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ENERGY EFFICIENCY AUDIT REPORT



KAZAKHSTAN

ALMATY HEATING SYSTEMS ENTERPRISE
Almaty, Kazakhstan

International Resources Group, Ltd.
Washington, D.C.

June 1993

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ENERGY EFFICIENCY AUDIT REPORT

ALMATY HEATING SYSTEMS ENTERPRISE (AHSE) Almaty, Kazakhstan

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New Independent States Task Force
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ACRONYMS AND ABBREVIATIONS

AGTKE	Alma-Ata Municipal Authority (Almaatagorteplokommunenergo)
AHSE	Alma-Ata Heating Systems Enterprise
A.I.D.	Agency for International Development
atm	atmospheres
b/d	barrels per day
Btu	British thermal unit
° C	degrees Celsius
Gcal	gigacalories
GJ	gigajoules
IRG	International Resources Group
m ³	cubic meters
MT	metric ton
MW	megawatt
NIS	Newly Independent States
MOE	Ministry of Energy and Fuel Resources, Republic of Kazakhstan
NMP	Net Material Product
rb	rubles; unit of currency in NIS countries. As of May 1993, 820 rubles = US \$1.

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The International Resources Group (IRG) District Heating Audit Team for Kazakhstan would like to express sincere thanks to the management and technical staff of the Almaty Heating Systems Enterprise (AHSE) and its distributor, the Almaty Municipal Authority - Almaatagorteplokkommunenergo (AGTKE). Extensive preparation for and commitment to the audit work by the plant staff facilitated a productive exchange of ideas and experiences in energy management. AGTKE provided valuable assistance to the project by supplying engineers to assist with the energy audits throughout the Almaty District Heating System.

IRG would also like to thank the U.S. Agency for International Development, Newly Independent States (NIS) Task Force, Office of Energy and Infrastructure, for coordinating the activities under the Energy Efficiency and Market Reform Project. It is the hope of the IRG Energy Audit Team that the initiatives implemented under this project will contribute to improvements in energy efficiency and economic development throughout Kazakhstan.

EXECUTIVE SUMMARY

As part of the U.S. Agency for International Development (A.I.D.)-funded Energy Efficiency and Market Reform project, the International Resources Group (IRG) Energy Audit Team visited Kazakhstan in April 1992. During this time, Team members spent approximately one week conducting an energy efficiency audit of various facilities within the Almaty District Heating Systems Enterprise (AHSE) in Almaty, Kazakhstan. The overall purpose of this audit was to assist AHSE in identifying and implementing low- and no-cost opportunities for energy savings. Team members also trained key plant personnel in energy management techniques practiced in the United States.

To accomplish these objectives, the IRG Energy Audit Team collected data at each of the facilities selected for the audit to make informed decisions regarding energy saving opportunities. Data were compiled using plant instrumentation, audit measurements (with A.I.D.-funded infrared thermometers), plant records, and personal interviews. Following the audit, the Team members returned to the U.S. to develop the specifications for, and procure, energy efficiency equipment to be used within the AHSE system to implement the initiatives identified.

Unlike other technical assistance projects, the Energy Efficiency and Market Reform Project is an action-oriented project, designed to demonstrate the potential for energy savings in the Newly Independent States through the implementation of appropriate energy efficiency projects. This audit report is designed to provide the reader with a background against which to view the activities initiated under this project.

Background

Almaty, the capital city of Kazakhstan, has a highly developed district heating system – unlike any found in the U.S. – and is unique in both its supply and end-use configurations. The heart of this system is a mixing station which receives hot water from two cogeneration plants. The supply configuration then utilizes this heated make-up water from the warmed cooling water of the steam-turbine condensers at the cogeneration plants.

For end users of system heat, the circulated hot water serves both space heating and domestic consumption functions. Approximately 23,000 to 27,000 m³ of hot water are pumped through this loop of the system hourly, and as much as 7,500 m³ of make-up water is pumped through the circulation loop each hour. More than 70% of this hot water is sold by AHSE to one organization, the Almaty Municipal Authority (AGTKE), which in turn distributes the hot water to end-users through its own networks.

As a whole, the system has been relatively inefficient. Due to both institutional and technical factors such as government ownership of the system, energy subsidies, and the legacy of centralized planning, the importance of energy efficiency has long been ignored. Similarly, the billing system used by AHSE, which is based on estimated average use within the entire district, has further eliminated incentives for end-users to implement meaningful energy conservation measures.

Most equipment within the audited facilities is relatively outdated. There are few measuring devices or instruments for monitoring either supply or end-use (demand) energy. On the demand side, little individual metering is installed and operating. Even where monitoring instruments are available, few have been utilized on a regular basis. On the supply side, monitors and controls for automatic combustion are absent from virtually all facilities, and pollution monitoring and control equipment are also nonexistent.

The AHSE and AGTKE have also consistently suffered from a lack of spare parts for plant equipment and an absence of budgetary provisions to upgrade older facilities. These two organizations are now attempting to secure foreign capital to finance the needed improvements.

Audit Findings, Recommendations, and General Outlook

In April 1992, the IRG Energy Audit Team initiated the first segment of the Energy Efficiency and Market Reform Project by assisting the AHSE and AGTKE in improving the operational efficiency of their plants. This segment of the project involved developing specifications for, purchasing, and assisting in the installation of gas analyzers, heat meters, flow meters and other conservation and energy efficiency equipment to demonstrate the potential savings from such instrumentation and controls. To further improve energy efficiency among end-users, the installation of thermostatic valves, and controls and metering devices for residential apartment buildings is also being considered.

The IRG Energy Audit Team examined both of AHSE's distribution systems and found tremendous potential for energy savings in all segments of system operation; for example, the mixer station contains boilers whose only current function is to heat water. There are also opportunities to satisfy the growth in demand for electric power within the system through the cogeneration of electricity. Further, since most hot water boilers within the system are fired by natural gas, they would be better suited for gas turbines with combined cycle capabilities.

The current, artificially low electricity prices and the uncertainty of future natural gas prices and supplies (now imported from Uzbekistan) appear to make investments in combined cycle gas turbines unfeasible in the short-term. Nevertheless, the long-term outlook for this option is very attractive, particularly with the Tengiz and other oil/natural gas fields in northwestern Kazakhstan promising to yield significant energy resources through newly formed joint ventures with Western companies.

Energy conservation, which will be encouraged through the removal of energy subsidies and the institution of rational, individual billing, has the potential to achieve energy savings of 30% among all end-users. On the production side, improvements in efficiency resulting from the installation of modern instrumentation and controls could achieve savings of almost 20%, offering a total reduction of approximately 50% in overall energy use to Kazakhstan district heating systems.

In addition, new privatization laws were passed by the Kazakh government in 1992 to attract foreign companies and to facilitate their investment in the country.

1. BACKGROUND

In the aftermath of the collapse of the Soviet Union, its former republics are faced with a host of economic and political crises, with energy among the most serious. The energy sector has historically been plagued by inefficiencies resulting from subsidized pricing, lack of instrumentation and control for energy inputs, and the overall aging of the sector's infrastructure. However, during the past few years, the perennially inefficient economic system of the former Soviet Union deteriorated further, dramatically decreasing production throughout the region. This situation adversely affected the energy sector by adding production and distribution bottlenecks to the already difficult task of procuring raw material inputs (particularly coal and natural gas) for the generation of electricity and heat.

After the termination of the Soviet Union in December 1991, long-standing inter-republic supply arrangements for energy inputs were disrupted due to political considerations. At that time, it was necessary for most republics to pay for energy supplies with scarce hard currency or through barter, aggravating the cash-flow situation even further. As a result, a number of energy enterprises failed during the 1991/1992 heating season, causing tens of thousands of people to go without heat or electricity for significant periods of time.

1.1 Project Origin and Rationale

The Washington Coordinating Conference of January 1992 – which included representatives from more than 50 nations and international donor agencies – recognized the critical nature of these energy issues. To this end, its Energy Working Group developed an action plan to address those problems confronting the Newly Independent States (NIS). As part of this plan, the United States Agency for International Development (A.I.D.) agreed to fund a technical assistance initiative to assist NIS nations in improving the performance and efficiency of selected district heating systems.

One initiative, known as the Energy Efficiency and Market Reform Project, was designed to combine in-plant, on-the-job training with the identification and implementation of no- and low-cost programs to maximize energy efficiency. The specific goals of Component #1 of this project, Heating System Energy Efficiency Improvement, are to:

- 1) foster better management of energy use in district heating plants by identifying and implementing inexpensive energy efficiency improvements that are cost effective;
- 2) transfer Western technologies in the conduct of energy audits and in plant management to heating system staff, including instruction in the formulation of financial and technical analyses;
- 3) provide support, in the form of energy efficiency equipment, to implement these identified options and to improve overall energy monitoring and management; and
- 4) identify additional opportunities for energy conservation and efficiency.

In each NIS nation, one or two district heating systems were selected as target enterprises for these energy efficiency audits. These systems were selected on the basis of their potential for significant energy savings, the applicability of audit results to similar plants in other countries in the NIS region, and the importance of the system's efficiency and effectiveness in the overall context of the country's economic development.

International Resources Group, Ltd. (IRG) of Washington, DC was chosen to implement the Energy Efficiency and Market Reform Project in Kazakhstan and Kyrgyzstan. IRG Energy Audit Team members first visited the country in March 1992 to discuss energy-related needs with development officials and to develop the workplan for this project, the initial energy activity under the new U.S. Economic Assistance Program for the NIS.

In Kazakhstan, Team members chose to examine the Almaty District Heating Systems Enterprise (AHSE) and its distributor, the Almaty Municipal Authority (AGTKE - Almaatagorteplokkommunenergo). Within the system, Team members audited generation, transmission, and end-use facilities; the end-use facilities evaluated included one industrial complex, one commercial facility, and one multi-unit residential building. Given the limitations in project resources, the initial audit of the heating system, which took place in April 1992, lasted approximately one week.

As part of the project, the IRG Energy Audit Team presented a workshop for AHSE management to discuss key, energy-related problems, as well as possible solutions. In addition, Team members presented a brief seminar on the use of economic techniques for evaluating investment options in energy efficiency programs and equipment, as well as providing them with the tools necessary to complete the strategic planning process at the plant level. Finally, representatives of U.S.-based, private-sector energy companies discussed equipment options and financing mechanisms.

Before the Team returned to the NIS in fall 1992, IRG had procured, with A.I.D. funding, the equipment necessary to improve overall energy efficiency and to help prevent failures within the system during the heating season. AGTKE technicians assisted AHSE staff in installing the equipment in the audited facilities.

1.2 Participating Entities and Roles

As mentioned above, the primary organizations involved in the implementation of the Energy Efficiency and Market Reform Project for Kazakhstan include the U.S. Agency for International Development (A.I.D.), AHSE, AGTKE, and the IRG Energy Audit Team. The Ministry of Energy and Fuel Resources (MOE) is overseeing the implementation of the project on behalf of the Government of Kazakhstan.

Mr. Mukhtar Kembaevich Kembaev, Director of AHSE, serves as the General Director of the project for Kazakhstan, with Mr. Anatoly Alexseivich Perelevsky, Assistant Chief Engineer at AHSE, leading the AHSE project team. In addition, Mr. Yuri Eduardovich Airih, Director of AGTKE, directs AGTKE's participation in the Project, and Mr. Altai K. Kadyrjanov, General Director of the Industrial Union of Electrical Engineering of Alma-Ata ENERGO (the holding company for AHSE) serves as overall advisor.

IRG is subcontracting with local Kazakhstan organizations and individuals for technical, logistic and other support services. Finally, private-sector American firms specializing in energy efficiency equipment and project development participate in the project on a no-cost basis, providing additional information on equipment and financing options.

1.2.1 Audit Process

Based on guidelines established by A.I.D., and in consultation with the managerial staff of AHSE and AGTKE, the IRG Energy Audit Team collaborated with AHSE engineers to conduct an energy efficiency audit of the Almaty District Heating System. This audit resulted in the identification and implementation of several energy efficiency opportunities, examined areas where future training of AHSE and AGTKE staff was needed, and classified and prioritized purchases of energy efficiency equipment.

1.2.2 Equipment Procurement and Installation

During mid- and late-1992, IRG purchased all instrumentation and equipment as approved by A.I.D. and arranged for its transfer to Almaty, as well as its subsequent delivery to AHSE and/or AGTKE. The Ministry of Energy and Fuel Resources ensured the equipment passed through customs duty free and was delivered to the appropriate enterprise. During late 1992, the IRG Energy Audit Team returned to Kazakhstan and assisted engineers and technical specialists from ASHE and AGTKE in the installation of this equipment and instrumentation.

1.2.3 Seminar

IRG staff, AHSE personnel, and representatives from the MOE will organize a seminar in Almaty in mid-1993 to discuss and disseminate the results of the joint Kazakhstan-American project. AGTKE staff, relevant Kazakhstan government officials, subcontracting engineers and American suppliers of instruments and equipment will be invited to participate.

1.3 Background on Kazakhstan

The section below briefly describes the relevant geographic, social, and economic conditions present in Kazakhstan. It also presents an overview of the energy supply and demand situation, including recent consumption and production levels.

Geographic, Social, and Economic Background

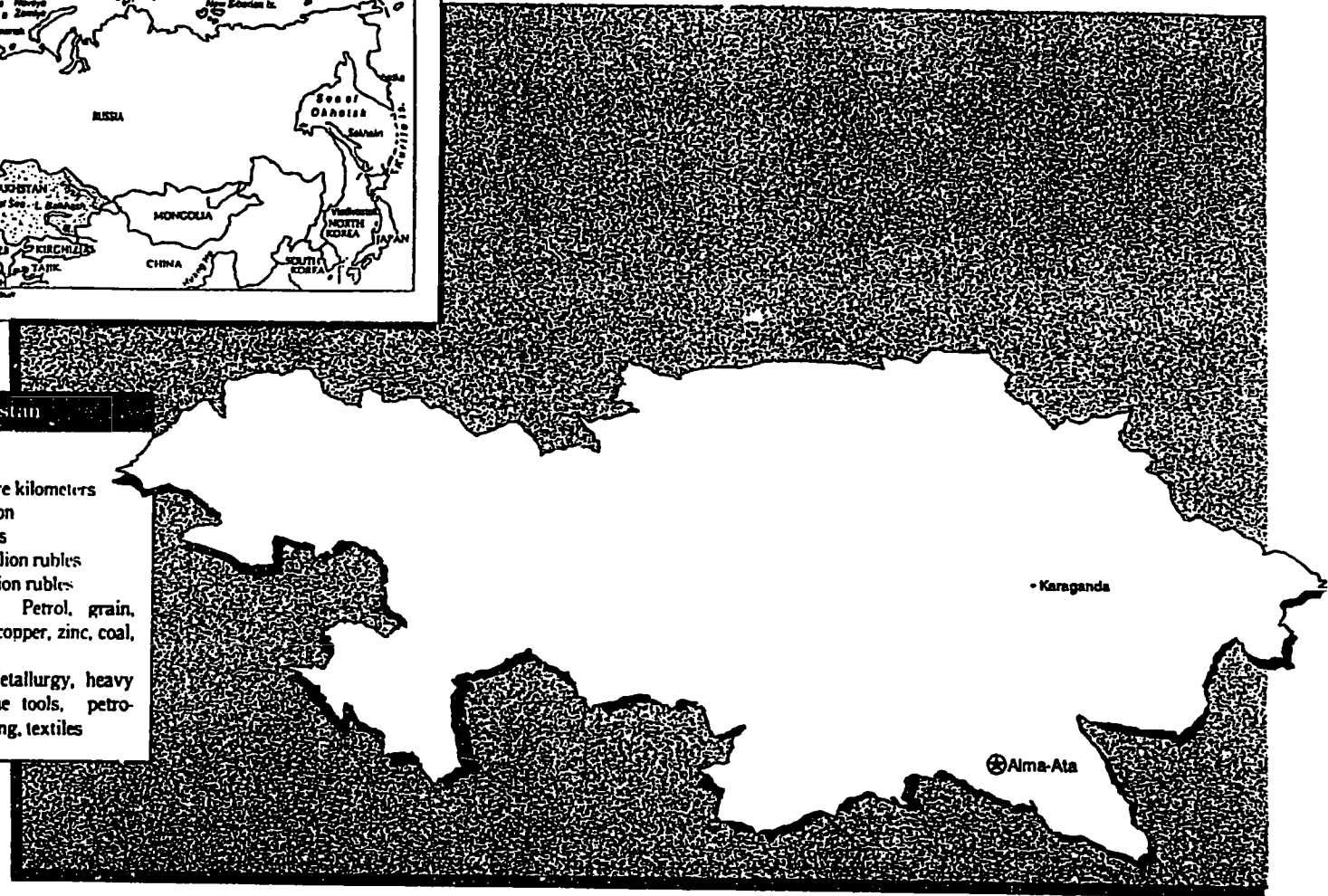
Kazakhstan, with a land area of approximately 1,050,000 square miles, has a population of 16.5 million. The republic is bordered by Russia to the north, China to the east, and Uzbekistan, Turkmenistan, and Kyrgyzstan to the south. A map which depicts the country and its location within the region and presents additional basic economic data, is shown in Figure 1 on the following page.

Figure 1.
Kazakhstan: An Overview



Kazakhstan

Capital: Alma-Ata
Area: 27 million square kilometers
Population: 16.9 million
GDP: 92.0 billion rubles
Total exports: 15.8 billion rubles
Total imports: 22 billion rubles
Natural resources: Petrol, grain, chrome, lead, wolfram, copper, zinc, coal, iron ore, wool, meat
Main industries: Metallurgy, heavy machinery and machine tools, petrochemicals, agro-processing, textiles



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Major ethnic groups include Russians, comprising 41% of the population, Kazakhs 36%, Ukrainians 6%, and Tatars, who make up approximately 2% of the total population. In addition to the capital city of Almaty, the city of Karaganda, located in the northeastern part of the country, is an important industrial center.

Kazakhstan's major imports include machinery, light industrial goods, chemicals and petrochemicals, oil, and natural gas. The country is a major exporter of several raw materials, including coal.

The measure of economic growth as used in the NIS countries -- Net Material Product (NMP), was 27.8 billion rubles in 1989, representing a NMP growth rate of 1.3% from 1988.

Energy Supply/Demand

Kazakhstan is a resource-rich republic, and produces several primary energy products, including coal, oil, and natural gas. The Ekibastuz and Karaganda Basins in the northeastern region of Kazakhstan are considered to be the third largest coal-producing areas among the NIS. Kazakhstan is also one of only four former Soviet republics that is a net exporter of energy.

Figures for overall energy production in Kazakhstan are included in Table 1.

Table 1. Energy Production Levels in Kazakhstan (by fuel type).

Fuel Type	Production Level	Year
Crude oil	526,169 barrels/day	1991
Natural gas	7.89 billion m ³ /year	1991
Oil products	350,000 barrels/day	1991
Coal	130 million tons/year	1991

Sources: Ministry of Energy and Fuel Resources and World Bank.

Figures for energy consumption in selected energy subsectors for 1989 are shown in Table 2 on the following page.

Table 2. Kazakhstan Energy Consumption (1991 million tons oil equivalent/year).

Fuel Type	Consumption Level (million tons oil equivalent per year)
Oil and products	19.4
Natural gas	13.1
Coal	44.6
Nuclear and hydro	1.7
Total Consumption	76.2 **

** Total values due to conversion factors.

Sources: Ministry of Energy and Fuel Resources and World Bank.

Oil and Gas Production and Refining

Significant oil and natural gas reserves are found in the northwestern region of Kazakhstan near the Caspian Sea. The potential for additional oil production depends largely on the development of the relatively deep, high-sulphur deposits in the remote Guryev region, particularly the Tengiz field. Despite the logistic difficulties to be encountered in this region, the tremendous size of the oil reservoirs has attracted significant attention among the international oil industry. Chevron has already entered into a joint-venture agreement with the Government of Kazakhstan to exploit the Tengiz field, and Elf Aquitaine (France) has signed a contract to explore for oil in the Aktyubinsk region. These resources represent an important component of the republic's future energy self-sufficiency.

Kazakhstan has three refineries; the industrial complex in Chimkent processes some 120,000 barrels per day (b/d), while the Guryev facility refines 90,000 b/d, and Pavlodar 150,000 b/d. These refineries partially supply the primary population centers in Kazakhstan, Kyrgyzstan, and southern Siberia via pipeline. Given the high sulfur content of existing oil reserves, the republic's capacity to accomplish this type of refining will undoubtedly have an important impact on the development of its oil industry.

1.4 Audit Methodology and Scope

To accomplish the goals of the Energy Efficiency and Market Reform Project, IRG developed a work plan which outlined the overall methodology and scope for the project; this plan determined that Team members would need to make four trips to the country. The first trip, involving the IRG Energy Audit Team Leader and A.I.D. representatives, served as a definitional mission. Team members conducted the energy audit during their second trip. The third trip allowed Team members to solicit comments on the recommendations and reports generated

through the project, and to assist with equipment installation. In its fourth trip, IRG Energy Audit Team will formally present the results of the project in a workshop format.

The energy audit of the AHSE, the focus of the Energy Efficiency and Market Reform Project, involved two major components: the system slice Audit and the general (total system) audit. The "slice audit" refers to the process of monitoring, measuring, and conducting a detailed energy audit in representative installations within an energy complex (in this case, AHSE). These installations depict a narrow "slice" of the heat production, distribution, and end-use facilities within the system, and allow audit specialists to directly evaluate energy use at specific points throughout the system. This type of examination enabled IRG Energy Audit Team members to draw broad conclusions about the entire system. Given the time and resource constraints of this project, the "slice audit" method served as an effective, efficient way to gain needed insights into the energy consumption practices throughout the entire AHSE system.

Members of the IRG Energy Audit Team also conducted a "general (total system) audit" using information from the "slice" audit, as well as data from plant management and operating staff, various plant records and statistics, and general observations and interviews. This broader audit provided an evaluation of overall energy use and broader management issues.

To facilitate this process, a detailed questionnaire developed by IRG Team members was translated and sent to AHSE prior to the actual audit. This questionnaire prepared the AHSE specialists for the audit program and allowed the IRG Energy Audit Team the opportunity to collect data that would be difficult to compile during the short time allotted for the two audits. A copy of the questionnaire is included as Appendix I of this report.

1.5 Completed Activities

In March 1992, the IRG Energy Audit Team Leader, Gerald Decker, completed the definitional mission and submitted his observations and recommendations in the form of a trip report. His findings, as well as those of the A.I.D. representatives who also participated in the mission, served as the basis for the development of the audit methodology and project workplan.

The entire IRG Energy Audit Team travelled to Kazakhstan the following month to conduct slice audits of one heat production system, one distribution system, and three end-use installations. End-use facilities audited included an industrial installation, a commercial facility, and a multi-unit residential (apartment) building. Team members also held detailed discussions with representatives of the AHSE management, key government officials, and relevant independent engineers.

At the end of the week-long audit, Team members presented an informal energy management seminar which focused on transferring Western techniques for the economic evaluation of energy investments and strategic planning. In addition, representatives of U.S. private-sector energy equipment vendors and project developers gave brief presentations on equipment and financing opportunities available to Kazakhstan.

2. DESCRIPTION OF FACILITIES WITHIN THE ALMATY DISTRICT HEATING SYSTEM

2.1 Heat Production (Thermal Generation)

Hot water and industrial steam utilized by the AHSE are provided by several sources. Much of the thermal energy used is supplied by two cogeneration stations (Station #1 and Station #2), while three district boiler houses and one independent boiler house provide the balance.

Although the boiler houses belong to AHSE, the two cogeneration stations are controlled by a separate administrative entity under the authority of the Kazakhstan Ministry of Energy and Fuel Resources (MOE). While these cogeneration stations were not part of the energy audit, a brief description of each is provided below for information purposes.

2.1.1 Thermal Energy Station #1 (TES-1)

TES-1 was completed in 1935, and is comprised of six steam boilers each producing 420 gigajoules (GJ) of power and 160 metric tons (MT) of steam per hour. The station has a total electric power capacity of 145 megawatts (MW), and a total thermal capacity of 920 MW. There are also three turbines in TES-1 which are capable of producing 435 MW of power. Base-load boilers at this station, which generate 40 to 60% of the total power capacity, are fueled by pulverized coal from the Karaganda region. Conversely, the peaking-load boilers are fired by natural gas and heavy fuel oil (mazut).

Approximately 2,500 m³ of hot water is produced hourly at this station. This hot water originates as cooling water used for the turbine condensers, which is then reheated using double extracted steam to maintain an average temperature of 150 degrees Celsius (°C). The average steam load of this station is 220 MT/hour, with a maximum of 336 MT and a minimum of 105 MT. The hot-water load has a maximum flow of 2,800 m³/hour and a minimum of 2,240 m³/hour.

2.1.2 Thermal Energy Station #2 (TES-2)

TES-2, constructed in the 1980s, consists of seven boilers, with individual capacities of 480 GJ per hour. Each of these seven boilers produce 420 MT of steam per hour at a pressure of 140 atmospheres (atm), and 540° C. There are also six turbines in this facility, 2 with a capacity of 110 MW, 3 with 80 MW, and 1 with 50 MW. The total electric power capacity of this station is 510 MW, while its total thermal capacity is 1,000 MW.

This station produces 5,000 m³ per hour of hot water at 150° C by reheating cooling water from the condenser. Base-load boilers for TES-2, which generate 40% to 60% of the total thermal output, are also fueled by pulverized coal. Mazut or natural gas is burned in the hot water/heating boilers, while natural gas is used in the peaking (hot water) boilers. The average steam load at this facility is 385 MT per hour, with a maximum of 700 MT and a minimum of 624 MT. The maximum hot water load is 5,600 m³ per hour.

2.1.3 Management and Organization

As stated above, neither station is administratively part of AHSE, but each belongs to a separate entity under the overall authority of the MOE within the republic. AHSE is, however, the primary customer of the hot water produced by these two cogeneration units. Electricity produced by these stations is then supplied to the national power grid, also under MOE jurisdiction. Table 3 below outlines the thermal and electric power production capacity of each of these stations.

Table 3. Thermal and Electric Generation Capacity - Almaty, Kazakhstan

Generation Unit	Thermal Capacity (MW)	Electric Capacity (MW)	Total Capacity (MW)
Station #1	920	145	1,065
Station #2	1000	540	1,540

When extensive interaction between the organizations is necessary, MOE serves as liaison. In addition, both AHSE and the two cogeneration stations are part of a larger enterprise known as Alma-Ata ENERGO (AAE), an administrative entity made up of 18 operating institutions within the country. An organizational chart detailing the entities which comprise AAE is depicted in Figure 2.

2.1.4 Operation and Maintenance

A diagram detailing the pipeline network of TES-2 is shown in Figure 3. Coal used to fuel this station is shipped in by rail from the city of Karaganda, approximately 1,000 kilometers (km) from Almaty. This coal is approximately 40% ash content by weight and has a heating value of roughly 6,000 Btu per pound.

According to estimates by the Ministry of Geology, approximately 700 MT of bottom ash are produced hourly by operational coal boilers in Kazakhstan, creating a total ash accumulation of 14 million MT by January 1992. TES-2 in Almaty alone contributed 4.3 million MT through its production of 0.8 million MT of bottom ash each year.

2.2 District Heating System

The Almaty Heating System Enterprise (AHSE), established in 1960, was constructed in stages as demand grew. Consequently, while some pipelines are relatively new, others are more than 25 years old. The entire AHSE system covers a territory spanning 15 km east to west and 10 km north to south, and serves most of the 1.2 million people currently living in Almaty.

Figure 2.
Organizational Chart of the Alma Ata Energo Enterprise

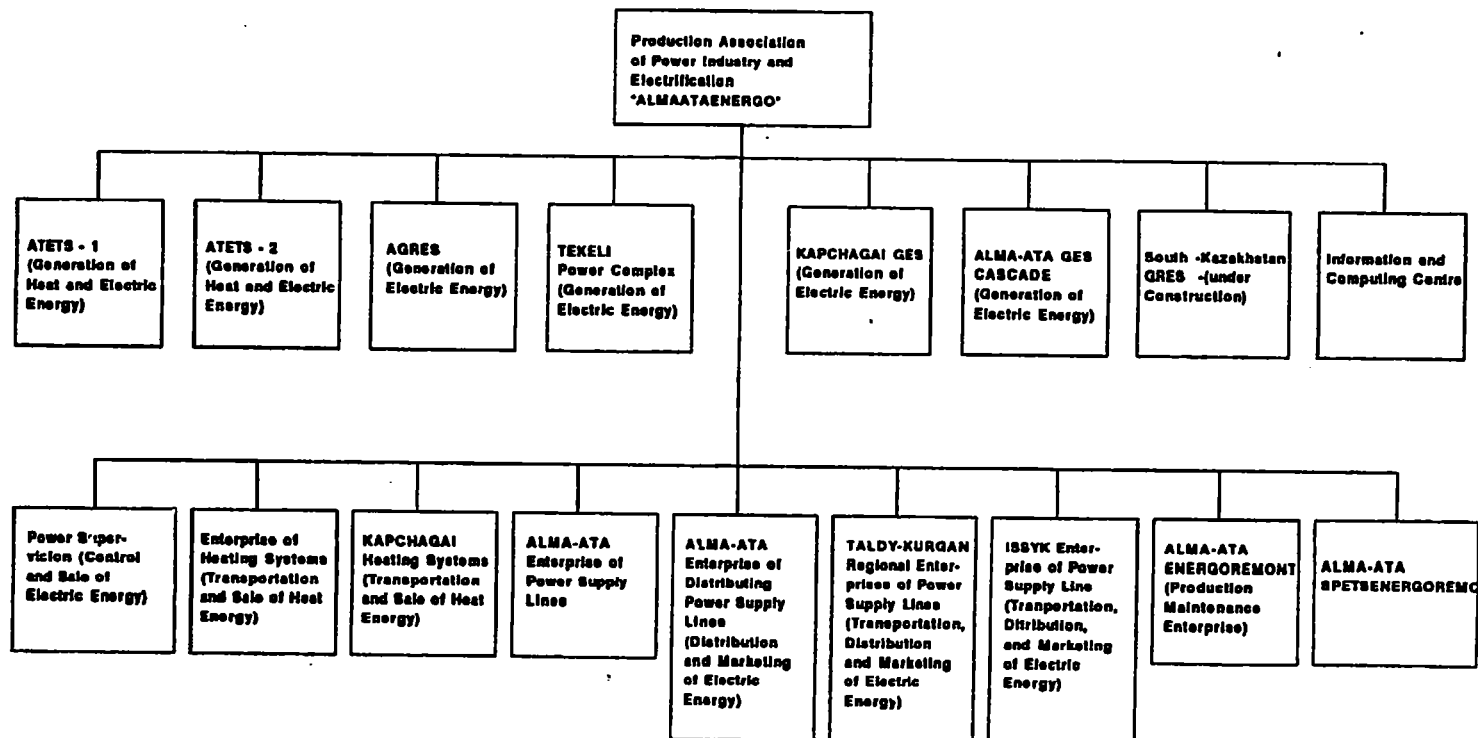
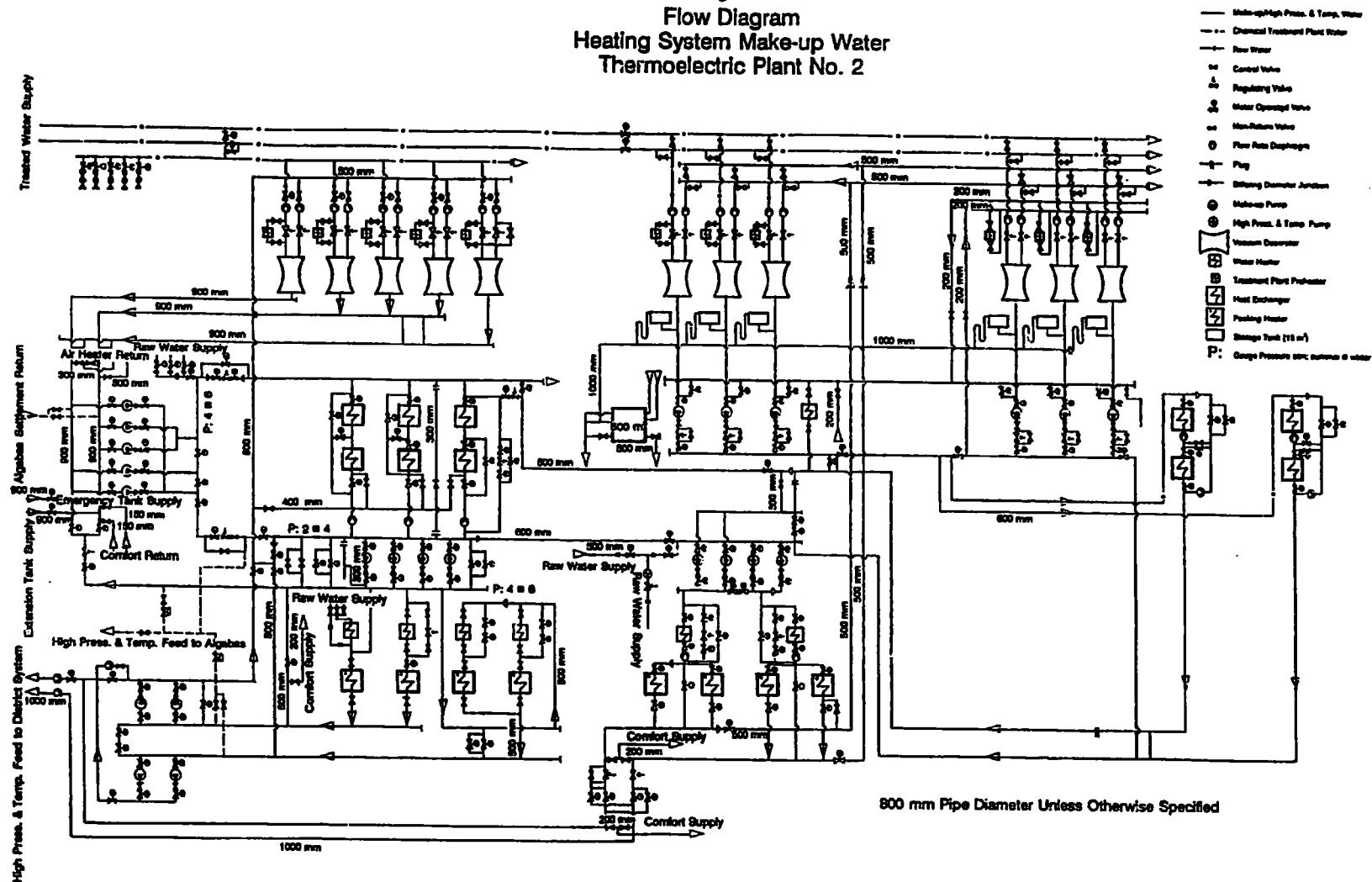


Figure 3.
Flow Diagram
Heating System Make-up Water
Thermoelectric Plant No. 2



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The eastern section of the city has historically been supplied by Station #1 (TES-1), with the western portion supplied by TES-2. Maps depicting the layout of AGTKE and AHSE pipeline networks are shown in Figures 4 and 5, respectively.

AHSE is unique in two respects. First, its hot water supplies are primarily utilized for space heating and domestic consumption. Second, make-up water for the system is supplied by the cooling water from the condensers which operate in TES-1 and TES-2. Figure 6 presents a schematic diagram detailing the way in which cooling water from the turbine condensers is heated by steam removed from the turbine extractors to provide the 150° C water necessary for AHSE operations.

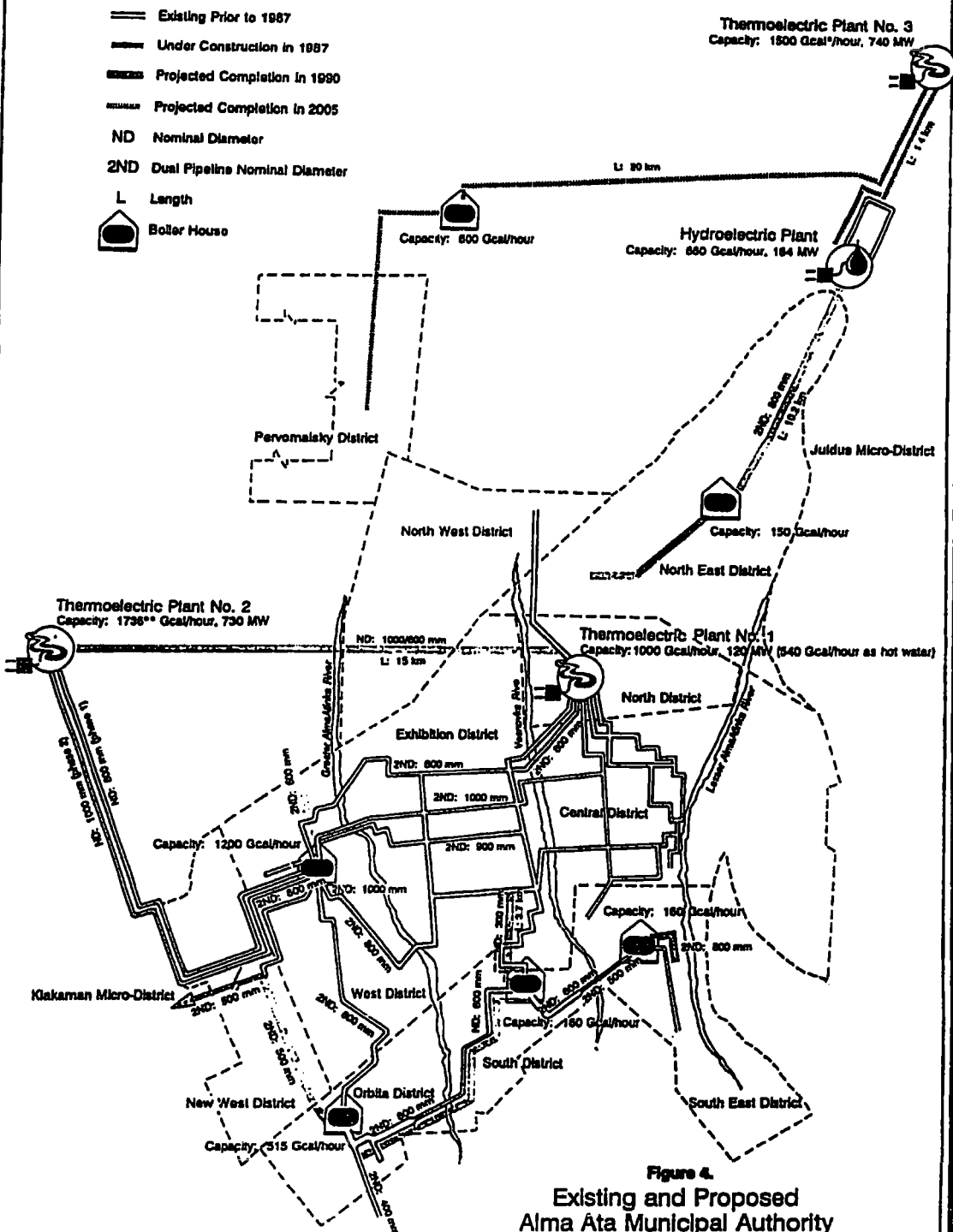
At the beginning of its operation, AHSE consisted only of TES-1, then located in the heart of the city. Due to environmental considerations, this station was not developed beyond its initial configuration. As the city grew and new housing was added, additional thermal demand was satisfied through the installation of local district boilers. When the base-load became overburdened, TES-2 was constructed, with these boilers used only during peak demand.

The average annual flow of make-up water at AHSE is approximately 7,000 m³ per hour, the majority of which (5,000 m³ per hour) is prepared in Station #2. The total capacity of the hot water storage tanks used to balance the instantaneous peaking demand is some 70,000 m³, with only 42,000 m³ of this currently in use. The total heating load capacity of the system is estimated at 5,400 MW. Of this, 2,900 MW of thermal energy is supplied from Stations #1 and #2, and an additional 1,700 MW is provided by the district boiler houses. In 1991, these boiler houses provided approximately 2.2 million gigacalories (Gcal) of thermal energy to the system, while the cogeneration plants provided an additional 7.3 million Gcal.

Problems within the AHSE system include:

- difficulty in localizing damaged or major leakage areas due to the relative size of the system;
- trouble in maintaining the system's hydraulic pressure and temperature levels to operate properly the heating system;
- insulation materials and mechanisms having a different service life than the pipelines, requiring replacement more frequently than the pipelines themselves; and
- lack of automatic instrumentation and control equipment to properly maintain and operate service areas.

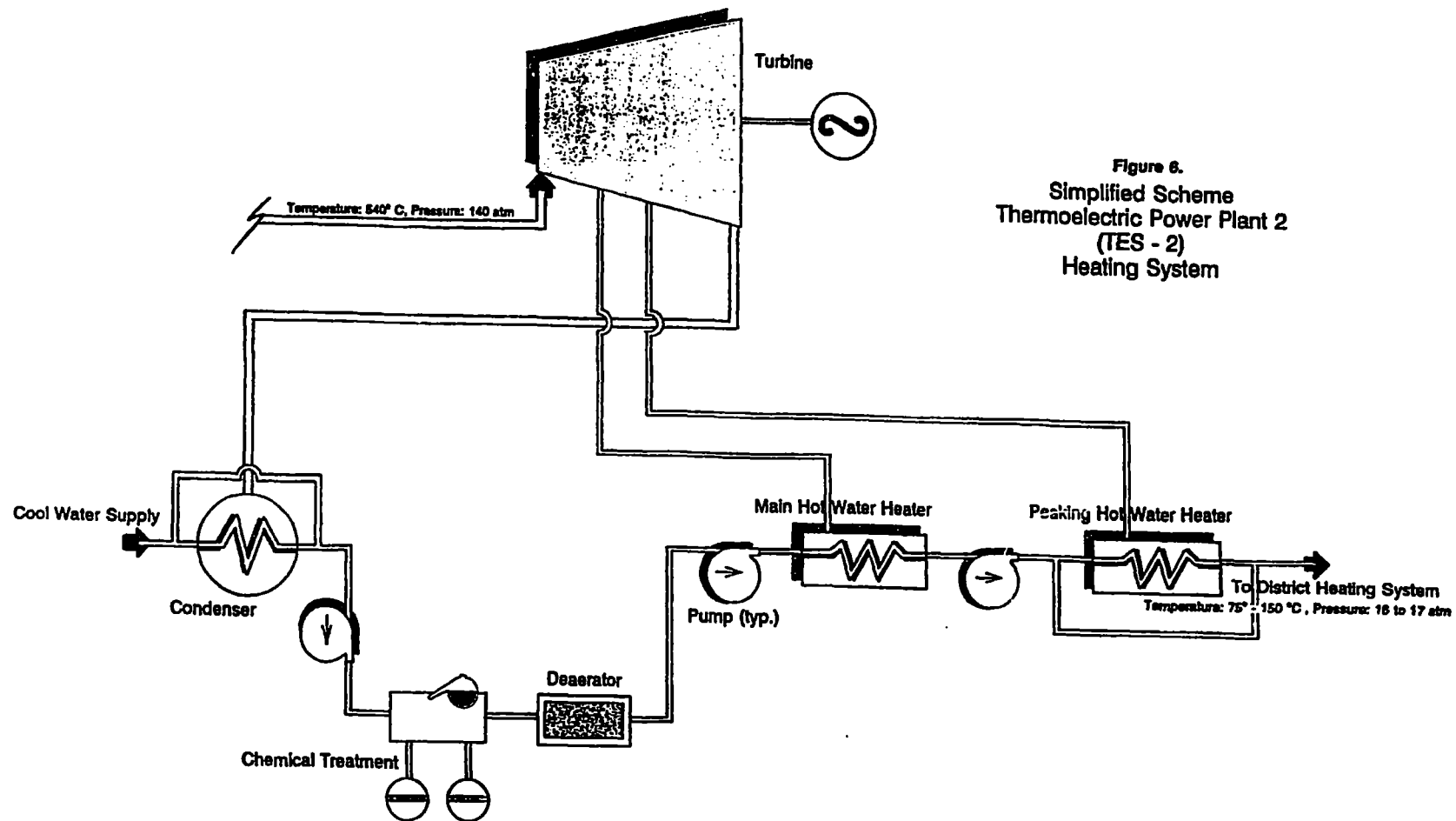
The projected annual level of growth for the heating load of Almaty is estimated to be 100 MW to 120 MW. This increase is expected to expand the overall load on the district heating system from its present level of 70% of capacity to 90%. As a result, a new cogeneration plant will be needed within the next 10 to 15 years, with an electric capacity of 500 MW to 700 MW and thermal capacity of 1,000 MW to 2,000 MW. Due to environmental considerations, the next station constructed will have to be located outside city limits, approximately 20 to 25 km from the other two stations.





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Figure 6.
Simplified Scheme
Thermoelectric Power Plant 2
(TES - 2)
Heating System



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In the near future, however, AHSE plans to construct an additional district boiler house in the northwestern sector of the city to accommodate the increased demand resulting from a number of new residential areas. This project will involve the construction of a facility with six hot water boilers and four steam boilers.

2.2.1 Management/Organization/Staffing/Customers

The AHSE system, as detailed in Figure 7, employs 732 people with an annual payroll of approximately 3.58 million rubles (based on 1991 figures); approximately 270 staff per shift are technical specialists. Its customer base includes 365 industrial enterprises, 706 institutions (offices, hospitals, and schools), 83 non-industrial enterprises, and 258 private residential buildings (houses/flat blocks). The total number of individuals serviced by AHSE is estimated to be more than 900,000.

Although the Repair-Services section completes most in-plant repairs, a separate Electrical Services Group maintains electrical equipment at the pump stations. The primary functions of these pump stations (depicted in Figure 8) are to:

- increase pressure in the hot water feeding line to 6 or 6.5 kg/cm², and deliver it to the pumps at a capacity of 1,250 m³ per hour and a head of 140 m;
- deliver return water from various users to a similar regulator, where pressure is maintained at a preset level; and
- fill storage tanks at the stations during those hours when hot water consumption is low (to be returned later to the system when demand is greater), enabling station operators to maintain a stable pressure level in the heating system.

While personnel employed by the operational districts service the heating manifolds and booster pumping stations within their individual district, they do not maintain the automatic controls; this equipment is serviced by the Measurement Services Group. The Transport and Mechanic Services Group handles out-of-plant maintenance and repair duties, and the Repair and Construction Center oversees those parts of the network with small- to average-diameter pipelines. All boiler houses are maintained by their own personnel.

2.2.2 Distribution System/Peaking Plants

In addition to hot water and/or steam supplied from TES-1 and TES-2, three district boiler houses (Western, New Western, and Southwestern) and one independent boiler house (Northeastern) service peak-load needs and major industrial steam customers. These boiler houses range in age from 2 to 30 years, and are fueled by natural gas and mazut. The Western, Southwestern and New Western district boiler houses are comprised of four hot water boilers each, with the Western and Northeastern boiler houses consisting of four and ten steam boilers, respectively.

Figure 7.
Organizational Chart of ASHE

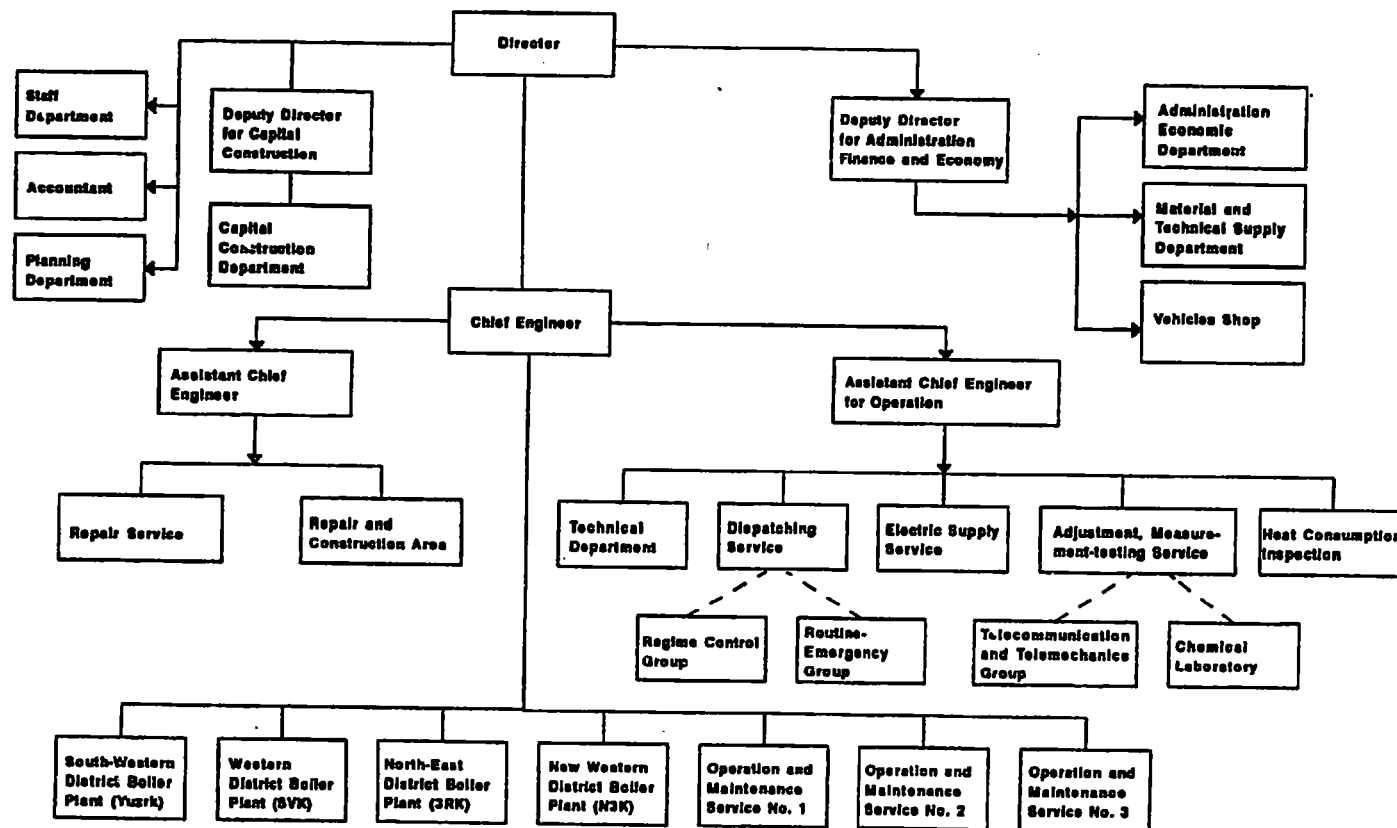
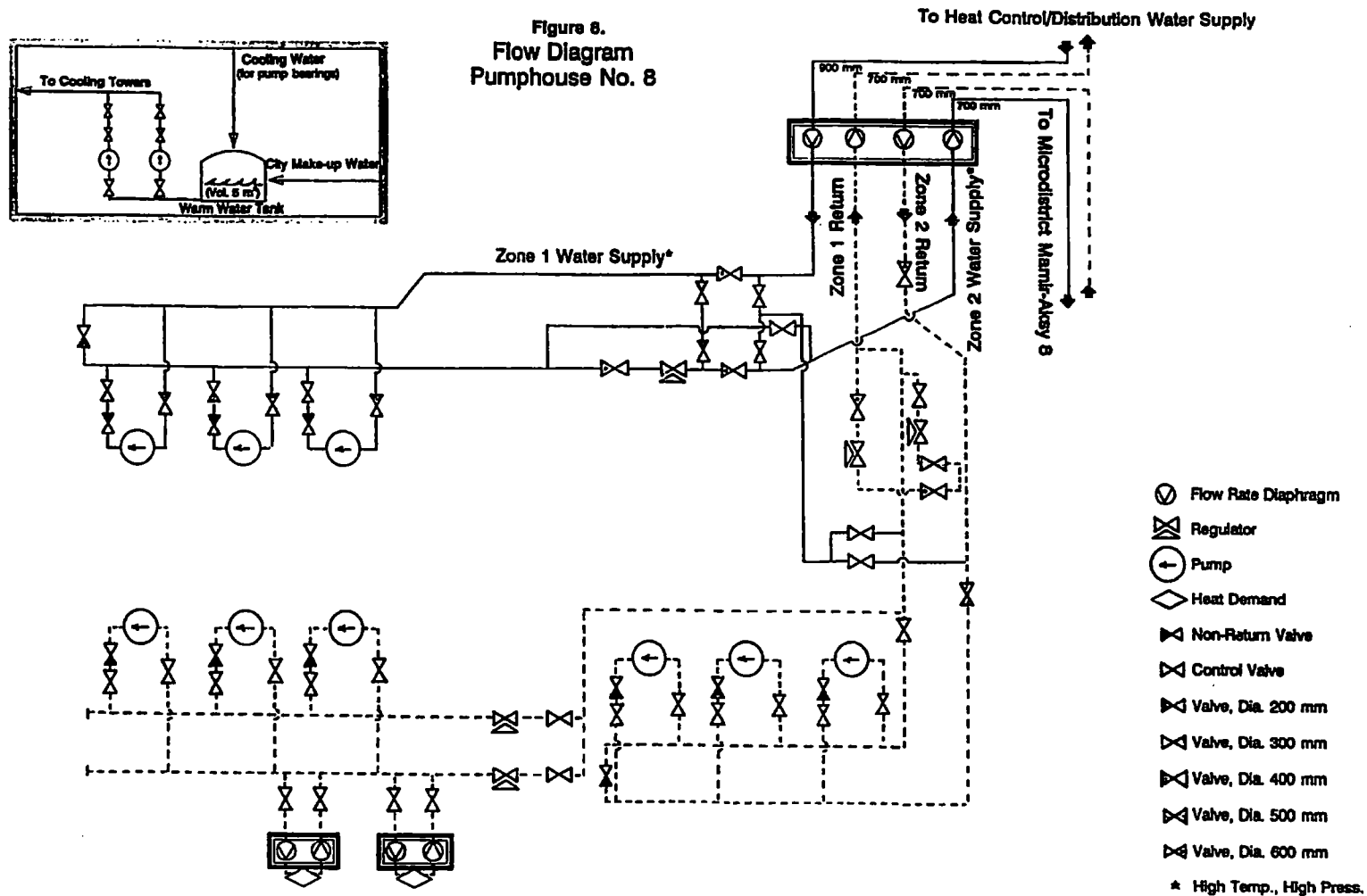


Figure 8.
Flow Diagram
Pumphouse No. 8



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Within the system itself, a net drop in elevation of 160 meters exists from south to north. This change is compensated by the use of three hydraulic zones within the network interconnected through automatic breaking nodes and booster pump stations. There are 12 such pumping stations, having a combined capability of pumping 69,000 m³ of water per hour. Six automatic controls on the hot water pressure lines serve to prevent the backflow often caused by breakdowns in the system. Nevertheless, this elevational change presents certain problems in the overall reliability of the single pipeline, hot-water supply system.

The addition of an automatic control system for the hot water supply made it possible for a single pipeline, hot-water supply system to move from its thermal source (TES-2) to peak demand areas. This single pipeline system needed only two pipes (800 and 1,000 mm diameter) to be laid, rather than a set of six pipes each with a diameter of 1,200 mm. This method of heat/hot water transportation has generated interest in other countries, including Czechoslovakia, East Germany, and Austria. A similar system will be designed for the future Station #3.

Control of system pressure and heating conditions is performed at the AHSE dispatch center, which is equipped with telephones, computers, and telemetric equipment. On the average, 3 to 4 km of the older, small diameter pipelines are reconstructed annually. In addition, annual upgrades are made to 2.5 to 3 km of older pipelines in the heating system, and to 3 or 4 boilers; another 4 to 5 boilers are modernized each year.

2.3 End-Use Systems

This section discusses each of the following end-use systems present (industrial, commercial, and residential) in the Almaty district heating system.

2.3.1 Industrial Customers

As mentioned in Section 2.2.2 above, the AHSE has 365 industrial customers. In all cases, industrial clients are government-owned enterprises, although in the near future some of these enterprises may be privatized. The growth rate for energy demand as currently contracted is approximately 2% annually.

Little data were available regarding the characteristics of typical AHSE industrial customers. In general, all industrial equipment is outdated, and the facilities need varying degrees of repair. Hot water and steam usage among industrial customers is metered by the receiving station, but controls placed on their usage are rare.

To date, few initiatives to improve energy efficiency have been implemented or even considered at industrial facilities in Kazakhstan. This is partially explained by the history of tariff-subsidies, which did nothing to encourage the conservation of energy, since investments in energy efficiency did not have sufficient economic paybacks. Most industrial customers of AHSE, therefore, paid little attention to energy efficiency, since prices were adjusted only once during the thirty year period prior to 1991.

Energy conservation on the demand side is not practiced or emphasized due to state ownership and the lack of individual metering. On the production side, lack of monitoring instrumentation and other energy equipment has limited energy efficiency initiatives.

Heat tariffs/regulations/contracts

Prior to 1991, tariffs for heat and electricity were set by the State Committee on Prices within the framework of the entire Soviet Union. Subsequently, however, tariffs for industrial heat have been determined by the Cabinet of Ministers of Kazakhstan. A breakdown of the changes in these tariffs over time is listed below in Table 4.

Table 4. Industrial Heat Tariffs for Almaty (January 1991 - February 1993)

Date	Tariff (Rubles/Gcal)
Before January 1991	11
January 1991	16
February 1991	23
March-June 1991	42
July-December 1991	34
January 1992	146
February-April 1992	182
May 1992	406
June-October 1992	1,316
November 1992-January 1993	2,106
February 1993	6,320

The Almaty Carpet Factory and the Pepsi-Cola Bottling Plant were selected by the IRG Energy Audit Team for system slice audits. Details on these plants and the observations and recommendations of the Team are presented in Section 3.

2.3.2 Commercial Customers

AHSE has 83 non-industrial commercial enterprises as customers, as well as 706 commercial customers, including offices, schools, and hospitals. The growth rate of energy demand within this sector is approximately 3% per year.

Commercial customers of AHSE generally require utility services for space heating, ventilation, and hot water. However, AHSE delivers hot water only to the "gates" of the commercial installation, while the heat-energy monitoring and auditing instruments needed to monitor efficiency levels are installed at the end-use receiving station. Although only approximately 10% of commercial customers utilize monitoring instruments, all commercial users are supplied with this type of equipment.

Clients in the commercial sector have traditionally been unconcerned with energy conservation due to previously subsidized tariffs outlined in Table 4 above. Price increases since January 1991, however, have caused some commercial facilities to explore options for the development of cost-cutting measures. However, commercial customers, as public sector entities, traditionally have been entitled to heavily subsidized services, including hot water. It is unlikely these institutions are concerned with energy issues, and energy efficiency is a low priority.

Heat tariffs/regulations/contracts

Prior to January 1991, heat tariffs for the commercial sector were set by the State Committee for Pricing of the Soviet Union. Since January 1992, tariff rates for heat energy have been set by the Cabinet of Ministers of the Government of Kazakhstan. This Cabinet has increased tariffs several times for commercial customers (Table 5).

Table 5. Commercial Heat Tariffs for Almaty (January 1991 - February 1993)

Date	Tariff (Rubles/Gcal)
Before January 1991	6
January-February 1991	14
March-June 1991	16
July-December 1991	14
January 1992	60
February-May 1992	71
June-October 1992	110
November 1992-January 1993	220
February 1993	490

2.3.3 Residential Customers

There are 258 residential customers connected to the AHSE distribution system, and 491 residential customers connected to the AGTKE distribution system. These residential facilities, including stand-alone housing and apartment buildings, are owned by a number of entities. Although private homes do exist, most residential buildings serviced by the AHSE and AGTKE belong to either the Ministry of Community Services or a housing authority, or are associated with government agencies or government-owned enterprises. The growth rate for heat demand in the residential sector is approximately 20% per year.

Hot water is supplied to most residential customers for both space heating and domestic consumption. At each receiving substation, instruments for monitoring heat energy are installed, although individual regulation and control of space heating temperature is virtually non-existent. The flow diagram of a typical substation is shown in Figure 9.

As mentioned above, the previous energy-pricing system offered little incentive for customers to conserve energy. Moreover, since residential end-users are not individually metered, conservation by specific individuals had little effect on the overall cost and consumption of heat. In general, energy efficiency appeared to be a completely foreign concept to most residential customers. For example, since there are no individual controls to regulate the amount of heat each residence receives, every end-user receives a high level of heat input and regulates the temperature by opening windows.

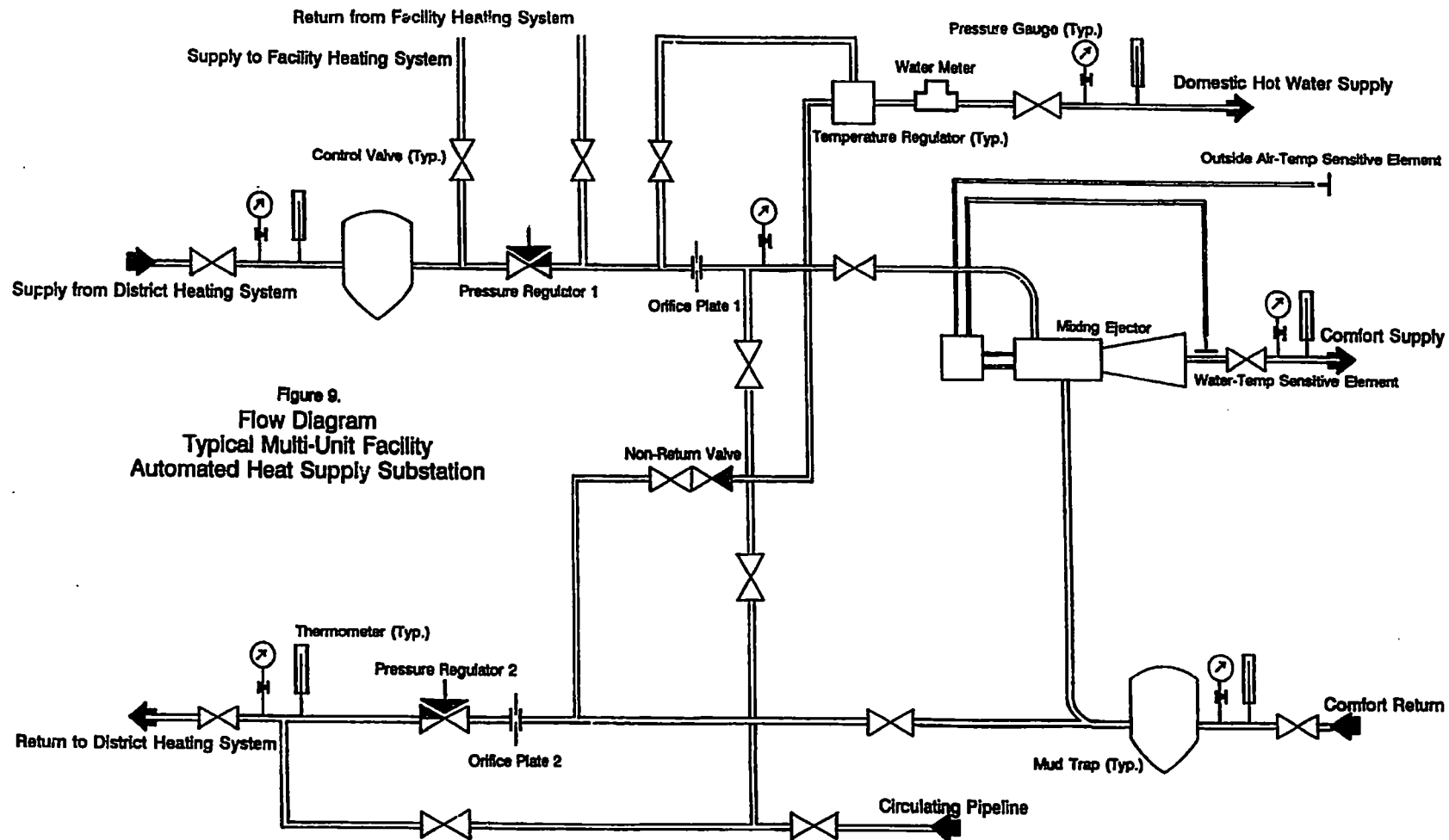


Figure 9.
Flow Diagram
Typical Multi-Unit Facility
Automated Heat Supply Substation

Orifice Plate 1 provides for circulation of District Heating System Supply (high pressure/high temperature) into District Return

Orifice Plate 2 is necessary as back-up to Pressure Regulator 2



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Heat tariffs

Since January 1992, the tariff rate for residential customers has grown steadily, despite larger price increases among the industrial and commercial sectors. The Cabinet of Ministers of Kazakhstan also regulates both the tariff and contracts with residential customers, and has made corresponding increases in this sector as well (Table 6).

Table 6. Residential Heat Tariffs for Almaty (January 1991 - February 1993)

Date	Tariff (Rubles/Gcal)
January 1991	9
February 1991	15
March-June 1991	13
July-December 1991	22
January 1992	90
February-April 1992	87
May 1992	75
June-October 1992	170
November 1992-January 1993	n/a
February 1993	1,860

3. DESCRIPTION OF AUDITED FACILITIES

3.1 System Slice Audit

This section details equipment within the production and peaking plant, distribution system, and end-use (customer) systems that were part of the system slice audit.

3.1.1 General Description and Scope

The IRG Energy Audit Team conducted a system slice audit of the AHSE complex by visiting selected generation, distribution, and end-use installations within the system, and were assisted by fifteen specialists from AHSE and AGTKE. Team members then divided into three groups to facilitate evaluation of the generation, transmission and end-use installations. IRG Energy Audit Team Leader Gerald Decker led the inspection of the boilers (steam and hot water) at the mixing station; Dr. Tadeusz Swierzawski supervised the examination of the main pump station located at the mixing station; and Frank Wang directed the analysis of two AHSE industrial customers, as well as the audit of the AGTKE distribution system.

3.1.2 Production and Peaking Plant

The IRG Energy Audit Team selected the Central Thermal Distribution Stations of the AHSE as "representative" distribution installations, since these stations are the heart of the district heating system. Primary distribution begins at this facility, with the mixing and conditioning of the hot water accomplished before being pumped out to the pipeline network. Several components of these stations were specifically examined as part of the slice audit, including the hot water boilers, pumps, pipelines and associated insulation, heavy oil and gas burners, and the soot blowing system.

Four boilers of the New Western Boiler House were included in the slice audit. These boilers were originally designed to burn natural gas. However, since the boiler house frequently burns mazut as a substitute due to shortages in the supply of natural gas, these boilers have been re-worked with two sets of burners, one suitable for each type of fuel. These burners are of a rotating type, where the burner sleeve revolves at 5,000 rpm. While mazut has a heating value of only 10,500 - 11,000 kilocalories (Kcal) per kilogram (kg), and a sulphur content as high as 3%, its temperature must be constantly monitored and maintained at 90° C for effective operation. When the fuel is trucked in, its core temperature is approximately 60° C, and is reheated to 90° C before being fed to the burner. Natural gas, when it is used, is fed into the burner with 2.5 bar pressure. The pressure in the combustion chamber is equal to 0.8 to 1.0 bar.

Two fans service these boilers, one which is a forced-draft model delivering 80,000 m³ of air per hour, and the other an induced fan, handling 160,000 m³ per hour of flue gas. The pressure drop across the boiler is currently 5 bars, although the design specifies an optimal pressure drop of no more than 3 bars. Inlet water temperature is 70° C, while outlet temperature is

maintained at 135° C to avoid scale formation within the pipeline as the quality of the water supply deteriorates. Design temperature limits on these boilers are 150° C. The pressure in the tube side is 17 - 18 bar, with a flow rate of 1,250 - 1,400 m³ per hour. The temperature of the flue gas entering the stack is maintained at 180° - 190° C for mazut, and 160° C for natural gas.

All four boilers within the New Western Boiler House were manufactured in Russia, and the operating crew is quite satisfied with their performance. This facility, however, has experienced problems with tube-side internal fouling, and plant staff have unsuccessfully attempted to find instruments capable of detecting deposit buildup within the tubes. Currently, they detect these deposits only after the tube is broken by listening to changes in the sound waves that are created when water changes to steam.

Boilers are normally operated with an estimated excess air ratio of 1.2, while the design value is 1.08. To date, there is no instrumentation available to monitor the oxygen (O₂), nitrogen oxide (NO_x), or sulfur dioxide (SO₂) content of the exhaust gas. As a result, the combustion efficiencies of these boilers are far from optimal. The operations chart for Boiler KVGМ-100 at the New Western district boiler house in Table 7 on the following page presents current operating conditions.

Steam Boiler Area

Insulation on older boilers within the system was originally installed manually and is in generally poor shape. This insulation was manufactured from asbestos, and there is currently no program to date to replace this type of insulation. Insulation on newer boilers, however, is in much better condition and manufactured from more modern materials.

Boiler Control Room

More than 50% of the measurement and control instruments in the boiler control room were removed from the panel for calibration during the energy audit. It was anticipated that by late summer 1992, testing and re-calibration on those instruments should be completed and the instrumentation re-installed.

Table 7. Operations Chart for Boiler KVGM-100-150C at the New Western District Boiler House.

Parameter Name	Heat Load (Gcal/hr)			
	50	60	70	80
1. City water consumption (t/hr)		1,420		
2. Water pressure at boiler input (Mpa)		1.85		
3. Water pressure at boiler output (kgf/cm ²)		13.4		
4. Water temperature at boiler input (°C)		55		
5. Water temperature in the boiler (°C)	35	42	49	56
6. Temperature of escaping gases (°C)	145	155	180	210
7. Mazut temperature (°C)		85	90	
8. Mazut pressure (Mpa)	0.092	0.115	0.145	0.175
9. Air pressure behind the blower fan (kgf/m ²)	90	145	220	280
10. Oxygen content behind the boiler (%)	3.7	3.2	2.9	2.7
11. Content of three-atom gases (%)	13.6	14.0	14.2	14.4
12. Excessive air behind the boiler		1.2	1.14	
13. Boiler efficiency (%)	92.3	92	90.0	90.7

NOTES: 1. The chart was completed when the outside air temperature was +2° C
 2. Gate valves for secondary air before the boilers are opened fully.

Under normal operating conditions, all instrumentation in the control room is operated manually, with the exception of the safety and protection systems. At the time of the audit, instrumentation installed in the boiler room measured:

- Heat consumption through the boiler;
- Water temperature at both the boiler inlet and outlet;
- Consumption of natural gas;
- Temperature of exhaust gas;
- Water pressure at both the boiler inlet and outlet;
- Oxygen and carbon dioxide content of hot water;
- Air and gas pressure in front of the burners; and
- Vacuum in the boiler combustion chamber.

3.1.3 Distribution System

The Central Thermal Distribution Station is the heart of the distribution system. As shown in the flow diagram presented in Figure 10, this station has seven outgoing lines and seven return lines to supply the district heating network. Two lines from TES-2 which supply make-up water are fed by water intake pumps of the New Western Boiler House and mixer station.

Five of the seven return lines connected to the intake pumps of the New Western and Southwestern Boiler Houses were designed for reheating; similarly, the remaining two lines are fed to the Western Boiler House for this purpose. Heated water from the three boiler houses plus that from TES-2 is delivered through all seven lines to the mixing station for distribution to the network. To maintain and regulate hot water temperature within the requisite range, a bypass line from the discharge header of the supply line pumps directly to the mixing header, circumventing the boiler houses.

When sources fail to supply the required feed water to the Western Boiler House, AHSE relies on a backup water-treatment plant which supplies water at 1,000 m³ per hour. To balance water circulation and maintain stable operations, storage tanks which currently hold 40,000 m³ are also available within the network. These tanks are filled at night when demand is low, and discharged during peak demand (daytime) hours.

Insulation

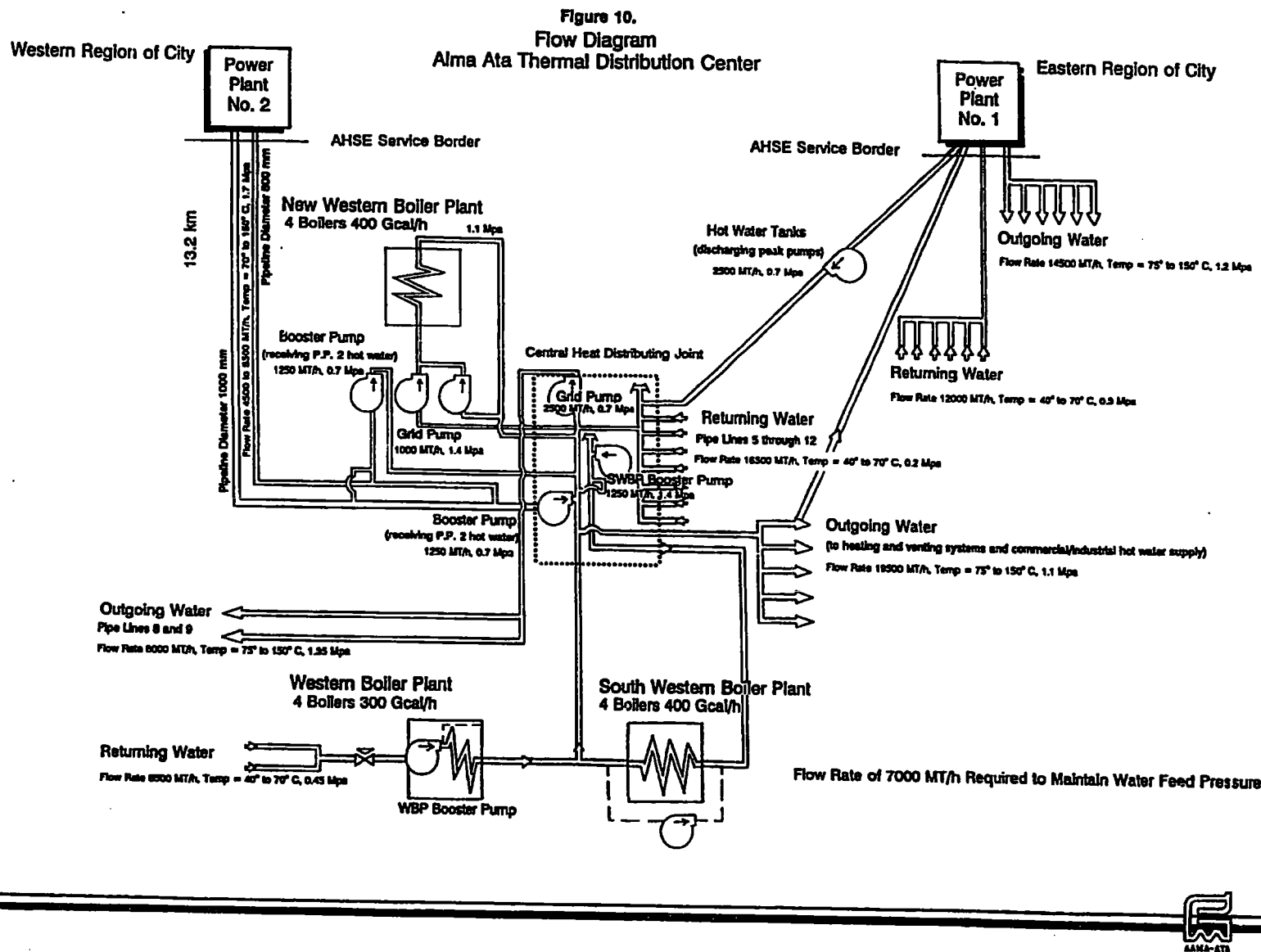
Insulation used throughout the distribution system is manufactured from mineral wool incorporated with a metallic net covering to make the insulation rigid. The service life of pipelines insulated in this manner is estimated to be 25 years; at that point, pipelines are replaced in sections of 8 kilometers each.

Corrosion resistance is assured through the application of polymeric paint on exterior surfaces. Recently, the system received improved coatings for the pipelines that have previously only had military applications.

Surface temperature readings of the pipeline insulation taken by the IRG Energy Audit Team were not unacceptable, even though the general condition of this insulation was less than desired. The basic problem is that insulation is poorly attached to the pipes, creating open air pockets between the insulation and the pipelines. This then results in lower insulation efficiency and ultimately in heat loss during the distribution process.

System Leakages

The total length of the pipeline distribution system at AHSE is 240 kilometers, with individual pipelines ranging from 300 to 1,000 mm in diameter. These pipelines are manufactured of carbon steel at a design pressure of 25 bar, and range in age from 1 to 30 years. Of the total 240 km of pipelines, only 43 km of these are above ground. Underground pipelines are located in culverts, with concrete chambers at major junctions. Pipe insulation is not protected against underground water anywhere within the system.



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Discovery of leakages in underground pipelines is of primary importance to any distribution system; however, AHSE has no instrumentation to detect such leaks. Currently, distribution leakages are estimated at 500 m³ per hour from a total hourly circulation rate of 23,000 to 30,000 m³. This loss ratio represents a much larger percentage of total heat loss relative to the losses due to poor insulation. Furthermore, flooding around the pipelines through such leakages contributes to additional heat loss since it adversely affects the insulating ability of the mineral wool. Early detection of leakages should be a priority throughout the entire system.

Controls

The control system within the distribution facility includes both temperature and pressure equipment. All equipment is operated manually, with the exception of emergency and protection devices. The response time of the manual controls is often slow to the extent that corrective action is invariably too late. By AHSE's own estimation, some 3 - 5% of total energy inputs could be conserved if automatic control systems were installed to replace the manual controls. Upon evaluation of data, the IRG Energy Audit Team suggested actual savings could be even higher.

The pipeline network is designed in such a way that any major break in the hot water loop would interrupt the entire distribution system. This type of breakdown could become quite serious if it happened during the winter heating season, and management staff consider improvement in the reliability of this system to be a top priority. As a result, many solutions recommended by the IRG Energy Audit Team are designed to help accomplish this important task.

3.1.4 End User Customer Systems

The following sections present information collected during the representative slice audit of end-use (customer) systems conducted by the IRG Energy Audit Team. These include discussions on the industrial, commercial, and residential facilities selected, and includes data on each facility's insulation, system leakages, and monitoring and control facilities, as well as temperatures taken throughout the system.

1. Industrial Customer: Almaty Carpet Factory

The Almaty Carpet Factory was selected as a representative industrial customer for the April 1992 audit by the IRG Energy Audit Team. This factory, located on a 3-hectare lot within the city, was founded 55 years ago and is the only carpet factory in Kazakhstan. As of April 1992, the factory employed approximately 1,000 workers, 90% of whom were women. The majority of plant staff work in two main shifts, although some shops operate on a three-shift basis. Current production at the plant averages 5,000 m² of finished product per day.

The carpet factory is an integrated operation: raw wool is processed and carpets are produced within this facility. Chemical fibers, also used in the plant's products, are purchased primarily from domestic sources. Product quality has been recognized at several international exhibits,

and buyers from other parts of the world have begun showing considerable interest. Export sales have already been made to Iran, and negotiations are underway to begin exporting to Korea and Germany.

Before 1984, all carpets were woven by hand. Since that time, machines have been incrementally incorporated in the process, and are now used throughout the production and assembly lines, replacing "hand made" processes entirely. Machines used in this factory were manufactured in East Germany, Poland, and Kazakhstan.

In addition to space heating and office consumption, the carpet factory utilizes hot water in its process for dyeing natural and synthetic fibers and for air-conditioning its fabric treatment shops. Hot water is purchased from AHSE at 0.7 Mpa pressure and 70° C. At the contracted levels presented in Table 8, annual consumption for hot water would appear to be 5,526 Gcal/year. However, actual hot water consumption was only 3,002 Gcal in 1991, with a steam consumption level of 3,703 Gcal.

Table 8. Contractual Hot Water Demand - Almaty Carpet Factory

Function	Hot Water Demand (Gcal/hour)
Space Heating	1.422
Shop Conditioning	0.694
Process Hot Water	1.286
Technical Hot Water	0.542
Total Hot Water Demand	3.944

It was unclear how the carpet factory is billed for its hot water and steam usage, since the AHSE does not have a meter at the "gate" of this facility. It seemed that billings were based on estimates of consumption made by AHSE engineers.

Steam is also used in the dyeing solution and for drying carpets when the latex backing is applied. This steam is supplied by TES-1 at 1.2 Mpa pressure and 190° C, with a condensate return at the facility of 45%. The contractual demand for steam is 2.8 Gcal/hour, with approximately 9,953 Gcal of steam consumed per year, with a minimum condensate return of 34%.

Insulation

Insulation for the above ground portion of steam and hot water piping within the factory complex is manufactured of rock wool. This insulation is covered with either rigid sheets of chemical fiber that have been coated with a thin layer of aluminum or with flexible [uncoated] sheets of

the same fiber. The IRG Energy Audit Team observed many sections of both the steam and hot water pipes that were poorly insulated. Most visible pipelines had insulation that was partially or completely exposed to the elements, with the covering sheets missing or loosely attached.

Leakages

There were no visible signs of hot water leakages within the plant; this does not mean, however, the plant is leak-free. At the time of audit, the heating season had drawn to a close, and most of the hot water lines used for space heating were inactive. Consequently, leakages were not likely to be evident. There were several places, however, where IRG Energy Audit Team members observed steam escaping within the processing and drying shops. This situation appeared to occur in areas where steam is injected into the solution tanks to keep the temperature regulated, but should be examined more closely.

Controls

At both the hot water and steam receiving station, flow rates, temperature, and pressure levels are metered. Instruments in this station are outdated, and pie charts are frequently used to diagram temperature and pressure measurements. Technicians in the receiving station record these data manually every hour, and manually adjust flow rates of both the steam and hot water feeding lines based on the demands of various shops. These demands are communicated to the receiving station via telephone.

Air Conditioning within the Fiber Shops

Since the maintenance of a constant level of humidity is critical in handling wool fibers, two space conditioners are located in the spinning and weaving shops. One conditioner serves as a humidifier, with the other as a de-humidifier. These two appliances each consume 55 kwh of electricity daily, or approximately 10% of the 4 million kwh consumed by the entire plant each year.

Efficiency Measures Undertaken to Date

Management at the factory have always considered issues related to energy efficiency, but the equipment and processes used in this factory are so outdated that substantial capital would be required to bring the factory up to modern standards. In light of current cash shortages, it is unlikely the plant can become highly energy efficient.

For example, the two space conditioners described above were almost 20 years old at the time of the audit. If high-efficiency appliances were used in place of these conditioners, some 30% of total power, equivalent to 0.6 million kwh per year, currently used to operate the appliances could be saved. Using the average U.S. electricity rate of \$0.06 per kwh, savings would equal \$36,000 a year. However, when the dollar value of savings is calculated at the April 1992 tariff rate of less than \$0.01 per kwh, savings would only total \$6,000 annually. Thus, the payback

period would be lengthy, making it an unwise investment with the electricity tariff so low.

At one time, plant management seriously considered constructing a diesel-fired generation station to produce their own electricity since several times during past winters, the plant was forced to shut down due to power shortages. If the plant had its own diesel generator as a backup, such power shortages would have minimal effect on production. However, the capital cost of this project was prohibitive.

2. Commercial Customer: Pepsi-Cola Bottling Plant

The Pepsi-Cola Bottling Plant was selected by AHSE for inclusion in the April 1992 energy audits as a typical commercial end-user within the distribution system. This plant was established in 1982, and uses equipment manufactured in East Germany. It is now a branch of the Pepsi-Cola plant in Moscow, although it was operated as part of a brewery complex until early 1992. At that time, it became a private enterprise and was purchased by the employees. Although plant equipment is quite old, an ample supply of spare parts is available from the Pepsi-Cola Authority in Austria. The local bottling plant pays for these parts by underwriting local Pepsi advertising.

The plant currently operates on one shift due to the shortage of glass bottles. Since there is no such factory in Kazakhstan, bottles are shipped in from Russia. With the current political uncertainty in inter-republic relations, this plant is often unable to receive all the bottles it orders, and moreover, must absorb the cost of approximately 2% breakage per shipment. Thus, the lack of reliability in the supply of bottles combined with the cost/loss of 6 million bottles per year is a significant problem.

As mentioned above, the shortage of glass bottles is the reason the plant has limited production to only one shift per day. Furthermore, this situation has caused the plant to institute the practice of bottle recycling. As of the time of audit, there was no plan to use plastic bottles as a substitute, although this alternative should be considered in the near future if the Russian glass supply situation does not improve.

Steam and hot water consumption are important components of the plant's resource costs. Hot water is used primarily for space heating and internal office consumption, while steam is used for controlling the water bath temperatures in the bottle washing machine. Technological steam for the brewery compound is purchased from TES-1 at 1.2 Mpa pressure and 190° C, with a condensate return of 60%. Conversely, hot water is purchased from AHSE at 0.7 Mpa pressure and 70° C.

The consumption level of these two resources is metered only at the main receiving station for the compound. Thus, it is important for the plant to implement its own metering system to monitor steam and hot water usage. To this end, a substation was built and flow meters ordered. The plant was expected to have its own steam and hot water meters in place by the summer of 1992.

Since this metering was only accomplished at the brewery compound at the time of audit, data on energy consumption at the plant and contracted demand are estimated. For example,

contractual demand for steam within the compound is estimated at 8.4 Gcal/hour, with an annual consumption of 30,820 Gcal, and a minimum condensate return of 60%. Consumption for steam in 1991 was 31,208 Gcal, based on estimated billing records. Estimated consumption levels for the Pepsi-Cola Plant as calculated to determine contracted loads were 1.58 Gcal/hour (389 Gcal/month) for steam and 2.158 Gcal/hour (1,431 Gcal/month) for hot water. Electricity use at the bottling plant is estimated to be 220,000 Kwh/month.

Contractual demand for hot water by function is presented in Table 9.

Table 9. Contractual Hot Water Demand - Brewery Compound

Function	Hot Water Demand (Gcal/hour)
Space Heating	2.000
Shop Conditioning	1.290
Process Hot Water	0.530
Total Hot Water Demand	3.820

On an annualized basis, hot water consumption would appear to be estimated at 10,298 Gcal. In 1991, however, actual consumption was only 8,595 Gcal.

Insulation

Insulation of pipelines leading to the receiving station at this plant appears to be in better condition than that of the carpet factory. Pipeline insulation between the receiving station and the Pepsi-Cola substation was in average condition. IRG Energy Audit Team members did not observe any sections where insulation was missing or obviously damaged.

Leakages

The Energy Audit Team members saw no signs of hot water or steam leakages within the plant during the audit. However, the use of hot-water space heating was being minimized as the heating season nearing its end.

Controls

Since steam demand is steady, there is no need for hourly dispatches regarding demand nor an elaborate control system at the substation. Instruments that are currently in place to measure and record temperature and flow rates are sufficient for plant requirements. Portable

contact thermometers and infrared thermometers, purchased as part of the A.I.D. Energy Efficiency and Market Reform Project, were used during the audit by AHSE technicians to measure the surface temperature of inlet steam pipes at the substation.

Steam is primarily used to control the temperature of cleaning solutions in the bottle washing machine. Water to be used for the bottle-washing process must first flow through pipelines that have been fitted with a filtering device. The first bath, which contains the alkaline solution, is kept at 70° C. The temperature of the second bath is maintained at 50° C, while the third bath containing the rinse water, remains at 30° C. This is the only place in the plant where steam is used for process purposes.

All machinery within the plant are made of stainless steel, and must be cleaned with a chlorine-and-water solution each night to disinfect them for the next day's use. Cleaned bottles are then chilled with water cooled by an ethylene glycol chiller kept at 4° C, before being filled with carbonated water. This chiller accounts for a large portion of total electric power consumption at the plant.

Water quality is vitally important in making any soft drink, and Almaty has an advantage in having clear mountain water readily available. Even so, this water must be treated with an ion exchanger to ensure quality, and an analysis of incoming water is conducted in the laboratory every hour. In addition, samples are sent each month to the Pepsi authority in Austria for overall quality control, and a team from Austria visits this plant quarterly to monitor the quality of the entire production process.

Efficiency Measures Undertaken to Date

At the time of audit, there was no program in place to improve the energy efficiency of the bottling process, since the first priority for plant management has been to establish record keeping and cost accounting procedures to track expenses by components. To properly implement the cost accounting system, however, the plant must meter and monitor energy consumption (i.e., steam, hot water, and electricity), a major component of total production costs. Until this system is established, management staff will be unable to determine whether the price negotiated with the government will yield reasonable profits.

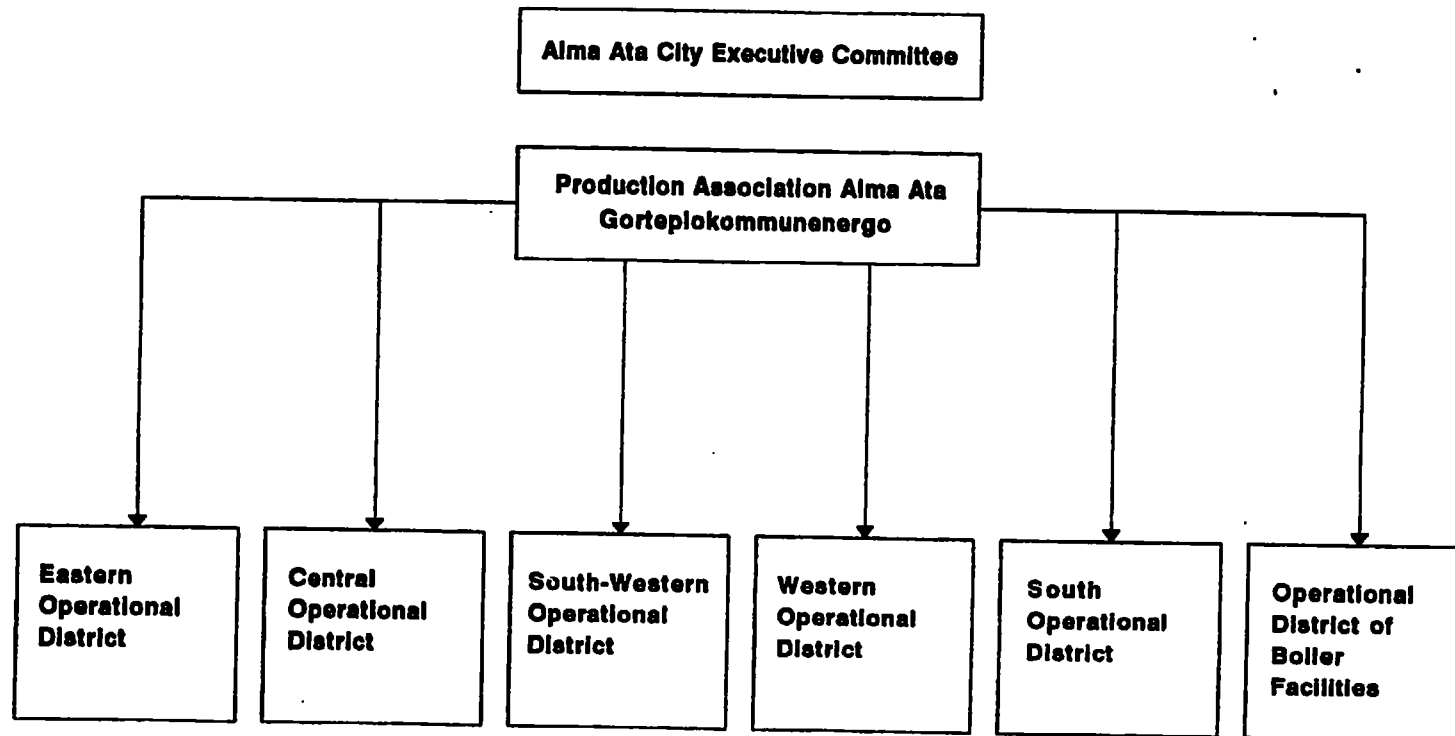
Management staff realize that the price of product inputs will continue to increase, and that they must be ready to raise sale prices accordingly. For example, the thermal energy cost to industrial users in 1991 was 11 rubles per Gcal, increased to 182 rubles per Gcal in early 1992, and is expected to rise again in the near future.

3. Residential Customer: Almaty Municipal Authority

Almaastagorteplokkommunenergo (AGTKE or Almaty Municipal Authority) was selected as the representative residential system due to its significant role in distributing thermal energy to residential, as well as commercial, customers. Controlled by the executive committee of the City of Alma-Ata, it employs approximately 1,500 people. The organizational chart of AGTKE is depicted in Figure 11.

Figure 11.

Alma-Ata Municipal Authority Organizational Chart



NOTE: Each operational district has 5 production sections.

AGTKE is the largest wholesale customer of AHSE energy, purchasing approximately 70% of the hot water distributed to service 600,000 to 700,000 residents. This system is divided into two regions: one served by hot water purchased from AHSE - part of AHSE's circulation loop - and the other provided by AGTKE's own hot-water generation stations. The circulation rate within this loop is 5,400 m³ per hour, and to function properly, it requires a make-up water flow of 1,000 m³ per hour. This creates a demand for thermal energy from their boilers of approximately 1.4 to 1.6 million Gcal of the 5.5 million Gcal they receive annually from AHSE.

All AGTKE boilers were manufactured in Russia, with their performance guaranteed by the factory. The capacities of these boilers range from 1 MW to 40 MW, and are fueled either by natural gas (97% of those used), coal (2%), or Mazut (1%). There are also three major boiler stations with a thermal capacity of 160 MW each. The overall efficiency of these boilers (total heat input versus total heat output) was plotted against boiler loads, and falls in the 90% range. Combustion efficiency of the boiler stations was also reported to be approximately 90%. This level of efficiency is tested at least once every three years, with testing done after any major repair work.

Pumps utilized by the system are constant-speed models. Three booster pump stations are used to overcome the differences in elevation, which vary from 0 to 300 meters within the system. More than 800 km of pipelines connect pumps of different sizes, often running parallel to each other to provide combination levels of supply, and attempting to match seasonal variations in the hot water load required. All underground pipes within this system are placed within concrete culverts. The oldest pipelines in the system date back 30 years, but a new AHSE maintenance program calls for the replacement of approximately 25 km of pipelines each year to rehabilitate this network.

Many of the peaking tanks and boiler housings are insulated with asbestos cement coated with a protective sealer to prevent the dispersement of asbestos fibers. While this method is sufficient to meet current government regulations, insulation utilized on the hot water tanks is constructed of rock wool, and is secured by a thin layer of sheet metal attached to the tank wall by tie bars which are welded on the wall itself. Management is quite concerned about the use of this method as piles of loose rock wool are often present throughout the station yard.

Leakages

Hot water leaks present one of the biggest problems in the day-to-day operations of AGTKE. Although there is a central dispatch center to control and regulate the supply and demand of hot water, there are no flow meters at the customer site. In addition, AGTKE staff only have access to simplistic devices to monitor pressure changes along the pipeline; thus, leaks are often undiscovered until they have become serious. Instruments that can detect water leaks early will not only be cost effective, but will also increase the reliability of the system.

Controls

There are no automatic controls on the distribution loop. The receiving stations only monitor temperature and flow rate, and these records are not transmitted or accumulated anywhere; billings to customers are based on estimates calculated by the engineers. A water-ejector system is also housed at the receiving station which circulates hot water within the building; a flow diagram of a typical substation with such an ejector system is presented in Figure 12. Although some 400 of these ejector systems are already installed, an additional 900 are needed.

Energy Efficiency Measures

Plant management is anxious to improve overall energy efficiency on the supply side, and are working to keep all boilers within the system in top condition. On the consumption side, however, they are also a large part of the current inefficient and wasteful system. Energy costs have previously been heavily subsidized by the government so there is little incentive for end users to consider conservation, especially when customers are not metered and billed based on individual use. As a result, there have been few measures attempted by management to conserve thermal energy on the consumption side.

3.2 General (Total System) Audit

Energy losses within the district heating system are primarily caused by:

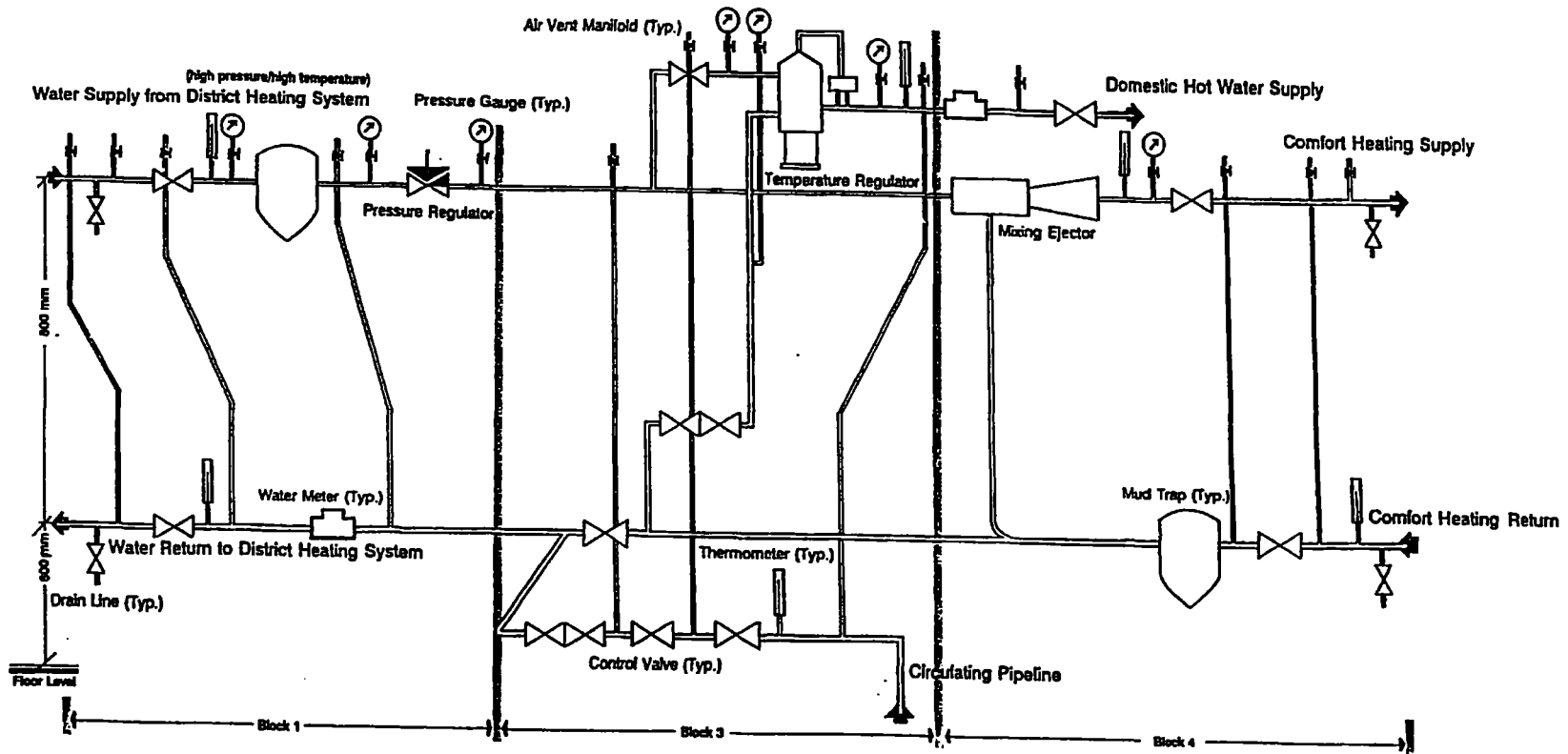
- Water leaks. Since both AHSE and AGTKE are open-loop heating systems, it is difficult to separate those water losses due to leaks from those due to domestic consumption. According to AHSE officials, water losses within the system due to leaks are estimated to be approximately 500 m³ per hour under normal conditions, almost 10% of the total make-up water of 7,500 m³ per hour.

Considering the age of the pipelines, and the fact that booster pumps must work to overcome the differences in elevation - thus adding pressure within the pipe - actual losses may well be even higher.

Water leaks are identified by either completing a visual inspection; measuring the ground surface temperature with infrared thermometer/thermalvision; monitoring pressure drops between sections; or analyzing the flow rate between sections.

- Failure to meter individual energy usage (industrial, commercial, and residential). Approximately 10% of the industrial customers in Kazakhstan have the orifice-type flow meters necessary to measure hot water/steam flow rates; all other customers are unable to measure individual heat consumption. Customers are generally charged a flat rate for heat, resulting in no incentive to conserve heat; many regulate the temperature of a room by opening a window, even in the middle of winter. One research institute in Poland, where such behavior is common, estimated that as much as 25% of the thermal energy delivered by the district heating system there was lost in this manner.

Figure 12.
Flow Diagram
Heating Sub-Station Scheme
Multi-Unit Residential Building



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- Inadequate insulation. Damaged or inadequate insulation around exposed pipelines can be easily detected by using an infrared thermometer.
- Throttling of constant-speed pumps. Constant-speed pumps are commonly used in the Almaty district heating system. Often, two or three different-sized pumps are installed in parallel on the same line to service different load conditions. Through the use of these different size combinations, variations in load can be approximately matched with pump-station output. In locations between the combined pumps, however, flow rates are controlled by throttling the water through the pumps, resulting in large energy losses.
- Excessive changes in pressure. Obstructions in the distribution system can cause excessive changes in pressure and waste energy. These obstructions can be accidental, gradual, or the result of faulty design (such as inadequate valves, undersized pipelines, or too many fittings or bypasses).

4. FINDINGS AND RECOMMENDATIONS

4.1 General

This section presents the overall findings and recommendations of the IRG Energy Audit Team members.

4.1.1 Mixing Station

The heart of the Almaty District Heating System is a mixing station comprised of 18 large water mains, each 1,000 mm in diameter. This mixing station receives fresh, heated make-up water and recirculates this from the loop; it also adds make-up thermal energy through its own boilers to provide the district's total hot-water supply. There are, however, no automatic instruments to monitor and balance the heat flow of this water. This lack of automated equipment represents a serious drawback for the distribution system and presents a major risk for the reliability of the system as a whole.

4.1.2 Boilers

Few boilers are equipped with oxygen analyzers to monitor excess air flow; this is an area in which combustion efficiency can be greatly improved. The use of these oxygen analyzers is especially critical when boilers are capable of using more than one type of fuel as in the case of the AHSE complex, where boilers can be fired by either natural gas or mazut.

4.1.3 Insulation

Insulation around the pipelines was found to be in poor condition in many sections, and in several instances, missing altogether. One major problem is the capability to securely attach insulation onto these pipelines.

4.1.4 Instruments and Measurements

A minimal number of instruments and automatic controls are available in the district heating system. Those that are available are quite old, either needing repair or re-calibration. Without instruments which function properly to monitor and record such essential variables as flow rate, temperature, and pressure, it is difficult to accurately determine balance measurements and conduct effective energy-efficiency analyses, on which overall plant performance should be based.

4.1.5 Cost Accounting and Performance Criteria

Although management staff are knowledgeable about the use of capital-cost analyses - as indicated by the previous emphasis on new construction - the lack of modern instruments to accurately measure and monitor heat flows at different levels of the system makes it difficult to complete such a detailed analysis. There is also a serious lack of plant performance criteria based on operating costs (and savings); management should institute such a directive.

4.1.6 Long-Term Energy Outlook and Policy

One factor which may make focusing on energy conservation and efficiency issues difficult is that government pricing subsidies are complicating the transition from a centralized to a market-based economy. The current energy situation in Kazakhstan bears strong similarity to that of Eastern and Central European countries in the sense that energy resources have been dependent on other republics [within the NIS].

A second factor complicating this shift is the question of a common currency among the NIS republics (i.e., Rubles). Whether the NIS remains an economic commonwealth sharing the same currency is uncertain at this time; the fundamental desire of each republic, however, is not to be economically dominated by Moscow. Based on this scenario, it is simply a matter of time before the formation of individual currencies within each republic.

Coal represents 50% of Kazakhstan's total energy consumption. The coal has a low Btu capacity, high ash content, and must be transported more than 1,000 km to major population centers. One long-range solution is to develop coal refining/processing facilities close to production sites.

When the resources of the Tengiz and other fields in northwestern Kazakhstan are developed, the country will become a net exporter of oil and natural gas. Until then, however, the country must rely on imports of these fuels, and will be subject to world-market level prices. Electricity and heating energy consumed has been subsidized not only by the Kazakh government but by those republics which have supplied Kazakhstan with inexpensive energy resources for many years.

4.1.7 Underlying Social and Economic Problems

Most industries are currently running in deficit and, subsequently, district heating systems are operating at a loss. As a result, the government is subsidizing industry. Industrial operations want to increase their energy efficiency to cope with existing and/or future price increases. However, improving energy efficiency entails modernizing facilities and implementing new production processes, since current facilities and production methods are already outmoded by Western standards.

Heavy capital investment will be needed to upgrade industries to be competitive in energy efficiency and productivity. Until industry achieves this level of efficiency, it will be difficult to pay for energy at prices approaching world market levels. On the other hand, without the existence

of world market-level energy costs, industry will not attract the necessary capital investment.

4.2 System Slice Audit

This section discusses the overall findings and recommendation of the heat production and distribution segments of the system slice audit.

4.2.1 Concept of Free Market System

There is a strong need to have the middle management of both AHSE and AGTKE learn the simple fundamentals of a free-market system; they are entirely unfamiliar with cost accounting procedures and practices. Many are unaware of the true cost of energy resources, and what the market price of thermal energy should be. It is also unclear if management fully understands the far-reaching effects of world price levels.

Their current, fundamental concerns focus on a mixture of price increases and job losses. They need to understand that temporary suffering and hardship are unavoidable during this transition. Recent examples (such as those of the Eastern and Central European countries) should be brought to their attention, and a workshop focusing on simple, practical issues of market economy is badly needed.

4.2.2 Revolutions in Energy Billing

Energy billings to customers are primarily based on estimated averages over the entire population. Even in cases where meters are installed, charges to customers are still based on estimated use. Government subsidies and ownership promoted customer insensitivity to such billing practices; to make customers liable for the amount of energy they consume, the billing system will need to be overhauled. This includes the widespread installation of heat meters, and the subsequent hiring and training of meter readers. Without a rational billing system in place, it will be difficult to implement energy conservation measures.

4.3 Equipment - Low Cost

Both the heat production and distribution segments of the IRG energy audit are covered by the following equipment recommendations. A list of low- and medium-cost equipment to be procured was also provided by specialists from both AHSE and AGTKE and appear in the sections below.

4.3.1 AHSE Equipment Recommendations

For the New Western Boiler Plant:

- A microprocessor. This processor will measure and monitor signals of flow and heat rates of different thermal production boilers, hot water distribution lines and transportation pumps, and automatically control and manage the supply to and demand from the mixing station.
- Mechanic suspension or chemical dispersing agent. This will improve the combustion efficiency of mazut.
- A refining system. This system will reduce the sulphur content of mazut.
- A gas analyzer. This will monitor pollutants in the exhaust gas. The German made Testo-33, 452, or its equivalent, is recommended.
- A system to control the oxygen content of the hot water.
- A non-contact type of water flowmeter. This flowmeter should be capable of monitoring water flow ranging from 5,000 to 50,000 m³ per hour.
- A flue gas oxygen analyzer. This analyzer will regulate the amount of excess air for optimal combustion efficiency of the five hot water boilers at the New Western boiler house. Using one boiler at the New Western boiler house as an example, 154 MT of fuel oil can be saved in one year, equivalent to 1,004 barrels. Assuming a fuel oil cost of US \$20 per barrel, the annual savings per boiler would be US \$20,080, and together, five boilers could save more than US \$100,000 a year. Since the cost of analyzers to monitor five boilers is approximately US \$35,000, the payback period would be 4 to 5 months.
- A liquid level indicator. A 12-foot ultrasonic model to be used on the Mazut storage tanks.
- Flowmeters. Flowmeters are needed to monitor both (a) the natural gas line, and (b) the fuel oil supply line.

For industrial users:

- Heat meters. These meters will measure and control the quantity of heat used in space heating, ventilation, and utility consumption of an individual customer. Such signals can be transmitted to remote central stations. These meters should have a range of 500 to 3,000 m³.

For residential users:

- Heat meters for the local mixing house. These meters will measure, record, and control the operations of the mixing house, and should range from 500 to 3,000 m³.
- Residential heat meters. These will serve to measure, record and control the space heating and hot water utilization of one section of a residential building.

For overall telemetering and data acquisition:

Two projects aimed at the remote acquisition of data on telecomplex "Granit" have been implemented at AHSE. Due to insufficient computing power of the central computer (Electronika-60), the following functions could not be carried out:

- * thermal energy generation audit;
- * power consumption audit;
- * local computing network;
- * connection with supervisory level;
- * information imaging (graphic presentation) at central terminal;
- * automatic control of the boiler house regime;
- * automatic control of the heating system regime, etc.

To realize these functions, the following automated data acquisition and control system is proposed for the district heating system. A primary data collection unit should be installed at the hot water boiler or pump station, and collected data initially transmitted to the district boiler house control board, then to the AHSE dispatching center, and subsequently to service departments and other users.

To implement this system, the following computer-facility configuration is proposed:

- a. A local controller based on MP80186 with automatic central processor for 64 channels to collect telemeasurement readings; a binary signals adapter for 120 channels to capture telesignals; a telecontrol adapter for 128 channels; and a RS-232 juncture adapter to transmit data to the boiler dispatcher's PC.
- b. A local network consisting of three PCs (IBM PC/AT-286) to perform the following functions at the Mixer station:
 - The first PC will acquire, store, accumulate, complete graphic imaging, and retransmit acquired data to/from local controllers;
 - The second PC will monitor the working regimes of boilers and other equipment based on information obtained from the first PC; and
 - The third PC will provide parallel operation as well as serve as a reserved backup of the first two PCs.

- c. A local network developed from an IBM PC/AT-286 or 386 PC and two work stations (IBM PC/RT):

The first station (IBM PC/AT-386) would store, accumulate, image and retransmit data acquired by computers in the local and district boiler houses;

The second station implements the working regime of the boilerhouses, pump stations, and other equipment based on information obtained from the first station; and

A PC of the local network is located within AHSE to automate their operation.

To accomplish this program fully, 4 local controllers, 1 IBM PC/AT 286 computer, 2 IBM PC/AT 386 computers, 2 IBM PC/RT work stations, 52 modems, and 20 local network adapters. There are also options to consider if this recommendation were implemented as follows:

Option No. 1. To accomplish one part of this program, 4 local controllers, 1 IBM PC/AT 286 PC, 1 IBM PC/RT work station, and 2 modems would be needed.

Option No. 2. To implement another part of this program, 3 local controllers, 6 IBM PC/AT 286 computers, 2 IBM PC/RT work stations, 3 modems, and 8 local network adaptors would be required. To put this program into effect, the necessary software should be provided in addition to the hardware indicated.

- d. Parameter tracing system for the heat consumption regime.

4.3.2 AGTKE Equipment Recommendations

- Gas analyzers. These would be used to measure O₂, CO, CO₂, NO_x, and SO₂ in the exhaust gas.
- Hot water flowmeters. These flowmeters should have the capability to withstand pressures of up to 1.6 Mpa, 150° C, and should range from 10 to 300 m³ per hour.
- Hot water heat meters. These should be able to withstand pressure of 1.6 Mpa, temperatures up to 150 °C, and water flows from 0 to 10 Gcal/hour.
- Contact resistance thermometers. Five (5) sets are needed, each with a measuring range between -50° and 200° C.
- Infrared thermometers. Two sets are needed, each with a measuring range between -50° and 500° C.

4.3.3 IRG Energy Audit Team Recommendations

The IRG Energy Audit Team developed the following list of recommendations for the purchase of low- or medium-cost energy efficiency equipment. This list is presented in order of priority.

- Infrared and/or contact thermometers. Such simple, inexpensive devices are useful to detect defective pipeline insulation, as well as to locate severe heat/hot water leakages in underground pipelines. Since it is difficult to detect small leaks in a large pipeline network, Team members recommend the use of hand-held infrared (IR) thermometers to measure the surface temperature of the ground where pipelines are buried. These thermometers are priced between \$500 and \$1,000 each.
- Pipeline insulation fastener system. Because of defective fasteners, many above and underground sections of pipeline have either missing or ineffective insulation.
- Pitot tube type hot water flow meters. These devices are easy to use and their accuracy good. Such instruments would permit readings of water flow rate, accounting for half of the information provided by heat meters. With this device, flow rates could be measured at sufficient points within the distribution system. Consequently, significant leaks in the system could be located within a brief amount of time.

When readings are taken in sufficiently small time intervals, the total amount of hot water passage can be estimated with reasonable accuracy, providing a basic quantitative analysis for hot water consumption within a range of boundaries. If a temperature differential between the feed and return line can be estimated with some degree of accuracy, then the heat consumption rate can be computed.

- Heat flow meters and temperature indicators. These are medium-priced items which, when used in conjunction with Pitot flowmeters would provide information on heat consumption rates between any supply and return hot water line. The IRG Energy Audit Team strongly recommends heat meters be installed for individual customers or groups of customers (such as those in apartment complexes), so individuals may be charged for actual consumption. Suitable meters for hot-water systems are available in the US for \$800 to \$1,800 each, based on the size of the heat load to be measured.

The Team also suggests a joint venture be set up in Kazakhstan to manufacture these heat meters for local markets.

- Stationary or portable gas analyzers. Hand-held oxygen and stationary CO analyzers manufactured by Bacharach are highly recommended as an inexpensive way to determine the combustion efficiency of boilers. In addition, portable gas analyzers (Enerac 2000, or Bacharach 300) are medium priced instruments which monitor oxygen, CO, CO₂, SO₂, and NO_x. They not only calculate combustion efficiency, but also monitor other air pollutants, and perform well in dust-free environments.
- A basic monitoring and control system for the AHSE mixing station. On the advice of experts from Honeywell, a basic heat flow monitoring and recording system is proposed which is capable of monitoring incoming heat streams (make up), outgoing heat streams

(total heat in-flow to the loop), and return streams from the loop. A total of 18 monitoring stations would be installed to allow measurement of hot water flow rates, temperatures, and heat flow rates of all major streams. This system would be the foundation upon which other control systems could be built.

- A demonstration heat input regulated system for a residential customer in AGTKE district. With experts from Honeywell, a basic heat flow monitoring, recording and regulating system is proposed. This system would cover 40 to 68 individual apartments in one building, where each apartment's radiator would be thermostatically controlled.
- An automatic system for the pump stations. IRG recommends an automatic system installed with funding from USAID. In the AHSE and AGTKE distribution systems, where more than 100 pumps are installed providing a total electricity load of 90 MW, a 10% savings can be achieved through the use of variable speed pumps; this savings translates into a reduced consumption of roughly 45 million kwh per year. At a cost of \$0.06/kwh (the average U.S. price in 1961), savings could reach almost US \$3 million annually.

4.4 Replication Potential

This section discusses the replication potential of these recommendations at the system and national levels.

4.4.1 System Level

Heat Production

- Combustion gas analyzers can be recommended for all four district boiler houses in the AHSE system and three district boiler houses in the AGTKE system. Portable analyzers can be utilized extensively in small boilerhouses throughout the city.
- The basic monitoring and control system for the Mixing station will eventually be part of the microcomputer control system which includes the automatic regulation of individual boilers. Such systems can be extended to cover all district boiler houses.
- A refining system to reduce the sulphur content of the mazut is too complicated and expensive to implement in this project. Even though a decision must be made whether to treat the fuel or to treat the flue gas, either option is too expensive to undertake at this time.
- Although an oxygen scavenger is commonly used in industry, locating one which could function in an open system (i.e. treated water suitable for drinking) is hard to find since most industrial units are manufactured for closed systems. The amount of water to be treated (7,500 m³ per hour) is also an indication that such a system would be very costly to set up and expensive to operate.

Distribution Systems

- Pressure, temperature, flow, and heat meters suggested earlier are badly needed throughout the distribution systems, as well as for individual customers, (commercial, industrial, and residential) to ready them for new billing procedures. AHSE and AGTKE staff need them to trace water leaks, measure pressure balance, monitor heat balance, and to evaluate the performance of each section of their network.
- Contact and infrared thermometers are useful to trace heat leaks within pipeline insulation and hot water leaks of above and below ground pipelines anywhere in the networks. They are also useful to detect the potential bearing failure of water pumps in the booster pump stations.
- Pitot tube flow meters and pressure gauges at strategic locations are necessary to monitor general performance of the local sections, as well as in tracing the source of water hammer effect, and helping to eliminate such problems.
- Pipeline insulation fastener systems should be useful to all networks.

End User/Customer Systems

- Heat meters with varying degrees of sophistication would be useful to all customers within the networks.
- Monitoring and control systems designed for apartment buildings can be applied to commercial and industrial customers as well.

4.4.2 At the National Level

Heat production

Such instruments and control systems would be applicable to other municipal district heating systems within the Republic.

Distribution systems

All recommendations made for AHSE and AGTKE are applicable to other open distribution systems within the Republic.

End-user/customer systems

All recommendations made for customers of AHSE and AGTKE are applicable to other district heating systems within the Republic.

Appendix I

IRG Energy Questionnaire

INTERNATIONAL RESOURCES GROUP
DISTRICT HEATING QUESTIONNAIRE

A. IDENTIFICATION

1. PLANT'S NAME _____ PHONE NUMBER _____
2. ADDRESS _____
3. NAME OF CONTACT, AND POSITION _____
- PHONE NO _____ FAX NO _____ TELEX _____
4. CUSTOMERS AND TERRITORY IT SERVES:

INDUSTRIAL: No OF CUSTOMERS _____;	SIZE _____	Kg OF STEAM/HR
AVG _____; MAX _____; MIN _____;		M OF H2O/HR
COMMERCIAL: No OF CUSTOMERS _____;	SIZE _____	Kg STEAM/HR
AVG _____; MAX _____; MIN _____;		M H2O/HR
RESIDENTIAL: No OF CUSTOMER _____;	SIZE _____	Kg STEAM/HR
AVG _____; MAX _____; MIN _____;		M H2O/HR

B. MODE OF OPERATION

5. DATE OF PLANT COMMISSIONING _____
6. NUMBER OF EMPLOYEES; TOTAL; PER SHIFT
7. HOW MANY HOURS/DAY DOES THE PLANT OPERATE (AVERAGE)
HOW MANY DAYS PER YEAR
8. WHEN IS THE PLANT SHUT DOWN FOR MAINTENANCE, AND FOR HOW LONG
9. IS THE PLANT OPERATION NEAR AROUND ?
IF NO, WHEN IT IS ON AND WHEN IT IS OFF;

C. HEAT EXCHANGE STATIONS

10. ATTACH A DIAGRAM SHOWING THE TERRITORY THE HEATING PLANT IS SERVING
11. HOW MANY STEAM TO HOT WATER EXCHANGER STATIONS ARE THERE IN THE SYSTEM ?
12. WHAT IS THE TOTAL LENGTH OF STEAM LINE ? ARE THERE PRIMARY AND SECONDARY STEAM LINES IN THE SYSTEM ?
13. WHAT IS THE TOTAL LENGTH OF THE HOT WATER LINES IN THE SYSTEM ?

14. LIST OF ALL LINE SIZES AND THEIR RESPECTIVE LENGTHS.

PIPE DIAMETER

LENGTH IN KM

15. HOW MANY KCAL, BTU, OR GJ OF HEAT PER HOUR DELIVERED BY THE SYSTEM ?

MAXIMUM

MINIMUM

AVERAGE

16. WHAT IS THE WATER CIRCULATION RATE OF THE SYSTEM ?

MAXIMUM

MINIMUM

AVERAGE

17. HOW MANY HOT WATER PUMPS USED IN THE SYSTEM ? WHAT ARE THEIR SIZES ?

HORSE POWER FOR THE MOTORS

FLOW RATE FOR THE PUMPS

18. ARE THE PUMPS EQUIPPED WITH CONSTANT SPEED OR VARIABLE SPEED MOTORS ?

19. ARE THERE SPARE PUMPS AVAILABLE FOR ROTATIONAL MAINTENANCE ?

20. ELECTRIC POWERED PUMP OR DIESEL POWERED PUMP ? IS THERE EMERGENCY POWER AVAILABLE IN CASE OF A BLACKOUT ?

21. WHAT ARE THE HOT WATER PIPELINE MADE OF ? STEEL, COPPER, IRON ETC.

22. HOW OLD ARE THE HOT WATER LINES ? OLDEST ____ YRS. NEW ONE ____ YRS

23. WHAT IS THE PRESSURE OF THE HOT WATER LINE ON THE DELIVERING END ?

24. WHAT IS THE PRESSURE AT THE RETURN END ?

25. WHAT IS THE TEMPERATURE OF THE HOT WATER AT THE DELIVERING END ?
WINTER _____ SUMMER _____

26. WHAT IS THE TEMPERATURE OF THE HOT WATER AT THE RETURN END ?
WINTER _____ SUMMER _____

27. ARE THERE BOOSTER PUMPS ALONG THE ROUTE TO MAKE UP FOR THE PRESSURE LOSS ?

28. WHAT IS THE WATER LOSS OF THE ENTIRE SYSTEM ? WINTER _____
SUMMER _____

D. ENERGY SUPPLIES AND DEMANDS

29. LIST ALL ENERGY PRODUCTS USED IN THE PLANT, E.G.
NATURAL GAS, LOW Btu GAS, COAL, LIGNITE, COKE, CHARCOAL, WOOD, FUEL
OIL, DIESEL OIL, BAGASSE, AGRICULTURAL WASTE, ELECTRICITY, STEAM, HOT
WATER, ETC
30. HOW ARE THEY BROUGHT TO THE PLANT ?
PIPE LINE, TRUCK, TANK CAR, RAIL CAR, BARGE, HIGH VOLTAGE LINE, ETC
31. IS THERE EXTRA MARGIN OF SUPPLY OF SUCH FUELS IF THE PLANT CHOOSES
TO GO COGENERATION ?
IF YES, HOW MUCH ?
IF GAS, HOW MUCH, AND UNDER WHAT PRESSURE ?
32. LIST THE RELEVANT SPECIFICATIONS FOR EACH FUEL/ENERGY PRODUCT
HEATING VALUE (HV & LV) KCAL/KG (SOLID OR LIQUID)
 KCAL/CU. M (GAS)
STEAM PRESSURE, TEMPERATURE, AND RATE (KG/HR)
GAS PRESSURE, FLOW RATE
ELECTRICITY VOLTAGE, AND LINE (TRANSFORMER) CAPACITY
HOT WATER PRESSURE, TEMPERATURE, AND RATE (KG/HR)
33. IN CASE OF STEAM OR HOT WATER, WHAT IS THEIR SOURCE, BOILER, TURBINE ?
34. WHAT IS THE CURRENT PRICE OF EACH ?
RB /CU. METER OF GAS
RB /METRIC TON OF COAL, COKE, LIGNITE, ETC
RB /METRIC TON OF FUEL OIL
RB /kWh OF ELECTRICITY FRM THE GRID
RB /METRIC TON OF STEAM, OR HOT WATER
35. WHAT IS THE TARIFF OF ELECTRICITY CONSUMED AT THE PLANT ?
DEMAND CHARGE
CONTRACT DEMAND CHARGE RB /kW
MAX DEMAND CHARGE RB /kW
OVER CONTRACT PENALTY RB /kW
DEMAND CONSTRAINTS
36. DO THEY EXPERIENCE POWER INTERRUPTIONS OR SHORTAGE ?
ROTATIONAL BLACK OUT
BROWN OUT

37. FOR THE MOST RECENT 12 MONTHS, PLEASE FILL OUT THE TABLE BELOW:

Month	Year	HOT WATER		Cost prod (RB) x1,000	NATURAL GAS		FUEL OIL	
		Gener (GJ) x1,000	Demand (GJ)		Usage (MCM)	Cost (RB) x1,000	Usage (MT)	Cost (RB) x1,000
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								
Total								

38. ARE THERE DATA AVAILABLE ON DAILY AND SEASONAL VARIATIONS IN HOT WATER LOAD ?

39. IS THERE A DAILY HOT WATER HEATING LOAD CURVE AVAILABLE ?

40. IS COGENERATION AVAILABLE AT THE SITE ?

IF YES, HOW MUCH ELECTRICITY IS GENERATED BY THE PLANT LAST YEAR ?

FUEL USED FOR COGENERATION, QUANTITY, AND HEAT CONTENT (H)

IS THE STEAM CONSUMED WITHIN THE PLANT AND HOW MUCH ?

E. BOILER INFORMATION

41. PROVIDE DATA FOR EACH BOILER

MAKER

TYPE/MODEL

CAPACITY

DATE INSTALLED

HOW MANY TIMES OF MAJOR WORKS DONE, AND ON WHAT BOILERS ?

STEAM PRESSURE

TEMPERATURE

65

FUEL CONSUMPTION

FUEL USED

WHAT ARE THE ALTERNATIVE FUELS ?

SOURCE OF FEED WATER

WATER TREATMENT USED

WATER QUALITY AFTER TREATMENT

MAKE UP WATER

PERCENTAGE OF CONDENSATE RETURN

PEAK DEMAND FOR STEAM

F. TURBINE INFORMATION

42. PROVIDE DATA FOR EACH TURBINE

MAKER

TYPE/MODEL

**CONDENSING
BACK PRESSURE
EXTRACTION**

RATING CAPACITY

DATE INSTALLED

**STEAM PESSURE
INLET
OUTLET**

**STEAM TEMPERATURE
INLET
OUTLET**

BY PASS

VALVES

MAJOR REPAIR WORKS DONE

G. MEASUREMENT AND METERING

43. HOW IS HOT WATER SUB-METERED FOR RESIDENTIAL END USERS ?
HOW IS HOT WATER SUB-METERED FOR COMMERCIAL END USERS ?
HOW IS STEAM/HOT WATER SUB-METERED FOR INDUSTRIAL END USERS ?
44. WHAT IS THE PERCENTAGE OF TOTAL ELECTRICITY USED IN OFFICES ?

G. COGENERATION FACILITY

45. WHAT ARE THE REQUIREMENTS FOR CONNECTION TO THE GRIDS ?
46. WHAT IS THE ELECTRIC RATE IF DISTRICT HEATING PLANT INTENDS TO SELL ITS COGENERATION POWER TO THE GRID ?
- | | | |
|-----|------|--------|
| RB. | /kW | DEMAND |
| RB. | /kWh | USAGE |
47. WHAT IS THE BACK-UP POWER COST CHARGED BY THE GRIDS ?
- | | | |
|-----|-----|--------|
| RB. | /kW | DEMAND |
|-----|-----|--------|
48. HAS THE PLANT EVER BEEN CONSIDERING TO DO COGENERATION THEMSELVES ?
- IF YES, WHAT HAPPENS NEXT ?
- IF YES, WHY THERE IS NO COGENERATION ON SITE ?
- IF NOT, WHY NOT ?
49. IS THE ELECTRIC UTILITY CO. WILLING TO BE A PARTNER OF THIS COGENERATION VENTURE ?
- IF NOT, WHY NOT ?
- IF YES, WHAT % THEY WOULD LIKE TO PARTICIPATE ?
50. DOES THE HOST SITE (PLANT) WANT TO BE A PARTNER IN THIS JOINT VENTURE?
- IF NOT, WHY NOT ?
- IF YES, WHAT % THEY WOULD LIKE TO PARTICIPATE ?

51. ARE THERE OTHER PARTIES WHO WOULD LIKE TO CONSIDER TO BE A JOINT VENTURE PARTNER ?
52. IS THE DISTRICT HEATING PLANT ALSO IN CHARGE OF DISTRIBUTING THE HOT WATER TO CUSTOMERS ?
53. ARE THERE TWO SEPARATE AUTHORITIES: ONE TAKES CARE OF THE BOILER SIDE, AND THE OTHER TAKES CARE OF DISTRIBUTING THE HEAT ?
54. WHAT IS MANAGEMENT'S PREDICTION THE GROWTH OF HEATING DEMAND IN THE NEXT TEN YEARS ?
55. ARE THERE ANY ENERGY MANAGEMENT OR ENERGY CONSERVATION PROGRAMS IMPLEMENTED IN THE LAST THREE YEARS ? IF YES, WHAT ARE THEY ?
56. OTHER COMMENTS OR INFORMATION THAT ARE PERTINENT TO THE ENERGY AUDIT OF THIS DISTRICT HEATING PLANT ?
57. WHAT ARE THE CRITICAL AREAS WHERE LOW COST INSTRUMENTS CAN MAKE A SIGNIFICANT CONTRIBUTION TOWARD EFFICIENCY IMPROVEMENT OF THE SYSTEM.
58. PLEASE ATTACH AN ORGANIZATION CHART SHOWING THE MAJOR FUNCTIONS:
- * ADMINISTRATION
 - * OPERATIONS
 - * MAINTENANCE
 - * ENGINEERING
 - * ACCOUNTING
 - * CUSTOMER SERVICE
 - * ETC
59. PLEASE INDICATE THE TOTAL NUMBER OF PERSONS AND THE NUMBER OF SUPERVISORS IN EACH FUNCTIONS.
60. ARE ANY MAINTENANCE AND/OR REPAIR FUNCTIONS CONTRACTED TO OUTSIDE COMPANIES ? PLEASE DESCRIBE THE ARRANGEMENT.
61. HOW MANY POWER STATIONS SUPPLY THERMAL ENERGY TO THE DISTRICT HEATING SYSTEM ? PLEASE DESCRIBE EACH ONE BRIEFLY.
62. HOW IS THE PRICE FOR THERMAL ENERGY ESTABLISHED ? HOW OFTEN CAN IT BE ADJUSTED ? WHO HAS THE AUTHORITY TO APPROVE A PRICE ADJUSTMENT ?

63. PLEASE DESCRIBE THE TYPES OF CUSTOMERS WHO RECEIVE SERVICE FROM THE DISTRICT HEATING SYSTEM ?

* PRIVATE RESIDENTIAL	%	_____
* COLLECTIVE RESIDENTIAL	%	_____
* LIGHT INDUSTRY	%	_____
* HEAVY INDUSTRY	%	_____
* GOVERNMENTAL AGENCIES	%	_____
* COMMERCIAL	%	_____
* OTHER	%	_____

64. WHAT ARE THE RATES FOR EACH GROUP OF THE ABOVE CUSTOMERS ?

65. HOW ARE THE RATES DERIVED ? ARE THERE COST ACCOUNTINGS PRACTICED ? IF YES, PLEASE DESCRIBE BRIEFLY.

66. ARE EACH CUSTOMER'S USAGE METERED, AND CHARGED ACCORDING TO HOW MUCH THEY EACH CONSUME ?

67. ARE ANY CUSTOMERS TO WHOM STEAM OR HOT WATER IS DIRECTLY SUPPLIED BY THE POWER PLANTS, WITHOUT INVOLVEMENT FROM THE DISTRICT HEATING SYSTEM ? IF SO, WHAT ARE THE QUANTITIES SUPPLIED, AND WHAT ARE THE PRICE CHARGED ?

68. WHO IS RESPONSIBLE FOR OPERATION AND MAINTENANCE OF THE PRIMARY PUMPS FEEDING THE SYSTEM ?

69. WHO AND WHAT DEPARTMENT IS RESPONSIBLE FOR DEVELOPING AND DIRECTING ENERGY MANAGEMENT AND CONSERVATION PROGRAMS ?

70. WHAT HAS BEEN THE RESULT OF THESE PROGRAMS DURING THE PAST YEAR ?

71. WHAT ARE THE MOST IMPORTANT CAUSES OF HEAT LOSS IN THE SYSTEM ?

- * WATER LEAKAGE
- * STEAM LEAKAGE
- * LACK OF SUB-METERING
- * PIPING LAYOUT AND SIZES
- * POOR INSULATION
- * PUMP INEFFICIENCY
- * LACK OF TEMPERATURE REGULATOR FOR INDIVIDUAL CUSTOMERS
- * OTHERS (PLEASE SPECIFY)

72. PLEASE ESTIMATE THE AMOUNT OF EACH OF THE ABOVE LOSSES AS A PERCENT (%) OF TOTAL THERMAL ENERGY DELIVERED TO THE SYSTEM.

73. WHAT CREATES SUCH HEAT LOSSES ?

- * LACK OF MAINTENANCE
- * LACK OF PERSONNEL
- * LACK OF ACCURATE INSTRUMENTS
- * LACK OF SPARE PARTS
- * LACK OF INCENTIVE
- * POOR DESIGN
- * PIPE NETWORK TOO OLD
- * PUMPING EQUIPMENT TOO OLD
- * OTHER (PLEASE SPECIFY)

74. WHO MANAGES THE WATER TREATMENT AND WATER QUALITY FOR THE SYSTEM ?

75. PLEASE DESCRIBE THE COSTS OF OPERATING THE DISTRICT HEATING SYSTEM. PLEASE PROVIDE COSTS AS RUBLES PER KCAL FOR A TYPICAL MONTH DURING THE HIGH DEMAND SEASON AND DURING THE LOW DEMAND SEASON:

	HIGH DEMAND RB/KCAL	LOW DEMAND RB/KCAL
* WATER DEMAND CM/HR		
* FUEL COST		
* WATER COST		
* MAINTENANCE COST		
* LABOR		
* MATERIAL		
* OPERATING COST		
* ELECTRICITY COST		
* DEPRECIATION		
* TAXES AND INSURANCES		
* ADMINISTRATIVE OVERHEAD		
* SUPPLIES		
* OTHERS (PLEASE SPECIFY)		

76. WHAT ENERGY-SAVING PROJECTS HAVE BEEN IDENTIFIED THAT MAY REQUIRE CAPITAL EXPENDITURES:

- A. PROJECTS THAT WOULD REQUIRE LESS THAN U.S. \$10,000. EACH.
- B. PROJECTS THAT WOULD REQUIRE MORE THAN U.S. 10,000. EACH.

77. PLEASE ESTIMATE THE ANNUAL BENEFITS THAT WOULD BE ACHIEVED BY EACH ABOVE PROJECTS.

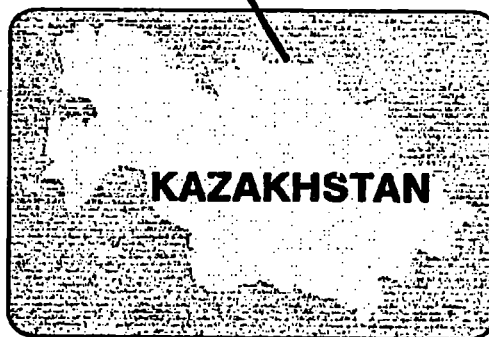
78. ARE COMPUTERS USED IN THE SYSTEM ?

- * FOR PROCESS CONTROL
- * FOR DATA COLLECTION
- * FOR PROCESS MONITORING
- * FOR BILLING AND BOOK KEEPING
- * FOR OFFICE AND COST ACCOUNTING

79. PLEASE DESCRIBE BRIEFLY THE TYPE OF COMPUTER EQUIPMENT USED AND THE FUNCTIONS PERFORMED.
80. DO WORKERS, AND MANAGERS RECEIVE TRAINING IN ENERGY SAVING AND COST SAVING ? IF YES, WHAT ARE THE TRAINING PROGRAMS, AND WHO DOES THE TRAINING ?
81. DO WORKERS AND MANAGERS RECEIVE BONUSES OR OTHER FINANCIAL RECOGNITION FOR ENERGY SAVING AND COST SAVING IDEAS ? IF SO, HOW MUCH AND HOW OFTEN ?
82. WHAT IS THE WATER PRESSURE
- * AT THE OUTLET OF THE PUMPS FEEDING THE SYSTEM ?
 - * AT THE FURTHEST POINT IN THE SYSTEM ?
 - * AT THE POINT OF RETURN TO INLET OF PUMPS ?
83. IS WATER TEMPERATURE AND PRESSURE MEASURED AT INTERMEDIATE POINTS IN THE SYSTEM ?
84. IS WATER FLOW RATE MONITORED AT INTERMEDIATE POINTS IN THE SYSTEM ?
85. HOW ARE MAJOR LEAKS DETECTED ?
86. WHAT IS THE HOT WATER LOSS FOR THE ENTIRE DISTRICT HEATING SYSTEM,
- * HIGH DEMAND SEASON
 - * LOW DEMAND SEASON
87. WHAT IS THE FURTHEST POINT FROM THE MAIN PUMPING STATION IN KM ?
88. WHAT IS THE ESTIMATED RESIDENCE TIME FOR WATER IN THE SYSTEM,
- * AT PEAK LOAD
 - * AT OFF PEAK LOAD

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POLICY AND INSTITUTIONAL ANALYSIS REPORT



ENERGY EFFICIENCY IN THE DISTRICT HEATING SYSTEM OF ALMATY

**International Resources Group, Ltd.
Washington, D.C.**

June 1993

PN-ABR-097

KAZAKHSTAN

**ENERGY EFFICIENCY
IN THE DISTRICT HEATING SYSTEM
OF
ALMATY**

POLICY AND INSTITUTIONAL ANALYSIS

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ACRONYMS AND ABBREVIATIONS

AAE	Alma Ata Energo
AHSE	Alma Ata Heating Systems Enterprise
AGTKE	Alma Ata Gorteplokkommunenergo (City Commnal Heat Supply)
b/d	barrels (of oil) per day
bcm	billon cubic meters (of natural gas)
CIS	Commonwealth of Independent States
IRG	International Resources Group, Ltd.
kWh	kilowatt hour
m³	cubic meters (of natural gas)
MW	megawatt
NIS	Newly Independent States (of the former Soviet Union)
TES	Thermal Energy Station
USAID	United States Agency for International Development
USD	U.S. dollar

Note: Although the name of the capital of Kazakhstan was changed to Almaty during the course of the project, the proper names of organizations have not yet changed and retain the former version of "Alma Ata."

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IRG also would like to thank the U.S. Agency for International Development, New Independent States Task Force, Office of Energy and Infrastructure for coordinating the activities under the Energy Efficiency and Market Reform Project. IRG hopes that the initiatives undertaken in this project will contribute to the economic development of Kazakhstan.

EXECUTIVE SUMMARY

After the collapse of the Soviet Union in December 1991, long-standing inter-republic supply arrangements for energy inputs were disrupted, and the economies of the Newly Independent States (NIS) steadily deteriorated. As a result, during the winter of 1991-1992, a number of energy enterprises failed, causing tens of thousands of people to go without heat or electricity for significant periods of time. In order to provide immediate technical assistance to alleviate the problem, the United States Agency for International Development (USAID) agreed to fund an initiative to improve the performance and efficiency of selected facilities within the district heating system of Almaty. International Resources Group, Ltd. (IRG) of Washington, DC was chosen to serve as the contractor to USAID for the *Energy Efficiency and Market Reform Project* in Kazakhstan.

The project entailed two components: (a) the technical auditing task was designed to combine in-plant, on-the-job training with the identification and implementation of low-cost or no-cost energy efficiency initiatives, and; (b) the second effort involved developing recommendations for policy and institutional reforms to enhance energy efficiency management and investment decision-making at the enterprise-level, and to promote the development of national initiatives and legislation which foster energy efficiency. This analysis addresses the second of these tasks.

Energy and Economic Situation

The economy of Kazakhstan is in substantial decline and increasingly exhibits considerable instability. In the first nine months of 1992, industrial production plummeted 15 percent from the same period in the previous year, and industrial energy demand continues to decline. Inflation is soaring to hyper-inflation levels and the ruble is undergoing steady, massive devaluation, all resulting in real income deterioration and erosion in the standard of living. In addition, the breakdown of historic trading networks within the former Soviet Union (FSU) has disrupted the traditional supply patterns of critical raw materials, industrial goods, agricultural

products, capital, and energy.

Despite these difficulties, its sheer size, strategic geographic location, cheap and skilled labor force, and abundant natural resources provide a strong base upon which to build economic (and energy) self-sufficiency, as well as offer an attractive opportunity for foreign investment.

Within the NIS, Kazakhstan is the second largest producer of oil (530,000 b/d) after Russia, and the third largest producer of coal (130 metric tons/year) after Russia and Ukraine. Despite its prodigious oil resources, under the FSU the economy of Kazakhstan was heavily dependent upon Russia. This anomaly arose from the fact that while Kazakhstan's oil production is concentrated in the western part of the Republic, the bulk of its energy consumption is in the east where the major oil refineries are located. As a result of the lack of west to east oil pipelines, most of Kazakhstan's own petroleum production is exported while it imports crude oil from the western Siberian oil fields of Russia to meet the feedstock requirements of its refineries. Thus, it was realized early on that foreign investment would be the key to provide the infusion of western capital and technology needed to develop vast indigenous oil deposits and establish export pipelines to international markets. To date, three major, long-term agreements have been signed with western companies (including U.S.-based Chevron) to exploit oil fields in northwestern Kazakhstan.

Energy Efficiency: The Role of Government

Senior government policy-makers recognize that energy efficiency must be a national policy and that specific mechanisms to promote the rational use of energy need to be developed. Toward this end, national energy legislation is being developed which will specifically incorporate a commitment to improve and promote energy efficiency. This legislation will be submitted to Parliament for review in June 1993 and will incorporate many Western concepts, including regulations which provide incentives for investment in efficiency programs and equipment rather than large-scale construction of new generation facilities.

Energy Pricing

Thermal and electricity tariffs for all classes of consumers have been raised five times since February 1992. These increases were made in an attempt to cover increasing costs of generation, including inflation, labor, materials, and spare parts. In addition, one of the most important variables in recent thermal and electricity price increases is the cost of primary fuels such as coal, natural gas, and mazut, all of which have increased in price several times the levels of early 1992.

The Government has made a deliberate decision to raise thermal and electricity tariffs on industrial customers at a faster pace and to higher levels than on residential and commercial consumers in an effort to continue subsidies for households, thus cushioning the impact of rising prices on the average consumer and limiting potential social and political backlash. Tariffs for commercial customers remain lower than industrial tariffs owing to the fact that most public buildings are state-owned institutions or facilities and traditionally have been entitled to subsidized services from all utilities.

Despite increases in all consumer categories, tariffs for thermal energy and electricity remain well below production costs and even below the costs of primary fuels. Although industrial customers are increasingly recognizing the importance of energy efficiency owing to higher energy costs, there is an urgent need to raise all tariffs, especially in the commercial and residential sectors, to provide market incentives for investments to improve the rational and efficient use of energy. Finally, the policy of virtually free energy service to state-owned institutions and public buildings needs to be ended as soon as possible.

Financing and Foreign Investment

Prospects for financing projects to improve energy efficiency are not promising. Tariffs are insufficient to provide the necessary capital to finance such activities from internally generated capital, and loans from commercial banks have extremely prohibitive interest rates. In addition, there is a 20 percent value added tax (VAT) and other import duties, both of which

raise the price of imports of energy efficiency equipment. There are no government programs such as grants for technology demonstration or audits, subsidized interest loans, loan guarantees, or tax-related incentives for energy efficiency investments. However, legislation is being developed which may incorporate some of these financing mechanisms.

There are obstacles to foreign investment in Kazakhstan such as ruble inconvertibility and the uncertainty surrounding the repatriation of profits. Nevertheless, there are considerable opportunities for foreign participation. A joint venture law has been established and considerable interest has been expressed in Kazakhstan for establishing joint ventures for the supply and/or manufacture of meters and other energy efficiency instrumentation and equipment. In addition, there is a strong commitment to liberalization and privatization of the economy: the Government has issued a formal program governing denationalization and privatization for the period 1993-1995. Clearly, greater decentralization and managerial autonomy at the enterprise level will promote market-oriented decision-making, and thus enhance the prospect for energy efficiency investments which improve competitiveness and productivity. It remains to be seen, however, how fast this process will move, and indeed if it will include a significant number of high energy consuming enterprises.

Energy Efficiency in the District Heating System

The system as a whole is inefficient; government ownership, energy price subsidies, and centralized planning and control have, on the institutional level, resulted in a general lack of concern for the significance of energy efficiency. In addition, many enterprise managers are unaware of their real costs given the fluidity of the economy (i.e., constantly changing prices, inflation, and exchange rates). Moreover, inadequate and/or lack of modern equipment and systems allows tremendous scope for energy savings. The IRG Audit Team estimated that on the production side alone, efficiency improvements resulting from the installation of modern instrumentation and controls has the potential to achieve savings as high as 20 percent. On the demand side, the removal of energy price subsidies together with the institution of rational billing have the potential to achieve 30 percent energy savings.

There is a need to upgrade the skills of plant management in cost accounting procedures, business management, and the economic and financial evaluation of potential projects, including training in concepts such as return on investment, net present value and discounted cash flow. In addition, there is also a need to create formal energy management teams and to increase awareness of energy efficiency in all district heating facilities as well as in all other industrial enterprises. The lack of an indigenous energy efficiency industry and other organizations which provide services also limits the promotion and widespread adoption of energy efficiency equipment and practices. One exception is *Interenergys*, a 50 percent privately-owned company established to provide energy efficiency services and equipment to enterprises throughout Kazakhstan through joint ventures with foreign equipment suppliers and manufacturers.

Recommendations

It is clear that as long as thermal energy and electricity prices remain subsidized, there will be little incentive for energy efficiency. Thus, there is a pressing need for the continued removal of energy price subsidies.

The Government needs to examine the viability of implementing various financial incentives for energy efficiency, specifically: (a) reduction or elimination of the VAT and other duties on imports of energy efficiency equipment; (b) granting of priority access to foreign exchange for industries making efficiency investments; (c) various funding programs such as grants/no-risk loans, subsidized interest loans, loan guarantees, or revolving credit funds, and; (d) tax-related incentives.

Experience in other countries indicates that one of the most important ingredients in promoting energy conservation and implementing a successful national program is a demonstrated commitment at the highest political levels of government. Legislation and regulations should be enacted and enforced under a coordinated national energy plan administered by a separate governmental energy efficiency institution. Specific policies include

mandatory energy efficiency standards and regulations for enterprises; energy efficiency labeling and standards for energy-using equipment such as electric motors, HVAC systems, boilers, and household appliances, and; energy efficiency building codes.

At the plant-level, enterprises should develop incentives and awareness-building programs to promote worker productivity and improve overall energy efficiency. In addition, greater decision-making autonomy will assist in the move toward operating as profit- and market-oriented businesses. Continued decision-making decentralization is required to increase in-house energy efficiency capabilities at all levels. Also, there is a strong need to establish training programs for enterprise managers in the technical aspects of energy efficiency improvement, the basics of business management, and free market principles.

A massive influx of equipment and technology is required to assist individual enterprises to rebuild and become competitive. Most energy efficiency technologies/practices are inadequate or simply absent. Equipment needed includes small-scale, low-cost, no-cost, fast payback instrumentation and control systems such as microprocessors, gas analyzers, flow meters, flue gas oxygen analyzers, heat meters and thermostatic controls, automated PC-based control and monitoring systems, infrared and contact thermometers, and pipeline insulation. Rational billing systems and steam traps are other examples of systems/technologies which can be inexpensively and quickly implemented with fast paybacks.

Finally, there is the need to develop a domestic energy efficiency industry. The Government and USAID should encourage the creation of joint ventures between U.S. firms and Kazakh enterprises, whether to form an energy efficiency company to provide services, training and market support, and promote private sector investment, or to establish a joint manufacturing capability.

INTRCDUCTION

In the aftermath of the collapse of the Soviet Union, the former republics are faced with a host of problems in the energy sector, which historically has been plagued by inefficiencies resulting from subsidized energy prices, lack of instrumentation and control for energy inputs, lack of investment, and the overall aging of the energy infrastructure. During the past few years this situation has been aggravated by steadily deteriorating economic conditions, resulting in decreased industrial output. Moreover, with the dissolution of the Soviet Union, long-standing inter-republic supply arrangements for energy inputs have been disrupted, leading to production and distribution bottlenecks in the process of procuring raw material inputs (especially coal and natural gas) for electricity and heat generation. Simultaneously, it has become necessary for most republics to pay for energy supplies with scarce hard currency or through barter. As a result of these developments, during the winter of 1991-1992, a number of energy enterprises failed, causing tens of thousands of people to go without heat or electricity for significant periods of time.

Project Origin and Rationale

Recognizing the critical nature of the energy problems confronting the NIS, the Energy Working Group of the Washington Coordinating Conference of January 1992 developed an action plan for addressing the energy problems of these now sovereign countries. The Coordinating Conference was a meeting of representatives from over 50 countries and international donor organizations to develop an assistance plan for the region. As part of this plan, USAID agreed to fund a technical assistance initiative designed to improve the performance and efficiency of selected district heating systems in the NIS. This initiative is the *Energy Efficiency and Market Reform Project*.

In each newly independent state, one or two district heating networks were selected as target systems for audits. Systems were selected on the basis of potential for significant energy savings, the applicability of results to similar plants in the NIS, and the importance of the system

in the overall context of the country's economic development.

Project Description

IRG of Washington, DC was chosen to serve as the contractor to USAID for the *Energy Efficiency and Market Reform Project* in Kazakhstan. The IRG Audit Team visited the Republic of Kazakhstan in March 1992 to discuss energy-related needs with development officials, and to develop the scope of the project, which is the initial energy activity under the new U.S. Economic Assistance Program for the Commonwealth of Independent States (CIS).

In Kazakhstan, the IRG Audit Team chose to audit the Alma Ata Heating Systems Enterprise (AHSE) and its distributor, the Alma Ata City Communal Heat Supply (AGTKE). Within the system, the IRG Team conducted audits of generation, transmission and end-use facilities. The technical auditing phase of the project is designed to combine in-plant, on-the-job training with the identification and implementation of low-cost or no-cost energy efficiency initiatives. The specific goals of this phase are to:

- 1) foster improved management of energy use in the heating plants by identifying and implementing cost effective "low-cost/no-cost" energy efficiency improvements;
- 2) transfer energy auditing and management techniques including financial and technical analysis techniques;
- 3) provide equipment support to implement low-cost options, improve monitoring and energy management; and
- 4) identify additional energy efficiency opportunities.

This project also includes a Policy and Institutional Analysis component, which is the subject of this report. It seeks to:

- 1) describe the role of government entities, including district heating organizations, in influencing the investment decision-making process for energy efficiency;
- 2) review possible reforms under consideration;
- 3) examine management and investment decision-making practices for energy efficiency at the enterprise and plant-level; and,
- 4) identify options for enhancing energy efficiency management and the investment climate at the national and plant levels.

I. BACKGROUND: STATE OF THE ECONOMY

The economy of Kazakhstan, like that of the other countries of the NIS, is in substantial decline. According to the State Committee for Statistics, Gross Domestic Product decreased 16.7 percent in Kazakhstan during the first nine months of 1992, as compared with the first nine months of 1991. Industrial output showed a slightly lower decline of 14.8 percent. Equally troubling is the very sharp rise in mutual debts, or the sums which enterprises and organizations owe each other, to 48 billion rubles.¹

This decline in economic activity has been accompanied by rates of inflation reaching almost hyper-inflation proportions. State controls on the prices of most goods were removed in early January 1992. At the end of October 1992, for example, the average cost of a basket of basic food items was 1,470 rubles (calculated on a monthly basis), or nine times the cost in December 1991. In the capital city of Almaty, this same food basket cost 2,396 rubles.

At the same time, wages have not kept pace with inflation, resulting in a decrease in the standard of living. Sales of basic food items are down, as the consumer has to make the difficult choice of what not to buy against the background of reduced real income.

Yet Kazakhstan, despite these financial pressures, offers a semblance of stability not present elsewhere in the CIS. The President of Kazakhstan, Mr. Nursultan Nazarbayev, has demonstrated a strong commitment to economic reform and is moving, albeit slowly, towards privatization. In addition, its sheer size, strategic geographic location, cheap and skilled labor force, and abundant natural resources make Kazakhstan an attractive target for foreign investment.

¹ This figure is an estimate as of December 1992. The exchange rate at that time was 400 rubles/USD.

Kazakhstan produces 19 percent of all the coal mined in the former Soviet Union, and its oil production averages around 532,000 b/d. Although Kazakhstan's proven oil reserves are believed to be 1.6 - 2.1 billion barrels, most observers believe this number will rise substantially in the future, presaging the nation's emergence as a significant actor in the world petroleum market.

In terms of energy consumption, the energy economy is dominated by coal which accounts for about 56 percent of total consumption. Oil accounts for 25 percent, followed by natural gas (16 percent) and electricity (5 percent). Distribution of fuel consumption by economic sector is well balanced among industry (31 percent), transportation (28 percent) and municipal requirements (26 percent). In the electric power sector, industry consumes 72 percent of all power generated, agriculture 13 percent, and the residential sector 10 percent.

Kazakhstan, despite its size, is not a large producer of electric power, accounting for 4.8 percent of total electric power production of the former Soviet Union. Power generation in 1991 totalled 81 billion kilowatt-hours (kWh), down 3.6 percent from 1990. There is one nuclear power station, at Shevchenko on the Caspian Sea, consisting of one 350 MW fast breeder reactor built for water desalination. This reactor is scheduled to be shut-down in 1992-1993, when it will reach the end of its 20-year life. Current public opinion is strongly against the further development of the nuclear industry, owing to the extensive environmental damage the country suffered as a result of hundreds of nuclear weapons testing exercises in the past.

Despite the fact that the production of energy exceeds domestic requirements by 19 percent, largely for reasons of geography Kazakhstan is engaged in major inter-republic exchanges of energy.² For example, all of the oil production is concentrated in the western part of the Republic, while demand is centered in the eastern regions where the major refineries are located. Thus, Kazakhstan has become heavily dependent on crude oil from Western Siberia

² Also, Kazakhstan is a supplier of raw materials and an importer of finished products.

to meet the requirements of these refineries, while most domestic crude oil production is exported. There are no west-to-east oil pipelines, a major deficiency in the infrastructure of the economy. More importantly, as crude oil production continues its sharp decline in Western Siberia, Kazakhstan may find its refineries short of feedstock. In addition, West Siberian producers may offer what they have to sell at world market prices, with payment required in hard currency.

The Government is moving to reduce the overwhelming linkages with Russia and the other republics, but economic independence has been more difficult and time-consuming to achieve than political independence. It was realized early on that foreign investment would be the key to economic self-sufficiency, and there would be no better attraction for foreign investment than the very rich oil resources of the Republic. Considerable success has been achieved in this regard, in part because of the country's comparative economic and political stability, but also because of Kazakhstan's willingness to understand the need to link investment risk and rates of return. Furthermore, American companies in particular have found it easier to negotiate with Kazakhstan than with Russia, for example, because in Kazakhstan there is no question as to where the decision-making authority rests. Not so in Russia, where the multiplicity of interests has complicated foreign participation in the energy sector.

TABLE 1
STATUS OF AGREEMENTS: KAZAKHSTAN - U.S.
(as of May 1993)

<u>Agreement</u>	<u>Status</u>
Trade Agreement	Yes
Most Favored Nation	No
Generalized System of Preferences	No
Overseas Private Investment Corporation	Yes
Export-Import Bank lending	Yes
Investment Treaty	Yes

TABLE 1 indicates significant progress in facilitating trade and investment between the United States and Kazakhstan, and foreign companies are reasonably confident that the authorities understand what is needed to attract and keep the investor. The conclusion of three major oil and gas projects is evidence of these developments. Chevron signed a deal in April 1993 to develop the Tengiz and Korolev fields, located to the Northeast of the Caspian Sea. Tengiz at its peak should produce around 800,000 b/d, but development will be technologically challenging and expensive, and peak output likely will not be reached until later this decade. British Gas, together with the Italian firm Agip, will develop the Karachaganak gas field, while French Elf Aquitaine will explore in Northwest Kazakhstan.

This open attitude to foreign investment could double oil production to 1 million b/d by the late 1990s and gas production could triple to 27 bcm/yr by 2000. Moreover, these regions will benefit from Western involvement, as oil and gas development will provide employment, higher living standards and greatly improved local infrastructure. The Republic also will benefit from higher hard currency earnings as exports rise over time.

Bringing these major projects to fruition will take time and economic uncertainty will continue for the next several years, which implies a delay in attaining energy independence. Given this likelihood, reform in Kazakhstan will largely continue to track reform in Russia for the foreseeable future. These close economic ties will affect the pace of economic reform in Kazakhstan.³

³ A more complete examination of the relationship between the two economies is beyond the scope of this report. However, for a more detailed discussion of the linkages with the Russian economy, especially in regard to pricing, see IRG's *Kazakhstan Energy Pricing and Taxation Study: Petroleum, Gas and Coal Pricing and Taxation*, also sponsored by USAID and produced in collaboration with the World Bank.

II. ENERGY EFFICIENCY: ROLE OF THE GOVERNMENT

In terms of energy efficiency, Kazakhstan's annual per capita requirement of primary energy amounts to 3.6 tons of oil equivalent, while per capita electricity consumption is 6,000 kWh. These high levels of consumption place Kazakhstan on a par with countries with a far higher per capita income and suggest a tremendous scope for energy conservation and a vast market for energy efficiency equipment.

The Government has not formally articulated an overall energy efficiency policy, or adopted specific programs and laws designed to provide incentives for energy conservation activities or investments. However, senior government policy-makers recognize that energy efficiency must be a national policy and that specific mechanisms to promote the rational use of energy need to be developed. Indeed, this process has already begun. National energy legislation is being developed which will specifically incorporate a commitment to improve and promote energy efficiency. This legislation is being prepared primarily by Kazakhstan Energo and will be submitted to Parliament for review in June 1993. In the field of energy efficiency this legislation will incorporate many Western concepts, including regulations which provide incentives and allocate funds for energy efficiency programs and equipment rather than large-scale construction of generation facilities. Self-financing programs, tax incentives, promotion of foreign investment in energy efficiency and other programs also are expected to be proposed.

Previously, the Government's role in energy conservation consisted of the centrally planned system supervising the "rational" utilization of energy. For each enterprise, the state estimated what it considered to be an "appropriate" level of energy consumption over a certain period of time. If the enterprise surpassed this level, then the state energy supplier shut-off, or cut-back service. Thus, energy conservation was achieved by limiting supply -- the enterprise couldn't consume what it didn't have.

Under the previous system, if an individual enterprise sought to undertake an investment to improve plant/equipment efficiency, the state conducted its own review or feasibility study to determine if the investment was necessary. Everything was centrally-controlled – even the decision to make a plant-level energy efficiency investment.

Officially, this policy has changed. If an individual enterprise wants to make such an investment out of its own profits, it is free to do so. Enterprises are free to enter into joint-stock or joint venture arrangements with foreign investors, which in turn can assist with equipment, funds, and/or expertise. As detailed throughout this report, however, improvement has been slow in practice.

A. Pricing

In a free market environment energy pricing is the primary force that encourages producers and consumers to use energy efficiently. Energy prices should reflect the full cost of extraction, production/conversion, transportation and distribution, including the cost of capital for additional supplies of energy. Officially, the Government is committed to the gradual liberalization of all prices but most energy is still priced below cost.

Proposals for revising prices for steam and heat are first developed by the planning and economic department of Alma Ata Energo (AAE), with input from senior personnel of AHSE, to reflect changes in the cost of generation.⁴ This proposal is then submitted to Kazakhstan Energo and then to the State Pricing Committee, which administratively is under the Cabinet of Ministers. At the level of AAE and AHSE, managers are attempting to develop tariffs which cover their rising costs such as primary fuels, inflation, maintenance, and construction. At the higher levels of the governmental review process, however, political considerations often result in the proposed tariffs being lowered, resulting in final price levels always lagging actual

⁴ AGTKE, the residential distributor for AHSE, purchases hot water and steam from AHSE at wholesale and then distributes to the residential sector at prices below its wholesale cost. It also sells steam to industrial customers above cost. It has no role in the development of price proposals.

generation costs.

Despite the considerable political resistance to rapidly increasing price levels, it is clear that eventually moving to prices based on long-run marginal costs is important to the district heating sector if it is to attract needed capital investment for modernization and supply expansion. Nevertheless, given the severe impact that economic instability and rising prices are having on the average citizen, political considerations in the setting of prices remain dominant.

Although steam and heat prices have been increased steadily since January 1991, (See TABLE 2 and FIGURE 1) including five times between January 1992 - February 1993, prices are still below production costs for residential consumers. In December 1992, AHSE estimated the cost of heat production at 600 rubles/Gcal, and the cost of steam generation at 800 rubles/Gcal. However, by May 1993, costs had increased three times these levels. Further complicating the estimation of prices and costs are the inflation and exchange rates. In November 1992 inflation was estimated at 20 percent/month, but increased to 40 percent/month by early 1993. Over the same period, the ruble decreased in value from 400 rubles/USD to 800 rubles/USD. Assuming a monthly inflation rate of 20-30 percent in the period November 1992 - February 1993, thermal energy tariffs were increased sufficiently in February to match inflation, but keeping pace with continually rising costs is problematic as tariff increases in the commercial and residential sectors have not kept pace with the increase in total costs. The Government hopes to offset this trend by increasing thermal energy prices to eight times current levels by the end of 1993.

Managers responsible for the production of heat and steam complain that the upper echelons of the pricing review process consistently fail to raise tariffs to cover costs. In addition, wages always lag price increases resulting in decreased buying power for the average consumer, including employees in the district heating system. Nevertheless, there has been no labor unrest among the workers in the district heating system, no doubt partly owing to the fact that it is illegal for them to strike.

One of the most important variables in recent heat and steam price increases is the cost of primary fuels, estimated at 30 percent of total generation costs. AHSE estimated that over the period January 1991 - January 1993, the price of coal increased from 11 rubles/ton to 5,500 rubles/ton, and mazut increased from 34 rubles/ton in 1991 to 5,300 rubles/ton by the Fall of 1992. By May 1993, mazut reached 19,700 rubles/ton. In addition, natural gas prices rose sharply in 1992 and again in early 1993 owing to increases in the cost of gas from Turkmenistan and Uzbekistan. Kazakhstan is at the end of the pipeline for these deliveries and thus bears the brunt of increased duties and transit fees leading to higher prices for AHSE. As of May 1993, natural gas from these sources is 19,050 rubles/1000 m³, several times higher than in the previous year. These prices reveal a significant burden considering that of total thermal energy generation, approximately 25 percent is natural gas-based, and 75 percent is mazut-based. Electricity generation is almost entirely coal-fired, with a small peaking capacity based on mazut.

The Government has made a deliberate decision to raise thermal tariffs on industrial consumers to a higher rate than on residential end-users, in an effort to continue subsidies for households and to maximize revenues. Nevertheless, large industrial consumers currently require less energy than previously since their output is declining owing to the decrease in economic activity. Conversely, the relative share of heat and hot water usage by smaller industrial and commercial consumers is increasing, as their commodity output has been holding constant. Tariffs for commercial customers remain low (even below residential price levels) owing to the fact that most buildings are state-owned institutions or facilities and traditionally have been entitled to subsidized services from all utilities.

Although managers estimate that industrial tariff levels cover costs of production, it is unlikely that current price levels for any end-user actually cover hot water and steam production costs. According to senior district heating managers and other government officials, high rates of inflation and rapidly changing prices and costs throughout the economy prevent any precise determination of whether current tariffs are adequate. Indeed, senior decision-makers clearly do not believe that their costs are being recovered. Thus, in sum, district heating profits are

TABLE 2

HEAT TARIFFS FOR ALMATY^a
(January 1991 - February 1993)
Rubles/Gcal

Date	Industrial	Commercial	Residential
Before January 1991	11	6	n/a
January 1991	16	14	9
February 1991	23	14	15
March 1991	42	16	13
July 1991	34	14	22
January 1992	146	60	90
February 1992	182	71	87
May 1992	406	71	75
June 1992	1316	110	170
November 1992	2106	220	n/a
February 1993	6320	490	1860

Numbers are rounded. n/a = not available

^a Sources: AAE and AHSE.

Industrial tariffs are for hot water and bleed steam. Other categories of steam have slightly different tariffs which, for example in February of 1993 ranged from 5480 - 7000 rubles/Gcal.

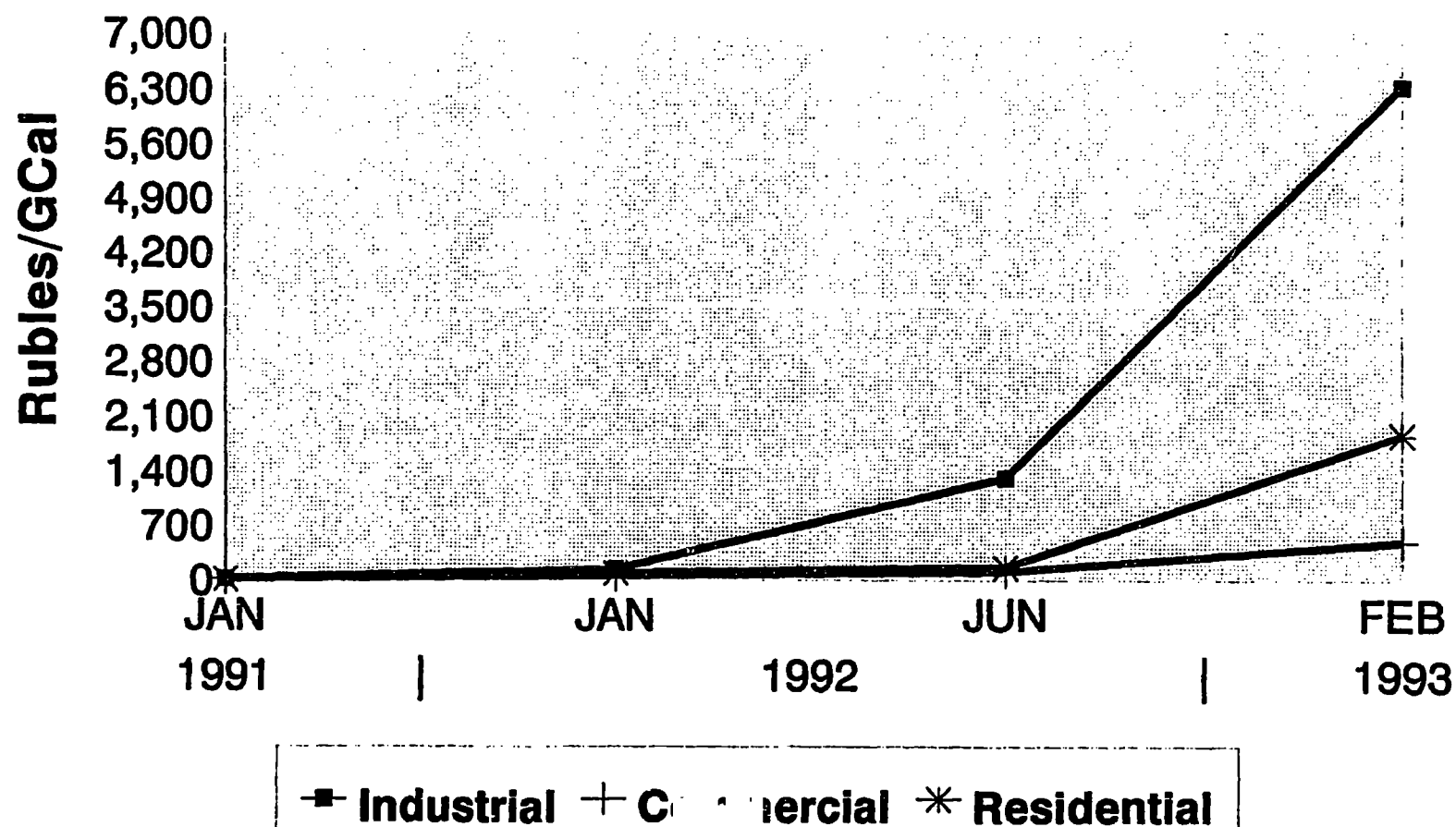
Kazakhstan's consumer tariff categories do not fit into conventional Western definitions of Commercial and Residential. Therefore, here we have used a composite of the following categories to provide an indication of how prices are moving: "Commercial" includes housing construction cooperatives, bathhouses, laundry facilities, and hotels; "Residential" includes housing organizations and the wholesale rate charged to AGTKE.

FIG. 1

ALMATY

Heat Tariffs

January 1991 - February 1993



declining. Whereas it is estimated that a profit level of around 10 percent is needed to generate adequate new capital for AHSE, the profit level at the end of 1992 was 3 to 5 percent of revenues.

Electricity Tariffs

Tariffs for electricity also have increased five times since the beginning of 1992, and most recently in February 1993 (See TABLE 3 and FIGURE 2). Industry continues to pay much higher tariffs, while the agriculture, urban and rural residential sectors remain politically-preferred customers. While tariffs have been raised for agriculture and residential consumers, they remain

TABLE 3
ELECTRICITY TARIFFS FOR ALMATY*
Kopecks/kWh*
(1991 - February 1993)

Consumer Class	1991	Feb 92	May 92	Jun 92	Nov 92	Feb 93
Industrial						
A. > 750 kVa	3.67	35	44	114	310	770
B. < 750 kVa	6.08	70	90	235	520	1150
Agriculture	1.63	8	8	32	135	540
Residential						
A. Urban	3.92	12	12	24	48	130
B. Rural	.99	8	8	16	32	100

* There are 100 kopecks/ruble.

at or well below generation costs. In December, it was estimated that the average cost of generation of electric power was about 94 Kopecks per kilowatt-hour. As with costs for thermal power production, electricity generation costs increased several times by May 1993 to 5 rubles/kWh. One official commented that his electric power bill for a month was equal to no more than the cost of 3 loaves of bread or a pack of cigarettes. Under such circumstances, there can be no incentive to save energy. Indeed, such low tariffs are conducive to the use of electric power far beyond normal needs, and wastage is high.

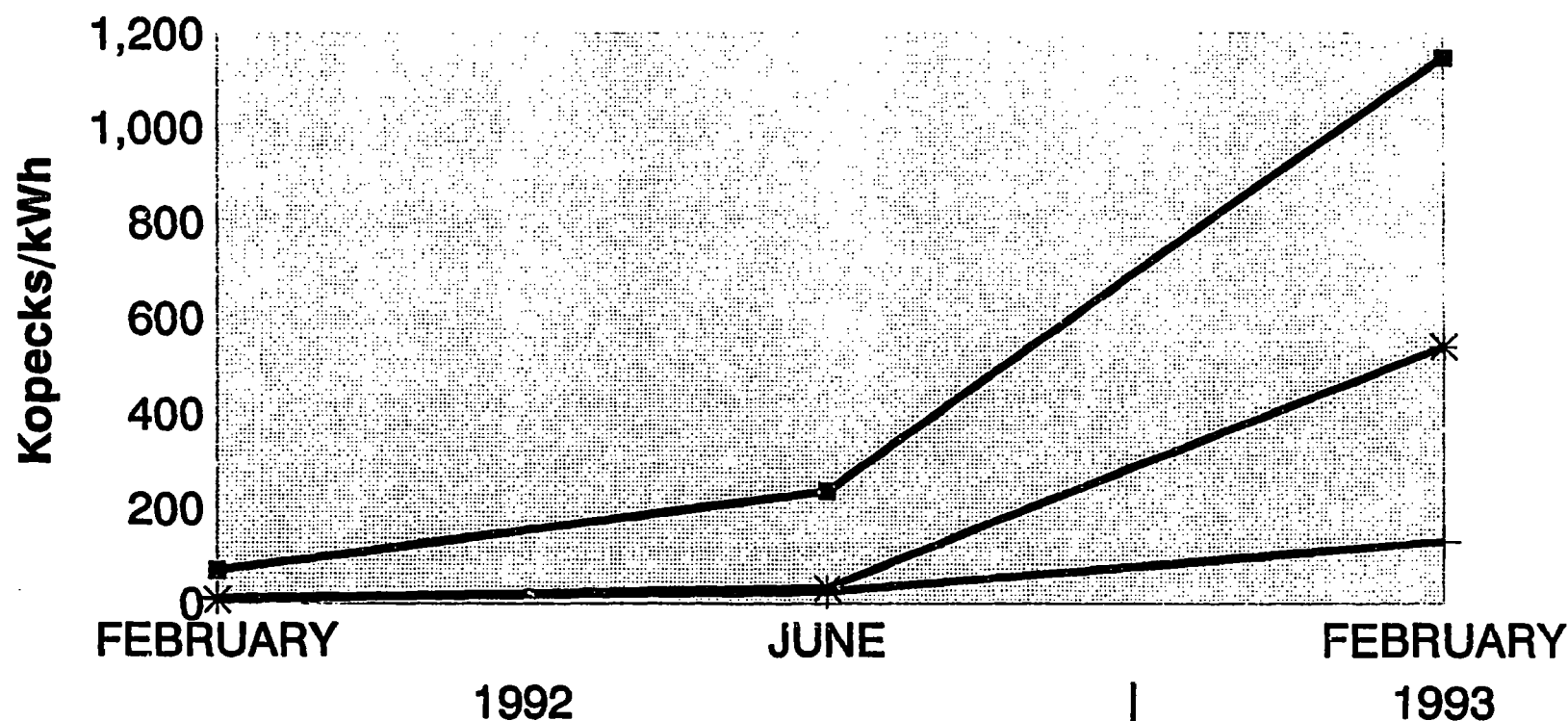
* Source: AAE

FIG 2

ALMATY

Electricity Tariffs

February 1992 - February 1993



■ Industrial* + Urban Residential * Agriculture

* Category 1, capacity to ≤ 750 kVa.

B. Financing

Prospects for financing projects to improve energy efficiency in district heating operations are not promising. Tariffs are not high enough to provide the necessary new capital and domestic commercial banks, to the great displeasure of the authorities, charge 70-80 percent interest for loans. The banking system has come under severe criticism for such practices. However, considering that the inflation rate is averaging 40 percent per month, banks' interest rates could be significantly higher in an attempt to match soaring inflation. In addition, Kazakhstan may benefit from proposed efforts by Russia's central bank to lower the interest rates charged by its commercial banks. Since interest rates in Kazakhstan closely track those in Russia, rates in Kazakhstan also could come down.

In addition, there is a value added tax (VAT) on imported goods which raises prices to potential buyers of energy efficient equipment in Kazakhstan. Thus, any metering or other control equipment purchased by Kazakh companies from suppliers in Russia or other NIS countries would have to pay the VAT. Some relief was granted beginning January 1, 1993 when the VAT was reduced from 28 percent to 20 percent.

Similarly, Kazakhstan also imposes import duties on most goods, including energy efficiency equipment, posing significant physical and financial barriers in obtaining such technology. Import duties on equipment could be reduced or eliminated, leading to more efficient energy utilization since importing such equipment would be cheaper and more easily accessible. The revenue from such duties undoubtedly is limited and the loss of revenue could easily be recouped through conservation and enhanced energy efficiency. In addition, granting priority access to foreign exchange for industries making energy efficiency investments can help enterprises in procuring equipment.

There are no government programs such as grants for technology demonstration or audits, subsidized interest loans, loan guarantees, insurance programs for project technical performance, or revolving credit funds. Currently, there are no tax-related incentives for energy

efficiency investments, such as tax credits, tax holidays, performance-based credits, or accelerated depreciation of conservation investments. Conversely, there are no tax-related penalties. As indicated, legislation is being developed incorporating some of these financing mechanisms.

C. Prospects for Foreign Investment

If new investment capital cannot be generated internally in the short-term, then much will depend upon attracting the foreign investor. As noted, Kazakhstan is viewed by American companies as providing a more stable investment climate than Russia. U.S. Export-Import Bank lending and project insurance from the Overseas Private Investment Corporation (OPIC) are available, and a trade agreement is in place, but a number of obstacles remain:

- 1) a bilateral tax treaty has not yet been ratified;
- 2) an oil and gas law is not yet in place; and,
- 3) the ruble is not yet convertible.

Joint ventures for the supply and/or manufacture of meters and other energy efficiency instrumentation and equipment holds considerable promise for the foreign investor. A joint venture law with clear guidelines and documentation requirements has been established and a preliminary IRG estimate indicates that there is a \$2 million/year market for steam traps alone. However, how and in what form profits are earned and repatriated is the critical question in any foreign investment. Ruble profits are meaningless for the foreign firm owing to rising inflation and the rapidly declining value of the ruble. Some form of guarantee to protect the foreign investor from inflation would be required.

Rubles may be re-invested domestically in the short-run, but eventually the foreign investor will look to repatriate hard currency profits. Until the ruble is fully convertible, this will prove to be difficult on a large scale. A foreign investor may be willing to take his profits out in kind, using commodities which in turn could be exported to hard currency markets – Kazakhstan offers much in this regard in the way of raw materials. In addition, if the foreign

Investor is engaged in a joint manufacturing venture in Kazakhstan, for example, production of meters, he may be willing to export some of the meters to hard currency markets or, alternatively, barter meters excess to local needs. The foreign investor will need to examine carefully any barter payment arrangement, however, especially with regard to transportation costs, infrastructure logistics, and export restrictions and legalities.

One option to compensate foreign investors is to arrange payment in terms of a percentage of energy savings as a result of equipment installation. This provides an incentive to both the supplier and the enterprise to undertake a project which yields concrete energy savings. Payment, however, is still likely to be in rubles.

D. Energy Efficiency Labeling and Standards

To ensure that energy-using equipment operates efficiently, it should be subject to design and operating standards. Energy efficiency standards and labeling are most cost-effective for large energy-consuming buildings and equipment. Within the former Soviet Union, consumption standards existed for energy-using household appliances such as refrigerators and televisions and design and operating standards were in place for other equipment. However, officials at AAE suggested that standards should be increased and enforced to a greater degree.

Building standards have not been in place, but stricter building codes with minimum thermal efficiency levels are under consideration for construction of new facilities. For example, there are currently eight hotels under construction in Almaty (by Western companies) and the Government has required the installation of energy metering systems. With the long life span of new buildings, strict codes can lead to significant energy cost savings in the long-term.

E. Privatization

President Nazarbayev, as part of his commitment to economic reform, outlined a two-stage program for the privatization of state-owned enterprises (See Annex A for a description of the denationalization and privatization program for 1993-1995). There is a longer-range goal

of privatizing up to one-third of all Kazakh enterprises within the next few years. Thus, the official government policy is to denationalize and demonopolize many industries, and the government is continuing its efforts to develop mechanisms for privatization.

However, privatization in the energy sector is more complicated. A critical issue is determining who should be the owner of vast state energy assets and how to distribute these assets. This is a large-scale problem considering that the value of all of the fixed energy assets throughout the former Soviet Union is estimated at around several trillion rubles. As might be expected, there is some opposition to privatization and thus the Government expects that any privatization efforts in the energy sector will take place in stages over the next several years.

Clearly, greater decentralization and managerial autonomy at the enterprise level will promote market-oriented decision-making, and thus enhance the prospect for energy efficiency investments which improve competitiveness and productivity. It remains to be seen, however, how fast this process will move, and indeed if it will include a significant number of high energy consuming enterprises.

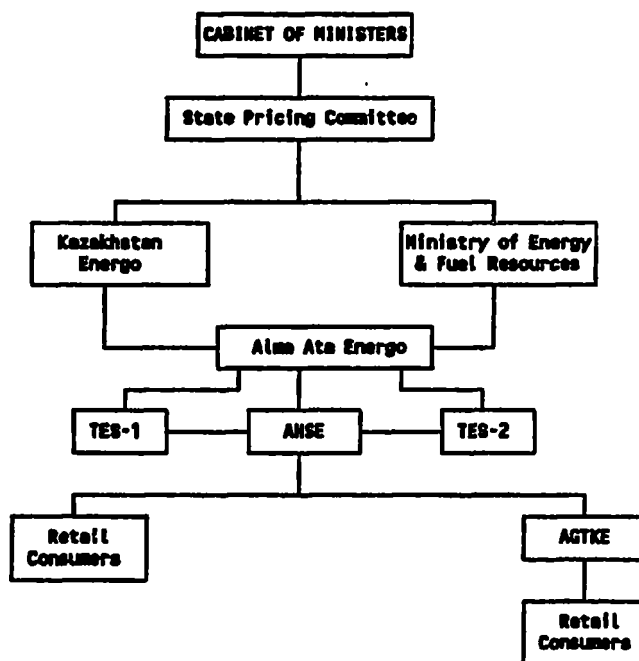
III. ENERGY EFFICIENCY IN THE DISTRICT HEATING SYSTEM

There are a number of key problems in the district heating system serving Almaty which need to be addressed in order to improve overall energy efficiency.

A. Structure of the District Heating System

FIGURE 3 illustrates the operational and technical relationship among the various organizations generating, supplying and consuming heat and steam in the Almaty district heating system.⁷

FIGURE 3.



⁷ This report draws on information included in the *Kazakhstan Audit Report for the Energy Efficiency and Market Reform Project*, prepared by the IRG Audit Team. For a more detailed technical summary of the district heating system, please contact IRG.

Two thermal energy stations (cogeneration) stations – TES-1 and TES-2 – supply thermal energy to the central mixing station of the Alma Ata Heating Systems Enterprise (AHSE). TES-1 supplies industrial steam and TES-2 supplies heat in the form of hot water. AHSE also has several of its own district boiler houses which supply thermal energy inputs to the production/mixing of steam and hot water.

The system was established in 1960 and grew over the years as demand for service increased. AHSE started with TES-1, then at the center of the city but, owing to environmental considerations was not developed beyond its initial configuration. As the city grew and new housing and industry was constructed, additional thermal demand was satisfied by the installation of local boiler houses. When the base-load became large enough, TES-2 was built.

AHSE sells steam to industrial consumers and hot water for space heating and domestic consumption (shower, bath, cooking, etc.) to industrial, residential and commercial end-users. Approximately 70 percent of AHSE's hot water is sold wholesale to Alma Ata Gorteplokkommunenergo – Alma Ata City Communal Heat Supply – (AGTKE) for distribution to residential customers (AGTKE also sells hot water to some industrial customers). AGTKE thus serves as a distributor for AHSE.

AHSE, AGTKE and TES-1 and TES-2 are part of the administrative enterprise of Alma Ata Energo (AAE). Within AAE, AHSE is one of 13 other operating entities. The operations, management, and decision-making functions of AHSE and TES-1 and TES-2 are separate. AAE serves as a coordinating body for management and operational issues which concern AHSE, AGTKE, and the two generation stations. AAE also oversees many policy issues such as developing new tariff schedules (as described in Section II), as well as financial operations. With regard to the latter, the income derived by AHSE from the supply of industrial steam and hot water to its customers is passed on to AAE, which in turn takes a percentage for administrative, review and technical costs incurred, and then redistributes a reduced sum to AHSE.

Two government entities exist at the Ministry level and loosely oversee the activities of AAE. Kazakhstan Energo is responsible for the development of policy and strategy, including energy conservation, and has input into the development of tariff schedules. The Ministry of Energy and Fuel Resources is primarily concerned with operation, administration and management of energy facilities.

The major institutional barrier to promoting energy efficiency created in this structure is the lack of autonomy in decision-making at individual enterprises. TES-1 and TES-2, AHSE, AGTKE and individual industrial facilities are subject to central control/review in most technical, administrative or financial questions by at least one (or two) levels above. Some level of regulation or oversight may be desired as is the case with many utilities serving the general public in other countries. However, the current system appears not to leave enough flexibility or independence in developing plans and making decisions to improve energy efficiency at the operational level. In other words, senior personnel concerned with making decisions regarding the improvement in energy efficiency at the enterprise level are often hindered by factors and decisions made at another level. In the case of AHSE, one major concern is the inability to control revenue flow. All revenues from sales of steam and hot water are passed on to AAE. This diversion limits the amount of funds that may be otherwise utilized for key energy efficiency investments.

In addition, AHSE maintains contracts with the industrial end-users it supplies for general supervision of facility-level energy questions, including installation of energy equipment, monitoring, and some training. In the past, this arrangement has served the purpose of centralizing technical and policy questions in one supervisory body. Individual industrial consuming entities thus have developed little in-house energy expertise, and many still have no incentive to do so (see more detailed discussion of this topic in Section III-E).

Despite this problem, communication between the various entities in the district heating system appears to be very good. Also, many senior personnel indicated that political and

central control is loosening, leaving organizations with increased independence of action, but a high level of centralization still exists.

B. Energy Pricing

Most senior policy makers and enterprise managers recognize the crucial role of higher energy prices in stimulating increased rational use of energy. AHSE and AGTKE managers are beginning to monitor energy use more closely and identify potential energy efficiency investments. Industrial plant managers also now are experiencing the impact of rising steam, heat, and electricity prices. However, rapidly changing price levels (inflation rates, ruble-dollar exchange rate fluctuation and other input cost factors) are creating a very unstable and uncertain business climate. Many enterprise managers could not identify accurately their energy costs or profit levels owing to the volatile external economic climate.

C. Lack of Adequate Technology and Systems

The district heating system is relatively old, established in 1960. Some of the pipelines have been in operation more than 25 years. There are very few control or measuring devices in evidence for either supply (AHSE), distribution (AGTKE), or end-users (industrial facilities). Little individual metering has been installed and where monitoring instruments are available, few have been utilized on a regular basis. The IRG Audit Team estimated that on the production side alone, efficiency improvements resulting from the installation of modern instrumentation and controls has the potential to achieve savings as high as 20 percent. In addition, pollution monitoring and control equipment are non-existent and there is a lack of replacement parts.

At all levels of the Almaty district heating system, from suppliers to end-users, the lack of energy metering, control and monitoring equipment is identified as the single largest (technical) impediment to the efficient provision and consumption of energy. Without instruments to monitor and record essential variables such as flow rates, temperatures and pressure, it is difficult to make any accurate balance measurements and conduct energy efficiency analyses on which plant performance can be based. This problem is particularly

severe in the residential and commercial sector. Few residences or commercial establishments have meters making it virtually impossible to charge consumers for the heat they actually use. Individual apartments do not have thermostats; customers are charged a fixed rate based on the area to be heated rather than the amount used.

Energy accounting systems, cash flow management systems, and billing systems are generally not in place or are inadequate. For example, energy billings to customers have primarily been based on estimated averages over the entire population. Government subsidies and ownership make customers insensitive to such billing. To make customers pay for what they consume, the billing system needs to be overhauled, including the installation of meters and the hiring and training of meter readers. Without a rational billing system in place, it is difficult to implement energy conservation measures. The IRG Audit Team estimated that the removal of energy price subsidies together with the institution of rational billing have the potential to achieve 30 percent energy savings on the demand side.

D. Planning and Decision-Making

Under the centralized economic system, capital investment decisions were made by the government with more emphasis placed on production capacity and meeting absolute output targets rather than productivity or efficiency. Thus, management lacks an understanding of fundamental free market principles. They are unfamiliar with cost accounting procedures and have not been exposed to analyzing the true cost of energy resources and the market price of thermal energy.

There is a significant void at individual enterprises such as AHSE, AGTKE, and end-user industrial facilities in planning, analysis, and general business management skills. There is no experience in strategic planning and thus little understanding of the techniques for evaluating and comparing alternative courses of action. In addition, there is little knowledge of how to conduct economic and financial evaluations of potential energy efficiency projects, incorporating such concepts as return on investment, net present value and discounted cash flow.

Plant management are knowledgeable in the conduct of capital-cost analyses, as indicated by their past emphasis on new construction. There is, however, a serious shortage of performance criteria based on operating costs.

E. Energy Efficiency Awareness and Programs

None of the supply, distribution, or end-user organizations in the district heating system has formal energy management teams dedicated to the review of energy efficiency issues. There is little or no training or other educational efforts aimed at increasing the awareness among staff of the benefits of energy efficiency. No detailed or extensive analyses of energy consumption patterns are conducted. Some energy data is collected and energy use is monitored, but the frequency is limited and computer systems to collect and store data are not common.

There is now greater attention given to environmental factors in operations and potential investments, and the senior staff at the district heating organizations recognize the link between improved energy efficiency and the positive impact on the environment. However, the ability to factor in environmental costs and to formalize an environmental impact review process is absent.

In general, senior personnel at AHSE, AGTKE, and AAE are very aware of the benefits of improving energy efficiency and recognize the importance of transferring this awareness to mid- and junior levels. These personnel are acutely aware of the impact of changing price levels and the need to increase prices to promote greater efficiency in the use of energy. However, while recognizing the political considerations involved in raising prices too rapidly, they understand where the potential for energy efficiency improvements exists, are generally aware of the extent of energy wasted, and are anxious to address specific investment/project ideas. For example, most of the energy losses in district heating systems are mainly due to the following causes:

- ▶ water leaks within the system;
- ▶ failure to meter usage;

- ▶ inadequate insulation;
- ▶ throttling of constant speed pumps, and;
- ▶ excessive drops.

Senior staff are keen to operate more as businesses and profit-oriented enterprises. AHSE, AGTKE, and AAE managers and senior engineers recognize that they must take action to reduce energy costs and increase overall efficiency. Senior staff fully recognize the potential benefit of increased energy efficiency in the supply of hot water and steam supplanting the need to construct additional large, new generation and distribution facilities.

This focus and awareness on energy problems in general and on energy efficiency specifically at AHSE, AGTKE, and AAE is concentrated primarily at higher levels of management. Even here, this is unusual for Kazakhstan. It must be noted that this is in large part owing to the fact that the central business of these entities is the generation and distribution of energy, so that energy problems and the focus on how to utilize energy more rationally and efficiently is a natural, everyday concern of the management by definition. Most of the senior management of these three organizations have given a great deal of thought to these issues.

A key factor which has served to raise energy efficiency awareness at AHSE and among other senior government officials, and which was cited numerous times during the IRG Team's visit, was the 1992 USAID-sponsored Energy Tour to the United States. This exposure to U.S. energy industries provided tremendous stimulus to thinking about energy conservation issues.

Despite this recognition of the benefits of increasing energy efficiency, senior management at these three organizations agreed that the obstacles described in this section discourage immediate action on energy conservation issues. In addition, however, there is widespread feeling among the IRG Team and host-country senior management that one of the most important preconditions for energy efficiency improvement is a change in attitudes and behavior at all levels of enterprises, especially mid- and lower levels. Generally, personnel at this level are not aware of, or actively involved in, energy efficiency efforts or its benefits.

AHSE

AHSE does have a 4-person team which is responsible for energy issues. However, this team looks only at technical issues, specifically telemechanization. They do not have the requisite skills to conduct strategic planning, economic or financial analyses of energy conservation investments. There is no system in place to examine energy consumption patterns, collect, store and analyze data. In addition, they lack a primary accounting system. However, AHSE is beginning to computerize all types of information, including energy data and it is expected that this will greatly assist in targeting areas for energy conservation.

In mid-1992, AHSE established mandatory weekly classes, but these primarily focus on engineering and equipment issues. They are starting to incorporate instruction in the value of energy efficiency. Many engineers do not want to attend the classes and it has even been reported in other enterprises that workers will destroy equipment deliberately out of fear that increased efficiency and productivity introduced through modern equipment will threaten their jobs. Nevertheless, there was no indication that labor unrest was a problem for enterprise managers.

AHSE has recently (in place for about one year) approved an employee incentive/bonus program (complete with suggestion box). Bonuses are paid to those employees based on a percentage of energy saved from their ideas. This program reportedly is beginning to show results.

AHSE is starting to look at environmental questions -- particularly related to siting of new structures -- but formal environmental impact analysis is not conducted. The environmental movement in Kazakhstan might be expected some day to take strong exception to the regular practice by AHSE of dumping some 100,000 metric tons (3.1 million gallons) of hot water into the streets every year in order to carry out scheduled repairs of the pipeline network. The discharged hot water, cascading down the open drainage systems in the streets, is responsible for damaging and/or killing trees.

There has been no consideration of AHSE assuming the role of direct distributor to AGTKE's residential customers. This would add a significant administrative burden since AGTKE has 5,000-6,000 personnel. Also, the lack of metering and thermostat controls at the residential building level makes the monitoring of energy use difficult, and thus a major additional technical concern that AHSE does not necessarily want to assume.

AGTKE

As indicated, AHSE sells hot water wholesale to AGTKE, which serves as the distributor to the residential sector. AGTKE sells retail to households at a lower rate than its wholesale cost from AHSE, but also sells hot water to some large industrial consumers. AGTKE indicated that the residential subsidy is covered by its sales to industrial consumers, providing a slim profit margin. The tariffs charged at each level are determined by the government (Kazakhstan Energo and the State Pricing Committee). AGTKE is independent operationally and administratively from AHSE and has no input into the development of prices (as does AHSE) - that is, it does not contribute to tariffs proposals developed by AAE.

Customers have a fixed payment – due monthly – which they send to the bank. The bank then forwards notification of payment to AGTKE where billing is tracked on a computer program. This computerized process has been in existence for three years and AGTKE appears to be content with it in as far as the tracking aspect. However, the difficult economic environment, especially increasing prices and inflation, has taken its toll on customers' ability to pay. At the end of 1992, its customers owed AGTKE 300 million rubles, and AGTKE, in turn, owed AHSE 250 million rubles.

Management is anxious to improve overall energy efficiency on the supply side. Energy measurements are taken on individual boilers on a monthly basis. Temperature regulation and material consumption is regulated at a centralized source. AGTKE does not have a formal, in-house energy conservation team. Some technical training is conducted for engineers, but it is done once every three years and then only to upgrade and/or maintain certification. This

training does not include specific instruction in energy conservation activities at the plant level. Only minimal economic and environmental analysis is conducted on investments, and these limited skills are concentrated at the senior management level.

On the consuming side, however, there is no incentive for household end-users to consider energy savings – none of the customers are metered for thermal energy consumption and billed as such. As the primary residential distributor, AGTKE determines how much heat and hot water is provided to individual apartment complexes. However, AGTKE has insufficient metering to monitor heat and hot water consumption at the substation and building level and, as mentioned previously, individual end-users cannot control unit temperatures owing to lack of thermostats. The challenge, therefore, is two-fold: (a) to obtain and install much needed instrumentation, and (b) to educate the customer. They strongly emphasized that these are their most significant problems and are extremely interested in any efforts to address them, including participating in residential demonstration programs.

Pepsi Cola Bottling Plant and Alma Ata Carpet Factory

It is fair to say that few energy efficiency initiatives have been implemented or even considered at industrial facilities in Kazakhstan to date. This is in large part explained by the history of tariff subsidies which have discouraged the conservation of energy. Many commercial customers are institutional entities which are entitled to free services from all utilities, including hot water. Thus, these customers typically have not been concerned with energy issues and overall energy efficiency for these customers is a very low priority.

Both the Pepsi Plant and the Carpet Factory exhibit energy efficiency problems common throughout the industrial sector. As with most of the industrial consumers it supplies, AHSE has a contractual relationship with both of these enterprises to conduct energy engineering work, including the installation of equipment and monitoring/measuring activities. There is no group of in-house energy conservation specialists working at the plants, although there are engineers who supervise general technical operations. There are no in-house energy efficiency awareness

programs or training efforts.

Both facilities consume energy in the form of heat, steam and electricity supplied from AHSE. However, as with most industrial enterprises, there is a severe lack of measuring and control of energy use and what instruments are available are relatively old and crude. AHSE does not have a meter at the "gate" of the Carpet Factory, and billing is based on estimates of consumption. At the Pepsi Plant, steam and hot water are metered at the main receiving station for the entire compound.

Each of these enterprises recently became joint stock companies. This independence together with rising energy prices and costs have increased awareness of the benefits of energy efficiency, especially the importance of energy measuring and controls. This is a typical scenario throughout the country. In Kazakhstan, only 10 percent of the industrial users have orifice-type flow meters to measure hot water/steam flow rates. Senior staff at both plants strongly indicated that installing energy metering and control technology is a very high priority.

Currently, however, most industries are experiencing a deficit and, subsequently, district heating systems are operating at a loss. As a result, the government is subsidizing industry. A real dilemma exists: industrial enterprises want to increase their energy efficiency in light of rising energy prices but any significant steps toward improving energy efficiency entail modernizing facilities and implementing new production processes, since current facilities and production methods are already outdated by Western standards.

In other words, significant capital investment is needed to upgrade industrial operations in order to be competitive in energy efficiency and productivity. Until industry achieves this level of efficiency, it will be difficult to pay for energy costs approaching world market levels. On the other hand, without the existence of world market level energy prices, industry will not attract the substantial capital investment needed in the first place.

Despite the increased awareness of energy efficiency needs, including greater instrumentation at the plant level, each of these enterprises is content for the moment to continue its relationship with AHSE to oversee energy matters since the energy expertise lies with this latter organization and because prices are still relatively low. Although energy costs have risen, there is no perceived urgency to develop their own in-house expertise in these matters.

In fact, although senior Pepsi staff indicated a strong desire to increase instrumentation, they described a scenario in which they would purchase this type of equipment and AHSE would conduct the installation. This raises several additional obstacles to energy efficiency. First, these meters are manufactured in Russia and there is not a high level of confidence in their quality or regular supply. Second, and more importantly, is obtaining the funding for energy efficiency investments in general. Most industrial enterprises have been suffering in the midst of the economic transition. Rising prices and inflation as well as fluctuating exchange rates have dampened consumer demand and led to a decrease in industrial output. As described in Section II, high interest rates are making loans/financing for enterprise-level investments virtually impossible. In addition, there is the 20 percent VAT on the sale of this type of equipment.

It is also clear that many industrial enterprises in Kazakhstan are very interested in joint partnerships with foreign companies to assist them in financing and equipment purchase/upgrading. Although foreign companies have approached industrial enterprises and there are laws on the books governing the establishment of joint ventures, there has been little participation to date, much to the disappointment of the Kazakhs. This is owing to the still unstable economic situation and in particular to the inconvertibility of the ruble. (These problems are discussed in more detail in Section II).

An additional impediment to the efficient supply of heat to the Pepsi Plant is administrative. Heat supply is contracted with the "Drinks" Trade Association which, in turn,

obtains heat from AHSE. Pepsi wants to contract with AHSE directly, believing that this would be technically and administratively more efficient.

Staff at both plants emphasized that estimating energy costs is extremely difficult in the current economic climate – spiralling prices, inflation, and the increase in many other costs makes it virtually impossible to estimate these figures with any degree of detail or reliable accuracy.⁶ Clearly, this is not a climate conducive to investing, including in energy conservation. Thus, improved economic conditions would be one of the prime incentives in promoting energy conservation.

Pepsi staff do conduct market analyses and are aware of other companies' efforts. However, Pepsi enjoys a significant advantage over competitors in name recognition and quality. At the time of the visit, there was no production since there is a shortage of bottles, owing in large part to the disruption of supplies from Russia and Ukraine. Pepsi also expressed that it would welcome the opportunity to become a demonstration plant for energy efficiency.

At the Carpet Factory, several of the shareholders in the new joint stock company are some of their raw material suppliers as well as AHSE, creating an interlocking relationship where all parties have a stake in the success of the enterprise. The business appears strong and the factory is current on its energy debts, i.e. payments to AHSE. The plant only exports about 1-2 percent of its product, although management would like to export more. They have a barter arrangement for spare parts with Germany, and also export to Turkey, China and Iran. They have no current interest in foreign share participation.

F. Energy Efficiency Industry and Services

To increase energy efficiency awareness and implementation, an approach successfully implemented in many countries has been to use industry and professional organizations as

⁶ Although Pepsi did hazard an estimate that energy costs represent about 10 percent of total final product value.

primary vehicles to promote and disseminate information on energy efficiency options, costs, and returns. However, in Kazakhstan there are no enterprises or Government units that have adequate (or any) equipment to conduct energy audits or to identify and institute energy improvement programs. The IRG Team found no providers of industrial energy efficiency services, nor a network of reliable providers of such equipment. There are no institutes, foundations, or centers for energy conservation which might make engineering specialists, equipment, or services available to stimulate energy efficiency. While overall energy engineering skills and training is good, there is no organized pool of trained energy efficiency specialists to be tapped by enterprises needing such services.

However, one exception to this situation has emerged. An organization, *Interenergiya*, has been formed as a private subsidiary of AAE, which is 50 percent government-owned and 50 percent held by private individuals. The largest government entity in terms of financing provided is AAE and many of the private individuals are members of large state energy enterprises. It is expected that the government share of the company will be bought out by the private investors by the end of 1993. The purpose of the company is to provide energy efficiency services and equipment to enterprises in Kazakhstan through joint ventures with foreign equipment suppliers, manufacturers, and developers.

The energy efficiency equipment industry itself is severely underdeveloped. There are few producers of instrumentation/controls and other equipment. As mentioned, there are several manufacturers of meters in the other NIS countries, but most equipment is outdated and/or unreliable.

IV. RECOMMENDATIONS

The potential benefits of energy efficiency improvement to the district heating system enterprises and industrial end-users, as well as the economy of Kazakhstan in general, are sufficiently great to justify continued action and assistance in this area. The following are the IRG Team's recommendations to be pursued.

1. Continued Removal of Energy Price Subsidies

It is clear that as long as thermal energy and electricity prices remain subsidized, there will be little incentive for energy efficiency. Policy makers recognize this and have made a commitment to raising prices, as illustrated in TABLE 2. However, the burden on average consumers of rising prices cannot be ignored. Therefore, pricing policy should be balanced and attempt to minimize the social and economic impact as government subsidies disappear.

2. Financial Incentives

Rather than specialized financial incentives, perhaps the most beneficial incentive is an overall economic and monetary situation which permits reduction of nominal interest rates to reasonable levels and, on a controlled basis, creation of sufficient liquidity in the financial system to permit long-term lending to borrowers based on enterprises' credit-worthiness and prospective returns from the proposed funds borrowed. Certain specific policies can be helpful, however, and the Government should consider some of the following policies and programs.

- A. Reduction or elimination of the VAT and duties on imports of energy efficiency equipment. This will encourage the importation of much needed equipment not found in the domestic market.
- B. Grant priority access to foreign exchange for industries making energy efficiency investments. Importing specialized energy efficiency equipment and services has a high foreign exchange component. Facilitating access to foreign exchange can

increase access to these services and equipment.

- C. Grants/No-Risk loans for audits and preliminary engineering studies. In order to enhance knowledge of the potential benefits of energy efficiency and to alleviate some of the risk and uncertainty attendant with first time investments, governments can establish grants or no-risk loans for preliminary engineering work or audits. The enterprise would be obligated to repay the loan only if the audit/engineering work identifies energy efficiency opportunities. The overwhelming benefit is that a small amount of government funds can result in significant capital outlay in energy efficiency improvements. These programs are most effective when the loans are interest-free or below market rates. The disadvantage to this program is the increased administrative burden and capital expenditure by the government.
- D. Subsidized-Interest loans. Under this type of program, the government can make credit available to energy users for energy efficiency investments at a lower cost of capital than could be obtained from financial institutions at market rates. The drawback to this program is that actual capital cost is not lowered, only the financing cost is reduced. In addition, it requires capital expenditure from the government.
- E. Loan guarantees. Financial institutions may not be prepared to make loans to enterprises for energy efficiency investments owing to the perceived risk and uncertainty of such projects or concern about the stability of the borrower. A mechanism to address this problem is for the government to guarantee qualifying loans, often 80-90 percent of a loan. These programs tend not to promote marginal projects but can be implemented at relatively low cost to the government. However, in Kazakhstan, where interest rates at local banks are in the range of 70-80 percent, this program would not offset the cost to the

borrower, rather reduce the risk to the lender.

- F. Revolving credit fund. This program creates a protected reserve of funds to be used only for energy efficiency project financing and cannot be appropriated for other purposes. Funds are lent through the government and when loans are repaid and/or as additional capital becomes available, it is added to the fund. To attract interest in this type of program, money has to be provided at below-market rates. In addition, there is an increased administrative burden to the government in implementing such a fund.
- G. Tax-related incentives. These programs can include tax credits for energy efficiency investments and the production of energy efficiency equipment and instrumentation, accelerated depreciation of efficiency investments, and tax holidays. Tax credits allow an enterprise to reduce its tax burden based on a government-established percentage of the energy efficiency investment, e.g. 3 percent of the expenditure. The disadvantages of these programs is that they will only be effective if the tax code is enforced and they require active administration by the government. In addition, tax-related incentives may strengthen enterprises' inclination to seek capital-intensive solutions to their problems, while most enterprises are not yet implementing low-cost, no-cost actions.

The Government could also exempt from price or profit controls energy supply companies that provide and aggressively market energy efficiency services. This would allow supply companies to use their capital to invest in the provision of energy efficiency services.

3. Formal Government Commitment to Energy Efficiency

Experience in other countries indicates that one of the most important ingredients in promoting energy conservation and implementing a successful national program is a

demonstrated commitment at the highest political levels of government. This priority must be communicated to all relevant government agencies and to the principal energy consumers in the public and private sector. Legislation and regulations should be enacted under a coordinated national energy plan. Several policies designed to establish this commitment are presented below.

- A. Mandatory efficiency requirements and regulations for enterprises. This legislation requires enterprises of a certain size or with a certain level of energy consumption to appoint energy managers. These programs also can require firms to implement an energy management service, have energy use patterns examined over fixed periods, or develop fixed-year plans for rational energy use.
- B. Energy efficiency standards and labeling. Increasing the design and efficiency standards of energy-using equipment such as electric motors, HVAC systems, boilers, and household appliances promotes efficiency and energy savings. In addition, implementing strict building construction codes (including mandating the use of meters and insulation) to improve thermal efficiency and energy monitoring can enhance significantly rational energy use in the residential and commercial sectors.
- C. Creation of a separate energy efficiency institution. Responsibility for promoting energy efficiency is often fragmented throughout the government. Creating a separate institution, with a full-time staff, appropriate authority, technical expertise, and effective communication with other government agencies and the private sector can substantially bolster the government's ability to promote and implement a successful national energy efficiency program. This organization's responsibilities can include analyzing consumption patterns, establishing quantitative conservation goals, collecting data, undertaking special studies, sponsoring research, development and demonstration programs, conducting

public awareness and outreach campaigns to educate the public on the benefits of energy efficiency, developing, enacting, and enforcing regulations and standards, and developing and implementing training programs.

4. Plant-Level Incentives and Awareness-Building

The following practices/efforts are recommended to promote worker productivity and improve overall energy efficiency:

- awarding bonuses to employees for energy-saving suggestions;
- establishing annual goals for energy consumption per unit of product, with monthly monitoring;
- creating "Energy Committees" to identify energy-saving opportunities and implement solutions;
- assigning specific individuals the responsibility for improving energy efficiency;
- holding regular meetings or seminars on energy-saving for all employees;
- completing daily (or weekly) analyses of energy consumption to detect potential problems; and
- scheduling operations to minimize energy demand.

5. Decentralizing Management in an Emerging Market Economy

Despite considerable progress in moving toward a market economy, many managers still cling to the essence of central planning and to multiple layers of bureaucracy. Unnecessary bureaucracy can be removed, costs reduced, and decision-making facilitated.

Entities which generate revenues (and sometimes profits) are unable to raise new capital required for maintenance, repairs, expansion and investment in energy efficiency equipment because revenue flows to other, generally administrative, levels within the hierarchy. What is returned to the operational level is inadequate for these needs. If Kazakhstan is to implement successfully its economic reform programs, more freedom of operation, decision-making, and full access to revenues must be granted to energy enterprises and end-users in the industrial sector. Greater autonomy will assist in the move toward operating as profit- and market-oriented businesses. In short, continued decision-making decentralization is required to increase in-house energy efficiency capabilities at all levels.

6. Technical Assistance In Energy Efficiency

The current USAID program serves to demonstrate the benefits of energy efficiency, particularly the low-cost, no-cost options which will yield rapid returns. This assistance is building support for more far-reaching programs, laying the groundwork for an effective long-term energy efficiency program.

A massive influx of equipment and technology is required to assist individual enterprises to rebuild and become competitive. Additional assistance in conducting basic energy auditing and identification of low-cost and no-cost energy efficiency measures should be intensified. This assistance can be provided by USAID and other international donor agencies, but must be undertaken rapidly. Most required energy efficiency technologies/practices are inadequate or simply absent. Equipment needed includes small-scale, low-cost, no-cost, fast payback instrumentation and control systems such as, microprocessors, gas analyzers, flow meters, flue gas oxygen analyzers, heat meters and thermostatic controls, automated PC-based control and monitoring systems, infrared and contact thermometers, and pipeline insulation. Rational billing systems and steam traps are examples of systems/technologies which can be implemented inexpensively and quickly with fast payback.

Of particular importance for district heating systems in Kazakhstan is assistance in conducting water audits and leak detection. Estimates of the volumes of hot water lost through leakages and accidents are difficult to establish, but is considered to be substantial. While the service life of pipelines is reportedly 25 years, they actually last no longer than 15-20 years. Just 5 kilometers (km) are replaced annually -- out of a system that covers a territory 15 km (east to west) by 10 km (north to south) with 232 km of pipelines. Thus, these inexpensive and highly effective measures/technologies can yield very rapid, tangible energy savings.

Larger scale, more capital intensive projects and equipment are also needed to modernize facilities and implement new production processes. For example, there are opportunities to satisfy electric power demand growth within the system through the

cogeneration of electricity. In addition, since most of the hot water boilers in the system are natural gas-fired, they would be suitable for gas turbines with combined cycle capabilities. The long-term outlook for the combined cycle option is very attractive, especially given the expected development of the Tengiz oil/natural gas field in Kazakhstan which promises to yield significant oil and gas supplies. Development of the Aktyube deposit in the western part of the country, being developed by Turkey, also will contribute to this strategy. In addition to help meet demand, increased use of natural gas will assist in reducing pollution especially during the winter heating season which begins October 15. The IRG Audit Team concluded that combined cycle gas turbines are the most attractive alternative for upgrading Kazakhstan's power generation and district heating systems. However, these indigenous gas resources are not likely to be developed to service Almaty in this decade owing to long-lead times for project development/implementation and pipeline construction.

7. Residential Metering Demonstration Program

Residential demonstration projects are needed to illustrate the effectiveness of demand side management at the household end-use level. These programs can involve selecting typical residential and commercial buildings and related substations, and include the installation and operation of heat and flow meters, temperature and pressure gauges, transmitters, thermostatic valves, heat exchangers (if the same hot water source is supplying both space heating and other uses, as in Kazakhstan), recorders and indicators, computer consoles, modems and phone lines. Care must be taken to identify typical buildings with common physical features, such as piping layout, boiler conditions, substation design and set-up, and pipe conditions. In buildings over 30 years old, space heating systems (radiators) are equipped with double pipe systems, while newer buildings have a single pipe system. With a double pipe system it is relatively easy to apply a thermostatic control at each radiator in individual apartments. Single pipe systems require additional plumbing work to regulate and monitor usage. In addition, it should be noted that in comparison to some of the short-term equipment and technical assistance described above, this type of program is likely to be more expensive to implement and have a longer payback period. Nonetheless, it remains an area where significant gains in

energy efficiency are possible.

8. Training

There is a strong need to establish training programs for enterprise managers to assist them in the technical aspects of energy efficiency improvement, the basics of business management, and free market principles. Managers and all levels of technical personnel require training to evaluate new investments, as well as in the installation and operation of energy efficiency instrumentation and equipment. Training is required in the development of energy efficiency programs, and to improve skills in the areas of economic project analysis, investment project evaluation, and long-term strategic planning. One alternative is to present intensive 3-5 day workshops on strategic planning and decision-making to invited executives from all across the district heating and industrial sectors. Other efforts can include utilizing outside experts to provide technical assistance in developing strategic plans at the plant/organizational level and sending key host country executives to training programs in the United States.

9. Development of Domestic Energy Efficiency Industry/Activities

Kazakh district heating enterprises as well as industrial end-use facilities have little access to modern energy efficiency technologies and to companies, particularly U.S. firms, providing those technologies. Virtually all entities contacted by the IRG Team in conducting the policy and institutional analysis expressed a strong desire to establish relationships with U.S. companies in order to improve overall energy efficiency, stimulate domestic activities, and disseminate information and technology concerning the benefits of energy efficiency. IRG highlights several recommendations to USAID that accomplish these goals:

- Assist in the development of private service firms and joint ventures. Although there are few, if any, Kazakh private sector companies manufacturing energy efficiency equipment, AGTKE and several industrial end-users expressed interest in joint partnerships involving capital investment and technology transfer. Industrial end-use enterprises are good candidates for partnerships with American firms. Production oriented partnerships are all the more promising, given that the labor force is highly skilled and relatively inexpensive. The USAID Enterprise Fund could be a potential vehicle in addressing this issue.

- **Early Involvement of U.S. Vendors in USAID Technical Assistance.** This has proved to be effective in introducing vendors to potential markets. Vendors' participation at an early stage enables them to understand the specific heating systems and experience for themselves various local problems and prepare them for realistic and reasonable solutions.
- **Development of an Energy Efficiency Center.** This approach has been implemented in other countries. It would establish a non-profit organization dedicated to improving the country's economic development and environmental protection through energy efficiency. Although there are currently no institutes, foundations or centers dedicated to energy and energy efficiency, there is a pool of trained and skilled energy engineers, who are mostly part of government-run organizations. Once energy efficiency awareness improves throughout the country and more and more specialists in energy efficiency are trained, these individuals could form the nucleus of such an Energy Efficiency Center or Foundation. These individuals would provide audits, general services, and training to the district heating and end-user entities in order to disseminate awareness, skills and the benefits of energy efficiency.

10. Formation of a Energy Efficiency Company

A recent idea which has gained much support is to form a company specifically for the purposes of supplying and installing low-cost energy efficiency equipment with high payback. This company would be partly owned by a U.S. energy development firm, a U.S. equipment manufacturer/supplier, and potentially an appropriate government and/or private sector entity in Kazakhstan. The U.S. private sector as well as U.S. government entities such as the Export-Import Bank and OPIC (for example, with the latter, under the *Project Development Program for Central and Eastern Europe and the Newly Independent States of the Former Soviet Union*) could provide some initial capital financing. The goal of such an entity would be to facilitate immediate transfer of much needed energy efficient equipment with high payback and quick impact. The most appropriate technologies for the district heating systems are water audit/leak detection equipment and steam traps. As discussed, the formation of *Interenergiya* is a start in this direction.

ANNEX A

**NATIONAL PROGRAM OF
DENATIONALIZATION AND PRIVATIZATION**

SECOND PHASE 1993-1995

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**THE NATIONAL PROGRAM OF DENATIONALIZATION
AND PRIVATIZATION IN THE REPUBLIC OF KAZAKHSTAN
FOR 1993-1995 (SECOND PHASE)**

Introduction

The national program of denationalization and privatization, hereafter referred to as "The Program", defines the goals, tasks, procedures, and timetable for the conversion of state-owned property in the Republic of Kazakhstan into different forms of private property from 1993 to 1995.

The primary goal of privatization is to create the necessary conditions for a transition from a centralized planned economy to a market economy on the basis of personalizing property rights in the process of returning state-owned property to the republic's population by means of gratuitous and non-gratuitous transfer of industrial plants and other material and non-material assets currently owned by the state.

The realization of this goal will require the accomplishment of the following basic tasks:

- promotion of the emergence of market-oriented business entities by means of converting most state-owned companies into joint stock companies, small-scale and large-scale privatization of state-owned property, and the creation of conditions which will allow all segments of the population to participate in the privatization process;
- development of a stratum of private property owners as efficient managers;
- the implementation of specialized plans for converting large and unique national economic sectors;
- the development of economic organizational structures in which private business will predominate and which will involve the participation of foreign investors;
- the development and consolidation of a system of investment businesses as participants in the securities market;

The Program defines the basic strategies for denationalization and privatization from 1993 to 1995. It defines privatization procedures and categories consistent with the Constitution of the Republic of Kazakhstan and a "Program of Emergency Anti-Crisis Measures and Measures to Advance Social and Economic Reform (for the Period of Economic Stabilization and Transition to a Market Economy)", the prospects for Kazakhstan's social and economic development, the characteristics of different industries, and the place and role of businesses and organizations in social production.

The second phase of the process of denationalization and privatization of state-owned property in the republic will involve the appropriate combination of measures prescribed by the Program.

The list of entities subject to denationalization and privatization in line with the Program itemized for each category of privatization is subject to government approval on an annual basis. Information on these entities will be made public on a regular basis.

All state-owned entities are divided into two categories:

- entities subject to denationalization and privatization;
- entities whose privatization is prohibited by law. The grounds for assigning an entity to one of the above categories include the advisability of maintaining state ownership; the industrial affiliation of the entity; and the social and economic significance of the goods and services it produces.

Entities which are defined as the exclusive property of the Republic of Kazakhstan, including its land, its mineral resources, its water, its air, its flora and fauna, other natural resources, historical and cultural landmarks, the cultural and historical treasures of the people of the Republic, government budget funds, national insurance reserve and other funds, businesses and property which serve to preserve the republic's sovereignty, sustain its social and economic development, and institutions which are financed exclusively with government funds are not subject to privatization.

I. Basic Categories of Privatization

The basic categories of privatization mean combinations of privatization procedures and forms tailored to meet the specific needs of each type of entity subject to privatization.

The criteria for assigning an entity to one category of privatization or another include the economic importance of the entity, its industrial affiliation, the number of employees, and the value of its fixed assets.

Businesses and organizations are conventionally classified as follows on the basis of the number of employees:

- small businesses with less than 200 employees;
- medium-sized businesses with 200 to 5,000 employees;
- big businesses with more than 5,000 employees.

In drafting the annual lists of entities subject to privatization, an entity's classification as a small, medium-sized, or big business may be revised on the basis of its industrial, regional, and other characteristics.

On the basis of size classifications, the Program calls for denationalization and privatization processes to develop in the following directions:

- the privatization of big and unique property agglomerations on the basis of specialized plans;
- large-scale privatization of medium-sized businesses;
- small-scale privatization on the basis of auctions and competitive bidding for small retail and service businesses.

Specialized privatization plans make it possible to provide an optimal organizational structure for important businesses in key sectors of the economy, determine the best possible mix of private and state management, and attract domestic and foreign investors, starting at the state of development of the plan.

Large-scale privatization will provide a solid foundation for the emergence of a broad segment of property owners directly engaged in supplying goods and services to the consumer market.

Small-scale privatization will provide a solid foundation for the emergence of a broad segment of property owners directly engaged in supplying goods and services to the consumer market.

Privatization vouchers which give each resident of the republic the right to acquire a certain share of state-owned property will allow members of all social strata of the Republic to participate in the privatization process.

Two types of privatization vouchers will be used in the second phase of privatization in Kazakhstan:

- privatization vouchers used to purchase housing (housing vouchers);
- privatization investment vouchers.

Housing vouchers, which could only be used to purchase housing in the first phase of privatization, may also be used in the second phase as a means of payment at small-scale privatization auctions and competitive bidding procedures conducted for the purpose of selling small retail and services businesses in addition to (after) their use for purchasing housing. Privatization investment vouchers may be used in large-scale privatization by means of investing

them in special privatization investment funds used to purchase shares of stock in businesses converted into joint-stock companies.

1. Converting State-Owned Businesses Into Joint-Stock Companies

The conversion of state-owned businesses into joint-stock companies means converting them into companies in which all the shares are fully owned by the state. This process is an essential initial phase in the privatization of all entities not subject to auction or sale by competitive bidding in the small-scale privatization process.

The conversion of state-owned businesses into joint stock companies will make it possible to:

- change the organizational structure of the management of these companies and make management more efficient by allowing the stockholders (i.e., in state-owned holding companies and joint-stock companies, the government) to appoint the boards of directors of these companies;
- make the boards of directors and management of joint-stock companies personally accountable for the financial condition and legitimacy of all of the company's activity and responsible for submitting annual reports to the stockholders;
- commercialize the activity of converted businesses;
- accelerate the privatization process by having the government transfer its ownership rights to all or a portion of the shares to juristic and natural persons (corporations and individuals) on a non-gratuitous or gratuitous basis;
- lay the ground-work for converted state-owned companies to engage in entrepreneurial activity in foreign markets.

The republic's government will initiate the conversion of state-owned businesses into joint-stock companies, whose shares will be owned by the state and which will be managed by a system of holding companies.

The procedure and conditions for converting state-owned businesses into state-owned stock companies will be established by an appropriate order of the President of the Republic of Kazakhstan. These measures must facilitate the implementation of an effective government investment policy and an orderly procedure for registering the transfer of stock and protecting the interests of the stockholders.

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In order to encourage employees of the businesses to support the conversion process, labor collectives (employees) who develop a conversion plan for a business acceptable to a subcommission of the National State Property Commission of the Republic of Kazakhstan will be given the right to acquire up to 10 percent of the charter capital of the converted business free of charge in the form of preferred stock, but not to exceed 12 times the average monthly salary per employee at the business.

After state-owned businesses have been converted into joint-stock companies, the National State Property Commission will be responsible for further privatization of the businesses.

Businesses included on the list of privatized entities subject to government control in the transitional period will be converted into joint-stock companies with varying percentages of government ownership.

If the Commission so decides, government-owned blocks of shares in joint-stock companies partly owned by the government may be transferred to holding companies or holding-type stock companies. These companies shall be established as restricted joint-stock companies which shall operate on a commercial basis and allow the government to maintain effective control of key sectors of the economy.

The establishment of holding companies will involve the successive implementation of the following steps:

- the conversion of state-owned businesses into joint-stock companies;
- determination of a list of businesses which must be coordinated from a single center and have very close economic ties to one another;
- determining the government's controlling block of shares;
- establishing a holding company and transferring rights of ownership, use, and control of the government's controlling block of shares to the holding company.

The implementation of this conversion procedure will make it possible to provide a clear delineation of the functions of government regulation and business management.

Government administrative agencies should be responsible for regulating the activity of the holding companies by appointing their managers (their presidents and members of the boards of directors) and by monitoring the advancement of national interests, including environmental protection, the implementation of government programs, and so forth.

The holding company's board of directors will be responsible for financial oversight over the operations of the holding company's stock companies by including representatives of the

holding company in the companies' governing bodies, analyzing the profitability of the companies over time, monitoring major investments, and so forth.

The companies' managers, which will be appointed by the holding company and report to it, will be responsible for the day-to-day management of the companies' operations.

The most desirable option for the Republic of Kazakhstan would be to establish several specialized holding companies for different industries and give them the opportunity to diversify by developing new operations or acquiring blocks of stock at their discretion. By providing for the concentration of financial resources and targeted investment of these resources, the holding company's organizational structure will facilitate rapid diversification of capital by developing new operations or acquiring existing businesses.

If immediate changes in the management structure of an industry are necessary, holding companies may be established from existing state-owned businesses to be followed by conversion into joint-stock companies.

As soon as the companies become stably profitable and efficient and there is no longer any need for government control of their operations, the state-owned blocks of shares could be sold to private individuals and non-government corporations, including foreign corporations.

If the Commission so decides in consultation with government administrative agencies, the state-owned blocks of shares in the aforementioned stock companies might be replaced by so called "gold stock".

A "gold stock" is a security which is owned by the government and confers veto powers in deciding the following issues: changes in the company's profile, limiting the company's fulfillment of priority government purchase orders, allowing the company to engage in environmentally hazardous operations, and a number of others.

Monopolies will be eliminated and kept from re-emerging by establishing several holding companies in the same industry or diversifying their operations.

The National Privatization Fund established by the Commission will be responsible for organizing auctions of state-owned blocks of shares to privatization investment funds at the behest of the Commission.

Centralized recording and gathering of information on the registration and operations of joint-stock companies will be the responsibility of an information center, which, as it develops, could be converted into a national archive.

2. Privatization on the Basis of Specialized Plans

Specialized denationalization and privatization plans will be developed for especially large and unique facilities and businesses.

Unique facilities means businesses which manufacture products or provide services of special social significance or are natural government monopolies.

Specialized denationalization and privatization plans will be developed under the supervision of the Commission, which will, if necessary, be responsible for the choice of consulting or management firms.

A specialized plan will involve a phased program of action, to include:

- a comprehensive analysis of the operations and competitiveness of the entity and an appraisal of its property;
- a system of proposed organizational, engineering, and other changes in the entity, including steps to demonopolize its operations;
- a choice of privatization forms and procedures.

Privatization plans must be designed in accordance with the requirements of the law of the Republic of Kazakhstan and in consultation with the National Commission for Anti-Monopoly Policy.

On the basis of the evidence provided, the National State Property Commission shall determine the readiness of the entity for privatization, and if its conclusion is in the affirmative, it shall approve the plan and authorize conversion of the entity. Specialized privatization plans might be implemented by the following procedures:

- sale to a specific investor on explicit terms;
- sale by means of auctions or competitive bidding processes;
- the conclusion of a management contract;
- public sale of stock.

The sale of stock to a specific investor on explicit terms involves the sale of stock to corporations and individuals who agree to meet certain conditions (the implementation of investment programs, preserving a certain number of jobs, preserving the current type of operations, improving the quality and competitiveness of the businesses' products, and so forth).

This type of privatization may be used to establish a stable group of potential investors attracted for the purpose of "putting the business back on its feet."

Auctions are public competitive trading sessions at which individuals or corporations can acquire state-owned entities. In this process, purchasers are not required to meet any conditions with respect to the entity, and ownership rights will be transferred to the purchaser offering the highest bid during the auctions.

In a competitive bidding process the purchaser may be required to meet certain conditions with respect to the entity (preserving the businesses' current profile or using the entity for its existing purpose, preserving a certain number of jobs, providing funds for social amenities, and so forth). Competitive bidding processes may be classified as commercial or investment processes.

In an investment competitive bidding processes, state-owned businesses may be sold to purchasers who agree to implement investment programs. The entity will be sold to the purchaser who proposes the best version of the Program as defined by the criteria for the competitive bidding process.

Rules for investment and commercial competitive bidding processes are subject to approval by the Commission.

A management contract is a way of transferring use rights to a corporation or individual. This procedure should be used if privatization of the entity would be economically impractical or premature.

A contract may stipulate the rights and percentage of ownership of the private managers in the event of subsequent privatization of the entity.

The choice of individuals or non-government corporations as contractors may be made on a competitive basis.

The public sale of stock means the sale of stock to corporations and individuals in the securities market.

The Commission may authorize the National Privatization Fund to sell stock intended for sale to the general public at public competitive bidding sessions to privatization funds in exchange for privatization investment vouchers.

On the basis of the national interests of the Republic, the Commission may decide to convert the property of an entity in its entirety without any preliminary structural changes if the process of "putting the businesses back on its feet" will be a difficult and time-consuming process. The aforementioned structural changes would then be carried out within the framework of the operations of the converted entity.

3. Large-Scale Privatization

In large-scale privatization, the general public of the Republic of Kazakhstan will be given the opportunity to acquire property rights by means of exchanging privatization investment vouchers for shares in privatization investment funds which purchase stock in businesses.

Large-scale privatization will offer the participants in the process freedom of choice, competition, openness, speed, and simplicity and will create the conditions for the efficient distribution of property with extensive participation by all segments of the populations.

Large-scale privatization is a phased process designed to last three to four years. Every year, the Commission will draft a list of the businesses to be converted into joint-stock companies with shares transferred to privatization investment funds. The mass media will inform the general public of Kazakhstan of the conditions and schedule for large-scale privatization.

At least 51 percent of the stock in joint-stock companies established from businesses and organizations not included in the small-scale privatization or specialized privatization processes shall be sold to privatization investment funds. All of the shares in businesses (except for employee shares) whose privatization will not require the preservation of government blocks of stock will be open for bidding at large-scale privatization auctions.

The block of stock left after the employees have received their shares (no more than 10 percent of charter capital) and after stock has been sold at auction to privatization investment funds in exchange for privatization investment vouchers will remain state property. This reserve government block of stock will be used for government regulations of the operations of businesses in the transitional period. Government blocks of stock may be put up for sale on the open market as needed.

Large-scale privatization will involve the following actions.

- issuance of privatization investment vouchers to the general public of Kazakhstan
- the establishment of a system of privatization investment funds operating on a commercial basis as brokers between the owners of privatization investment vouchers and businesses.

The issuance, circulation, and use of privatization investment vouchers will be governed by special regulations subject to approval by the President of the Republic of Kazakhstan.

Privatization investment vouchers will be issued by offices of the Savings Bank at the recipient's place of residence on the basis of a list of family members issued by the recipient's housing office and the recipient's passport and will be issued in the form of personal accounts with a balance equal to the total of the investment vouchers. Privatization investment vouchers will be deposited in a separate account for each resident of the Republic of Kazakhstan.

A multiplier of 1.2 will be applied to the total value of the privatization investment vouchers issued to residents of the republic living in rural areas.

These vouchers will be credited to separate accounts for children under the age of 16, and the right to dispose of these separate accounts will be transferred to one of the child's parents on the basis of an application submitted by the parents and the child's birth certificate.

The funds contained in privatization investment voucher accounts shall be invested in privatization investment funds within the time frame established by the government. The percentage of the vouchers which may be used in the first phase of the process shall be determined by the government in accordance with the approved list of entities subject to large-scale privatization. The restriction on the number of privatization investment vouchers which may be used in the first phase of the process will be imposed for the purpose of reducing the risk of the voucher's owners in the face of the still uncertain competitiveness of the privatization investment funds. In subsequent phases of the process the owners themselves will be responsible for determining the number of privatization investment vouchers they will use.

The dates for investing privatization investment vouchers will be announced through the mass media.

In each phase of privatization, a voucher owner will have the right to invest his voucher in several privatization investment funds. The choice of privatization investment funds and the number of privatization investment vouchers invested in chosen privatization investment funds are up to the owner of the vouchers.

Voucher owners should invest their vouchers in several privatization investment funds in order to reduce the risk of losses caused by the inefficiency of certain investment funds.

The prohibition against the direct exchange of privatization investment vouchers for shares in privatized businesses was compelled by the desire to avoid excessive speculative demand for stock in certain businesses and protect the vouchers of the republic's residents from unwarranted devaluation.

Privatization investment vouchers will be invested by transferring them from the owner's account to the corresponding accounts of specially established privatization investment funds. Each privatization investment fund will issue stock to be transferred to citizens in exchange for the privatization investment vouchers invested by owners in the fund. Owners of privatization investment vouchers will receive stock in the privatization investment fund which will indicate the number of vouchers they invested. The face value of stock in a privatization investment fund is given as a percentage of the fund's charter capital, not in rubles.

The establishment and operations of privatization investment funds shall be governed by special privatization investment fund charters subject to approval by the Commission.

Non-governmental corporations and individuals may be founders of privatization investment funds. Privatization investment funds shall be established as public stock companies whose stockholders are residents of the Republic of Kazakhstan who have invested their privatization investment vouchers in exchange for stock in the fund. The establishment of private privatization investment funds is compelled by the need for real, and not just formal privatization and for the involvement of full-fledged owners, the stockholders of the funds, in the management of these funds.

The Commission will establish an information center to provide organizational support for large-scale privatization. This center will be responsible for gathering and processing information on the establishment and operation of joint-stock companies, the number of vouchers issued and invested, and the traffic in businesses stock. The information center will have regional departments assigned to regional offices of the National State Property Commission.

The operations of the funds will be governed on the basis of licenses issued by an Interagency Commission specially established by the National State Property Commission. In order to ensure the impartiality of its decisions and provide independent oversight of the operations of privatization investment funds, the Interagency Commission will include representatives of the National State Property Commission, the Ministry of Economics, the Commission for Statistics and Analysis, and the National State Bank. In order to obtain a license, the founders of a privatization investment fund will be required to submit complete and accurate information to the Commission on the founders of the fund, the fund's capital, the terms on which the fund acquires privatization investment vouchers, and the liability of the fund to voucher depositors for any losses it may sustain. The Commission is responsible for regulating the operations of the funds with respect to determining minimum capital requirements and stock investment procedures and the public accessibility and accuracy of the information on the fund's operations. All of the investment fund's property is subject to liability for shareholder claims. Any inaccurate information submitted by an investment fund or violation of the terms under which its license was obtained constitutes grounds for the Commission to revoke the fund's license and liquidate it.

Privatization investment funds accumulate the general public's privatization investment vouchers in exchange for stock in the fund. The National Privatization Fund accumulates government shares earmarked by the Committee for sale within the framework of large-scale privatization, is responsible for announcing auction times, receives applications from privatization investment funds to take part in auctions, and organizes public auctions at which privatization investment vouchers invested by citizens. Plans call for organizing auctions at two levels: auctions to sell stock in national businesses and auctions to sell stock in regional businesses. A list of businesses whose shares will be put on the auction block in exchange for privatization investment vouchers must be published at least 45 days prior to the announced date of the auction and should indicate the number of shares in each entity to be sold at auction, the financial condition of the business, and the minimum amounts (initial bids) of vouchers per share of the business. Privatization investment funds must submit applications to the National

Privatization Fund at least 15 days prior to the announced date of the auction. The application should indicate the number of shares the fund plans to purchase in which joint stock companies and the maximum number of privatization investment vouchers which the fund can offer per share of stock.

Some of the shares in businesses will be sold to the public by the National Privatization Fund in order to determine the market rate of the stock.

Additional (secondary) issuance and investment of stock will be the responsibility of joint-stock companies in accordance with the applicable law of the Republic of Kazakhstan.

Competition between funds at auctions to acquire stock is based on the assumption that they will offer the maximum possible number of investment vouchers for the stock at auction. A particular investment fund may not acquire more than 10 percent of the stock in a particular business at a single auction. A particular investment fund may not hold more than 20 percent of the shares in a particular joint-stock company. Privatization investment funds may sell and acquire stock in joint-stock companies from other investment funds, corporations, and individuals after the auctions of stock for vouchers have concluded.

The success of large-scale privatization will require the organization of information and publicity services involving both the mass media and a system of special courses, question-and-answer sessions, and education with the participation of qualified experts.

At the end of the large-scale privatization process, any unsold share of stock in joint-stock companies will be put on the open market. If no buyers are found, the Commission may transfer the stock on negotiated terms to holding companies or similar entities.

4. Small-Scale Privatization

Small-scale privatization will involve small businesses and organizations with less than 200 employees subject to mandatory privatization.

This privatization category includes most retail and wholesale businesses, public dining facilities, and services. Trucking businesses will be privatized at the same time in order to guarantee the success of small-scale privatization.

Retail outlets and public dining facilities which serve low-income segments of the population will remain under state ownership.

The privatization of company stores owned by agribusiness operations will be carried out within the framework of these operations.

The privatization of an entity will begin with preparing it for auction or competitive bidding by providing timely notification to the business' employees. In certain cases the government

will assume all the liabilities of the business, including debts and obligations to employees. The sellable assets of the business will include only its property, namely its fixed assets (if selling a building would be impractical, long-term leasing rights would be sold), its raw and processed materials, supplies, tools, and so forth.

The Commission will draft lists of businesses subject to small-scale privatization on a quarterly basis in consultation with government agencies. Publication of a list constitutes official notification of the beginning of privatization of the businesses included on the list. Creditors must be given a certain amount of time to file claims against the business in accordance with the established liquidation procedure.

Small-scale privatization shall be carried out by means of auctions or competitive bidding processes involving the participation of individuals and non-government corporations. The procedures for conducting auctions and competitive bidding processes within the framework of small-scale privatization shall be defined by appropriate regulations subject to approval by the Commission. In competitive sales of an entity, preference will be given to citizens of the Republic of Kazakhstan and employees of the entity to be sold under the condition that the latter form their own company. If this company includes more than 50 percent of the employees of the entity, the company will be given a discount of up to 10 percent of the sale price in an auction or competitive bidding process.

Non-competitive auctions or bidding processes are prohibited. The total amount payable by a purchaser for property acquired in an auction or competitive bidding process may consist of 50 percent money and 50 percent housing privatization vouchers acquired by the person desiring to take part in an auction.

Unrestricted sale and purchase of housing vouchers will be instituted for the purpose of facilitating the use of housing privatization vouchers in the small-scale privatization process. Housing vouchers may be bought and sold by means of privatization check books through offices of the Savings Bank.

Citizens have the right to avail themselves of the services of brokers (on a contractual basis) to participate in auctions and competitive bidding processes conducted with housing vouchers as a means of payment.

The use of housing vouchers in small-scale privatization is governed by special regulations.

The procedure for using housing vouchers to purchase housing will remain the same.

II. The Denationalization and Privatization of State Property in Agribusiness

Denationalization and privatization in agribusiness will be carried out on the initiative of the owner in accordance with the Program with allowances for the specific characteristics of the industry's sectors, businesses, and organizations.

Land and other natural resources will remain the exclusive property of the Republic of Kazakhstan and are not subject to privatization but may be leased on a long-term basis for up to 99 years.

State-owned agribusinesses will be privatized in the following basic ways:

- the conversion of state farms and other state-owned agribusinesses into individual proprietor and peasant farms, agricultural cooperatives, small businesses and their associations, and other non-government forms of management;
- the establishment of unrestricted or restricted joint-stock companies;
- the sale of state property in auctions or competitive bidding processes.

The privatization of large poultry and livestock operations and greenhouse conglomerates will be carried out by means of converting them into joint-stock companies or other types of companies or partnerships for which process-related goods producers will be given priority in purchasing stock (shares) under the condition that they maintain uninterrupted production and existing horizontal relationships.

Agribusiness procurement, processing, and service businesses will be privatized by means of converting them into public joint-stock companies with priority purchase rights given to agricultural goods producers with contractual relationships with the converted businesses. Any undistributed and unsold shares will remain government property. The National State Property Commission of Kazakhstan will appoint a trustee for the government block of stock.

The privatization of chronically unprofitable agribusinesses will be carried out by means of the gratuitous transfer of their property to partnerships or joint-stock companies established by the employees of these businesses or, if the employee decline to accept the property, the property may be sold at auction or in a competitive bidding process.

Housing privatization vouchers may be used by individual employees or partnerships formed by employees to purchase the property of state-owned agribusinesses. The vouchers may be used to cover up to 75 percent of the sale price of the property of an agribusiness. The

purchasers of the property of an agribusiness are required to preserve the agricultural profile of the operation. The new owner may use the acquired property at his discretion as long as this use does not violate the terms of the purchase and sale agreement.

All the employees of the privatized business and other citizens residing on the territory of the business may take part in the privatization of state-owned agribusinesses.

All producers of agricultural commodities will be afforded the opportunity to take part in small-scale privatization in cities in competitive bidding processes and auctions.

Some of the revenues derived from the privatization of state property will be used to develop and support market structures in agriculture.

Collective businesses (farms) will be asked to re-register as partnerships or joint-stock companies.

III. The Participation of Foreign Corporations and Individuals In the Privatization Process

Foreign corporations and individuals may participate in all types of privatization processes. Their activity is subject to the applicable law of the Republic of Kazakhstan and international treaties and agreements.

Foreign corporations and individuals may take part in the privatization of state property after their financial capabilities have been reviewed and they have been issued an appropriate license by the National Foreign Investment Agency.

The procedures and conditions by which foreign corporations and individuals may participate in the privatization of state property on the basis of specialized plans shall be defined by the National State Property Commission and the Ministry of Economics in accordance with the applicable law of the Republic of Kazakhstan, unless stipulated otherwise by intergovernmental treaties and agreements.

To the best of its ability, the Ministry of Economics will provide information on the economic and financial capabilities of prospective investors to concerned corporations and individuals.

When foreign corporations and individuals take part in privatization, the entity subject to privatization will be valued (appraised) in the national currency and in foreign currency in accordance with world market prices for similar types of property and types of activity.

IV. The Organizational Framework for Administrative of the Denationalization and Privatization Process

The National State Property Commission and its regional offices will be responsible for the denationalization and privatization of state property in the Republic of Kazakhstan in cooperation with ministries, departments, and local governments.

The privatized state-owned businesses themselves, privatization offices, and non-government commercial organizations duly licensed by the National State Property Commission will perform the preparatory work of appraising property and drafting privatization documents along with offices of the National State Property Commission.

The President of the Republic of Kazakhstan is responsible for monitoring the implementation of the Program. Information on the progress of the Privatization Program will be published on a regular basis in the national and local print media.

V. The Procedure for Receiving and Distributing Funds Derived from the Privatization of State Property

Funds derived from privatization mean all monetary and other revenues from the sale of state-owned property.

Dividends for state-owned blocks of stock and lease payments received by the National State Property Commission and its regional offices will not be included in funds derived from privatization and are to be transferred to the appropriate budget account minus any bank transaction expenses.

According to the Law "Governing Denationalization and Privatization", the funds derived from privatization are the property of the state and shall be deposited in special accounts.

Monies derived from small-scale privatization auctions will be transferred to special accounts after the debts of the privatized entities have been paid.

Funds deposited in a special national accounts will be used to pay the national domestic debt and for other purposes indicated by the government in a submission to the President of the Republic of Kazakhstan.

Funds received by local governments and a portion of the funds from the special national account may be used to provide subsidies and security for needy and socially insecure segments of the population, for unemployment benefits, for personnel training and retraining, and for other purposes.

The procedures for expenditures of these funds are to be determined by the heads of local governments.

The national government is responsible for approving the portion of the funds used to implement the Privatization Program.

VI. Social Security Guarantees

The implementation of the Program must be accompanied by social security guarantees for the republic's population, including:

- **guarantees of employment for employees discharged in the privatization process by means of giving them the opportunity to change jobs and occupations through a system of public and private training and retraining facilities; the organization of a system of public works on the basis of regulations approved by the government; financing public works from national and local budgets and the funds of concerned businesses; the establishment of a system of tax concessions for small business development which would utilize the manpower resources left idle by the privatization process and the labor of retirees and disabled persons;**
- **the establishment of special public, private, and mixed funds to provide subsidies and social security to the needy and socially insecure segments of the population in the amount of 10 to 15 percent of the funds derived from the privatization of state property; the payment of unemployment compensation by deductions from employers and national and local budget funds; voluntary contributions from corporations and individuals; social and economic development of environmental disaster zones by deducting 10 percent of the revenues from the privatization of state property and the voluntary contributions of entrepreneurs.**