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BURNS AND ROE ENTERPRISES, INC.

DELIVERY ORDER NO. 5

ARMENIA: CRITICAL ENERGY NEEDS

FINAL REPORT

July 1994 - March 1997

Submitted by: Burns and Roe Enterprises, Inc.

Submitted to: U. S. Agency for International Development

Contract No.: CCN-0002-00-3154-00
Energy Efficiency and Market Reform Project
Delivery Order No. 05
Critical Energy Needs

LIST OF EXHIBITS

2-1 Procurement Plan for Local Purchasing of Commodities Needed to Meet Critical Energy Needs in Armenia

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1.0 INTRODUCTION

1.1 Background

The purpose of Delivery Order No. 5 was to address the critical emergency needs of the energy sector of Armenia by expanding domestic, non-nuclear energy supplies and by improving the efficiency of energy consumption. The scope of work to achieve this objective comprised the following specific tasks:

- Task 1 Mini-Hydro Electric Turbine-Generator Replacement
- Task 2 Urgently Needed Commodities for District Heating and Thermal Power Plants
- Task 3 Fast-Track Coal Mining Program
- Task 4 Hydroelectric Rehabilitation and Development Engineering Assistance
- Task 5 Critical Industries Energy Conservation
- Task 6 Oil and Gas Drilling
- Task 7 Continuation of Building Weatherization and Development of Weatherization and Energy Services Companies
- Task 8 Power Plant Outage and Inventory Control Management

The Delivery Order was performed in two phases:

Phase 1 was initiated July 11, 1994. The objective was to produce an activity implementation plan for each of the above tasks. This phase was completed September 11, 1994.

Phase 2 of the Delivery Order was initiated on September 19, 1994. The objective was to implement the activities developed for each task in the Phase 1 plan. Phase 2 was to have been completed by December 31, 1995; however, Amendment/Modifications Nos. 5 and 6 were issued, which extended the final completion date to March 1, 1997

The budgets for the two phases of the delivery order were as follows:

	Phase 1	Phase 2	Total
Labor	$163,554	$2,436,036	$2,599,590
Other Direct Costs	$191,264	$1,266,146	$1,457,410
Ceiling Price	$354,818	$3,702,182	$4,057,000

Under the core contract, funds were allocated toward the purchase of commodities and equipment, totaling $11,138,000.

1.2 Objectives of Tasks

Task 1 Mini-Hydro Electric Turbine-Generator Replacement

In early 1993, USAID agreed to assist Armenergo in the purchase of seven mini-hydro turbines, generators and governors to replace damaged equipment in existing hydro plants. USAID had intended to have the turbines purchased by the contractor of a previous delivery order, but the manufacturer increased its prices and the budget on that delivery order was insufficient, allowing purchase of only four of the seven turbines. The scope of Task 1, Delivery Order 5, was to purchase and deliver the remaining three turbines and the balance of equipment necessary for seven complete replacement units (Seven sets of generators, governors, switchgear and accessories).

Harza Engineering was Burns and Roe's subcontractor on Task 1, providing expertise in hydraulic engineering and in selection of the replacement equipment. Harza had assisted the previous USAID contractor in the purchase of the first four hydro-turbines and had intimate knowledge of the technical requirements of the replacement installations.

Task 2 Urgently Needed Commodities for District Heating and Thermal Power Plants

USAID has recognized Armenia's inability to obtain sufficient spare parts and materials needed for repair and minimum maintenance of district heating and thermal power plants. USAID had obtained, through previous delivery orders, lists of the required items. The scope of Task 2 of Delivery Order 5 was to update these lists and purchase the recommended spare parts and materials.

Task 3 Fast Track Coal Mining Program

A USAID mining engineering consultant had previously identified two sites for coal mining in Armenia and had determined that a fast track coal mining program could produce a significant quantity of coal by the winter of 1994 (if begun in Spring 1994). Although Delivery Order 5 was not initiated early enough, the scope of its Task 3 was to implement this fast-track program as soon as possible.

Task 4 Hydroelectric Rehabilitation and Development Engineering Assistance

As hydroelectric power is one of Armenia's few indigenous resources, the objective of Task 4 was to establish a least-cost ranking for the rehabilitation and development of identified hydroelectric projects, and to aid in the preparation of necessary project financing documentation.

Task 5 Critical Industries Energy Conservation

USAID has recognized that there is an immediate need for rapid improvement in industrial energy efficiency in Armenia due to a variety of poor energy utilization practices and lack of proper maintenance. The objective of Task 5 was to identify and implement improvements in energy efficiency in five industrial plants that either provide critical products for the Armenian market or produce essential export products. This number of industrial plants was later increased to seven.

Task 6 Oil and Gas Drilling

An earlier U.S. Government report identified several oil and gas bearing areas in Armenia. The Government of Armenia had initiated an oil and gas exploration program and had an arrangement with the Government of Greece whereby the Greek state oil company, DEP-EKO, would donate an oil drilling rig with accessories to Armenia, but not including transportation. The U.S. Government offered to pay the shipping costs. USAID had allocated $900,000 to the contractor of another delivery order, Resource Management Associates (RMA) to purchase the required oil and gas drilling consumables for the Armenian drilling program.

The objective of Task 6 was to coordinate and manage the shipment and receipt of the oil drilling rig, to identify the required oil and gas drilling consumables for purchase by RMA, to arrange for shipment and delivery of the consumables, and to provide overall management/consultancy to the drilling operation of the oil wells.

Task 7 Continuation of Building Weatherization and Development of Weatherization and Energy Services Companies

Under a previous USAID delivery order, another contractor, Resource Management Associates (RMA), had completed several weatherization projects in four hospitals and various apartment buildings in Yerevan. RMA had trained several local personnel in application of the weatherization materials and had developed the potential for local enterprises to produce the materials in Armenia.

The objective of Task 7 was to manage the continuation of the weatherization work by RMA on additional selected buildings, purchase the required materials and provide assistance to this core of trained local personnel in establishing their own private weatherization businesses.

Task 8 Power Plant Outage and Inventory Control Management

USAID recognized that proper control of power plants' inventory of maintenance equipment and materials will permit cost effective outage management and maintenance planning. Currently, inventory at power plants is controlled manually, if at all.

The objective of Task 8 was to develop a computerized maintenance management program for Unit No. 5 of Hrazdan Power Plant, which was under construction at the time, and train plant personnel in its use.

2.0 DESCRIPTION OF WORK PERFORMED

Burns and Roe established an office in Yerevan to serve as a base for managing all Delivery Order No. 5 activity in Armenia and for performing procurement of all equipment and commodities sourced in NIS countries for the various tasks. The office was staffed with one full-time ex-pat manager and local support personnel. During the course of the project, the staff was supplemented at times with additional Burns and Roe and subcontractor personnel, as the activities at the time dictated.

Task 1 Mini-Hydro Electric Turbine-Generator Replacement

Negotiations with the manufacturers of the hydro-turbines, generators, governors, switchgear and accessories revealed that prices had increased further. It was determined that the Task 1 budget would allow purchase of only enough equipment which, when combined with the four previously purchased hydo-turbines, would result in only five complete units. Task 1 purchase orders were placed for the one hydro-turbine, five generators and five sets of governors, switchgear and accessories. Arrangements for shipment were made for all items of equipment. The hydro-turbine and the five sets of governors, switchgear and accessories have been delivered. However, only two of the five generators were delivered, as the manufacturer, Armelectromash, a subcontractor to Andron, (both located in Yerevan), was unable to complete manufacture of the other three generators.

The accomplishments of Task 1 are summarized in Section 3 of this report.

Task 2 Urgently Needed Commodities for District Heating and Thermal Power Plants

Starting with the previously prepared lists of recommended spare parts and materials, Burns and Roe conferred with the Yerevan utilities (Armenergo, Armgasprom, District Heating and City Electric Distribution) to determine the items currently required. The updated lists of commodities, with budget cost estimates, were approved by USAID.

To prepare for the extensive procurement activity to be performed in the Yerevan office, Burns and Roe prepared "Procurement Plan for Local Purchasing of Commodities Needed to Meet Critical Energy Needs in Armenia" (Exhibit 2-1). This document was approved by USAID. Procurement of items from U.S.A. sources was performed by Burns and Roe's Washington office in accordance with previously established U.S. Government procedures.

Procurement of NIS sourced items was performed in Burns and Roe's Yerevan office in accordance with the Procurement Plan, while procurement of U.S.A. sourced items was done in Burns and Roe's Washington office. Items procured under Task 2 are summarized in "List of Commodities Purchased" (Exhibit 2-2).

The accomplishments of Task 2 are summarized in Section 3 of this report.

Task 3 Fast Track Coal Mining Program

The two coal mining areas previously identified as favorable by the USAID mining consultant were at Djadjur and Idjevan. Burns and Roe's subcontractor, Fluor Daniel Intercontinental, Inc. analyzed the data from both areas and recommended Djadjur as the more favorable. This recommendation was approved by the Armenian authorities.

ELTA Company, Ltd., a Yerevan based holding company involved in mining coal in these two areas was selected to be the mine management organization. Responsibility for day-to-day operation of mine was assigned to its subsidiary, Djadjur Mine Works.

A Conceptual Mining Plan to extract 50,000 tonnes of coal during the winter of 1994-95 was developed. The Plan included the use of scrapers and dozers as primary earth movers and backhoes for coal extraction. The precise location of the coal seam was confirmed through exploratory trenching. An estimate of mine operating cost was developed. The Plan was approved by Armenian authorities.

Contracts prepared, approved by USAID, and placed included Operating Agreement, Fuel Supply Contract, and Equipment Rental Contract.

A detailed accounting system was developed to carefully control the disbursements of funds to each contractor.

All accessories required for the mining operation were purchased by Burns and Roe.

The coal mining operation commenced in November, 1994 and proceeded until May, 1995 when it was stopped. The mined coal was stored in a pile on the site, awaiting Government of Armenia (GOA) trucks to haul it away and distribute it to the local population for home heating. A minor quantity had been distributed from the pile by the time work on the mine stopped, despite numerous requests by local USAID and Burns and Roe personnel to the GOA to organize a distribution system for the mined coal. Burns and Roe arranged for humanitarian distribution of a small quantity to the needy of the earthquake-effected communities in the area.

US AID and the GOA negotiated directly over the distribution of the mined coal, without the involvement of Burns and Roe. The GOA wanted to be paid for all coal distributed, while US AID wanted most of the coal to be distributed at no charge. An agreement was reached, but US AID decided that all Burns and Roe work at the mine was to be stopped.

The accomplishments of Task 3 are summarized in Section 3 of this report.

Task 4 Hydroelectric Rehabilitation and Development Engineering Assistance

Harza Engineering, Burns and Roe's subcontractor on this task, performed a brief design review and developed a preliminary capital cost estimate for the Loriberd Hydroelectric Project, which had been proposed for development in the Dzoraget River Basin by EREVANGHIDROPROYECT, the national design institute of the Republic of Armenia. The results are summarized in Harza's draft report "Preliminary Estimate of the Capital Cost for the Loriberd Hydroelectric Project" (Exhibit 4-1). This effort was performed early in the Phase 1 period, using "core" funds.

Before any further progress could be accomplished, Burns and Roe received notice from USAID in October, 1994 that Task 4 was canceled and its funds deobligated from the delivery order.

In May of 1995, there was an accident at the Gyumush Hydropower Station, which resulted in a failure of the dam bypass channel. The Gyumush Hydropower Station is the largest in Armenia. The failure was caused when a leak developed in the power house and the operators were forced to divert 100 % of the flow to the bypass. However, the bypass had not been maintained properly and the joints were in a deteriorated condition. Because of the high flow rate and poor condition of the joints, erosion started under the concrete channel. This condition continued until there was a complete collapse of the channel, resulting in a rock and mudslide which covered 90% of the powerhouse.

At the request of US AID, Burns and Roe dispatched hydraulic engineers from Harza Engineering, the designated Task 4 subcontractor, to do an on-site assessment and determine estimates of short term and long term costs to rehabilitate the station. Harza's report was used by the World Bank and US AID to develop a plan to disburse $3,000,000 in emergency funds to the Government of Armenia for rehabilitation of the Gyumush Station. This amount was suitable for restoring two units to operation, a total of 85 MW.

Task 5 Critical Industries Energy Conservation

Burns and Roe, together with Resource Management Associates (RMA) (Burns and Roe's Task 5 subcontractor), and European Community Energy Center (ECECA) (a separately funded group, also involved in energy conservation activities) met with representatives from the involved Armenian Government Agencies and USAID to identify industrial enterprises which provide critical products for the Armenian market or produce export commodities, as possible candidates for improvement in energy conservation and energy efficiency. A total of sixteen candidate enterprises were identified. Criteria for screening this total down to the required number of seven enterprises were developed.

Burns and Roe's Report on Selection of Enterprises, dated August 30, 1994, revised September 14, 1994 (Exhibit 5-1), identified the sixteen candidate industrial plants. Included in the report are the criteria used in screening these candidates. The seven plants selected and recommended for energy efficiency audits are identified and justifications for their selections presented. This report was approved by USAID and authorization given to proceed with energy audits on the following recommended enterprises:

Yerevan Brewery	Yerevan Cable Plant
Ararat Cognac Plant	Luis Lamp Plant
Ararat Cement Plant	Yerevan Thermal Power Plant
Avansk Salt Mine Plant	

The energy audits were performed at all enterprises except Yerevan Thermal Power Plant. At that enterprise, the Burns and Roe team were not permitted to perform a complete audit and, therefore, no further effort to improve the plant's efficiency was done.

Results of the other audits were analyzed, conceptual energy improvement modifications were developed, and costs and payback periods were estimated. The results were documented by Burns and Roe in" Summary and Evaluation of Energy Audit Reports for Energy Efficiency Improvements at Seven Industrial Plants in Armenia", dated March 30, 1995, revised May 30, 1995 (Exhibit 5-2). This document was approved by USAID, with the authorization to proceed with implementation of the recommended improvement modifications.

Specifications were prepared for the energy efficiency improvement equipment, as recommended in the report, and purchasing commenced. As in Task 2, procurement of NIS sourced equipment and materials was accomplished in Burns and Roe's Yerevan office, while procurement of U.S. sourced equipment was done in Burns and Roe's Washington office.

The accomplishments of Task 5 are summarized in Section 3 of this report.

Task 6 Oil and Gas Drilling

Burns and Roe and its subcontractor, Fluor Daniels, inspected the oil drilling rig being donated by the Government of Greece to the Government of Armenia. Lists of required drilling consumables for this rig were developed and sent to the other USAID contractor (RMA) for procurement. Later, Burns and Roe was informed that the agreement involving the donated Greek rig was canceled.

Burns and Roe was then informed that another oil drilling rig, located in Texas, would be donated, by an unidentified organization, and the U.S. Government would pay shipping costs and Burns and Roe would coordinate delivery of the rig and consumables, as before.

Burns and Roe and Fluor Daniels inspected the Texas rig and developed a listing of its requirements for consumables and accessories. It was determined that additional equipment and consumables would be needed to supplement the items being purchased by RMA. Approval was received from USAID for Burns and Roe to purchase the additional items and Burns and Roe's Washington office started the procurement process.

Burns and Roe then received notice from USAID that the task was cancelled and its funds deobligated from the delivery order and the Core. All purchase orders placed for the additional equipment and consumables were cancelled and cancellation charges negotiated.

Task 7 Continuation of Building Weatherization and Development of Weatherization and Energy Services Companies

Resource Management Associates (RMA), as subcontractor to Burns and Roe, prepared lists of weatherization materials for Burns and Roe's Washington office to purchase and ship to Armenia. Initially, the delivered materials were stored in RMA's Yerevan facilities, but later were transferred to Burns and Roe warehouses and a rigid inventory control system established.

RMA, with its knowledge of Armenian weatherization needs, developed a list of recommended sites at which to continue the weatherization work. The list, approved by USAID, included the following facilities in Yerevan:

Maternity Hospital No. 3
Republican Hospital, Medical Clinic Center
Children's Hospital No. 1
Cardiology Institute
Public Areas at Sayat-Nova Residential Housing
Energy Institute
Nork Orphanage

Installation of the weatherization materials was accomplished, under RMA supervision, by the trained local technicians. Mid-way through the installation period, USAID elected to have Armenian Relief Society (ARS) become involved in the weatherization installation effort. Burns and Roe and RMA carved out a portion of the remaining budget for ARS to install weatherization materials at selected needy sites in the northern cities of Giumri, Vanadzor and Maralik.

The accomplishments of Task 7 are summarized in Section 3 of this report.

Task 8 Power Plant Outage and Inventory Control Management

Burns and Roe performed an overall assessment of the status and location of the material and equipment stored for Hrazdan Unit No. 5. Also assessed were the existing systems for inventory control and material processing

An Activity Implementation Plan was developed, with estimated budgets, and approved by USAID. In accordance with the Plan, Burns and Roe prepared functional requirements and a detailed specification covering the computerized Material Management and Warehousing System for Unit No. 5. Only one suitable Armenian bidder submitted a proposal for developing and furnishing the computer and program. A sole source proposal to install and implement the system was requested from Hill International, the contractor presently involved in the construction of Hrazdan Unit No. 5. USAID approved Burns and Roe's recommendations to accept both proposals, and purchase orders were placed. The computer equipment was delivered to the plant and Hill International set up the system and trained the operators, in accordance with its contract.

The accomplishments of Task 8 are summarized in Section 3 of this report.

3.0 SUMMARY OF RESULTS

Task 1 Mini-Hydro Electric Turbine-Generator Replacement

The original objective of this task was to provide additional equipment which, together with four hydro turbines provided by others, would result in seven complete hydro-turbine generator units to replace aging equipment. However, equipment costs proved to be higher than expected and the available budget supported the outfitting of only five complete turbine generator units. All equipment required for these five units was procured and delivered, except for the generators. Only two of the five generators were manufactured, due to numerous problems at that Armenian factory.

Burns and Roe had contracted with a local Armenian company, Andron, to supply the generators. Andron, the designer of the generators, contracted with another local Armenian company, Armelectromash, to manufacture them. It took two years for the generators to be designed, tested and accepted. Initially, design flaws required over eight months to be corrected and successfully tested on a prototype. The effort that followed to expedite manufacture and delivery of the generators was excessive. During this period, manufacture started on the five generators but, at the end, only two were completed. Upon their completion, Armelectromash refused to deliver them because it had not received any payment from Andron. After many communications, Burns and Roe dispatched its Procurement Manager to Yerevan to negotiate with Andron and Armelectromash. After an agreement was reached, the two generators were delivered.

The US AID mission encouraged procurement of the generators from the local company, Andron, in order to help local industry. As it turned out, this company and its contractor were not capable of producing the equipment in accordance with the contract, and the procurement would have been better served by going to a more reliable, proven source for this equipment.

In spite of these problems, two full hydro-turbine generator sets were delivered to the Her-Her Hydro Station in the Spring of 1997. The equipment was installed and commissioned by the station personnel, and is known to be producing 1.26 MW to the grid.

The balance of the purchased equipment, consisting of three complete hydro units, less generators, was turned over to Armenergo.

Task 2 Urgently Needed Commodities for District Heating and Thermal Power Plants

Included in the items procured for Armenergo, the electric generating utility, was the rewinding, installation and commissioning of a hydroturbine generator stator. The unit provided 12.5 MW and was brought on line in December 1995.

The commodities supplied to the District Heating System resulted in an improvement to the availability of heating and power from 30 % or 1,400 buildings in 1994 to 45 % or 2,100 buildings in 1995. The USAID supplied material focused on providing dedicated electric power to the heating plants and restoration of the network and the boilers.

Commodities supplied to Armgasprom, the gas distribution utility, allowed it to distribute about 17 - 21 million cu m / day during the winter of 1994 - 1995. Most parts went to the rehabilitation of the underground storage facility. These parts were supplied by the Russian firm, RUMO, the manufacturer of the gas compressors.

Yerevan Thermal Power Station was provided with a substantial amount of chemicals and resins for water treatment. This allowed the station to provide heat for two districts during the winter of 1994-1995.

Task 3 Fast Track Coal Mining Program

When work on the mine stopped in May 1995, about 25,000 tonnes had been stockpiled and another 25,000 tonnes left stored in place, with the overburden removed, for relatively easy extraction later. Burns and Roe understands that the coal in the stockpile was distributed to the population for heating, with about 80 percent sold by the Ministry of Underground Resources and 20 percent given to poor families.

In accordance with original agreements, Burns and Roe provided Djadjur Mine Works with a plan for reclamation of the land after the mine operation was completed; however, the plan was not implemented.

Task 4 Hydroelectric Rehabilitation and Development Engineering Assistance

(Task 4 cancelled by US AID.)

The emergency evaluation and subsequent report relating to the Gyumush rehabilitation were performed under this task. This work supported the decision of the World Bank to provide a total of $3 million to the Government of Armenia for rehabilitation of Gyumush. Of this $3 million, US AID provided $1.3 million. These funds were partially provided from the deobligation of funds allocated to Task 6 - Oil & Gas Drilling.

Task 5 Critical Industries Energy Conservation

The following energy conservation equipment was installed:

1. Yerevan Brewery - completed in the Spring of 1996

Package boilers	Air compressor
Condensate return tank and pumps	Fuel oil heater
Metering system	Piping and accessories
Insulation and heat tracing	Emission analyzers
Heat exchanger	Computer

Installation of this equipment has enabled the Brewery to operate both the Brew House and the Bottling Plant simultaneously. In addition, the installation of higher efficiency boilers and improvements in the brewing process have resulted in a potential saving of about $62,800 a year, based on 4,200 hours of operation a year.

2. Ararat Cognac Plant - completed in the Spring of 1996

Package boilers	Steam Valves
Pipe insulation	Emissions analyzer

Installation of the new boilers and energy saving equipment are estimated to save 6,012,000 Btu/hr for an annual savings of about $108,000.

3. Ararat Cement Plant - to be completed by June 1998

CO & O_2 analyzers	Pyrometer
Emission analyzer	Computer

The installation of this equipment is expected to save 128,000 GJ/year of energy for an annual savings of about $205,000.

4. Avansk Salt Mine Plant - equipment delivery to be completed by June 1998, with installation to be by plant.

Cooling water pumps	Insulation and heat tracing
Heat exchanger	Thermometers
Emissions analyzer	Cooling tower instrumentation
Fuel oil heater	

The installation of this equipment is expected to save 43,500 GJ/year of energy for an annual savings of about $220,000.

5. Yerevan Cable Plant - completed in the Summer of 1997
   O2 determinator — Pyrometer
   Emissions analyzer

   Use of the oxygen determinator has enabled the plant to reduce the previous high cable rejection rate (37%), resulting in an estimated annual savings of about 324,000 cubic meters of gas, based on operation at design capacity.

6. Luis Lamp Plant - cancelled
   (Plant has become officially bankrupt and under the direct control of the government.)

Task 6 Oil and Gas Drilling

(Task 6 cancelled by US AID.)

Funds amounting to $756,954 were deobligated from this task and used to support the rehabilitation of Gyumush Hydroelectric Station, which was damaged from a failure in the bypass system, causing a rock and mudslide to cover most of the powerhouse.

Task 7 Continuation of Building Weatherization and Development of Weatherization and Energy Services Companies

The prime objective of Task 7, installation of weatherization, was completed successfully and the following final reports on the results of the effort were submitted to USAID:

From RMA: Energy efficiency and Market Reform Project: Armenia Weatherization, dated September 1995

From ARS: Energy Efficiency and Market Reform Project: Armenia Weatherization, dated March 1996

RMA completed weatherization on the following facilities in Yerevan:

Maternity Hospital No. 3	Energy Institute
Republican Hospital, Medical Clinic	Nork Orphanage
Children's Hospital No. 1	School No. 67
Cardiology Institute	Spitak School
Sayat Nova Residences - Common Areas	Armenian Art Museum
Saryan Gallery	

ARS completed weatherization on a total of 14 hospitals and schools in the northern cities: 6 in Giumri, 7 in Vanadzor and one in Maralik.

Numerous letters of thanks were received from building administrators of the above facilities. Copies are included in the above reports.

The second objective of Task 7, Developing Weatherization and Energy Services Companies, was not accomplished. The above RMA report acknowledges some of the difficulties in trying to establish private weatherization companies which could continue after USAID funding is stopped. Training is required in marketing and business practices, cost estimating and accounting, and project management. Potential (paying) clients must be identified. Facilities must be established for manufacturing the weatherization materials within reasonable distances, in order for the weatherization services to be cost-effective. Until these factors are accomplished, the prospect for success of private weatherization enterprises without funding is questionable.

Task 8 Power Plant Outage and Inventory Control Management

Installation and implementation of the Material Management and Warehousing System was completed in October, 1995. At that time, the computerized system had been completely checked out, and specific Hrazdan Unit No. 5 data entered into the data base. All Unit No. 5 materials were logged and placed in allocated numbered areas and racks in the plant warehouses. Personnel were trained in operation of the computerized system and on proper warehousing.

The Director of Hrazdan Plant was appreciative of the system. It was noted that a planned $400,000 purchase of materials was reduced to $40,000 when the system identified that the remaining materials were already at the station. Without the system, these materials would not have been located.

EXHIBIT 2 - 1

PROCUREMENT PLAN FOR LOCAL PURCHASING OF COMMODITIES NEEDED TO MEET CRITICAL ENERGY NEEDS IN ARMENIA

2nd Revision
to
Procurement Plan
for
Local Purchasing of Commodities Needed to Meet Critical Energy Needs
in
Armenia
(Reference Delivery Order No. 5)

I. General.

A. Objective. The potential for loss of life and widespread disease and disability due to severe energy shortages caused by crippled and debilitated power and heating plants and transmission and distribution systems has put Armenia in crisis. Therefore, the objective of this plan is to expedite the purchase of critically needed energy and power related replacement parts and materials within a time frame which will stave off national disaster.

B. Time Frame. It has been agreed by USAID Yerevan Mission officials, Armenian experts and leaders and Burns and Roe field project team that the deadline for purchasing and taking delivery of these critically needed goods is October 15, 1994. This date is considered a "drop dead" date: receipt of the goods beyond that date will not allow technicians enough time to incorporate them into the systems to ameliorate the severe and potentially deleterious effects of the fast-approaching Armenian winter months.

C. Local Purchasing. There exists in the NIS the remnants of the old Soviet supply system by which commodities such as those on the attached list(s) were obtained previously. In that system all such commodities were listed in centralized catalogs along with identification of the source or sources of supply. Plant operators would locate the needed parts in the catalog, contact the supplier, order the needed items and the supplier would ship.

Burns and Roe, Armenian technical experts and leaders and USAID Mission personnel consider that tapping into this existing supply system is the only practical way to obtain the critically needed commodities within the extremely truncated time frame within which they are needed. The two main reasons for this conclusion are:

1. The commodities in the catalog are already "spec'd" and sized to the equipment in the Armenian systems for which they are required. It is anticipated that some of these commodities can be purchased from local suppliers "off the shelf": no production time would be required. Others should be quickly produced by the local

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suppliers because those suppliers already have the necessary tooling on hand. Contrariwise, to purchase these commodities in the U.S. would require significant additional time for engineering and development of specifications, blue prints and/or shop drawings, tooling as well as production run planning and scheduling – which time is not available if the October 15 deadline is to be met.

2. Purchasing from local sources of supply saves the considerable time it would take to ship these commodities from the U.S. – if commodities could be found here which were compatible with existing Armenian equipment and readily available for immediate export. Whereas the shipping time from local suppliers should be only a matter of days, overseas transportation by ocean-going vessel would take weeks. Alternatively, airfreight from the U.S. – especially for commodities purchased which are of large size or great bulk – would prove to be prohibitively expensive. Such expense would easily offset any cost savings that might be realized in the price of the goods purchased in the U.S. over those purchased from local NIS sources.

C. Critical Commodities List(s). Attached to this Procurement Plan is the list(s) of critical commodities to be purchased. The list includes budgetary estimates of the costs for their purchase. Approval of this procurement plan shall also constitute approval to purchase the listed goods within the budgetary numbers. Such approval shall constitute Contracting Officer's blanket consent and shall preclude the necessity for obtaining consent prior to the execution of individual purchase orders.

D. Budget. As the list(s) indicate, the total anticipated budget to purchase all the critical commodities is $7,000,000.00. It is anticipated that shipping/freight charges may total an additional $1,000,000.00. Therefore, the entire budget is anticipated to be $8,000,000.00.

II. Purchasing Plan.

A. Approval of the Plan.

1. Burns and Roe submits the list of critical commodities with budgetary pricing estimates to USAID COTR and/or Mission Director in Yerevan for approval.

2. Burns and Roe Submits the list of critical commodities (including budget estimates) *with* the purchasing plan to USAID Contracting Officer (Washington, DC) for approval.

3. Once both approvals have been granted, Burns and Roe proceeds to purchase the critical commodities from local sources (i.e., Cooperating NIS) without the necessity of obtaining further approvals or consent from USAID.

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NOTE: BRFPA will attempt to get the Armenian Requisitioner to utilize Burns and Roe requisition forms. If this is not practicable, BRFPA will have the English translation prepared on the Burns and Roe requisition form. *Both* the original requisition as prepared by the Armenian Requisitioner and the English translation (as well as copies of any other translations) shall be filed in the purchase order file.

C. Purchasing Process.

1. Upon receipt of the authorized requisition, BRFPA will review the potential sources of supply with the appropriate Armenian entities and responsible USAID personnel and obtain consensus on the final bidder(s) list.

2. Competitive Purchases.

a. BRFPA prepares RFQ/RFP and, with the assistance of the Armenian Requisitioner as is appropriate and required, sends it out to all identified potential suppliers.

b. Suppliers prepare and submit quotes/proposals which shall include prices, delivery schedule and delivery terms, payment terms (if other than net 30 days after delivery), also bonds and insurance as may be appropriate and available.

c. BRFPA evaluates the bids/proposals with the assistance of the Armenian Requisitioner as is appropriate. **NOTE:** It is anticipated that the bids/proposals will have to be translated into English. BRFPA obtains Armenian assistance in this matter as required.

d. Upon determination of the low evaluated bidder – delivery schedule considered – BRFPA prepares the purchase order for issuance.

e. If necessary to finalize the transaction, BRFPA together with the appropriate Armenian representative travel to the Seller's (i.e., low evaluated bidder's) office and negotiate the final pricing and quantities, payment terms, etc.

f. BRFPA completes the purchase order on the spot.

g. If Seller agrees to hold his price(s) firm long enough, BRFPA FAX's the purchase order to the Project Purchasing Agent (Washington, DC) for review, assignment of purchase order number and approval to issue.

h. Project Purchasing Agent takes immediate action and FAX's back the approved purchase order to BRFPA for issuance.

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B. Requisitioning Process.

1. A purchase requisition shall be prepared by the requisitioning agency/engineer of the Customer (namely the Armenian entity that requires the commodities). The requisition shall include:

   a. Item description – including part/catalog numbers (if available), pertinent specifications, drawing references and/or standards or performance criteria as appropriate.

   b. Quantity required.

   c. Unit of measure.

   d. Delivery requirements – including delivery address, date the material is required and any special packaging and/or handling requirements, if appropriate.

   e. Budgetary target pricing which is to be based on and consistent with the budgetary estimates submitted with the lists attached hereto and submitted for approval herewith.

2. Requisitioner shall attach catalog cut sheets to the requisition for all items requested, if possible.

3. Requisitioner shall attach to the requisition a list of all known sources of supply for the items being requisitioned. Information to be included shall be Supplier's name, street address, name of contact and contact's telephone and FAX(Telex) number, if available.

4. Requisitions shall be prepared in the appropriate local language and translated into English and the local language of the potential supplier if the latter is different from the language of the Requisitioner.

5. Completed requisitions and copies of all translations shall be provided to the Burns and Roe Field Purchasing Agent (BRFPA) for action.

6. BRFPA FAX's the requisition to Burns and Roe Washington, DC Project office to the attention of the Project Purchasing Agent who obtains the authorization signature of the Project Managing Director.

7. Project Purchasing Agent FAX's the authorized requisition back to BRFPA to initiate the purchasing process.

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i. If the Seller does not agree to hold his price(s) firm long enough to execute g. and h. above and the final negotiated pricing, quantities and terms are consistent with the seller's bid, BRFPA shall be authorized to execute the purchase order immediately.

j. A copy of the executed purchase order shall be given to the Seller immediately upon its execution.

k. A copy of the executed purchase order shall be provided to the Armenian Requisitioner.

3. Non-Competitive (Sole Source) Purchases.

a. If the review of potential sources for a given requisition determines that one and only one source exists for local purchase of the critical commodities in question, BRFPA together with the Appropriate Armenian representative travel to the Seller's office and negotiate the final quantity of items to be purchased as well as the price, adjusting quantity as necessary to stay within the target price of the requisition.

b. BRFPA shall write the purchase order on the spot.

c. If the Seller agrees to hold his price(s) firm long enough, BRFPA shall FAX the purchase order to Project Purchasing Agent (Washington, DC) for review, assignment of purchase order number and approval to issue.

d. Project Purchasing Agent will immediately take action and FAX the approved purchase order back to the BRFPA for issuance.

e. If the Seller does not agree to hold his price(s) firm long enough to execute b. and c. above and purchase order pricing is within the target price of the requisition and unit pricing has not escalated excessively over approved budgetary pricing; BRFPA shall be authorized to execute the purchase order immediately.

f. A copy of the executed purchase order shall be given to the Seller immediately upon execution.

g. A copy of the executed purchase order shall be provided to the Armenian Requisitioner.

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D. Payment Process.

a. If BRFPA is able to negotiate standard payment terms, Burns and Roe shall pay Seller net 30 days after Seller presents Burns and Roe with a proper invoice consistent with the terms of the purchase order.

b. If Seller requires other payment terms – notably terms requiring advance payment – the following procedure shall be used:

i. Immediately upon receiving the executed purchase order, Seller shall present BRFPA with an invoice for the amount of the advance payment as negotiated

ii. BRFPA shall FAX the invoice and the executed purchase order to Project Purchasing Agent (Washington, DC) for processing.

iii. Project Purchasing Agent shall obtain Project Managing Director's approval for payment.

iv. Project Purchasing Agent shall then tag the approved invoice for expedited processing and forward it – along with the executed purchase order – to Burns and Roe Accounts Payable.

v. Accounts Payable immediately vouchers USAID for the amount of the invoice in accordance with Burns and Roe's prime "Core" contract Section H.12, "Costs Paid in the Ordinary Course of Business". The voucher is marked for expedited processing.

vi. USAID processes the voucher immediately and wire transfers the funds to Burns and Roe.

vii. Burns and Roe makes payment to the Seller in accordance with the payment terms as negotiated and consequently incorporated into the executed purchase order.

vii. Upon receipt of payment, Seller delivers the goods to the Aremenian Customer.

E. Receiving, Inspection and Acceptance.

1. Commodities shall be shipped to Burns and Roe C/O the Armenian Customer. Destination shall be the Customer's site.

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2. Upon arrival of the commodities, the Armenian Customer shall notify the Burns and Roe Delivery Order Project Director or Burns and Roe Yerevan Field Office Manager.

3. A Burns and Roe technical representative as designated by the Burns and Roe Delivery Order Project Director or Field Office Manager and/or the BRFPA shall then go to the destination point and, along with the Customer's designee, formally receive and inspect the goods and obtain the written acceptance of the Armenian Customer.

4. During the inspection process, all over shipments, under shipments and damaged goods shall be noted and documented and all issues pertaining thereto resolved and the resolution documented.

5. All shipping and receiving documents including packing slips or shippers, receiving reports, OS&D reports and acceptance documents shall be given or forwarded to BRFPA for inclusion in the purchasing file.

6. Upon final resolution of all issues pertaining to receipt and Customer's acceptance of the order, BRFPA shall recommend release of final payment to the Seller.

F. Price Reasonableness.

Since, in general, the former Soviet system did not foster competitive entrepreneurial activity, it is anticipated that the majority of purchases to be made under this plan will be of the sole source variety – either from a) Original Equipment Manufacturers whose parts would be considered proprietary in nature or from b) so-called captive suppliers/manufacturers to which there is no other known practicably accessible alternative because of distance or unstable and dangerous socio-political conditions – Burns and Roe shall make all reasonable and prudent effort to verify and document that the prices to be paid are not unreasonable. Such effort may include but shall not necessarily be limited to:

1. Prices to be paid are standard catalog prices.

2. Prices compare favorably to historical pricing recently paid by the Armenians for the same or similar items.

3. Prices compare favorably to prices charged for the same or similar items in the U.S. or other country from which such pricing information is available.

4. Certification by the Seller that the pricing to be charged is the same as he charges to all customers for the same or similar items for like quantities.

5. Prices compare favorably with the budgetary pricing as included in the approved commodities lists.

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G. Documentation.

1. BRFPA shall assemble a procurement file for each purchase order.

2. Each procurement file shall contain the following minimum documentation including copies of all translations:

   a. Approved purchase requisition.

   b. Executed purchase order.

   c. Packing slips/shippers.

   d. Inspection and acceptance documentation.

   e. Payment documentation (e.g., invoices, records of payment, etc.).

3. Purchase order files shall contain the following additional documentation as applicable:

   a. Competitively Bid Procurements.

      i. Copy of the RFQ including General Provisions and any specifications, standards or drawings referenced in the RFQ.

      ii. Bidders' quotations.

      iii. Bid abstract.

   b. Sole Source Procurements.

      i. RFQ, if separate from the purchase requisition.

      ii. Seller's quotation, if applicable.

      iii. Memorandum of negotiations.

      iv. Sole source justification, to include

         aa. Steps taken to attempt to obtain competition.

         bb. Reasons/justification for why the source of supply is the only available source.

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cc. Efforts made to verify and document that the negotiated pricing is not unreasonable.

c. All Procurement Files.

i. Change order requisitions, if applicable.

ii. Purchase order amendments, if applicable and all supporting documentation and justification.

iii. Receiving Reports. This may be a separate form or it may be notations on the packing slip/shipper.

iv. Over, Short and Damage(OS&D) Reports.

v. Documentation of how the OS&D issues were resolved to the satisfaction of Burns and Roe and the Customer.

vi. Correspondence and/or records of telephone conversations or contact reports, if applicable.

vii. Any other documentation pertinent to the purchase, its receipt, acceptance and payment.

4. All purchasing files for local purchases shall be maintained by the BRFPA in Armenia until the purchasing/receiving/ acceptance process is completed. Upon completion of the procurement process, the complete file shall be forwarded to the Project Purchasing Agent in Washington, DC for maintenance with the other Project purchasing files.

END OF PROCUREMENT PLAN

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EXHIBIT 2 - 2

LIST OF COMMODITIES PURCHASED

Product List By Description: Armenia (D.O. 5, Task 2)

13-May-98

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
Administrative, Tax,					
	5825- 207	1	lot	$6,896.72	$6,897
					$6,897
Battery, Storage,					
	5825- 188	2	sys.	$19,021.00	$38,042
	5825- 188	1	sys.	$24,285.00	$24,285
	5825- 188	1	sys.	$24,285.00	$24,285
	5825- 188	2	sys.	$33,385.00	$66,770
	5825- 232	5	each	$53.40	$267
	5825- 232	10	each	$78.70	$787
	5825- 232	10	each	$101.20	$1,012
	5825- 232	10	each	$118.00	$1,180
	5825- 232	10	each	$182.60	$1,826
					$158,454
Cable, Electrical, High Voltage					
	5825- 207	3	km	$1,211.11	$3,633
	5825- 210	1	lot	$135,000.00	$135,000
	5825- 210	1	lot	$472,365.35	$472,365
	5825- 210	1	lot	$64,000.00	$64,000
	5825- 230	1	lot	$399,974.00	$399,974
					$1,074,973
Chemicals, Industrial, General					
	5825- 200	1200	tonne	$195.00	$234,000

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
	5825- 200	7	tonne	$19,600.00	$137,200
	5825- 200	100	tonne	$760.00	$76,000
	5825- 203	9	tonne	$780.00	$7,020
	5825- 227	1	lot	$160.00	$160
	5825- 227	1	lot	$900.00	$900
	5825- 236	3.8	tonne	$1,800.00	$6,840
					$462,120
Computer, Desktop,					
	5825- 238	2	each	$2,250.00	$4,500
	5825- 238	2	each	$2,050.00	$4,100
					$8,600
Computer, NoteBook,					
	5825- 409	1	each	$2,473.00	$2,473
	5825- 418	1	each	$2,500.00	$2,500
					$4,973
Computer, Notebook, Accessories					
	5825- 409	1	each	$92.00	$92
	5825- 409	1	each	$35.00	$35
					$127
Computer, Peripheral,					
	5825- 238	4	each	$400.00	$1,600
	5825- 238	1	each	$1,150.00	$1,150
	5825- 409	2	each	$70.00	$140
	5825- 409	2	each	$277.00	$554
	5825- 409	2	each	$33.00	$66
	5825- 409	2	each	$70.00	$140

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
	5825- 418	1	each	$6.00	$6
	5825- 418	1	each	$277.00	$277
	5825- 418	1	each	$70.00	$70
					$4,003
Consumables, Computer, Miscellaneous					
	5825- 418	2	each	$33.00	$66
					$66
Consumables, Lubricants/Fuel,					
	5825- 209	210.9	tonne	$1,000.00	$210,900
	5825- 216	16	tonne	$1,100.00	$17,600
	5825- 216	70	tonne	$1,100.00	$77,000
	5825- 216	5	tonne	$1,080.00	$5,400
	5825- 219	3950	kg	$1.10	$4,345
	5825- 219	8000	liter	$1.10	$8,800
	5825- 219	1	lot	$11,000.00	$11,000
	5825- 224	168.8	tonne	$830.00	$140,084
	5825- 229	350	tons	$840.00	$294,000
	5825- 229	1	lot	$5,292.00	$5,292
	5825- 242	66.5	tonne	$830.00	$55,195
	5825- 244	179	tonne	$908.00	$162,532
	5825- 247	43100	kg	$1.00	$43,100
					$1,035,248
Consumables, Tools, Bits, Blades & Etc.					
	5825- 207	50	each	$2.92	$146
					$146
Consumables, Welding,					

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
	5825- 200	1	lot	$14,000.00	$14,000
	5825- 203	2300	lbs	$1.50	$3,450
	5825- 208	1	tonne	$1,764.00	$1,764
	5825- 236	2.5	tonne	$1,500.00	$3,750
					$22,964
Equipment, Communication, Radio					
	5825- 201	16	sets	$9,650.00	$154,400
	5825- 201	16	sets	$10,600.00	$169,600
	5825- 201	10	sets	$1,100.00	$11,000
	5825- 201	4	sets	$10,000.00	$40,000
	5825- 352	5	each	$350.00	$1,750
	5825- 352	5	each	$930.00	$4,650
	5825- 352	30	each	$650.00	$19,500
	5825- 352	5	each	$125.00	$625
					$401,525
Equipment, Electrical, Circuit Breakers					
	5825- 201	8	sets	$48,500.00	$388,000
	5825- 201	24	sets	$16,250.00	$390,000
	5825- 220	10	each	$3,100.00	$31,000
	5825- 220	32	each	$1,950.00	$62,400
					$871,400
Equipment, Electrical, Starters					
	5825- 236	118	each	$14.50	$1,711
					$1,711
Equipment, Electrical, Stator					
	5825- 226	1	each	$382,000.00	$382,000

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
					$382,000
Equipment, Mechanical, Bearings					
	5825- 215	1	lot	$30,270.00	$30,270
					$30,270
Equipment, Mechanical, Pumps					
	5825- 203	1	each	$1,900.00	$1,900
	5825- 203	5	each	$1,300.00	$6,500
	5825- 203	6	each	$1,000.00	$6,000
	5825- 203	10	each	$1,480.00	$14,800
	5825- 203	6	each	$1,600.00	$9,600
	5825- 207	4	each	$1,250.00	$5,000
	5825- 207	10	each	$440.83	$4,408
	5825- 236	3	each	$1,600.00	$4,800
	5825- 236	1	each	$600.00	$600
	5825- 236	8	each	$1,000.00	$8,000
	5825- 236	2	each	$1,300.00	$2,600
					$64,208
Equipment, Mechanical, Valves					
	5825- 207	20	each	$73.09	$1,462
	5825- 207	200	each	$1.32	$264
	5825- 207	300	each	$1.31	$393
	5825- 207	180	each	$73.08	$13,154
	5825- 207	370	each	$1.21	$448
	5825- 207	130	each	$1.22	$159
	5825- 223	1	lot	$12,802.00	$12,802
	5825- 223	1	lot	$21,335.00	$21,335

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
					$50,017
Freight, International,					
	5825- 355	1	lot	$15,585.00	$15,585
	5825- 355	1	lot	$2,442.00	$2,442
	5825- 373	1	1	$2,754.75	$2,755
	5825- 373	1	1	$407.63	$408
	5825- 415	1	lot	$900.00	$900
	5825- 419	1	lot	$850.00	$850
					$22,939
Freight, Local,					
	5825- 145	1	each	$8.99	$9
	5825- 169	1	ea	$67.15	$67
	5825- 188	1	lot	$13,150.00	$13,150
	5825- 212	1	lot	$1,410.00	$1,410
	5825- 409	1	lot	$0.00	$0
	5825- 418	1	lot	$53.00	$53
					$14,689
Hardware, Nuts & Bolts,					
	5825- 208	2	tonne	$427.00	$854
					$854
Labels, USAID, Logos					
	5825- 145	100	each	$0.50	$50
	5825- 145	100	each	$0.68	$68
	5825- 145	100	each	$1.35	$135
	5825- 145	25	each	$8.25	$206
	5825- 145	25	each	$4.95	$124

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
	5825- 169	1	Lot	$333.00	$333
	5825- 169	1	lot	$97.00	$97
	5825- 169	180	each	$4.95	$891
	5825- 169	20	each	$8.25	$165
	5825- 169	1	lot	$236.00	$236
	5825- 169	1	lot	$212.00	$212
	5825- 169	1	Lot	$87.00	$87
					$2,604
Machine Parts, Bearings,					
	5825- 203	10	each	$15.00	$150
	5825- 203	15	each	$32.30	$485
	5825- 203	20	each	$6.00	$120
	5825- 203	100	each	$10.30	$1,030
	5825- 203	30	each	$6.00	$180
	5825- 203	15	each	$32.30	$485
	5825- 203	20	each	$44.00	$880
	5825- 203	10	each	$6.00	$60
	5825- 236	150	each	$6.40	$960
					$4,349
Machinery, Compressor, Spare/Repair/Replacement Parts					
	5825- 212	1	lot	$575,758.37	$575,758
					$575,758
Machinery, Construction/Excavation,					
	5825- 213	1	each	$19,700.00	$19,700
	5825- 217	1	lot	$54,150.00	$54,150

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
	5825- 237	1	each	$33,600.00	$33,600
					$107,450
Machinery, Construction/Excavation, Spare Parts					
	5825- 234	1	lot	$70,500.00	$70,500
	5825- 237	1	lot	$31,087.00	$31,087
					$101,587
Machinery, General, Spare/Replacement Parts					
	5825- 211	1	each	$1,381.58	$1,382
	5825- 211	2	each	$7,736.84	$15,474
	5825- 211	2	each	$1,381.58	$2,763
	5825- 211	2	each	$6,907.89	$13,816
					$33,434
Materials, Boiler, Insulated Metal Netting					
	5825- 231	2000	sq. m.	$2.50	$5,000
					$5,000
Materials, Control Cable,					
	5825- 223	1	lot	$5,737.00	$5,737
					$5,737
Materials, Electrical, Wire					
	5825- 222	1	lot	$32,067.90	$32,068
					$32,068
Materials, Fireproofing, Asbestos (Russian)					
	5825- 203	500	lbs	$1.80	$900
	5825- 236	5	tonne	$500.00	$2,500
					$3,400

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
Materials, Power/Heating Plant Repair, Brick					
	5825- 200	250	tonne	$250.00	$62,500
	5825- 200	210	tonne	$250.00	$52,500
					$115,000
Materials, Power/Heating Plant Repair, Miscellaneous					
	5825- 206	1200	meter	$0.84	$1,008
	5825- 206	300	meter	$0.84	$252
	5825- 206	1	tonne	$1,235.00	$1,235
	5825- 206	1	tonne	$1,235.00	$1,235
					$3,730
Materials, Sheet Metal, Sheets					
	5825- 208	5	tonne	$427.00	$2,135
					$2,135
Materials, Sheet Steel,					
	5825- 239	60	tonne	$350.00	$21,000
					$21,000
Materials, Wire,					
	5825- 207	6	km	$216.67	$1,300
	5825- 207	4	km	$216.66	$867
					$2,167
Pipe, Steel,					
	5825- 204	20	tonne	$326.00	$6,520
	5825- 204	60	tonne	$326.00	$19,560
	5825- 204	15	tonne	$342.00	$5,130
	5825- 204	10	tonne	$342.00	$3,420

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
	5825- 204	60	tonne	$315.00	$18,900
	5825- 204	35	tonne	$326.00	$11,410
	5825- 204	30	tonne	$325.00	$9,750
	5825- 204	60	tonne	$342.00	$20,520
	5825- 204	70	tonne	$342.00	$23,940
	5825- 204	20	tonne	$342.00	$6,840
	5825- 205	2500	lbs	$0.44	$1,100
	5825- 205	2500	lbs	$0.44	$1,100
	5825- 205	5	tonne	$600.00	$3,000
	5825- 205	2500	lbs	$0.44	$1,100
	5825- 214	15	tonne	$500.00	$7,500
	5825- 214	35	tonne	$500.00	$17,500
	5825- 227	65	tonne	$1,500.00	$97,500
	5825- 227	1	lot	$68,500.00	$68,500
	5825- 227	1	lot	$22,100.00	$22,100
	5825- 249	45	tonne	$1,400.00	$63,000
					$408,390
Resins, Water Treatment, Industrial					
	5825- 202	69.99	tonne	$3,800.00	$265,973
	5825- 202	39.96	tonne	$3,300.00	$131,868
	5825- 227	81	tonne	$3,200.00	$259,200
	5825- 227	14	tonne	$3,200.00	$44,800
					$701,841
Supplies, Computer, Miscellaneous					
	5825- 238	320	each	$1.20	$384
	5825- 418	20	pack	$9.00	$180

PRODUCT	P.O. NUMBER	QTY	UNIT	UNIT PRICE	EXTENDED PRICE/TOTAL
					$564
Supplies, Miscellaneous,					
	5825- 205	10	cylin	$50.00	$500
					$500
Tools, Power, Electric/Pneumatic					
	5825- 207	10	each	$161.66	$1,617
					$1,617
Tools, Welding,					
	5825- 203	2	each	$1,500.00	$3,000
	5825- 207	20	each	$81.66	$1,633
					$4,633
				SUMMARY TOTAL:	**$6,751,148**
				4% FEE:	**$270,046**
				GRAND TOTAL:	**$7,021,194**

EXHIBIT 4 - 1

PRELIMINARY ESTIMATE FOR THE CAPITAL COST OF THE LORIBERD HYDROELECTRIC PROJECT

ARMENIA CRITICAL ENERGY NEEDS

HYDROELECTRIC REHABILITATION AND ENGINEERING

PRELIMINARY ESTIMATE OF THE CAPITAL COST FOR THE LORIBERD HYDROELECTRIC PROJECT

Draft

Prepared for

Burns and Roe Company

by

Harza Engineering Company

September 1994

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Chapter 1

INTRODUCTION

USAID authorized Burns and Roe to expend one person-month of Core time to "review a high priority project such as the Loriberd hydro project, develop a capital cost based on existing data, and prepare a report". Harza Engineering Company has performed a brief design review and developed a preliminary estimate of capital cost for the Loriberd Hydroelectric Cascade which was proposed for development in the Dzoraget River Basin by EREVANGHIDROPROYECT, the national design institute of the Republic of Armenia. These services were performed for Burns & Roe under Item No.3 "Hydroelectric Rehabilitation and Engineering" of Delivery Order No.5 (Armenia Critical Energy Needs).

The design review consisted of an examination of technical documentation consisting of several volumes of the "Construction Project" Parts 1 through 8 for the "Powerplant Cascade on River Debed, Loriberd Powerplants". Main materials relevant to this review were :

- Construction Project Part 2, Topo Contract and Geodesic Engineering Review;
- Construction Project Part 3, Water Economics, main Parameters, Economic Effectiveness;
- Construction Project Part 2, Basic (Natural) Studies, Climate and Hydrology;
- Construction Project Part 1, General Part, Patent Investigation (a presentation to prospective bidders);
- Construction Project Part 1, General part, Summary Report;
- Construction Project Part 1, Passport (Summary);
- Construction Project Part 1, Main Explanatory report (the technical justification).

The findings of the design review are presented in the following chapters. The estimate of capital cost is based on materials quantities developed by EREVANGHIDROPROYECT and used without any revisions or alterations. Unit prices based on international direct costs (with the exception of labor rates which were estimated for current conditions in the republic of Armenia) were assembled and applied to the original quantities to define construction costs.

Additional efforts are needed to complete a subsequent phase of design optimization and to provide a better backup for the cost estimates. Based on the existing information, the findings and the estimates included in this study should be considered preliminary.

Chapter 2

SELECTED PROJECT DESCRIPTION

2.1 General

The proposed hydroelectric development in the Dzoraget River Basin includes three plants; the Malaya Project on the Urut River, Loriberd 1 on the Gerger River, and Loriberd 2 on the main stem of the Dzoraget. The total installed capacity within the Dzoraget watershed amounts to 59.2 MW in the selected alternative. The main characteristics of the three projects that make up the development are shown in Table 1 :

Table 1

Plant	Design Head m	Number of Units	Design Discharge m3/s	Installed Capacity MW	Energy GWh/yr
Malaya	70.0	3	3.5	1.8	8.1
Loriberd 1	46.3	2	20.0	8.0	25.0
Loriberd 2	274.1	4	21	49.4	165.0

All three projects are basically run-of-river and form a cascade of diversions connecting to powerplants located on three different rivers. Two of the projects have some peaking capability that varies from 2.5 hrs for Loriberd 2, to over three hours for Malaya. Design discharges for hydroelectric developments are selected after allowing for water supply, irrigation, and preservation (environmental) releases. The configuration of the three projects that form the hydroelectric development in the Dzoraget basin is presented on Drawings 1 to 3.

2.2 Malaya Powerplant

The intake works for the Malaya plant are located on the Urut River (a second-order tributary of the Dzoraget), and the powerhouse is located on and discharges into the Dzoraget River. The diversion dam consists of a free overflow weir 10 m high and 35 m long. The power intake consists of an opening in a training wall located on the right bank. It has a flushing path controlled by a radial gate in front of the opening. Periodic operation of the gate protects the intake front from bed load depositions. The 3,840-m long headrace crosses the divide between Urut and Dzoraget. It is an almost-horizontal reinforced concrete free flow box conduit (2 x 2.5 m) placed in cut in a trapezoidal trench. The invert elevations vary under an 0.08 percent slope between 1418.4 m and 1415.3 m. At the downstream end, a reinforced concrete headpond (forebay) with a volume of 40,000 m3 connects with a 260-m long penstock that descends about 71.5 m to the powerhouse.

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The penstock has an inverted "U" shape and is made out of reinforced concrete, lined with an 8-mm thick, 1.15-m diameter steel piper. The head pond is also a penstock intake and is controlled by slide gates at both ends (conveyance and penstock). At the downstream end of the head pond, the capability exists to close the penstock and divert flow through a reinforced concrete rectangular spillway canal that runs parallel to the penstock to the Dzoraget River. The spillway canal is designed to begin discharging into Dzoraget if and when the Malaya powerhouse is shut down (outage or repairs). With this operation, the Loriberd 1 intake located downstream on the Dzoraget will use the flows derived from Urut whether the Malaya powerhouse is operating or not. The Malaya powerhouse has three horizontal-shaft Francis units rated 0.6 MW each and fed by a three-branch manifold (steel tubes embedded in reinforced concrete, including the two bifurcators and the branch elbow). The common turbine-generator floor is at elevation 1344.5 m and unit centerline is at elevation 1345.82 m. The powerhouse, located on the left bank of Dzoraget River, is a surface indoor structure made out of reinforced concrete, with a total height of 11.6 m from the bottom of the turbine pit, including a superstructure 7.6 m high. The plan of the plant is a rectangle 23.2 m x 15.4 m. The units discharge through open flumes. A tailrace canal collects the open flume discharges and connects with the river where normal tailwater is at elevation 1342 m. Arrangements at the Malaya powerplant and some of the most significant features of the project are shown on Drawing 1 (Sheets 1 and 2).

2.3 Loriberd 1 Powerplant

The intake of Loriberd 1 is located on the Dzoraget River, about 3 km downstream from the tailrace of the Malaya powerplant. The intake consists of a free overflow diversion weir with a structural height of about 11 m and a crest elevation at 1334.5 m. It has a spillway consisting of 10 uncontrolled bays 7 m x 2.5 m separated by 2 m piers and the structure spans 90 m across the river (effective crest length is 70 m). Six intake openings, 5 m x 2 m, with the invert at elevation 1334.5, are located in a training wall on the right bank of the river, oriented perpendicularly to the spillway/diversion dam axis. The intake openings are protected by trashracks and discharge into a 4.5-m wide concrete canal with its initial reach parallel to the river. Overflow openings are located in the left wall of the canal, downstream of the spillway position, to permit excess flows to be returned to the river. The intake is controlled by the operation of a flat gate located in the canal between the intake and the overflow openings. This gate will have to be operated by mobile crane. A flushing path, controlled by a radial gate, is provided between the spillway and the intake training wall. Its periodical operation will protect the intake openings from bed load deposition. The radial gate (4.5 m x 4.5 m) is operated by a permanent gantry crane.

An 87-m long intake canal leads to a 10,400-m long tunnel conveyance via a 20 m-long portal. The tunnel is designed as free flow and will be excavated by drill and blast to an inverted U shape. The entire length of the tunnel will be lined with 30 cm to 40 cm of plain or reinforced concrete. The net cross section area is 4 m x 4 m. About 2,050 m of the tunnel will be excavated in weak and permeable zones of sedimentary rocks (including rock formation contact crossings), and will be completely lined with reinforced concrete, including the invert. About 4,000 m downstream from the intake, a 65-m deep shaft is proposed to allow for the opening of two more excavation fronts. Beyond the tunnel outlet portal, the conveyance becomes a free flow concrete box conduit (5.2 m x 3.5 m) placed in a trapezoidal cut through sands and clays, and backfilled with gravel. The total length of the canal reach is 1,585 m. At the initiation of the box conduit and, again about 400 m

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downstream, surge wells are incorporated into the configuration with the function of protecting the conveyance from accidental pressurizing when the upstream control gate is closed.

The conveyance discharges into a reinforced concrete headpond. The headpond is about 200-m square with an average depth of 6 m. Thee usable volume of the headpond is about 200,000 m^3 which will provide for slightly over 2.5 hours of peaking at the installed capacity. The headpond is an intake for the penstock to Loriberd 1 and it is also connected to a concrete box conduit that by-passes the Loriberd 1 powerhouse and feeds directly the Loriberd 2 power conveyance. Both ends of the headpond are controlled by flat gates. A 1,980-m penstock with an internal diameter of 3.0 conveys the power discharges to the powerhouse along a cut an cover alignment under an average slope of 1.7 percent. The penstock consists of a concrete tube embedding a 20-mm thick steel liner. Both the concrete box conduit and penstock are placed in the same trench for most of the alignment and stiffened together through 12 anchor blocks. Just before the powerhouse, the discharge canal and the penstock split. At the downstream end of the head pond, gate controls have the capability to close the penstock and divert flow through the reinforced concrete rectangular by-pass that runs parallel to the penstock. This by-pass will operate if the Loriberd 1 powerhouse is shut down (outage or repairs).

The powerhouse is a surface, indoor reinforced concrete structure, 14.4 m high not including infrastructure. Total height from the draft tube slab invert is 23.4 m. The floor plan size is 38 m x 12.5 m including erection bay. It houses two vertical-shaft Francis units rated 4 MW each. The main generator) floor is at elevation 1278.0 and transformers, located in an adjacent patio, are at the same elevation. The switchyard is also located by the powerhouse structure. The two draft tubes discharge into the by-pass canal that feeds the Loriberd 2 power conveyance. The arrangement of the Loriberd 1 powerplant and some of the most significant features of the project are shown on Drawing 2 (Sheets 1 to 5).

2.4 Loriberd 2 Powerplant

The main intake of this plant is represented by the connection between the Loriberd 1 tailrace and the Loriberd 2 conveyance. An additional intake for Loriberd 2 is located on the Gerger River, about 1 km downstream from the Loriberd 1 powerhouse. It consists of a free overflow diversion weir with a structural height of about 11 m and with the crest at elevation 1275.38 m. The diversion has four uncontrolled bays (7 m x 2 m) separated by 2.0 m wide piers and the structure spans 38 m across the river (effective crest length is 28 m). This structure would be installed to supplement the design flow of 20 cms coming from the upstream powerplant with 1.0 cms diverted from the Gerger River, providing a design discharge of 21 cms to the Loriberd 2 plant. A small intake canal is fed by a 16.6-m long side spillway located in a training wall on the left bank of the river. A flushing path controlled by a radial gate with head wall is provided between the weir dam and the intake canal wall. Its periodical operation will protect the intake openings from bed load deposition. The radial gate (5.0 m x 5.0 m) will have to be operated by a mobile gantry crane.

The 5.2-m wide concrete by-pass from the Loriberd 1 headpond, becomes the Loriberd 2 conveyance and runs parallel to the river, receiving the 1.0 cms supplement within 50 m from the Loriberd 2 side overflow intake. The total length of the conveyance down to the forebay is about 3,260 m. A 625-m long open power canal (measured from the connection with the by-pass canal),

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connects to a 2,000-m long buried, free flow concrete conduit (cut and cover). The last 650-m long portion of the power conveyance is a rectangular concrete canal.

The conveyance discharges into a 200-m square, reinforced concrete headpond with an average depth of 6 m. The headpond has a usable volume of about 200,000 m^3 which provides a capability for slightly more than 2.5 hours of peaking at the installed capacity. The penstock begins at the downstream end. A 1,020-m, 3-m internal diameter penstock conveys the power discharges to the powerhouse along a variable slope alignment. The penstock consists of a steel liner of thicknesses varying between 10 mm and 20 mm. The initial 400 m of the penstock are embedded in a concrete tube placed in cut and cover and anchored to the ground through three concrete blocks. The balance of the waterway is an pressure shaft inclined at 46 degrees followed by a tunnel, both steel lined and backfilled with mass concrete. An embedded steel manifold connects to the powerhouse through four steel penstocks.

The powerhouse is a surface, indoor reinforced concrete structure 20 m high, not including infrastructure. The total height from the draft tube slab invert is about 30 m. The floor plan size is 50 m x 14 m including erection bay. It houses four vertical-shaft Francis units rated 12.35 MW each. The main floor of the powerhouse is at elevation 995.60 and the transformers are located in an adjacent patio at the same elevation. The switchyard is also located by the powerhouse structure. The arrangement of the Loriberd 2 powerplant and some of the most significant features of the project are shown on Drawing 3 (Sheets 1 to 4).

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Chapter 3

MEASUREMENTS AND COST ESTIMATES

3.1 Quantity Measurements

Construction of the three-plant development in the Dzoraget basin would entail the execution of the following :

- unclassified excavations and earthworks in the amount of 3,135,000 m3;
- rock excavations of about 610,000 m3, including 228,000 m3 of tunnelling;
- placement of random and gravel fill measuring about 1,880,000 m3;
- placement of 290,000 m3 concrete and reinforced concrete (a consumption of 74,900 metric tons of cement);
- installation and embedment of about 3,190 tons of structural steel, including penstock steel liner.

The above quantities are detailed by powerplant and scheme component in Annexes 1, 2, 3, and 4.

3.2 Unit Prices

In developing unit prices for the Dzoraget River hydropower development, a brief effort was made to obtain information on local current conditions; however, no general guide lines were prepared. According to the verbal information made available by Mr. Jack Adrian (a U.S.citizen of Armenian origin interested in the promoting these developments), only minor equipment is presently available in the area; however, local labor (skilled and unskilled), can be utilized for construction work.

Harza's recent experience in the New Independent States (NIS), indicate that the prevailing economic and construction environment is changing rapidly, and that the previous price structure is no longer applicable to the current conditions in Armenia. Consequently, a price structure based on world market conditions was generally applied, and only labor rates were selected to correspond to recent NIS conditions.

In addition to labor costs reflecting the NIS conditions, the unit prices listed below take into account the necessity of importing construction equipment and materials as required. It was assumed that local materials such as cement, aggregate, sand, explosives, reinforcing bars, concrete blocks (or bricks), structural steel, lumber and diesel oil will be available in sufficient supply during construction.

Construction will be undertaken by foreign/local contractors, maximizing the use of local labor and materials and importing construction equipments only as required. Total foreign involvement would increase the prices substantially.

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All estimated unit prices are in U.S. Dollars per unit at the 1994 level. Following is a partial list of unit prices used in estimating construction costs:

1.	Common Excavation:	$2.4	Per CuM
2.	Rock Excavation:	$4.0	Per CuM
3.	Underground Excavation	$44.0	Per CuM
4.	Fill:	$2.5	Per CuM
5.	Mass Concrete:	$90-108	Per CuM
6.	Reinforced Concrete:	$135	Per CuM
7.	Structural steel:	$2200	Per Tonne
8.	Reinforcing:	$750	Per Tonne
9.	Cement:	$60	Per Tonne

These unit prices are preliminary and subject to adjustments after further studies of the location and site conditions.

3.3 Capital Cost Estimates

For the purpose of simplification, the total development was divided in three areas, namely **Area I** (the Malaya Plant down to, and including tailrace), **Area II** (the Loriberd 1 Plant, from the intake, down to the connection with the power conveyance of the Loriberd 2 Plant), and **Area III** (the balance of the development). Based on the above unit prices, total construction costs were developed for the three areas and then for the total development. Under the present review and capital cost estimate, the only scenario taken into consideration was the development of all three plants under a continuous construction schedule, for a total installation of 59.2 MW. This assumption might warrant further scrutiny, and alternative configurations based on a single powerhouse located at the current Loriberd 2 site, should probably be evaluated.

The total development construction costs, valid only under the current unit price structure, are presented in U.S.Dollars at the 1994 price level in the following table :

Table 2

Location	Malaya Plant	Loriberd 1	Loriberd 2	Totals
DAM	500,000	7,638,000	5,748,000	
DIVERSION	3,600,000	29,900,000	6,846,000	
HEAD POND	2,380,000	4,541,000	4,210,000	
PENSTOCK	550,000	9,700,000	6,343,000	
POWERHOUSE	560,000	4,265,000	7,812,000	
MECHANICAL/ ELECTRICAL	1,117,000	2,332,000	9,631,000	
SUBTOTALS	8,707,000	58,376,000	40,590,000	107,673,000
CONTINGENCY +/-20%	1,293,000	11,624,000	8,410,000	21,327,000
TOTAL PRICE AT 1994 LEVEL	10,000,000	70,000,000	49,000,000	129,000,000
MEGAWATTS				59.4
PRICE/KW				$2,172 Avg.

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Chapter 4

DESIGN REVIEW

4.1 General

Based on a limited review, the three run-of-river project configurations are viable and well-designed. Although apparently correct, as can be determined from the drawings and text, the hydraulic and structural design is sometimes expensive and perhaps, too conservative. High cost features include tunnel steel liners (sometimes backfilled with reinforced concrete), long diversions in reinforced concrete box conduits, heavily reinforced concrete headponds controlled by gates and built on relatively flat areas to provide artificial pondage, and one river intake (the one for Loriberd 2), built to augment only slightly the design discharge of the powerplant. On a preliminary basis and without visiting the sites, some alternative configurations aimed at reducing the construction costs are detailed in the following paragraphs first for some items common to all projects and then for each specific project..

Special consideration should be given to the sediment control aspect. The inclusion of a flushing path provided with radial-gate control in the free overflow weirs in each of the three schemes will probably take care of the bed load accumulating in front of the openings. It will not take care, however, of the suspended sediment that seems to be present in significant quantities during floods and that can damage the units through abrasion erosion. Also, the insignificant volumes provided in the riverbed upstream of the weirs (several orders of magnitude smaller than flood volumes) are too small to produce sand particle settling. The only effective solution would be a settling basin incorporated in the diversion alignment immediately downstream of the intake openings, before entering any underground or buried conveyance. The alternatives to this solution is to weld-repair the turbine runners based on a regular maintenance schedule (generally, Francis runners have to be taken apart), to buy additional runners, or to procure special alloy runners clad in abrasion-resistant steel (marcasitic steels) that are fabricated by few manufacturers. All these are expensive alternatives when compared to a desander that is a civil structure replacing a reach of the conveyance.

Another feature incorporated in all projects is the headpond. The design of these structures could be revised to result in simpler configurations. First, an electrical power demand analysis should define if the country is really in need of peaking power at this time, or if it only needs energy to keep various sectors of consumption minimally satisfied. If there is no urgent need for peaking, then the function of the headpond could be performed by a much smaller structure provided with a free overflow to discharge the upsurge produced by load rejection at the turbines. With these provisions, the depth would be controlled by the submergence requirements of the penstock.

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4.2 The Malaya Project

This project is a low capacity development and, as such, low cost features should be implemented in order to lower the overall cost. Potential simplifications could include :

The free flow diversion could be built as an open canal with a trapezoidal cross section protected by a bituminous layer;

If the headpond configuration is to be simplified (see above), the concrete by-pass conduit could be eliminated;

The number of units in the powerhouse could be reduced to two or even to one (still Francis type with an open flume configuration);

The powerhouse building could be designed as a semi-outdoor structure without an erection bay and with erection and maintenance performed with the help of a mobile crane rented for the occasion (especially if the number of units is reduced).

4.3. The Loriberd 1 Project

In this development, the 10.5-km tunnel is a high cost component. As permanent support, about 2,200 m of the tunnel are lined with reinforced concrete, and the balance is lined with simple concrete. Thicknesses of concrete vary between 30 cm and 50 cm. The lining extends over the walls and includes the invert. This configuration results in significant quantities of cement and reinforcing steel. In order to lower costs, support along some reaches through more competent rock and with enough cover could be reconsidered and changed to a less expensive type. Along such more favorable reaches, a check should be made for hydrojacking and hydraulic gradient and, if conditions permit, a lighter and more elastic support that would include shotcrete over rockbolt pattern and wire mesh should be implemented whenever possible. Heavier measures should be used only as required. Another possibility would be to consider a comparison between the drill and blast procedure and the use of a TBM. The temporary and permanent support requirements will also be tied to the tunnel driving procedure. Even if the rock type changes along the tunnel alignment, current machines can accommodate these variations. A tunneling specialist from the prospective contractor, together with the geotechnical engineer, will have to make recommendations.

Some of the potential optimization concepts mentioned under the Malaya scheme are applicable for the Loriberd 1 Project as well. In particular, the free flow diversions could be envisaged as open trapezoidal canals instead of reinforced concrete conduits; and the current headpond configuration could be replaced by a simpler tank structure provided with an overflow.

4.4 The Loriberd 2 Project

The design review comments offered for the Loriberd 1 Project apply to the Loriberd 2 Project (except the tunnel-related propositions) In addition, a major component of this plant is a free overflow diversion weir proposed across the Gerger River, sized to pass the design flood and for the purpose of increasing the design discharge at Loriberd 2 from 20 cms to 21 cms. The 20 cms design discharge is guaranteed without any major control structure on the Gerger as a result of the connection of the Loriberd 1 tailrace and the Loriberd 2 power conveyance. The physical connection of the two waterways is located on the left bank and the two plants are in cascade, without the need of an additional heavy structure. Loriberd 2 can operate even when the upstream plant is shut down, due to the provision of a powerhouse by-pass, thus increasing the reliability of the cascade. An incremental cost-benefit analysis should be performed on the additional economic advantages and liabilities related to the construction of the diversion dam on Gerger River, before including it in the configuration.

At this head, turbines for Loriberd 2 could very well be Pelton, or any other impulse-type machine. Under the previous political organization, the Russian or Ukrainian "Normalized" Francis turbines might have been cheaper and readily available. Currently, under an international bidding environment, there could be manufacturers of Pelton units that are competitive (especially Italian manufacturers which would enjoy about same logistic advantages and could benefit of government grants). Of course, the powerhouse layout would have to be modified to accommodate impulse machines, but significantly less excavation would be required in the turbine pit. Also, Pelton turbines could be easily repaired by welding without the necessity of taking the runner apart, thus allowing for a configuration without settling basin at the intake.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Based on a preliminary examination of the available documents related to the hydroelectric developments in the Dzoraget River Basin, it is concluded that:

1. The configurations are viable and the hydraulic and structural design are characterized by a high professional level.

2. There might be ways to lower construction costs by simplifying or even reducing specific project features, such as power conveyances, headponds, and river intakes.

It is recommended that:

1. Additional effort should be put forth to find acceptable solutions to control suspended sediment traveling to the machines during flood events.

2. Visits at the intake and powerhouse sites, walks along the conveyance alignments, as well as examination of the geologic cores should be performed to confirm some of the statements made in the **Construction Project for the Loriberd Powerplant Cascade** issued by **EREVANGHIDROPROYECT**. Visiting teams should include a hydroelectric project specialist, a geotechnical engineer, and a contractor management team representative that would have knowledge of the tunnel constructability aspects.

3. Meetings should be held with the armenian Institute specialists to explore the feasibility of some of the mentioned alternatives and to assess the local contractors' capabilities and the need for construction management expatriate activities.

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Summary of Civil Works Measurements

Item	Malaya	Loriberd 1	Loriberd 2	Total (Rounded)
Unclassified Excavation[1] ($1000m^3$)	265	1,840	1,030	3,135
Rock Excavation ($1000m^3$)	200	73	110	383
Tunneling ($1000m^3$)	–	214	14	228
Fill [2] (1000^3)	263	1,170	445	1,878
Concrete, Reinforced Concrete ($1000m^3$)	31	150	109	290
Cement (Tons)	9,350	37,630	27,940	74,920
Structural Steel[3] (Tons)	275	1,462	1,454	3,191

[1] Includes all earthworks in the powerhouse area.

[2] Includes random and gravel fill.

[3] Includes penstock steel (liner) and powerhouse superstructure. Does not include gates, bridges, or electro-mechanical equipment.

Civil Works Measurements

Malaya Project

Item	Dam	Diversion	Head Pond	Penstock, Powerhouse	Total
Unclassified Excavation[1] ($1000m^3$)	4	181	56	23	264
Rock Excavation ($1000m^3$)	–	141	56	2	199
Tunneling ($1000m^3$)	–	–	–	–	–
Fill[2] (1000^3)	2	260	–	2	264
Concrete, Reinforced Concrete ($1000m^3$)	4	10	11	6	31
Cement (Tons)	1,300	3,000	3,400	1,650	9,350
Structural Steel[3] (Tons)	4	–	148	123	275

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[1] Includes all earthworks in the powerhouse area.

[2] Includes random and gravel fill.

[3] Includes penstock steel (liner) and powerhouse superstructure. Does not include gates, bridges, or electro-mechanical equipment.

Civil Works Measurements

Loriberd 1 Project

Item	Dam	Diversion	Head Pond	Penstock, Powerhouse	Total
Unclassified Excavation[1] ($1000m^3$)	68	919	660	191	1,838
Rock Excavation ($1000m^3$)	10	–	–	63	73
Tunneling ($1000m^3$)	–	214	–	–	214
Fill[2] (1000^3)	10	869	120	171	1,170
Concrete, Reinforced Concrete ($1000m^3$)	17	51	31	50	149
Cement (Tons)	4,800	8,000	9,500	15,330	37,630
Structural Steel[3] (Tons)	–	5	27	1,430	1,462

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[1] Includes all earthworks in the powerhouse area.

[2] Includes random and gravel fill.

[3] Includes penstock steel (liner) and powerhouse superstructure. Does not include gates, bridges, or electro-mechanical equipment.

Civil Works Measurements

Loriberd 2 Project

Item	Dam	Diversion	Head Pond	Penstock, Powerhouse	Total
Unclassified Excavation[1] ($1000m^3$)	21	269	660	80	1,030
Rock Excavation ($1000m^3$)	10	67	–	33	110
Tunneling ($1000m^3$)	–	–	–	13	13
Fill[2] (1000^3)	1	322	58	63	444
Concrete, Reinforced Concrete ($1000m^3$)	11	27	34	36	108
Cement (Tons)	3,200	8,200	4,800	11,740	27,940
Structural Steel[3] (Tons)	26	–	27	1,400	1,453

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[1] Includes all earthworks in the powerhouse area.

[2] Includes random and gravel fill.

[3] Includes penstock steel (liner) and powerhouse superstructure. Does not include gates, bridges, or electro-mechanical equipment.

EXHIBIT 5 - 1

REPORT ON SELECTION OF ENTERPRISES

Task No. 5
Critical Industries Energy Conservation.

REPORT ON SELECTION OF ENTERPRISES.

Issued: August 30, 1994
Revised: September 14, 1994

Prepared for the

USAID/YEREVAN

by

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Task No. 5
Critical Industries Energy Conservation.

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Task No. 5
Critical Industries Energy Conservation.

REPORT ON SELECTION OF ENTERPRISES.

Issued: August 30, 1994
Revised: September 14, 1994

I. Background

The objective of this task is to identify and implement improvements in energy efficiency in seven industrial plants in Armenia that either provides critical products for the Armenian market or produce essential export products.

There is an immediate need for rapid improvements, due to high cost and limited supply of fuel. The needs for these improvements are due to a variety of poor energy utilization practices and low energy efficiency of designs, which were based on very low fuel cost existing when the plants were built and lack of necessary maintenance. The program developed by USAID/Yerevan to reduce energy consumption and emissions in existing plants required careful selection of active enterprises. The economic assistance provided by USAID, subsequent implementation of recommendations, and installation of new equipment will save the facilities energy, reduce the need for imported fuel, reduce emissions, and reduce cost of the final product.

This report is a summary for Phase I of Activity Implementation Plan, which required field investigation and evaluation of industrial enterprises in Armenia that provide critical product for Armenian market or produce export commodities. This report shows the selection criteria developed by involved Armenian Governmental Agencies, USAID/Yerevan and representatives from Burns and Roe Company (BRC), Resource Management Associates, Inc. (RMA) and European Community Energy Center - Armenia (ECECA). It is also lists names of industrial enterprises visited during field audit and list of industrial enterprises selected for the future Phases II, III and IV of Activity Implementation Plan.

II Key Participants

Three firms were participating in Phase I of Task #5 investigation. Burns and Roe Company (BRC) represented by Mr. V.Shames P.E., Resource Management Associates, Inc. (RMA) represented by Mr. Robert Erickson, and European Community Energy Center - Armenia (ECECA) represented by Mr. A.Littler. The European Community Energy Center - Armenia is a separately funded group, which is cooperating with BRC and RMA during

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energy audit phase.

The following Governmental Agencies were participating in Phase I of Task #5 helping to create the list of possible candidates for energy audits:

a) Ministry of Energy.
b) Armenergonaladka.
c) Ministry of Food Industry.
d) Ministry of Light Industry
e) Ministry of Construction Materials

III Selection Criteria.

The following criteria for the selection of the industrial enterprises were developed during the meetings with the Governmental Agencies:

a) Enterprise shall be active
b) Enterprise shall provide critical material
c) Enterprise shall use majority of raw materials from Armenia.
d) Enterprise shall have potential for energy conservation
e) Enterprise shall be of manageable size.

IV List of Industrial Enterprises.

With the assistance of Armenian Governmental Agencies, Burns and Roe Company, Resource Management Associates, Inc. (RMA) and European Community Energy Center - Armenia (ECECA) were able to identify sixteen (16) possible candidate industrial plants. These plants were investigated for their operational conditions for energy conservation possibilities. The selection consisted of the following industrial enterprises:

1) Yerevan Thermal Power Plant (YTPP) - plant is currently producing steam and hot water for district heating and electricity for electrical distribution needs.

2) Yerevan Cable Plant - plant is producing electrical cables and wires needed for rebuilding of electrical systems in Armenia.

3) Ararat Cement Plant - plant is producing cement needed for rebuilding of the Armenian infrastructure. The cement is also the export commodity.

4) Yerevan Ceramic Plant - plant is producing ceramic tiles and is being modernized to produce perlite insulation needed for the energy sector.

5) Aansk Salt Mining Plant - plant is producing salt required for domestic, animal and agricultural needs. It is also the export commodity.

6) Yerevan Oil Refinery Factory is producing domestic soup, margarine, etc.

7) Yerevan Canning Factory is producing canned fruits, vegetables and juices.

8) Ararat Cognac Plant - plant is producing high quality cognacs and brandies for Armenian and international consumption.

9) Yerevan Brewery Plant - plant is producing beer for domestic consumption.

10) "Caritas" Woodworking Plant - plant is producing doors, windows, etc. It is also a training school for carpenters.

11) "Centrolite" Plant is a foundry, which are producing cast iron, brass and aluminum for heavy industry.

12) "Sirius" Plant - plant is producing resistors, diodes, etc.

13) Yerevan Vitamin Factory are producing vitamins needed for humans and animals.

14) Silk Factory is producing silk textile for domestic use.

15) Yerevan Gatch Plant is producing gypsum materials for the construction industry.

16) Luis Lamp Plant is producing large variety of incandescent, fluorecent and high intensity discharge lamps.

V. Selected Industrial Enterprises.

Using the selected criteria the following industrial enterprises were selected for the future energy audits:

1) Yerevan Thermal Power Plant (YTPP)
2) Avansk Salt Mining Plant
3) Ararat Cognac Plant
4) Yerevan Cable Plant
5) Yerevan Brewery
6) Ararat Cement Plant
7) Luis Lamp Plant

The Yerevan Thermal Power Plant (YTPP) is a main producer of electricity and district heating water for City of Yerevan. YTPP installed capacity is 5.5 MW. Currently only one (out of seven) unit is operating. The operational losses for one unit are very high. Therefore, an increase of overall efficiency of operation will provide saving of energy and fuel. As result of previous energy audits done by RMA, oxygen trim controls were installed for two main units. Considering size of Yerevan TPP, only one or two improvements should be considered during this scope of work.

Avansk Salt Mining Plant consists of salt mines and the main plant. The plant is operating 24 hours per day providing Armenia with high grade salt for human, animals and agricultural demands. The salt mine and the plant are the source for large electric and heat consumption. The boiler plant which consists of three (3) operating boilers could use some energy saving improvements and additional controls. The exhaust gases from the boilers may be used for the heating purposes.

Ararat Cognac Plant requires process steam 24 hours per day. The boilers installed in the boiler plant are very old and unreliable. The efficiency of the units is less than 40 percent. There are numerous combustion gas leaks into the boiler room. The installation of modern packaged boiler with the efficiency of 85% can drastically reduce fuel consumption and reduce cost of the final product. The plant has manageable size for energy conservation improvements. The plant is using Armenian raw materials and the final product is a source of export.

Yerevan Cable Plant is the main supplier of cooper and aluminum wires for Armenia and one type of the cables is being exported to Russia . The previous energy audits performed by Resource Management Associates (RMA) show some potential energy saving measures, which could be done by modifying boiler plant and by modifying the cooper melting process.

Yerevan Brewery is a main producer of the beers for City of Yerevan. The brewery consists of the main plan, the boiler plant and the chiller plant. The brewery is operating most of the time. The plant has manageable size for energy conservation improvements. The modification of the boilers, the chillers and installation of additional insulation for the steam and chilled water lines can produce large savings of energy and reduce the cost of the final product.

Luis Lamp Plant is producer of a wide variety of incandescent, fluorescent and high intensity discharge lamps. It also produces all packaging material necessary for shipping of finished products. Because of the glass furnaces, plant operates 24 hours per day all year round.

Within recommended seven industrial enterprises, the Ararat Cement Plant is highly depending on the natural gas imported from Russia and Turkmenistan. At the same time, the production of this plant is highly needed to rebuild Armenian infrastructure. The plant has

capability of exporting cement to Georgia, Turkey, Iran and Saudi Arabia at the below market prices. By replacing damaged filters and providing better filtration system for this plant can save 20 metric tons of the cement per each hour of operations. This will greatly reduce atmospheric pollution. The conversion of the kilns to burn Armenian mined coal instead of imported natural gas will reduce dependence of the plant from foreign energy sources.

VI Industrial Enterprises not Selected for Energy Audits.

The following reasons for not selecting nine (9) other candidates are:

1. Yerevan Ceramic Plant - need investment in excess of $1,000,000 USD to modernize its conveyer lines to produce perlite insulation. However, this cost could be greatly reduced by making multi-segment type of the perlite insulation. Modernization of this plant shall be a separate task.

2. Yerevan Oil Refinery Factory - highly depends on delivery of row material from Georgia and Russia. Production is near 5-10% of previous capacity.

3. Yerevan Canning Factory operates only 3-4 month per year due to seasonable type of operations.

4. "Caritas" Woodworking Plant - plant is very small and very energy efficient. However, it could be recommended for the solar heating project, which should be part of the different task.

5. "Centrolite" Plant - most of the plant is closed due to lack of raw materials and energy.

6. "Sirius" Plant - most of the plant is closed due to lack of raw materials and energy. Most of the products produced by this plant is outdated.

7. Silk Factory - factory is temporary closed.

8. Yerevan Gatch Plant - plant will be closed in 3-4 years because the nearby source of the raw materials near its end and the plant will be relocated to the different area.

9. Yerevan Vitamin Factory production is highly depending on foreign raw material. Most of the plant is closed due to lack of raw materials and energy. Production is near 5-10% of previous capacity.

VI Conclusions

The selected seven enterprises represent wide range of different industries found in Armenia. Such industries include Energy and Power Generating Plants, Mining Industry, Food Industry, Manufacturing Industry and Construction Industry. The selected plants represent active enterprises were energy improvements could be achieved in relatively short time with the future reduction in fuel consumption and reduction of airborne pollutants.

EXHIBIT 5 - 2

SUMMARY AND EVALUATION OF ENERGY AUDIT REPORTS FOR ENERGY EFFICIENCY IMPROVEMENTS AT SEVEN INDUSTRIAL PLANTS IN ARMENIA

SUMMARY AND EVALUATION OF ENERGY AUDIT REPORTS FOR ENERGY EFFICIENCY IMPROVEMENTS AT SEVEN INDUSTRIAL PLANTS IN ARMENIA

PRELIMINARY REPORT
March 30, 1995
Revision: May 30, 1995

Prepared for United States Agency for International Development/Armenia
Task #5 "Critical Industries Energy Conservation"

BURNS AND ROE COMPANY, INC.

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1.0 PREFACE.

This report presents the results of energy audits conducted at six industrial plants in Armenia from September 1994 to December 1994. International teams from Burns and Roe Company, Research Management Associates of Madison, Inc. and European Community Energy Center - Armenia participated in the audit work and in identifying the recommended Energy Conservation Measures (ECM's).

The ECM projects described in this report are being implemented by Burns and Roe Company within framework of the Emergency Energy Program for Armenia for United States Agency for International Development.

The main objective of this project is to identify and implement improvements in energy efficiency at seven industrial plants in Armenia that either provide critical products for the Armenian market or produce essential export products.

There is an immediate need for rapid energy improvements, due to the high cost and limited supply of fuel in Armenia. The needs for these energy improvements are due to a variety of poor energy utilization practices and low energy efficiency inherent in the plant designs. The plants were built on the basis of very low fuel costs which is inconsistent with the current "world cost" of energy.

The economic assistance, subsequent implementation of recommendations, and installation of new equipment will save energy, reduce need for imported fuel, reduce emissions, and reduce manufacturing cost.

During the initial visit to Armenia in August 1994, fifteen (15) industrial enterprises were surveyed and evaluated for potential Energy Conservation Saving Opportunities (ECSO's). The list of critical industrial enterprises and the selection criteria were developed by the Armenian Governmental Agencies, USAID/Yerevan and representatives from Burns and Roe Company (BRC), Resource Management Associates, Inc. (RMA) and European Community Energy Center - Armenia (ECECA). The European Community Energy Center - Armenia is a separately funded group, which was cooperating with BRC and RMA during the energy audit phase.

The following Armenian Governmental Agencies assisted to create the list of possible candidates for energy audits:

a) Ministry of Energy.
b) Ministry of Construction Materials
c) Ministry of Food Industry.
d) Ministry of Light Industry

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Based on the results of the initial visit to Armenia, seven industrial enterprises providing critical products for the Armenian market or produce essential export products were selected.

From September 1994 to December 1994 ECECA and RMA under the direct assistance of BRC conducted seven energy audit studies. A report of the energy audit for each facility was issued with recommendations for Energy Conservation Measures (ECM's). The list of implementation items to accomplish those recommendations was then discussed with the USAID/Yerevan office and Directors of the selected industrial enterprises. This report addresses only those implementation items which are within the scope and funding of this USAID Task.

2.0 LIST OF SELECTED ENTERPRISES.

The following criteria for the selection of the industrial enterprises were developed during the meetings with the Governmental Agencies:

a) Enterprise shall be active
b) Enterprise shall provide critical material
c) Enterprise shall use majority of raw materials from Armenia.
d) Enterprise shall have potential for energy conservation
e) Enterprise shall be of manageable size.

Using the selected criteria the following industrial enterprises were selected for the final detailed energy audits:

1) Yerevan Brewery
2) Ararat Cognac Plant
3) Avan Salt Mining Plant
4) Ararat Cement Plant
5) Yerevan Cable Plant
6) Luis Lamp Plant
7) Yerevan Thermal Power Plant

Yerevan Brewery is a main producer of beer for City of Yerevan. The brewery is in operation for most of the year. The plant has manageable size for energy conservation improvements. The improvement in process temperature controls, modification of the boilers and installation of additional insulation for the steam and chilled water lines will produce large savings of energy and reduce the cost of the final product.

Ararat Cognac Plant requires process steam 24 hours per day. The burners installed in the boiler plant are very inefficient. The plant is using Armenian raw materials and the final product is a source of export.

Avan Salt Mining Plant consists of salt mines and the main plant. The plant is operating 24 hours per day providing Armenia with high grade salt for human, animal and agricultural demands. The salt mine and the plant are the source for large electric and heat consumption. Within the selected industrial enterprises, the Ararat Cement Plant is highly dependant on the supply of natural gas imported from Russia and Turkmenistan. At the same time, the product of this plant is vital for rebuilding the Armenian infrastructure. The plant has the capability of exporting cement to Georgia, Turkey, Iran and Saudi Arabia at below market prices.

Yerevan Cable Plant is the main supplier of copper and aluminum wires for Armenia, and one type of the cable is being exported to Russia . The preliminary energy audits performed by RMA show some potential energy saving measures, which could be achieved by modifying the copper melting process.

Luis Lamp Plant is producer of a wide variety of incandescent, fluorescent and high intensity discharge lamps. It also produces all packaging material necessary for shipping of the finished products. Because of the glass furnaces, the plant operates 24 hours per day all year round.

The Yerevan Thermal Power Plant (YTPP) is a main producer of electricity and district heating water for City of Yerevan. Currently only one 55 MW unit (out of seven) is operating. Operational losses for the one unit are very high. Therefore, an increase of overall efficiency of operation will provide savings in energy and fuel.

3.0 UTILITIES COST IN ARMENIA.

The cost of the utilities in Armenia were provided by Armenia's Ministry of Energy.
The current price structure of energy products is very volatile and is being changed monthly. Energy rates, therefore, were prorated to international and USA rates.

Table #1 "Energy Rates in Armenia."

Item	Item Description	Quoted Rates, as of 04/25/95	USA Rates as of 03/15/95
1	Electricity	$0.035/ kwh	$0.05/ kwh
2	Mazout (Heating Oil)	$0.55/Gal	$0.65/Gal *
3	Natural Gas	$0.064 /Cu.M	$0.175 /Cu.M
4	Water	$0.125/Cu.M **	$0.09/Cu.M

* Price is based on international price for crude oil.
** Price of water in Armenia depend on cost of electricity and already higher then in USA.

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4.0 TECHNICAL SUMMARY AND PROPOSED COST OF IMPLEMENTATION OF ENERGY AUDIT REPORTS:

This section of the report provides the technical summary, engineering calculations, design sketches, payback calculations, and proposed cost of the recommended implementation items at each industrial plant. The items selected for implementation are based on the results of the energy audit reports performed by ECECA, RMA and BRC. These items were discussed with USAID office in Yerevan in December of 1994 and with the management of each industrial enterprise.

4.1 Yerevan Brewery.

Yerevan Brewery is one of the industrial enterprises in Armenia that operates all year round. Starting from the beginning of March and ending by end of November, the plant operates from 16 to 20 hours per day. During the winter the plant is partially closed, because it does not produce fresh beer, but is processing beer from storage tanks. Between October 1993 and September 1994 plant was operating for 4,218 hours.

The main energy sources used at Yerevan Brewery are the following:

Electricity
Fuel Oil (mazout)
Water

The electricity is mainly used to provide plant with electrical lighting, operate chilled water and brine systems, operate equipment, and run compressed air station. The fuel oil is being used at the boiler plant as a source of fuel for the boilers producing steam for the brew house and also for bottle washing equipment. Water is required for plant own needs and for brewing beer.

4.1.1 Modification to the Boiler Plant (ECM #1)

The boiler plant at Yerevan Brewery contains five (5) boilers. Two "Lancashire" type boilers are abandoned for safety reasons. The third "Lancashire" type is operating at the present time. Each boiler is rated at 1.8 tons of steam per hour. The operating boiler is past its useful service life and is unable to satisfy the required steam demand. This deficiency was observed during the energy audit. The efficiency test performed on the operating boiler, indicates that the unit operates at 38 percent efficiency, which is unacceptable. Two modern type boilers are also located in the boiler room. These boilers are DKVR-4.5-13 rated at 4.5 tons of steam per hour and are 15 years old. These boilers are presently not operating due to the lack of

sufficient fuel. The steam atomized burners and combustion controls installed on these boilers are of outdated design and therefore cannot properly modulate fuel flow to provide the load required by the brewery process. The boilers are also in need of minor repairs including refractory work and some tube replacement. While the DKVR boilers may be fired with mazout, there is a reluctance to operate these units as the electrical consumption of draft fans is high. The defficiencies of the boiler plant a re a main source of energy waste in the Brewery. As it's shown in ECECA report, boiler losses are accountable for 60 percent of annual use of mazout.

The estimated peak load required to operate the brewery is approximately 3.0 tons of steam per hour. As shown in ECECA report during May 1994 boiler plant used 75 tons of mazout. Hourly consumption of the mazout will be 48 gallons per hour with 460 working hours in May of 1994. With the efficiency of the boiler of 38 percent, boiler was able to produce 2.1 tons of steam per hour, which was insufficient to provide steam for Brew House and Bottling Plant at the same time. At some points, process in a Brew House was stopped until Bottling Plant would satisfy its need in steam. Installation of a modern high efficiency boiler/burner package operating with at least 83 percent combustion efficiency will reduce fuel oil consumption to approximately one half of current use.

In order to increase the operating efficiency of the existing boiler plant and reduce the fuel oil consumption, the following items are recommended for implementation in the boiler plant:

1. Install new boiler/burners package with automatic boiler combustion and feedwater controls.
2. Install stub fuel oil heater and electrical heat tracing for mazout pipes.

A saving of fuel at the boiler plant will be realized based on efficiency of modern combustion equipment operating at 83% efficiency versus outdated combustion equipment operating with 38 % efficiency. The new equipment will permit production of the required peak load of 3 tons of steam per hour.

Table #2 " Energy Saving with New Boilers".

Item Description	Existing Operating Boiler	New boiler w/new burner
Boiler Capacity, T/Hr	2.1	3.0
Efficiency, %	38	83
Fuel Consumption for required load, GPH	Not achievable	56
Fuel Consumption for 2.1 t/hr steam capacity, GPH	48	39.2

Based on fuel cost of $0.65 per gallon and 4,218 hours per year operation the annual saving to provide plant with 2.1 tons of steam per hour will be as follows:

$0.65 x4218 x (48.0 - 39.2) = $24,127 USD

This amount will be further reduced by electrical cost of operating air atomizing burners to annual saving of approximately $18,000 USD based on international price for mazout and to approximately $15,000 USD in local cost of mazout.

4.1.2 Beer Process - Flow Diagram.

The brewery house is a major user of steam at the Brewery. The simplified flow diagram for a beer making process is shown on Figure #1 and the detailed flow diagram of the process can be found on drawing M-101 "Beer Production - Flow Diagram in Appendix A. The pumps and valves are not shown.

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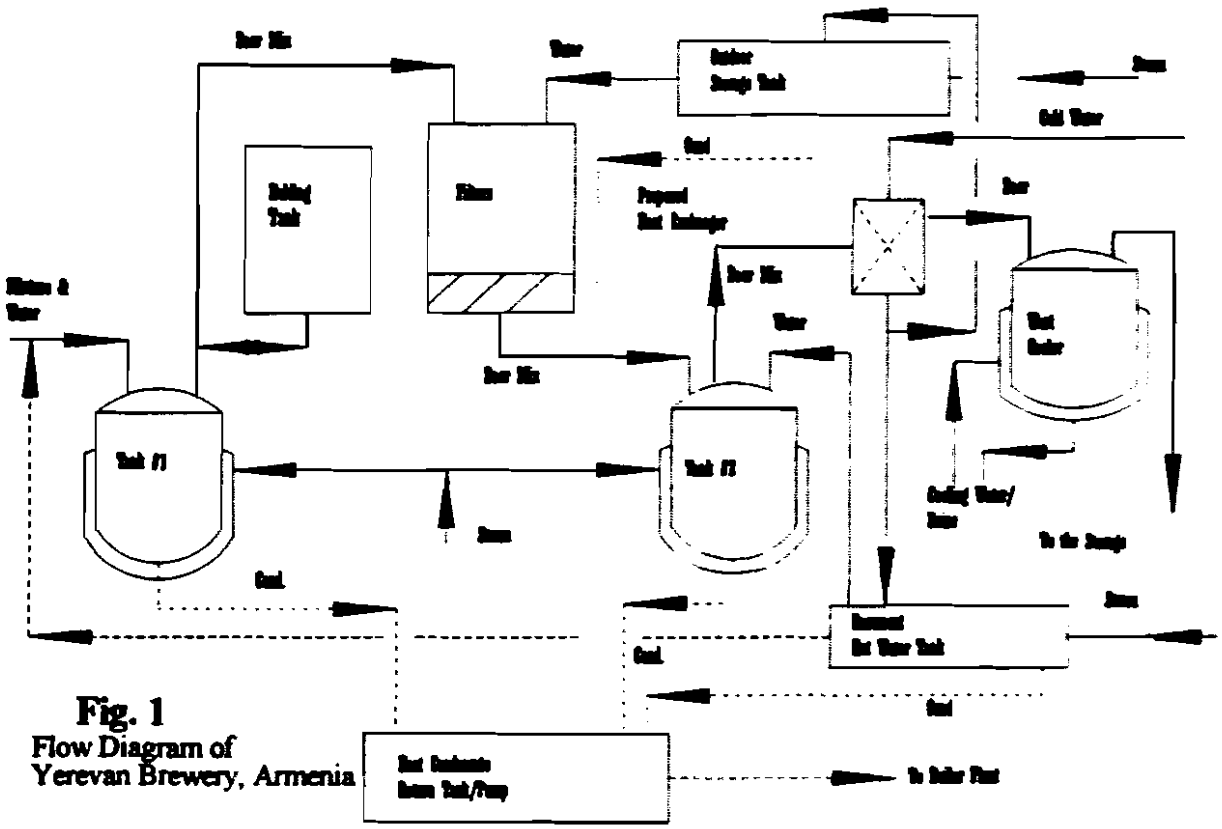

Fig. 1
Flow Diagram of
Yerevan Brewery, Armenia

4.1.3 Modification to Steam Usage in Brewing Processes (ECM #2).

The main users of steam in the Brew Houses are steam jackets of Tank #1, 2 and steam coils in the outdoor water storage tank and basement water storage tank. At the present time, most of the steam, after its been condensed in the above vessels, is being dumped to the city drain and some of it is being flashed to atmosphere due to lack of steam trapping devices. The temperature of this condensate and flashing steam mixture is approximately 120° C.

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Table #3 Steam Consumption at Brewery House.

Item Description	Unit	Tank #1	Tank #2	Outdoor Tank *	Basement Tank *
Volume of Liquid	Lb.	18800	18800	33100	5500
Temperature "In"	°F	53	140	53	53
Temperature "Out"	°F	158	210	194	167
Specific Heat	Btu/Lb*°F	1	1	1	1
Process Duration	Hrs	2	2		
Required amount of Steam	MBtu/Hr	1880	1316	4670	627
Required amount of Steam	Lb/Hr	1650	1145	4060	545

Note:

Items marked "*" require such amount of steam only during initial start-up. After that steam is only required to overcome losses to ambient conditions and occasional fill-up. Outdoor hot water storage tank losses during 10 °C weather are 1650 Lb/Hr of steam

Total amount of steam required for the Brewery House during peak operations is 3.0 tons of steam per hour. When the system is operating at its normal conditions (with the basement and outdoor hot water storage tanks heated), the required amount of the steam is approximately 2.6 Tons/Hr. The current boiler capacity is approximately 1.8-2.2 tons of steam per hour and is unable to provide plant with required amount of the steam.

The amount of energy saved by installing condensate return system is related to amount of steam saved less the cost of pumping the condensate back to boiler plant. Temperature of condensate in condensate pump will be around 120 °C. Temperature of feed water to the boilers is around 12 °C. Approximate energy saving with consideration for batch type process will be equal to 1.8 gph of mazout. Based on fuel cost of $0.65 per gallon and 4,218 hours per year operation the annual saving considering batch type process will be approximately:

$0.65 x 4218 x1.8 = $5,000 USD

4.1.4 Automatization of Beer Making Process (ECM #3).

The technological process of brew making is done manually by operators. The temperature control of the process is also done manually. As result of this, each batch of beer is brewed slightly different and a lot of steam is being wasted for overheating tanks #1 and 2 and the hot water storage tanks. The flow diagram for tanks #1 and 2 are similar and are shown in Figure #2 "Temperature Control for Tanks #1 and #2".

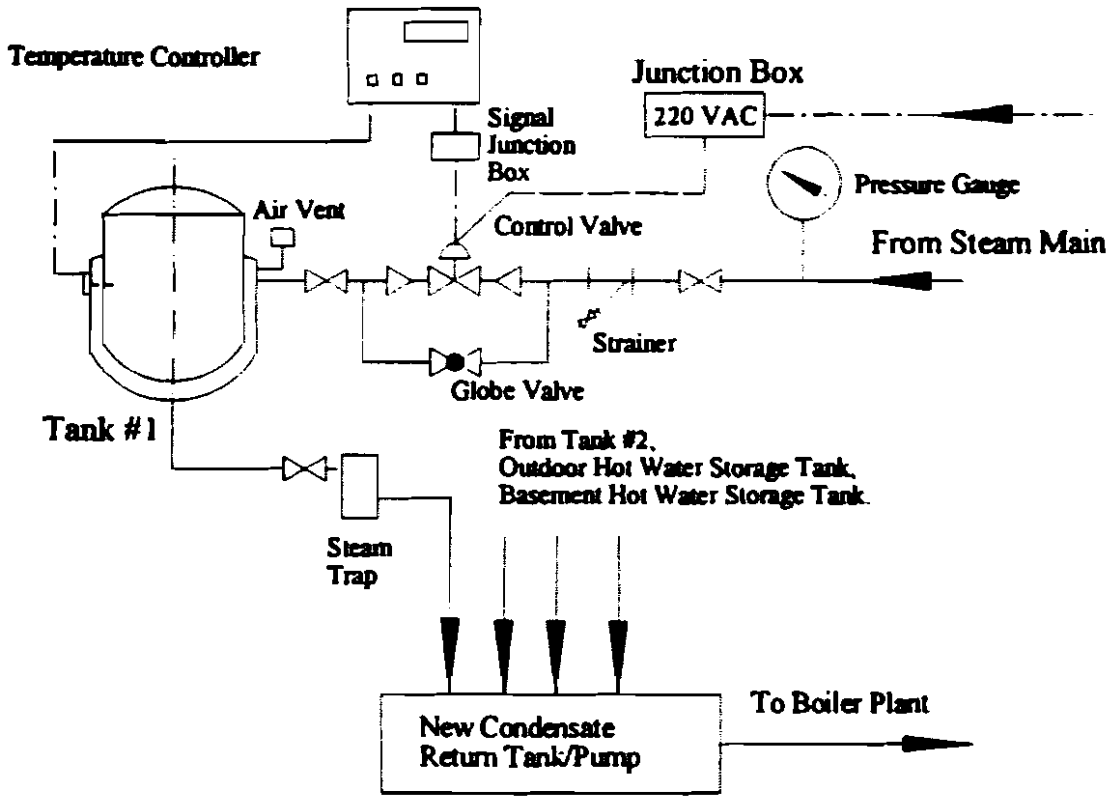

Fig. #2
Temperature Control for Tanks #1 and #2.

The flow diagram for outdoor hot water storage tank and basement hot water storage tank is similar to the diagram for Tanks 1 and 2. The complete flow diagram can be found on Drawing M101 in Appendix "A".

The automatic control system will prevent tanks from overheating and therefore approximately 10 percent of steam will be saved. The annual saving considering batch process will be equal to the following:

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(800,000 Btu/Hr x 10 % / 145,000 Btu/gal) x $0.65 x 4218/3 hr = $505 USD

The capital cost to implement this Energy Conservation Measure is approximately $7,560 USD. The payback from this implementation is approximately 15 years, which is economically unacceptable. However, when Brewery starts to operate at its rated capacity, the payback time will be reduced approximately 3 times or to approximately 5 years. Therefore, we recommend to implement this Energy Conservation Measure. This also will improve quality and consistency of final product.

4.1.5 Insulation of Pipes and Storage Tanks (ECM #4).

The hot water storage tanks need to be insulated in order to conserve energy. The outdoor storage tank has capacity of 15,000 liters and surface area of 49.6 sq. meters or 544 sq.ft. The storage tank located in the basement has capacity of 2,500 liter and surface area of 15.1 sq.meters or 163 sq.ft. The majority of steam pipes don't have insulation. The estimated area of steam pipes in the Brewery House and boiler plant is approximately 440 sq. meters or 4,750 sq. ft. The chilled water and brine piping are also in need of new insulation. The estimated area of chilled water and brine pipes and related equipment and tanks is 4,000 sq.ft. As calculated from ASHRAE "Fundamentals" the heat loss from the tank surface will be as shown in the Table 4 below:

Table #4" Heat Losses/Gains - Insulation

Item Description	Area, sq.ft.	Temperature degree F	Heat Loss without insulation, Btu/Hr	Heat Loss with insulation, Btu/Hr
Outdoor hot water storage tank	544	200	152320	38080
Basement tank	163	165	38300	9600
Pipes steam/condensate	4750	350	3236112	356400
Pipes & tanks for chilled water/brine	4000	5	111600	27900
Total			3538332	431980

Based on fuel cost of $0.65 per gallon and 4,218 hours per year operation and considering batch type of operations the annual saving calculated by ECECA and BRC will be equal to $11,500 USD

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4.1.6 The Wort Cooler Heat Exchanger (ECM #5).

Additional saving at the Brew House can be achieved by installing a wort cooler (heat exchanger) shown on Dwg M103 in Appendix "A" before wort cooling tank. The temperature of the finished wort before entering the wort cooler is approximately 95° C. In the wort cooler, the temperature is reduced to 6° C in two stages. During the primary stage, cooling is by water passing through primary cooling coil, and during the secondary stage, cooling is by brine passing through secondary coil in the wort cooler. The new heat exchanger will perform the following functions:

1. Precool wort from 95° C to 15° C and reduce amount of cooling water.
2. Preheat fresh water for a process from 12° C to 45° C
3. Reduce amount of steam required to preheat the above water.

Installation of wort cooler will save following amount of energy:

a. From precooling of wort

$$Q = 7{,}400 * 1 * (95-15) = 592{,}000 \text{ Btu/Hr}$$

b. From preheating process water

$$Q = 7{,}400 * 1 * (45-12) = 244{,}200 \text{ Btu/Hr}$$

or total energy saving achieved by wort cooler is equal to 836,200 Btu/hr or 245 KWH Based on electricity cost of $0.05 per KWH and 4,218 hours per year operation the annual saving calculated by ECECA will be equal to 5,200 USD.

4.1.7 Compressed Air (ECM #6).

The compressed air is used at the bottling lines and at the boiler plant. The duty compressor has no pressure control and operates continuously at full load. Pressure regulation is achieved through the use of pressure relief valves fitted to the air receivers and leaks in the systems. Air is used to operate the filling line and for fuel atomization during boiler start-up. Its usage at the boiler plant is occasional and is only to blowout mazout fuel lines in the winter. The new burners proposed for boiler room will be equipped with their own air compressor for start-up. The bottling plant is using approximately 5 cubic meters per minute of the compressed air at 5-8 atmosphere pressure. The plant' main compressor station is able to produce 10 cubic meters per minute using single air compressor equipped with the 75 KW motor. Three Moskva type BB-10/8 two stage reciprocating air compressors are located in the compressed air shop. Only one of the compressors is believed to be serviceable. The compressed air system is badly leaking with approximately 70 percent of the compressed air being lost. Therefore, a local air compressor with dryer and separator installed near the

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bottling lines will provide better operations and save energy. The new compressor sized for this operations and equipped with air driers and coolers as required by United States Drug and Food Administration requirements will have a 50 KW (65 HP) motor. Therefore, actual saving will be 25 KW per hour or annual saving of:

$ 0.05 x 4218 x 25 = $5,270 USD.

4.1.8 Sub-Metering (ECM #7).

In order to control energy use throughout the plant, the following metering system are recommended:

a. Steam.
   Steam metering station installed at the boiler plant to monitor and control steam flow to each shop.
b. Combustion Monitoring
   Portable Combustion Analyzer shall be provided to the boiler plant to adjust the burners.
c. Electricity.
   Electrical meters installed at the main electrical distribution station to monitor and control electrical consumption of each shop.
d. Water.
   Water metering station installed at the each shop to monitor and control water consumption of each shop.

When the energy usage information is available, it will be analyzed using PC-based energy management software, which will be able to show were additional energy could be saved. Monitoring and Targeting of energy use is a disciplined approach to energy management which ensures that energy resources are used to maximum economic advantage by controlling energy use and planning ways of reducing energy waste. The annual cost saving provided by sub-metering system is estimated to be approximately $8,000 USD. The annual cost saving provided by combustion analyzer is estimated to be approximately $3,200 USD.

4.1.9 Total Energy Saving Program and Cost Estimates

The estimated energy savings are shown in Table #5 "Energy Savings at Yerevan Brewery". The estimated construction cost of ECM's is shown in Table #6.
The shipping cost was estimated on the base of $0.35 per pound of item weight assuming that the shipment will be done by containers. The labor cost was estimated by using "Means Construction Cost" adjusted by lack of equipment by five times and based on $2 per hour salary rates.

Table #5 "Energy Savings at Yerevan Brewery"

Item Description	Possible Energy Saving	Possible Annual Saving,
ECM #1	8.8 GPH	$24,130
ECM #2	1.8 GPH	$5,000
ECM #3	.55 GPH	$505
ECM #4	4.2 GPH	$11,500
ECM #5	1.83 GPH	$5,200
ECM #6	25 KWH	$5,270
ECM #7		$11,200
Total		$62,805

Note: The actual saving based on the number of actual operating hours estimated to be 4,218 hours per year.

Table #6 "Cost Estimates and Economical Evaluation of Recommended Items for Yerevan Brewery.

Item Description	Possible Annual Saving	Estimated Equipment Cost, $	Estimated Cost of Installation, $	Estimated Cost of Shipment, $	Total Cost, $	Payback years
ECM #1	$24,130	$97,000	$3,600	$10,500	$111,100	4.6
ECM #2	$5,000	$12,600	$3,200	$200	$16,000	3.2
ECM #3	$505	$6,800	$560	$200	$7,560	14.97
ECM #4	$11,500	$32,000	included	none	$32,000	2.78
ECM #5	$5,200	$14,600	$2,500	$700	$18,600	3.58
ECM #6	$5,270	$14,500	$1,500	$400	$18,000	3.42
ECM #7	$11,200	$18,500	$2,500	$300	$21,300	1.9
Total	$62,805				$224,560	3.58

4.2 Ararat Cognac Plant.

Ararat Cognac Plant is one of the industrial enterprises in Armenia that operates all year round. The plant is one of the sources of export to other countries. The plant operates approximately 4,000 hours per calendar year. Because of its technological processes, Ararat Cognac Plant uses only fuel mazout or natural gas to produce steam required for distillation processes, water to produce cognacs and electricity to operate machinery. During the energy audit, electricity was supplied from the electric utility and factory's diesel generators. During January 1995, electricity generated from the factory's partially completed hydro-power plant started. The new plant is rated at 400 KW, but is presently generating only 200 KW due to equipment problems. The Ararat Cognac Plant is using 200 KW of electricity. Water for the plant is supplied from the city water system. Both electricity and water consumption are metered.

4.2.1 Modification to the Boiler Plant (ECM #1)

The boiler room at the Ararat Cognac Plant contains two (2) main boilers model DKVR-4.5-13, which are presently operating. These boilers are rated at 4.5 tons of steam per hour each and are 14 years old. The steam atomized burners and combustion controls installed on these boilers are of very outdated design and can not modulate fuel flow to provide the load required by the brewery process. The boilers are in need of minor repairs including some tube replacement. There are also four E-0.9 boilers rated at 0.9 tons of steam per hour, which are being used only for heating during the winter, when the main boilers are shutdown.

The measured combustion efficiency of the main boilers was approximately 56.2 percent. The existing burners are capable of operating with the settings of 40 percent and 100 percent of rated capacities. Providing these boilers with modern combustion equipment will increase combustion efficiency to approximately 80 percent with a fuel flow modulation of 5:1, which will permit adjustable output of from 0.9 to 4.5 tons of steam per hour.

The estimated peak load required to operate the Cognac Plant is approximately 3.6 tons of steam per hour. The observed daily consumption of fuel oil is maximum of 6 tons per day, which corresponds to the measured efficiency of the boiler and maximum hourly consumption of 107 GPH. Installation of modern high efficiency burner package operating with at least 80 percent combustion efficiency will require approximately 75 GPH to satisfy plant steam load. The daily saving of the fuel will be approximately 1.8 tons per day.

In order to increase the operating efficiency of the existing boiler plant and reduce fuel oil consumption the following items are recommended for implementation in the boiler plant:

1. Install new burners for DKVR-4.5-13 boilers with automatic boiler combustion controls.

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2. Install new automatic feed water controls.
3. Repair DKVR-4.5-13 boilers (tubes and refractory).

Table #7 " Fuel Saving with New Burners".

Item Description	Existing Boiler and Burner	Existing Boiler w/new burner
Boiler Capacity, Tons/Hr	4.5	4.5
Efficiency, %	56.2	80
Fuel Consumption for required load, GPH	107	75
Fuel saved per 4,000 hours, tons per year	480	

Based on 4,000 operating hours per year and cost of fuel of $0.65 per gallon, the annual saving will be $83,200 USD.

4.2.2 Insulation of Steam Pipes (ECM #2).

The steam distribution system at the Cognac Plant is in need of pipe insulation. Approximately 800 meters of 50 mm steam pipes are uninsulated. The calculated heat loss from uninsulated pipes as per ASHRAE "Fundamentals" is as follows:

a. Uninsulated pipes: 937,500 Btu/Hr
b. Insulated pipes: 62,000 Btu/Hr
c. Energy Savings: 875,500 Btu/Hr

Based on 4,000 operating hours per year and cost of fuel of $0.65 per gallon, the annual saving will be $15,700 USD.

4.2.3 Replacement of Steam Valves Pipe Leaks (ECM #3).

The steam shut-off valves on main steam header and some distribution pipes are leaking. At least 120 linear meters of distribution piping is leaking and should be replaced The estimated percentage of leaks claimed by valve manufacturers could be as high as 3 percent of total flow. The amount of steam saved by replacing valves will be 108 kg/Hr or approximately 262,250 Btu/Hr or approximately 1.8 gallons of mazout per hour. Based on 4,000 operating hours per year and cost of fuel of $0.65 per gallon, the annual saving will be $4,680 USD.

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4.2.4 Combustion Analyzer (ECM #4).

The installation of new burner require to perform some adjustments to obtain optimum performance. In order to do this task, purchase of portable combustion analyzer is required. The annual saving of fuel in keeping burners at their best performance will save approximately 6,450 gallons of fuel or $4,200 USD. The actual saving will be higher, if old heating boilers will be also properly adjusted.

4.2.5 Total Energy Saving Program and Cost Estimates

The estimated energy savings are shown in Table #8 "Energy Savings at Cognac Plant". The estimated construction cost of ECM's is shown in Table #9.
The shipping cost was estimated on the base of $0.35 per pound of item weight assuming that the shipment will be done by containers. The labor cost was estimated by using "Means Construction Cost" adjusted by lack of equipment by five times and based on $2 per hour salary rates.

Table #8 "Energy Savings at Ararat Cognac Plant

Item Description	Possible Energy Saving, Btu/Hr	Possible Annual Saving
ECM #1	4640000	$83,200
ECM #2	875500	$15,700
ECM #3	262250	$4,680
ECM #4	234230	$4,200
Total	6011980	$107,780

Table #9 "Cost Estimates and Economical Evaluation of Recommended Items for Ararat Cognac Plant".

Item Description	Possible Annual Saving	Estimated Equipment Cost, $	Estimated Cost of Installation	Estimated Cost of Shipment	Total Cost, $	Payback years
ECM #1	$83,200	$92,000	$7,600	$1,400	$101,000	1.2
ECM #2	$15,700	$14,600	included	none	$14,600	0.9
ECM #3	$4,680	$2,600	$200	none	$2,800	0.6
ECM #4	$4,200	$4,500	portable	$200	$4,700	1.1
Total	$107,780				$123,100	1.1

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4.3 Avan Salt Mining Plant

The Avan Salt Mining Plant is located outside city of Yerevan. The Plant consists of salt mines and the main plant. The plant is providing Armenia with high grade salt for human, animal and agricultural demands. The salt mine and the plant have large electric and heat consumption. The underground operations have a very large electric drives and are not energy intensive. Therefore, this area was regarded as low priority. The plant operations for production of crystalline salt consume large amounts of fuel, steam and electricity and therefore was regarded as high priority area for energy audit.

The following items were considered for implementation:

Install heat exchanger for preheating brine with condensate
Insulate condensate tank for first evaporation stage
Provide equipment for adjusting boilers (combustion analyzer) and insulate deaerator and repair insulation of boiler economizers.
Insulate hot air duct to drier and provide hot gas recirculation
Upgrade cooling tower with new controls and smaller size pumps.
Move mazout storage tanks closer to boiler plant, install electric stub fuel heater, insulate and heat trace fuel lines.

The production at the plant is divided in to two different groups. One of them is mechanical mining of rock salt and the second is a leaching of brine from the boreholes. The brine leaching method is used to produce crystalline salt.

The process diagram showing the crystalline salt process is shown in Figure #3 "Modified Process Flow Diagram".

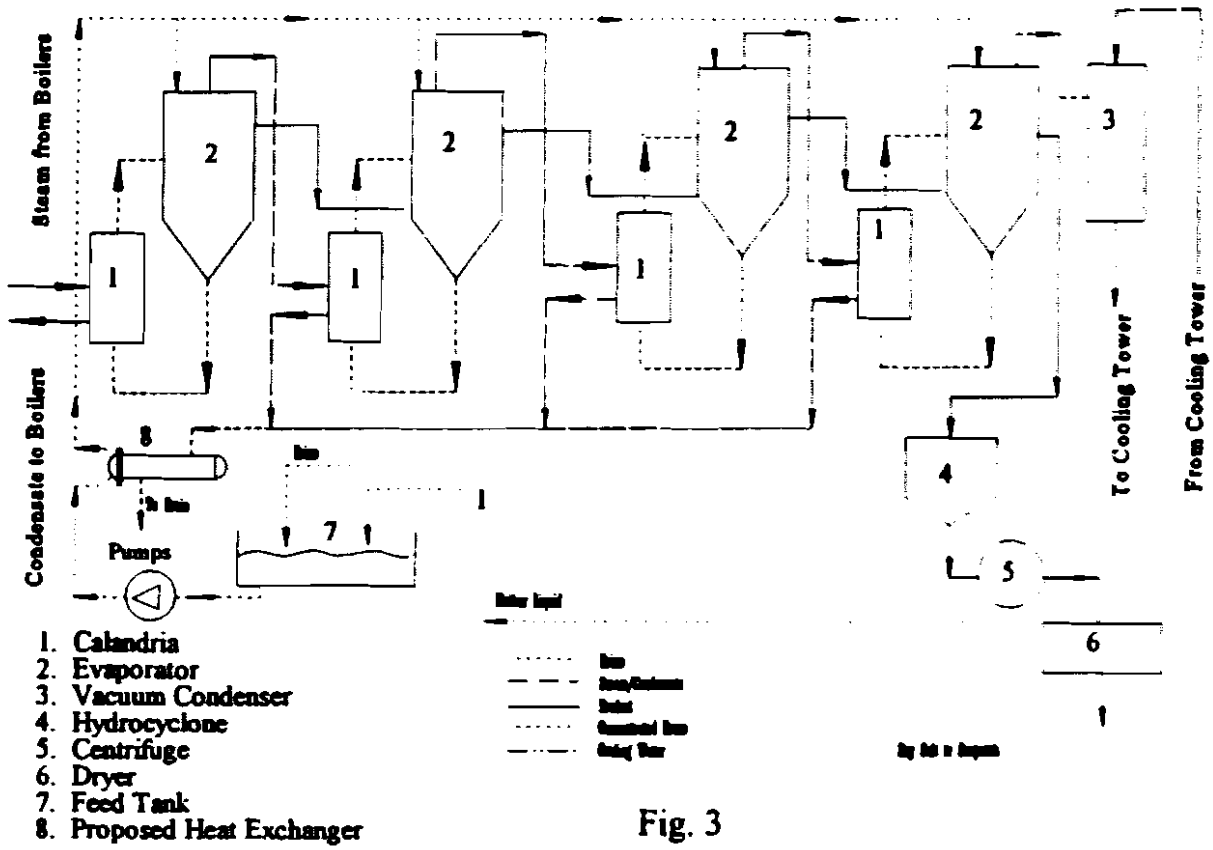

Fig. 3
Modified Process Flow Diagram

4.3.1 Heat Exchanger for Preheating Brine with Condensate (ECM #1).

The modified diagram shows proposed heat exchanger (item 8), which will preheat brine using condensate from stages 2, 3 and 4. The condensate from these stages has temperatures 90 °C, 70 °C and 50 °C, respectively. At the present time all condensate (90 GPM) from these stages is being discarded to the drain.

The heat exchanger installed after pumps as shown on drawing M-104 in Appendix "A" will preheat brine from 12 °C to 24 °C and provide saving of steam and fuel in the amount shown below.

$$Q = M * C *(T- Tn) = 6{,}700 \text{ GJ/year}$$

The annual saving will be $33,500 USD.

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4.3.2 Insulating Condensate Tank for First Evaporation Stage (ECM #2).

The condensate tank for first evaporation stage does not have insulation and heat is wasted to the environment instead of being used for crystallizing salts. The condensate from first evaporation stage has temperature close to 100 °C and currently is being fed to an uninsulated tank in the open air from which it is returned to the boiler plant at lower temperature. Insulating of this tank will save approximately 1,300 GJ/year, which correspond to annual savings of $6,500 USD.

4.3.3 Combustion Control of Boilers (ECM #3).

The boiler plant at the salt mines is relatively new. It was upgraded in 1990-1991. The plant has three (3) boilers, two (2) model DE-25-13 and one (1) model DKVR-25-13. All are rated at 25 tons per hour at 13 atm. The boiler plant does not have equipment to monitor and adjust combustion in the boilers. Addition of a combustion analyzer for adjusting boilers and burners can save as much as 11,700 GJ/ year based on the measured combustion efficiency during energy audit. This will correspond to $58,500 USD in savings. Sections of insulation inside boiler plant are to be replaced. Insulating deaerator and repair insulation of boiler economizers will save energy. However, during audit this saving could not be evaluated and calculated.

4.3.4 Insulation of Evaporators and Driers (ECM #4).

At the end of crystallization salt is dried inside two rotating drum driers. Hot air (10,000 cu.m/hr) is generated by two gas burners firing into a brick built combustion chamber. Insulating the hot air duct to the drier and providing hot gas recirculation will save approximately 1,000 GJ per year, which correspond to annual energy savings of $5,000. This ECM will be further investigated by ECECA for implementation. The evaporators at the plant are in need of the new insulation. The insulation of process evaporators will save approximately 11,000 GJ per year, which correspond to annual energy savings of $57,000. Total saving of this ECM will be $62,000 and 12,000 GJ per year.

4.3.5 Upgrade of Cooling Towers (ECM #5).

At the present time cooling water for the plant's vacuum condensers is pumped from the Hrazdan River approximately 2 kilometers away. The total electrical consumption of two pumps is approximately 600 KW. Modifications and upgrade to an existing cooling tower and addition of new controls and smaller size pumps can reduce electrical consumption to about 300 KW and save as much as 600,000 KW per year. Annual saving will be $30,000 USD.

4.3.6 Modification to Fuel Storage System (ECM #6).

The mazout tanks are located near an old abandoned boiler plant. Mazout is pumped from those tanks to the new boiler plant. During cold weather the mazout freezes in the pipes and the boiler plant can not operate. The existing water storage tanks located near the boiler plant will be refurbished and used for mazout storage. The installation of electric stub fuel heater, insulating and heat trace fuel lines will save on the fuel wasted during cold weather.
The annual saving of fuel for this ECM will be equal to 5,800 GJ/year. This will correspond to annual saving of $29,000 USD.

4.3.7 Total Energy Saving Program and Cost Estimates

The estimated energy savings are shown in Table #10 "Energy Savings at Avan Salt Mine Plant". The estimated construction cost of ECM's is shown in Table #11.
The shipping cost was estimated on the base of $0.35 per pound of item weight assuming that the shipment will be done by containers. The labor cost was estimated by using "Means Construction Cost" adjusted by lack of equipment by five times and based on $2 per hour salary rates.

Table #10 " Energy Savings at Avan Salt Mines"

Item Description	Possible Energy Saving	Possible Annual Saving
ECM #1	6700 GJ/Y	$33,500
ECM #2	1300 GJ/Y	$6,500
ECM #3	11700 GJ/Y	$58,500
ECM #4	12000 GJ/Y	$62,000
ECM #5	6000 GJ/Y	$30,000
ECM #6	5800 GJ/Y	$29,000
Total	43,500 GJ/Y	$219,500

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Table #11 "Cost Estimates and Economical Evaluation of Recommended Items for Avan Salt Mine Plant".

Item Description	Possible Annual Saving	Estimated Equipment Cost, $	Estimated Cost of Installation	Estimated Cost of Shipment	Total Cost, $	Payback years
ECM #1	$33,500	$22,500	$1,800	$700	$25,000	0.7
ECM #2	$6,500	$2,700	included	none	$2,700	0.4
ECM #3	$58,500	$5,700	included	$200	$5,900	0.1
ECM #4	$62,000	$34,600	included	included	$34,600	0.56
ECM #5	$30,000	$43,200	$3,200	$2,800	$49,200	1.6
ECM #6	$29,000	$11,600	$400	$250	$12,250	0.4
Total	$219,500	$120,300			$129,650	0.59

4.4 Ararat Cement Plant.

Ararat Cement Plant is the only plant selected for energy audit that is highly dependant on the supply of natural gas imported from Russia and Turkmenistan. At the same time, the product of this plant is needed to rebuild Armenian infrastructure. The plant has also a capability of exporting cement to Georgia, Turkey, Iran and Saudi Arabia at below market prices. The plant is located near the source of raw materials needed to produce cement.

The Ararat Cement Plant is one of the largest gas consumers in Armenia outside the power industry. In a full operating year the plant uses about 75 million cubic meters of natural gas, corresponding to an energy input of 2.5 PJ/year. With the current energy crisis there is insufficient gas available to provide a regular fuel supply to the plant. During entire 1994 year the plant has operated for only 450 hours.

The plant is responding to the crisis situation by making plans to recommission one of the old wet kilns using a fuel supply of locally mined coal. The coal preparation plant is already in place. The plant is planning to employ independent experts to carry out a detailed technical audit of the refurbished plant and equipment to ensure that it is safe to operate.

Due to lack of gas, the plant was not operating when the energy audit was conducted. Therefore, it was not possible to collect any first hand operating data. However, the opportunity was taken to make a study of the installed plant and equipment and to assess the company's approach to energy management. Operating data collected by plant operating personnel in the past were collected and analyzed.

It would be unreasonable to judge the normal working practices at the plant from the state of equipment and general conditions around the plant from the observations made during prolonged shutdown. However, it must be noted that the housekeeping standards at the site are poor. Some equipment in the control room is missing or damaged. Insulation on the district heating pipeline connecting the plant to the town of Ararat is in a state of repair and requires replacement.

When the plant is operating, there are very high dust emissions to the atmosphere. Much of the exhaust gas from the kiln/cyclone preheater system is uncleaned because only one of six precipitator fields is operational. In order to protect the environment around the plant, and to eliminate a major health nuisance, it is recommended that the precipitator internals, which are available in Russia, be purchased and installed without delay.

Ararat Cement Plant consists of two plants, the "old" 1931 plant which was using "wet" type technology for making cement and "new" 1989 plant, which is using modern "dry" type technology. At the 1931 site, there are three (3) wet process kilns which are no longer operational. These kilns were originally coal fired, but in 1960 they were switched to natural gas. The new kilns are modern Russian designed plant which utilizes some Japanese technology under licenses. The new plant is capable of producing 3,000 tons per day of cement. The simplified flow diagram for Ararat Cement Plant is shown on Figure #4 " Ararat Cement Plant Simplified Flow Diagram".

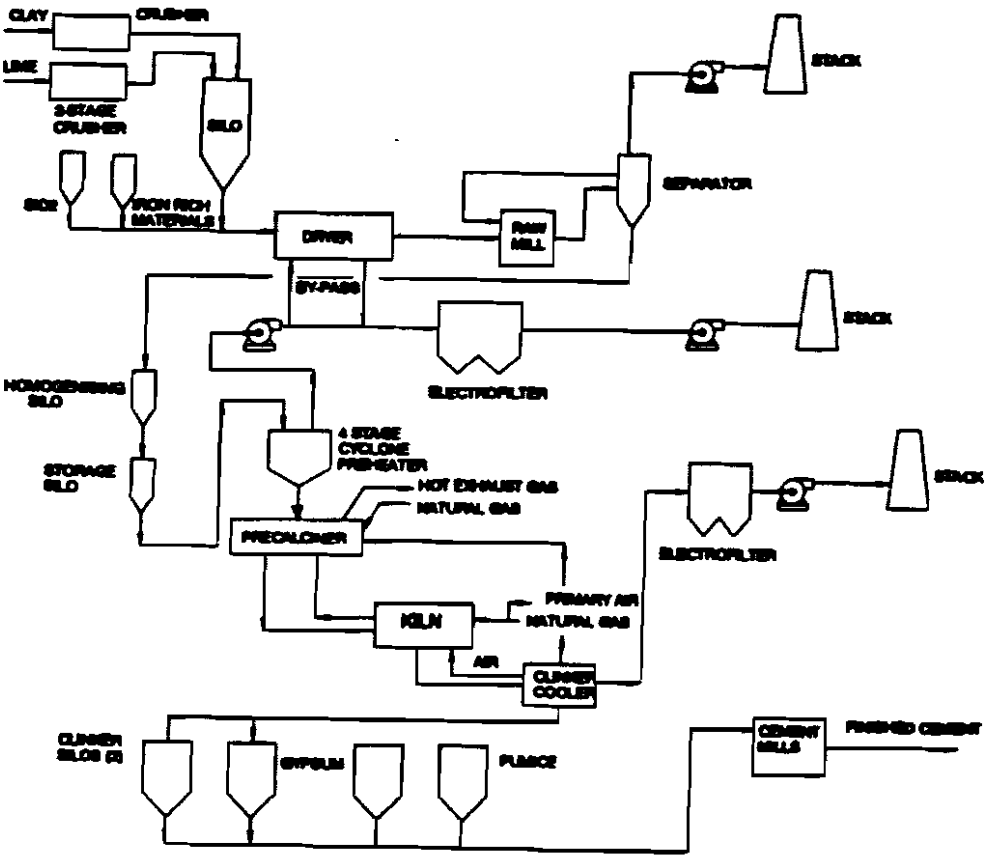

Fig.4 "ARARAT CEMENT PLANT SIMPLIFIED FLOW DIAGRAM'

The recommended low cost energy measures for the plant are following:

- Install Carbon Monoxide Meter
- Install Oxygen Meter
- Install Gas and Electric Meters and Provide PC with Energy Management Software
- Provide Portable Infrared Thermometer
- Provide Portable Combustion Analyzer

4.4.1 Installation of Carbon Monoxide (CO) Meter (ECM #1)

Carbon Monoxide (CO) Meter is required to produce high quality cement by controlling kiln conditions and for safety measures. The continuous measurement of the carbon monoxide concentration in the kiln will allow the plant performance to be monitored and controlled much more accurately that is presently done with infrequently taken Orsat measurement. It is normal practice to measure carbon monoxide concentration and arrange for plant trip in case of

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high CO content. This will avoid the possibility of explosion in the downstream electrostatic precipitator. **It is recommended that this instrument are installed as matter of high priority.**

4.4.2 Installation of Oxygen (O_2) Meter (ECM #2)

Oxygen (O_2) Meter is required to produce high quality cement by controlling kiln conditions and for safety measures. The continuous measurement of the oxygen concentration in the kiln will allow the plant performance to be monitored and controlled much more accurately that is presently done with infrequently taken Orsat measurement. There will undoubtedly be some energy savings, but in any case, the installation of oxygen analyzer is necessary for safety reasons and to ensure that there is complete combustion of natural gas. **It is recommended that this instrument are installed as matter of high priority.**

4.4.3 Installation of gas and electricity meters and Purchase Desk Top Computer with Energy Management Software (ECM #3).

Installation of gas and electricity meters is required to measure consumption of major processes and equipment uses. The utilization of computer will assist in analyzing energy and production data and will become beginning of Monitoring and Targeting System.

4.4.4 Provide a Portable Infrared Thermometer (ECM #4).

Portable infrared thermometer is required to measure outside temperature of the kiln shell and thereby locate hot spots, which are sign of damaged brick lining. Since the kiln was not observed in operation it is not possible to quantify the extent of the radiation and convection losses from the kiln. These losses are high if the internal lining of the kiln is damaged thus giving rise to hot spots. This is not only a waste of energy, it is also a warning sign for equipment damage.

4.4.5 Purchase Portable Combustion Analyzer to Monitor Boilers (ECM #5).

The power plant at the Ararat Cement plant consist of four (4) Russian type boilers model DE-25-13 rated at 25 tons of steam per hour. The power plant provides space heating and domestic hot water to nearby town of Ararat. The boilers were installed during modernization of 1989 and are physically in a good shape. The combustion monitoring for these boilers is done manually. In order to increase their efficiency, a portable combustion monitor should be purchased.

The energy saved by utilizing the above energy improvements was calculated by Mr. Alan Littler from ECECA and summarized in Table #12.

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4.4.6 Total Energy Saving Program and Cost Estimates

The estimated energy savings are shown in Table #12 "Energy Savings at Ararat Cement Plant". The estimated construction cost of ECM's is shown in Table #13.
The shipping cost was estimated on the base of $0.35 per pound of item weight assuming that the shipment will be done by containers. The labor cost was estimated by using "Means Construction Cost" adjusted by lack of equipment by five times and based on $2 per hour salary rates.

Table #12 "Energy Saving at Ararat Cement Plant"

Item #	Description	Energy Saving, GJ/year	Cost Saving, $
1	ECM #1	20000	$32,000
2	ECM #2	20000	$32,000
3	ECM #3	80000	$128,000
4	ECM #4		Cost Saving included in #1 and #2
5	ECM #5	8000	$12,800
6	Total	128000	$204,800

Table #13 "Cost Estimates and Economical Evaluation of Recommended Items at Ararat Cement Plant".

Item Description	Possible Annual Saving	Estimated Equipment Cost, $	Estimated Cost of Installation, $	Estimated Cost of Shipment, $	Total Cost, $	Payback years
ECM #1	$32,000	$29,600	$200	$250	$30,050	0.9
ECM #2	$32,000	$11,200	$200	$250	$11,650	0.4
ECM #3	$128,000	$32,400	$3,200	$300	$35,900	0.3
ECM #4		$4,500	portable	$200	$4,700	NC
ECM #5	$12,800	$4,500	portable	$200	$4,700	0.4
Total	$204,800				$87,000	0.42

4.5 Yerevan Cable Plant

Yerevan Cable Plant is the main supplier of copper and aluminum wires for Armenia and one type of cable for oil fields is being exported to Russia . Energy audits at the plant were performed by RMA in October of 1993 and in October of 1994 show some potential energy saving measures.

The energy audit reports performed by RMA address major issues related to the improvements to the boiler plant and to modification to the copper melting process.

The boiler plant at Yerevan Cable Plant consists of four boilers. Two boilers are DKVR-10-23 rated at 10 tons of steam per hour at 13 Bars each and two boilers are DKVR-6.5-13 rated at 6.5 tons of steam per hour at 10 Bars each. The boilers are equipped with outdated burners, outdated manual combustion controls and outdated burner safety systems. The feedwater pumps are leaking and only one pump is online.

During the visit of Burns and Roe energy audit team in December of 1994, the management of the Yerevan Cable Plant decided not to rehabilitate the boiler plant. The decision was made to bring steam directly from the Yerevan Thermal Power Plant. Therefore, only the following energy conservation measures should be implemented:

4.5.1 Copper Melt Oxygen Metering Station for analyzing oxygen content in cooper ingots and wires (ECM #1).

During the manufacturing process, copper ingots are melted in the furnace. The process requires that oxygen content and melt and furnace temperatures be maintained within limits; however, the factory has no such measurement devices. As a result, approximately 37.5 percent of the wire produced is of low quality and must be rejected and remelted.

The furnace is capable of producing 5 tons of wire per day. Daily consumption of gas is approximately 3,000 cu.meters. Approximately 350 cubic meters of gas are used during stand-by time. Installation of Copper Melt Oxygen Metering Station and use of pyrometer would save about 27,000 cubic meters gas per month. This would result in an annual gas saving totaling 324,000 cubic meters or $38,424 USD.

4.5.2 Pyrometer for Controlling Temperature of Copper Melt (ECM #2)

This ECM is part of ECM #1 and helps to achieve the above saving of gas.

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4.5.3 Portable Combustion Analyzer for Controlling Burners for Copper Melting Furnace (ECM #3)

The burners installed in the melting furnace are seldom adjusted for optimum combustion by using Orsat device or visually. By controlling combustion of the burners with a portable combustion analyzer an additional saving of natural gas could be achieved.

The energy saved by utilizing the above energy improvements were calculated by Plant Chief Engineer for RMA and summarized in Table #14.

4.5.4 Total Energy Saving Program and Cost Estimates

The estimated energy savings are shown in Table #14 "Energy Savings at Yerevan Cable Plant". The estimated construction cost of ECM's is shown in Table #15.
The shipping cost was estimated on the base of $0.35 per pound of item weight assuming that the shipment will be done by containers. The labor cost was estimated by using "Means Construction Cost" adjusted by lack of equipment by five times and based on $2 per hour salary rates.

Table #14 "Energy Saving at Yerevan Cable Plant".

Item Description	Unit	Possible Energy	Possible Saving, $
ECM #1	Cu.Meters	324,000	$38,434
ECM #2	GJ/Year	included in above	included
ECM #3	GJ/Year	included in above	included
Total	Cu.Meters	324,000	$38,424

Table #15 "Cost Estimates and Economical Evaluation of Recommended Items for Yerevan Cable Plant.

Item Description	Possible Annual Saving	Estimated Equipment Cost, $	Estimated Cost of Installation	Estimated Cost of Shipment	Total Cost, $	Payback years
ECM #1	$38,424	$80,000	Portable	$250	$80,250	2.08
ECM #2	included in above	$4,000	Portable	$200	$4,200	
ECM #3	included in above	$4,500	Portable	$200	$4,700	
Total	$38,424				$89,150	2.32

4.6 Luis Lamp Plant

Luis Lamp Plant is producer of a wide variety of incandescent, fluorescent and high intensity discharge lamps. It also produces all packaging material necessary for shipping of the finished products. Because of the glass furnaces, the plant operates almost 24 hours per day all year round. However, the boiler plant is operating approximately 4,000 hours per year.

RMA performed an energy audit of the plant in October of 1994. The following recommendations were made for energy saving implementations:

Install Condensate Return System in Corrugated Paper Shop
Insulate Boilers and Steam Piping
Replace Leaking Steam Valves on Main Header
Repair of Leaks in Corrugated Shop Equipment

4.6.1 Condensate Return System in Corrugated Paper Shop (ECM #1)

The main users of steam in the Corrugated Paper Shop are heating and process equipment At the present time, most of the steam condensate is being dumped to the city drain and other condensate flashes to atmosphere due to lack of steam trapping devices. The temperature of this condensate and flashing steam mixture is approximately 120° C.
The quantity of the steam condensate lost is approximately 0.5 tons per hour at a cost of about $2,500USD annually.

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4.6.2 Insulate Boilers and Steam Piping (ECM #2)

The majority of steam pipes are not insulated. The estimated length of steam pipes in the plant without insulation is approximately 466 linear meters with the total pipe surface area about 980 sq. ft. The value of insulation is illustrated by data from ASHRAE "Fundamentals". The heat loss from the pipe surface will be as shown below:

Heat loss from uninsulated pipe BTU per sq.ft-hr-T:	3.78
Heat loss from insulated pipe BTU per sq.ft-hr-T:	0.252

Total energy saving by insulating steam pipes (4,000 hrs):	7400 GJ/year
Annual Energy Saving	$37,000 USD

4.6.3 Replace Leaking Steam Valves on Main Header (ECM #3).

Shut-off valves on the main steam header are leaking. At least 100 linear meters of distribution piping is also leaking and should be replaced Valve manufacturers claim that if a valve is leaking, it could be losing at least 3 percent of steam flow. Therefore, the amount of steam saved by replacing valves could be equal to 4470 GJ/year, which correspond to annual saving of $22,350.

4.6.4 Repair of Leaks in Corrugated Shop Equipment (ECM #4).

The equipment installed in Corrucated Paper Shop is badly leaking steam. The repairs need to be done to the equipment are neccessary and will provide annual saving of 577,921 Btu/Hr or approximately $10,200 USD.

4.6.5 Total Energy Saving Program and Cost Estimates

The estimated energy savings are shown in Table #16 "Energy Savings at Lois Lamp Plant". The estimated construction cost of ECM's is shown in Table #17.
The shipping cost was estimated on the base of $0.35 per pound of item weight assuming that the shipment will be done by containers. The labor cost was estimated by using "Means Construction Cost" adjusted by lack of equipment by five times and based on $2 per hour salary rates.

Table #16 "Energy Savings at Lois Lamp Plant".

Item Description	Possible Energy Saving, GJ/year	Possible Saving, $
ECM #1	496	$2,500
ECM #2	7400	$37,000
ECM #3	4470	$22,350
ECM #4	2450	$10,200
Total	14816	$72,050

Table #17 "Cost Estimates and Economical Evaluation of Recommended Items for Luis Lamp Plant"

Item Description	Possible Annual Saving	Estimated Equipment Cost, $	Estimated Cost of Installation,	Estimated Cost of Shipment	Total Cost, $	Payback years
ECM #1	$2,500	$16,800	$3,600	$800	$21,200	8.48
ECM #2	$37,000	$6,600	$400	none	$7,000	0.2
ECM #3	$22,350	$24,600	included	none	$24,600	1.1
ECM #4	$10,200	$800	$240	none	$1,040	0.1
Total	$72,050				$53,840	0.75

ECM #1 is not recommended due to payback of 8.5 years.

4.7 Yerevan Thermal Power Plant

The Yerevan Thermal Power Plant (YTPP) is a main producer of electricity and district heating water for City of Yerevan. Currently only one 55 MW (out of seven) unit is operating. The operational losses for one unit are very high. Therefore, an increase of overall efficiency of operation will provide saving of energy and fuel.

The energy audit performed at Yerevan Thermal Power Plant in October 1994 and December 1994 by Mr. Alan Littler from ECECA with the assistance of BRC personnel reveled large deficiency with plant cooling towers. The efficiency of the cooling towers was found to be below acceptable levels and recommendation was made to repack at least one (1) cooling tower. However, the cost estimated at $480,000 USD, is beyond the budget of this Task and the idea to repack one (1) cooling tower was abandoned.

During the energy audits, the audit team was unable to investigate other areas of the plant for possible energy savings alternatives. As a result, there will be no improvements made at Yerevan Thermal Power Plant under this Task.

5.0 CONCLUSION.

The energy audit evaluation indicated that energy efficiency improvements are possible and cost effective for the plants selected for implementation. The energy efficiencies improvements are due to several factors including:

Utilization of improved technology for process and operations
Implementation of more efficient burners and control systems
Efficiency gains due to improved insulation and recovery of operating losses.
Modification of process operations to reduce operating losses and to take advantage of heat recovery.
Efficient tracking of energy use by intensive metering and monitoring of energy use.

The majority of the Recommended Energy Conservation Measure program for each facility have simple payback less than 2 years and each individual ECM has a payback within the 5 year payback criteria. The combined results of energy measures implementations are shown in the Table #18.

Table #18 "Combined Results of Energy Implementation Program"

Plant Name	Annual Savings, $ USD	Implementation Cost, $USD	Payback, Years
Yerevan Brewery	$62,805	$224,560	3.58
Ararat Cognac Plant	$107,780	$123,100	1.1
Avan Salt Mines	$219,500	$129,650	0.59
Ararat Cement Plant	$204,800	$87,000	0.4
Yerevan Cable Plant	$38,424	$89,150	2.32
Luis Lamp Plant	$72,050	$53,840	0.75
Total	$705,359	$707,300	1.00

The program represents a significant opportunity for the selected industries to improve operating performance through reductions in energy. The program should yield significant

reduction in the cost of the final product since the cost of production will decrease with implementation of the proposed energy reduction program.

The program has been constructed to utilize Russian materials wherever possible. United States technology, however, is recommended for major process upgrades and improvements to the combustion efficiency of the existing boiler plants.