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Energy Efficiency and Power Sector Improvements for Russia
Task 1 - Energy Efficiency Activities

Draft Audit Report
MOSCOW OIL REFINERY

August 1994

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Prepared for

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Preface

The work described in this report is being carried out by Resource Management Associates of Madison, Inc (RMA), 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-Q-00-3154-00

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

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1 0 EXECUTIVE SUMMARY

During the week of April 25, 1994 an energy audit was performed at the Moscow Oil Refinery (MOR) located near Moscow in Kapotnia, Russia This energy audit was performed by Dr Bob Terrell and Mr Chuck Sasso, P E representing Resource Management Associates of Madison, Inc

The facility is a State-run company which refines crude oil into a variety of oil-based products Raw, crude oil is obtained via pipeline from the Central Asian republics Products made from this crude oil include gasoline, mazout fuel (residual fuel oil), diesel fuel, dry gases (such as butane and propane), other petroleum by-products (principally propylene gas, from which polypropylene and polypropylene goods are made), and asphalt The entire facility is spread over an area approximately 2 2 km by 1 5 km (1 3 miles by 0 9 mile) There are about 10 similar plants in Russia

In 1993, the oil refinery consumed 548 million kWh of electricity and 2 million Gcal of steam 90%-95% of all energy consumed by the refinery is used for production processes, the cost of this energy consumed accounts for 8%-10% of production costs Energy rates charged by Mosenergo are summarized in *Table 1*

The boiler and steam distribution systems in the refinery were examined, and three energy efficiency measures are being recommended for this facility These measures are

1) installation of an American automated boiler control system on one supplemental steam boiler to be constructed in 1995,

2) installation of steam traps on the drip legs of the main steam distribution system, and

3) installation of steam traps on a lateral steam line serving some residential and commercial facilities

The total savings estimated for all 3 measures is 14,187 Gcal/year with a resulting annual cost savings of $56,170/yr using local energy rates and $168,510/yr with world energy rates The total cost for all ECO's in this report is $72,100 The average simple payback period for the 3 measures is 1 28 years at local energy costs and 0 43 years with world energy costs A summary of the Energy Conservation Opportunities (ECO's) are shown in *Table 2*

The overall impression of the auditors is that Moscow Oil Refinery has at best, moderate hopes for future success Their ability to obtain oil from the Central Asian republics is intermittent And when crude oil is available, the refinery does not always have the money to pay for it It is hoped that the addition of the new propylene processing facility currently under construction will provide MOR with new markets to penetrate

Most of the energy management staff are only mildly interested in the topic of energy efficiency While moderately helpful with the week's audit activities, most of the recommendations made by the auditors were not openly received Long-term equipment and system maintenance and training procedures are also lacking Even with the installation of energy saving measures, it is doubtful that the MOR staff will keep the equipment properly maintained to ensure the persistence of the savings The one area of interest regarding energy efficiency is the installation of western-style automatic boiler controls on 4 new steam boilers

Table 1 Moscow Oil Refinery Energy Rates [April 1994]

Category	Units or Measure	Local Cost	World Cost	Ratio W C /L C
Electric Demand	$/kW-mo	6280 R $3 49*	$0 064/kWh Demand & Energy Combined	2 86
Electric Energy	$/kWh	30 R $0 0167*		
Steam	$/Gcal	18000 R $10*	$30	3 0
Natural Gas**	$/cubic m	33 R $0 01844*	$0 141	7 6

* At an exchange rate of 1,800 rubles/dollar

** Natural gas is used as a feedstock only by the refinery

Table 2 Moscow Oil Refinery Energy Conservation Opportunities

Table 2 Moscow Oil Refinery Energy Conservation Opportunities						
Energy Conservation Opportunities (ECO) Description	Estimated Energy Savings	Estimated Local Cost Savings [$/yr]	Estimated World Cost Savings [$/yr]	Estimated Implement Cost [$]	Estimated Simple Payback Local [years]	Estimated Simple Payback World [years]
Automatic Boiler Controls	2,857 GCal/yr	$28,510	$85,710	$70,000	2 45	0 82
Main Drip Leg Traps	2,423 GCal/yr	$24,230	$72,690	$1,500	0 06	0 02
Lateral Line Steam Traps	337 GCal/yr	$3,370	$10,110	$600	0 26	0 09
TOTAL SAVINGS	5,617 GCal/yr	$56,170	$168,510	$72,100	1 28	0 43

2 0 FACILITY BACKGROUND

2 1 Description of Facility

The company audited, the Moscow Oil Refinery (MOR), is located in the region of Kopotnia, a small suburb of Moscow, on the southeastern edge of the Moscow Outer Ring highway The facility is a State-Owned and operated facility which has been in operation since 1938 MOR refines crude oil into a variety of oil-based products Products made from this crude oil along with the approximate annual percentages of these products produced are as follows

gasoline	22 0%
mazout	22 0%
diesel fuel	26 0%
petroleum by-products	29 7%
dry gas	0 03%
asphalt	0 04%
losses	0 20%

The full production capacity of the plant is not always utilized because of crude oil supply problems, and shortages of funds to purchase crude oil Plant personnel estimated that the annual amount of crude oil processed is about 6 million metric tons

The entire facility is spread over an area approximately 2 2 km by 1 5 km (1 3 miles by 0 9 mile) The primary production area of the plant is the Full Catalytic Cracking (FCC) facility It is in this portion of the plant that approximately 40% of the facility's profit is obtained The remaining 60% of plant profits come from sales of fuels (gasoline and diesel) and residual fuel oil (mazout) Also currently under construction is a new propylene plant to increase the propylene production capability This production facility will be using the latest Western technology and is being constructed by an Italian crew During the past several years, propylene production has been increasing and represents a major contribution to the profitability of the plant Planned upgrades at the plant include the construction of new buildings which will house processes to manufacture polypropylene products such as plastic piping All capital improvements to the plant facilities are being financed with after-tax profits

Crude oil is pumped from the main incoming pipeline from Central Asia The crude oil is pumped either directly to the processing areas or is pumped into one of four 50,000 ton

(metric ton, 1,000 kg) storage tanks It is sometimes necessary to store the crude oil in these storage tanks in order to stabilize the oil and remove any water

2 1 1 Management Structure

The refinery is essentially in operation 365 days per year, 24 hours per day

The office of the Chief Power Engineer, Konstantin Belanov, reports to the refinery's Technical Director Reporting to Mr Belanov are a staff of seven technical and clerical personnel Also reporting to Mr Belanov are supervisors of three workshops responsible for various energy related services around the refinery These three workshops are responsible for steam, electric supply and telecommunications A total of 300 people work in these three workshops and report to the office of the Chief Power Engineer The refinery currently employs a total of 3200 workers

2 2 Product History

The decision to construct a refinery near Moscow was made in 1935 By 1938 a thermal cracking plant was constructed By 1940 an asphalt plant was added to the facility, which is still in operation today During 1962 and 1964 2 plants for catalytic reforming were built This added the capability to produce high-octane (95 octane) gasoline In 1967 a polypropylene plant extraction and granulization plant was constructed A second polypropylene plant is currently under construction A facility for the production of manufactured polypropylene products such as plastic piping will also be built

About 3% of the production of the facility is exported (primarily diesel fuel in the summer) throughout the NIS, the remaining 97% is being consumed in Russia The diesel fuel produced by the refinery for wintertime use is potentially a source of additional export revenue, however current production is totally consumed domestically

Future expectations for this facility depend on the overall health of the Russian economy since approximately 70% of the goods that MOR produces are fuels, and the remaining products (polypropylene products or precursors) are major inputs to consumer goods

2 3 Facility Energy Use

2 3 1 Facility Energy Consumption

Mosenergo (ME) supplies electricity to the facility from Moscow Region Electric Station Number 22 Thermal energy in the form of steam is also supplied by ME The steam is generated at the ME regional district heating plant and is supplied to MOR at a single location within the facility, and piped throughout the plant in a MOR steam distribution system Steam is used at MOR primarily for process heating requirements, with a small

amount of usage for space heating Without metering, this space heating usage cannot be accurately estimated, but is probably less than 1% of total steam usage Steam supplied to MOR is delivered from Regional Plant #22 at a pressure of 13 atmospheres gauge (191 psig) However, due to frictional and thermal losses in the long steam delivery main, the steam pressure at the entrance of the plant varies from 6 to 7 atmospheres gauge (88 to 103 psig) Steam to water heat exchangers are used to satisfy the domestic hot water heating requirements of the plant

Several large ovens and boiler facilities are present at the refinery The ovens are used to preheat crude oil to allow it to flow easily through the processing equipment The oil is heated in each oven in vertical tubes by radiative and convective heating from the burners firing vertically from the bottom of each oven This facility consists of 5 ovens of various capacities

2 ovens, each	38 million kcal/hr (151 MMBTUh)
1 oven	30 million kcal/hr (119 MMBTUh)
1 oven	29 million kcal/hr (115 MMBTUh)
1 oven	20 million kcal/hr (79 MMBTUh)

A typical burner for each of these ovens has a capacity of 4 5 million kcal (18 MMBTUh) and has a diameter of approximately 60 cm (24 inches) The exhaust gases from the ovens are sent through two waste heat boilers, and the primary objective of the facility is to produce as much steam as possible in these waste heat boilers Induced draft fans are used to provide combustion air to the burners The fuel gas by-product stream energy content changes from time to time as different waste gases are inputted When this happens, the inlet dampers (very crude flappers arranged circumferentially around the bottom of the burner) must be adjusted manually to maintain excess oxygen levels at the oven outlet at about 16% This can take up to an hour to accomplish Oven exhaust gas temperature (input to the waste heat boilers) is maintained at up to 750 °C (1382 °F) and stack temperatures after the waste heat boilers are maintained at 300 °C (572 °F)

These two waste heat boilers are used to produce 40 tons (metric) of steam per hour (88,000 lbs/hr) at 12 atmospheres (176 psig) and 390 °C (734 °F) superheat This steam is used in the demineralization of the crude oil The fuel inputs for these ovens/boilers are obtained from streams of by-products of the refining process These by-products are essentially waste streams that are of little or no market value in the view of plant management The waste by-product stream consists of various hydrocarbon compounds occasionally containing butane and propane Any high sulfur by-product streams are processed to have the sulfur removed as hydrogen sulfide before the gas is burned in the boiler to reduce sulfur dioxide emissions Later, at another facility, the hydrogen sulfide is reduced to elemental sulfur and purified for sale

This process equipment particularly the ovens, could be more energy efficient Plant

personnel assert that the four largest ovens (using East German burners) are significantly better than the smallest oven (using Russian burners) Some oven insulation material is defective, the burners are old and worn out, and some ovens have continuous monitoring equipment while others do not The facility would benefit from a combustion air preheat system Improvement of this facility would require major capital investment presently beyond the capabilities of the plant, and well out of the range of this project

Within the possible scope of the audit on-site work is another boiler plant which consists of eight individual supplemental steam boilers Each individual boiler produces approximately 6 5 tons (metric) of steam per hour (14,300 lbs/hr) at 6 to 7 (88 to 103 psig) atmospheres and 190 °C (374 °F) superheat The eight boilers were originally manufactured in 1948 and the on-site assembly was completed in 1952

Four of the eight boilers are currently in the process of being replaced The estimated completion date for this project is August, 1994 Each new boiler will produce 10 tons of steam per hour (22,000 lbs/hr) at 13 atmospheres (191 psig) and 280 °C (536 °F) of superheat These four boilers will be equipped with Russian made control systems

The remaining four boilers are scheduled to be replaced during 1995 These four boilers will operate at the same capacity and characteristics as the other four new boilers MOR energy management staff hopes to equip these four boilers with American automatic control systems Presently, they cannot afford such systems If these systems could be installed as a result of this project, they would be able to compare the effectiveness of American control systems with that of Russian control systems (to be installed on the boilers constructed in 1994)

All eight new boilers will be induced draft boilers The boilers will also be equipped with stack heat exchangers (economizers) to preheat the boiler feedwater Each induced draft fan is to be powered by a 1500 rpm 30 kW (40 hp) motor with a nameplate efficiency rating of 92% Refer to Appendix A, figures 1 through 5, for photos of the existing boilers and equipment currently being prepared for installation this summer

The goal of replacing the eight boilers is to reduce the amount of steam purchases from the ME regional district heating plant #22 by 20% The cost of steam from ME is 18000 rubles per Gcal ($10/Gcal) Annual use of steam by the plant is about 2 million Gcal, about half of which is purchased from ME When completed, this project will reduce steam purchases from ME by about $2 million/year The estimated project cost for replacing all eight boilers is 800 million rubles ($444,400) This estimated cost does not include the cost for erecting two new 45 m (147 feet) exhaust stacks Since the cost of fuel input to these boilers is unknown, we cannot accurately estimate the simple payback for this investment, but plant personnel assured us that it would probably be less than one year Since the fuel input to the boilers would be produced by the refinery (its cost would be about 70% of the wholesale price of the same fuel) and the output steam would be replacing purchased steam from the Mosenergo facility, this estimate is probably reasonable

This project will also enable the refinery to use steam at a higher pressure than the steam supplied by ME The central plant is 1 5 to 2 km from the refinery Due to steam distribution pipeline losses, the steam arrives at MOR at a pressure of only 6 to 7 atmospheres The eight new boilers will supply steam at 13 atmospheres By increasing delivery pressure in the main steam line to 13 atmospheres, the rate of energy delivery will increase more than the losses Consequently, the distribution system losses will be a smaller fraction of the total energy input to the main steam delivery system In addition to reducing purchased steam costs, overall steam utilization efficiency should increase

MOR plant personnel are in the process of conducting a survey of the nearly 4,000 motors at the facility, which vary in size from about 1 kW to 4 MW The larger motors are synchronous motors The purpose of the survey is to identify potential variable speed drive applications The survey is expected to be completed by the end of 1994 Plant personnel estimated that about 10% of all the existing motors are presently equipped with variable speed drives

The MOR facility consumed energy in 1993 in the following forms

- Electricity - 548 million kWh/year

  The refinery nominates a peak electrical demand of 72 MW Every six months they are asked to estimate the peak demand for the next six months This is called the "nominated demand " They pay demand charges for this amount each month of the six month period, even if they never reach this demand level If, however, they were to exceed the nominated demand, they would pay a penalty of ten times the per kW demand charge

- Steam - 2 million Gcal/year (7,936,000 million BTU/year)

  Energy consumption figures were unavailable for years prior to 1993 Plant personnel claim that energy consumption for 1992 was at nearly the same levels as 1993, even

  though production has decreased This is apparently due to the fact that the plant has been continuing to run at minimal levels

Overall energy costs represent about 8% to 10% of total production costs for this plant An approximate split of the energy consumption by end-use is shown in *Table 3*

Table 3 Moscow Oil Refinery Energy Consumption By End-use

STEAM
95% Process
1% Space Heating
4% Hot Water
ELECTRICITY
90 to 95% Process
5 to 10% Lighting

2 3 2 Energy Costs

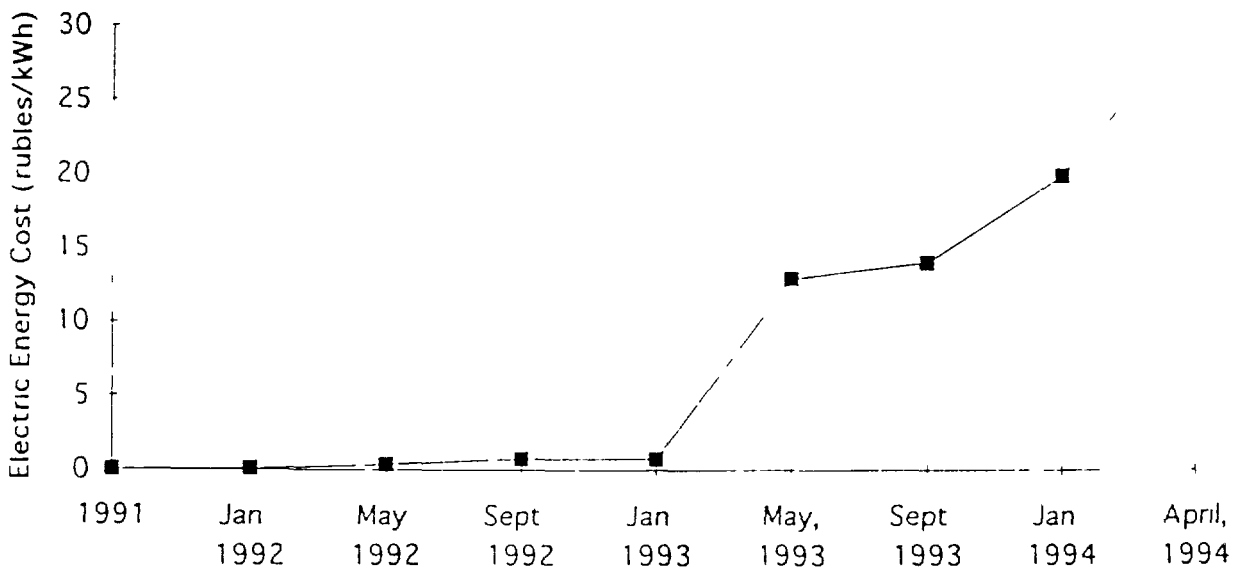
The following costs of energy are accurate as of April 1, 1994, using an exchange rate of 1,800 rubles per dollar

Steam
18000 Rubles/Gcal ($2 52/million BTU)

Electricity
6280 Rubles/kW monthly demand charge = $3,487/kW monthly demand
30 Rubles/kWh energy charge = $0 0167/kWh
($3 489/kW monthly demand, $0 0167/kWh energy)

See Figure 1 for historical electricity rates

Figure 1 Moscow Oil Refinery Historical Electrical Energy Rates



2 4 Viability of Facility

A number of factors will determine the future viability of the Moscow Oil Refinery The most important factor is the ability of MOR to obtain and even pay for crude oil from the Central Asian republics Hard Western currency is scarce for this state-run oil refinery The availability of Russian rubles is also extremely limited to the energy management staff of MOR Interest rates for ruble loans range from 240% to 280% (annual percentage rate), for a maximum term of one year Most employees are not paid on a regular basis At the current time, MOR is approximately three months behind on its payroll The business is operating on a "cash flow" basis, and net (after taxes) cash flow is defined as 25% of the difference between revenues and costs (labor, raw materials, and energy) Since this difference, defined as "profits," is taxed at a 75% rate, bartering is becoming a more important part of the Russian industrial economy This facility traded polypropylene granules to Moskabelmet for magnet winding wire to repair burned out motors at the refinery

Another significant obstacle is the tax situation Refer to Appendix B for a copy of an article from the April 29, 1994, issue of the Moscow Times This article describes the tax situation for loans and capital investments in the oil industry Western loans of hard currency for investment purposes are subject to a 20% VAT and a 3% special tax as well as custom taxes Up to 45% of potential loans would be spent on federal taxes

With the effort to generate government revenue, it appears that overall tax revenues are actually decreasing, in spite of the fact that more taxes are being created and others are being raised This policy is also discouraging Western investment, which could help create jobs and stimulate the Russian economy

3.0 SYSTEMS AUDITED

3 1 Steam Boilers

As previously discussed, the MOR is presently replacing eight supplementary steam boilers (originally built in the late 1940's and early 1950's) with eight new 10 metric ton per hour steam output boilers Replacement of four of the existing boilers will be completed by August, 1994, and the remaining four replacements will be installed in 1995 The new boilers will be capable of producing higher quality steam (13 atmospheres pressure, 280 °C superheat) than that presently being produced The first four boilers will have a conventional Russian boiler control system installed The design of this system is more than 10 years old Gas composition in the exhaust stream is measured through a sampling process, resulting in extended feedback times Adjustment of the inlet dampers on the induced draft combustion air supply system is done manually Plant personnel are very interested in installing an American automatic control system on the second set of four boilers in 1995

Energy Conservation Opportunity #1 Automatic Boiler Control System on one of Four Supplementary Steam Boilers

Plant personnel believe that boiler efficiencies on the four boilers to be installed in 1995 can be improved by 10% with the installation of a modern automatic control system with short response time and more accurate monitoring equipment on each boiler A more conservative savings estimate of 5% was assumed in the calculations in Appendix C Due to the cost of this measure, installation of only one control system is recommended as a demonstration at this time See Appendix D for specifications Any boiler efficiency improvement will reduce MOR's steam purchase requirements (their most expensive energy budget requirement) by the amount of the efficiency improvement For example, if the automatic control system allowed them to produce 5% more energy with the same fuel use, their steam purchase requirements would be reduced by 5% of the estimated steam output of the boilers, in this case 5% of 10 metric tons/hour or 5 metric tons/hour reduction in steam purchase requirements At an approximate cost of $70,000, estimated savings for this measure are 2,857 Gcal/yr Simple payback at local cost is 2 45 years Payback at world cost is 82 years See Appendix C for calculations

3 2 Steam Distribution System

The internal steam distribution system at MOR appears to be reasonably well insulated although there are a few short lengths of line where the insulation has been damaged All the condensate delivered to the condensate line at the refinery is supplied to the existing supplemental steam boilers, none is returned to Mosenergo The main steam lines are not equipped with steam traps to remove condensate Significant steam leakage occurs at various points along the main steam line Valves, leading off of the steam line at low points are

slightly cracked open to blow condensate from the line This condensate spills on to the ground as steam is leaked into the air

Energy Conservation Opportunity #2 Installation of Steam Traps in the Main Drip Legs of the Main Steam Distribution System

Installation of steam traps on the main drip legs of the steam distribution system will allow condensate to be returned to the supplementary boilers, increasing boiler efficiency and steam production Ten locations were identified where the installation of steam traps would be beneficial These locations, approximately 100 meters (328 feet) apart on the steam line, were identified by plant personnel Because of the nature of the steam and the system, stainless steel steam traps will be required See Appendix D for specifications The MOR personnel were initially very uninterested in this proposal, despite its good payback estimate (see Appendix C), saying that the steam traps probably would not remain in place long enough to pay back their cost from savings When asked to explain what they meant by this, they asserted that the steam traps would probably be stolen in less than six months U S made steam traps are quite expensive and valuable compared to Russian steam traps

Inverted bucket steam traps, as recommended for this application, are more suited to these conditions than the Russian bi-metallic steam traps which would otherwise have been installed Being constructed of stainless steel they should also last significantly longer than the Russian cast iron bi-metallic steam traps Russian bi-metallic traps typically fail in this type of application in about two months, while American steam traps are guaranteed for two years As mentioned earlier, the primary concern of MOR personnel for these trap installations was the possibility of theft Stainless steel, being very bright, is like having a flag attached saying "valuable piece of equipment " We indicated that the steam traps would be specified as flanged traps for attachment to the system We suggested that the bolts could be hardened and fastened with nuts requiring one or more special tools to unfasten In addition the traps could be painted to hide their bright appearance At an approximate cost of $1,500, estimated savings for this measure are 2 423 Gcal/yr Simple payback at local cost is 20 days, payback at world cost is 7 days See Appendix C for calculations

Energy Conservation Opportunity #3 Steam Traps in Side Distribution Line to some Residential and Commercial Facilities

At one location, steam is taken from the distribution system to supply space heating energy to some residential housing and some energy to commercial facilities, including two bathhouses and a laundry facility During the winter, there are times when the demand by these facilities is high enough that plant production must be reduced at locations beyond this steam diversion point because of insufficient supply of steam

There are two points where steam is presently being extracted from the distribution line to ensure condensate extraction and dry steam delivery to the laundry facility If steam traps are

installed at the suggested four locations on this small distribution line, plant personnel will construct a condensate line for returning condensate to the main condensate return line at the main steam distribution system At an approximate cost of $600, estimated savings for this measure are 337 Gcal/yr Simple payback at local cost is 3 2 months, payback at world cost is 1 month See Appendix C for calculations

Installation of three steam flow meters (see Section 5, Monitoring Recommendations) to monitor use by the above commercial and residential facilities will enable plant personnel to evaluate the effectiveness of the recommended steam traps, to institute other measures within the facilities to reduce steam usage and to evaluate the effects of these other measures

4 0 IMPACT OF SAVINGS

Based on the findings of this audit, it appears that steam trapping is not being successfully practiced in Russia If conditions similar to those found at the Moscow Oil Refinery exist at the other oil refineries in Russia, savings estimated for this plant would exist at nearly all other operating facilities

The installation of automatic boiler controls could also be implemented throughout the oil refineries of Russia Boiler controls could actually be installed in any industry that produces its own steam New construction of boilers, as is being implemented at this refinery, is not a pre-requisite for new boiler controls New controls can be used to replace older, less accurate controls

As long as steam is being used for production, the actual end product of the refinery (gasoline, mazout, etc) will not significantly affect the impact of implementing these conservation opportunities This oil refinery is the only one in the Moscow area It is not known how many refineries exist in all of Russia

5 0 MONITORING RECOMMENDATIONS

Monitoring of the Western boiler control system will be best accomplished by comparing its operation to the Russian controls to be installed in 1994 The number most relevant for comparison is the steam energy delivered to the distribution system per unit of residual fuel consumed by the boilers

Monitoring of the efficiency improvements produced by the main steam line drip leg steam traps is not easily nor cheaply done The savings, though substantial, will not represent a major fraction of steam purchases Estimating the savings attributable to the main steam line drip legs would be very difficult, and if possible, very expensive We do not recommend monitoring this improvement

Steam usage in the lateral line serving the residential and commercial facilities can be monitored Three flow meters, pressure and temperature compensated, will be adequate One flow meter should be installed near the beginning of the line The remaining two meters should be installed after the laundry facility one monitoring the steam usage of the residences and the second monitoring the steam usage of the bath facility associated with the residences If these meters are installed before the condensate line is constructed, a comparison of use before and after steam trap installation during periods of comparable weather will enable the savings attributable to the four new steam traps to be estimated

Plant personnel suggested that there could be significant waste of steam by the residential facilities in particular Structural improvement is one option to improve efficiency in the future Modulation controls could also be introduced for space heating energy The meters could demonstrate the effectiveness of these future measures if and when installed

APPENDIX A

Photographs

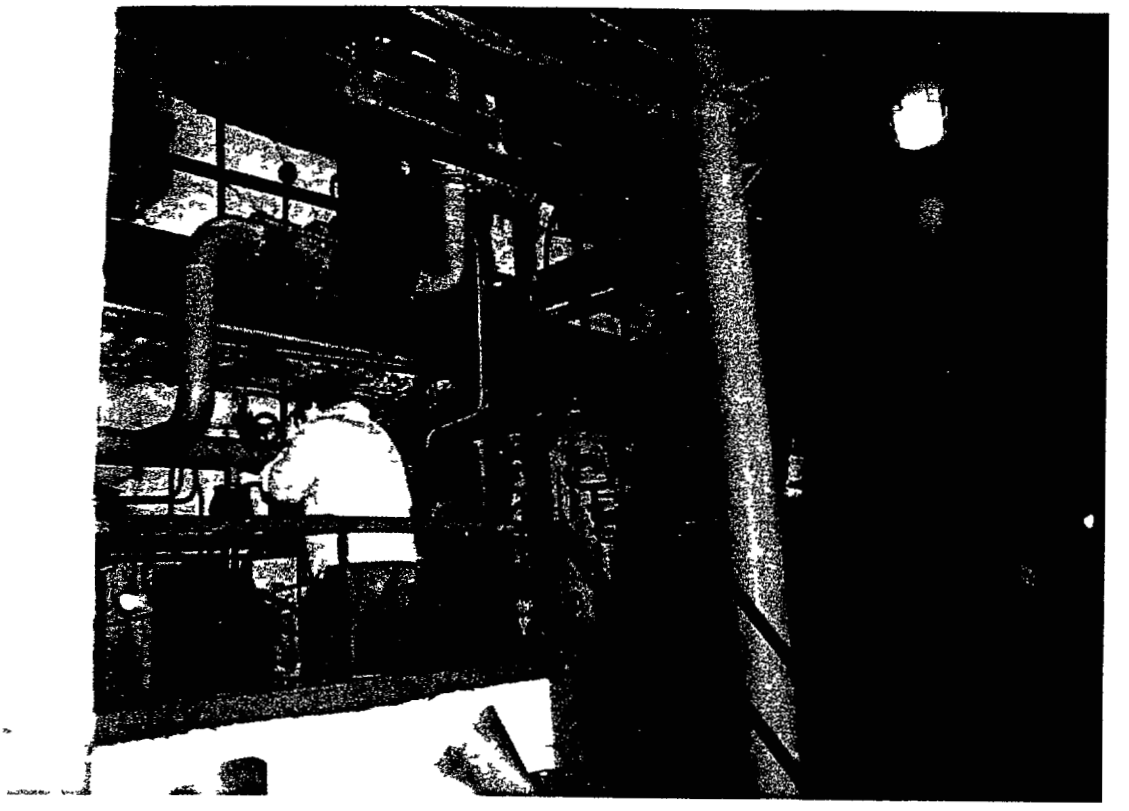


Figure 1 Existing Refinery Boiler Plant

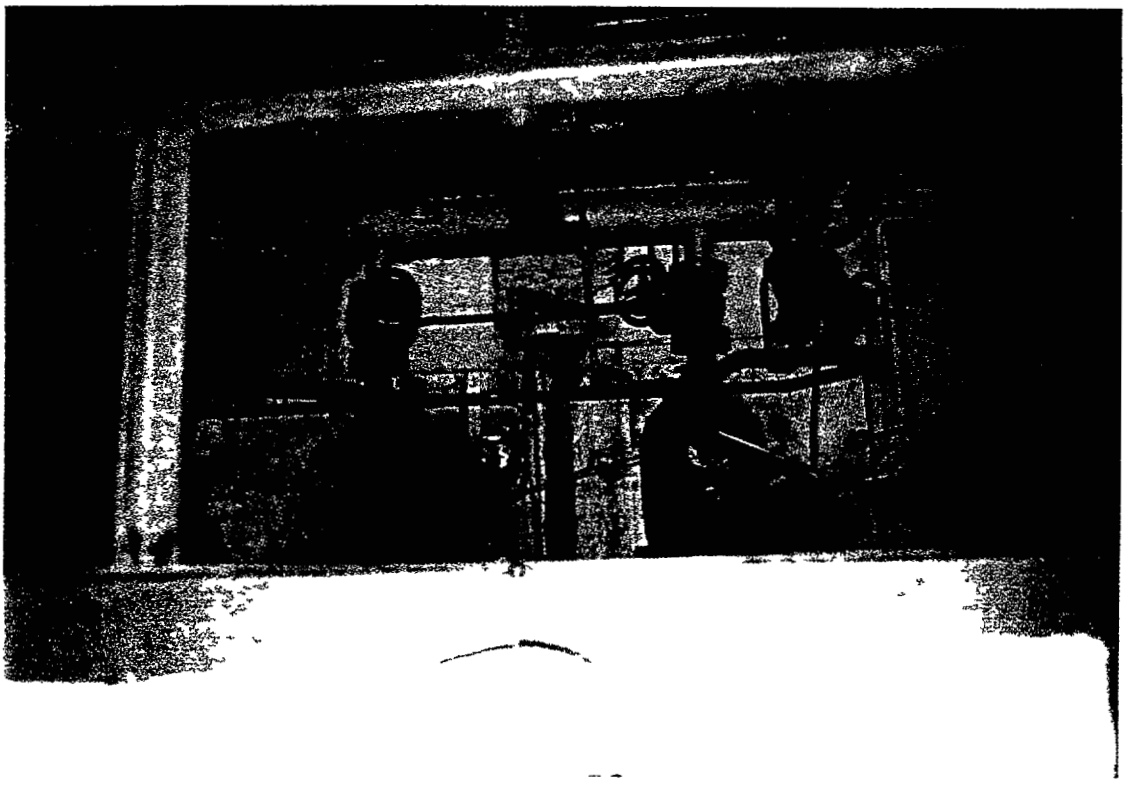


Figure 2 Existing Refinery Boiler Plant

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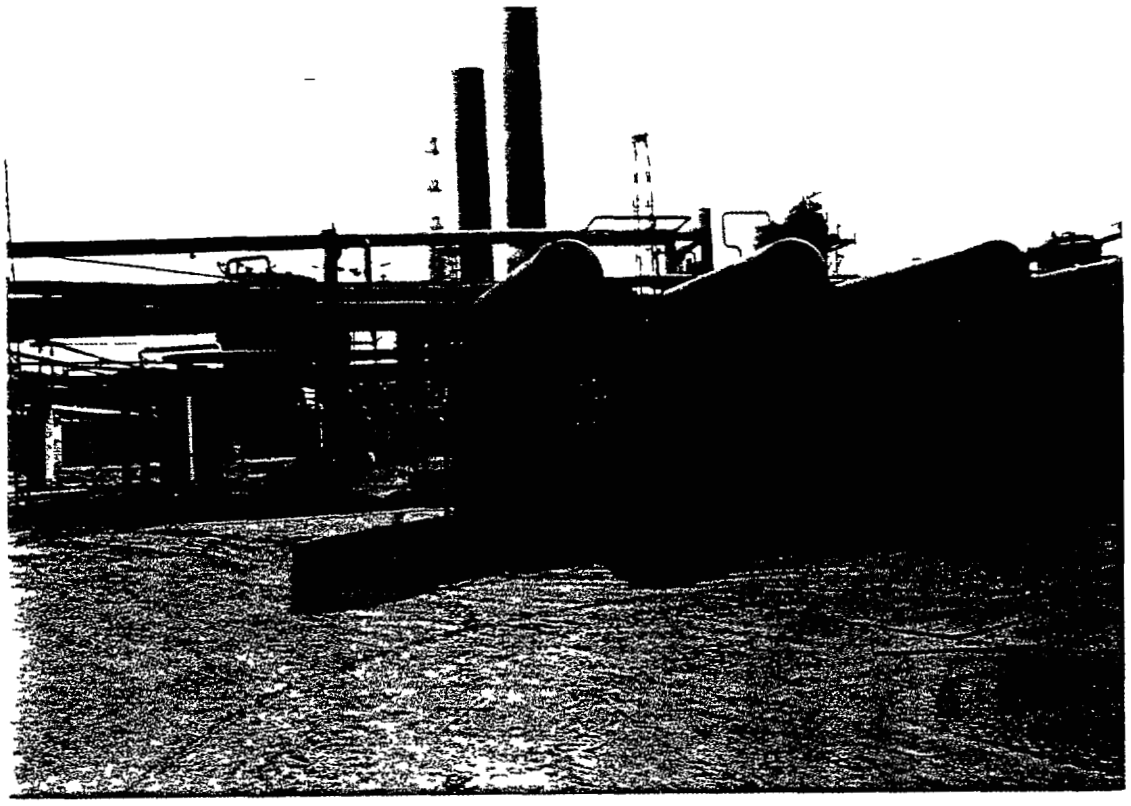

Figure 3 New Boiler Equipment at the Refinery

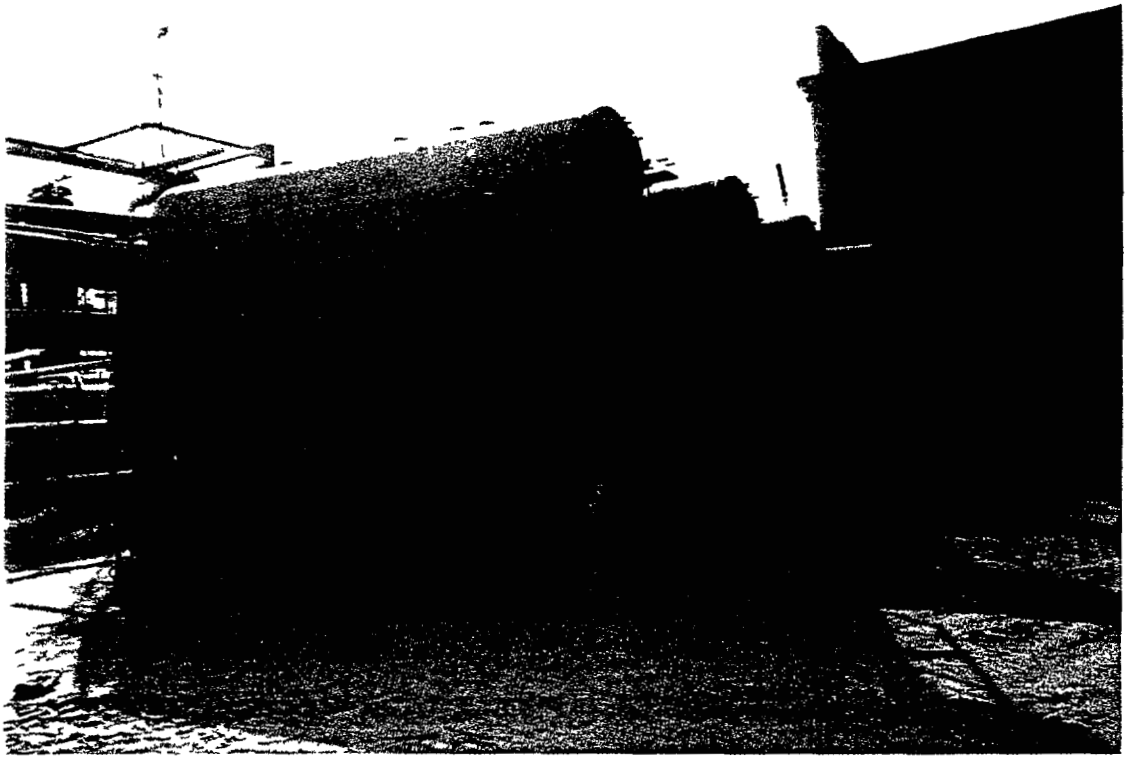

Figure 4 New Boiler Equipment at the Refinery

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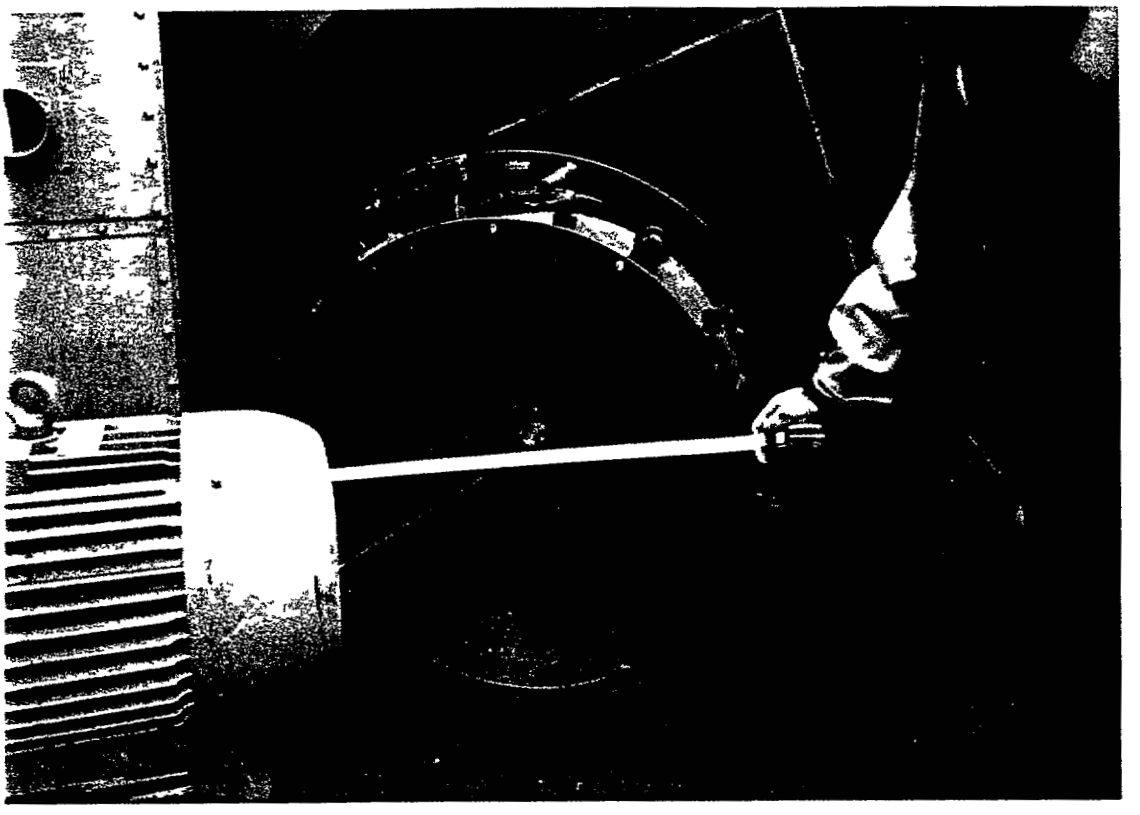

Figure 5 New Boiler Equipment for the Refinery (Inlet Induced Draft Fan)

Figure 6 Auditor with Moscow Oil Refinery Staff

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APPENDIX B

Moscow Times Article

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The Moscow Times

SINCE 1992

NO 452 FRIDAY APRIL 29 1994 16 PAGES

Politicians Sign Pact, But Is It 'Historic'?

By Thomas de Waal
THE MOSCOW TIMES

President Boris Yeltsin presented his political peace accord at a grand signing ceremony in the Kremlin on Thursday but as he hailed the pact as a "historic chance for the country doubts remained that it carried any real weight

Yeltsin flanked by his Prime Minister Viktor Chernomyrdin Patriarch Alexy II and the speakers of both houses of parliament told a packed gathering under the chandeliers of St George's Hall that "we have a historic chance of initiating a process of reconciliation and rebuilding accord in the country

Almost eight decades ago a terrible tragedy befell our country Yeltsin told more than 200 invited guests at the ceremony which was broadcast live on national television

Russia was plunged into civil war when brother fought brother and father fought son, a bloody line divided people into Whites and Reds into us and them into enemies of each other he continued in an appeal for unity The curse of that war has been haunting Russia ever since.

Yeltsin and his allies have promoted the Pact on Social Accord as the most important political event of the year a two-year truce that would take Russia from under the shadow of political violence

But much of the opposition has rejected the accord as a cynical attempt to consolidate on Yeltsin's crushing of the Supreme Soviet last October and on the strong presidential constitution he pushed through at a referendum last December

In a curious political dance Communist Party leader Gennady Zyuganov who has called the pact an invitation to

See ACCORD Page 2

STEVE LEE

Easter Time Alexandra Pryazhevo, 71, preparing the graves of her mother and grandparents at Vagankovskoye cemetery for Russian Easter, the most important Orthodox festival, which falls this weekend. Page 3.

New Taxes Jeopardize Billions for Oil Sector

By Steve Liesman
THE MOSCOW TIMES

Several billion dollars in critical foreign assistance to the Russian oil sector are at risk because the government has refused to exempt the loans from a bevy of new taxes Russian and Western officials say

Despite World Bank requests and official statements to the contrary the government has yet to issue assurances that taxes would not be charged on equipment purchased with loans provided by the World Bank and the European Bank for Reconstruction and Development the officials said

Igor Starostin an official with the Fuel and Energy Ministry said that purchases with the proceeds of two loans to the oil sector — $610 million from the World Bank and $174 million from the EBRD — would be subject to a 20 percent value added tax and a 3 percent special tax as well as other levies for transportation and customs services.

Both loans are now being disbursed and equipment has been ordered

The effect of taxing the loans is to diminish and in some cases halt aid to the Russian oil sector which has been a top priority of Western governments The industry has experienced steep production declines, and badly needs investment so the country can increase its hard-currency earnings.

The expansion of investments in this sector is in jeopardy said Lou Naumovski resident representative for the EBRD in Moscow He added that some Russian companies had recently decided not to use EBRD oil loans at all largely because the unforeseen taxes had made their projects uneconomical

Starostin said that the same taxes would apply to a second $610 million loan to the oil industry that the World Bank hopes to complete in June as well as to $2 billion in guarantees being provided by the U.S Export Import Bank for the purchase of U.S oil equipment and other loans planned by the EBRD

The taxes did not exist when the loans were approved last year and have become a major point in ongoing negotiations between the World Bank and the Russian government, said Vadim Voronin head of oil projects at the World Bank office in Moscow

A meeting between government officials, the Finance Ministry and the tax service is planned for next week to discuss the matter But Starostin said a vote by the parliament might be needed

See TAXES, Page 2

INSIDE

Ames Gets Life in Jail
After pleading guilty to espionage the CIA agent turned Russian spy Aldrich Ames faces life imprisonment. Page 5

Plane Payout
Russian insurers will pay Aeroflot $78 million for the loss of a plane that killed 75 people when it crashed last month, but all families will not be compensated until the cause is determined. Page 3

Musicians Bloom
Spring has brought St. Petersburg's street musicians — from classical to rock — back onto the city streets. Citywise, Page 9

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Watch Out, Comrades: Yak's Back

By Alexander Gordeyev
THE MOSCOW TIMES

Dmitry Yakubovsky the 30-year-old lawyer who fled the country last summer after helping President Boris Yeltsin investigate corruption is back in business — and making up to 20 million rubles a month.

Back in Russia after a cloak-and-dagger escape from the country last year Yakubovsky keeps an air of dangerous glamour at his residence in the wealthy dacha suburb of Zhukovka, which is guarded by men with submachine guns.

Yakubovsky's story which kept the Russian scandal presses humming last summer began on a day in July when he was summoned out of self imposed exile in Canada by Yeltsin s staff

According to published accounts that read like spy fiction but have been largely confirmed by officials involved the young lawyer was installed in a remote office in the Kremlin and told to sift through piles of documents to find evidence of corruption Two of his targets were Viktor Barannikov and Alexander Rutskoi security minister and vice president of Russia at the time according to these accounts.

Barannikov was dismissed shortly afterwards but a few days later Yakubovsky fled from scores of security agents sent out by Barannikov's allies, and drove hundreds of kilometers south before eventually flying back to Canada from Armenia.

Only last December — after Barannikov Rutskoi and the former Supreme Soviet were crushed — did it become safe for Yakubovsky to return from Canada where he had been living with his fourth wife a Canadian citizen and their daughter Since then he said, two of his cars have been hit by lorries.

I don't know if those were just accidents but quite honestly I don't care about this rubbish he said. What can they do to me if I can draw my gun and fire off two rounds in only two and a half seconds?

It is hard to picture such agility from this portly figure who orders a servant to bring salads dumplings and cake only half an hour after lunch

But Yakubovsky is far from idle He has set up his own law firm Attorney Yakubovsky and Comrades which provides consulting on international business legislation He said he expected to make about 20 million rubles ($11 600) in April from clients like Mosbank Stolichny Bank and the Chemicals Committee of the Russian Federation

At the same time he said he is working on a post graduate thesis on Russia's Constitutional Court.

I don't care how much money I make It's the work that I enjoy Yakubovsky said while adding that he only enjoyed it in Russia. He did not work in Canada. "Over there it's a different atmosphere present indefinite regular he said "But in Russia it's a

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LAWYER

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different environment, it's changing all the time — and so am I"

Part of the secret of Yakubovsky's success lies in his bare faced gall It would seem that no official has ever been too highly placed for the young lawyer to call him up or strike up a conversation. He refers to government ministers by their first names and with a fair measure of coarse language He can afford to — he knows many of them personally and a great deal about them.

Six years ago when Yakubovsky was a lowly 24-year-old clerk at the Lawyers Union he dialed the number of Defense Minister Dmitry Yazov only to find himself talking to Yazov directly

Eager to exploit the opportunity Yakubovsky put a plan to Yazov on how to hold on to Soviet military property in East Germany A few days later he was commissioned to supervise a team of generals that flew to Germany to evaluate the property

M. METAL FU

The lawyer Dmitry Yakubovsky, back making money in Russia after a spectacular escape last year, but now under 24-hour guard.

Yazov subsequently played down the appointment in public saying it was a bureaucratic error Yakubovsky's indignant response?

Yazov is an old bastard who is simply too ashamed to admit that he didn't have the brains to solve the problem himself and had to use the services of a boy

Vladimir Shumeiko then a first deputy prime minister once described Yakubovsky as a non standard thinker clever if slightly insolent

In 1992 Shumeiko believed Yakubovsky to be so clever that he suggested promoting him to the rank of colonel in order to represent the security defense and interior ministries inside the government.

The nomination was swiftly blocked by Shumeiko's cabinet adversaries. It was a rare setback for Yakubovsky a man consumately skilled in making friends in high places.

Yakubovsky's political shrewdness appears to be based on his ability to establish personal relationships It is this quality that makes the former Soviet parliament speaker Anatoly Lukyanov a "very bright statesman in Yakubovsky's eyes.

"I remember when Yeltsin was sacked as the Moscow Communist boss Lukyanov made a point to come to a party only to say hello to Yeltsin's children" Yakubovsky said.

Lukyanov later was jailed for his role in the August 1991 putsch against Mikhail Gorbachev a fate shared by Yazov

Yakubovsky remains on first name terms even with his political adversaries. He addressed Public Prosecutor Valentin Stepankov with the informal Valya in a much publicized telephone conversation last summer which was at the time interpreted as a murder plot.

Barannikov's wife called Yakubovsky Dimulya in telephone conversations before her own husband was fired according to transcripts published in the Russian media which Yakubovsky admits to be authentic.

Although in private business now Yakubovsky still enjoys the protection of the state which supplies the armed men who guard him 24 hours a day For while he says he likes all people he adds. "There are people who consider themselves my enemies.

TAXES

Continued from page 1

to resolve the matter

The issue of taxing the use of the loans is the most serious result of a December presidential decree that made foreign investments technically subject to VAT Application of the decree by officials has spread a chill through the foreign business community in Russia.

In recent weeks a slew of other taxes including levies on rental property and excess wages have been slapped on foreigners leading to a series of protests from foreign business.

Last Friday Finance Minister Sergei Dubinin in an internal government document made the most unambiguous statement to date that the 20 per cent value-added tax and 3 percent special tax did not apply to foreign loans

Loans and credits granted by foreign banks and by credit giving institutions should not be subject to the value added tax and the special tax said the document, dated April 22.

But the document did not say whether equipment purchased with proceeds of foreign loans would be exempt from value-added tax or the other levies listed by Starostin.

In the past foreign investors and Western aid officials have been unimpressed by assurances from the Finance Ministry With conflicting signals coming from different ministries some investors have put their projects on hold until the law is officially revised

In a letter sent earlier this month to Prime Minister Viktor Chernomyrdin, the head of one Russian oil company that has already ordered $330 million worth of equipment under the World Bank oil project said the taxes would be ruinous.

"Under the current taxation system it comes about that 45 percent of the loans would be spent on federal taxes which affects the economic effectiveness of the loans, wrote Viktor Ageyev director of Purneftegaz, a Russian oil production association Our numerous appeals to the Russian government to be exempted from taxes were left unanswered.

A source familiar with the loans said that two of the three production associations involved with the World Bank and EBRD oil loans are prepared to quit if the situation is not resolved

The World Bank position is twofold according to World Bank chief economist Charles Blitzer

First it wants the same tax regime applied to its first oil loan as existed when the loan agreement was signed in August Second it does not want any special exemptions for its next oil loan It is negotiating for the government to change the rules for all foreign investment.

Michael Hetzer contributed to this article.

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ACCORD

Continued from page 1

unconditional surrender decided to attend the ceremony His party later said Zyuganov had refused to sign the accord but might at a later date

The relatively mild formulations of the most recent draft of the pact appeared to have won over a majority of the Duma Five parliament factions — Russia's Choice the Party of Russian Unity and Accord Women of Russia, the Democratic Party of Russia and Vladimir Zhirinovsky's Liberal Democratic Party — signed the pact.

The leader of the influential Duma grouping New Regional Policy in the Duma, Vladimir Medvedev also attended the ceremony but did not sign because his group decided that it was not a political party

Two political groups did not turn up at all the reformist Yabloko bloc of Grigory Yavlinsky who has called the whole concept a waste of time and the conservative Agrarian Party

Zhirinovsky decided with typical showmanship to put his pen to the pact only at the last moment Commenting on the pact to reporters as he left for the Kremlin he said "to hell with it but signed all the same

"I have come here to take a look Reuters quoted Zhirinovsky as saying as he entered the hall, indicating his cavalier attitude to the affair If Yeltsin smiles at me I'll sign. If not I don't know

The pact is not legally binding on signatories. Instead it will be monitored by a special commission with as yet undefined powers. It sets out the terms of a political truce for the next two years in which signatories promise neither to call for pre-term elections nor for strikes.

Over a number of drafts some of the document's tougher points have been watered down.

An earlier obligation not to exploit the violent events of August 1991 and September-October 1993 for political purposes has been replaced by a vague undertaking to avoid simplified and insulting evaluations of the past. Signatories are no longer required not to call for changes in the constitution but can now request changes which will facilitate the stabilization of the situation in society

The pact was also signed by trade unions and religious organizations. All the republics of the Russian federation signed with the exception of rebel Chechnya and all the regions except for Vladimir and Kemerovo whose leader Aman Tuleyev is an old adversary of Yeltsin.

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Waste Train Arrives

HELSINKI — A train carrying spent nuclear fuel the target of a protest by Finnish antinuclear activists this week crossed into Russia on Thursday a Finnish state power company said.

An official of the Imatran Voima company said there were no incidents during the fuel's journey from a power plant on Finland's south coast to the border

WEATHER

FRIDAY
Sunny
High 17, Low 5

SATURDAY
Rain, unfortunately
High 15, Low 7

SUNDAY
Drizzle
High 17, Low 9

REPUBLICS	high	low	outlook
Almaty	8	8	rain
Baku	18	8	cloudy
Irkutsk	12	0	cloudy
Kiev	21	9	cloudy
Minsk	20	7	sunny
Novosibirsk	5	1	cloudy
Odessa	15	[illegible]	cloudy
Riga	21	6	sunny
St. Petersburg	18	9	rain
Tbilisi	13	10	sunny
Vladivostok	9	3	rain
Yerevan	10	8	sunny
THE WORLD	high	low	outlook
Berlin	18	8	cloudy
Buenos Aires	24	13	cloudy
Helsinki	18	5	cloudy
Hong Kong	31	26	sunny
Jerusalem	30	18	cloudy
London	20	13	sunny
Nairobi	23	15	sunny
New York	28	15	rain
Paris	22	10	sunny
San Francisco	21	11	sunny
Tokyo	19	16	rain
Vienna	19	10	cloudy

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APPENDIX C

Energy Conservation Opportunities (ECOs)

ECO-1

Automatic Boiler Control System on one of Four Supplementary Steam Boilers

A Problem

The MOR is presently replacing eight supplementary steam boilers originally built in the late 1940's and early 1950's with eight new 10 metric ton per hour steam output boilers Replacement of four of the existing boilers will be completed by August 1994, and the remaining four replacements will be installed in 1995 The first four boilers will have a conventional Russian boiler control system installed The design of this system is more than 10 years old Gas composition in the exhaust stream is measured through a sampling process resulting in extended feedback times Adjustment of the inlet dampers on the induced draft combustion air supply system is done manually This control process is slow and inaccurate

B Solution

Plant personnel believe that boiler efficiencies on the four boilers to be installed in 1995 can be improved by 10% with the installation of a modern automatic control system with short response time and more accurate monitoring equipment A more conservative savings estimate of 5% was assumed These boilers will operate about 8,000 hours per year delivering a total of 40 metric tons of steam per hour At this time, controls for one boiler are being recommended as a demonstration Any boiler efficiency improvement will reduce MOR's steam purchase requirements (their most expensive energy budget requirement) by the amount of the efficiency improvement In other words, if the automatic control system allowed them to produce 5% more energy with the same fuel use their steam purchase requirements would be reduced by 5% steam output of the boilers, in this case 5% of 10 metric tons/hour or 5 metric tons/hour reduction in steam purchase requirements

C Analysis

Since the new boilers will be displacing the use of purchased steam from Regional Plant #22, the savings can be calculated on the basis of this reduction in steam purchases It is also assumed that with the exception of maintenance periods, the boilers will be in operation all year round Thus, a value of 8,000 hours per year will be used From steam tables, the enthalpy of steam at 13 atmospheres gauge (191 psig) and 280 °C (536 °F) can be found to be 714 17 x 10^6 Gcal/kg (1,288 Btu/lb)

The annual energy savings can then be calculated

$$E = 5 \text{ tons/hr} \times 1{,}000 \text{ kg/T} \times 8{,}000 \text{ hr/yr} \times 714\ 17 \times 10^{6} \text{ Gcal/kg}$$
$$E = 2{,}857 \text{ Gcal/yr}$$

At the local energy rate of 18,000 R/GCal ($10/GCal) the annual cost savings, CS_{local}, can be calculated

$$CS_{local} = 2{,}857 \text{ Gcal/yr} \times \$10/\text{Gcal}$$
$$CS_{local} = \$28{,}510/\text{yr}$$

Using the world energy rate for steam of $30/Gcal, the annual cost savings, CS_{world}, can be calculated

$$CS_{world} = 2{,}857 \text{ Gcal/yr} \times \$30/\text{Gcal}$$
$$CS_{world} = \$85{,}710/\text{yr}$$

Cost of the equipment = $70,000

The simple payback period for this recommendation using the local energy rate is estimated to be

Simple Payback = $70,000 / ($28,570/yr) = 2 45 years (9 months)

Using the world energy rates, the simple payback period is estimated to be

Simple Payback = $70,000 / ($85,710/yr) = 0 82 years (10 months)

ECO-02

Installation of Steam Traps in the Drip Legs of the Main Steam Distribution System

A Problem

Currently condensate formed in the main steam distribution pipelines is drained along with steam escaping into the atmosphere through gate valves which are left slightly open None of this condensate is returned to the boiler room even though condensate return lines are located adjacent to the steam lines The overall efficiency of the boiler plant is significantly decreased because boiler make-up water at 10°C (50 °F) must be supplied to the boilers Additional costs are incurred due to boiler feedwater treatment chemicals (if any water treatment actually occurs) which must be added to the incoming feedwater

B Proposed Solution

Install 10 steam traps in a section of the main steam distribution system Connect the discharge of the steam traps to the existing condensate return lines for the return of the condensate to the boiler system

C Analysis

The pressure for calculation and trap sizing purposes is estimated to be 6 atmospheres (88 psig) The inside diameter of the steam piping is 400 mm (15 75 inches) The drip legs are assumed to be approximately 100 m (328 feet) apart

Per Table 17-1, pg 17 of the Armstrong "Steam Conservation Guidelines for Condensate Drainage" the value for condensate drainage for a 16 inch pipe carrying 125 psig steam is 0 99 lb/hr/lineal ft The value provided is for a well insulated pipe in still air at 70 °F Because the actual piping is outdoors in non-still air, this condensate drainage value will be increased by 50% The new value conservatively accounts for increased condensate production heat loss Thus, the amount of condensate drainage per each drip leg can be calculated

Condensate Drainage = 0 99 lb/hr/ft x kg/2 2 lb x 1 5 x 328 ft
= 221 kg / hour (486 lb / hour)

The condensate return system operates at 3 atmospheres (44 psig), thus a steam trap with a 3 atmosphere pressure drop will be required The enthalpy content of saturated liquid at 44 psig is given in steam tables as 243 36 BTU/lb The enthalpy of saturated liquid at 50 °F is also found in steam tables as 18 07 BTU/lb Thus, the energy lost by venting the condensate to atmosphere can be calculated

Energy Loss = (243 36 BTU/lb - 18 07 BTU/lb) = 225 29 BTU/lb

The energy savings (E) can be calculated

E = 221 kg/hr x (225 29 BTU/lb x 2 2 lb/kg) x Gcal/3 96 MMBTU x 8,760 h/yr
E = 242 3 Gcal/yr/trap (959 5 MMBTU/yr/trap)

And for the total of ten traps for this retrofit, the energy savings is estimated to be

ES_{tot} = 10 x 242 3 = 2,423 Gcal/yr (9,595 MMBTU/yr)

The cost savings using current, local energy prices for steam (18,000 R/Gcal) can be calculated

Cost Savings = 2,423 Gcal/yr x 18,000 R/GCal x $/1,800 R
Cost Savings = $24,230/year

The estimated cost of the steam traps is $150 00 per steam trap Thus, for ten traps, the total cost will be approximately $1,500

Simple Payback = $1,500 x year/$24,230 = 0 06 year (20 days)

Simple payback using World Energy costs ($30/Gcal)

Savings = 2,423 Gcal/yr x $30/Gcal = $72,690/yr
Simple Payback = $1,500 x year/$72,690 = 0 02 year (7 days)

ECO-03

Installation of Steam Traps in the Lateral Steam Line serving some Small Service Hot Water and Space Heating Requirements

A Problem

Currently, a small (150 mm ID [5 91 inches]) lateral steam distribution line serving a small office, two bath houses, a laundry facility, and some residential buildings with space heating and/or service hot water is causing production problems for the refinery in severe winter weather The use of steam by this lateral in very cold weather often reduces delivery to processes downstream of the lateral When this happens, the production rate of the process is lowered, reducing the plant utilization factor In addition, there are no steam traps on the lateral, and any condensate produced in the line is blown off at two locations by slightly opening an existing valve to the atmosphere At one location the steam blown off in this manner produced a very large plume with ambient temperatures of about 12-15 °C (54-59 °F)

B Proposed Solution

Install 4 steam traps in this lateral steam line and construct a condensate return line from the last steam trap back to the main distribution system condensate return Connect the discharge of the steam traps to this condensate return line for the return of the condensate to the boiler feedwater system This will reduce the steam wasted by blowing off condensate Return of condensate will increase steam production at the supplemental boilers Future building structural improvements and/or space heating modulation controls can reduce steam usage in this diversion line even further

C Analysis

The pressure for calculation and trap sizing purposes is estimated to be 6 atmospheres (88 psig) The inside diameter of the steam piping is 150 mm (5 91 inches) up to the location of the second steam trap At this point the diameter of the steam line is reduced to 80 mm (3 15 inches) The distance from the main steam distribution system to the location of the first steam trap is about 87 meters (285 feet) The distance between the location of trap #1 and trap #2 is about 143 meters (470 feet) The remaining two traps are at distances of about 76 meters (250 feet), respectively

Per Table 17-1, pg 17 of the Armstrong "Steam Conservation Guidelines for Condensate Drainage" the value for condensate drainage for a 6 inch pipe carrying 125 psig steam is 0 44 lb/hr/lineal ft, and about 0 24 lb/hr/lineal ft for a 3 inch pipe The value provided is for a well insulated pipe in still air at 70 °F Because the actual piping is outdoors in non-still air, this condensate drainage value will be increased by 50% The new value conservatively accounts for increased condensate production and heat loss Thus the amount of condensate drainage at each trap can be calculated

Trap #1 Condensate = 0 44 lb/hr/ft x 0 454 kg/lb x 1 5 x 285 ft
= 85 4 kg/hour (188 lb/hour)
Trap #2 Condensate = 0 44 lb/hr/ft x 0 454 kg/lb x 1 5 x 470 ft
= 140 8 kg/hour (310 lb/hour)
Trap #3 Condensate = 0 24 lb/hr/ft x 0 454 kg/lb x 1 5 x 250 ft
= 40 9 kg/hour (90 lb/hour)
Trap #4 Condensate = 0 24 lb/hr/ft x 0 454 kg/lb x 1 5 x 250 ft
= 40 9 kg/hour (90 lb/hour)
Total Condensate = (85 4+140 8+40 9+40 9) kg/hr = 308 kg/hr (679 lbs/hr)

The condensate return system operates at 3 atmospheres (44 psig), thus a steam trap with a 3 atmosphere pressure drop will be required The enthalpy content of saturated liquid at 44 psig is given in steam tables as 243 36 BTU/lb The enthalpy of saturated liquid at 50 °F is also found in steam tables as 18 07 BTU/lb Thus, the energy lost by venting the condensate to atmosphere is 225 29 BTU/lb The energy savings (E) can be calculated

E = 308 kg/hr x 225 29 BTU/lb x 2 2 lb/kg x Gcal/3 968 MMBTU x 8,760 h/yr
E = 337 Gcal/yr (1,337 MMBTU/yr)

The cost savings using current, local energy prices for steam (18,000 R/Gcal) can be calculated

Cost Savings = 337 Gcal/yr x 18,000 R/Gcal x $/1,800 R
Cost Savings = $3,370/year

The estimated cost of the steam traps is $600 total and MOR personnel will construct the lateral condensate return line for $300 Thus the total cost will be approximately $900

Simple Payback = $900 x year/$3,370 = 0 26 year (3 2 months)

Simple payback using World Energy costs ($30/Gcal)

Savings = 337 Gcal/yr x $30/Gcal = $10,110/yr
Simple Payback = $900 x year/$10,110 = 0 09 year (1 month)

APPENDIX D

Flow Meter and Steam Trap Specifications

Flow Meter Specifications

Flow meter (one 6" model, two 4" models) In-line vortex shedding flow meter with LCD display, 4-20 mA DC and scaled pulse outputs, 300 psi rated flanges

Pressure transmitter (three required) 0-300 psig rangeability, stainless steel construction, 4-20 mA DC output, 110/220 VAC 50/60 Hz

Temperature sensor with remote mount transmitter (three required) 110/220 VAC 50/60 Hz, 0-300 °C range, thermowell required

Mass flow computer (three required) 110/220 VAC 50/60 Hz powered, accepts pressure, temperature, and flow signals from the meters above, compensates flow rate to standard conditions, mounted in a NEMA 4 fiberglass enclosure

Installation kit (three required) two each interconnect wire, two wire (20 gauge) shielded, 200' spool, 4" or 6" flanges and gaskets as required, stud bolts, nuts and washers (stainless steel) to be used with the above 4" and 6" flanges

Estimated Cost $15,500

Steam Trap Specifications

At an estimated flowrate of 221 kg/hr and a pressure drop of 3 atmospheres, a steam trap similar to Armstrong model 1010 should be selected Using the Russian designations, ten 1/2" steam traps with 1/8" orifice should be installed The trap should have a 1/2" flanged fitting and be fully constructed of stainless steel To prevent theft, tamper resistant bolts should also be supplied with the ten steam traps A tool should also be supplied to install and remove the tamper resistant bolts

At estimated flowrate of 40-140 kg/hr and a pressure drop of 3 atmospheres, a steam trap similar to an Armstrong steam trap model 1010 and 1011 can be selected One Armstrong steam trap, model no 1010 1/2" steam trap with #38 orifice (installed as the second trap), and three Armstrong steam traps, model no 1011 with 5/64" orifice should be installed Each trap should have a 1/2" flanged fitting and be fully constructed of stainless steel To prevent theft, tamper resistant bolts should also be supplied with the four steam traps A tool should also be supplied to install and remove the tamper resistant bolts

APPENDIX E

Boiler Efficiency Test

Boiler Efficiency Test on old Supplemental Boilers*

A combustion efficiency test was performed on one of the existing boilers The results of this test showed

- excess air of 55%
- CO emission levels of 3 ppm
- NOX emission levels of 120 ppm, and
- SO2 emission levels of 601 ppm

Combustion efficiency estimated using

- LHV for the fuel was 81%
- HHV for the fuel the efficiency was about 77%

* Supplemental Boilers are in the process of being replaced

APPENDIX F

Contacts List

Representatives of MOR were as follows

Konstantin A Belanov Chief Power Engineer,
phone number 355-32-01

Alexander A Marevv Deputy Power Engineer,
phone number 355-86-65

Dr Nikolai Yalovega Chief Research Worker, KOPEN Co

Lyudmila Donchenko Electrical Engineer,
phone number 355-88-36

Valeriy Babkov Chief Instrumentation Foreman

Albert Smirnov Deputy Instrumentation Foreman

Additional MOR staff were contacted for information during the audit as required

Representatives of the Moscow Inspection Agency, EnergoNadzor were

Sergie Goryachev, Inspector

Alexandra Dolguina, Chief Inspector

Translation services - Ms Rita Ratner phone number 456-0033

APPENDIX G

Glossary

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 CelsiusT[°C] = 5/9*(T[°F] - 32)
°F	= degree Fahrenheit
°R	= degrees RankineT[°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
Kgce	= 7,000 kcal = 27,776 BTU
kJ	= kilojoules = 1 thousand joules = 0 947813 BTU
km	= kilometer = 0 621 miles
kN	= kilonewton = 1 thousand newtons
kp	= kopeck = 1/100 ruble
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 hour = 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
therm	= volume of natural gas 100 cubic feet, 100,000 BTUs
TPS	= Thermal Power Station
V	= volts
VA	= volt-amps
VArs	= volt-amps (reactive)
VSD	= variable speed drive
yr	= year