Board With Water Jet Cutter



25. Fiber Board Drier



26 Energy Conservation Sign In Russian



27 Storage of Completed Concrete Pipe

28 Presentation of Findings to Plant Management

APPENDIX "C"

Plant Energy Consumption History

TABLE # "C-1" ELECTRICITY CONSUMPTION

Year 1994	Electricity Consumption in kWh		Electrical Demand in kW		Electrical Reactive in rkVAh		Electrical Average Cost	
	USAGE	COST (Thousands of Ukrainian Coupons)	USAGE	COST (Thousands of Ukrainian Coupons)	USAGE	COST (Thousands of Ukrainian Coupons)	TOTAL COST PER 1000 kWh USAGE	TOTAL COST (Thousands of Ukrainian Coupons)
January	1,536,346	436,634 1	9,000	219,919 8	100,540	10,617 7	434	667,171 6
February	896,645	269,436.3	9,000	270,000	44,860	10,022 6	613	549,458 9
March	1,286,086	386,392 4	9,000	270,000	165,160	13,384 5	521	669,776.9
April	1,391,659	417,849 8	9,000	270,000	262,660	11,369 0	502	699,218 8
May	1,054,795	316,653 9	9,000	270,000	19,120	9,970 7	566	596,624.6
June	1,459,324	438,260 0	9,000	270,000	336,720	12,331 8	494	720,591 8
July	1,164,078	349,671 8	9,000	270,000	226,600	11,165 4	542	630,837.2
August	1,480,554	444,526	9,000	270,000	477,180	14,423 0	492	728,949 0
September	1,727,286	829,754	9,000	450,000	606,360	26,874 8	756	1,306,628 6
October	1,957,529	1,347,187 2	9,000	653,225 2	488,440	53,737 3	1,049	2,054,150.3
November	1,955,955	3,700,564 2	9,000	1,980,000	630,700	122,932 0	2,967	5,803,496 2
December	2,162,750	5,490,192	9,000	2,711,961 3	437,040	143,556 1	3,859	8,345,709 4
Annual Totals	18,073,007	14,427,121 7	-	7,905,106 9	3,815,380	440,384 9	1,260	22,772,613.5

TABLE # "C-2" NATURAL GAS CONSUMPTION

Year 1994	Natural Gas Consumption in cubic meters	
	USAGE	COST (Thousand of Ukrainian Coupons)
January	4,943,925	2,215,155
February	4,535,553	2,936,004
March	4,211,667	2,764,403
April	3,287,138	2,130,938
May	2,057,553	1,300,949
June	2,086,798	1,319,434
July	2,101,216	1,350,661
August	2,722,982	1,746,929
September	2,994,529	2,536,665
October	3,956,377	3,360,151
November	5,497,610	18,448,879
December	5,554,883	20,253,103
Annual Costs	43,950,231	60,363,331

B \TBLEC1&2 BMP

TABLE "C-3" PRODUCTION OF BUILDING MATERIALS

Year 1994	Mineral Wool, Meters^3	Roof Covering Materials Plant			Linoleum Plant			
		Tar Paper, Thousand Meters^2	Tar Paper Intermediate, Thousand Meters^2	Cardboard Paper, Tons	Linoleum, Thousand Meters^2	Linoleum with Wool Lining, Thousand Meters^2		Mastic, Tons
Jan	3,980	269 5	96 8	139 2	35 8	114 8	24 0	10 2
Feb	2,274	-	79 4	-	22.5	16 8	30 0	12.0
Mar	4,478	674 6	84.2	568 6	48 5	85 0	61 0	20 0
Apr	4,000	783	140	554	22.0	110 0	7.7	16 0
May	3,034	330 2	46 3	159.3	32.3	81 9	30.3	18 0
June	5,178	670 9	159 0	855 4	46 0	147 0	25 8	29 0
July	1,133	1,127 9	74 7	551 7	37 9	94 5	39.3	29.0
Aug	2,850	1,339 8	123 4	817 5	41.4	107 7	35 4	20.5
Sept	5,550	2,071 1	139 8	928 4	48 0	140 0	45 0	42.0
Oct	5,400	1,204 8	202.7	559.7	39.5	149 0	49 0	24 5
Nov	5,568	1,647 2	203 9	715 6	34.0	96 3	44 7	37.5
Dec	5,849	1,421 7	167 4	541 6	48 0	13 0	45 0	35
Annual Totals	49,294	11,540 7	1,517 6	6,391 0	455 9	1273 0	437.2	293.7

TABLE "C-4" PRODUCTION OF BUILDING MATERIALS

Year 1994	Fiber Board, Thousand Meters^2	Concrete Pipes and Parts						
		600 mm Pipe, No. of Items	800 mm Pipe, No. of Items	1000 mm Pipe, No. of Items	1200 mm Pipe, No. of Items	1400 mm Pipe, No. of Items	Concrete Panels, No. of Items	Concrete Foundation Blocks, No. of Items
January	51	311	-	113	-	-	553	238
February	19	251	88	110	36	31	312	-
March	68	389	52	110	58	85	199	447
April	32	281	62	101	116	194	412	418
May	30	26	52	38	19	40	102	66
June	63	445	168	169	-	228	485	386
July	43	517	40	15	128	215	518	589
August	68	333	16	1	97	94	646	743
September	110	32	151	57	23	-	909	978
October	88	322	124	64	43	59	879	834
November	66	406	145	87	58	54	1,073	957
December	85	319	155	68	40	33	763	785
Annual Totals	723	3,632	1,053	933	618	1,033	6,851	6,441

APPENDIX "D"

World and Local Energy Prices

LOCAL ENERGY PRICES

Note: One Dollar Currently Equals 148,000 Ukrainian Coupons.

Electricity Consumption in kWH Cost in US $	Electrical Demand in kW Cost in US $	Electrical Reactive in rkVAh Cost in US $
0.0155 for 10,000 volts	1.88	0.0017 if limit exceeded
0.0159 for 380 volts		0.00068 if limit not exceeded

Natural Gas Consumption in 1,000 Cubic Meters Cost in US $
80.00*

* Includes recently imposed tax of approximately $ 15.00 per 1000 cubic meters.

PROPOSED
by Deputy Minister of Energy and Electrification
O M Sheberstov

APPROVED
by Deputy Ministry of Economics
V M Kalnik

TARIFFS

on Electricity Generated by Energy Enterprises under the Ministry of Energy of Ukraine

Valid from August 25, 1994

Energy Enterprises	Two -part tariffs		One-part tariffs, karb/kW h					
	Demand charge per 1 kW karb per month	Charge for 1 kW h of consumed electricity Karb	Industry or treated similarly consumers of the current up to 750 kVA Group 2	Food-processing industry Group 4	Electrified rail road transportation Group 5	Electrified local transportation Group 6	Non-industrial consumers Group 7	State establishments
1 VinitskEnergo	240,000	1500	2000	1300	1800	1800	1800	1200
2 DneprEnergo	125,000	1000	1300	1200	1800	1800	1800	1100
3 DonbassEnergo	125,000	900	1300	1200	1800	1800	1800	1100
4 KievEnergo	150,000	1400	1800	1400	1800	1800	1800	1300
5 CrimeaEnergo	240,000	1900	2200	1400	1800	1800	1800	1300
6 LvivEnergo	240,000	1400	1800	1400	1800	1800	1800	1300
7 OdessaEnergo	240,000	1400	1900	1300	1800	1800	1800	1200
8 KharkivEnergo	125,000*	1200*	1500*	1300*	1800*	1800*	1800*	1200

*The ecological supercharge of 5 % have to be added to these tariffs

Notes 1 The existing rules on settling of energy purchases are valid

2 The tariffs for electricity consumed by the district heating system, and domestic hot water system are
750 karb/kW h -- during the time of low night consumption
3490 karb/kW h -- during any other hours

3 The limits for monthly electricity consumption by consumers are canceled

Director of the department of prices
on the production of enterprises of energy, chemical,
metallurgical, and construction materials industry

O I Gridasov

STRUCTURE OF THE ELECTRICITY CONSUMPTION
IN THE CITY OF KIEV PER SEPTEMBER 1994

	Millions kW h	%	
Gross Consumption	477 5	100	
Losses	91 7	19 2	
Net Consumption	385 8	80 8	
including			
1 Industry, total	129 4	27 1 (from gross), 33 5 (from net)	
out of it			
"Controlled"	116 6	24 4	30 2
Motorcycle Plant	1 8		
Machine Construction Plant	1 8		
Industrial Enterprise "Bolshevik"	1 5		
Plant "Traktordetal" (Tractor's Part)	6 3		
Industrial Enterprise "Khimvolokno" (Chemical Fiber)	10 4		
Industrial Enterprise named after Korolev	0 6		
Chemical and Pharmacy Enterprise	0.6		
Engineering Machine Plant	0.5		
"Non-controlled"	12 6	2.6	3.3
2 Construction	9 5	2.0	2 5
3 Non-Industrial Consumers	146 4	30 7	37.9
out of it			
Service Sector	104 9		
Transportation	36 9		
State Establishments, Military Units, Universities	10 6		
4 Population	100 5	21 0	26.1

PROPOSED by
Deputy Minister of Energy
and Electrification
O M Sheberstov

APPROVED by
Deputy Ministry of
Economics
V M Kalnik

TARIFFS
on Thermal Energy Generated by
Energy Enterprise of Ministry of Energy of Ukraine

Valid from August 25, 1994
Karbovants per Gcal

Energy Enterprises	Industrial or considering Equal to Industry Sectors (not shown into the other Groups) Group 1	Residential Enterprises, small industrial and commercial enterprises Group 2	Greenhouses, hotbeds, Agriculture Group 3
1 VinitskEnergo	639,800	95,000	397,500
2 DneprEnergo	1,433,200	95,000	556,500
3. DonbassEnergo	678,000	95,000	397,500
4 KievEnergo	1,123,900	95,000	556,500
5. CrimeaEnergo	1,552,500	95,000	556,500
6 LvivEnergo	510,200	95,000	420,000
7 OdessaEnergo	1,643,400	95,000	556,500
8 KharkivEnergo	1,274,100	95,000	397,500

Notes 1 The existing rules on settling of energy purchases are valid
2 Value added taxes are not included in these tariffs
3 The tariffs introduced from March 1, 1994 are canceled with the introduction of new ones

Director of the department
of prices on the production of enterprises
of energy, chemical, metallurgical, and
construction materials industry

O I. Gridasov

June 2 1994

ENERGY PRICE UPDATE

End-use energy prices for OECD Europe

Source OECD, third quater 1993, IEA Statisitics, Energy Prices and Taxes

	units		year of price estimate
Gasoline	$US/liter	0 988	1992
	$US/toe	1220 5	1992
Diesel Fuel	$US/liter	0 623	1992
	$US/toe	712	1992
Light Fuel Oil	$US/1000 liter	312 46	1992
for industry	$US/toe	363 2	1992
Light Fuel Oil	$US/1000 liter	401 27	1992
for households	$US/toe	468 3	1992
Heavy Fuel Oil	$US/1000 liter	151 08	1992
for industry	$US/toe	156 5	1992
Electricity	$US/kWh	0 076	1991
for industry	$US/toe	887	1991
Electricity	$US/kWh	0 138	1991
for households	$US/toe	1607 7	1991

	units		year of price estimate
Heavy Fuel Oil	$US/1000 liter	137 43	1991
for utilities	$US/toe	143 2	1991
Natural gas	$US/10^7 kcal	170 54	1991
for industry	$US/toe	189 5	1991
Natural gas	$US/10^7 kcal	145 48	1991
for utilities	$US/toe	161 6	1991
Natural gas	$US/10^7 kcal	490 7	1992
for households	$US/toe	545 2	1992
Steam Coal	$US/tonne	103 41	1991
for industry	$US/toe	154 3	1991
Steam Coal	$US/tonne	80 2	1991
for utilities	$US/toe	137 3	1991

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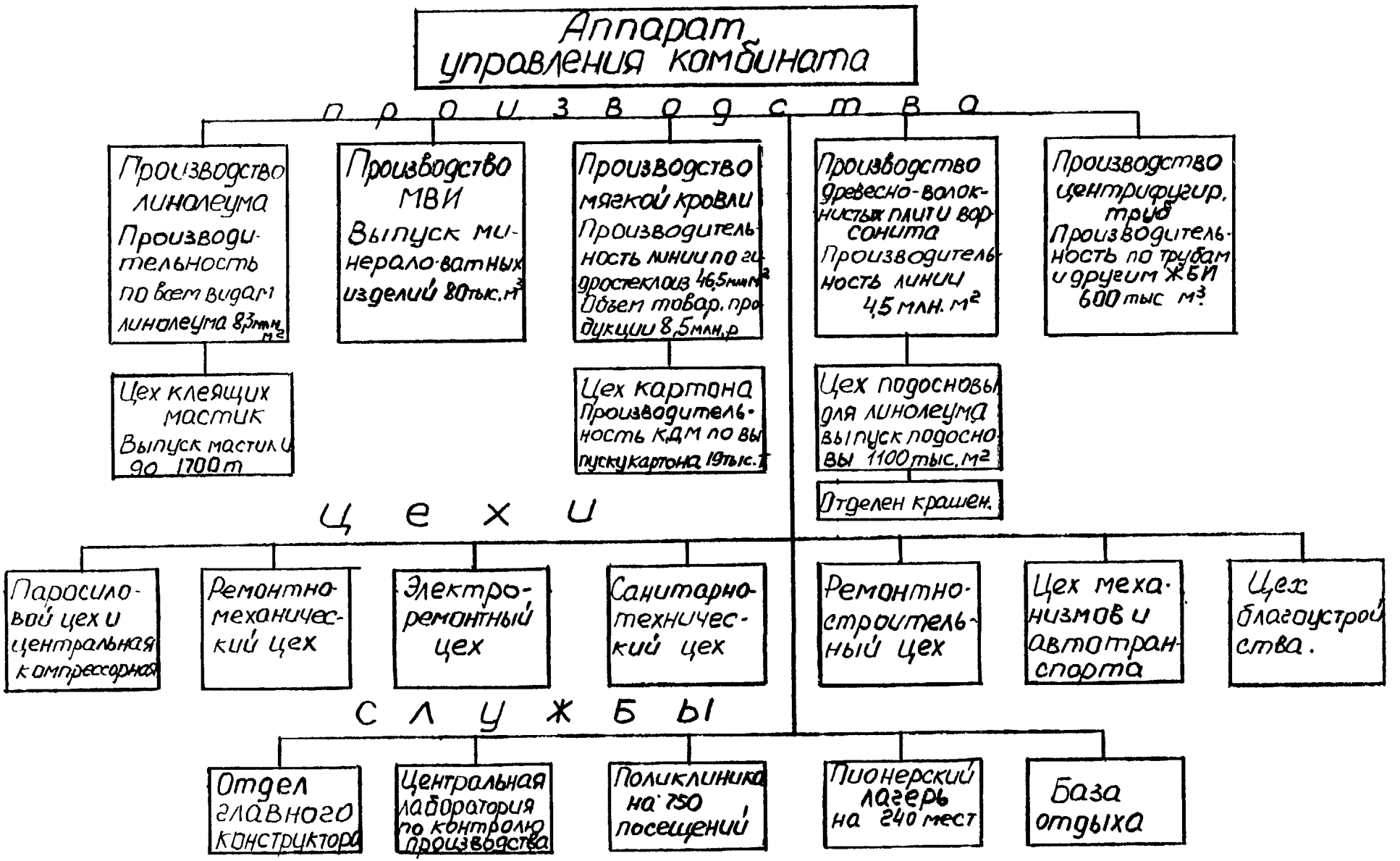
APPENDIX "E"

Organization Chart

Производственно организационная структура Киевского комбината стройиндустрии



Management structure of the Kiev Kombinat Budindustrii

- Management
- Plants
  - Linoleum, 8,3 mln. m² — Mastic shop, 1700 ton
  - Mineral wool, 80 000 m³
  - Roof cover materials, 46 mln m² — Card board shop, 19 000 ton
  - Fiber board, 4,5 mln m² — Substrate for Linoleum 1100 000 m²
  - Concrete tile and parts, 600 000 m³
- Services
  - Chief designer department
  - Central laboratory for production control
  - Polyclinic
  - Health recovery camp for children
  - Resort base
- Shops
  - Steam-power (boiler and compressor)
  - Repair-mechanical
  - Electrical repair
  - Sanitary technical
  - Repair-construction
  - Machinary and autotransport
  - Territory handling

THIS PAGE IS AN ENGLISH TRANSLATION OF THE PRECEEDING PAGE

APPENDIX "F"

List of Contacts Made In Facility

CONTACTS MADE DURING SITE AUDIT

COMPANY NAME & PLANT ADDRESS

Strojindustria Building Materials Plant
Strojindustrii St., 7
252013, Kiev -13

KIEV TELEPHONE COUNTRY AND CITY CODE (7 044)

PLANT TELEPHONE - **PLANT FAX** -295-47-43

Anatoly Vladimirovich Guzik
Chief Engineer - Vice Director
Tel. - 295-47-45

Eduard Mikhailovich Dolgiy
Vice Director
Tel. - 295-40-08

Leonid Nikolaevich Sukhobrus
Chief Power Engineer
Tel. - 295-41-17

Vitaly Antonovich Sukhonosov
Chief Heat Engineer- Steam Power
Workshop Chief - Tel. - 295-40-08

Anton Prokofievich Reznichenko - Deputy Boiler Chief

From The Ukranian Academy of Sciences Gas Institute
Degtjarivska St., 39
252113, Kiev
Tel. (044) 446-00-34 Fax. (044) 446-88-30

Dr. Vladimir M. Olabin
Leader Senior Scientist of Thermal Layer Process Department

Alexander B. Maksimuk M.E.
Research Associate of Layer Processes

Local Engineer Peter G. Garkun
<<Kievenergo>>
Tel. 442-03-38
Fax. 443-05-08

APPENDIX "G"

Abbreviations and Units Conversions

AC	=	alternating current
amps	=	amperes
atm	=	atmosphere = 14.696 pounds per square inch
bar	=	100,000 pascals = 14.504 pounds per square inch
BTU	=	British thermal unit
cfm	=	cubic feet per minute
cm	=	centimeter = 0.3937 inches
cm^2	=	square centimeter = 0.155 square inches
CO	=	carbon monoxide
CO_2	=	carbon dioxide
DC	=	direct current
°C	=	degree Celsius T[°C] =(5/9)x(T[°F] - 32)
°F	=	degree Fahrenheit
°R	=	degrees Rankine T[°R] = T[°F] + 460
ECO	=	Energy Conservation Opportunity
eff	=	efficiency
ex air	=	excess air
ft^2	=	square feet
ft^3	=	cubic feet
Gcal	=	gigacalorie = 1 billion calories = 3.968 million BTU
GJ	=	gigajoules = 1 billion joules
gph	=	U.S. gallons per hour
gpm	=	U.S. gallons per minute
GWh	=	gigawatt hours = 1 billion watt hours
H_2	=	hydrogen
H_2O	=	water
H_2SO_4	=	sulfuric acid
hectare	=	10,000 square meters = 2.471 acres
hectoliter	=	100 liters = 26.42 U.S. gallons
Hg	=	mercury
hr	=	hour
Hz	=	hertz = cycles per second
J	=	joules
kcal	=	kilocalories = 1 thousand calories = 3.968 BTU
kg	=	kilogram - 2.2046 pounds
Kg_f	=	kilogram
Kgcc	=	7,000 kcal = 27,776 BTU
kJ	=	kilojoules = 1 thousand joules = 0.947813 BTU
km	=	kilometer = 0.621 miles
kN	=	Kilonewton = 1 thousand newtons
kPa	=	kilo pascals = 1 thousand pascals = 0.14504 pounds per square inch
kV	=	kilovolts = 1 thousand volts

kVA	=	kilovolt-amperes
kVAr	=	kilovars = 1 thousand volt-amperes (reactive)
kW	=	kilowatt = 1 thousand watts
kWh	=	kilowatt = 1 thousand watt hours
lbs	=	pounds
liter	=	0.2642 U.S. gallons = 0.03531 cubic feet
m	=	meter = 39.37 inches
m^2	=	square meter = 10.76 square feet
m^3	=	cubic meter = 35.31 cubic feet
mA	=	milliampere = 0.001 amperes
MCal	=	megacalorie = 1 million calories
metric ton	=	1 thousand kilograms = 1.1023 U.S. tons
mg	=	milligrams
min	=	minute
MJ	=	megajoules
MM	=	million
mm	=	millimeter = 0.03937 inches
MPa	=	1 million pascals = 145.04 pounds per square inch
MVA	=	megavolt-amperes
MW	=	megawatt = 1 million watts
MWh	=	megawatt hours = 1 million watt hours
NG	=	natural gas
nm	=	nanometer
Nm^3	=	cubic meters at standard conditions of temperature and pressure (20°C and 1 atmosphere)
NO_x	=	nitrogen oxide
O_2	=	oxygen
P	=	pressure
PC	=	personal computer
ppm	=	parts per million
psi	=	pounds per square inch
psig	=	pounds per square inch (gauge)
R	=	ruble
s	=	second
SO_2	=	sulfur dioxide
sq ft	=	square feet
Tcal	=	teracalorie = 1 trillion calories = 3.968 billion Btu
T	=	temperature
TPS	=	Thermal Power Station

V	=	volts
VA	=	volt-amps
VArs	=	volt-amps (reactive)
VSD	=	variable speed drive
yr	=	year

APPENDIX "H"

Proposal for Heat Recovery in Melting Furnace

Proposal for Heat Recovery in Melting Furnace

The following is a translation of a joint proposal from the Strojindustria Building Materials Plant (AP Kiev Construction Plant) and the National Academy of Sciences of Ukraine. The cost estimates in this proposal are used in ECO #11 to estimate cost of the heat recovery project to preheat the solid feed material.

Although the project includes an O_2 analyzer (#12) and a portable gas analyzer, Foster Wheeler does not consider this equipment to be critical to the project and has not included them as part of ECO #11.

For reference the O_2 analyzer estimated cost is $8,000 USD. The cost of the portable analyzer has been included in ECO #1.

Dear Mr. Osborn,

I would like to forward to you the materials, developed on the basis of the resolution of a meeting on 03/22/95, based on the results the assessment conducted under the USAID program on the efficiency of use of energy resources in the plant.

If necessary, we are ready to provide you with additional information on given materials.

Attachment :

1. The working plan on reduction of energy usage on smelting converter for fiberglass products manufacture 1 page (2 copies).

2. The list of equipment to be acquired and manufactured, necessary for reduction of energy usage on smelting converter MVI 2 pages (2 copies).

Sincerely,

A.V. Guzik
Technical Director of the plant

AP Kiev Construction Plant

The working plan on reduction of energy usage on smelting converter for fiberglass products manufacture.

#	Description of activity	Cost, US$	Financing organization	Executant	Dates for Completion
1	Design and engineering	18,000	Kiev Construction Plant (ККС - KCP)	Gas Institute, KCP	
2	Purchase of the equipment, including instruments	74,900	USAID	KCP	
3	Preparation of the facility for installation of the new equipment	7,000	KCP	- " -	
4	Installation of the equipment, expansion of the technological line	18,500	- " -	- " -	
5	Adjustment and operation	16,000	- " -	KCP, Gas Institute	
	Total of:	**134,400**	**of which KCP - $59,500, USAID - $74,900**		

Deputy Director of the plant O. M. Dolgiy

Leading Scientist of the Gas Institute
NASU (НАНУ) - National Academy of Sciences of Ukraine V.M. Olabin

The list of equipment to be acquired and manufactured, necessary for reduction of energy usage on smelting converter MVI.

#	Description of the hardware	Cost, US$	Overall Dimensions, mm	Material	
				Name	Weight, kg
1	Charge heater with exhaust bunker	18,000	3000x2000x3000	Stainless steel Steel #3 Refractory	1500 4000 2000
2	Charge dosage unit	5,500	1500x1000x1500	Stainless steel	900
3	Dust purification block / fallout chamber, battery of cyclones, Dust feed system - dust feed into furnace (melting tub)	3,300	2000x1500x2500	Steel #3	4500
4	Water-cooled assembly of the melting tub /panels/ 7 units	6,000	2000x16000x80	Steel #3	2400
5	Air heater	16,000	⌀ 2000x6000	Stainless steel Steel #3 Refractory	3500 4000 20000
6	Discharge unit	2,500	1200x1000x800	Stainless steel Steel #3 Refractory	100 500 1000
7	Smoke exhaust system	700			
8	Electric motor	800			
9	Conveyer	1000			
10	Scale /2 units/	800			
11	Charge heater and Smoke exhaust system automatic control components /pneumatic distribution valves, time relay, power supply block, thermocouple etc./	800			

The list of equipment to be acquired and manufactured,
necessary for reduction of energy usage on smelting converter MVI.

#	Description of the hardware	Cost, US$	Overall Dimensions, mm	Material	
				Name	Weight, kg
12	O_2 analyzer /stationary/				
13	Pyrometer (Пирометр) on temperature interval: 0 - 900^{0}C 900 - 2000^{0}C	20,000			
14	Portable gas analyzer (Gas detector) C_2, CO, O_2, H_2				

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