PN ACQ-440

ENERGY AUDIT
AO KOKHMATEXTIL
IVANOVO REGION
RUSSIA

Prepared for

US AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D C 20253

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QUALITY ASSURANCE STATEMENTS

The contents of this report include recommendations based on data provided by the client organization, measurements made on site, calculations and engineering judgement The conclusions reached were based on a limited engagement of less than ten days duration at the enterprise and not an exhaustive engineering analysis Hagler Bailly Services Inc certifies that this report conforms to the level of best commercial practice for industrial energy audits of similar level of effort, as conducted in the United States This report has been prepared under the guidance of a registered Professional Engineer, licensed to practice in the United States

SECTION 1

EXECUTIVE SUMMARY

Cost-effective energy efficiency measures can result in large savings for an industrial enterprise, thus releasing money spent on energy for other important uses by the management of the enterprise These cost savings can help to make the enterprise stronger, more productive and more competitive

One of the programs sponsored by the United States Agency for International Development (USAID) is the Energy Efficiency and Market Reform Project for Russia (Contract No CCN-0020-C-00-152-00) As part of this project a team of engineers from East West Energy Agency in Moscow, led by Hagler Bailly carried out site activities at the AO Kokhmatextil facility in the Ivanovo Region Their objectives were to work with the enterprise personnel and technical personnel from Ivenergo and to identify opportunities for improvements in energy efficiency of the various industrial processes at AO Kokhmatextil

During the site visit, a vast amount of data was collected on the operating characteristics of the facility, the equipment installed, and the energy usage Metering and measurements were done at key locations to determine the energy usage levels and operating efficiencies of the equipment All of this information was then analyzed by the energy efficiency experts and evaluated for areas of potential improvements These evaluations resulted in some recommendations for implementing cost-effective modifications to improve the energy efficiency of the enterprise

Based on the recommendations, the estimated overall savings for all energy efficiency measures for eleven measures is 1 334 million rubles per year Table 1 is a summary of these recommendations The table shows each recommended measure and includes the estimated costs and benefits, together with the simple payback for implementing these

The management of AO Kokhmatextil should review these energy efficiency measures and the costs and benefits of each A decision on the measures to be implemented and the determination of the financing for these should occur as soon as possible Following that, the specifications for equipment and business plans for implementation will be written These will be used in determining the financing arrangements Once approved, the energy efficiency measures will be procured and installed

Cotton and cotton products are the main products of the enterprise The requirements in steam and hot water for technological purposes as well as heat load of the heating and hot water supply systems are met by the enterprise's own boiler house

While making the calculations related to the efficiency of using various measures the following assumptions were made

1 The calculations of the estimates of energy saving amount were done in natural terms While using the saving percentage during the implementation of a specific measure the estimates were done against the 1996 level of consumption

2 The following tariffs for energy resources were used in estimating the costs and savings in the study

- Electricity 450 rubles per kWh
- Natural gas 289,177 rubles/thousand m^3 of natural gas
- Water consumption 300 rubles/m^3

3 An exchange rate of 5,700 rubles per U S dollar was used in the calculations of costs and savings

4 During the calculation of tons of reference fuel into thousands of m^3 of natural gas, it was assumed that natural gas heating value was at the level of 8000 Ccal/m^3 of natural gas (reference fuel has heating value of 7000 Ccal/kg)

5 During the calculation of heat losses in the heat supply system expressed in Gcal into thousands of m^3 of natural gas it was assumed that boilers efficiency was at the level of 90%

Table 1
Recommended Energy Efficiency Measures

No	Description Of Measure	Units Of Measure	Annual Energy Savings	Annual Savings M Rubles	Cost of Measure M Rubles	Simple Payback In Years
1	Flexible Scheduling	Mwh Tce/year	566 510	155	0	Immediate
2	Reschedule spinning & weaving to 3 shift operation (install metering and monitoring capacity)	Na	0	709	0	< 1 month
3	Sectionalize the lighting systems	Mwh	40	10	4	< 2 months
4	Optimize the boiler operations	Tfs		7	0	Immediate
5	Install condensate tap	Tfs	424	20	4	3 months
6	Steam header split	Mwh	190	48	2	< 1 month
7	Install regulated speed drives	Mwh	105	26	67	2 5 years
8	Fabric impregnation	Gcal	500	350	900	2 5 years
9	Install heat recovery (Units TSI-3)	Gcal	0 2-0 8 per hr	200	170	10 months
10	Heat recovery system on drying and washing	Gcal	0 35 per hr	220	260	1 2 years
11	Optimize exhaust ventilation system	Gcal	0 07 per hr	35	60	1 7 years
	Total for all Measures (2)			1 780	1 484	10 months

(1) The energy savings and costs reflect a single measure There are numerous points throughout the facility where these measures are appropriate, hence the costs, and savings will be much greater
(2) The total reflects only a single measure as described in (1), the totals will be greater as more measures are accomplished

Section 2

Introduction

The purpose of conducting the energy audit at OAO Autoagregat was to collect and analyze appropriate data and information about the enterprise and the energy usages within the facility then use this information to make recommendations on cost-effective measures to increase the efficiency level of the plant The process involved the collection of historical use of electricity, gas, coal and other fuels and their associated costs It also involved some metering and measurements of key energy using equipment at the facility This was done using the most current and sophisticated energy auditing equipment available

The energy audit was conducted at the Kokhmatextil plant during the period from 18 February through 25 June 1997 Energy auditing experts performed the audit, including the measuring, metering and other data acquisition necessary to analyze the energy uses

Section 3

Enterprise Description and Energy Consumption

In order to better understand the overall situation with the enterprise and its energy use, it is important to look at the characteristics operations, processes and energy requirements This section provides the description of the enterprise, followed by a description of the facility itself, and then a description of the energy uses and requirements After that is a description of the data collection from the measurements and metering that was done during the energy audit

A Enterprise Description

AO Kokhmatextil is located in Kokhma in the Ivanovo Region The plant consists of three distinct operations each with its own plant The three operations include the spinning plant, the weaving plant and the finishing plant They do not necessarily operate in a closed cycle For example, the finishing plant processes the end products from the weaving plant, but also processes coarse material the comes from outside sources The current capacity load is 40% to 45%

B Facility Description

The spinning plant produces cotton yarn from raw cotton The process consists of three shops a preparation shop a carding/drawing/combing shop, and, a spinning shop All three shops use electric power for production processes, ventilation (380 V) and lighting equipment (220 V) In addition, middling products are transported between shops by electric-drive mechanical conveyors (380 V) The latter two shops use steam and compressed air for humidification Input ventilation heaters also use steam The plant operates two shifts, seven days a week with night shifts occurring six times per month

The weaving plant produces coarse fabric from yarn The plant consists of two shops, a preparation shop and a weaving shop The plant consumes electric power to process equipment, compressed air in air humidifiers and weaving tool blowers It also uses steam for air humidification and sizing machines in the preparation shop, and thermal energy for heat supply as hot water from the boiler house The plant is equipped with a water heating system The plant operates on the same schedule as the spinning plant

The finishing plant produces finished fabric from the coarse fabric The plant comprises five shops, which include sizing, dyeing, roving, bleaching, and printing The plant consumes electric energy for production processes and lighting The plant is the primary consumer of heat energy, the bleaching shop consumes 17,000 tons of steam per year and the dyeing shop 19,000 tons The finishing plant is also a primary user of water, as is the boiler house

C Energy Consumption

Heat energy is generated by a boiler house plant which operates 11 boilers (DKVR 10/13) The boiler house generates steam for input feed into the production processes, for sub-users, for the finishing plant heating for water heating in the heating and hot water supply boilers, to preheat mazut, and for other miscellaneous uses The gas consumption is registered by two meters (DCC711) which have interchangeable summer and winter diaphragms The boiler operation control is automatic In 1996, the boiler house consumed 26,059 tce The boiler uses natural gas (Qm=7,950 kcal/cu m) as the primary fuel and mazut as backup The plant has an in-house heat energy accounting arrangement

Electricity is supplied from Ivenergo s grid via four 6 3 KV input lines to 6 transformer substations The spinning plant substation has four 1,000 KVA transformers, one 1,600 KVA transformer and one 630 KVA

transformer Another spinning plant substation has two 1,000 KVA transformers The finishing plant substation has three 1,000 KVA transformers and two 630 KVA transformers The bleaching shop substation has three 1,000 KVA transformers The weaving plant substation has three 1,000 KVA transformers, one 315 KVA and one 250 KVA transformer The boiler house substation has two 1,000 KVA transformers The plant operating voltage is 0 4 and 0 5 KV In 1996, the combined electrical usage for the entire enterprise was 18,257 Mwh

The electric power consumption, by factory plant, is shown in Figure 3 1 The figure shows data for 1990 which was a stable period, and 1996, which is a more recent period

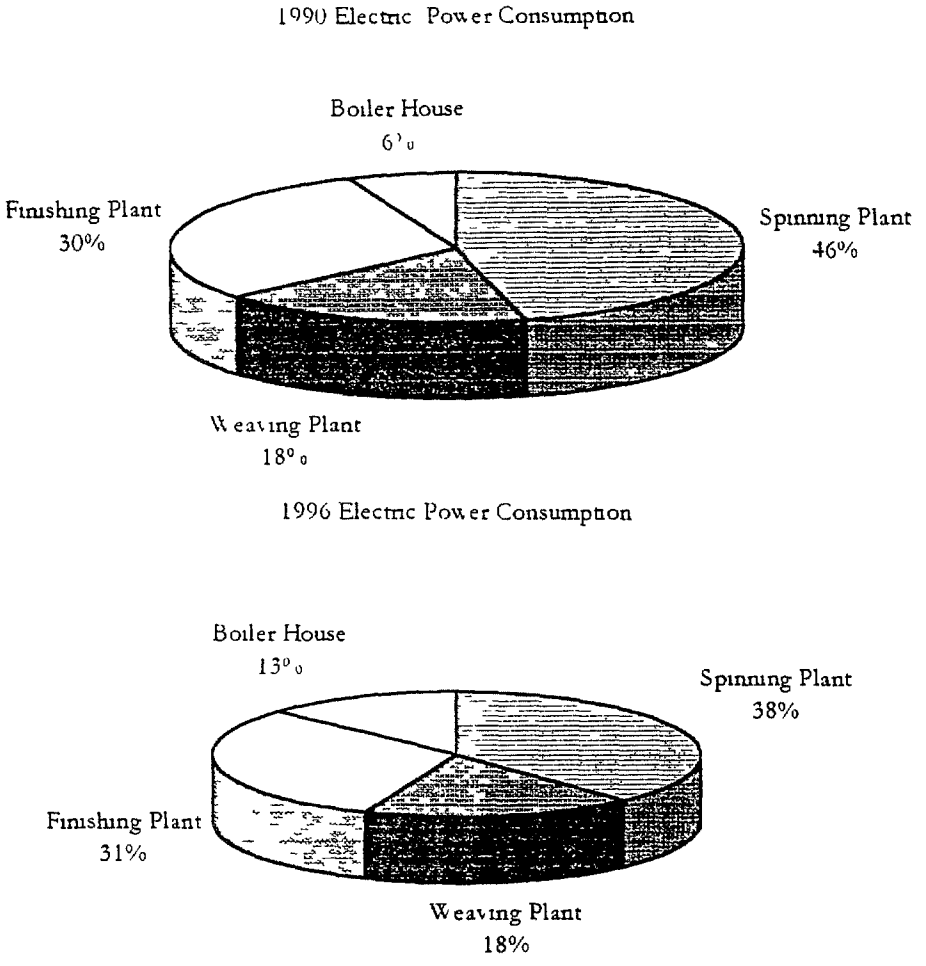


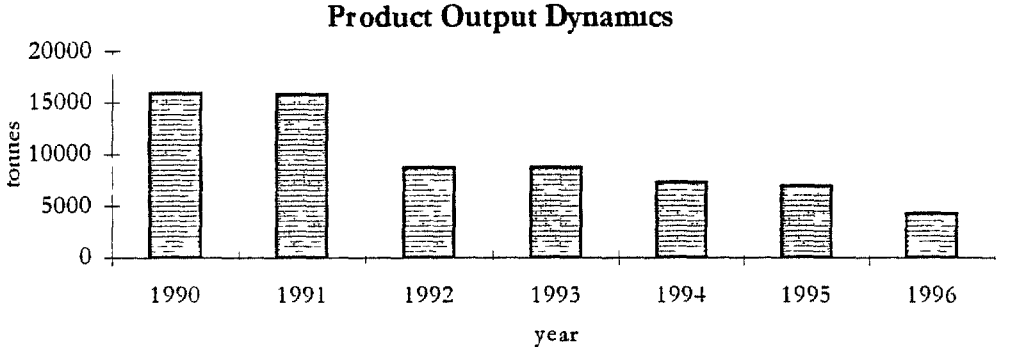
Fig 3 1 1990 and 1996 Electric Power Consumption

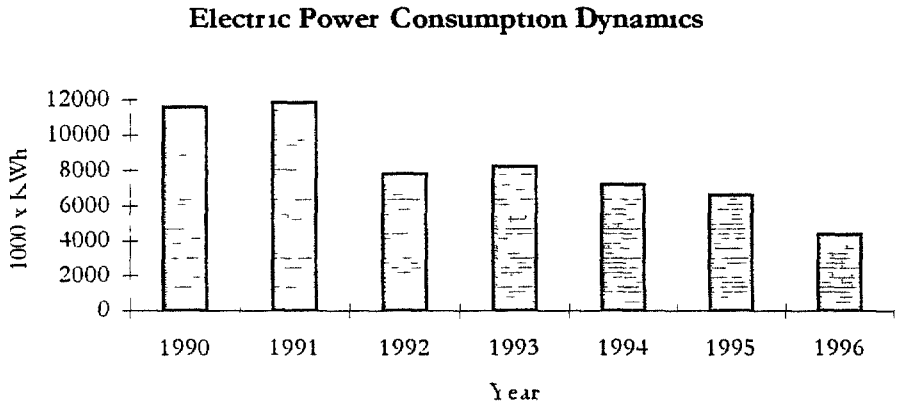
Table 2 1996 Capacity Percentages in % of Rated Capacity

	Plant	% Load
1	Spinning	25
2	Weaving	38
3	Finishing	36
4	Boiler House	74

The enterprises primary electricity consumer is the spinning plant The process there is continuous therefore there are no significant losses of electric power due to the idling of energy-intensive equipment Another major consumer of electricity, and the largest consumer of steam, is the finishing plant

Figure 3 2 provides an example of how the energy consumption correlates with the production output changes While this figure provides some useful information, it should be noted that the impacts from cuts in production capacity and service loads varied For example, the boiler house, ventilation loads, lighting and some other energy costs diminished much less that the costs for primary equipment resulting in increased specific heat and electricity consumption per product unit





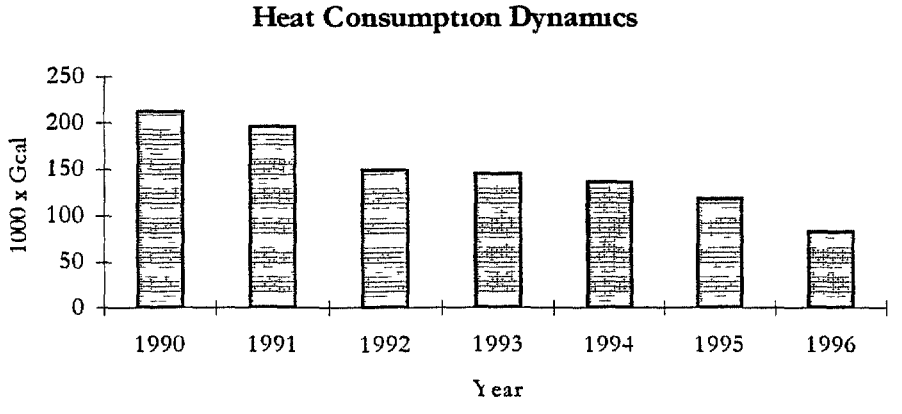
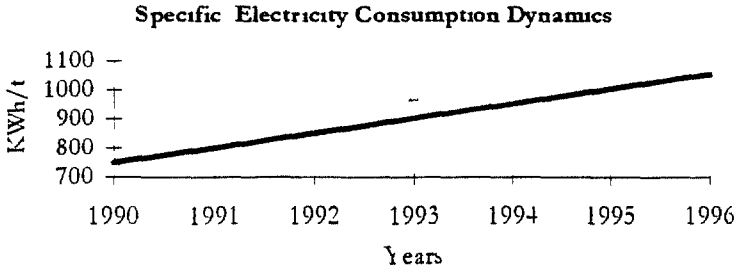


Fig 3 2 Finishing Plant Energy Consumption and Output Dynamics

Figure 3 3 shows the dynamics of the specific electric and heat consumption for the years 1990 through 1996 The trend towards lower specific water consumption is caused by the introduction of water consumption accounting and metering arrangements



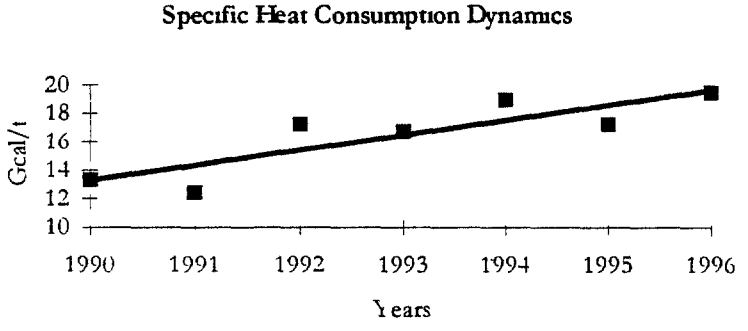


Fig 3 3 **1990-1996 Specific Energy Consumption**

Figure 3 4 shows the percentage of electricity requirements for 1996 for each of the primary users at the enterprise The auditors were told that electrical energy amounted to 20% of the total production costs in 1996, therefore, electricity savings is a priority

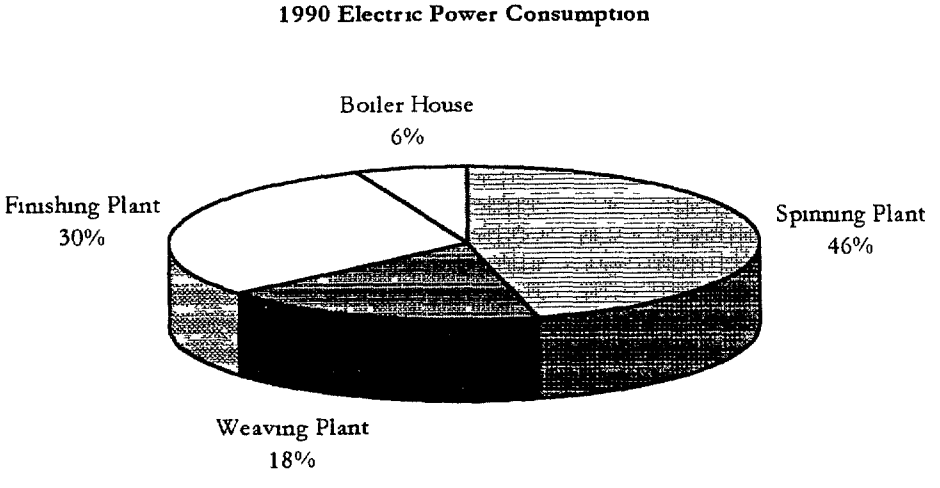


Fig 3 4 **1996 Energy Resources Payment Structure**

The electricity payments pattern in 1996 (see Figure 3 5) indicates that it is equally important to reduce both total electricity consumption as well as the requested peak-time capacity

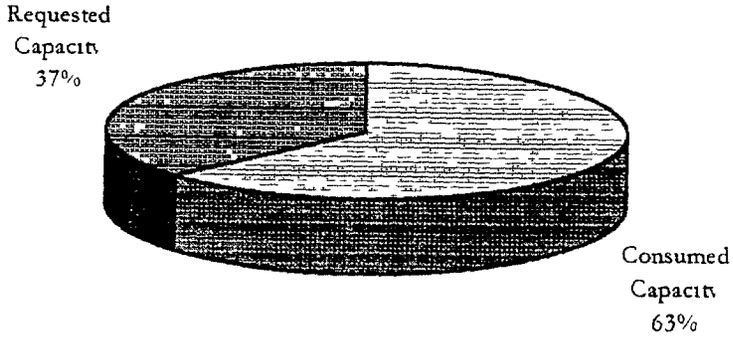


Figure 3 5 1996 Electricity Payment Structure

Beginning January 1 1997, the plant had proposed to have implemented a new night electricity tariff at 163 Rubles/kwh (2300 to 500) However it will become possible to introduce the new system only after new meters have been installed

Table 3 shows the energy tariff rates for the enterprise for each month during 1996

Table 3
1996 Energy Tariff Rates

Tariff Rate	1	2	3	4	5	6	7	8	9	10	11	12
Gas Fuel R/t cu m	257 151	263 940	269 852	280 212	275 465	275 465	275 465	275 465	283 230	289 177	289 177	289 177
Electricity												
Total electricity consumption R/kWh	174	174	174	209	209	209	209	209	261	261	251	251
Requested peak-hours capacity R/kW	48 200	48 200	48 200	51 314	51 314	51 314	51 314	68 134	68 134	68 134	63 753	63 753
Water R/cu m												
Water consumption	172	174	174	272	272	272	272	272	317	317	317	317
Water discharge	630	630	630	916	916	916	916	916	1037	1037	1037	1037

Energy Resources – Generation an Distribution

Boiler and Furnace Fuel

Natural gas is used for heat energy generation by the boiler house and for singeing furnaces (GOF-220 and MTO-1-240) The furnaces consume insignificant gas amounts (about 2,000 cm^3 per month or 0 1% of total consumption) and, therefore, have been left out of further analysis The boiler house has 11 steam boilers (DKVR 10/13) generating steam for process needs, finishing plant steam heating, boiler water heating for hot water and heating supply to the spinning plant, the weaving plant and the workers accommodations for mazut preheating, and other needs The boiler operation is controlled automatically Some boilers are equipped with instruments indicating flue gas temperature after boilers and after economizers Boiler #9 is equipped with a gas analyzer measuring O_2 content of flue gases after the boiler A water feed to Boiler #7 is equipped with a thermometer The boiler house flow diagram is presented in Figure 3 7 Boiler feed comes from the water reservoir plus condensates from the spinning and finishing plants, and the boiler house The water flows through the chemical treatment and de-aeration in DSA50 and DSA25 de-aerators De-aerated water is then cooled to 90-94 °C in a heat exchanger and channeled into an economizer Feed water is pumped into the boiler at 120 °C The boilers have a capacity of 10 tons/hour at an operating pressure of 5 to 6 atm

The actual specific fuel consumption for heat energy generation in 1996 was as follows

1st quarter	170 6 kg ce/Gcal
2nd quarter	162 5 kg ce/Gcal
3rd quarter	170 9 kg ce/Gcal
4th quarter	167 1 kg ce/Gcal

The seasonal gas consumption analysis indicates a reduction outside of the heating season

Excessive gas consumption is caused by the boilers operating in less than optimum operating mode The lack of monitoring and measuring instruments currently available prevent the identification of all of the causes for this excess use Of the five boilers operating at the time of the inspection, three were not working in an optimum mode, with gas analyzer readings of oxygen content of flue gases after Boiler #9 ranging from 6 2% to 7 4%, and flue gas temperature reaching 305 °C after Boiler #8 and 190 °C after the economizer The same information was obtained for Boiler #3 Increased gas consumption in the summer is due to the fact that the finishing plant needs largely determines the boiler house operation The unstable operation produces irregular operation of the boiler house, with the boilers often times under-loaded, resulting in increased fuel consumption

An instrument-assisted study was carried out at the combined plant from 18 June through 25 June 1997 A Bacharach Model 300 gas analyzer was used to evaluate the boiler house fuel combustion efficiency Three boilers were in operation at the time, specifically nos 2, 3 and 10 Boilers #3 and #10 and gas-fired, while Boiler #2 fires a mixture of gas and mazut Flue gases were analyzed for chemical composition in various boiler operation modes

The measured results and corresponding operational chart requirements are presented in Table 4 The instrumentation was not able to be used to test the efficiency of the economizers because the probe length was not sufficiently long to penetrate the thickness of the gas duct wall

Table 4
Boiler Operation Parameters

#	Parameter	Boiler #2		Boiler #3		Boiler #10	
		Op Chart	Actual	Op Chart	Actual	Op Chart	Actual
1	Boiler Capacity t/hr	9	9	10	10 4	10 8	9 6
2	Gas Temperature After Boiler ^{0}C	270	324	260	336	273	274
3	Gas Composition						
	O_2	5 1	10 1	5 3	4 5	4 6	6 1
	CO_2	9 0	6	8 8	9 2	9 2	8 3
	CO	0	0	0	0	0	0
4	Excess Air Ratio	1 46	1 86	1 29	1 25	1 25	1 37
5	Losses in Flue Gases after Boilers	-	19 9	-	14 7	-	12 6

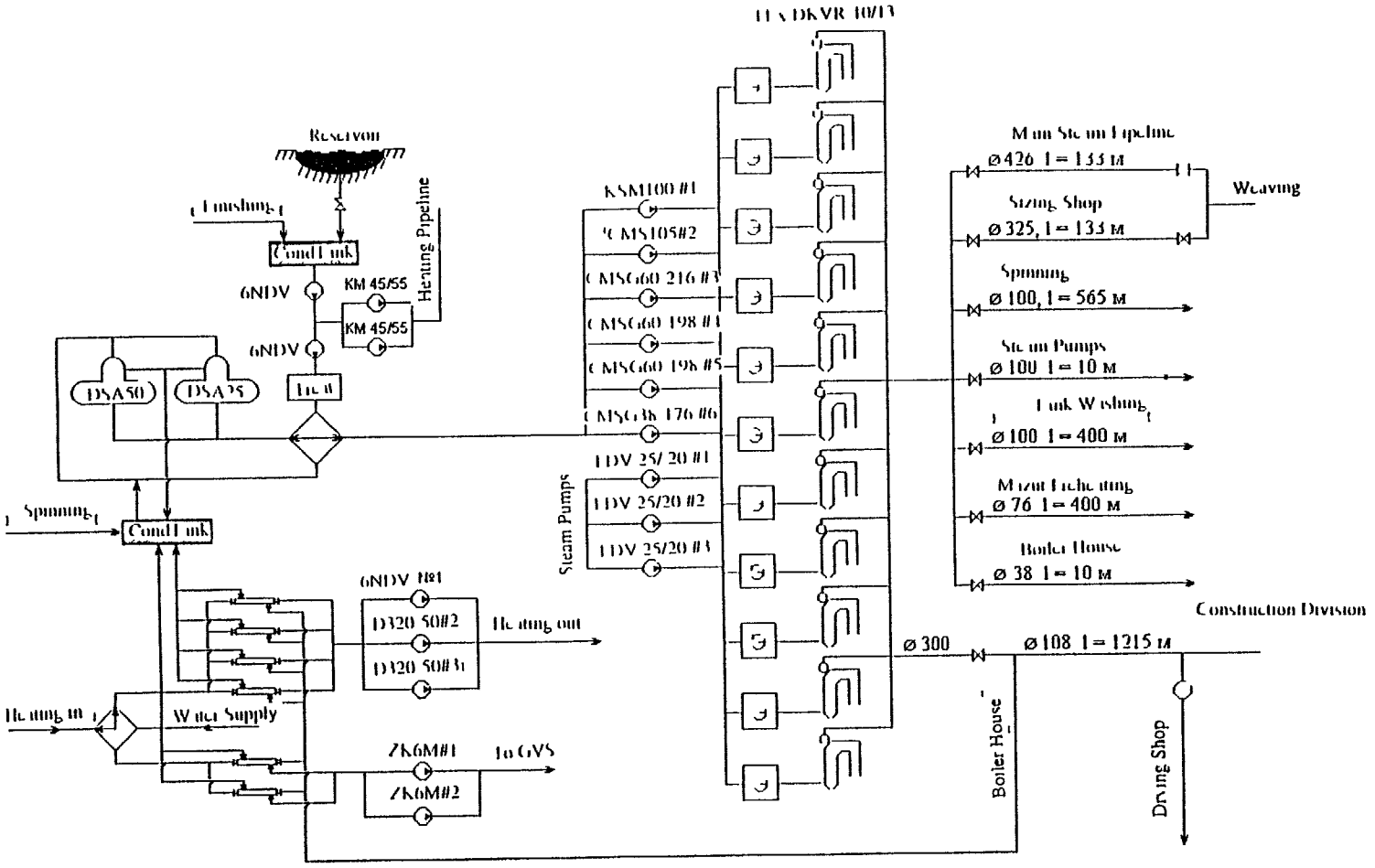
The above gas composition analysis indicates inefficient boiler operation Specifically Boilers #2 and #10 indicated an excessive oxygen content of flue gases, the excess air ratios are also in excess of operative values Air is supplied for combustion in the automatic mode therefore, the inefficiencies are due to the automatic controls operating defectively, as well as suction in the gas line for Boiler #2 Boilers # and #3 have flue gas temperatures higher than operating chart requirements which is probably due to dirt on their heat exchanger surfaces

An increase of 0 1% in the air ratio causes an increase in excessive fuel consumption of 0 7% The excessive in Boiler #2 reached 2 8% A deviation from the optimum value of 0 1% in CO2 content results in an increase of 0 6% in excessive fuel consumption For Boiler #2, this reached 1 8%

In order to improve the heat exchange, it is believed that the heat exchange surfaces should be cleaned on Boilers #2 #3 and #8 Boilers #2 and #10 need adjustments in their automatic controls of the fuel feed feed for combustion Boiler #2 should be checked for leaks in the lining

Fuel losses due to inefficient fuel combustion in Boilers #2, #3 and #9 amount to 240 tons ce or 70 million Rubles per year

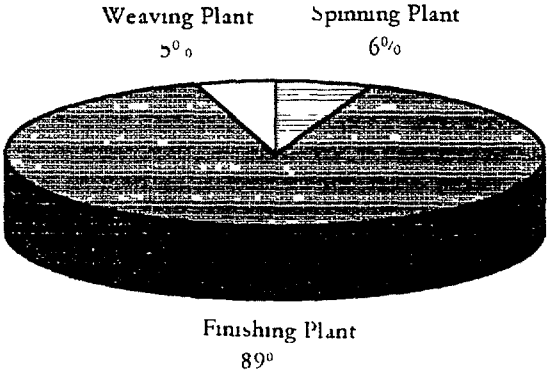
Figure 3 7
Boiler House Flow Diagram



Heat Energy

Boiler house generated heat energy is used in the finishing and weaving processes and for plant and district heating Six to seven boilers are operated in the winter and three to four during the summer The heat energy consumption structure is presented in Figure 3 8 (information received during the energy inspection)

Figure 3 8
Heat Consumption by Various Plants



The principal plant heat consumer is the finishing plant with 89% of the total combined plant consumption The spinning plant uses 6% of the heat energy and the weaving plant 5% The finishing plant consumes 92% of the heat energy in the production process and 8% for heating The weaving plant uses 72% in the process technologies and 28% for heating The spinning plant consumes no heat energy in the production process Therefore, the potential for heat energy savings can primarily be secured by improving the thermal efficiency of the process equipment The finishing plant process technology uses 6 atm steam

Major heat quantities are consumed in the bleaching shop by *Amdess* lines (474 Gcal/t) drying drums (204 Gcal/t) and the LJO-2 line (248 Gcal/t) In the dyeing shop, the major heat is consumed by Amdess lines LPS line (571 Gcal/t) and LKS line (1 029 Gcal/t) Other major heat consumers are LU-120 lines (280 Gcal/t), SShR lines (172 Gcal/t) and LAO-120 lines (140 Gcal/t)

All heat consuming equipment have condensers, except the sizing machines in the weaving plant The sizing machine is fed with steam at 3 atm The unit consumed 1 212 Gcal in 1996 The principal purpose of the condenser is to reduce free steam in the heat exchanger return pipe, otherwise there is a drastic drop in thermal efficiency due to unused latent evaporation heat which is 517 Kcal/kg steam In addition, if steam is carried with condensate, hydraulic shocks become a hazard The condenser helps remove air from the steam and condensate Air impairs the heat transfer Dissolved carbon dioxide and oxygen corrode pipes, thus causing more inefficiency in the system The economic feasibility of condensate return to the boiler house for recycling is arguable since the weaving plant is far from the boiler house If installed, a condenser prevents heat losses in free steam in pipes The percentage of free steam in condensate is computed as follows

$$X_{fs} = S \times P \times 100\%$$

Where, X_{fs} – free steam content of condensate (%)
S = 0 2 – empirical coefficient
P = 3 atm – steam pressure

The sizing machine has X_{fs} = 35% or 424 Gcal or 72 tce per year, given total consumption of 1 212 Gcal per year Free steam losses amount to 21 million rubles per year in monetary terms

Analyzers were used to check the operation of some heat consuming equipment as part of the instrument inspection of the company, including two LAO-120 lines and LJO lines Analysis of load changes over a two-day period (see Appendices) indicates that the equipment was stopped several times for a period from 30 minutes to 3 hours LAO-120 lines #1 and #3 were stopped eight times during the period LJO line had ten stoppages which lasted from 45 minutes to three hours The potential of a reduction in heat consumption by this equipment can be achieved by increasing its efficiency in order to reduce heat losses during start-ups and run-ups after shutdowns

Hot water for hot water supply and heating purposes is prepared by the boiler house boilers which include three heating boilers and two hot water supply boilers Steam feed to the boilers is from a common steam drum Boiler capacity is insufficient to maintain the heating water temperature schedule in winter at 100-104 °C feed and 60 °C return The finishing plant requirements disallow pressures in excess of 6 atm Under this circumstance, it is impossible to meet the recommended heat schedule

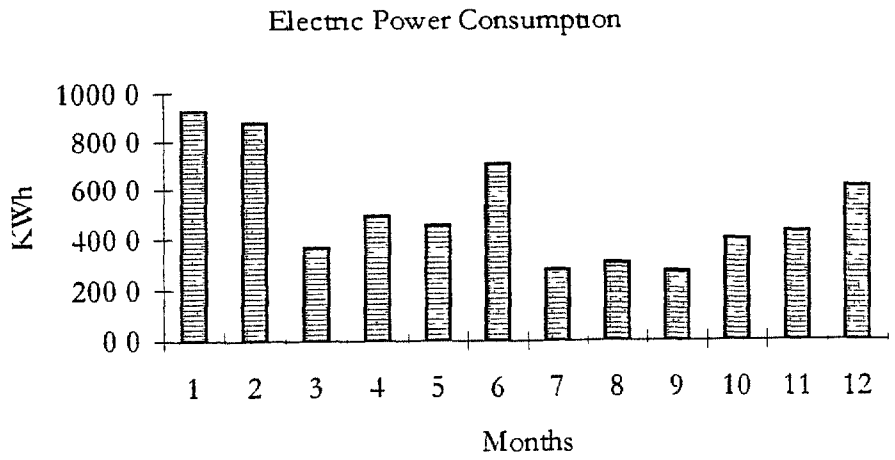
On possible way to remedy the situation would be the installation of a steam cooler/reducer unit Another solution would be to split the common steam drum into process and heating sections Both options would ensure a new heating schedule which would reduce water flow in the system and reduce pump loads The electricity consumption for water pumping in the heating system is proportional to the cubed specific water consumption per 1 Gcal of heat delivered The first option increases boiler efficiency in all boilers, the other applies to heating boilers only The installation of a cooler/reducer unit will entail significant capital costs and third party installation services, while a steam drum split calls for minimal capital costs and can be done using the enterprises labor resources

Electric Power

Spinning Plant

The spinning plant is the principal consumer of electricity at the combined plant It accounted for 38 2% of the electricity consumption in 1996 Figure 3 9 presents the spinning process electricity consumption and output data The graphs indicate that there may be a discrepancy between electricity consumption and product output The analysis of specific electricity consumption as a function of product output indicates that the electricity consumption varys from 73 to 79 kWh/ton Figure 3 10 shows this in graphical form

Figure 3 9
1996 Spinning Plant Electricity Consumption



Output

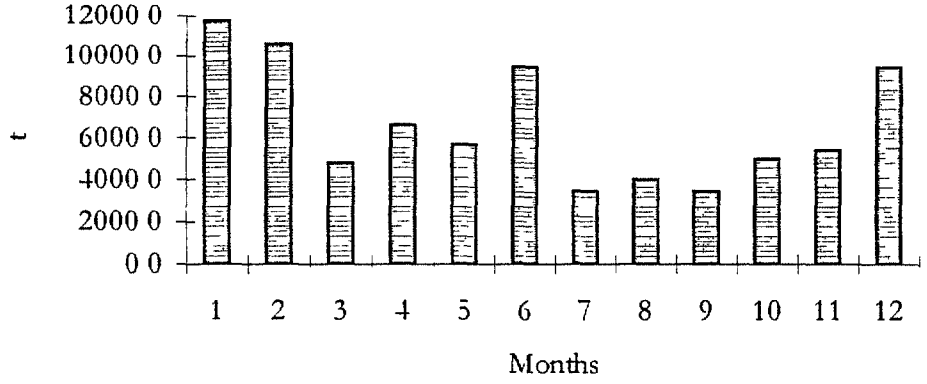
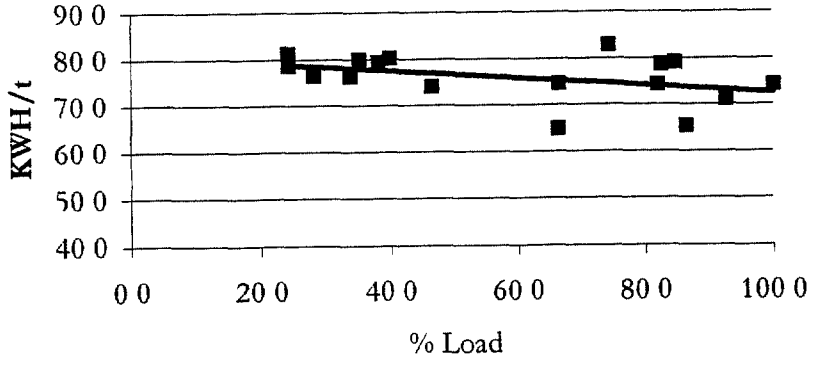
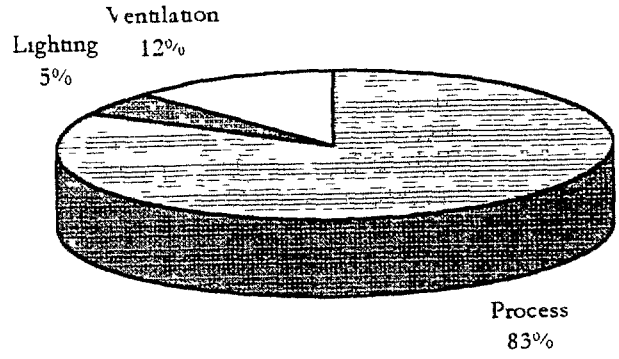


Figure 3 10
Specific Electricity Consumption by Spinning Plant



The increase in the electricity consumption per unit output is primarily due to the fact that when production decreases, the non-production uses of electricity, such as lighting and ventilation, do not decrease proportionally The full production capacity load of electrical uses for the spinning plant is presented in Figure 3 12

Figure 3 12
Electric Power Consumption Structure at Full Production Capacity



The average daily production capacity load ratios have been computed (see Table 5) in percentage terms against the maximum output in January and February 1996

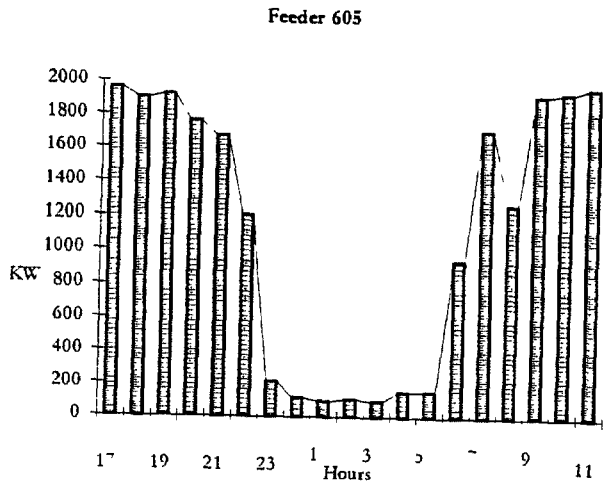
Table 5
1996 Production Capacity Loads

#	Parameter	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	t/day	380	379	155	221	183	315	111	129	115	161	181	305
2	% 2 shifts	100	100	40 8	58 2	48 2	82 9	29 2	33 9	30 3	42 4	47 6	80 3
3	% 2 shifts	66	66	26 9	38 4	28 2	54 7	19 3	22 4	20	28	31 4	53

The spinning plant operates in two shifts seven days a week The production capacity loads in various months in 1996, computed against the maximum achieved loads (accepted as a base load of 100 %) vary from 30% to 100 %, or 20% to 66% with round-the-clock operation Such production fluctuations are related to raw material supply outages, leading to irregular operation and a significant increase in specific electricity consumption per unit of product

The daily schedule of electricity consumption is presented in Figure 3 13

Figure 3 13
Daily Active Power Consumption



The existing shift schedule produces a peak of electricity consumption from 0600 to 2200 hours therefore electricity consumption is at its minimum from 2200 until 0500 hours This is a time period when reduced night rate hours could be taken advantage of to reduce the overall monthly billing

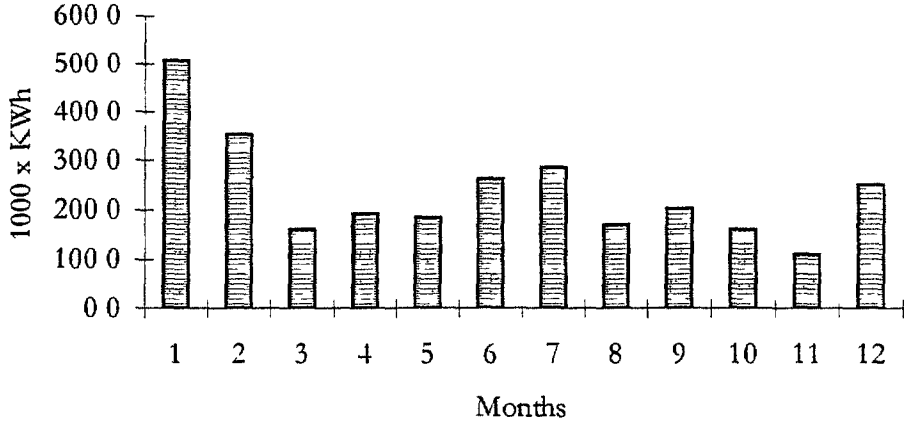
Weaving Plant

The weaving plant operates as part of the common production cycle together with the spinning plant roving between the end product of the latter and the input product of the weaving process The weaving plant electricity consumption and product output performance for 1996 are presented in Figure 3 14

Figure 3 15 shows a graphical representation of the electricity consumption per unit output compared to the percentage of load Increased specific consumption at lower productivity is primarily due to an increase in the percentage weight of shared costs (ventilation, lighting air compression for water spraying and weaving tool blowing) in the electricity consumption structure and idle equipment operation

Figure 3 14
1996 Electricity Consumption in Weaving Process

Electric Power Consumption



Product Output

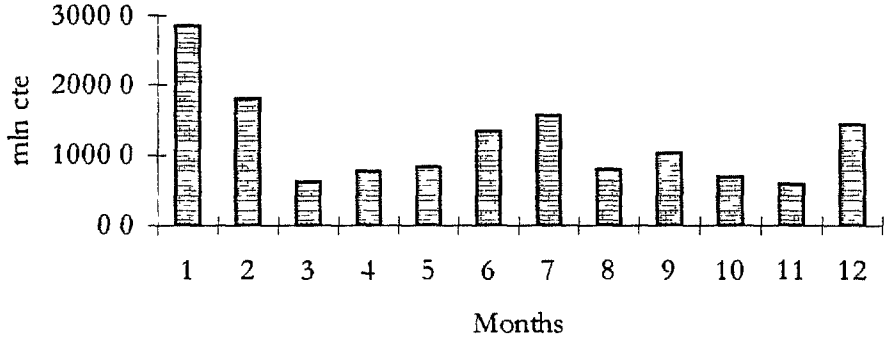
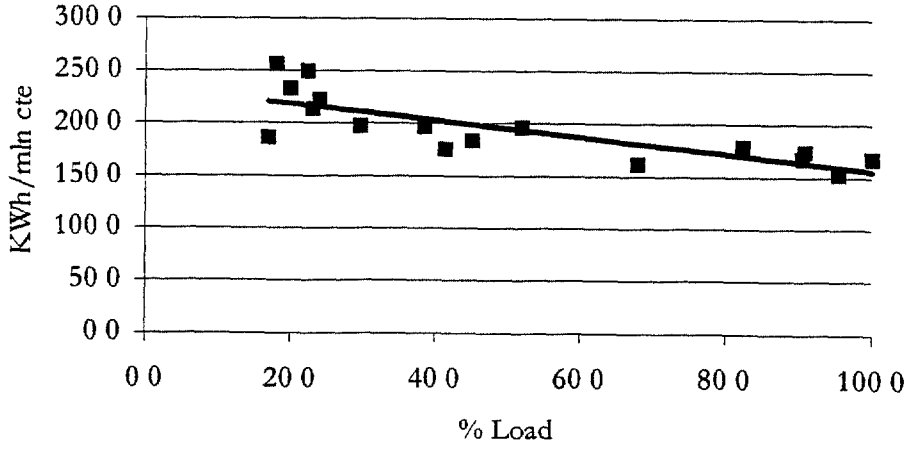


Figure 3 15
Specific Electricity Consumption in Weaving Process



Ventilation and lighting consumption amounted to 46% (see Figure 3 16) for the weaving plant

Figure 3 16
Weaving Process Electricity Consumption Structure

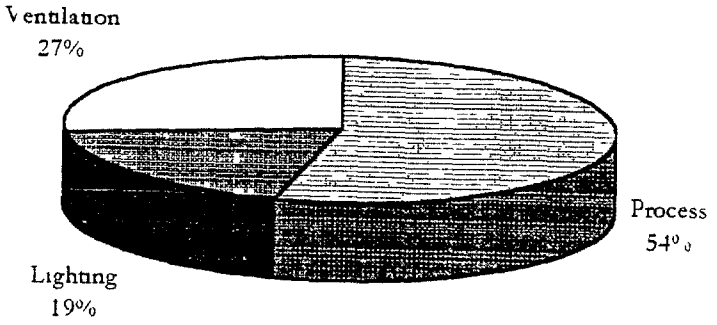


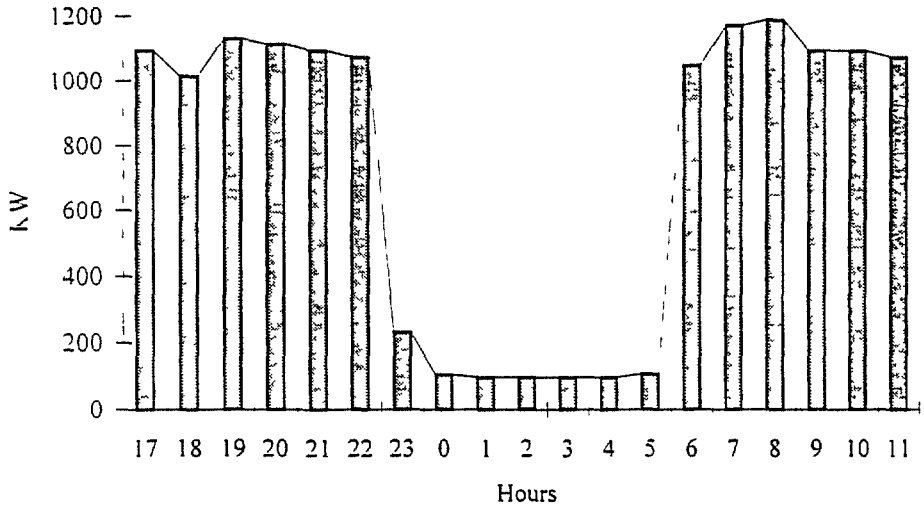
Table 6 shows the daily average production capacity load ratios in percentage terms, compared to the maximum outputs in January and February 1996 The weaving plant operates in two shifts, seven days a week The production capacity loads varied from 15% to 67% in various months in 1996 (adjusted to round-the-clock operation) Irregular operation significantly increases the specific electricity consumption per unit output

The existing two-shift schedule produces a peak of electricity consumption from 0600 to 2200 hours therefore, electricity consumption is at its minimum from 2200 to 0500 There is potential for a reduction in billing if load could be moved to these off-peak hours

Table 6
1996 Production Capacity Loads

#	Parameter	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	mln tce/day	92	64 9	20 2	25 8	26 9	44 4	50 3	25 8	34 2	22 3	19 6	46 2
2	% 2 shifts	100	71	22 4	28 7	29 9	49 3	55 9	28 7	38	24 8	21 8	51 3
3	% 3 shifts	67	47 6	15	19 2	20	33	37 5	19 2	25 5	16 6	14 6	34 4

Figure 3 17
Weaving Plant Hourly Electric Power Consumption



A significant percentage of electricity consumed by the weaving plant is accounted by the compressor station Air compressed to 3 atm is generated by two VP-202 12/13 compressors (# 1 and #2) with 75 kW installed capacity The compressed is used for water spraying in plant buildings Compressor #4, VP-202 10/8 (75 kW installed capacity) and #5, KSE-5EM (90 kW installed capacity) compress air to 5 atm for weaving tool blowing

The actual compressor station electricity consumption was measured in the course of an instrumental inspection on 24 June 1997 A Fluke Model 39 electric power analyzer was used to measure active capacity reactive capacity and total power factor The resultant readings and capacity factor computations are preseneted in Table 7

Table 7
Compressor Station Electricity Consumption

#	Compressor #	Parameter	Total Value	Capacity Factor
1	Compressor 1	Active power KWh	45 4	0 61
2		Reactive power KVAh	29 2	
3		Total power KVA	54 0	
4		cos φ	0 84	
5	Compressor 2	Active power KWh	43 9	0 59
6		Reactive power kvar	33 3	
7		Total power KVA	55 7	
8		cos φ	0 77	
9	Compressor 4	Active power KWh	43 3	0 58
10		Reactive power kvar	35 1	
11		Total power KVA	55 9	
12		cos φ	0 78	
13	Compressor 5	Active power KWh	62	0 69
14		Reactive power, kvar	63	
15		Total power KVA	89	
16		cos φ	0 7	
17	Ventilator	Active power KWh	0 22	0 04
18		Reactive power kvar	1 4	
19		Total power KVA	1 42	
20		cos φ	0 16	

The compressor station has not changed for ten years It was designed for full load production capacities To date, the weaving plant output is down by 62% (i e there are significantly fewer machines requiring compressed air) Because of this, the compressed air capacity is excessive It seems that it may be appropriate, after further investigation to replace KSE-5M compressors with smaller machines For example, if the motor is replaced with a 75 kW motor, the compressors electricity consumption could be reduced by 91,000 kWh, with a savings of 23 million rubles per year

If the spinning and weaving plants move from two shifts to three shifts per day, at least one third of the daily electricity consumption will shift to night hours (i e the period when night rates apply) To do so would require the installation of new meters, at a cost of about 4 million rubles to install (not counting the cost of the meter) The proposed operational schedule change could result in a cost saving of 289 million rubles per year in electricity

It would also seem appropriate to investigate the implementation of flexible scheduling This may depend upon raw material and semi-finished input product availability A flexible schedule may mean working for two weeks, then two weeks off A rough estimate of such a schedule may say electricity in the compressor station in the amount of 296,000 kWh per year, or about 74 million rubles

If possible it is proposed that all power transformers, except those supporting the repair and maintenance operations and emergency lighting, be switched off during the plants shutdowns The following empirical formula can be used to compute the electricity savings

$$E = \frac{S_N \times t}{100} \times (5K + 0\ 5), \text{ kwh/year}$$

Where S_N = transformer rated capacity (KVA)
t = shutdown period (hours)
K = 0 05 (empirical factor – losses)

Transformer power-downs on the 2 weeks on/2 weeks off schedule will save 270,000 kwh per year, or 68 million rubles

The proposed operation schedule will also help reduce heat consumption, as all industrial building heating systems at the spinning and weaving plants could be switched over to standby mode for shutdown periods The above will reduce heat generation requirements by 300 Gcal and reduce gas consumption by 510 cte with a resultant saving of 13 million rubles per year

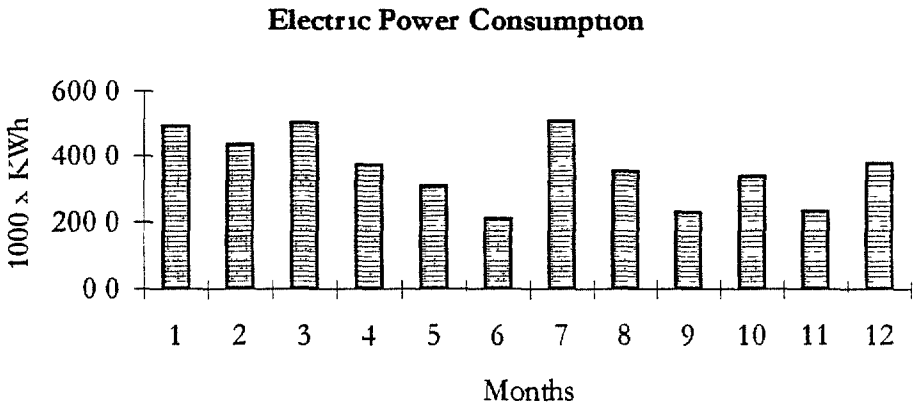
Finishing Process

The finishing plant is not tied into the common production cycle with the spinning and weaving processes It processes raw material sourced outside as well as the combined plants semi-finished product The finishing plant comprises five shops bleaching, dyeing, sizing, printing and roving The roving shop consumes insignificant electrical capacity and will be left out of the further discussion

The finishing process, just like the spinning and weaving processes, operates under reduced irregular loads, with the resultant impact on monthly electricity consumption (see Figure 3 18)

In general, electricity consumption correlates with product output At the same time, the analysis of specific electricity consumption, as a function of plant output, produces scattered results Figure 3 19 provides the graphical representation of this analysis

Figure 3 18
Electricity Consumption of the Finishing Process



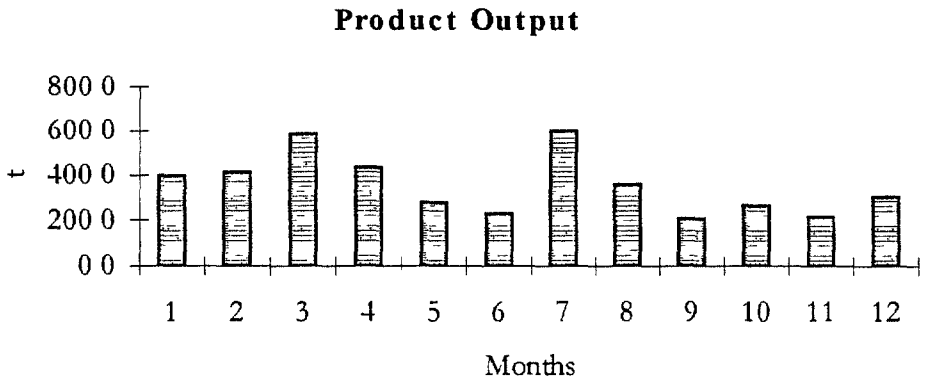


Figure 3 19
Specific Electric Power Consumption in Finishing Process

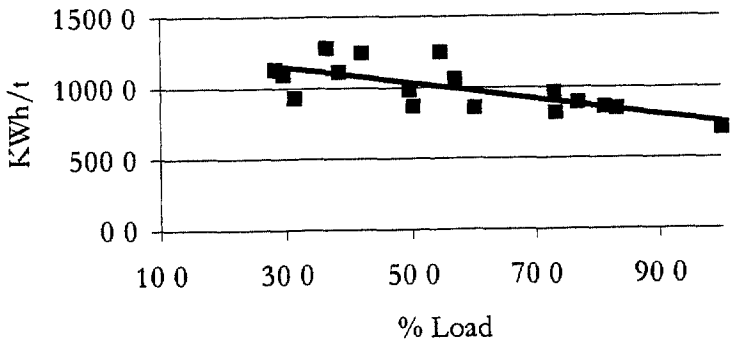


Figure 3 20 shows the percentage of electricity consumption for each of the primary uses in the Finishing plant Obviously the largest use for electrical energy is the process itself, with lighting and ventilation equal at about 10% each

Figure 3 20
Electricity Consumption Structure for Finishing Process

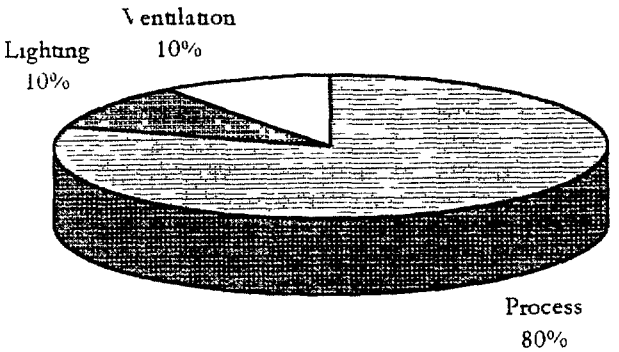
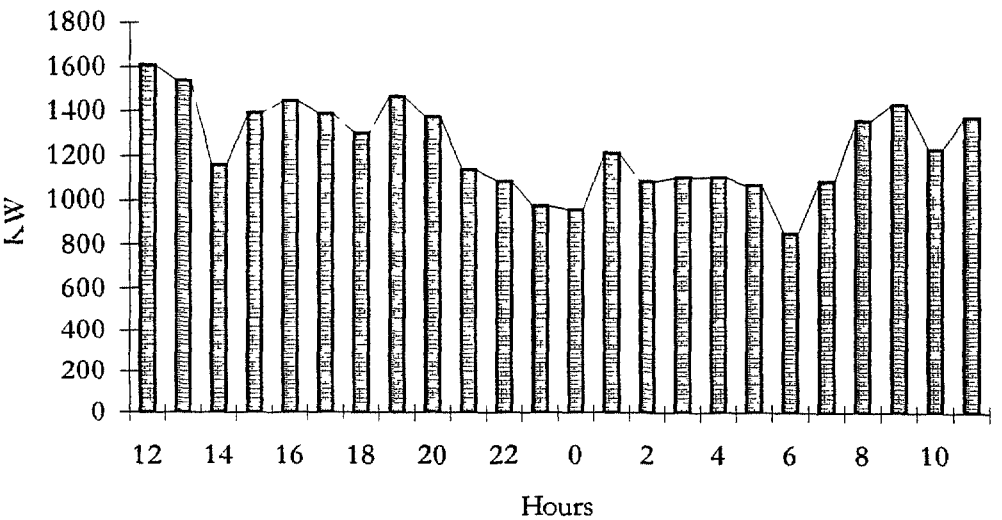


Table 8
1996 Finishing Plant Capacity Loads

#	Parameter	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	t/month	395 1	411 7	586 6	434 6	277 6	226 7	601	358 5	205	264	214	304
2	% capacity load	65 74	68 5	97 6	72 31	72 31	3552	100	59 65	34 11	43 94	35 59	50 58

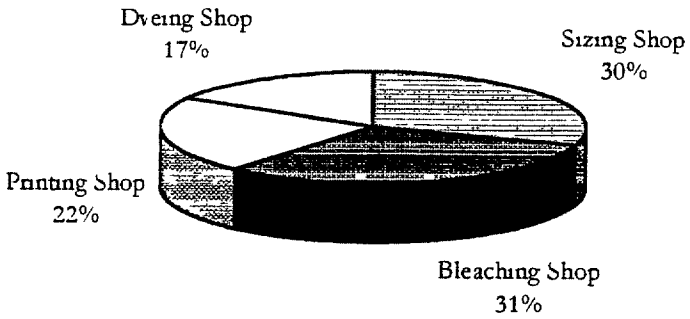
The daily load pattern of the finishing plant is relatively flat, going down slightly between 2300 and 0600 hours This is shown in Figure 3 21

Figure 3 21
Daily Active Load Schedule of Finishing Plant



The breakdown of energy consumption, by shop, as provided by the plant energy inspection department is presented in Figure 3 22

Figure 3 22
Electric Power Consumption Structure for Finishing Plant



The principal finishing process electricity consumers area the bleaching and the sizing shops, the roving plant share is insignificant and will not be taken into account

Energy and Elite electrical power recorders were installed on the major energy consuming equipment units in the bleaching and sizing shops for the periods from 23 to 25 July These measured the operation modes power consumption profile and power factor changes in the course of the instrumental inspection of the combined plant Readings were recorded at 15-minute intervals The measurement readings are tablulatd in Appendices #1 through #3 and are presented below in the form of graphs (See Figures 3 23 through 3 27)

The Amdess line, the principal consumer of heat energy (644 Gcal/t) with high aggregate installed capacity (126 kW) was shut down during the test Readings were taken of a LJO-2 line (248 kW aggregate electric drive installed capactiy) in the bleaching shop and two LAO-120 lines (#1 and #2, 156 KW aggregate installed electric drive capacity each) Readings were recorded from 1700 on 23 June 1997 through 1000 on 25 June 1997

Figure 3 23
Active Power Consumption, LAO-120 Line #1

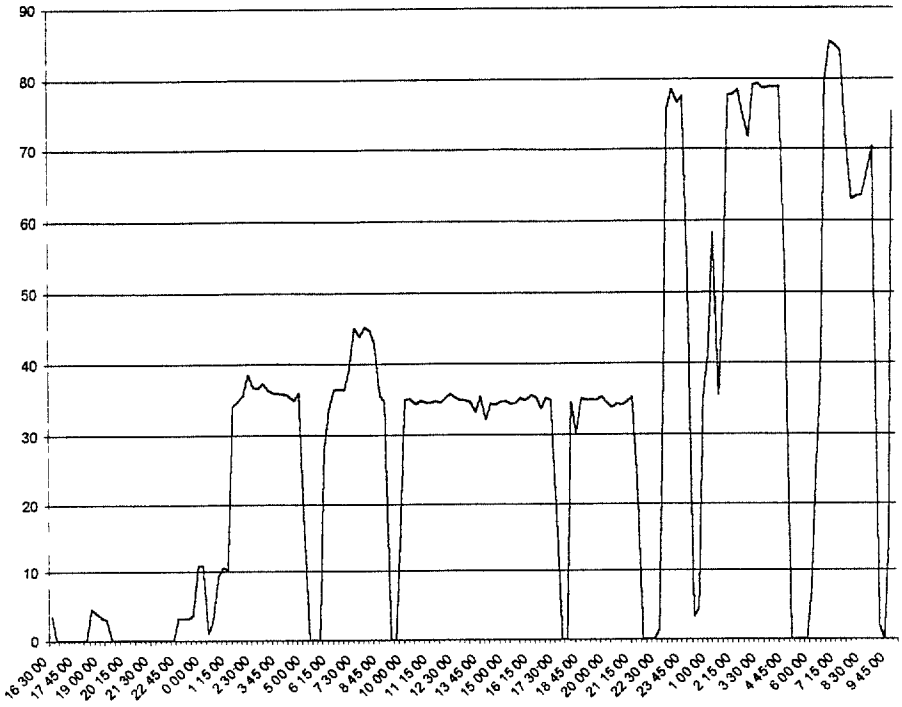


Figure 3 24
Power Factor, LAO-120 Line #1

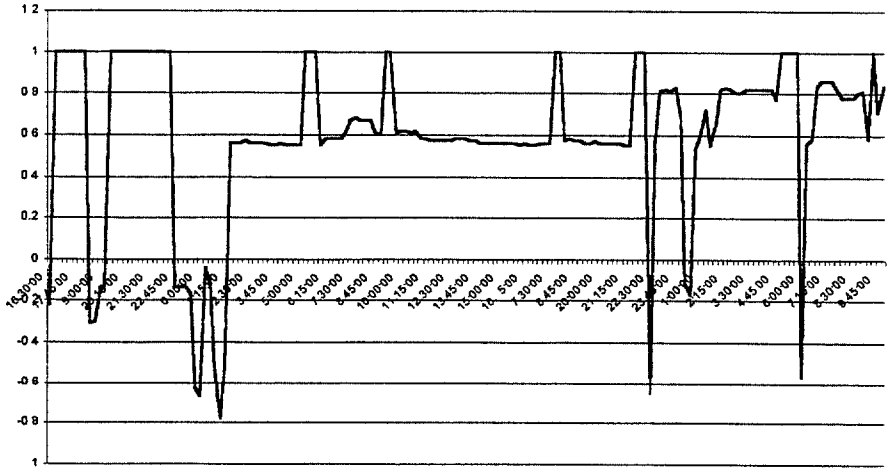


Figure 3.25
Active Power Consumption, LAO-120 Line #3

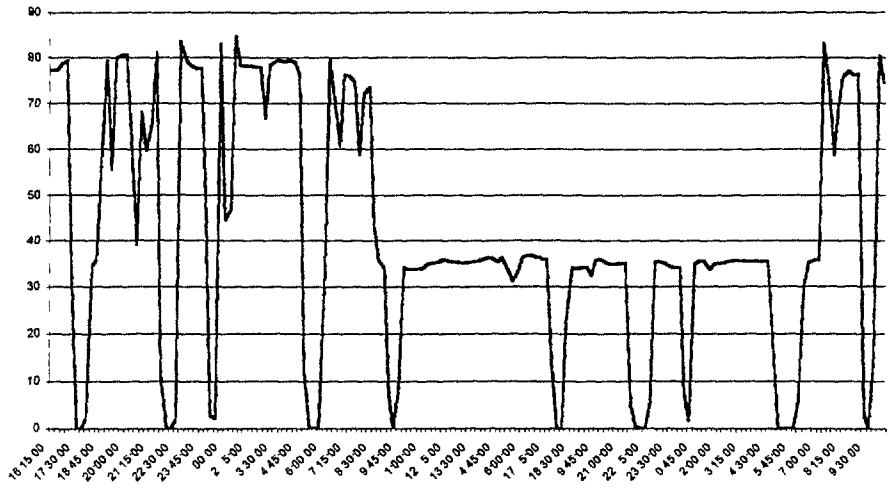


Figure 3 26
Power Factor Change, LAO-120 Line #3

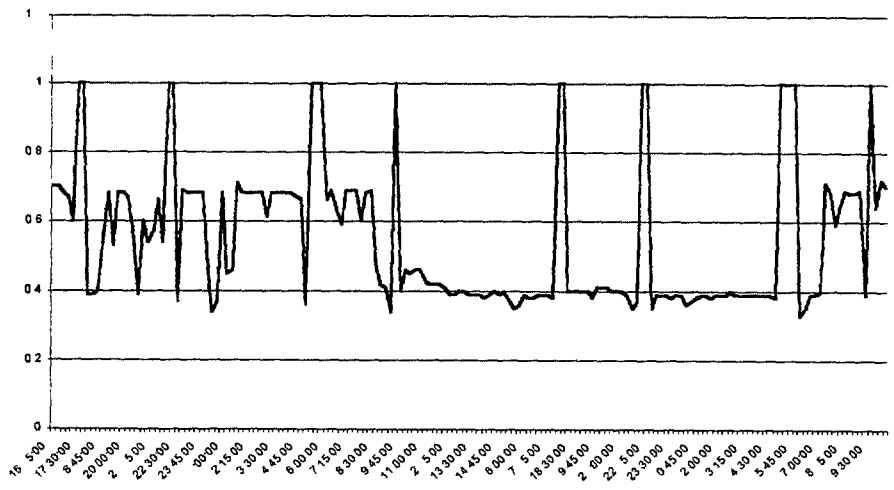
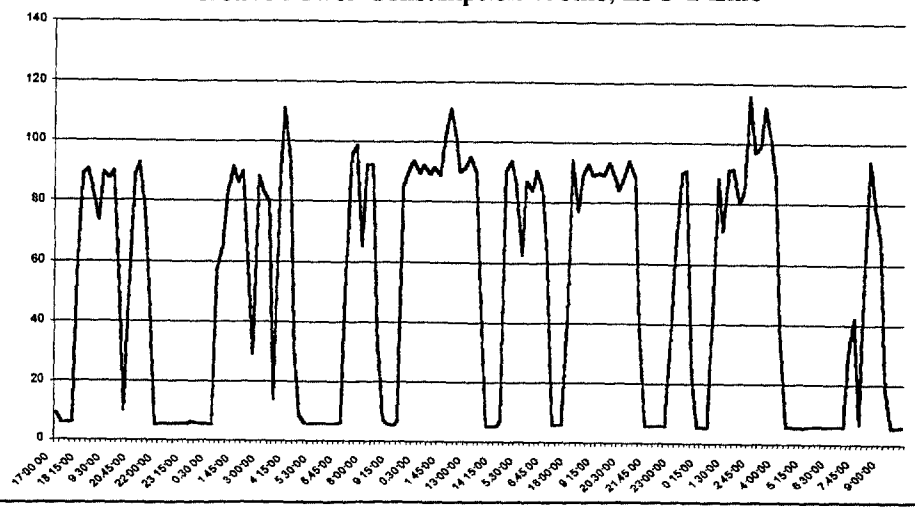


Figure 3 27
Active Power Consumption Profile, LJO-2 Line



Analysis of load changes over a two-day period (See Appendix #2), indicates that the equipment was stopped several times from 30 minutes to 3 hours LAO-120 lines #1 and #3 were stopped eight times during the period The LJO line stopped ten times, from 45 minutes to 3 hours Such modes of operation leads to increased electricity consumption during start-ups and shutdowns, as well as idle equipment runs during warm-ups

The LAO-1 line was observed to operate for 21 hours at full load, as corroborated by the the corresponding active capacity values and cos O = 0 56 (at full load cos O = 0 82) LAO-3 over the same time period worked for 18 hours at partial load at cos O = 0 4 (at full load cos O – 0 7)

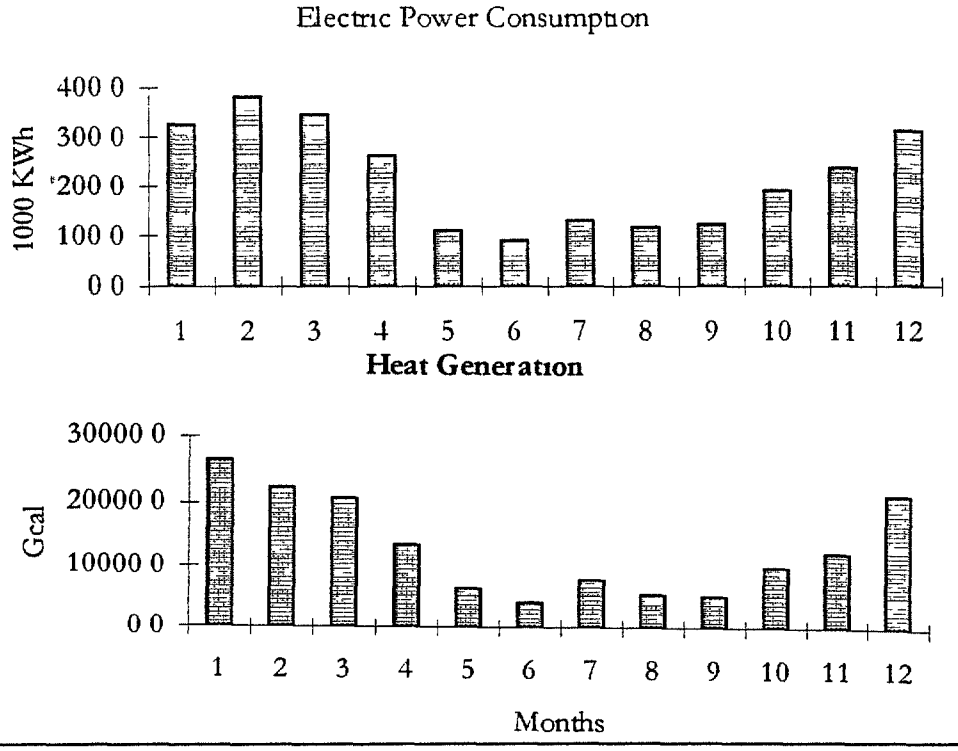
Based on the analysis of production capacity load profiles, the daily load schedule and the main process equipment operation schedules, it is recommended that a flexible work schedule be investigated for possible implementation in the finishing plant For example, operate for three weeks, then shut down for one week depending on the actual quantities of coarse input product available This proposal may increase the main production equipment loads and, thereby, reduce heat and electricity losses due to start-ups, shutdowns and idle run warm-ups Some other general costs may be reduced (i e lighting, ventilation, etc) The proposed schedule would mean switching the heating system into standby mode for the duration of idle periods A steam flow regulator would need to be installed on the feed pipe At 20% supply, the resultant heat energy savings would amount to about 1,000 Gcal/year or 4 5 million rubles

If the power transformers are also switched off for the duration of idle period it would result in electricity savings of about 94,000 kwh, or 24 million rubles annually

Boiler House

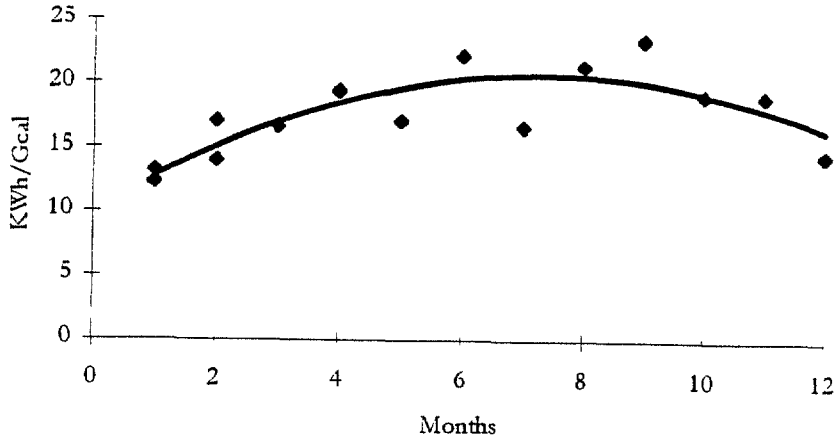
The boiler house generates steam primarily for the finishing plant and the heating/hot water system for the plant and township

Figure 3 28
1996 Heat Generation and Electricity Consumption by Boiler House



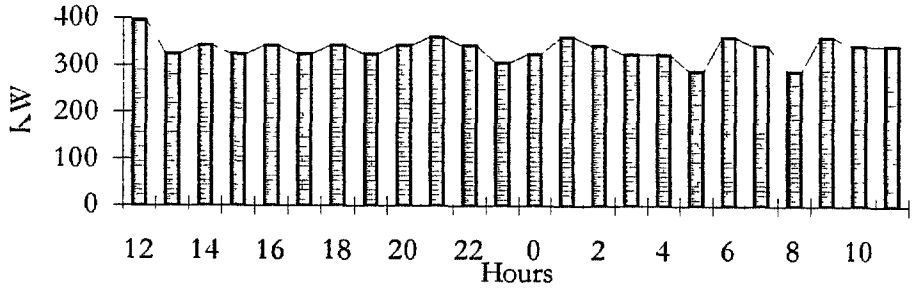
Analysis of the 1996 boiler house electricity consumption indicates there were variations in the season from 12 to 22 kwh/Gcal (See Figure 3 29)

Figure 3 29
Seasonal Specific Electricity Consumption to Generate Heat



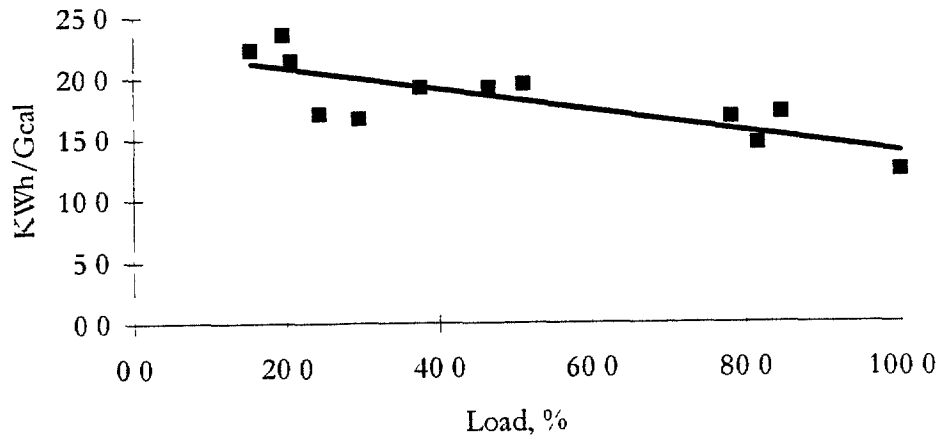
The summer increase in specific electricity consumption can be attributed to the fact that the boiler house operation is directly contingent upon the operation of the finishing plant Therefore any instability in the operation of the latter will lead to irregular operation of the boiler house and the possible incomplete loading of the boiler house Figure 3 30 provides a typical daily electrical load for the boiler house

Figure 3 30
Daily Active Load Variation of Boiler House



If the boiler output is reduced, the general auxiliary electricity consumption (i e feed pumps, blower fans, exhaust fans, lighting) remains unchanged while specific electric power consumption increases (See Figure 3 31) At the same time, the output of feed pumps and blower fans changes as a function of boiler house output

Figure 3 31
Specific Electric Consumption as a Function of Heat Energy Output for Boiler House



The electrical parameters of the pumps in operation were measured as part of the instrumented inspection of the boiler house Measurements were made using a Fluke Model 39 electric power meter Table 9 presents some of the data from these measurements

Table 9
Characteristics of Boiler House Pumps

#	Description	P_{inst} KW	W, KW	Q, kvar	S, KVA	cosφ	Power Factor
1	Pump GVS K90/85 P=3 atm	70	28 2	27 1	38 9	0 72	0 4
2	Feed Pump CNSG-60 P=4 atm	90	56	43 3	70 6	0 79	0 8

A point will be made of the excessive capacity of the hot water supply pump with a power factor of 0 4

It is a common practice to adjust electric power consumption to changing load on variable output equipment by using a variable drive with variable frequency, or other types (60-70% of total number of electric drives) If installed in pumps, a variable speed electric drive will reduce electric power consumption by 20 to 30 percent and water losses by 10%

Boiler feed is generally provided by two parallel pumps Pinst=90 and 37 KW in winter and 55 and 37 KW in summer It will be appropriate to install a variable electric drive on a pump with variable load, e g DNSG-38 (Pinst=38 KW) If necessary, the variable electric drive can be equipped with an automatic switch to switch it from one pump to another A variable electric drive costs about $250/KW, an automatic switch is about $50/KW The potential savings from reduced electric power consumption by the feed pumps may amount to 40%

Section 4

Recommended Energy Efficiency Measures

A Potential Energy Efficiency Measures

The energy auditors investigated as many potential efficiency measures as possible in the time budgeted for the project Subsequent to this, the most cost-effective measures are recommended for implementation by the enterprise Some of the potential energy efficiency measures are not reasonable because of the long payback period, or very high initial cost Those measures in the recommended list consist of actions that have simple paybacks of less than 3 years Given the economic conditions in Russia, this seems like the most reasonable maximum time period for the measures to be paid for by the savings

B Recommended Cost-Effective Measures

The following are the recommended energy efficiency measures for AO Autoagret to undertake to reduce its energy costs and improve the efficiency of the enterprise

Project No 1 – Flexible Scheduling of Work

1 Purpose	Increase the load of production capacities
2 Description of Project	A flexible schedule of work means a more intensive mode of work due to the introduction of non-working weeks a) This change will allow the enterprise to increase the load of production machinery and lower the electricity consumption per unit of output An example is the compressing stations, which will result in a decrease in electricity usage of 296,000 kwh per year b) During the period of the factory down time, it is suggested to switch off the power transformers which provide the power to the repairing and emergency work, as well as emergency lighting This will save about 270,000 kwh per year c) The suggested schedule of work will also allow the decrease of heat consumption due to the transfer of the system for heating the production shops of the weaving and spinning factories to the emergency mode during the down time This will allow a decrease of heat consumption by about 300 Gcal, or reduce gas consumption by 510 tons of reference fuel per year
3 Implementation Costs	None
4 Annual Savings	566,000 kwh and 510 tons of reference fuel 272 million rubles
5 Payback Period	Immediate

Project No 2 – Reschedule Spinning and Weaving to 3-shift Operation

1	Purpose	Take advantage of electric night-time tariff
2	Description	The rescheduling of the weaving and spinning factories from a two-shift operation to a three-shift operation will allow the enterprise to take advantage of the night-time electricity tariff by shifting load to those hours It is estimated that approximately one-third of the kwh could be shifted to this period
3	Costs	Metering – 4 million rubles
4	Annual Savings	289 million rubles
5	Payback Period	Less than one month

Project No 3 – Sectionalize the Lighting Systems

1	Purpose	Savings of Electricity
2	Description	Sectionalize of the lighting systems by providing appropriate switches, thus allowing un-used areas to be turned off
3	Costs	1 million rubles
4	Annual Savings	40,000 kwh 10 million rubles
5	Payback Period	Less than two months

Project No 4 – Optimize the Boiler Operations

1	Purpose	Provide higher combustion efficiency of boilers
2	Description	Install automated devices to regulate the air supply to boilers #2, #9 and #10 Clean the heating surfaces of boilers #2 and #3 Check the bricklining of boiler #2 for leakage and repair
3	Costs	None
4	Annual Savings	27 tons of reference fuel 7 million rubles
5	Payback Period	Immediate

Project No 5 – Installation of Condensate Tap

1	Purpose	Saving of heat energy by elimination of flying steam

2	Description	Install steam trap in the sizing machine to allow use of the latent heat from the flying steam and improve the heat exchange process
3	Costs	4 million rubles
4	Annual Savings	20 million rubles
5	Payback Period	3 months

Project No 6 – Split the Steam Header

1	Purpose	Provide higher efficiency of the boilers and savings of electricity in the network pumps
2	Description	Divide the steam collector (drum) into a technological section and a heating section This will allow the enterprise to increase the operating pressures in the boilers of the heating sections and transfer the heat networks to the operation in the temperature schedule of 130-70 °C with a decrease in the network water consumption
3	Costs	2 million rubles
4	Annual Savings	48 million rubles
5	Payback Period	less than one month

Project No 7 – Installation of Regulated Speed Drives

1	Purpose	Electricity Savings
2	Description	The installation of a regulated electric drive in one of the two feeding pumps of the boilers which operate in parallel During the winter, pump #2 (90 kW) operates on a constant load and pump #6 (37 kW) operates on the alternating loads During the summer, pump #5 (55 kW) operates on the constant load and pump #6 (37 kW) operates on the alternating load
3	Costs	$300/kW 67 million rubles
4	Annual Savings	26 million rubles
5	Payback Period	2 5 years

Project No 8 – Introduction of technology for Fabric Impregnation

1	Purpose	Steam savings
2	Description	Impregnation of fabrics with technological solutions by the surface finishing method makes it possible to reduce the moisture content in fabrics before drying from 90% to 30%, thus decreasing steam consumption for drying by

		150% (steam saving – 350 to 500 Gcal/hour) and increasing efficiency by 50%
3	Costs	900 million rubles
4	Annual Savings	350 million rubles
5	Payback Period	2 5 years

Project No 9 – Installation of Heat Recovery Units TSI-3

1	Purpose	Thermal energy savings
2	Description	Installation of heat recovery units to recover heat of steam effluent from finishing machines (dryers, steam maturity machines, steam-printing plants) makes it possible to save 0 2 to 0 8 Gcal/hour of thermal energy
3	Costs	170 million rubles
4	Annual Savings	200 million rubles
5	Payback Period	10 months

Project No 10 – Introduction of heat recovery systems on dyeing and washing lines

1	Purpose	Steam and water savings
2	Description	Heat and recovery systems will reduce steam consumption for fabric washing (to 0 35 Gcal/hour) and water consumption (to 10 to 20 m^3/hour)
3	Costs	260 million rubles
4	Savings	220 million rubles per line
5	Payback Period	1 2 years

Project No 11 – Optimize Exhaust Ventilation System on Drying Machines, Installation of thermal energy recovery systems on dyeing and washing lines

1	Purpose	Thermal energy savings
2	Description	This measure will help to reduce air consumption for drying by 2,000 m^3/hour and save 0 07 Gcal/hour of thermal energy
3	Costs	60 million rubles
4	Annual Savings	35 million rubles
5	Payback Period	1 7 years

Section 5 – Appendix

Appendix 1

Transformer Capacity of Substations

Substation No		No of Transformers		KVA per Transformer		Total KVA
1		4		1 000		4 000
		1		1 600		1 600
		1		630		630
						===
						6 230
2		2		1 000		2 000
3		3		1 000		3 000
		2		630		1 260
						===
						4 260
4		3		1 000		3 000
5		3		1 000		3 000
		1		315		315
		1		250		250
						===
						3 565
6		2		1 000		2 000
Total Substation Capacity						21 055

Appendix 2 – LAO 1 Electric Power Consumption Measurement Data

Record Number	Record Date	Record End Time	Chan 1 Avg Volts	Chan 1 Avg Amps	Chan 1 Avg kW	Chan 2 Avg Volts	Chan 2 Avg Amps	Chan 2 Avg kW	Chan 3 Avg Volts	Chan 3 Avg Amps	Chan 3 Avg kW	Chan 5 Avg Volts	Chan 5 Avg Amps	Chan 5 Avg kW	Chan 5 Avg kVA	Chan 5 Avg PF	Chan 5 Avg kVAR
1	6/23/97	16 30 00	231 3	23 46	1 351	230 2	22 06	1 257	230 1	22 11	0 934	230 7	67 86	3 516	15 77	0 22	15 111
2	6/23/97	16 45 00	228 5	0	0	230 9	0	0	230 9	0	0	230 1	0	0	0	1	0
3	6/23/97	17 00 00	229 1	0	0	231 4	0	0	231 5	0	0	230 7	0	0	0	1	0
4	6/23/97	17 15 00	230 5	0	0	233	0	0	232 8	0	0	232 1	0	0	0	1	0
5	6/23/97	17 30 00	231	0	0	233 8	0	0	233 1	0	0	232 7	0	0	0	1	0
6	6/23/97	17 45 00	230 9	0	0	233 6	0	0	233 3	0	0	232 6	0	0	0	1	0
7	6/23/97	18 00 00	230 3	0	0	232 9	0	0	232 6	0	0	232	0	0	0	1	0
8	6/23/97	18 15 00	228 8	0	0	230 8	0	0	230 9	0	0	230 2	0	0	0	1	0
9	6/23/97	18 30 00	228 1	20 31	1 702	230 3	21 71	1 615	230 7	21 83	1 202	229 7	63 82	4 519	14 666	0 31	13 719
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166	6/25/97	9 30 00	225 6	0	228 2	0	227 5	0	227 1	0	0	0	1	0 01
167	6/25/97	9 45 00	224 9	30 8	227 3	34 4	226 7	32 5	226 3	97 7	13 973	21 918	0 64	15 839
168	6/25/97	10 00 00	220 9	160 8	223 1	174 2	222 7	167 9	222 2	502 9	80 335	111 779	0 72	77 264
169	6/25/97	10 15 00	219 9	153 6	222 3	167 1	221 9	162 4	221 4	483 2	74 528	106 977	0 7	76 583

Appendix 3 – LAO 3 Electric Power Consumption Measurement Data

Record Number	Record Date	Record End Time	Chan 1 Avg Volts	Chan 1 Avg Amps	Chan 2 Avg Volts	Chan 2 Avg Amps	Chan 3 Avg Volts	Chan 3 Avg Amps	Chan 5 Avg Volts	Chan 5 Avg Amps	Chan 5 Avg kW	Chan 5 Avg kVA	Chan 5 Avg PF	Chan 5 Avg kVAR
1	6/23/97	16 15 00	227	152 7	229 5	167	229 2	162 4	228 6	182	77 328	110 205	0 7	78 371
2	6/23/97	16 30 00	227 6	153 3	230	167 9	229 7	162 8	229 1	181	77 337	110 919	0 7	79 294
3	6/23/97	16 45 00	228 3	159 7	230 7	174 6	230 2	168 9	229 7	503 1	78 707	115 61	0 68	84 508
4	6/23/97	17 00 00	228 8	162 8	231 3	178	230 7	171 9	230 3	512 7	79 439	118 082	0 67	87 213
5	6/23/97	17 15 00	230 3	76 9	232 9	85 5	232 2	81 1	231 8	213 7	33 96	56 296	0 6	41 042
6	6/23/97	17 30 00	231	0	233 8	0	232 9	0	232 6	0	0	0	1	0 012
7	6/23/97	17 45 00	230 8	0	233 6	0	232 8	0	232 1	0	0	0	1	0 012
8	6/23/97	18 00 00	230 4	6 2	233 2	7 7	232 3	7 1	231 9	21	1 873	1 837	0 39	4 305
9	6/23/97	18 15 00	228 6	118 4	230 8	139 6	230 3	127 2	229 9	385 2	34 574	88 58	0 39	81 302
10	6/23/97	18 30 00	228	120 4	230 3	140 9	230	128 9	229 4	390 2	35 698	89 542	0 4	81 91
11	6/23/97	18 45 00	227 8	142	230 2	159 5	229 9	151 5	229 3	453	57 556	103 889	0 55	84 599
12	6/23/97	19 00 00	227 9	161 9	230 5	177 1	230 2	172 2	229 5	511 2	79 324	117 369	0 68	86 336
13	6/23/97	19 15 00	228 5	143 7	230 9	162	230 8	153 7	230 1	459 4	55 649	105 705	0 53	87 501
14	6/23/97	19 30 00	228 2	162 6	230 8	178 7	230 3	172 9	229 8	514 2	80 07	118 185	0 68	86 765
15	6/23/97	19 45 00	228 3	163 2	230 9	179 5	230 3	172 9	229 8	515 6	80 615	118 526	0 68	86 727
16	6/23/97	20 00 00	229 1	163 3	231 8	180 1	231 1	171	230 7	517 4	80 569	119 373	0 67	87 905
17	6/23/97	20 15 00	229 3	148 8	231 9	167 8	231 2	158 9	230 8	475 5	61 957	109 771	0 56	88 164
18	6/23/97	20 30 00	229 6	131 1	232 1	151 1	231 6	111 1	231 1	426 9	38 895	98 69	0 39	90 448
19	6/23/97	20 45 00	229 3	154 1	231 8	172 3	231 3	164 5	230 8	190 9	68 22	113 325	0 6	88 813
20	6/23/97	21 00 00	230	147 7	232 5	167 1	232	158	231 5	472 8	59 613	109 453	0 54	89 601
21	6/23/97	21 15 00	231 3	154	233 7	171 9	233 4	164 9	232 8	490 8	65 583	114 311	0 57	91 744
22	6/23/97	21 30 00	232 8	167 1	235 2	182 8	235	178 3	234 1	528 2	81 335	123 814	0 66	93 051
23	6/23/97	21 45 00	235 5	27 4	237 9	30 8	237 6	29 3	237	87 5	11 097	20 548	0 54	16 873
24	6/23/97	22 00 00	236 6	0	239 1	0	238 7	0	238 1	0	0	0	1	0 012
25	6/23/97	22 15 00	234 5	0	236 9	0	236 5	0	235 9	0	0	0	1	0 012

Appendix 3 – LAO 3 Electric Power Consumption Measurement Data

21	6/23/97	21 30 00	233 2	0	0	23[illegible] 1	0	0	23[illegible] 5	0	0	231 8	0	0	0	1	0
22	6/23/97	21 [illegible] 00	23[illegible] 6	0	0	238	0	0	2[illegible] 1	0	0	2[illegible]7 1	0	0	0	1	0
23	6/2[illegible]/97	22 00 00	236 9	0	0	239 3	0	0	2[illegible]9 1	0	0	238 [illegible]	0	0	0	1	0
24	6/23/97	22 [illegible] 00	233 8	0	0	236 1	0	0	236 2	0	0	23[illegible] 1	0	0	0	1	0
25	6/23/97	22 30 00	230 9	0	0	233 1	0	0	233 [illegible]	0	0	232 6	0	0	0	1	0
26	6/23/97	22 [illegible] 00	227 3	32 1	1 126	230	[illegible]1 13	1 [illegible]17	230 1	33 38	0 61	229 1	99 87	3 283	22 886	0 11	22 038
27	6/23/97	23 00 00	226 7	31 31	1 121	229 1	31 2	1 121	229 1	33 38	0 611	228 1	101 86	3 1[illegible]7	23 27	0 11	22 601
28	6/23/97	23 [illegible] 00	226 1	34 66	1 129	229	3[illegible] 48	1 396	229 9	31 66	0 62	228 1	101 93	3 116	23 93[illegible]	0 13	23 171
29	6/23/97	23 30 00	22[illegible] 9	31 4	1 2[illegible]6	228 4	32 [illegible]6	1 619	229 2	31 28	0 81[illegible]	227 [illegible]	9[illegible] 22	3 72	21 664	0 17	20 192
30	6/23/97	23 4[illegible] 00	22[illegible]	2[illegible] 33	3 6[illegible]1	227 9	26 96	1 203	227 7	24 28	3 11	227 1	76 [illegible]2	10 991	17 377	0 63	4 81
31	6/21/97	0 00 00	226 1	23 [illegible]8	3 6[illegible]9	228 [illegible]	2[illegible] 09	1 06	228 3	23 11	3 187	227 6	71 72	10 906	16 321	0 67	4 311
32	6/24/97	0 [illegible] 00	229 2	39 68	0 273	232 1	38 98	0 128	231 3	38 63	0 279	230 9	117 33	0 981	27 086	0 01	26 912
33	6/24/97	0 30 00	229 6	35 01	0 9[illegible]7	232 3	34 9	1 1[illegible]4	231 [illegible]	31 13	0 8[illegible]3	231 1	101 37	2 964	24 127	0 12	23 21
34	6/24/97	0 4[illegible] 00	229 4	23 [illegible]8	2 86[illegible]	231 3	2[illegible] 36	3 293	230 9	27 43	3 18[illegible]	230 [illegible]	76 [illegible]3	9 343	17 613	0 [illegible]3	10 939
3[illegible]	6/24/97	1 00 00	229 9	19 14	3 39	231 7	22 41	4 317	231 2	17 39	2 859	230 9	[illegible]8 91	10 [illegible]66	13 60[illegible]	0 78	2 767
36	6/24/97	1 15 00	228 8	29 18	3 631	231	29 06	3 871	230 7	26 73	2 669	230 1	8[illegible] 04	10 173	19 [illegible]4	0 52	4 07
37	6/24/97	1 30 00	227	86 6	11 024	229 [illegible]	89 4	12 1[illegible]7	229 1	87 77	10 81[illegible]	228 [illegible]	263 64	34 026	60 2[illegible]1	0 [illegible]6	48 6[illegible]
38	6/24/97	1 45 00	227 1	88 93	11 169	229 5	91 39	12 4[illegible]2	229 1	90 22	11 017	228 6	270 48	34 638	61 82[illegible]	0 [illegible]6	[illegible]0 061
39	6/24/97	2 00 00	227	90 1	11 282	229 5	91 07	12 9[illegible]2	229 3	92 9	11 391	228 6	277 08	35 62[illegible]	63 341	0 [illegible]6	[illegible]1 18[illegible]
40	6/24/97	2 [illegible] 00	227 1	94 54	11 883	229 [illegible]	101 07	13 946	229 2	99 67	12 72[illegible]	228 6	29[illegible] 32	38 [illegible]1	67 [illegible]02	0 [illegible]7	[illegible]3 87[illegible]
41	6/24/97	2 30 00	227	94 19	11 763	229 1	96 7[illegible]	13 321	229 1	9[illegible] 59	11 607	228 [illegible]	286 47	36 691	6[illegible] 157	0 [illegible]6	[illegible]2 9[illegible]
42	6/24/97	2 4[illegible] 00	226 9	93 49	11 618	229 1	96 29	13 13[illegible]	229	9[illegible] 47	11 779	228 3	28[illegible] 2[illegible]	36 [illegible]31	6[illegible] 131	0 [illegible]6	[illegible]2 66
43	6/24/97	3 00 00	227 1	93 6	11 6[illegible]1	229 3	9[illegible] 7	13 06[illegible]	229	101 07	12 [illegible]3	228 [illegible]	290 16	37 246	66 362	0 [illegible]6	[illegible]3 69
44	6/24/97	3 [illegible] 00	227 2	94 19	11 648	229 7	9[illegible] 82	13 0[illegible]	229 3	9[illegible] 17	11 [illegible]97	228 7	28[illegible] [illegible]1	36 29[illegible]	6[illegible] 30[illegible]	0 [illegible]6	[illegible]3 033
4[illegible]	6/24/97	3 30 00	227 2	92 2	11 289	229 7	9[illegible] [illegible]9	13 032	229 3	9[illegible] 3[illegible]	11 [illegible]86	228 7	28[illegible] 11	3[illegible] 907	61 7[illegible]2	0 [illegible]	[illegible]2 62[illegible]
46	6/24/97	3 4[illegible] 00	227 2	92 [illegible]	11 433	229 6	9[illegible] 17	13 001	229 3	9[illegible] [illegible]9	11 437	228 7	283 61	3[illegible] 871	61 876	0 [illegible]	[illegible]2 79[illegible]
47	6/24/97	4 00 00	227 4	91 97	11 39[illegible]	229 9	91 6[illegible]	12 99[illegible]	229 7	91 19	11 393	229	280 81	3[illegible] 783	61 312	0 [illegible]6	[illegible]2 173
48	6/24/97	4 [illegible] 00	227 9	92 32	11 329	229 8	9[illegible] [illegible]9	12 918	229 7	91 12	11 3[illegible]1	229 2	282 14	3[illegible] 631	61 728	0 [illegible]	[illegible]2 832
49	6/24/97	4 30 00	229	90 1	11 133	230 6	93 02	12 691	230 [illegible]	91 27	10 916	230	274 36	34 71	63 11	0 [illegible]	[illegible]1 181
50	6/24/97	4 45 00	229 4	92 79	11 [illegible]07	230 7	94 6[illegible]	12 806	230 7	94 42	11 [illegible]97	230 3	281 87	3[illegible] 91	64 906	0 [illegible]	[illegible]2 8[illegible]3
51	6/24/97	5 00 00	233 6	42 13	5 311	234 8	43 07	[illegible] 795	234 6	41 9	5 224	234 3	127 21	16 33	29 507	0 55	24 119
52	6/24/97	5 15 00	235 4	0	0	236 8	0	0	236 4	0	0	236 2	0	0	0	1	0

53	6/21/97	30 00	236	0	0	237	0	0	236	0	0	236	0	0	0	1	0
54	6/21/97	15 00	237	0	0	236 7	0	0	236	0	0	236 1	0	0	0	1	0
55	6/24/97	6 00 00	230 1	71 66	8 861	232 2	7 06	9 869	232 2	7 63	9 01	231 6	218 12	27 777	30 389	0 77	38 731
56	6/21/97	6 15 00	226	85 08	11 053	228	86 02	11 783	227 9	81 35	10 713	227	223 33	38 111	63 085	0 68	46 167
57	6/21/97	6 30 00	228	93 81	12 059	227 2	92 2	12 571	227	91 97	11 628	226 6	278 03	36 261	63 015	0 68	50 395
58	6/24/97	6 45 00	224 8	92 67	11 763	226 6	93 81	12 956	226 1	92 79	11 73	225 9	279 28	36 451	63 099	0 68	50 341
59	6/24/97	7 00 00	223 4	91 74	11 753	225 3	91 19	12 916	221 8	91 71	11 59	221 3	277 73	36 289	62 358	0 68	49 572
60	6/24/97	7 15 00	222 8	95 35	12 056	224 7	91 19	13 11	221 2	95 47	12 897	223 9	285	38 831	63 813	0 61	49 312
61	6/24/97	7 30 00	221 8	102 24	14 108	224 2	96 29	15 101	223 3	103 17	15 825	223 2	301 75	45 038	67 329	0 67	48 815
62	6/24/97	7 45 00	221	98 85	13 792	223 6	92 2	11 542	223 1	100 11	15 465	222 6	291 11	43 88	61 786	0 68	46 592
63	6/24/97	8 00 00	220	102 71	14 165	222 4	97 22	15 166	222 3	103 06	15 817	221 6	303 05	45 177	67 145	0 67	48 511
64	6/24/97	8 15 00	219 8	101 66	13 992	222 1	95 94	14 85	222	102 91	15 885	221 3	300 31	44 726	66 503	0 67	48 013
65	6/24/97	8 30 00	218 9	97 69	13 206	221 1	90 92	11 237	221	98 97	15 23	220 3	287	42 674	63 343	0 67	45 574
66	6/24/97	8 45 00	218	89 28	11 338	220 2	88 23	12 395	220 2	90 15	11 848	219 5	267 91	35 581	58 806	0 61	45 714
67	6/24/97	9 00 00	218 9	88 7	11 227	221 1	86 37	11 882	221 2	87 65	11 492	220 1	262 7	34 601	57 891	0 6	45 34
68	6/24/97	9 15 00	221 5	0	0	223 9	0	0	223 6	0	0	223	0	0	0	1	0
69	6/24/97	9 30 00	222	0	0	224 4	0	0	224	0	0	223 5	0	0	0	1	0
70	6/24/97	9 45 00	218 8	40 62	5 182	221 2	10 62	5 621	221	10 85	5 328	220 3	122 15	16 131	26 587	0 61	19 102
71	6/24/97	10 00 00	213 8	87 42	11 181	215 9	87 53	11 959	215 6	88 17	11 721	215 1	263 4	34 861	56 66	0 62	43 659
72	6/24/97	10 15 00	213 8	88 7	11 344	215 9	86 02	11 882	215 7	88 23	11 821	215 1	262 88	35 017	56 544	0 62	43 271
73	6/24/97	10 30 00	213 6	86 6	11 005	215 6	85 67	11 691	215	87 18	11 568	211 9	259 54	34 268	55 773	0 61	42 984
74	6/24/97	10 45 00	213 5	89 63	11 422	215 1	85 78	11 798	215 2	87 77	11 561	214 7	263 24	31 781	56 514	0 62	43 189
75	6/24/97	11 00 00	220 7	88 23	11 119	222	88 17	11 919	222 1	89 05	11 132	221 9	265 77	31 501	59	0 58	46 805
76	6/24/97	11 15 00	223	88 58	11 259	224 7	89 05	11 981	221 8	88 17	11 159	221 1	266 01	34 402	59 628	0 58	17 66
77	6/21/97	11 30 00	223	89 17	11 099	225 3	89 75	12 162	225 7	90 22	11 425	221 8	269 06	31 686	60 191	0 57	18 156
78	6/24/97	11 45 00	224	89 28	11 123	226	89 87	12 111	226 3	88 23	11 171	225 1	267 38	34 139	60 277	0 57	18 398
79	6/24/97	12 00 00	223 8	90 33	11 345	225 8	91 62	12 518	225 7	90 22	11 331	225 1	272 11	35 196	61 263	0 57	19 051
80	6/24/97	12 15 00	223 1	91 85	11 517	225	92 9	12 609	225 2	92 67	11 627	221 7	277 39	35 783	62 326	0 57	19 911
81	6/24/97	12 30 00	223 2	90 57	11 349	225 2	91 62	12 139	225 2	92 2	11 192	221 5	274 51	35 28	61 639	0 57	19 113
82	6/24/97	12 45 00	222 9	89 17	11 242	221 9	90 57	12 364	224 8	89 52	11 146	224 2	269 23	34 751	60 352	0 58	48 229
83	6/24/97	13 00 00	222 6	89 4	11 175	224 5	90 22	12 291	224 5	89 87	11 304	223 9	269 52	34 77	60 34	0 58	48 233
84	6/24/97	13 15 00	223 4	89 4	11 137	225 3	89 05	12 185	225 5	88 12	11 18	224 8	266 62	34 502	59 925	0 58	47 868

85	6/24/97	13 30 00	223 5	85 78	10 62 5	225 6	86 95	11 66	225 8	87 07	10 837	225	259 79	33 119	58 138	0 57	17 129
86	6/24/97	13 45 00	221 9	90 22	11 197	226 9	91 71	12 567	227 1	92 11	11 693	226 1	271 32	35 158	62 11	0 57	49 883
87	6/24/97	14 00 00	225 9	83 22	10 323	227 9	85 68	11 585	228 5	82 98	10 401	227 1	249 9	32 107	56 828	0 56	16 015
88	6/24/97	14 15 00	221 8	90 33	10 971	226 5	90 1	12 065	227 1	90 69	11 306	226 1	271 17	31 316	61 311	0 56	19 677
89	6/24/97	14 30 00	221 3	90 33	11 012	226 2	92 2	12 33	226 5	87 07	10 785	225 7	269 6	31 127	60 811	0 56	49 289
90	6/24/97	14 45 00	221 4	89 52	11 075	226 2	90 92	12 07	226 1	92 67	11 16	225 7	273 1	31 605	61 639	0 56	49 925
91	6/24/97	15 00 00	221 3	90 69	11 165	226 3	91 5	12 225	226 5	91 71	11 262	225 7	273 81	34 651	61 798	0 56	50 09
92	6/24/97	15 15 00	224 6	88 93	11 067	226 6	89 1	11 923	226 6	91 01	11 208	225 9	269 15	34 197	60 871	0 56	49 341
93	6/24/97	15 30 00	225 1	91 5	11 176	227 3	90 33	12 058	227 2	90 69	11 181	226 6	272 47	34 419	61 725	0 56	50 17
94	6/24/97	15 45 00	225 7	91 27	11 144	227 9	91 5	12 217	227 9	95 21	11 748	227 1	277 98	35 11	63 143	0 56	51 336
95	6/24/97	16 00 00	227	91 85	11 161	229 2	92 67	12 361	229 2	90 33	11 212	228 5	274 83	34 734	62 786	0 55	51 142
96	6/24/97	16 15 00	228	92 32	11 481	230 1	91 3	12 581	229 9	92 9	11 519	229 3	279 51	35 58	64 108	0 56	52 151
97	6/24/97	16 30 00	228 3	92 09	11 276	230 3	94 54	12 591	230	91 62	11 248	229 5	278 31	35 115	63 878	0 55	52 241
98	6/24/97	16 45 00	226 8	89 17	10 981	228 8	91 15	11 876	228 5	88 35	10 68	228	268 66	33 537	61 247	0 55	50 137
99	6/24/97	17 00 00	225 2	91 5	11 336	227 2	93 14	12 449	227 1	91 39	11 301	226 5	276 09	35 086	62 526	0 56	50 54
100	6/24/97	17 15 00	225 4	91 04	11 114	227 5	91 85	12 311	227 4	92 32	11 335	226 8	275 21	34 759	62 413	0 56	50 661
101	6/24/97	17 30 00	226 6	46 45	5 746	229 2	47 27	6 283	228 8	15 98	5 636	228 2	139 65	17 665	31 745	0 56	25 864
102	6/24/97	17 45 00	227 5	0	0	230 3	0	0	229 8	0	0	229 2	0	0	0	1	0
103	6/24/97	18 00 00	227 6	0	0	230 3	0	0	229 6	0	0	229 2	0	0	0	1	0
104	6/24/97	18 15 00	225 5	88 23	11 212	227 7	91 01	12 581	227 7	85 9	10 72	227	265 16	34 516	60 161	0 57	48 188
105	6/24/97	18 30 00	224 6	77 38	10 013	226 9	76 21	10 313	226 7	74 93	9 725	226 1	228 46	30 081	51 64	0 58	41 36
106	6/24/97	18 45 00	225	88 23	10 998	227 2	88 7	12 093	227 3	91 19	11 911	226 5	271 09	35 003	61 401	0 57	49 312
107	6/24/97	19 00 00	225 5	88 35	11 101	227 6	91 01	12 394	227 7	89 98	11 287	226 9	269 39	31 781	61 134	0 57	49 117
108	6/24/97	19 15 00	225 8	90 57	11 167	228	90 92	12 328	228	90 33	11 326	227 3	271 85	31 821	61 781	0 56	49 886
109	6/24/97	19 30 00	225 8	90 1	11 164	228 1	90 92	12 307	228	90 69	11 292	227 3	271 73	34 763	61 767	0 56	49 978
110	6/24/97	19 45 00	226 1	89 05	11 052	228 1	89 52	12 21	228 1	95 12	12 086	227 6	273 63	35 378	62 291	0 57	50 111
111	6/24/97	20 00 00	226 5	88 35	11 07	228 7	90 22	12 272	228 7	88 58	11 064	228	267 19	31 105	60 909	0 56	49 13
112	6/24/97	20 15 00	226 3	87 3	10 812	228 5	89 4	12 132	228 5	87 3	10 77	227 8	263 91	33 713	60 116	0 56	48 62
113	6/24/97	20 30 00	226 3	88 7	11 106	228 6	89 87	12 261	228 6	87 88	10 906	227 8	266 11	31 275	60 699	0 56	48 959
114	6/24/97	20 45 00	226 5	88 23	10 929	228 8	89 52	12 195	228 7	89 28	10 973	228	266 97	34 097	60 872	0 56	49 302
115	6/24/97	21 00 00	227 4	90 33	11 202	229 5	90 33	12 206	229 4	89 52	11 056	228 8	270 15	31 461	61 806	0 56	50 176
116	6/24/97	21 15 00	229 5	93 6	11 366	231 9	91 74	12 378	231 8	92 9	11 481	231	278 22	35 225	64 283	0 55	52 59

117	6/21/97	21 30 00	233 7	59 06	7 288	235 8	59 17	7 91	256 1	65 96	8 199	235 2	182 13	23 126	12 788	0 55	35 26
118	6/21/97	21 45 00	231 6	0	0	236 9	0	0	236 9	0	0	236 2	0	0	0	1	0
119	6/21/97	22 00 00	235 1	0	0	237 2	0	0	237 3	0	0	236 6	0	0	0	1	0
120	6/24/97	22 15 00	234 1	0	0	236 6	0	0	256 6	0	0	235 9	0	0	0	1	0
121	6/24/97	22 30 00	233 2	2 68	0 411	235 9	50 5	0 183	235 7	2 68	0 353	231 9	8 3	1 251	1 938	0 65	1 112
122	6/24/97	22 45 00	229 1	85 13	10 52	231 8	87 77	12 051	231 8	87 18	10 791	231	260 31	33 395	60 101	0 56	18 008
123	6/24/97	23 00 00	229 4	131 12	24 951	231 7	113 09	27 326	231 5	130 83	23 196	230 9	405 31	75 772	93 598	0 81	53 088
124	6/24/97	23 15 00	229 4	133 28	25 777	231 9	117 29	25 561	231 7	132 35	21 167	231	413 01	78 505	95 412	0 82	52 893
125	6/24/97	23 30 00	230 5	131 88	25 116	232 6	111 81	27 688	232 1	132 58	23 821	231 8	409 36	76 658	91 915	0 81	54 17
126	6/24/97	23 45 00	227 7	132 23	25 559	228 7	115 07	27 851	228 5	132 56	21 11	228 3	409 92	77 555	93 597	0 83	51 112
127	6/25/97	0 00 00	227 8	107 14	16 965	228 8	113 09	18 465	228 5	105 97	16 186	228 4	326 29	51 617	74 488	0 69	50 667
128	6/25/97	0 15 00	231 5	39 22	1 011	232 8	38 51	1 224	232	37 93	0 956	232 1	115 65	3 222	26 831	0 12	-21 774
129	6/25/97	0 30 00	232 2	38 87	1 405	233 2	38 63	1 717	232 6	37 81	1 301	232 7	115 33	4 456	26 82	0 17	19 717
130	6/25/97	0 45 00	231 2	95 7	11 608	231 4	97 1	12 519	231 1	91 19	11 29	231 4	286 96	35 448	66 388	0 53	54 925
131	6/25/97	1 00 00	231 1	99 09	13 487	231 4	101 89	11 62	231 4	98 27	12 966	231 3	299 35	41 073	69 232	0 59	53 62
132	6/25/97	1 15 00	230 7	114 96	19 248	231 3	122 2	20 942	231 2	113 44	18 082	231 1	350 62	58 273	81 032	0 72	52 992
133	6/25/97	1 30 00	230	91 62	11 342	231	94 65	12 617	230 6	93 95	11 405	230 5	280 14	35 391	64 58	0 55	52 866
134	6/25/97	1 45 00	229 3	105 39	16 137	230 2	112 28	17 707	229 9	107 02	15 703	229 8	324 62	49 518	74 6	0 66	52 791
135	6/25/97	2 00 00	229 2	132 7	25 657	230	111 72	27 76	229 8	133 28	21 24	229 7	410 67	77 656	91 322	0 82	52 27
136	6/25/97	2 15 00	229 1	132 12	25 671	230 1	141 19	27 909	230 1	132 7	24 194	230	409 37	77 779	91 149	0 83	51 714
137	6/25/97	2 30 00	229 9	133 87	25 957	230 6	145 89	28 011	230 6	131 57	24 172	230 1	414 26	78 441	95 141	0 82	53 125
138	6/25/97	2 45 00	231 3	128 85	24 422	231 5	145 07	27 005	231 7	131 77	23 365	231 5	405 79	74 791	93 926	0 8	55 375
139	6/25/97	3 00 00	231 9	125 23	23 817	232 1	136 67	25 815	232 2	125 58	22 13	232 1	387 54	71 763	89 926	0 8	52 777
140	6/25/97	3 15 00	231 9	135 15	26 327	232 1	147 29	28 277	232 1	133 05	21 39	232	415 48	78 994	96 405	0 82	54 05
141	6/25/97	3 30 00	231 9	135 97	26 377	232 1	117 52	28 353	232 2	131 8	21 587	232 1	118 23	79 317	97 055	0 82	54 692
142	6/25/97	3 45 00	232 2	133 17	26 06	232 4	141 81	28 085	232 1	133 52	21 14	232 3	411 5	78 585	95 59	0 82	53 153
143	6/25/97	1 00 00	232 1	133 1	26 107	232 5	145 31	28 138	232 6	133 17	21 521	232 5	111 92	78 769	95 771	0 82	53 242
144	6/25/97	4 15 00	232 3	133 87	26 134	232 5	145 51	28 132	232 5	133 75	24 529	232 1	113 1	78 791	96 012	0 82	53 588
145	6/25/97	1 30 00	232 3	133 28	26 097	232 5	145 31	28 128	232 1	131 1	24 585	232 4	412 61	78 81	95 904	0 82	53 377
146	6/25/97	4 45 00	233 9	98 62	18 008	234 5	105 97	19 453	234 3	97 69	16 891	231 2	302 23	54 351	70 597	0 77	42 873
147	6/25/97	5 00 00	236 8	0	0	237 7	0	0	237 4	0	0	237 3	0	0	0	1	0
148	6/25/97	5 15 00	236 1	0	0	237	0	0	236 6	0	0	236 6	0	0	0	1	0

159	6/25/97	7 30 00	226 6	0	0	236 9	0	0	236 7	0	0	236 1	0	0	0	1	0
160	6/25/97	7 45 00	231 6	0	0	236	0	0	236 9	0	0	236 7	0	0	0	1	0
161	6/25/97	8 00 00	233 1	22 06	3 413	236 1	19 02	2 611	236 7	17 97	1 95	231 6	58 99	7 956	1 823	0 57	9 358
162	6/25/97	8 15 00	229 3	61 78	8 097	230 1	65 83	5 935	231	65 36	7 963	230 2	195 91	21 993	11 987	0 56	26 786
163	6/25/97	8 30 00	226 1	95 12	12 337	227 1	96 05	1 511	227 6	95 21	12 293	227 1	286 37	38 01	65 036	0 58	51 053
164	6/25/97	8 45 00	225 2	136 55	26 156	226 1	146 21	28 22	226 1	158 5	25 715	225 9	121	80 092	95 117	0 81	50 065
165	6/25/97	9 00 00	221 3	111 61	27 581	226	119 97	29 59	226 1	116 17	28 027	225 5	111 02	85 2	99 138	0 86	50 12
166	6/25/97	9 15 00	223 1	112 39	27 205	221 8	119 71	29 151	221 9	117 11	28	221 3	139 13	81 656	98 56	0 86	19 371
167	6/25/97	9 30 00	222 1	113 21	27 222	223 5	149 39	29 21	223 6	115 12	27 549	223	438	84 011	97 695	0 86	48 764
168	6/25/97	9 45 00	223	125 17	23 251	221 2	135 62	25 3	221 3	126 17	22 102	223 8	387 16	70 951	86 663	0 82	18 31
169	6/25/97	10 00 00	222 3	111 26	20 503	223 7	125 82	22 111	223 6	119 1	19 833	223 2	359 58	62 782	80 266	0 78	48 809
170	6/25/97	10 15 00	223 2	116 18	20 824	221 1	131 07	23 281	221 5	116 36	19 188	221	363 92	63 293	81 536	0 78	50 212
171	6/25/97	10 30 00	226 1	115 89	20 924	227 5	127 92	23 083	227 8	116 48	19 16	227 1	360 31	63 466	81 832	0 78	50 474
172	6/25/97	10 45 00	223 9	120 21	22 051	225 6	130 13	23 866	225 8	120 45	20 695	225 1	370 66	66 612	83 423	0 8	48 873
173	6/25/97	11 00 00	222 8	125	23 04	224 6	137 72	25 308	224 9	125 93	21 996	224 1	388 56	70 345	87 079	0 81	49 252
174	6/25/97	11 15 00	226 5	5 72	0 707	229	3 97	0 564	228 9	3 85	0 516	228 1	13 51	1 786	3 074	0 58	2 474
175	6/25/97	11 30 00	225 5	0	0	228 1	0	0	228	0	0	227 2	0	0	0	1	0
176	6/25/97	11 45 00	224 5	32 56	5 119	226 7	34 08	5 718	226 7	32 56	5 01	226	99 2	15 847	22 223	0 71	12 543
177	6/25/97	12 00 00	220 9	130 02	24 649	223	142 39	26 884	223	131 3	23 704	222 3	403 75	75 238	89 758	0 84	47 745

Appendix 4 – LJO 2 Electric Power Consumption Measurement Data

Record Number	Record Date	Record End Time	Chan 1 Avg Volts	Chan 1 Avg Amps	Chan 2 Avg Volts	Chan 2 Avg Amps	Chan 3 Avg Volts	Chan 3 Avg Amps	Chan 5 Avg Volts	Chan 5 Avg Amps	Chan 5 Avg kW	Chan 5 Avg kVA	Chan 5 Avg PF	Chan 5 Avg kVAR
1	6/23/97	17 00 00	230 6	109 7	230	19 6	230 1	98 2	230 3	227 5	9 337	52 424	0 18	39 335
2	6/23/97	17 15 00	231 2	108 9	230 7	11 8	230 9	102	231	222 7	5 991	51 169	0 12	44 68
3	6/23/97	17 30 00	230 4	108 7	229 8	11 9	230	101 8	230 1	222 1	6 001	51 193	0 12	44 535
4	6/23/97	17 45 00	228 3	106 1	227 7	11 4	227 9	98 4	228	215 9	6 337	49 244	0 13	42 131
5	6/23/97	18 00 00	227	146 5	226 5	128 5	226 8	78 5	226 8	353 6	61 26	80 14	0 76	25 008
6	6/23/97	18 15 00	226 7	183 8	226 2	190 9	226 6	107	226 5	481 7	88 841	109 097	0 81	58 453
7	6/23/97	18 30 00	224 7	185 9	223 9	195 5	224 6	112 1	224 1	193 5	90 523	110 723	0 82	59 594
8	6/23/97	18 45 00	225	172 7	224 2	176 7	224 8	96 8	224 7	416 2	82 738	100 186	0 83	49 931
9	6/23/97	19 00 00	225 5	158 3	224 6	155 2	225 4	84 2	225 2	397 7	73 679	89 434	0 82	37 907
10	6/23/97	19 15 00	225 8	181 8	225	189 1	225 8	106 5	225 5	477 3	89 499	107 614	0 83	54 517
11	6/23/97	19 30 00	225	179 5	224 3	186	224 9	104	224 7	469 5	87 436	105 472	0 83	53 373
12	6/23/97	19 45 00	225 2	184	224 4	191 5	225	108 3	224 8	483 8	89 829	108 738	0 83	56 497
13	6/23/97	20 00 00	227 4	126 6	226 6	109 6	227 2	53 6	227	289 8	51 961	65 761	0 79	16 858
14	6/23/97	20 15 00	227 3	106	226 7	19 8	227 2	89 8	227 1	215 5	10 472	48 975	0 21	36 932
15	6/23/97	20 30 00	226 8	137 5	226 2	118	226 8	65 9	226 6	321 4	55 711	72 788	0 77	19 697
16	6/23/97	20 45 00	226 9	182 6	226 4	190	226 8	105 6	226 7	478 2	88 618	108 365	0 82	56 991
17	6/23/97	21 00 00	226 5	189 9	225 8	200	226 3	115 3	226 2	505 2	92 804	114 251	0 81	62 319
18	6/23/97	21 15 00	226 7	162 9	226	162 4	226 5	87 4	226 1	412 6	76 09	93 348	0 82	42 919
19	6/23/97	21 30 00	227 9	136 6	226 7	101	227 4	84 9	227 3	322 5	47 975	73 193	0 66	8 418
20	6/23/97	21 45 00	228 8	107 7	227 8	11 3	228 1	101 9	228 2	220 8	5 184	50 435	0 1	43 916
21	6/23/97	22 00 00	230 3	108 5	229 4	11 3	229 7	102 5	229 8	222 3	5 395	51 13	0 11	14 356
22	6/23/97	22 15 00	232 2	109 9	231 4	11 3	231 6	103 8	231 8	225	5 518	52 189	0 11	45 065
23	6/23/97	22 30 00	231 1	109 6	230 4	11 4	230 6	103 7	230 7	224 8	5 384	51 891	0 1	44 665
24	6/23/97	22 45 00	228 3	107 5	227 3	11 6	227 7	101 3	227 8	220 3	5 468	50 229	0 11	43 752
25	6/23/97	23 00 00	228 9	107 9	228	11 5	228 1	101 7	228 3	221	5 507	50 502	0 11	43 982
26	6/23/97	23 15 00	228 2	107 6	227 4	11 5	227 7	101	227 7	220 1	5 602	50 171	0 11	43 411

35	6/24/97	1 30 00	229 9	189 4	228 8	[illegible]								
36	6/24/97	45 00	230	179	229 8	187 5	230 3	101	230 2	467 6	88 087			
37	6/24/97	2 00 00	229 7	185 4	228 7	194 5	225	107	229	486 5	99 928	111 588	0 81	61 1
38	6/24/97	2 15 00	230	148 3	229 1	122 4	229 6	91 9	229 6	362 5	57 154	83 105	0 6	3 516
39	6/24/97	2 30 00	230 6	100 3	229 7	61	230 1	40 8	230 1	202 1	29 174	46 529	0 63	6 944
40	6/24/97	2 45 00	229 4	182 5	228 5	188 7	229 1	106 4	229	477 6	88 006	109 307	0 81	58 349
41	6/24/97	3 00 00	229 9	174 7	229	180	229 5	95 4	229 5	450 1	83 118	103 254	0 8	55 058
42	6/24/97	3 15 00	230 5	170	229 7	173 6	230 2	94 8	230 1	438 1	79 267	100 832	0 79	52 764
43	6/24/97	3 30 00	230 5	106 6	229 6	28 5	230	86 3	230	221 3	14 258	50 929	0 28	31 052
44	6/24/97	3 45 00	230 4	184 2	229 4	190 1	230	106 7	229 9	481	87 952	110 567	0 8	60 476
45	6/24/97	4 00 00	230 7	216 6	229 7	219 9	230 2	135 9	230 2	572 3	111 058	131 716	0 84	65 971
46	6/24/97	4 15 00	229 9	190 6	228 8	180 6	229 5	117 7	229 1	488 9	92 11	112 062	0 82	16 116
47	6/24/97	4 30 00	231 3	107 3	230 3	59 4	230 9	53	230 8	219 7	29 982	50 725	0 59	10 355
48	6/24/97	4 45 00	231 1	109 4	230 2	16 9	230 6	98 5	230 6	224 8	8 81	51 898	0 17	40 589
49	6/24/97	5 00 00	229 5	108	228 7	11 8	229 1	101 3	229 1	221 1	5 801	50 697	0 11	44 208
50	6/24/97	5 15 00	232	109 4	231 5	11 5	231 5	102 8	231 7	223 6	5 814	51 833	-0 11	44 971
51	6/24/97	5 30 00	231 4	108 9	230 9	11 5	230 9	102 3	231	222 7	5 809	51 473	0 11	44 769
52	6/24/97	5 45 00	230 2	108 3	229 6	11 3	229 3	101 8	229 7	221 4	5 785	50 874	0 11	44 297
53	6/24/97	6 00 00	228	107 6	227 4	11 7	227 2	100 8	227 5	220 1	5 791	50 09	0 12	43 676
54	6/24/97	6 15 00	226	107 1	225 4	12 2	225 4	100	225 6	219 3	5 894	49 501	0 12	43 162

55	6/24/97	6 [illegible]	221 7	106 5	223 9	12 1	[illegible]							
56	6/24/97	6 15 00	221 1	[illegible]		[illegible]	223 5	91 5	223 6	[illegible]				
57	6/24/97	7 00 00	223 4	137 6	222 7	111 5	[illegible]		[illegible]	318	55 596	70 918	0 76	
58	6/24/97	7 15 00	221 7	191 2	220 9	196 3	221 2	112 6	221 3	503 1	9	1	[illegible]	57 197
59	6/24/97	7 30 00	221 4	200	220 6	201 1	220 9	120 9	221	521 9	98 812	115 956	0 85	55 700
60	6/24/97	7 45 00	222 2	146 3	221 4	136 2	221 7	65 4	221 7	318	65 211	77 156	0 85	26 565
61	6/24/97	8 00 00	222 7	189 9	221 9	196 9	222 2	112 2	222 3	199 1	91 95	110 922	0 83	57 441
62	6/24/97	8 15 00	223 2	188 9	222 3	194 7	222 8	110 5	222 8	194 2	92 273	110 056	0 84	55 071
63	6/24/97	8 30 00	223 4	112 7	222 7	75 5	222 8	53 6	223	241 8	36 793	53 913	0 68	-1 562
64	6/24/97	8 45 00	222 7	105 5	221 8	15 3	222 3	95 8	222 3	216 6	7 368	48 18	0 15	39 837
65	6/24/97	9 00 00	222 8	105 2	222 3	13 5	222 4	97 7	222 5	216 4	6 157	48 166	0 13	-41 05
66	6/24/97	9 15 00	224 2	105 9	223 8	11 9	223 6	99 4	223 9	217 2	5 408	48 622	0 11	-42 548
67	6/24/97	9 30 00	225 8	105 7	225 2	15 1	225	95 9	225 3	216 7	7 431	18 811	0 15	-39 818
68	6/24/97	9 45 00	224 7	179 6	224	179 9	224	101 5	224 2	461	85 134	103 391	0 82	49 01
69	6/24/97	10 00 00	221 3	186 1	220 6	190 8	220 9	106 9	220 9	483 8	90 195	106 883	0 84	51 917
70	6/24/97	10 15 00	220 9	192 2	220	199 5	220 2	114 9	220 4	506 6	93 683	111 649	0 84	56 408
71	6/24/97	10 30 00	220 1	184 8	219 2	188 7	219 6	106 5	219 6	480	89 531	105 394	0 85	50 301
72	6/24/97	10 45 00	220	187 8	219 1	193 1	219 5	111 2	219 5	492 1	91 918	108 014	0 85	51 69
73	6/24/97	11 00 00	221 3	184 2	220 7	189 9	220 9	107 1	221	481 2	89 256	106 303	0 84	52 111
74	6/24/97	11 15 00	219 9	187 7	219 2	194 4	219 5	111 7	219 5	193 9	91 508	108 113	0 84	53 378
75	6/24/97	11 30 00	222 9	181	222 1	189 7	222 6	107 4	222 5	181 2	88 908	107 017	0 83	52 613
76	6/24/97	11 45 00	223 6	201 9	222 7	203 2	223 1	121 4	223 1	526 6	100 972	117 436	0 86	54 212
77	6/24/97	12 00 00	224 3	216 8	223 4	221 1	223 8	138 7	223 8	576 6	110 736	129 048	0 86	61 528
78	6/24/97	12 15 00	224 5	205 6	223 8	213 9	224	128 7	221 1	518 2	103 405	122 631	0 81	61 919
79	6/24/97	12 30 00	224 1	181 8	223 3	186 6	223 6	106 7	223 7	178 1	89 681	106 861	0 84	49 543
80	6/24/97	12 45 00	223 9	187 7	223 2	195 2	223 4	110 8	223 5	193 8	91 408	110 351	0 83	56 374
81	6/24/97	13 00 00	223 7	191 4	222 9	199 7	223 3	116 9	223 3	508	94 805	113 407	0 81	57 948
82	6/24/97	13 15 00	225	182 7	224 3	189 1	224 8	108 1	224 7	180 2	89 906	107 865	0 83	54 203
83	6/24/97	13 30 00	225 3	135 5	224 6	108 2	225 2	72 5	225	316 1	51 915	71 118	0 73	11 311
84	6/24/97	13 45 00	226 2	106 4	225 6	11 9	226 1	99 9	226	218 2	5 423	49 334	0 11	43 101
85	6/24/97	14 00 00	226 6	106 3	225 9	11 7	226 4	100	226 3	218	5 316	49 363	0 11	43 167
86	6/24/97	14 15 00	226 8	106 4	226 1	11 7	226 6	100 2	226 5	218 4	5 334	49 5	-0 11	43 301

88	[illegible]														
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90	6/24/97	15 1[illegible]	[illegible]	178 1	225	186 5	[illegible]								
91	6/24/97	15 30 00	226 5	140 2		[illegible]	226 1	62 1	226 3						
92	6/24/97	15 45 00	226 2	179 2	225 7	188 7	226 1		22[illegible]	172 3	86 838	106 706			
93	6/24/97	16 00 00	227 5	175 9	227	184 5	227 5	103 9	227 1	10[illegible] 3		1[illegible]		0 8	56 714
94	6/24/97	16 15 00	228 4	184 5	227 9	195 8	228 3	109 5	228 2	489 8	90 287	111 747		0 81	6
95	6/24/97	16 30 00	228 8	175 8	228 3	181 9	228 5	100 9	228 5	161 7	83 908	105 115		0 8	57 439
96	6/24/97	16 45 00	229 3	159 1	228 8	137	229 1	106 1	229 1	102 6	63 171	92 265		0 68	29 474
97	6/24/97	17 00 00	229 2	107 7	228 7	11 9	228 7	100 6	228 9	220 2	5 931	50 415		0 12	43 801
98	6/24/97	17 15 00	229 5	107 7	229 1	11 9	229 4	100 9	229 3	220 5	5 869	50 59		0 12	43 961
99	6/24/97	17 30 00	229 7	107 7	229 5	11 8	229 4	100 9	229 5	220 4	5 891	50 61		0 12	43 984
100	6/24/97	17 45 00	230 2	130 1	230	88 9	229 7	75 9	230	291 9	12 251	67 764		0 62	4 57
101	6/24/97	18 00 00	229 5	191 8	229 2	204 3	229	115 7	229 2	511 9	94 374	117 357		0 8	65 365
102	6/24/97	18 15 00	228 4	166 1	228 2	170 6	228 1	91 7	228 2	428 3	77 254	97 68		0 79	49 02
103	6/24/97	18 30 00	227 9	183 4	227 5	194 6	227 6	108 8	227 7	486 9	89 085	110 813		0 8	60 926
104	6/24/97	18 45 00	227 9	188 9	227 8	203	227 8	115 7	227 9	507 6	92 722	115 658		0 8	61 871
105	6/24/97	19 00 00	227 9	183 8	227 6	192 3	227 7	106 2	227 7	482 2	89 217	109 783		0 81	58 505
106	6/24/97	19 15 00	228	183 8	227 6	191 4	227 8	107 2	227 8	485 5	89 91	110 583		0 81	59 151
107	6/24/97	19 30 00	229 5	183	229 2	193 8	229 4	107 9	229 3	181 7	88 969	111 116		0 8	61 53
108	6/24/97	19 45 00	228 7	189 9	228 2	202	228 5	114 8	228 5	506 6	93 254	115 753		0 81	64 146
109	6/24/97	20 00 00	228 4	183 5	227 7	193 7	228 1	107 2	228	181 5	88 776	110 439		0 8	60 708
110	6/24/97	20 15 00	228 8	177 9	228 2	185	228 5	102 1	228 5	165 3	81 357	106 275		0 79	56 309
111	6/24/97	20 30 00	229 3	183 1	228 8	193 8	229 1	107	229	183 9	89 158	110 81		0 81	60 008
112	6/24/97	20 45 00	228 1	191 4	227 5	201 5	227 8	116 9	227 8	512 7	91 129	116 787		0 81	64 816
113	6/24/97	21 00 00	228 7	182	228 1	192 7	228 6	106 8	228 4	181 5	88 555	109 951		0 81	60 172
114	6/24/97	21 15 00	230 5	122 2	230	82 7	230 4	69 7	230 3	274 7	39 93	63 202		0 63	0 119
115	6/24/97	21 30 00	231 3	109 1	230 5	11 7	230 9	102 5	230 9	223 3	5 878	51 598		0 11	11 585
116	6/24/97	21 45 00	232 1	109	231 2	11 5	231 5	102 6	231 6	223 1	5 843	51 703		0 11	44 734
117	6/24/97	22 00 00	233 6	109 2	232 4	11 2	232 8	102 9	232 9	223 4	5 834	52 081		-0 11	45 129
118	6/24/97	22 15 00	231 3	108 9	230 3	11 7	230 5	102 2	230 7	222 8	5 9	51 434		0 11	44 571

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119	6/24/97	22 30 00	230 3	107 4	229 1	11 2	229 5	100 1	229 7	218 7	6 251	50 282	0 12	12 766
120	6/21/97	22 15 00	227 1	123 7	226 5	71	226 9	71 7	226 9	272 3	36 018	61 771	0 58	7 318
121	6/21/97	23 00 00	227 7	142 8	226 8	156 8	227 3	61 2	227 2	310 9	65 165	77 112	0 61	28 812
122	6/24/97	23 15 00	226 9	185 5	225 9	195	226 5	110 3	226 5	490 7	89 637	111 11	0 61	60 736
123	6/21/97	23 30 00	228 3	185 7	227 1	191 3	227 7	109 6	227 8	189 7	90 616	111 543	0 61	60 399
124	6/21/97	23 15 00	230 1	118 2	229 1	11 3	229 6	92 1	229 6	251 9	21 32	58 565	0 36	21 905
125	6/25/97	0 00 00	230 3	107 4	229 3	11 1	229 6	101 1	229 7	219 9	5 133	50 551	0 11	11 128
126	6/25/97	0 15 00	230 8	107 6	229 9	10 9	230	101 6	230 2	220 2	5 125	50 727	0 11	11 212
127	6/25/97	0 30 00	231 3	106 7	230 3	10 5	230 3	100 3	230 6	217 5	5 641	50 199	0 11	-43 373
128	6/25/97	0 45 00	230 7	140	229 7	95 5	230 1	98 7	230 2	331 1	14 457	76 874	0 58	8 783
129	6/25/97	1 00 00	230	183 5	229	192	229 1	101 2	229 5	179 7	88 026	110 1	0 8	61 078
130	6/25/97	1 15 00	229 7	158 3	228 7	155 4	229 2	79 7	229 2	393 5	71 017	90 033	0 79	41 522
131	6/25/97	1 30 00	226 8	187 6	225 8	196 5	226 3	110 5	226 3	491 6	91 151	111 926	0 81	60 541
132	6/25/97	1 45 00	226 5	187 9	225 6	194 9	226 1	110 7	226 1	493 5	91 261	111 557	0 82	59 821
133	6/25/97	2 00 00	225 9	170 5	224 9	172	225 6	93 6	225 5	436 1	79 973	98 242	0 81	48 672
134	6/25/97	2 15 00	227	177 6	225 8	168 6	226 6	101 3	226 5	417 5	84 125	101 256	0 83	41 417
135	6/25/97	2 30 00	225 7	224 3	224 6	227	225 3	111 9	225 2	596 2	115 736	134 241	0 86	63 505
136	6/25/97	2 45 00	227 1	193 6	226	193 7	226 7	111 8	226 6	499 1	97 208	112 988	0 86	51 721
137	6/25/97	3 00 00	226 2	197 6	225 1	198 4	225 8	116 9	225 7	513	99 153	115 72	0 86	53 811
138	6/25/97	3 15 00	226 6	218 1	225 6	222 9	226 3	140 1	226 2	581 4	112 213	131 466	0 85	64 377
139	6/25/97	3 30 00	226 1	205 9	225	210 6	225 6	127 9	225 6	544 5	103 767	122 805	0 84	61 323
140	6/25/97	3 45 00	227 3	184 3	226 3	187 8	226 8	106 9	226 8	178 9	88 84	108 586	0 82	55 248
141	6/25/97	4 00 00	228 1	119 8	227 2	75 5	227 7	62 7	227 7	258	39 097	58 74	0 67	5 317
142	6/25/97	4 15 00	228 9	107 6	228	11 7	228 2	101 1	228 4	220 4	5 676	50 377	0 11	43 988
143	6/25/97	4 30 00	229	107 7	228 1	11 7	228 3	101 2	228 5	220 7	5 712	50 163	0 11	44 077
144	6/25/97	4 45 00	230	108	229 1	11 6	229 3	101 6	229 5	221 2	5 669	50 786	0 11	44 386
145	6/25/97	5 00 00	232	108 7	231 3	11 2	231 3	102 5	231 5	222 3	5 605	51 501	0 11	41 958
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148	6/25/97	5 45 00	229 8	108	229 2	11 5	229	101 6	229 3	221 1	5 679	50 718	0 11	11 208
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151	6/25/97	6 30 00	221 9	106 5	221 5	12 2	221 7	99 6	221 7	218 3	5 677	19 086	0 12	12 77
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153	6/25/97	7 00 00	221 6	101	221 2	11 1	221 1	96 1	221 1	211 5	6 025	17 176	0 13	10 691
154	6/25/97	7 15 00	223 7	117 8	223 1	61	225 1	77 6	223 1	256 1	10 162	57 281	0 53	12 712
155	6/25/97	7 30 00	223	126	222 4	85 6	222 7	69 2	222 7	280 5	11 915	62 555	0 67	0 975
156	6/25/97	7 45 00	222 4	103	222	12 5	222 3	91 1	222 2	209 6	6 732	16 613	0 11	39 297
157	6/25/97	8 00 00	223 5	154 7	223	123 3	223 3	101 1	223 3	379 1	59 192	84 922	0 7	20 13
158	6/25/97	8 15 00	223 8	192 7	223 4	202 5	223 6	116 5	223 6	511 7	91 252	114 41	0 82	60 679
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160	6/25/97	8 45 00	222 6	151 8	222 4	161 8	222 3	76 3	222 1	389 9	67 091	86 7	0 77	48 405
161	6/25/97	9 00 00	222 5	115 6	222 1	43 1	222 2	96 4	222 3	255	17 982	56 69	0 32	23 662
162	6/25/97	9 15 00	223 3	105 7	223 1	12 2	222 9	99 1	223 1	217	5 513	48 413	0 11	42 357
163	6/25/97	9 30 00	225 4	106 6	225 1	11 9	224 7	100	225 1	218 5	5 556	49 187	0 11	42 926
164	6/25/97	9 45 00	224 6	104 3	224 4	11 2	224	96 8	224 3	212 3	6 022	47 63	0 13	-40 682