PN-ACC-226
97005

RMA/NIS-DO1-R-10

Delivery Order #1:
Energy Efficiency and Power Sector Improvements for Russia
Task 1 - Energy Efficiency Activities

Draft Audit Report
VOLGOGRAD ALUMINUM PLANT

August 1994

Prepared by: William Dries
Yevgeny Guterman
Doug Presny
Resource Management Associates of Madison, Inc.

Prepared for: Burns and Roe
Washington, D.C., USA
Contract Number:
CCN-0002-Q-00-3154-00

Resource Management Associates of Madison, Inc.
202 State Street, Suite 303, Madison, Wisconsin 53703, USA, telephone: 608-283-2880, facsimile: 608-283-2881

Preface

The work described in this report has been 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.

Table of Contents

1.0 EXECUTIVE SUMMARY 1

2.0 FACILITY BACKGROUND 3
- 2.1 Description of Facility 3
  - 2.1.1 Management Structure 3
- 2.2 Production Profile 3
- 2.3 Facility Energy Use 3
  - 2.3.1 Facility Energy Consumption 4
  - 2.3.2 Fuel Costs 5
- 2.4 Viability of Facility 5

3.0 SYSTEMS AUDITED 6
- 3.1 Smelting Facility Lighting 6
- 3.2 Boiler Plant 6
- 3.3 Cooling Water Pump 7
- 3.4 Condensate Return 8
- 3.5 Steam Distribution 8
- 3.6 Heat Recovery Potential 8

4.0 IMPACT OF SAVINGS 9

List of Tables

Table 1 Energy Conservation Opportunities (ECOs) 2

Table 2 Aluminum Plant Electricity by End-use 5

Appendices

APPENDIX A
Photographs of Volgagrad Facility and Equipment

APPENDIX B
Energy Conservation Opportunities and Equipment Specifications

APPENDIX C
Audit Equipment Utilized

APPENDIX D
Local Weather Data

APPENDIX E
World Energy Prices

APPENDIX F
Equipment Transfer Records

APPENDIX G
Contact List

APPENDIX H
References

APPENDIX I
Glossary

1.0 EXECUTIVE SUMMARY

The team of Dr. William Dries, Mr. Doug Presny, and Mr. Yevgeny Guterman spent four days in May, 1994 at the Volgograd Aluminum Plant. Initial discussions with plant management defined the scope of the audit. The plant has already made agreements with outside investors and firms to improve the energy efficiency of the refining process resulting in a plan to reduce electricity use of this process by 20 percent. Electricity used for the refining process will be reduced by 20%. The refinery process typically consumes about 96% of the electrical energy and about 50% of the heat energy of the plant. Since the use of electricity in the refining process has been addressed, this audit covers the remaining electrical and heat uses such as lighting, boilers and building heating, compressed air production, water pumps, and heat used for production of anode material.

The Volgograd Aluminum Plant is the largest aluminum smelting plant in European Russia, employing 4,000 workers on-site. Its propects for adjusting to the changes in the Russian economy appear to be good. Thirty percent of its products are exported, and initiatives are being developed to produce finished products, thereby increasing profits and revenues. It is fortunate that the plant is pursuing energy efficiency in a timely manner, as energy prices have been increasing at an average of 10-15% per month.

Due to Russia's current economic status, most companies are having cash flow difficulties. The Volgograd plant is no exception. Therefore, the recommendations in this audit were selected specifically for their short payback times and the availability of necessary resources. Most of these recommendations pay back within a year, and use labor and materials already on-site. The team identified five specific Energy Conservation Opportunities (ECOs):

(1) Lighting Upgrade
(2) Combustion Analyzer to Improve Steam Production Efficiency
(3) Control Scheme to Provide Standby Pumping
(4) Anode Production Steam Condensate Return
(5) Steam Leak Repair

See *Table 1* for a summary of these ECOs. Additional recommendations are also made within this report. The potential for energy savings in this plant is good, and a program to continue audits by the plant should be implemented. Plant management has the capability to do this. Other aluminum refineries in Russia have similar facilities and should consider similar energy conservation opportunities.

Table 1 Energy Conservation Opportunities (ECOs)

ECO #	DESCRIPTION	ANNUAL ENERGY SAVED	PROJECT COST (US$)	SIMPLE PAYBACK WORLD ENERGY PRICES	SIMPLE PAYBACK LOCAL ENERGY PRICES
1.	LIGHTING UPGRADE	277,608 kWh	$35,781	4.0 years	18.4 years
2.	PORTABLE COMBUSTION ANALYZER	14,450 MBTU	$5,000	0.3 years	0.7 years
3.	STANDBY PUMP CONTROL	1,232,000 kWh	$18,412	0.2 years	1.1 years
4.	STEAM CONDENSATE RETURN	27,000 MBTU	$20,868	0.2 years	0.8 years
5.	STEAM DISTRIBUTION LEAKS (20)	26,280 MBTU	$1,000	0.01 years	0.03 years
		TOTAL	$81,061	4.71 years	21.3 years

2.0 FACILITY BACKGROUND

2.1 Description of Facility

The Volgograd Aluminum Plant was commissioned in 1957. It has 4,000 workers on-site and is the largest aluminum factory in the European part of Russia. The Volgograd Aluminum plant is a single facility business, with production aimed at creating aluminum metal ingots from the raw material of aluminum oxide. Within the plant, eight buildings with aluminum smelting lines exist. In producing 11,000 metric tons of aluminum per month, the plant consumes 6,575,000 kWh of electricity daily. This power originates at the Volgograd Hydroelectric Dam.

2.1.1 Management Structure

The Volgograd Aluminum Plant is a joint stock company, with 49% state ownership and 51% employee ownership. Up to 15% of the stock may be sold to foreign investors.

By nature, the aluminum smelting process is a continuous process, operating 24 hours per day 365 days per year. The large plant staff performs production and administrative tasks in plant.

2.2 Production Profile

Domestic consumption accounts for 70% of production. Major users include electrical grade aluminum and the electrical wire industry.

Exports account for 30% of production. Due to cash flow difficulties, aluminum is often used as a trading commodity to receive raw materials.

Management at the plant realizes that if they invest additional resources to manufacture a finished product from their aluminum, they will receive additional revenue. Pursuant to this end, they are planning to begin the manufacturing of window frames to be used for gas filled windows. They believe this will yield a 500% increase in their profit per pound of aluminum used in the frames.

2.3 Facility Energy Use

Average daily peak electrical power demand is 274 megawatts with a 95% load factor. The majority of plant electricity is used to produce 11,000 metric tons of aluminum per month, with the aluminum electrolysis process consuming 96% of plant electricity. (See Appendix A-Figures 13 and 14 for photos of the electrolytic cells aluminum production.) Within the last year, the plant installed a new 175,000 amp bank of electrolysis cells, which showed an

electricity reduction of more than 20% per pound of aluminum according to plant reports. Primary use of non-electrolysis electrical consumption is for pumping cooling water, making compressed air, and high bay lighting.

Purchased power originates at the Volgograd Hydroelectric Dam. (See Appendix A-Figure 11 for a photograph of the hydroelectric power plant.) The hydro-generation facility was built simultaneously with the aluminum plant. The dam has 22 generation units of 115 megawatts each. The dam produces 12 billion kWh per year, of which the aluminum plant uses 20% or 2.4 billion kWh.

Electricity is received from the hydropower plant via three 220,000 volt, 50 hertz alternating current lines. Near the plant, the voltage is reduced from 220,000 volts, AC to 10,000 volts, AC. The plant takes ownership of the power at 10,000 volts, AC. The AC voltage is rectified to direct current in two silicon rectifier substations. Each rectifier substation contains 32 rectifiers of 25 KVA each. The end voltages used in the plant are 850 volts DC and 630 volts AC. Smaller substations transform both the AC and DC current voltages to appropriate voltages within the plant. In total, 66 substations exist on the plant site, with transformer capacities ranging from 63 to 3,1500 KVA.

Natural gas is also used onsite in 6 steam boilers with total capacity of 60 metric tons. One-half of the steam is used for process and the other half for space heating during winter. Steam is used as the medium to transfer thermal energy for space heating. Six central boilers produce steam for both production and space heating thermal energy. Three boilers are needed during the summer, and the other three are added during the winter to provide space heating capacity.

2.3.1 Facility Energy Consumption

The Volgograd Aluminum Plant receives power at 10,000 volts. It has a daily electrical consumption of 6,575,000 kWh, and an annual consumption of 2.4 billion kWh This total represents 13% of all electricity consumed in the Volgograd region. The plant has a 95% electrical demand factor, which is very high for most industries, but typical for an aluminum plant. Its electrical demand averages 270 MW, 96% of which goes towards electrolysis. For production of aluminum, all electrolysis electricity is rectified into direct current.

For 1994, planned consumption of thermal energy is 169,997 GCal. Neighboring industries purchase 35,479 Gcal of thermal energy. In total, 135,508 GCal of thermal energy are used at the plant site each year; 300 metric tons of steam are used on-site each year.

One half of the plant boiler capacity is used for process heating. The approximate split of the electric energy use by the plant boiler is shown below.

Table 2 Aluminum Plant Electricity by End-use

Aluminum Electrolysis	96%
Pump Motors, Hot Oil Electric Boilers for Anode Production, and Facility Lighting	4%

During 1992, 27% of the cost of aluminum production was attributed to electricity costs. Typical high efficiency aluminum smelting requires 17,350 kWh per metric tonne. With the new high amperage electrolysis cells recently installed, electricity consumption is 14,600 kWh per metric ton of aluminum produced. This is 20% less than the 18,200 kWh per metric ton of aluminum with the plant's standard electrolysis cells.

Natural gas is also used but to a lesser extent. Six steam boilers at the aluminum plant use natural gas as fuel.

2.3.2 Fuel Costs

Fuel costs have seen a rapid increase in the previous 3 years. Rates change on a monthly basis, typically increasing 10 to 15% percent per month.

Using an exchange rate of 1,800 Rubles per dollar (100 Kopeks = 1 Ruble) from April of 1994, the cost of electricity averaged 26 rubles, 46 Kopeks per kWh ($0.0139/ kWh). This is 8,646 rubles, 10 Kopeks ($0.4551) per kW of monthly electrical demand, and 12 rubles and 27 Kopeks ($0.0065) per kWh consumed. The local cost for natural gas was $1.00/MBTU.

2.4 Viability of Facility

During the audit, the management of the facility did not indicate any concerns regarding the possibility of the facility being closed. A test of new higher amperage equipment showed that a 20% electricity reduction could be achieved in production of aluminum. A 40 million dollar joint venture is being negotiated to retool the entire facility with the higher efficiency equipment.

3.0 SYSTEMS AUDITED

3.1 Smelting Facility Lighting

The aluminum smelting process is performed in large buildings with 12.2 meter (40 foot) ceilings. Ambient lighting that originates from the ceiling level provides general safety and object identification lighting for the workers. Tasks performed under this lighting include the addition of anode material to the electrolysis cells, breaking of electrolysis cell crust with fork lifts, and other maintenance activities.

Energy Conservation Opportunity #1: Lighting Upgrade

The Volgograd Aluminum Plant uses 700-watt mercury vapor fixtures and a limited number of high pressure sodium (HPS) fixtures for exterior night lighting. Each of the eight electrolysis buildings could be retrofitted with high pressure sodium technology. Due to the improved efficiency of the HPS technology, it is possible to retrofit the current 700-watt mercury vapor fixtures with 400-watt HPS fixtures. The resulting light level would be 13% greater than what currently exists, as high pressure sodium lighting generally produces twice light per watt of a mercury vapor lighting. Additional light output may result from this retrofit including gasketed and filtered fixtures. HPS fixtures have proven to be effective in foundry and other high particulate settings. They will provide additional light reflected down at the work area. The current lamp and ballast, without a reflector installation, allows approximately 25% of the light to be focused in areas not usable for the workers. (See Appendix B-01 for greater detail.)

The capital investment for this project is $35,781 per electrolysis building. The relighting project has a payback of 4 years using world energy prices, and 18.4 years using local energy prices.

3.2 Boiler Plant

A single boiler house with six boilers (averaging 40 years old) serves the plant with heat for process and space heating. Each boiler is rated at 10 metric tons per hour of steam at 10 kilograms per square centimeter pressure (142 psi). Makeup water is treated, which composes approximately 70 percent of the steam load. Two boilers are used for these processes while the others are used for heating. The average annual load is about 50 percent. Natural gas is used as fuel in these boilers.

Energy Conservation Opportunity #2: Combustion Analyzer to Improve Steam Production Efficiency

Combustion efficiency tests were run on boilers No. 3 and No. 4, and efficiencies ranging

efficiency by two percent. The combustion analyzer would allow the operator to monitor and control the fuel-air ratio. (See Appendix B-02 for energy calculations). The annual savings of fuel would pay back the cost of the analyzer in less than six months.

3.3 Cooling Water Pump

After the electrolysis process, pumps are the largest electrical energy consumers. To investigate how energy can be conserved in large pumps, a cooling water circulation pump was monitored while in operation.

The particular large pump monitored for this audit is used to circulate plant cooling water. Cooling water is utilized throughout the plant for production purposes. The cooling water is continuously circulated through inner plant piping. After being used to cool a process, the water is discharged into a cooling reservoir so that it can expel heat to the atmosphere. In the hottest part of summer, the water is also run through a cooling tower to guarantee ample temperature reduction. After heat has been removed, the water is returned to the process areas to once again provide cooling.

Energy Conservation Opportunity #3: Control Scheme to Provide Stand-by Pumping

Cooling water demand has recently been reduced. Consequently, two of the cooling water pumps had their impellers shaved to reduce their capacity, allowing two pumps to be run in parallel. Pumps are run in parallel so that there is another pump to provide cooling water at a reduced capacity if a pump fails. Although this method of redundancy is functional, it reduces pumping efficiency from 89% to 60% in this case.

Instead of an additional pump, a control scheme should be used to provide stand-by pumping. Although two of the pumps impellers were reduced, additional pumps exist with original impeller diameters. The control scheme has a lead pump which provides cooling water circulation. Should this pump fail to perform its task, discharge header pressure would drop. A control switch would be placed in the discharge header. When the header pressure drops, the pressure switch would start the stand-by pump. The stand-by pump would normally be isolated from the discharge header by a swing check valve. When the stand-by pump is activated, the pump discharge pressure would provide ample force to open the check valve and begin supplying the header with pressurized water.

This project proposal includes the equipment to implement the control scheme, as well as electrical monitoring equipment to verify savings on this project, and to seek out additional pump optimization opportunities.

Energy savings on this pumping station alone are 1,232,000 kWh per year. The equipment specified for this proposal will cost $18,412 and have a payback of 0.2 years at world energy

costs and 1.1 years at present local energy costs. (See Appendix B-03 for energy calculations.)

Another method for accomplishing the efficiency improvement while maintaining the parallel pumping redundancy is to provide two new pump and motor setups that are designed to be efficient at existing levels of cooling water demand. This option is significantly more capital intensive. The pumps would be identical, with optimum efficiency in production of 975 cubic meters per hour at 62 meters of head. This would provide the total of 1,950 cubic meters per hour at 62 meters of head, which is presently the total pumping output.

This investment would be $225,000 for the pumps, motors, and monitoring equipment. With efficiency of the new pumps at 89%, the project would save 1,500,000 kWh per year. The project would pay itself back in 2.4 years at world energy prices, and 10.7 years at local energy prices.

3.4 Condensate Return

Energy Conservation Opportunity #4: Anode Production Steam Condensate Return

The present process to make anode material uses steam to heat the petroleum product. (See Appendix A-Figure 6 for a photo of the anode production system.) The condensate is not returned to the boilers. Installation of steam traps and a condensate return pump will result in an annual saving of heat of approximately 27 GBTU. The payback for the traps and pump is less than one year. (See Appendix B-04 for energy calculations.)

3.5 Steam Distribution

Energy Conseration Opportunity #5: Steam Leak Repair

The audit team observed a number of steam leaks during the plant visit. (See Appendix A-Figures 7 and 8 for photographs.) The immediate repair of these leaks will result in fuel cost savings. The payback is less than 2 weeks for the repair of a steam leak at local prices and three days at world prices. After the leaks are repaired, a steam leak identification and repair program should be initiated. (See Appendix B-05 for calculations.)

3.6 Heat Recovery Potential

Heat recovered from boiler blowdown could be used to heat boiler feed water. The payback is estimated to be one to two years. There are other heat recovery potentials from air compressors, from water used to produce aluminum pellets, and from stack gases given off by furnace and refining cells. Payback periods for these items would depend on capital costs and could be determined with additional on-site investigation.

4.0 IMPACT OF SAVINGS

The described energy savings investments will typically provide financial payback within the same budget year. Implementing the conservation measures will actually reduce budget expenditures during the year because savings over and above expenditures will be seen from projects with less than a one year payback. Energy project money should come from electricity and fuel budgets, as equipment and manpower investment from the energy budget at the start of the year will be returned by the end of the budget year. Due to present national economic conditions, reserve cash flows are not available to make internal plant investments with greater than a month payback. Despite this cash flow problem, internal resources such as manpower and available materials can be utilized to improve energy efficiency in some areas.

All of the energy conservation projects have multiple applications within the aluminum plant as well as in other industrial facilities. The concepts proposed for energy conservation are commonly implemented in the U.S.

APPENDIX A

Photographs of Volgograd Facility and Equipment

List of Photographs:

1. Pump Station

2. Pump Number 4

3. Pump Power Monitoring

4. Lighting Power Monitoring

5. Pump Number 4

6. Condensate Return Anode Production

7. Steam Leaks

8. Steam Leaks

9. Aluminum Pellet Production

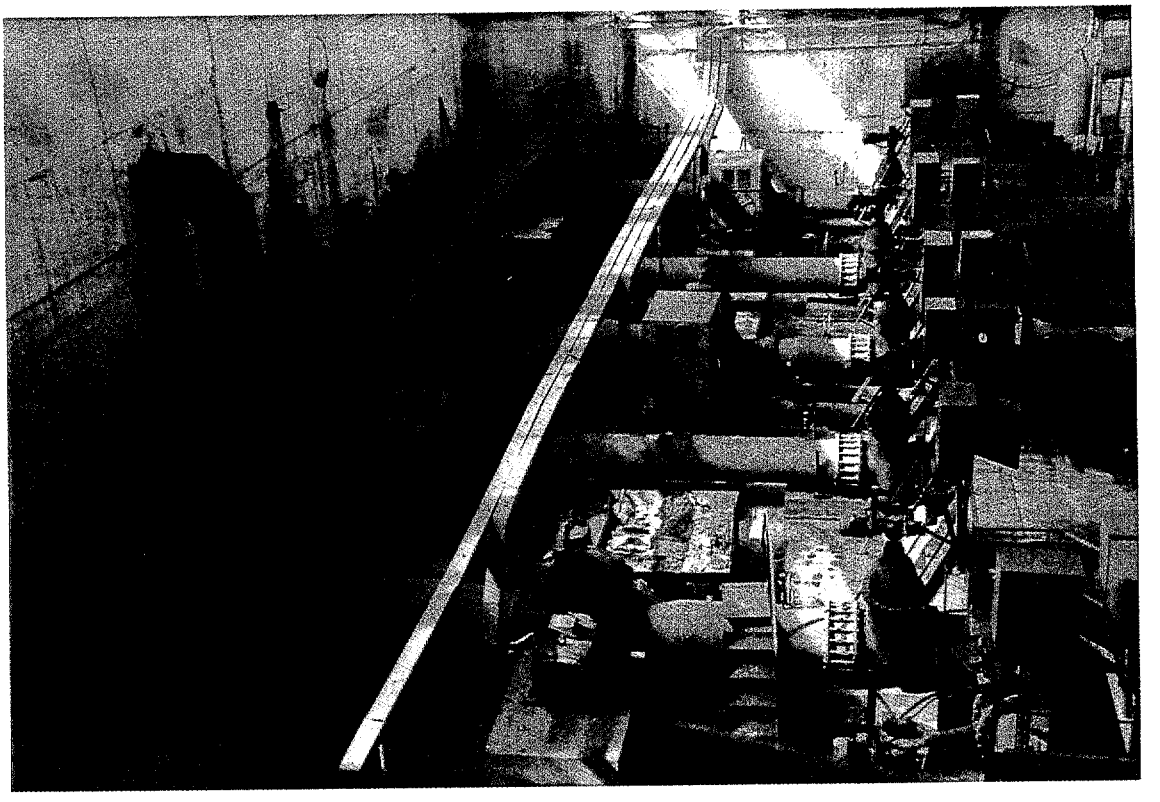
10. Aluminum Pellet Production

11. Hydroelectric Power Plant

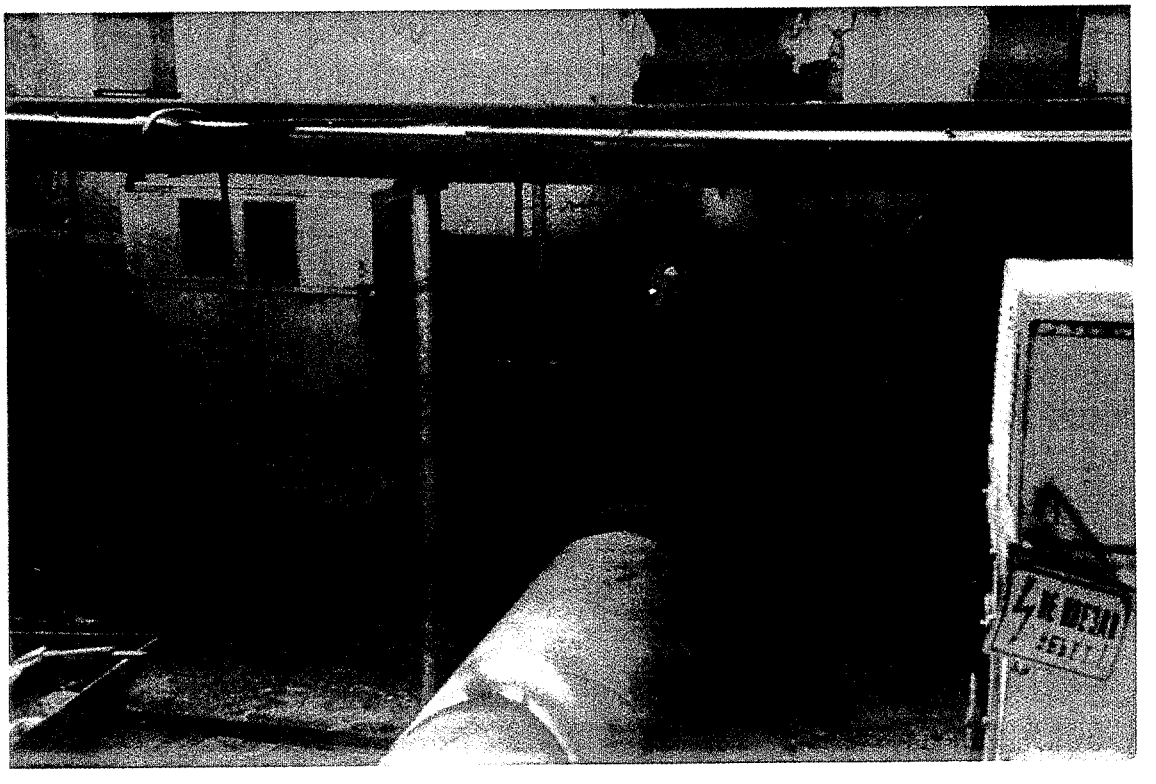
12. Audit Team

13. Electrolytic Cells Aluminum Production

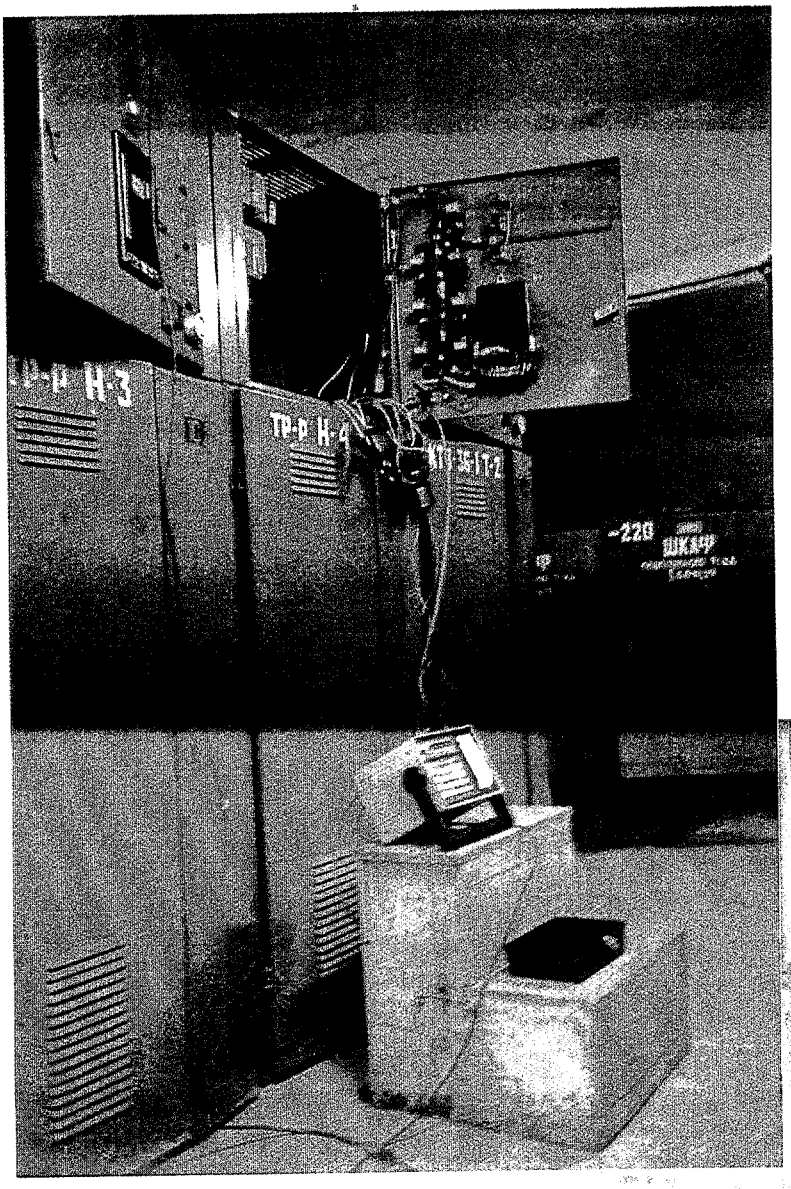
14. Electrolytic Cells Aluminum Production



1. Pump Station

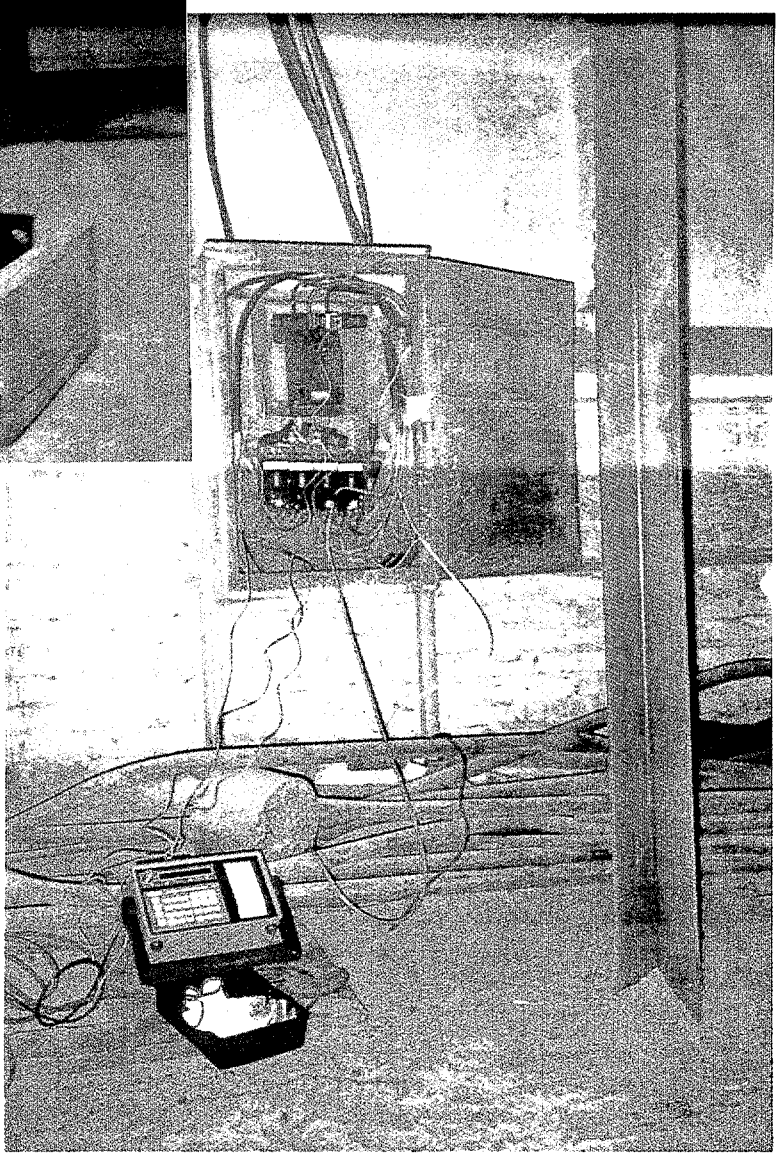


2. Pump Number 4



3. Pump Power Monitoring (top left)

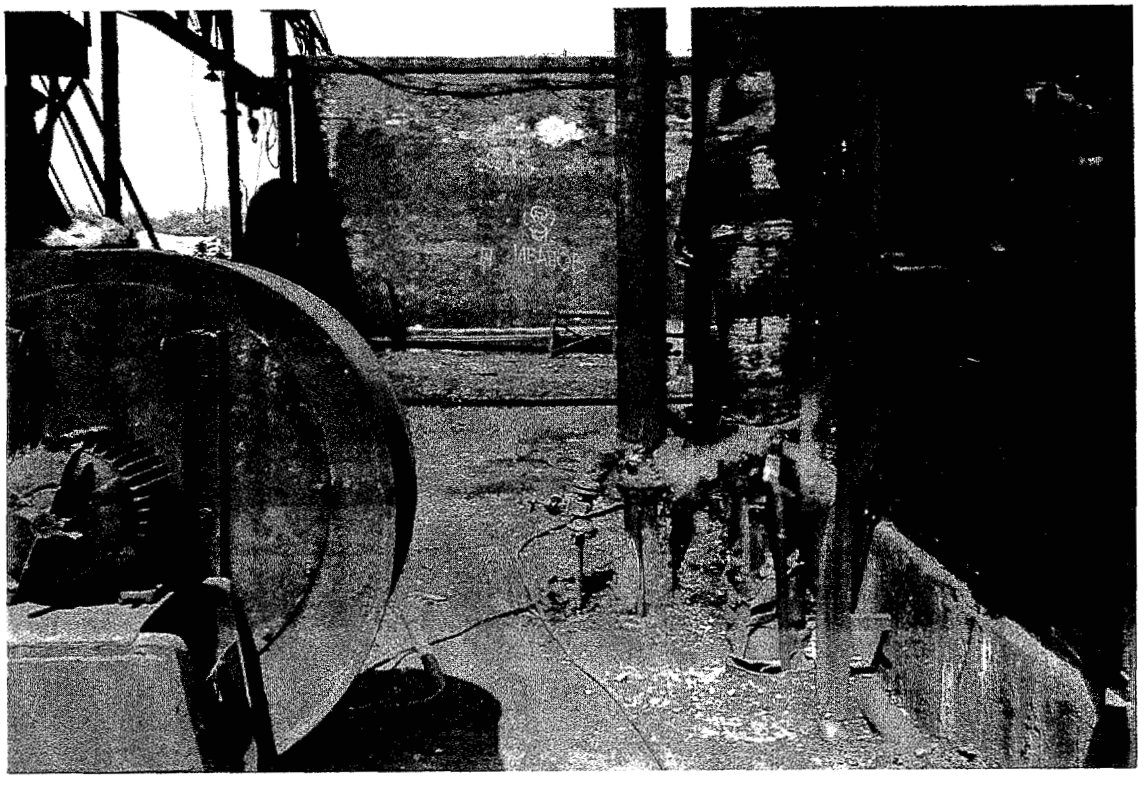
4. Lighting Power Monitoring (bottom right)



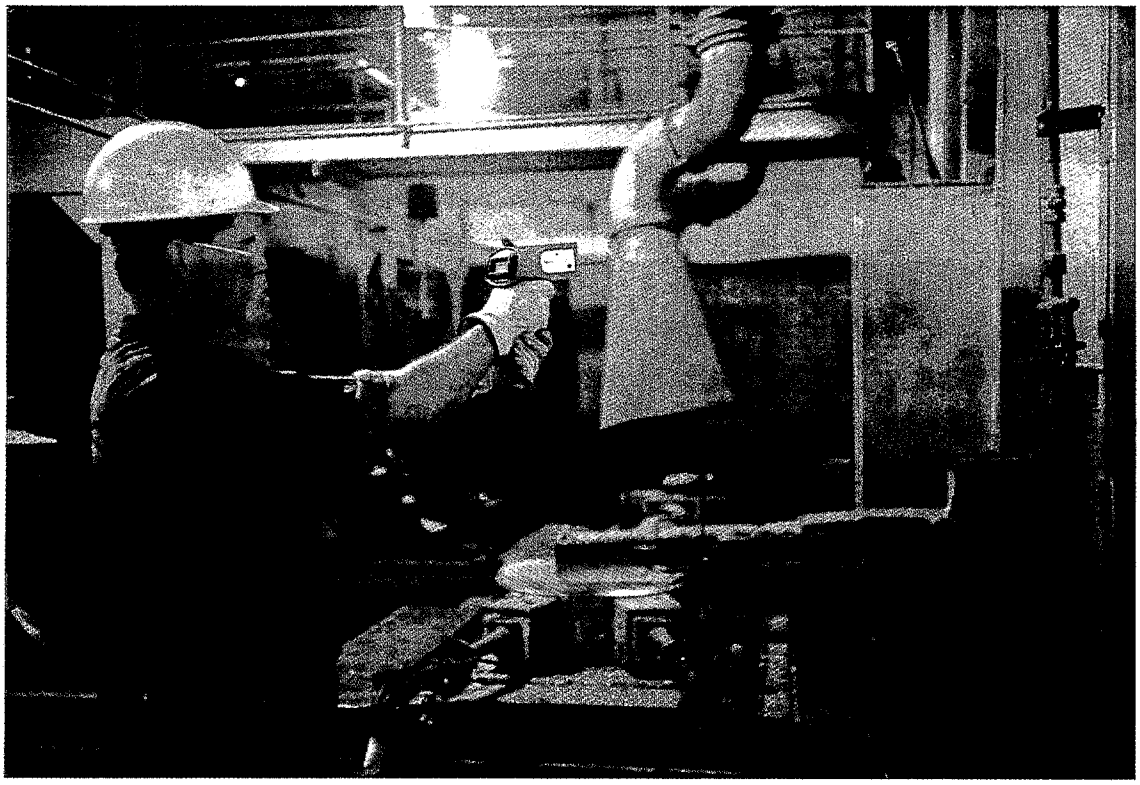
5. Pump Number 4

6. Condensate Return Anode Production

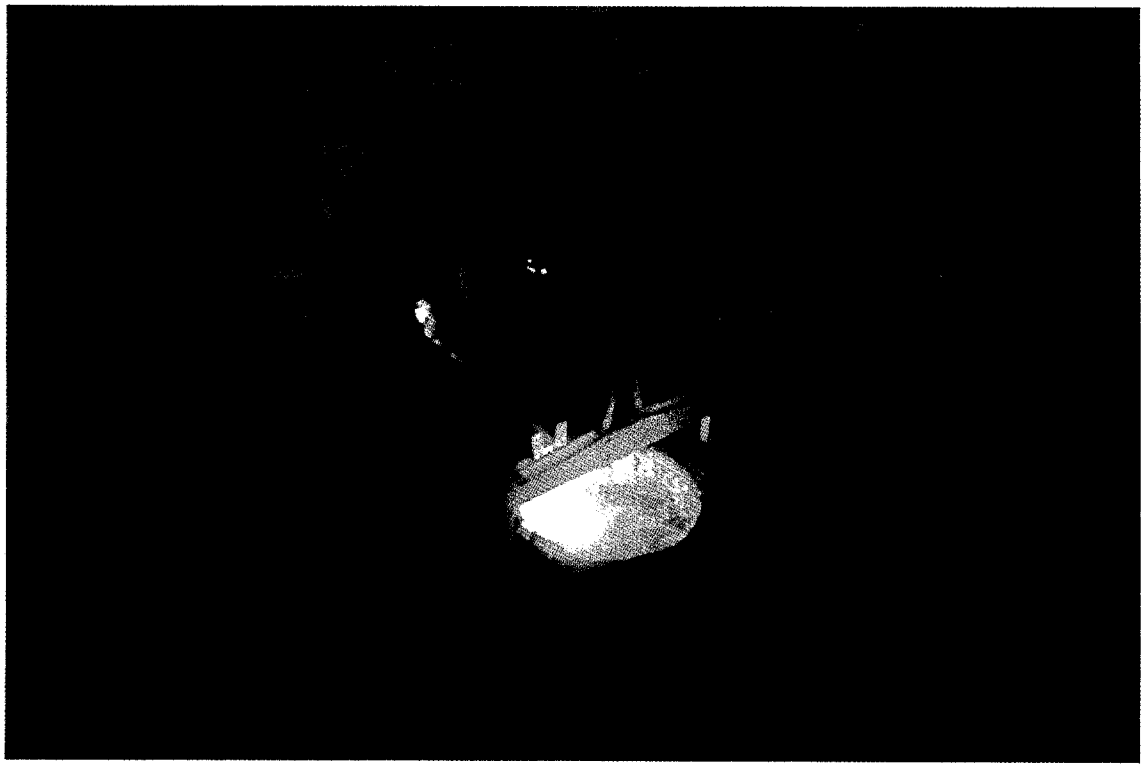
7. Steam Leaks



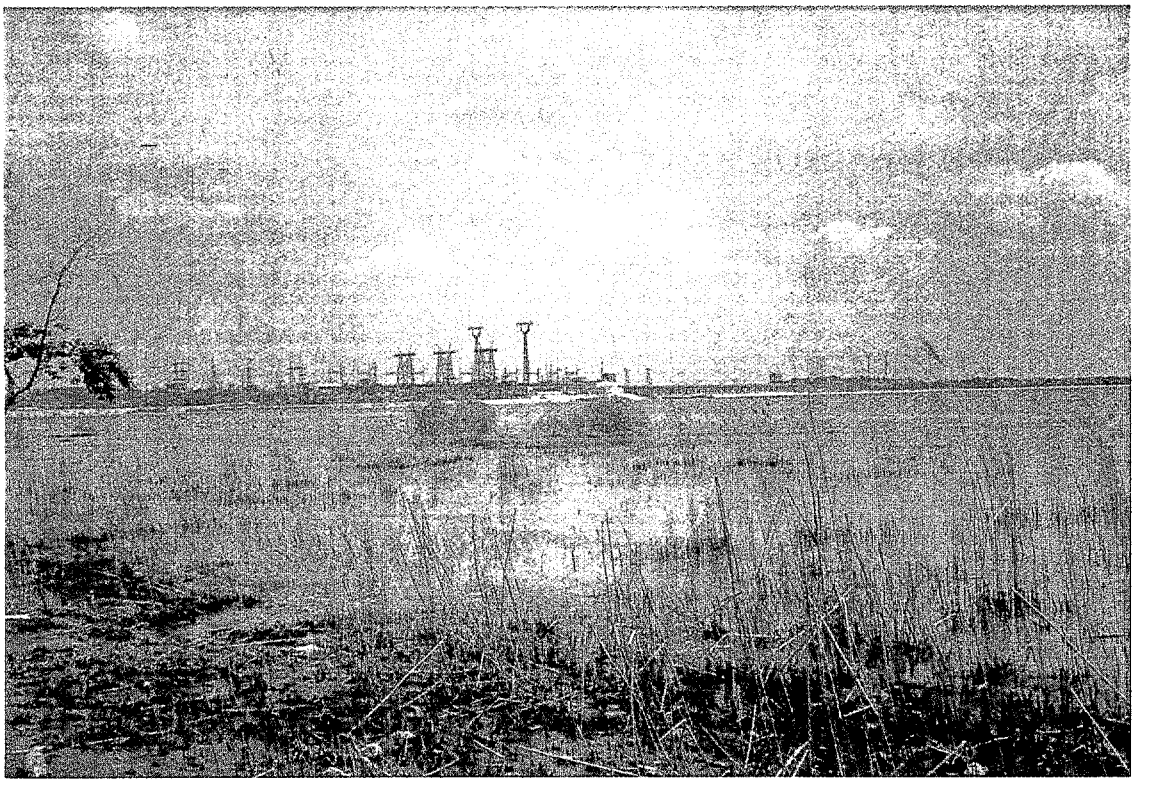
8. Steam Leaks



9. Aluminum Pellet Production

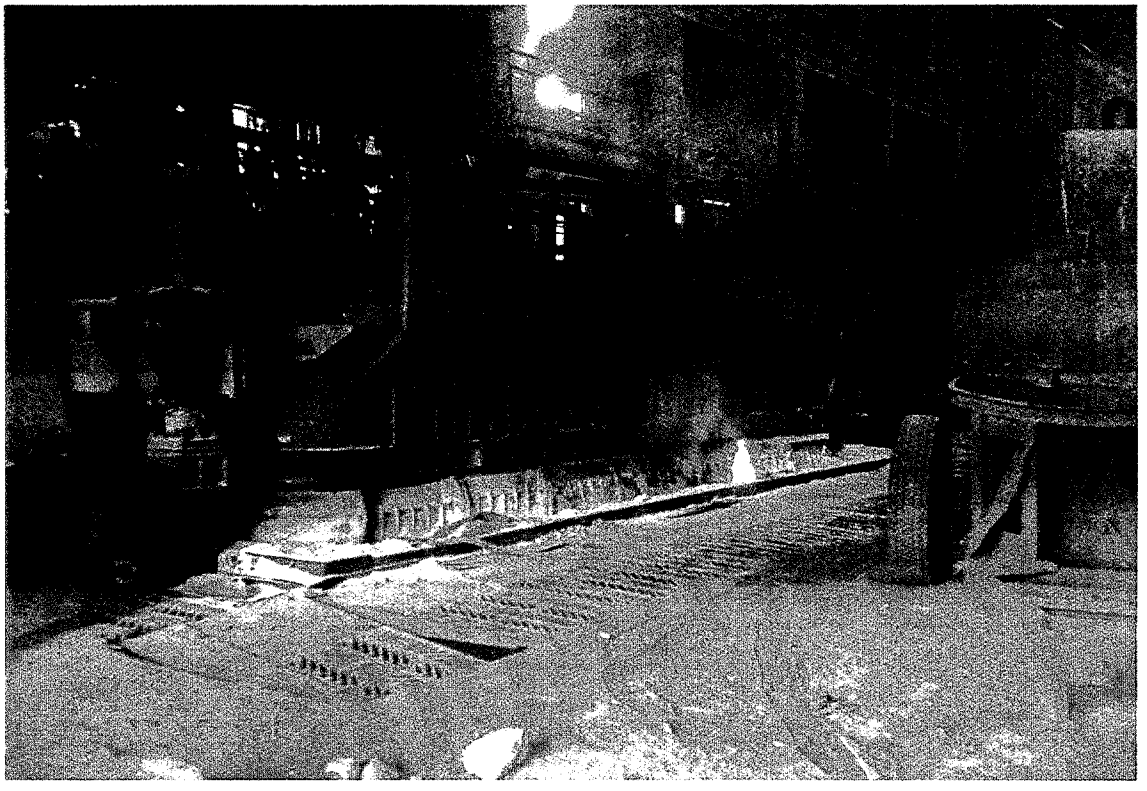


10. Aluminum Pellet Production

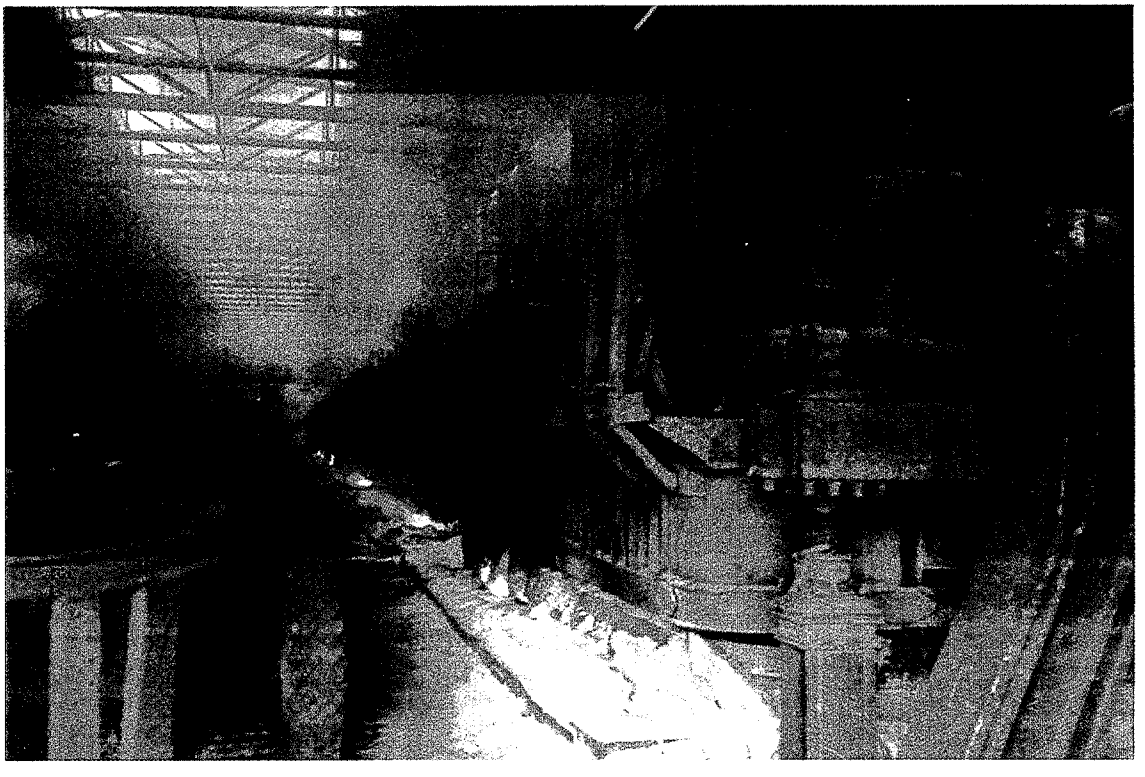


11. Hydroelectric Power Plant

12. Audit Team



13. Electrolytic Cells Aluminum Production



14. Electrolytic Cells Aluminum Production

APPENDIX B

Energy Conservation Opportunities (ECOs) and Equipment Specifications

ECO-01
Lighting Upgrade from Mercury Vapor Fixtures to High Pressure Sodium Fixtures

ECO-02
Combustion Analyzer to Improve Steam Production Efficiency

ECO-03
Control Scheme to Provide Standby Pumping

ECO-04
Anode Production Steam Condensate Return

ECO-05
Steam Leak Repair

ECO - 01

Lighting Upgrade from Mercury Vapor Fixtures to High Pressure Sodium Fixtures

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Currently, 700 watt mercury vapor fixtures are used to provide ambient lighting in the 12 meter (40 feet) tall aluminum electrolysis buildings. Due to particulate accumulation of fixture reflector surfaces, the fixture reflectors have been removed. Only the ballast and bulb are suspended from the ceiling. Lighting is shut off during 1/2 of daylight hours due to light entering from translucent panes on the ceilings and walls. Total operating time is 5,380 hours per year.

DESCRIPTION OF PROPOSED MODIFICATIONS

It is proposed to replace the mercury vapor technology with high pressure sodium technology. Fixtures will be replaced on a one-for-one basis. Due to the high lumen output of high pressure sodium technology (double the output of mercury vapor), the 700 watt existing fixtures will be replaced with 400 watt fixtures. The result will be 13% more light than currently exists. Two buildings with 75 fixtures each will be targeted in this technology upgrade.

ENERGY SAVINGS

Existing Conditions per Building

Watts per fixture:

ballast	= 105 watts
lamp	= 700 watts
TOTAL POWER	= 805 watts

Lumen output = 44,100 lumens per lamp

TOTAL POWER FOR 75 FIXTURES

kW_{TOTAL} = 75 fixtures x 805 watts per fixture / 1000 W per kW

kW_{TOTAL} = 60.3 kW

PROPOSED CONDITIONS

Watts per fixture:

ballast	= 60 watts
lamp	= 400 watts
TOTAL POWER	= 460 watts

Lumen output = 50,000 lumens per lamp

TOTAL POWER FOR 75 FIXTURES
kW_{TOTAL} = 75 fixtures x 460 watts per fixture / 1000 W per kW
kW_{TOTAL} = 34.5 kW

ENERGY SAVINGS

Power Reduction = 60.3 kW - 34.5 kW
= 25.8 kW

Annual operation hours

Daylight = (8760 - 2,000) x 50%
= 3,380 hours per year

Night = 2,000 hours per year

TOTAL = 3,380 + 2,000 hours per year
= 5,380 hours per year

Annual kWh Savings
kWh_{SAV} = 25.8 kW x 5,380 Hours per Year
kWh_{SAV} = 138,804 kWh

WORLD ENERGY PRICES - MODIFICATION SAVINGS
S_{WORLD} = 138,804 kWh x $.064/kWh
S_{WORLD} = $8,884 per year using world energy prices

LOCAL ENERGY PRICES - MODIFICATION SAVINGS
S_{LOCAL} = 26.46 rubles / kWh
S_{LOCAL} = 26.46 rubles per kWh / 1877 rubles per dollar
S_{LOCAL} = $0.014 per kWh as of April, 1994

S_{LOCAL} = 138,804 kWh x $.014 per kWh
S_{LOCAL} = $1,943 per year using local energy prices

PROJECT IMPLEMENTATION COST

MATERIALS	UNIT	QUANTITY	COST/UNIT	TOTAL COST
400 watt HPS Enclosed and Gasketed High Bay Fixture with Polycarbonite Lens	each	75	$300	$22,500
HPS Lamp Clear 400 Watt Vertical Burn	each	83	$120	$9,960

SUBTOTAL = $32,460

SHIPPING
Estimated at 10% of material costs or $32,460 x 10 % = $3,246

LABOR	UNIT	QUANTITY	COST/UNIT	TOTAL COST
Local installation	hours	150	$0.50	$75

TOTAL PROJECT COST
$P_\$$ = $35,781

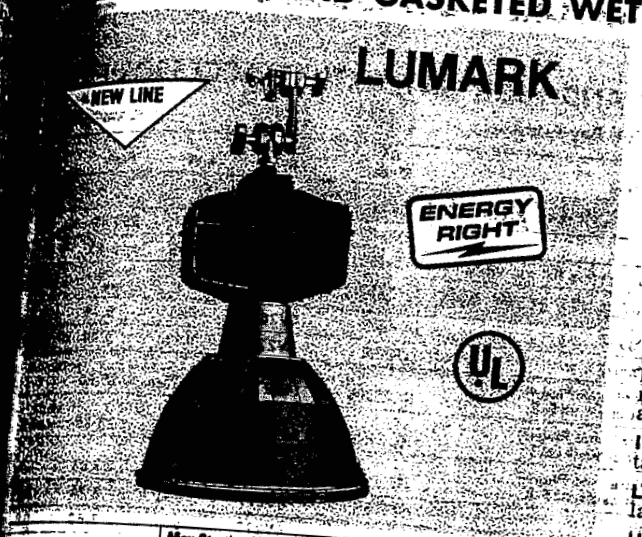
ECONOMICS

Simple Payback Using World Energy Prices
S_P = Project Cost / Annual Savings
S_P = $ 35,781 / $8,884
S_P = 4.0 Years

Simple Payback Using Local Energy Prices
S_P = Project Cost / Annual Savings
S_P = $35,781 / $1,943
S_P = 18.4 Years

INDUSTRIAL HID FIXTURES

ENCLOSED AND GASKETED WET LOCATION HIGH BAY FIXTURES



Applications: Gyms, foundries, hangars, and industrial/processing areas.

Housing: Durable die cast aluminum housing for lasting performance in the harshest environments. **Totally enclosed assembly features gasketing at three points:** door to reflector; reflector to neck; and neck to housing, for sealing out external contaminants. Unique design allows air flow between isolated electrical components for cooler operation. Textured black polyester powder coat finish.

Reflector: Computer designed, faceted reflector for maximum photometric performance and beam efficiency. Protective finish for stain and corrosion resistance.

Lens: Tempered glass lens with hinged and latched aluminum door frame.

Ballast: High power factor ballast with class H insulation. UL Listed for 65°C (149°F) ambient temperature operation. Minimum starting temperature is −40°C for High Pressure Sodium and −20°C for Metal Halide.

Installation: Heavy duty, die cast aluminum mounting box tapped for 3/4" conduit.

Lamp not included: Use suggested lamp listed below or see HID lamps on pages 740-744.

UL Listed for wet locations.

HID Type	Max Starting Line Amps @ Voltage 120	208	240	277	Max Running Line Amps @ Voltage 120	208	240	277	Suggested Lamp Stock No.	Dimensions Ht	Reflector Dia	Mtg Hgt Min	Mtg Hgt Max	Lumark Model	Stock No.	Less Lamp List	Less Lamp Each	Shpg. Wt.
High Pressure Sodium	2.20	1.28	1.11	0.96	4.36	2.52	2.18	1.90	2V453	24½"	18⅞"	20"	45"	HPEMM400MTWLENSA18	✓7V243	$599.67	$299.75	49.0
Metal Halide	3.80	2.20	1.90	1.60	4.00	2.32	2.00	1.70	2V658	26¾	18⅞	18	30	MHEMM400MTWLENSA18	✓7V244	562.67	281.25	41.0

UNIGLOW HIGH BAY FIXTURES

Housing: Die-cast aluminum finish is gray electrocoat paint.

Reflector: Alzak*-finished aluminum reflector is engineered to provide precise light control of all HID light sources. **Enclosed optical:** Has tempered glass enclosure for heat and impact resistance. Door glass assembly is hinged and latched for easy lamp access. Recommended for use with metal halide lamp types.

Ballast: Maximum ambient capability for all ballasts is 55°C (131°F). Minimum ambient temperatures are −20°F for mercury vapor and metal halide and −40°F for high pressure sodium. Quad-tap to operate on 120, 208, 240 or 277 volt, 60 Hz.

Socket: Heavy-duty porcelain adjustable socket bracket provides field adjustment and allows photometric performance to be tailored to the installation.

Installation: Threaded mounting hub permits easy attachment to 3/4" conduit. Wiring compartment opens wide for easy access.

Dimensions: 28 5/16H x 17" diameter.

Lamp not included: Use suggested lamp listed below or see HID lamps listed on pages 740-744.

UL Listed.

General Electric brand.

Suggested lamp Stock Nos.:
Nos. 7V201 and 7V208 use lamp No. 2V520.
Nos. 7V202 and 7V209 use lamp No. 2V453.
Nos. 7V203 and 7V210 use lamp No. 2V658.

Lamp not included

FIXTURE SPECIFICATIONS AND ORDERING DATA

Lamp Watts	Max Starting Line Amps, @ Voltage 120	208	240	277	Max Operating Line Amps, @ Voltage 120	208	240	277	Mounting Ht Min	Mounting Ht Max	S/MH	GE Model	Stock No.	Less Lamp List	Less Lamp Each	Shpg. Wt.
HIGH PRESSURE SODIUM																
150	2.0	1.2	1.0	0.9	2.5	1.5	1.3	1.1	15'	25'	1.5	UGS25SOA515V7	✓7V201	$331.63	$168.75	28.0
200	3.0	1.7	1.5	1.3	3.8	2.2	1.9	1.7	20	45	1.5	UGS40SOA515V7	✓7V202	327.66	173.00	28.0
250	2.0	1.2	1.0	0.9	2.5	1.5	1.3	1.1	15	25	1.5	UGS25SOA515E7	✓7V208	367.86	204.00	31.0
400	3.0	1.7	1.5	1.3	3.8	2.2	1.9	1.7	20	45	1.5	UGS40SOA515E7	✓7V209	363.89	208.25	31.0
METAL HALIDE																
400	4.0	2.5	2.1	1.8	4.0	2.5	2.1	1.8	18	30	1.5	UGS40MOA515V7	✓7V203	326.49	161.25	27.0
400	4.0	2.5	2.1	1.8	4.0	2.5	2.1	1.8	18	30	1.5	UGS40MOA515E7	✓7V210	362.72	196.50	30.0

(✓) Enclosed optical; all others open and ventilated. (*) Proprietary term of Aluminum Company of America.

ACCESSORIES FOR LOW AND HIGH BAY FIXTURES ON PAGE 868.

SEE WARRANTY INFORMATION ON PAGE OPPOSITE INSIDE BACK COVER

BEST AVAILABLE COPY

ECO - 02

Combustion Analyzer to Improve Steam Production Efficiency

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS
Six 10T/h boilers operate at an annual average load of 30T/h. The heat is used for process and heating.

Annual natural gas usage is equal to:
30T/h x 2,200,000 btu/T x 8760 h/yr/0.80
$30 \times 2.2 \times 10^6 \times 8760/0.80 = 722.7$ GBTU/yr

DESCRIPTION OF PROPOSED MODIFICATIONS
Tests and adjustments of the boilers are made biannually. The use of the combustion analyzer by the plant's staff will result in immediate savings and the ability to monitor combustion efficiency on a daily basis.

A two percent improvement in efficiency will save 14.45 GBTU/yr. Domestic natural gas costs $1.00/MBTU. The saving is $14,450/yr. The cost of a combustion analyzer is $5,000 and the payback is less than six months. At world prices for gas, the payback is less than two months.

Specification:

One Bacharach Model CA300NSX
with accessories and spare parts.....$5,000

FUEL COMBUSTION ANALYZER

Fuels capability:	Natural Gas (Russian composition) #5 fuel oil Coal Blast furnace gas Coke gas Mixes of above gasses
Measurement Capacity:	O2,CO,NO2,SO2,Temperature
Calculation Capacity:	Combustion efficiency CO2 concentration Excess air ratio
Accuracy:	
NO2	+/- 5% of reading
SO2	+/- 5% of reading
Probes:	12 inch and 48 inch
Sampling hose:	20 feet minimum
Output:	Thermal printer in unit

Power supply:	Rechargeable battery
Manufacturer:	Bacharach
Model:	CA 300 NSXE N 24-8032

(End of specification)

VOLGOGRAD

1

BACHARACH
MODEL CA300NSX
****
COMBUSTION ANALYZER

ID: No. 3 Right

SER NO: YCO 506

TIME: 11:34

DATE: 17,05,94

FUEL: NATURAL GAS

PRIMRY TEMP (C) 42

STACK TEMP (C) 335

% OXYGEN: 6.1

% EXCESS AIR: 37

% CARBON - DIOXIDE: 8.3

PPM CARBON - MONOXIDE: 0

PPM NOX: 83

PPM SULFUR - DIOXIDE: 1

% EFFICIENCY: 84.3

% STACK LOSS: 15.7

TEST PERFORMED BY:

COMMENTS ....

BACHARACH
MODEL CA300NSX
****
COMBUSTION ANALYZER

ID: No. 3 Left

SER NO: YCO 506

TIME: 11:23

DATE: 17,05,94

FUEL: NATURAL GAS

PRIMRY TEMP (C) 42

STACK TEMP (C) 414

% OXYGEN: 4.6

% EXCESS AIR: 25

% CARBON - DIOXIDE: 9.1

PPM CARBON - MONOXIDE: 0

PPM NOX: 87

PPM SULFUR - DIOXIDE: 0

% EFFICIENCY: 81.7

% STACK LOSS: 18.3

TEST PERFORMED BY:

COMMENTS ....

BACHARACH
MODEL CA300NSX
****
COMBUSTION ANALYZER

ID: No. 3 Right

SER NO: YCO 506

Boiler Out

TIME: 11:39

DATE: 17,05,94

FUEL: NATURAL GAS

PRIMRY TEMP (C) 42

STACK TEMP (C) 325

% OXYGEN: 5.2

% EXCESS AIR: 30

% CARBON - DIOXIDE: 8.8

PPM CARBON - MONOXIDE: 0

PPM NOX: 90

PPM SULFUR - DIOXIDE: 1

% EFFICIENCY: 85.6

% STACK LOSS: 14.4

TEST PERFORMED BY:

COMMENTS ....

	No. 4 LEFT	No. 4 RIGHT	INLET TO INDUCED DRAFT FAN NO. 3 & NO. COMBINED
	5 MAY 94	5 MAY 94	5 MAY 94
	NG	NG	NG
STACK TEMP (C)	268	332	175
% OXYGEN	6.9	5.9	9.8
% EXCESS AIR			79%
% CARBON - DIOXIDE			6.3
PPM SULFUR - DIOXIDE			2 ppm
% EFFICIENCY	87.4	84.7	91.0

ECO - 03

Use of a Control Scheme to Provide Stand-By Pumping

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS

Cooling water pumps are the largest non-electrolysis electrical energy users on site. The pump motors' electrical consumption was monitored using a Dranetz 808 Power Analyzer. Due to a reduction in required plant cooling water volume, 2 pump impellers were machined down so that the pumps could still run in pairs. Running pumps in pairs provides backup capacity should one pump fail during operation. Although cooling water capacity was reduced, distribution pressure requirements for the system remained unchanged. Original pumping efficiency at 62 meters of head was 89% according to the pump curve information. Pumping efficiency at the same head with a reduced impeller diameter is 60% for each of the two pumps running. The pumps are each driven with a 1,000 kW (1,340 HP) motor. With a full size impeller, the motor runs at 50% of full load. With a reduced impeller, the motor is running at 30% of full load.

DESCRIPTION OF PROPOSED MODIFICATIONS

It is proposed to improve the efficiency of the pumping process by returning the pumping process to the original impeller diameter and one pump operation. Backup would be provided with an automated pump starting relay. A check valve would be installed to eliminate backflow into the standby pump when not in operation. Header pressure would keep the stand-by pump discharge side check valve closed against the suction side head. When header pressure dropped below a minimum setpoint, the stand-by pump would be energized into service and the check valve would open.

Using the original pump and impeller will increase pumping efficiency from 65% to 89%. This will reduce electrical demand from 2 pumps at 305 kW each to one motor at 456 kW.

(See also long term projects regarding this pump system at the end of this description.)

ENERGY SAVINGS

Existing Conditions:
Measured developed head = 58 meters (62 M from curve)

Motor Loading	= 275 kW/1,000 kW motor = 27.5 % loaded
Motor Efficiency	= 90% estimated
Motor Power Consumption	= 305 kW
Pump Brake Power	= 305 kW x 90% efficiency = 275 kW
Pump Efficiency	= 65% from curve
Pump Delivery each pump	= 975 cubic meters per hour
Pump Delivery total	= 1,950 cubic meters per hour

PROPOSED CONDITIONS

Measured developed head	= 68 meters
Motor Loading	= 456 kW / 1,000 kW motor = 45.6 % loaded
Motor Efficiency	= 92% estimated
Motor Power Consumption	= 456 kW
Pump Brake Power	= 456 kW x 92% efficiency = 420 kW
Pump Efficiency	= 89% from curve
Pump Delivery total	= 1,950 cubic meters per hour

ENERGY SAVINGS CALCULATION

Electrical demand reduction	= ((2 x 305 kW) - (456 kW)) = 154 kW
Annual energy savings	= 154 kW x 8,000 Hours per Year = 1,232,000 kWh per Year

WORLD ENERGY PRICES - MODIFICATION SAVINGS

S_{WORLD} = 1,232,000 kWh x $.064/kWh

S_{WORLD} = $78,848 per year using world energy prices

LOCAL ENERGY PRICES - MODIFICATION SAVINGS

S_{LOCAL} = 26.46 rubles/kWh

S_{LOCAL} = 26.46 rubles per kWh/1877 rubles per dollar

S_{LOCAL} = $0.014 per kWh as of April, 1994

S_{LOCAL} = 1,232,000 kWh x $.014 per kWh

S_{LOCAL} = $17,248 per year using local energy prices

PROJECT IMPLEMENTATION COST AND SPECIFICATION

MATERIALS	UNIT	QUANTITY	COST/UNIT	TOTAL COST
Adjustable Pressure Switch Industrial Class 1-115 psi range (225 psi max) 230 volt AC	each	1	$200	$200
1/4 Inch pipe gage pigtail schedule 40 NPT 2 ends	each	1	$10	$10
1/4 Inch threadolet	each	1	$1	$1
1/2 Inch EMT conduit	10 ft	5	$2.20	$11
1/2 Inch Conduit connectors Set screw coupling die-cast zinc	each	5	$0.35	$1.75
1/2 Inch Conduit set screw connector die-cast zinc	each	2	$0.33	$0.66
Wire, 12 awg 600 volt rated THHN solid	spool	1	$30	$30
Terminal Block 4 terminations	each	1	$5	$5
Fuse Block Single Bay 240 V, 5 amp	each	1	$5	$5
Fuses for Above 5 amp	each	12	$1	$12
---				
16 inch swing	each	1	$3,000	$3,000

check valve
class 150
Flanged

Dranetz Power Platform (see below)	each	1	$12,000	$12,000
		subtotal	$15,277	

THREE PHASE ENERGY ANALYZER
Dranetz Power Platform

Quantities Monitored:	Kilowatt Hours
	Kilowatts
	RkVAH
	KVA
	Power Factor
	Volts
	Amps
	Harmonic Analysis
Data Storage:	All quantities monitored
Memory:	7 day recording of all parameters
Software:	To display and print results in graphical format from PC
Display:	LCD and Paper Tape Printer
Power supply:	Rechargeable, field replaceable
Current Transformers:	
range #1	0 to 10 amps
range #2	0 to 150 amps
range #3	15 to 300 amps
range #4	50 to 1,000 amps
range #5	100 to 3,000 amps
Manufacturer:	Dranetz
Model	8,000

(End of specification)

SHIPPING
Estimated at 20% of material costs or $15,277 x 20 % = $3,055

LABOR	UNIT	QUANTITY	COST/UNIT	TOTAL COST
Local installation	hours	160	$0.50	$80

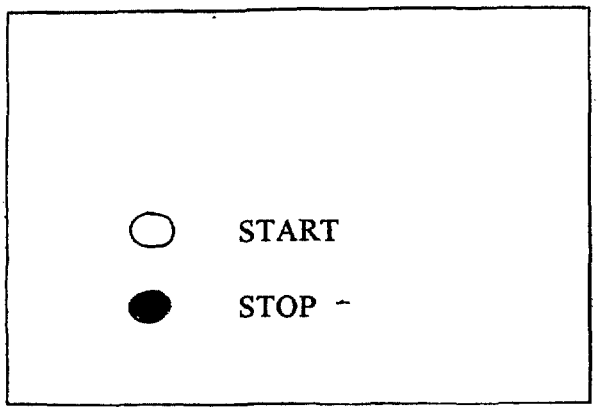
TOTAL PROJECT COST
P_s = $18,412

ECONOMICS

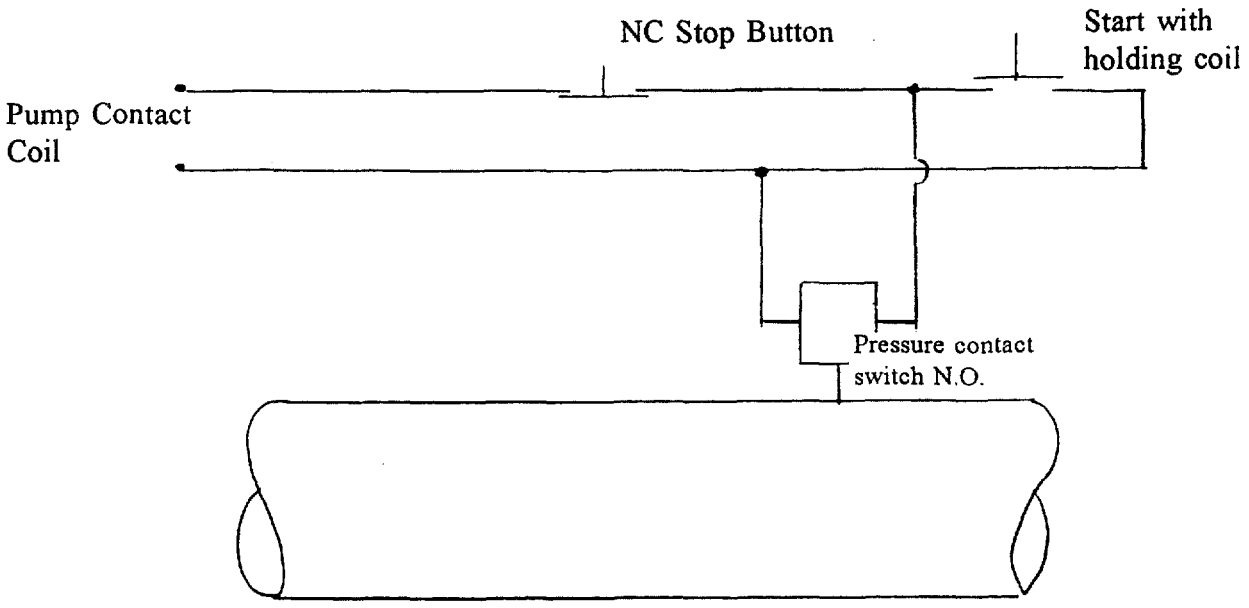
Simple Payback Using World Energy Prices
S_P = Project Cost / Annual Savings
S_P = $18,412 / $78,848 per Year
S_P = 0.2 Years

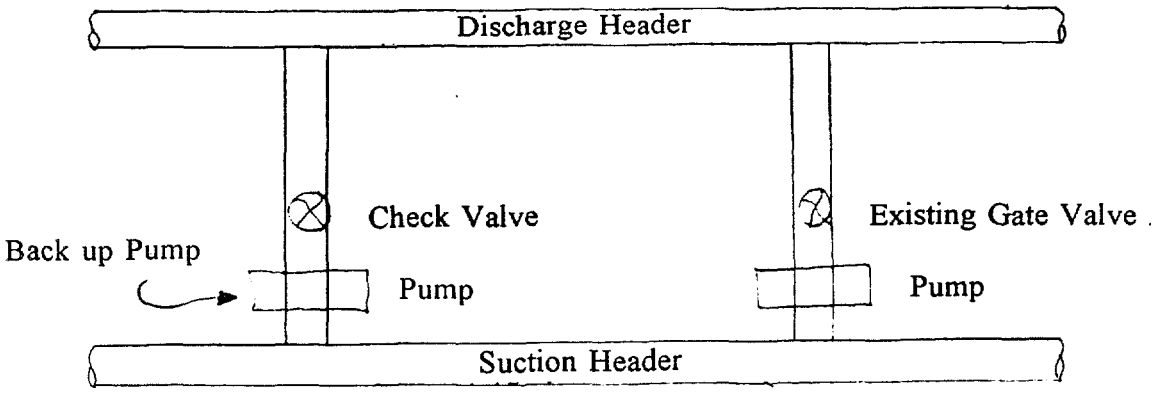
Simple Payback Using Local Energy Prices
S_P = Project Cost / Annual Savings
S_P = $18,412 / $17,248 per Year
S_P = 1.1 Years

Existing Panel in Pump Room



Typical Existing Control Wiring





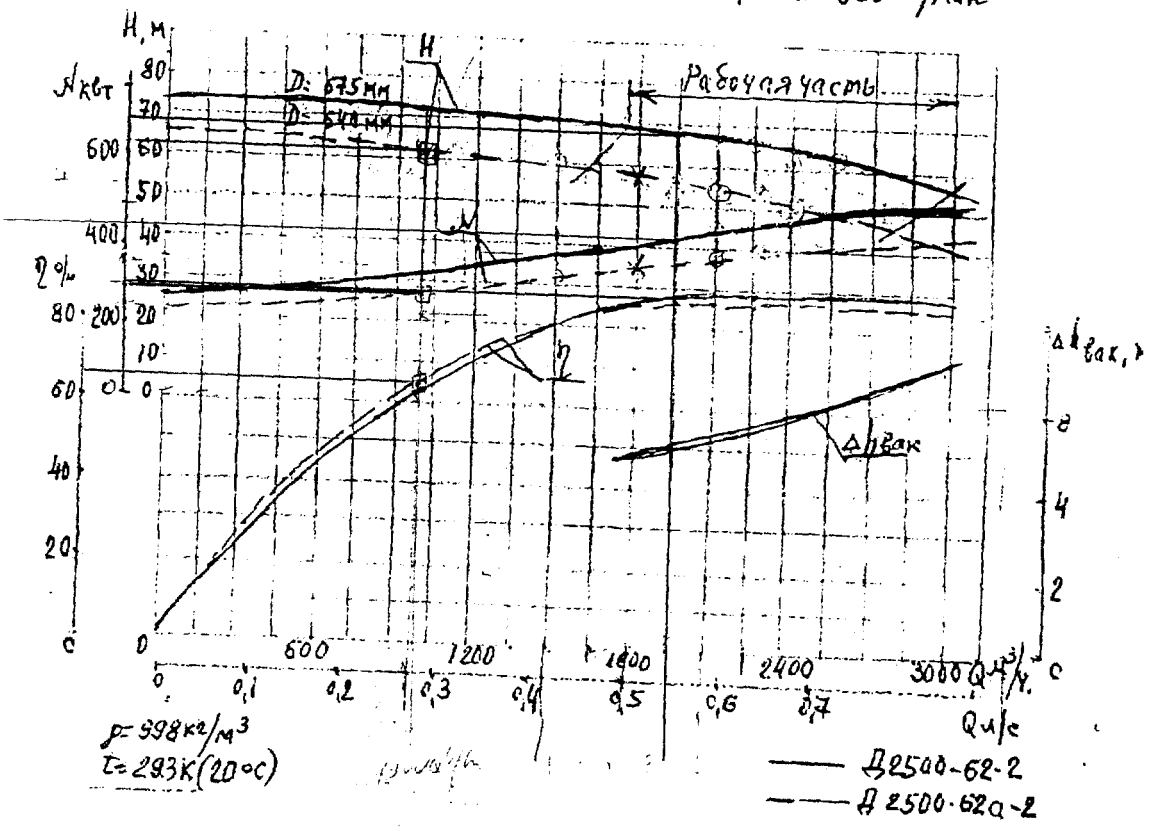
9.04.91
N227-31
факс не передан
Шнур

ФАКС 388442 771619

Куда, кому: Волгоград СПЛАВ ГЛАДКОВУ

Текст. По телефонному запросу НАПРАВЛЯЕМ ХАРАКТЕРИСТИКУ НАСОСА Д 2500-62

Характеристики насоса Д2500-62-2 при n = 980 об/мин



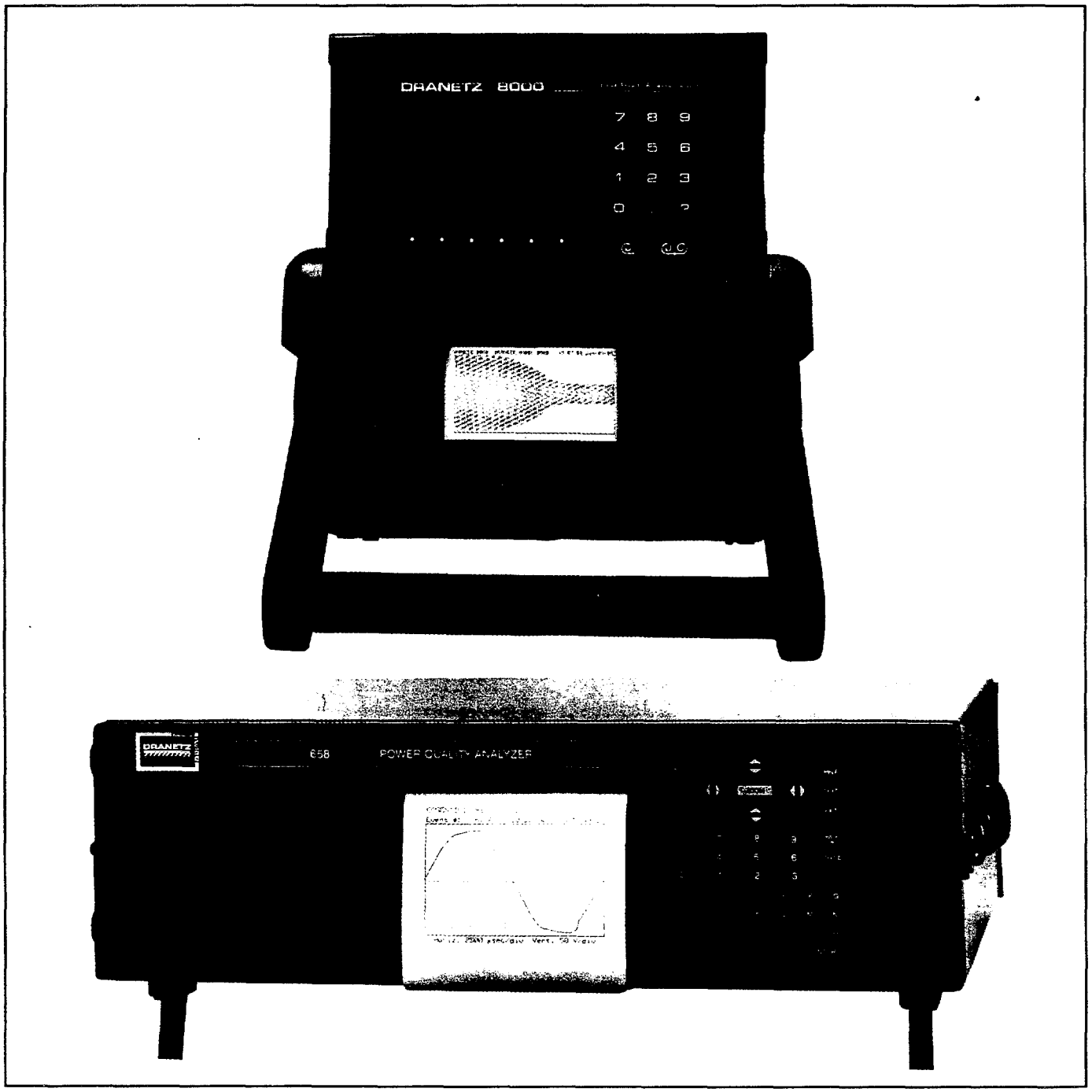
Главный инженер проекта 9.04.91 / П.А. Тенилов /

VOLGOGRAD

BEST AVAILABLE COPY

34

DRANETZ TECHNOLOGIES, INC.
DOMESTIC PRICE LIST



BEST AVAILABLE COPY

35

8000-2 ENERGY ANALYZER

8000-2 Energy Analyzer	$ 6,320
HUR 50 Harmonic Analysis Includes User Reports	2,725
EM 256 Extended Memory (256k)	730
MDM24 Internal Modem 2400 Baud	625
MIR8 Motor Inrush Analysis	800

OPTIONS AND ACCESSORIES

CT-10 Current Transformer 0.1 to 10A	$ 370
CT-150 Current Transformer 0.1 to 150A	370
CT-300 Current Transformer 15 to 300A	625
CT-1000 Current Transformer 50 to 1000A	625
CT-3000 Current Transformer 100 to 3000A	1,325
ISO-1 Isolated Current Transformer Box 1A	160
ISO-5 Isolated Current Transformer Box 5A	160
SCC-8 Soft Carrying Case	310
RSC-8 Shipping Container, Reusable	400
FBP-8 Field Replaceable Battery Pack	150
XBC-8 External Battery Charger	265
XBF-12 External DC Battery Filter	185
EDD-3 External Disk Drive 3-1/2 in.	$ 1,255
EDD-5 External Disk Drive 5-1/4 in.	1,255
CTP-16 Thermal Paper (Carton of 16 Rolls)	105
HB114415 Field Handbook For Electrical Energy Management	25
RSCOM Universal RS-232 Cables, 25 Pin to 25 Pin with Adapter Cable for 25 Pin to 9 Pin	55

MEMORY CARDS

CARD-512 512 KByte Memory Card	$ 175
CARD-1M 1 MByte Memory Card	275
CARD-2M 2 MByte Memory Card	400

MEMORY CARD READERS (For PC Interface)

MCR-R RS-232 Port Interface	$ 450
MCR-P Parallel Port Interface	450
MCR-B Plug-in Card	450

PC SOFTWARE

PC-8000 8000 PC Analysis Software	$ 1,500

SERIES 800 POWER & DEMAND ANALYZERS

808 Electric Power/Demand Analyzer (Incl. One 600V, 3 Phase 10' Cable)	$ 3,770

OPTIONS FOR 808

†OPT 101 Alarm Relays	115
†OPT 105-RS232C Interface (w/32K Buffer Memory)	580
†OPT 106 Modem Option (w/32K Buffer Memory)	985

REMOTE ELECTRIC POWER/DEMAND ANALYZERS

806 Remote Power/Demand Analyzer	$ 1,990
806/108 Modem Option (300 Baud)	2,220
810 Remote Power/Demand Analyzer	3,620
812 Remote Power/Demand Analyzer	4,640
†OPT 101 Alarm Relays (For 810, 812)	115

P.C. SOFTWARE

113485 PowerStar Software	$ 695

ACCESSORIES FOR 808

808-R1 Rack Adaptor For 808	$ 260
TR-2021A Clamp On CT, 30A	420
TR-2012 Clamp On CT, 300A	370
TR-2013 Clamp On CT, 1000A	370
TR-2015 Clamp On CT, 3000A	1,135
110635-G1 ISO-CT-Term 1A	160
110635-G5 ISO-CT-Term 5A	160
110656 Volt.Cur Conn Kit	40
110686 600V AC 10' Cable	115
103100 Shipping Container, Reusable	340
107901 800 To IBM RS232 Cable	50
102714C Thermal Paper (Carton of 27 Rolls)	160
S/P 8830 External Memory	1,810

26

U.S. SALES REPRESENTATIVES

ALABAMA-NORTH
Kemp Instruments, Inc.
P.O. Box 5430
Huntsville, AL 35816-5430
(205) 837-4304
FAX: (205) 837-0913

SOUTH
See Georgia

ALASKA
Alster Communications
1814 Governor Stevens
Olympia, WA 98501
(206) 754-7965
(800) 627-7939
FAX: (206) 754-0506

ARIZONA
Barnhill Associates, Inc.
8400 So. Kyrene Rd, Suite 105
Tempe, AZ 85284
(602) 598-0330
FAX: (602) 598-0411

ARKANSAS
See Oklahoma

CALIFORNIA - NORTH
MANCO
Building 55, 3350 Scott Blvd
Santa Clara, CA 95054
(408) 496-6611
FAX: (408) 496-6148

SOUTH
AMASCO
370 Amapola Ave, Suite 112
Torrance, CA 90501
(310) 781-9494
FAX: (310) 781-9059

COLORADO
Barnhill Associates, Inc.
12150 E. Briarwood Ave.
Suite 140
Englewood, CO 80112
(303) 721-9500
FAX: (303) 792-5800

CONNECTICUT
See Massachusetts

DELAWARE
See Maryland

DISTRICT OF COLUMBIA
See Maryland

FLORIDA
Datarep, Inc.
1313 44th Street
Orlando, FL 32809
(407) 843-5224
FAX: (407) 425-0247

GEORGIA
Kemp Instruments, Inc.
3781 Presidential Pkwy
Suite 115
Atlanta, GA 30340
(404) 452-8050
FAX: (404) 457-2587

HAWAII
See Alaska

IDAHO - NORTH
See Oregon

SOUTH
See Utah

ILLINOIS - NORTH
Loren Green Associates
Central, Inc.
30 Martin Lane
Elk Grove Village, IL 60007
(708) 593-0282
FAX: (708) 593-8527

SOUTH
See Missouri

INDIANA
WKM Associates, Inc.
7002 N Graham Rd
Indianapolis, IN 46220
(317) 594-0301
FAX: (317) 849-6692
(EXCEPT LAKE COUNTY)

LAKE COUNTY
See Illinois, North

IOWA - WEST
See Minnesota

EAST
See Illinois, North

KANSAS
Comtel Midwest Co.
12403 W. 62nd Terrace
Shawnee Mission, KS 66216
(913) 268-0874
FAX: (913) 268-0874

KENTUCKY
See Ohio, South

LOUISIANA
Kemp Instruments, Inc.
1604 W. Pinhook Rd, Ste 150A
Lafayette, LA 70508
(318) 269-9452
FAX: (318) 2690-1073

MAINE
See Massachusetts

MARYLAND
Electronic Marketing
Associates, Inc.
Suite A
14100 Laurel Park Drive
Laurel, MD 20707
(301) 792-9300
FAX: (301) 725-7869

MASSACHUSETTS
Eastern Systems, Inc.
P.O. Box 310
Hopkinton, MA 01748
(508) 435-2151
FAX: (508) 435-2517

MICHIGAN
WKM Associates, Inc.
1209 Chicago Road
Troy, MI 48083
(313) 588-2300
FAX: (313) 588-9332

MINNESOTA
Dytec Instruments, Inc.
7600 Parklawn Ave, Suite 339
Edina, MN 55435
(612) 831-7169
FAX: (612) 831-5114

MISSISSIPPI - NORTH
See Alabama

SOUTH
See Louisiana

MISSOURI
Comtel Midwest Co.
301 Sovereign Ct., #203A
Manchester, MO 63011
(314) 227-7220
FAX: (314) 227-9834

MONTANA
See Colorado

NEBRASKA
See Kansas

NEVADA
See New Mexico

NEW HAMPSHIRE
See Massachusetts

NEW JERSEY - NORTH
SDM Representatives, Inc.
258 Route 46 East
Fairfield, NJ 07004
(201) 882-5005
FAX: (201) 882-2836

SOUTH
See Maryland

NEW MEXICO
Barnhill Associates, Inc.
8421 Osuna Rd N.E., Suite A
Albuquerque, NM 87111
(505) 299-7658
FAX: (505) 299-7650

NEW YORK - METRO
See New Jersey, North

UPSTATE
Eastern Systems, Inc. of
New York
140A Metro Park
Rochester, NY 14623
(716) 292-1460
FAX: (716) 292-5897

NORTH CAROLINA
Baesel & Associates, Inc.
P.O. Box 6153
Charlotte, NC 28207
(704) 375-1044
FAX: (704) 375-6212

NORTH DAKOTA
See Minnesota

OHIO - NORTH
WKM Associates, Inc.
6000 W. Creek Rd, Suite 23
Independence, OH 44131
(216) 524-5930
FAX: (216) 524-0276

SOUTH
WKM Associates, Inc.
733 Congress Park Drive
Dayton, OH 45459
(513) 434-7500
FAX: (513) 434-6580

OKLAHOMA
Acudata, Inc.
6216 South Lewis, Suite 103
Tulsa, OK 74136
(918) 743-1875
FAX: (918) 743-1892

OREGON
Underwood-Hanify, Inc.
6168 NE Highway 99
Suite 101B
Vancouver, WA 98665
(503) 224-0583
FAX: (206) 737-6762

PENNSYLVANIA - EAST
See Maryland

WEST
WKM Associates, Inc.
12300 Perry Highway
Wexford, PA 15090
(412) 934-2730
FAX: (412) 934-2761

RHODE ISLAND
See Massachusetts

SOUTH CAROLINA
See North Carolina

SOUTH DAKOTA
See Minnesota

TENNESSEE
See Alabama, North

TEXAS
AUSTIN
Acudata, Inc.
2201 North Lamar, Suite 107
Austin, TX 78705
(512) 478-1018
FAX: (512) 478-8649

DALLAS
Acudata, Inc.
720 Avenue F, Suite 104
Plano, TX 75074
(214) 424-3567
FAX: (214) 422-7342

HOUSTON
Acudata, Inc.
110 Cypress Station
Suite 108
Houston, TX 77090
(713) 580-2451
FAX: (713) 580-6421

UTAH
Barnhill Associates, Inc.
930 So. State Street
Suite 120
Orem, UT 84058
(801) 226-1239
FAX: (801) 226-1244

VERMONT
See Massachusetts

VIRGINIA
See Maryland

WASHINGTON
Underwood-Hanify, Inc.
1729-208th Street S.E.
Suite 103
Bothell, WA 98012
(206) 483-2800
FAX: (206) 486-5822

WEST VIRGINIA
See Ohio, South

WISCONSIN - WEST
See Minnesota

EAST
See Illinois, North

WYOMING
See Colorado

DRANETZ

Dranetz Technologies, Inc.
1000 New Durham Road
P.O. Box 4019
Edison, NJ 08818-4019

Tel: (908) 287-3680
FAX: (908) 248-1834 Sales & Marketing
FAX: (908) 248-9240 Order Processing

REPRESENTED BY:
LOREN GREEN ASSOCIATES-CENTRAL, INC.
30 MARTIN LANE
ELK GROVE VILLAGE, IL 60007
(708) 593-0282

Long Term Opportunity For Pump Station Optimization

PROJECT IMPLEMENTATION COST

MATERIALS	UNIT	QUANTITY	COST/UNIT	TOTAL COST
Pump and Motor combination 1,950 cubic meters per hour at 62 meters head Water at 27 Degree C 3 phase, 50 Hertz 6000 Volt, Ph - N	each	2	$50,000	$100,000
Dranetz Power Platform (see above specification)	each	1	$12,000	$12,000
			subtotal	$112,000

SHIPPING
Estimated at 20% of material costs or $112,000 x 20 % = $22,400

LABOR	UNIT	QUANTITY	COST/UNIT	TOTAL COST
Local installation	hours	320	$0.50	$160

TOTAL PROJECT COST
$P_{\$}$ = $134,560

ECONOMICS

Simple Payback Using World Energy Prices
S_P = Project Cost / Annual Savings
S_P = $ 134,560 / $78,848 per Year
S_P = 1.7 Years

Simple Payback Using Local Energy Prices
S_P = Project Cost / Annual Savings
S_P = $134,560 / $17,248 per Year
S_P = 7.8 Years

ECO - 04

Anode Production Steam Condensate Return

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS
Six 10T/h boilers operate at an annual average load of 30T/h. The heat is used for process and heating.

Annual natural gas usage is equal to:
30T/h x 2,200,000 BTU/T x 8760 h/yr/0.80
$30 \times 2.2 \times 10^6 \times 8760/0.80 = 722.7$ GBTU/yr

DESCRIPTION OF PROPOSED MODIFICATIONS
The production of anode materials requires steam to heat the petroleum feed stock. The present system wastes the condensate. A new system will return the condensate to the boilers.

The estimated average condensate flow is 9T/h throughout the year. Heat saved annually is equal to:

9T/h x 2200 lbs/T x (100C -30C) x 1.8 x 8760h/yr/0.80
9 x 2200 x 70x1.8 x 8760 = 2.494 x 8.760 GBTU/yr = 27 GBTU/yr

At a domestic cost of $1.00/MBTU, the saving is $27,000 per year. Pumping costs are based on an average condensate flow of 9T/hr., and electricity use of 3 kW. Electricity for pumping is equal to 3kW x 8760 x $0.014 per kWh = $368 per year. Net savings equals $26,632 per year. The cost of equipment is $20,868 and the (domestic gas prices) payback is less than a year. At world prices for gas, the payback is less than three months.

Specifications:

One condensate pump set, Weil type NRG, VRC-1-1/2 complete with two 7.5HP, 380 volt, 3 phase, 50 cycle totally enclosed motors, float switch, alternator, starters all NEMA 4 enclosures, set to be complete with steel base plate 48" dia. with access cover, sump depth 48" capacity each pump 52 gpm, 70 psig. Note: Sump tank will be provided by the owner.

Pump Set - Estimated cost $10,000

Twelve Steam Traps, bucket type, Watson McDaniel model 1038, 1-1/4" size, cast iron inverted bucket trap with external strainer, body rated 250 psig, capacity 3100 lb/hr at 85 psig pressure drop.

Estimated Cost:	Traps, 12 x 276 =	$ 3,312
	Strainer, 12 x 50 =	$ 600

Total Cost (including shipping from USA) $20,868

weil

NRG VERTICAL

Recommended for all systems where receiver and return lines are

BELOW FLOOR LEVEL

UNDERGROUND CONDENSATE PUMP

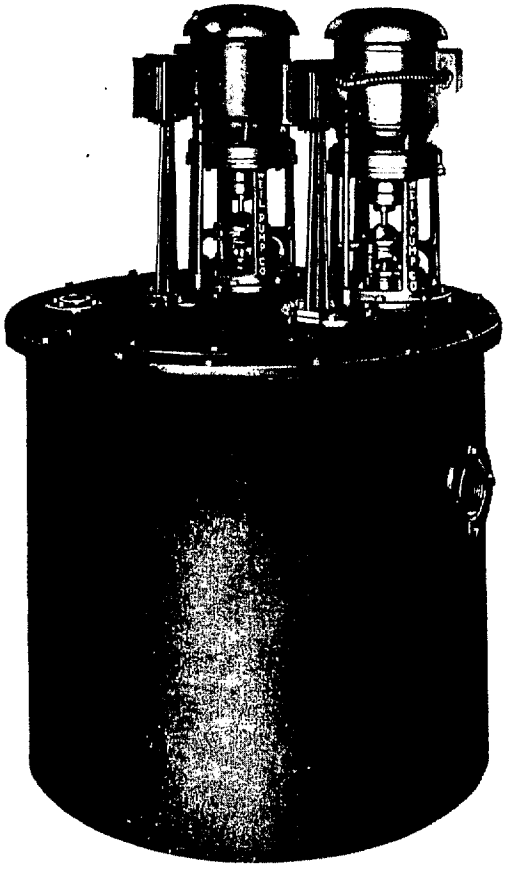


Fig. NRG 2001

INDEX

WHEN TO USE THE NRG PUMP	Page 2
Application and Const. Features	Page 3
Selection Table	Page 4
Dimension Tables	Page 5
Complete Pump Units	Page 6
Controls	Page 7
Typical Installations:	
High Pressure Boiler System	Page 8
Low Pressure Boiler System	Page 8

Weil PUMP COMPANY
5921 WEST DICKENS AVE. CHICAGO, ILL 60639
(312) 637-8844 TELEX 253603 FAX 1-312-637-5168

40

TABLE No. 2

Unit	"B"-Dimension		"E"-Dimension	
	Single	Duplex	Single	Duplex
VRC-1 ¼	18"	24"	20"	28"
VRC-1 ½	24"	30"	28"	34"
VRC-2	24"	30"	28"	34"
VRC-2 ½	24"	36"	28"	40"

Dimensions given are determined by size of pump. Dimensions are minimum for pump frame listed and may be increased as required.

TABLE No. 3

Approximate Dimensions			
Sq. Ft. Direct Radiation	C Minimum	D Maximum	F
3,000	36"	36"	3"
6,000	36"	36"	3"
10,000	36"	36"	3"
15,000	36"	36"	3"
20,000	36"	36"	3"
25,000	36"	36"	3"
40,000	48"	36"	3"
50,000	48"	36"	4"
65,000	48"	36"	4"
100,000	60"	36"	4"

Dimensions given are determined by sq. ft. of direct radiation. These dimensions are based upon pump capacities and may be changed to meet job conditions.

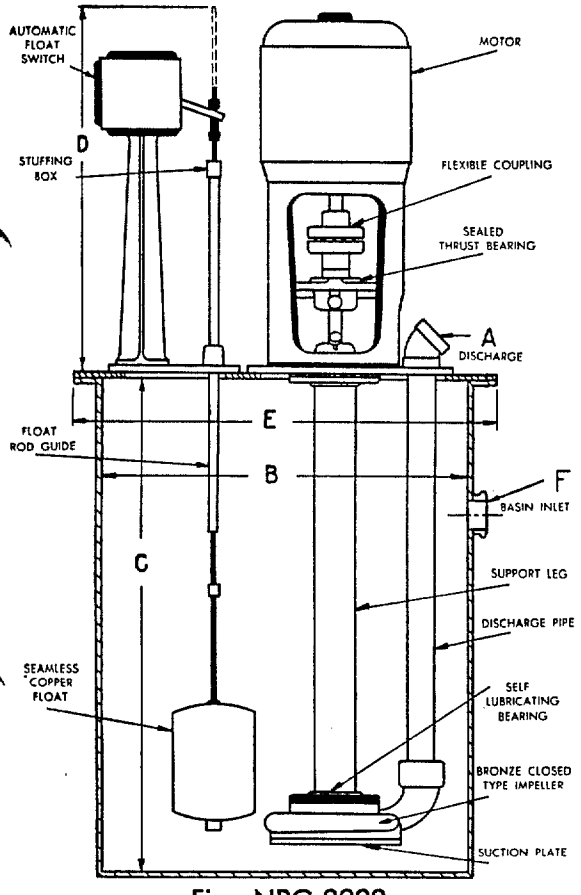


Fig. NRG 2002

Dimension "A", size of pump discharge, is given as part of unit designation.

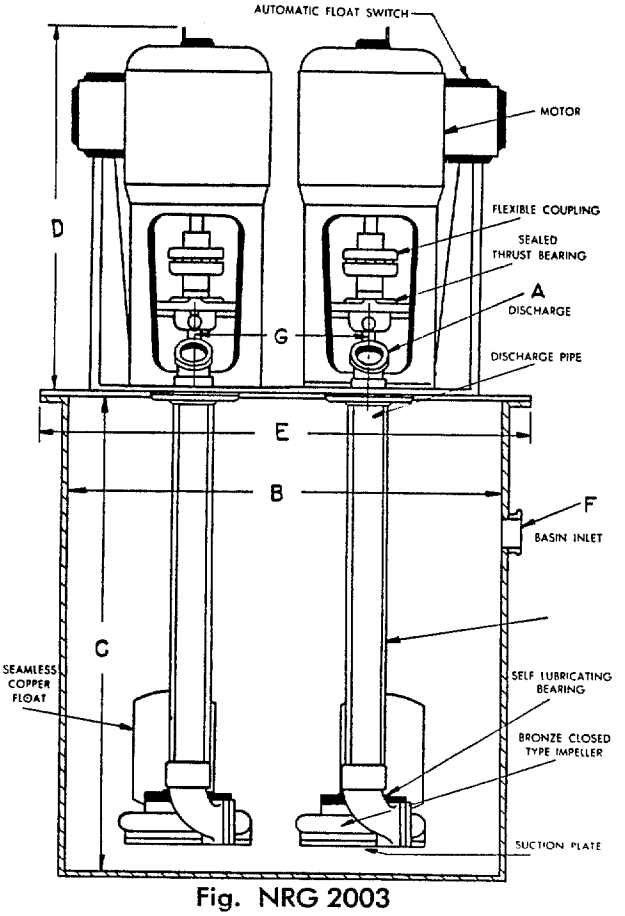


Fig. NRG 2003

Dimension "G" is given on certified drawings only.

TABLE No. 4—RECEIVER CAPACITIES IN GALLONS

For square or rectangular receivers use formula: cu. content in cu. ft. x 7.48 equal number of gal.

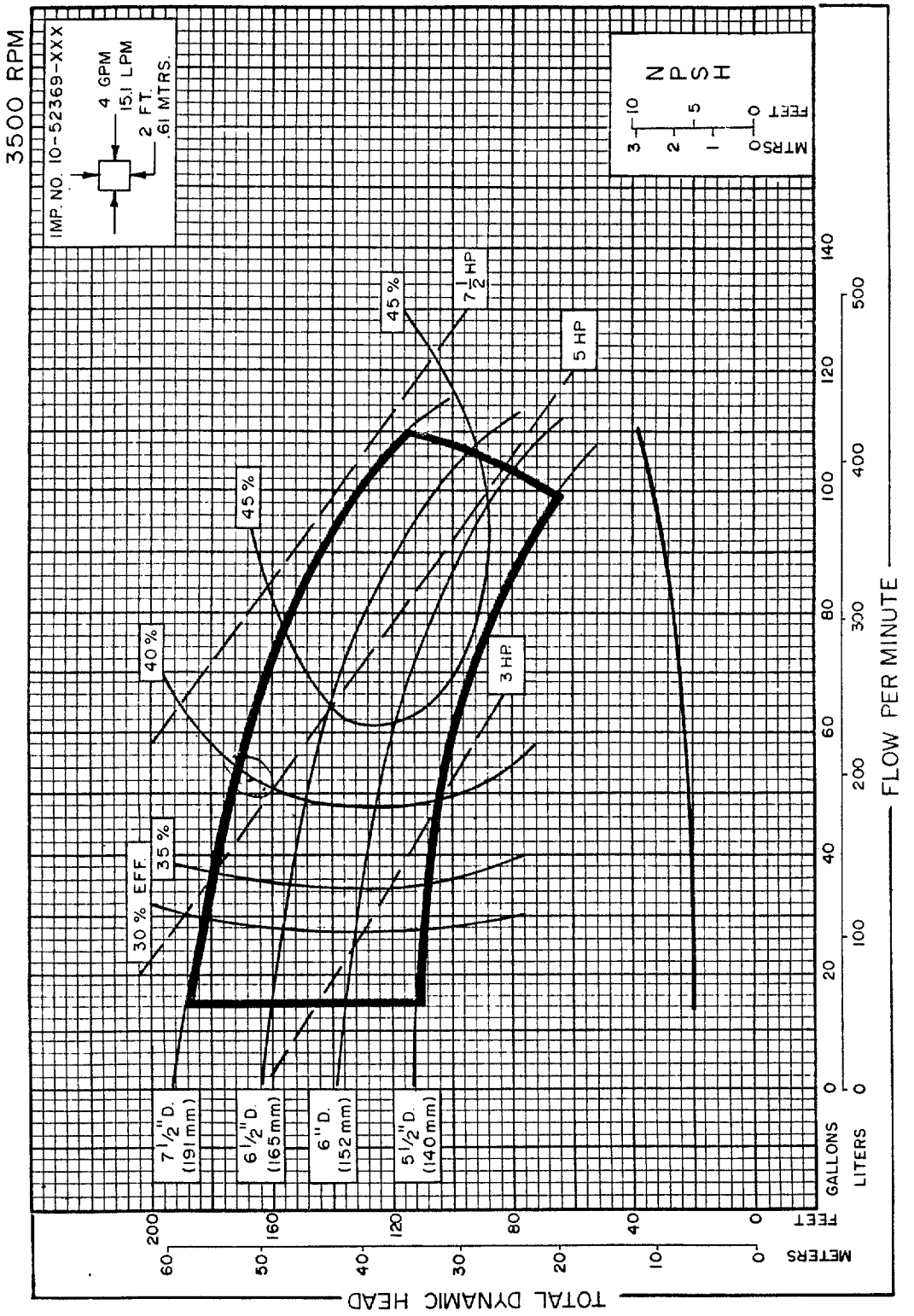
Receiver Diameter	18"	24"	30"	36"	42"	48"	60"	72"
Capacity per foot depth in gal.	14	24	38	53	77	95	150	212

pump performance

SERIES 4500
CONDENSATE PUMPS

DISCHARGE SIZE - 1 1/2 "(38mm)
IMPELLER TYPE - CLOSED

C-450222
October, 1984



● RECOMMENDED PUMPING RANGE IS SHOWN WITHIN HEAVY LINES.
● PERFORMANCE SHOWN BASED ON 85°F (29.4°C) WATER.

Weil PUMP COMPANY

WATSON McDANIEL

Since 1878

Manufacturers of pressure and temperature regulators
–steam traps
–relief valves

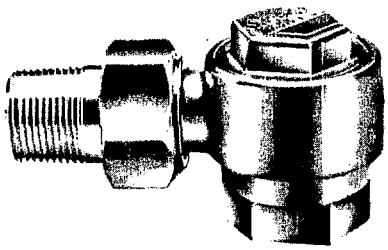
975 Madison Avenue • Valley Forge Corporate Center • Norristown, Pennsylvania 19403

215-666-5711 • Fax 215-666-0404

STEAM TRAPS

THERMOSTATIC STEAM TRAPS

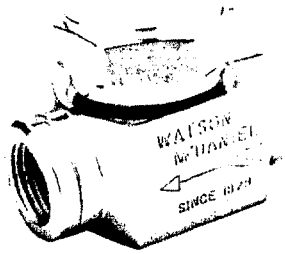
Excellent trap for the removal of condensate and air on low and medium steam pressure systems. Typical applications include radiators (vapor or vacuum), sterilizers, steam tables, coffee urns and stills.



Pressures from 1/4 PSI to 125 PSI. Sizes from 1/2", 3/4" and 1".

TURBO DISC TRAPS

Provides efficient removal of condensate. Particulary suitable for drainage where freeze proof protection is necessary, such as, tracer lines. Also used on sterilizers, drip legs, pressing machines and many other appliactions.

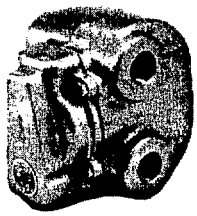


Can also be used to remove condensate from air lines.

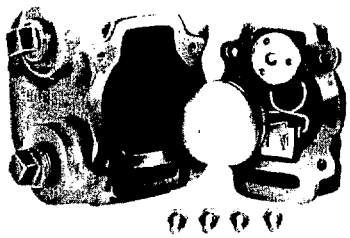
Pressures from 3.5 PSI to 600 PSI (no orifice change needed, one good trap for all pressures), sizes 3/8" through 1".

FLOAT & THERMOSTATIC TRAPS

Provides continuous and modulating drainage on low or medium pressure lines and where high venting of air is required.



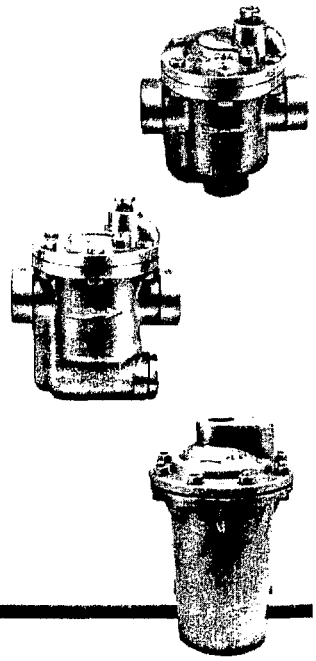
Head assembly provides complete repair kit without having to remove F&T from the line.



Pressures from 1/4 to 125 PSI. Sizes 3/4" through 3".

INVERTED BUCKET TRAPS

Provides efficient and intermittent condensate drainage for all types of equipment. Due to the blast action of the trap, this trap should not be used where continuous drainage is needed such as coils, heat exchanges and unit heaters. Can be supplied with or without integral strainer. Also available with thermic vent.



Pressures from 15-250 PSI. Sizes 1/2" - 1 1/2" side inlet and outlet. Sizes 1 1/4 - 2" bottom inlet, top outlet.

WATSON McDANIEL

215-666-5711 • Fax 215-666-0404

FOR LOCAL DISTRIBUTION CONTACT THE FACTORY

43

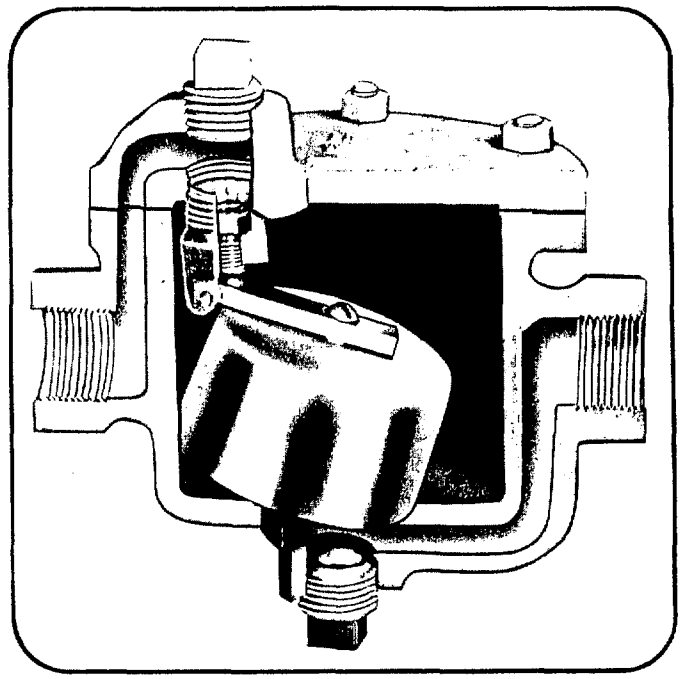
WATSON McDANIEL COMPANY
975 Madison Avenue
Valley Corporate Center, Norristown, PA 19403
(215) 666-5711 • FAX (215) 666-0404

INVERTED BUCKET STEAM TRAPS

Series 1038

Manufacturers of: RELIEF VALVES • PRESSURE & TEMPERATURE REGULATORS • EJECTORS • LEVEL CONTROLS • STEAM TRAPS

CAPACITIES TO 10,500 #/HR
SIDE INLET—SIDE OUTLET



SERIES 1038

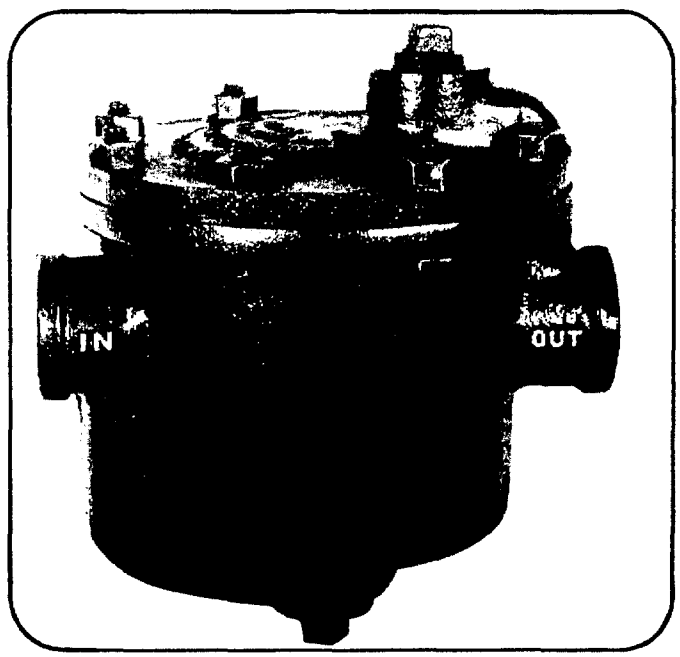
APPLICATION:
The Inverted Bucket Steam Traps are recommended for all services where the most important requirements are overall operating efficiency, freedom from maintenance and long, trouble free Service Life.
Watson McDaniel Series 1038 Inverted Bucket Steam Traps are designed to meet individual trapping needs required on such services as pressing machines, tire molds, cookers, unit heaters, etc.

OPERATION:
Inverted Bucket Traps operate on the big difference in density between steam and water. Steam entering the inverted submerged bucket causes the bucket to float and close the discharge valve. Condensate entering the trap changes the bucket to a weight that sinks and opens the trap valve to discharge the condensate. Unlike other mechanical traps, air and carbon dioxide are vented continuously at steam temperature. They are designed to open the discharge orifice for maximum capacity. Wearing points are heavily reinforced for long life.

CONSTRUCTION:
The Series 1038 Traps are compact and of rugged design with seats and valves made of hardened stainless steel to resist wire drawing. Only two moving parts, the valve lever assembly and the bucket. No complicated linkages, nothing to stick, bind or clog. The body and cover are cast iron ASTM-A-126 Class 30. The series 1038 traps are designed for maximum operating pressure of 250 PSIG saturated steam.

FEATURES:
- Simplicity—Only Two Moving Parts.
- Hardened Stainless Steel—Valves and Seats.
- Bucket—Heavy Duty Stainless Steel.
- Working Parts—All Attached to Cover for in Line Service.
- Bucket Vent—Continuous Air and CO_2 Venting at Steam Temperature.

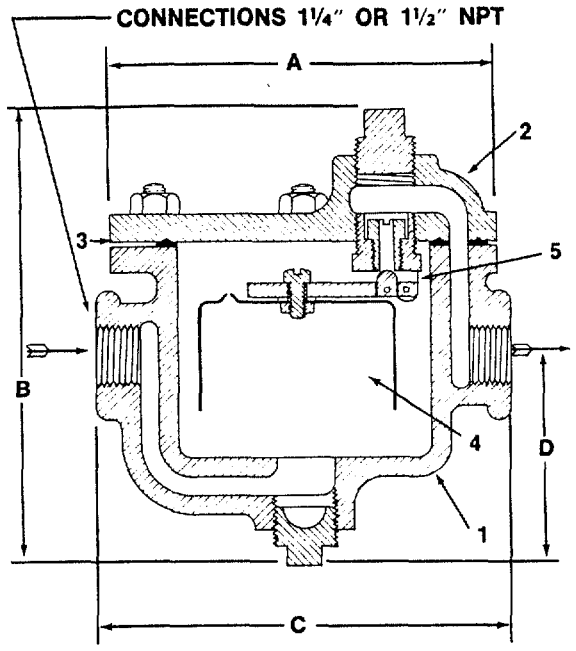
RECOMMENDATIONS:
For low pressure applications use the Float and Thermostatic Steam Trap for better performance.



SERIES 1038

INVERTED BUCKET STEAM TRAPS

SERIES 1038



REPAIR PARTS CONSIST OF:

*1-BODY & GASKET . . . . . .PART NO. 1-10
2-COVER ASSEMBLY . . . . .PART NO. 2-10
3-GASKET . . . . . .PART NO. 3-9
4-BUCKET ASSEMBLY . . . . .PART NO. 4-9
5-LEVER & SEAT ASSEMBLY . .PART NO. 5-12
*SPECIFY PIPE CONNECTIONS WHEN ORDERING.
**SPECIFY MAXIMUM OPERATING PRESSURE WHEN ORDERING.

DIMENSIONS & WEIGHTS

Series	1038
A	9"
B	11¾"
C	9½"
D	6¼"
Trap Size	1¼" or 1½"
Trap Weight	40 lbs.

OPERATING PRESSURES

Series	1038
Maximum Operating Pressure	250 PSIG @ 406°F
Maximum Allowable Pressure	250 PSIG @ 450°F

MATERIALS

Body & Cover. . . Cast Iron ASTM-A-126 Class 30
Nuts & Bolts. . . . . High Tensile Steel
Gasket . . . . . Compressed Asbestos
Bucket . . . . . Stainless Steel
Lever & Seat Assembly. . . Brass Lever, Hardened Stainless Steel Valve & Seat

NOTE: The Inverted Bucket Steam Trap can be used at any pressure below its maximum operating pressure stamped on the cover, but with resulting loss in capacity.

NOTE: A safety factor of 2 or 3 to 1 is required for peak loads.

CAPACITY TABLE IN POUNDS OF CONDENSATE PER HOUR

Trap Orifice	7/16"	5/16"	15/64"	7/32"	13/64"	11/64"	Trap Orifice
1/4	1090						1/4
1/2	1585						1/2
1	2165						1
2	3100						2
3	3800						3
4	4500						4
5	5200						5
10	6700						10
15	7700						15
20	8600						20
25	9400	6800					25
30	10000	7400					30
40		8200					40
50		9000					50
60		9700	6900				60
70		10500	7500				70
80			7800	5300			80
100			8300	5600			100
125			9000	6100	5000		125
150				6600	5400		150
180					5800	4700	180
200					6000	4900	200
225						5200	225
250						5400	250

Pressure Differential-PSIG

ECO - 05

Steam Leak Repair

DESCRIPTION OF EXISTING EQUIPMENT AND OPERATING CONDITIONS
Steam leaks were observed during our plant visit. Based on an estimate for one leak, the steam wasted assuming a 3mm diameter leak at 10 bar pressure equals:

150lb/h x 8760h/yr x 1000 BTU/lb. = 1314 MBTU/yr

The cost for natural gas to heat this wasted steam is

$1.00/MBTU x 1314/0.8 = $1642/yr

Estimated cost to repair the leak is. $50.00
The local payback time is about twelve days. At world prices, the payback is about three days.

DESCRIPTION OF PROPOSED MODIFICATIONS
Initiate a steam leak identification and repair program. On a routine basis, patrol the steam distribution system to identify any leaks that may have occurred. Repair leaks as identified, tracking to identify poor sections of distribution pipe. Repair as soon as possible. If shutdown of line is not possible at any time, create a banding device to clamp the leaks until it is possible to shut down the steam line. Leaks in elbows are typically due to large amounts of condensate entrained in the steam. Appropriate steam trapping and condensation separation will serve as a preventive measure against this problem.

4. Insulation

Radiation and convection heat losses from uninsulated hot surfaces are considerable. Figure V-I-1 depicts this heat loss from uninsulated steam lines at different surface temperatures. The boiler, tanks and steam lines should be adequately insulated.

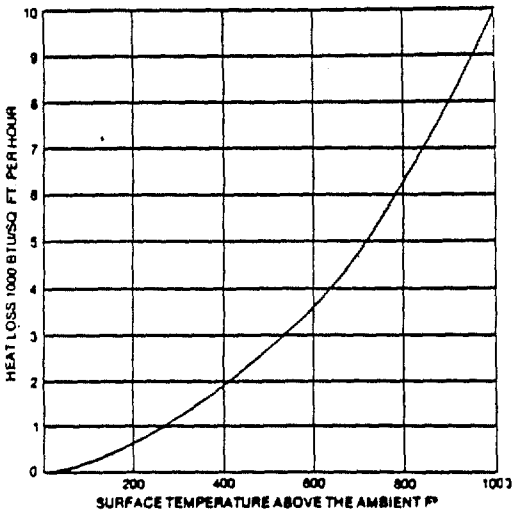


FIG. V-I-1 HEAT LOSS FROM UNINSULATED SURFACE

5. Steam Leaks

Steam leaks in the boiler system and mains should be detected and plugged as soon as possible. Steam leaks cause substantial energy waste, as shown in Figure V-I-2 and referred to in Section IV-C-5.

J. Load Management

Load management involves modifying certain conditions, such as the temperature and steam pressure.

1. Reduced Boiler Steam Pressures

In some instances, the operating steam pressure of the boiler may be set much higher than the actual requirement to deliver adequate steam to various points of end use. Reductions in steam pressure, where practical, can be an effective means of cutting down from 1 percent to 2 percent of the fuel bills. This efficiency improvement results primarily from lowered stack temperatures and reduced saturated steam temperatures. Other factors responsible for performance improvements are:

- Reduced energy consumption of the boiler feed pump
- Decreased heat dissipation from steam mains
- Lowered loss at flanges and packing glands
- Reduced-energy loss at pressure-reducing stations
- Put the most efficient boiler on line first and the least-efficient boiler last. Conversely, when the system load is falling, the least-efficient boiler should be shunted first.
- Consider the possibility of shutting down some of the boilers in swing seasons while operating process boilers at peak efficiency as opposed to operating all the boilers at a reduced load and lower efficiency.
- Consider the possibility of operating at reduced levels or even complete shutdown during slack production periods. This will be justified only when the energy saved during shutdown or reduced operation is greater than the additional energy required to bring the system to the operating level again.

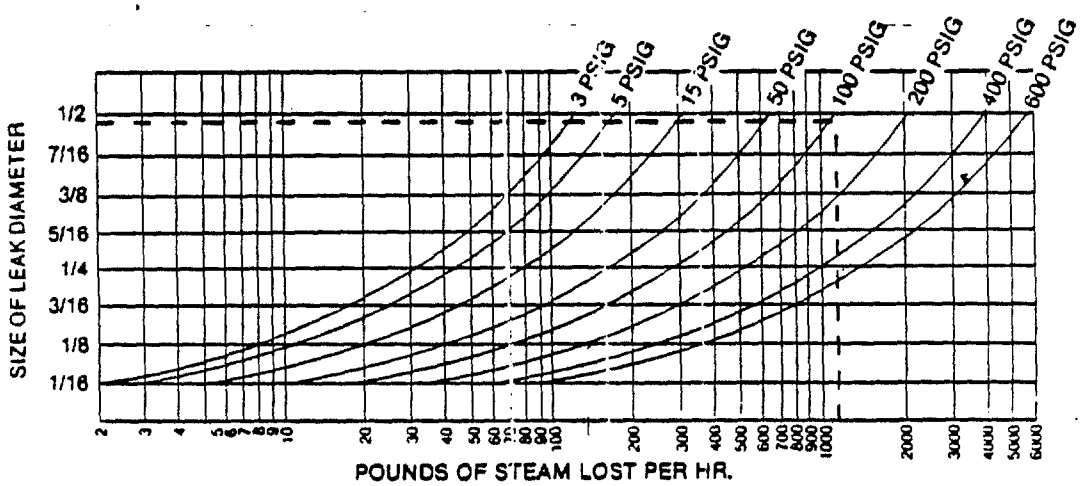


FIG. V-I-2 STEAM LOSS FROM LEAKS

APPENDIX C

Audit Equipment Utilized

Russia Initial Audit Equipment (preliminary) 10/19/93

ITEM	DESCRIPTION	SUPPLIERS	OPTIONS	QTY	COST/UNIT	TOTAL
1	Portable Combustion Analyzer	Bacharach	Model 300 NSXEB 220 V, 50 Hz RS-232 Siegert Fuel Equations NO2, SOX 12" and 48" probes 20' sampling hose	1	$4,796.10	$4,796.10
2	Air Velocity Meter	Kurz - Davis	Kurz Model 444 Metric, 220 V, HT option 24" probe Air velocity, temp, static pressure	1	$1,310.37	$1,310.37
3	Digital Thermometer	Cole Parmer	Platinum RTD thermometer Immersion probe Surface probe Needle probe Deluxe case	1	$587.00	$587.00
4	Non-contact Thermometer	Wahl	DHS-26X Heat Spy -20 to 1000 C Battery pack, 220 V	1	$2,428.00	$2,428.00
5	AC Power Analyzer	Dranetz	Model 808A 220 V, 50 Hz, option 105 3 TR-2013B current transformers Power Star software	1	$7,770.00	$7,770.00
6	Clamp-on Wattmeter	Grainger	TIF 2000A Watt Probe	1	$389.00	$389.00
7	Multimeter	Grainger	Fluke Model 85 w/ Clamp-on AC/DC current accessory	1	$474.00	$474.00
8	Power Factor Meter	Grainger	TIF 2300 power factor meter	1	$289.00	$289.00
9	Interchangeable Jaw for TIF 2300	Mitchell	jaw for larger applications	1	$20.00	$20.00
10	Foot Candle/Lux Meter	Davis	Extech Model P401025 Foot candle/Lux meter	1	$109.00	$109.00
11	Notebook Computer		486SX/25 80 MB HD, 4MB RAM 2400 baud internal modem Word Perfect, Quattro Lotus, EnergyAnalyst Printer, paper, etc	1	$3,800.00	$3,800.00
12	Batteries and chargers		Ni-Cd 9V rechargeable 9V charger other sizes?	1	$50.00	$50.00
13	Transformers and plugs	Magellans	220 V to 110 V 50 W transformers Plug adaptors	?	$150.00	$150.00
14	Cables		D25 male end to serial Null modem D9 and D25 serial connectors	1	$30.00	$30.00
15	Cables	Dranetz	D25 female end to serial Wiring adapter from Dranetz for D9 serial port	1	$50.00	$50.00
16	Miscellaneous		Clipboard	2	$1.50	$3.00
			Flashlight	3	$10.00	$30.00
			Extension cord	2	$20.00	$40.00
			Plug adaptor (3 to 2 prong)	3	$1.00	$3.00
			Measuring tape (5 meter)	2	$20.00	$40.00
			Pkg 500 sheets printer paper	1	$8.00	$8.00
			Package of pens	1	$1.00	$1.00
			Post it note pads (2x3)	3	$1.00	$3.00
			Stapler & staples	1	$15.00	$15.00
			File folders (12 pack)	1	$3.00	$3.00
			RMA letterhead	36	$0.15	$5.40
			RMA envelopes	24	$0.10	$2.40
		HD/DS →	Boxes of 10 DD/DS 3.5" diskettes	4	$10.00	$40.00
			Softsided disk holders	2	$10.00	$20.00
			Shop towels	12	$10.00	$120.00
					Subtotal	$22,586.27
					Shipping	$2,258.63
					Total	$24,844.90

NOTE This is a preliminary list of audit equipment for one (1) audit team only.

BEST AVAILABLE COPY

APPENDIX D

Local Weather Data

Rostov na Donu (use for Volgograd)

Month	Average Daily High Temp.		Average Daily Low Temp.		Degree Days (base 65F)
	°C	°F	°C	°F	
January	-2	29	-8	18	1457
February	-1	20	-7	20	1260
March	5	41	-2	29	1116
April	1	61	6	43	550
May	23	74	12	54	341
June	27	81	16	61	120
July	29	85	18	65	0
August	29	85	17	63	62
September	23	74	12	54	330
October	15	59	5	41	744
November	8	47	2	36	870
December	2	36	-3	27	1178
Average			6	42	Total 8138

APPENDIX E

World Energy Prices

END-USE ENERGY PRICES
second quarter, 1991

OECD - EUROPE

Sector	Fuel	US$/toe	US$/mmBtu	US$ per		notes
Transport						
	Gasoline	1,107	28	0.86	litre	1
	Diesel	661	17	0.58	litre	1
Industrial						
	Light Fuel Oil	290	7	383	tonne	2
	Heavy Fuel Oil	151	4	158	tonne	1
	Electricity	742	19	0.064	Kwh	3
	Natural Gas	151	4	141	k m^3	4
	Steam Coal	128	3	90	tonne	3
	Coking Coal	92	2	58	tonne	3
	Thermal	298	8	30	Gcal	5
Household						
	Electricity	1,282	32	0.110	Kwh	3
	Thermal	436	11	44	Gcal	5

Source: IEA, 1991, IEA Statistics, Energy Prices and Taxes;
Second Quarter 1991, OCDE/OCED Paris, pp.283-298.

es	comments
1	Q2 1991 OECD Europe price
2	Q3 1991 Danish price, similar to OECD Europe Price
3	1989 OECD Europe price
4	1988 OECD Europe price
5	per discussion at RMA meeting
6	Q2 1991 price
7	1990 price

Above fuel prices are to be used to calculate paybacks based on world energy prices. A calculation should also be done based on local fuel costs determined from facility staff.

MARCH 1994

APPENDIX F

Equipment Transfer Records

EQUIPMENT TURNED OVER TO VOLGOGRAD ALUMINUM FACTORY
VOLGOGRAD, RUSSIA

ITEM	DESCRIPTION	QUANTITY	RECEIVED
1	Bacharach 300SX combustion analyzer Serial # 24-7098-23	1	
2	Bacharach 48" probe for combustion analyzer	1	
3	Wahl heat Spy infrared thermometer Serial # SN-3-2315	1	
4	US -> Russia 220v plug adapter	1	
5	110v -> 220v 50 watt transformer	1	
6	9v rechargeable batteries	4	
7	Battery charger for rechargeable batteries	1	

The equipment listed above has been turned over to the Volgograd Aluminum Factory. By signing this form the receiver accepts full responsibility for the care and custody of items and must be able to provide accountability reports if requested.

Turned over by:

Name: WILLIAM C. DRIES
Title:
Signature: William C. Dries
Date: 20 May 94

Received by:

Name: Горденко Виктор.
Title: зл энергетик
Signature:
Date: 20.05.94

55

APPENDIX F

Contact List

Vladimir A. Molchanov
Association Volgogradenergo
14, Vorochilova St.
Volgograd, 400001
Russia
Tel: (8442) 33-07-65
Home: (8442) 38-65-51

Mikhail P. Kohohob
Volgograd Aluminum
21, Shkirjatova Street
Volgograd, 400014
Russia
Tel: (8442) 77-18-85
Fax: (8442) 77-32-33

Victor I. Gordkienko
Shkiriatova st. 21,
Volgograd, 400014
Russia
Tel: (844-2) 77-18-82
Fax: (844-2) 77-16-19

APPENDIX H

References

[1] Interview with Scanada Consultants - Ottawa, Ontario

APPENDIX I

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
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
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
MBTU	= mega BTU
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