PNACF-411

BURNS AND ROE ENTERPRISES, INC.

FINAL REPORT

POWER SUPPLY/CONSERVATION PROGRAM
REDUCING IRRIGATION LOSSES

DELIVERY ORDER No. 28
Hydro/Thermal Power Rehabilitation Feasibility Reports

ARMENIA

September, 1998

Prepared by	**Burns and Roe Enterprises, Inc**
Submitted to	**U S Agency for International Development**
Contract No	**CCN-Q-00-93-00154-00** **Energy Efficiency and Market Reform Project** **Delivery Order No 28,** **Hydro/Thermal Power Rehabilitation** **Feasibility Reports**

Background

In order to facilitate the shut down of the Armenian Nuclear Power Plant (ANPP, Medzamor), the United States Agency for International Development (USAID) has tasked Burns and Roe Enterprises, Inc under its Energy Efficiency and Market Reform Project (CCN-0002-Q-00-3154-00) to perform Delivery Order No 28 Armenia Power Supply/Conservation Program The overall objective of Delivery Order No 28 is to conduct the analytical work on six projects to promote investment in energy projects that could supplement or displace electrical consumption to ensure that the ANPP can be closed as planned without creating another Armenian energy crisis Therefore, this report, as one of the six referenced projects focuses on reducing irrigation losses to increase hydroelectric production

Introduction

USAID interest in irrigation losses, from an energy standpoint, came about partially as a result of a statement made by Lahmeyer International in their Armenia Least Cost Planning report Within this report, Lahmeyer states that irrigation losses amounted to approximately 900 gigawatt hours of electrical energy production due to decreased flow through the Hrazdan-Sevan Cascade hydropower system Although the World Bank has undertaken an extensive irrigation system rehabilitation program, some energy related issues could be further expanded within the context of the Bank's program

World Bank Project Components

The World Bank project is estimated to cost approximately $57 MM and is divided into 2 phases Phase 1 of the project is currently nearing completion

The primary project components are as follows

- Rehabilitation of 12 major conveyance systems and the Ararat Valley groundwater network
- Establish pilot projects for water distribution and new Water User's Associations (WUAs)
- Finance operation and maintenance (O&M) costs of the irrigation infrastructure
- Establish a project implementation unit

The conveyance systems that are to be rehabilitated include those systems with water derived from the Hrazdan-Sevan Cascade system Additional details can be found in the attached Trip Report

Rehabilitation works include

- 141 5 km of main canals
- 523 2 km of secondary canals
- 1,411 km of tertiary canals
- 548 km of nonpressure pipe
- 40 km of pressure pipeline
- Anticorrosion measures for new and existing pipelines

World Bank Project Specifics

Currently, approximately 30% of farmers do not receive a sufficient amount of irrigation water As a result, the overall area of arable land has decreased The water savings as a result of the rehabilitation project will be applied to additional arable land and maintaining a consistent irrigation resource to existing users It is worthwhile to note that additional water will not be withdrawn from the Hrazdan-Sevan Cascade to supplement the agricultural expansion aspect of the project In addition, the rehabilitation project will not significantly increase energy-related flow through the Hrazdan-Sevan Cascade

Energy Related Issues Within the World Bank Project

The World Bank has addressed some energy efficiency issues within the scope of the project For example, investments that would replace electric pumping with gravity irrigation were given the highest priority In addition, 650 existing pumps will be rehabilitated or replaced

Recommendations

As noted above, some energy saving steps are being incorporated into the rehabilitation project However, the following recommendations may further define or augment the energy savings options available to the World Bank project

- Instead of locally procuring new pumps, focus should be placed on the energy efficiency ratings of the pumps and variable drive pumps should be specified wherever appropriate
- The economic value of expanding arable land should be demonstrated That is, the market value of water versus the market value of the electricity that the water would otherwise produce
- Phase 2 of the rehabilitation project should provide for the development of a Memorandum of Understanding between electricity providers and WUAs for off-peak power purchases

TRIP REPORT

SUBJECT W O 05928-001
US AID Delivery Order #28
Development of Feasibility Reports for
Least Cost Plan for Armenia's Energy Sector

DATE 2/24/98

PLACE Republic of Armenia

OTHERS MAKING TRIP

Burns & Roe	Harza	RMA
David Cooksley	Mike Saunders	Mary Worzala
John Hallberg		
Yuling Chang		

PURPOSE The purpose of this trip was try to get local assistance to collect information about reducing irrigation losses to increase hydroelectric production, which is one project of the Least Cost Power Investment Program of Armenia To identify the possible sources of local materials for civil structural work, collect information on the design and present condition of the existing canals, local labor rates and productivity and any other information that will help produce the final cost estimate for the project

SUMMARY We arrived in Yerevan, Armenia at the night of January 31 of 1998 On February 2, we started to visit different Ministries and Departments, to discuss our projects and request information, we left Yerevan on the morning of February 11 Based on our findings, the information contained in the Lahmeyer report, which involves fixing the irrigation losses to save 20% of water is not necessarily accurate and the diversion of these saved waters for use in power generation is in question The government has recognized the agricultural sector as the first priority of the country's economy and the Government of Armenia has already secured Bank loans through the World Bank for an irrigation rehabilitation program This program includes most of the irrigation canals in our study area (i e the Hrazdan-Sevan Cascade Irrigation System) The Water Master Plan shall be determined by the Government of Armenia, and will decide who will get how much water A detailed discussion on all the meetings are in the following section

ATTACHMENTS

1 Document of The World Bank Report No 12811-AM, Staff Appraisal Report Republic of Armenia Irrigation Rehabilitation Project, November 2,1994
2 Document of The World Bank Report No P-6279-AM, Memorandum and Recommendation of the President of the International Development Association to the Executive Directors on A Proposed Credit of SDR 29 4 Million to The Republic of Armenia for an Irrigation Rehabilitation Project, November 2,1994
3 A Copy of Cost and Schedule "Procurement Plan, Armenia Irrigation Rehabilitation Project " prepared by Irrigation Rehabilitation Project Implementation Unit

DISCUSSION

The following are details from discussions of meetings listed by date and location,

Date	February 02, 98
Location	Armhydroenergyproject Institute
Person	Director, A Grigorian and Chief Engineer, Arkadi M Sarkisian
Tel	(8852) 532-362

After our introduction, Mr Grigorian introduced their Institute which contains Mapping, Hydrology, Geology, Economic, Water, Irrigation, Hydro-Technical, and Construction Departments They have about 80 engineers in the Institute, and performed the design and construction of Hydro-power station, canals etc We made a request for design information and design data on the existing canals Mr Grigorian stated that they designed all Hydro-power stations in Armenia and have the design information we required but need permission from the Ministry of Energy We also asked who is responsible for inspection and maintenance of the canals, Mr Grigorian stated that they are responsible for inspecting and maintaining the canal system as of January 1998 Armenergo previously did this work (i e , inspections and maintenance) The canals are typically inspected every three (3) years

Date	February 02, 98
Location	US AID at Yerevan
Person	Director, Bill Smith and Energy Program Assistant A Kazakhetsyan
Tel	(3742) 151-955

We reported the arrival of Burns & Roe task team, introduced every one in the team to US AID and requested assistance to meet various Ministry personnel, to explain the purpose of our mission, and to ask the different Ministry's help in providing the necessary information we required Mr Smith stated that he has sent letters to the

Ministries as previously requested and would facilitate any information needs if we experience delays Mr Smith plans to attend the meeting with the Ministry of Energy and to meet the Deputy Minister, Dr Garen Galustian

Date	February 02, 98
Location	Ministry of Energy EnergyInvest
Person	Director, Armen Yeghiazarian
Tel	(3742) 592-648 Fax (3742) 151-809

Mr Yeghiazarian has been assigned to coordinate our work with the Ministry of Energy He also answered some general questions about energy conservation programs in Armenia and locations where we may gather information for the projects However, he has no specific information about irrigation losses, he recommend to contact the Armhydroenergyproject Institute for this type of information

Date	February 03, 98
Location	Ministry of Agriculture
Person	Head of Water Resources and Melioration, Grigorian Razmik
Tel	(3742) 525 812

Based on our discussion with Mr Razmik, He gave us an overview of the irrigation system's present and future The country has approximately 284,000 ha that are dependent on irrigation, where 42% of area requires some kind of pumping, 65% of the total water cost is from energy use, total of 202 billion KWH energy was used He told us about the World Bank's irrigation rehabilitation project, which rehabilitates eight of the major conveyance systems These include repair of concrete canals, replacing steel pressure pipelines, building new spillways and canals at higher elevations, using gravity instead of pumping to save energy, and help in the establishment of a pilot project to form outlet-level water users associations(WUA) of 10-15 farmers, given responsibility for operating, maintenance and water charge collection, to improve the over all water management The WUA pilot project will be used by the government as a guide to reform the irrigation system in the future For detailed information he recommended we talk to the Armwaterproject Institute of the Ministry

Date	February 03, 98
Location	Ministry of Energy
Person	Deputy Minister, Garen Galustian
Tel	(3742) 525 205 Fax (3742) 151 687

We met Dr Galustian at the Ministry with Mr Bill Smith of US AID's presence Mr Smith gave the opening statement to introduce the projects, and Dave took over to do a detailed presentation of each project and requested for assistance to accomplish the work Dr Galustian appreciates our projects, promised cooperation and assigned Mr Armen Yeghiazarian of EnergyInvest as prime coordinator, along with Dr Robt Kharazin

and Dr Ruben Muradian as an assistant

Date	February 03, 98
Location	Ministry of Nature Protection
Person	First Deputy Minister, Simon R Papyan
Tel	(3742) 530-792 Fax (3742) 151-959

We try to find out is there any Environmental laws or regulations for power plant development Mr Papyan introduced their International Relation person, Mrs Kirakosyan to us, (Tel 53-36-29, Fax 15-18-40) she will help to collect any information we require

Date	February 04, 98
Location	Burns & Roe office at Yerevan
Person	Ministry of Energy Personal Dr Ruben Muradian & Dr Robt Kharazian
Tel	(3742) 525-783

Dr Muradian & Dr Kharazian visited Burns & Roe's Yerevan office, they talked about the energy conservation programs of Armenia, and about each of our projects Dr Muradian has visited the different irrigation systems and seen the damaged canals and pipes he will make arrangement for me to visit the Cascade

Date	February 04, 98
Location	Hydromet Department
Person	Gennady Kodjoyan, Head

The department has all kinds of meteorological and hydraulic data for 100 to 150 years of the country, they have 45 meteorological stations and 100 hydraulic monitoring points, they have maps for maximum and minimum temperature, rainfall, snow and much other information, but we have to identify the particular information we are interested in and help to make copies and they will provide the data Question about how much water used for irrigation, they refer to Armhydroenergyproject Institute, and Armwaterproject Institute

Date	February 05, 98
Location	Hagler-Bailley
Person	Director, Dean S White
Tel	(3742) 266-413 Fax (3742) 151-649

Mr White explained the experiences Hagler-Bailey have had with various Ministries of Armenia, and what kind information they have or they know of They will provide us with a copy of the English version of the Armenia Energy Law, and made comments about the Lahmeyer report Mr White states that the numbers used in the

report may not be accurate, they are collecting new data in the energy sector and will use a different model to perform a new analysis In the irrigation area he recommends checking the World Bank reports

Date	February 05, 98
Location	Energy Commission
Person	Commissioner, Mels Avagyan
Tel	(3742) 568-867, (3742) 592-708, (3742) 507-269 Fax (3742) 505-346

The existing hydropower plant equipment is old but is being kept in operating condition, because the hydropower system is the last reliable natural source of power I asked the commissioner about his vision of the waters usage for the Republic Mr Avagyan replied, that this is a political problem, and will determined by the Government But fixing the irrigation system to reduce the water loss is the determined direction Any other water saving measure is controlled by the Government especially the water from Sevan lake

Date	February 05, 98
Location	Operating and Maintenance Economy
Person	General Director, Mamikon T Gasparyan
Tel	57-09-09 Fax (8 8852) 57-06-03

The organization was the Water Project Institute under the Ministry of Agriculture, responsible for design construction and maintenance of all irrigation systems It is now a private enterprise, responsible for operating and maintenance of the irrigation systems He also points out that the World Bank has financed to rehabilitate 8 irrigation systems, which include the major and secondary canals, replacement of new pumps with spare parts, however, Mr Gasparyan claims his organization has no budget to perform maintenance services

Date	February 05, 98
Location	Tacis
Person	Director, Alan Littler
Tel	(3742) 651-262 Fax (3742) 151-730

We question if Tacis has any knowledge about the labor cost, material such as concrete, steel pipe cost We also asked about any information on the tunnel construction Mr Littler says Mr Armen Yeghiazarian of EnergyInvest has a list of labor costs In addition, the World Bank Human Resource report should also have the labor cost

Date	February 06, 98
Location	Armhydroenergyproject Institute

Person Director, A Grigorian and Chief Engineer, Arkadi M Sarkisian
Tel (8852) 532-362

We returned to the Institute to meet Mr Grigorian and Mr Sarkisian again They did receive instruction from the Ministry of Energy, and will cooperate in providing us with the information we require, however, when I requested the map of existing irrigation channels and the existing canal design data, they stated that they do not have a map which is maintained in the Armwaterproject Institute The existing canal design data is in the archives, and since the Word Bank project is doing the new design, for re-construction, therefore, they think the old design data is useless for us, and we should talk to the World Bank group and get the new design information

Date February 06, 98
Location Ministry of Finance and Economy
Person Senior Adviser to Minister, Merouzhan Mikayelyan
Tel (3742) 523-786 Fax (3742) 151-069

It is confirmed that World Bank loan is implemented and the rehabilitation project is started, the Project Implementation Unit is organized and the name and location of the Unit has been made available to us

Date February 06, 98
Location Ministry of Privatization
Person Vice Minister, Ashot Markossian
Tel (3742) 527-635 Fax (3742) 506-172

The country is moving toward the privatization of all state own utilities, factories, etc On December 2, 1997 Armenia set up new directives about privatization, now private shares can reach 70%, the foreign investment can be 51 %, some new laws will be issued around 1st of April

Date February 09, 98
Location Ministry of Energy Sevan-Hrazdan Cascade HPP
Person General Director, Mels Hakopian and Deputy, Garegin Baghdasarian
Tel (3742) 592-500

I visited the Sevan-Hrazdan Hydroelectric Power Plant, Mr Hakopian first introduced the HPP's Cascade system, which consists of 7 power plants, along the Hrazdan river Total design capacity are 550 MW, the power plants use the water from Sevan lake and the inflows of the Hrazdan river, there is also a tunnel (Arpa-Sevan) diverting the water of the Arpa river to the Sevan lake, an extension of this tunnel, is presently under construction, to connect the Vorotan river This is in order to divert the water of Vorotan river to the lake in the future Mr Hakopian points out that all the

power plants are between 30 to 60 years old, and are not very good, but the Sevan-Hrazdan Cascade is of strategic importance for Armenia, it is an emergency reserve power system, therefore, all the power plants are in working condition, but most of the irrigation canals are in unsatisfactory condition When I asked if anyone knew how much water was being lost, the reply is a lot, but no one can provide any numbers They say that most of the water being lost is in the canals under the irrigation system of Ministry of Agriculture The canals under the hydropower plant systems are in much better condition Because of the weather and snow cover, I could not see the actual condition of any of the canals The Argel HPP spillway, damaged due to land slide, was visible from across the river Mr Hakopian also provided me with a copy of "Sevan-Hrazdan Cascade of HPP State Enterprise - Business Plan", and a brochure "Power System of the Republic of Armenia- Sevan-Hrazdan Cascade of HPP SE '

Date	February 09, 98
Location	Irrigation Rehabilitation Project Implementation Unit
Person	Head of Water Management Section, Samvel Ghazaryan
Tel	570 653 Fax (3743) 906-913 e-mail samvel@irp-wms armenia su

I checked with Mr Ghazaryan about the status and scope of the Irrigation Rehabilitation Project of Armenia, which is financed by the World Bank Mr Ghazaryan states that the project rehabilitates eight of the major conveyance systems, which covers about 60% of Armenia's irrigated land including, aqueducts, siphons and hydraulic structures of Shirak, Talin, Abovian(**Kotaik**), **Arzni Shamiram**, **Lower Razdan**, Octemberian, **Artashat**, and Getik The four conveyance systems with bold faced letters are in the Sevan-Hrazdan River system, the system under our study These rehabilitation projects has been started, that include some 141 km main canals, 523 km of secondary canals, 1,411 km of tertiary canals, the contract for the first phase of rehabilitation works have been signed in 1997, the second phase rehabilitation works are to be signed in 1998

Date	February 10, 98
Location	Armenergo
Person	Head of Foreign Relations, Ruben Oganessian
Tel	

We asked about the organization's work, cost on large excavations, general concrete and civil works The replies are that Armenergo designed and constructed transmission line and sub stations The transmission towers use standard Russian designs There is no cost data for any of the work, because no work was performed in recent years They can provide some old day costs in Rubles if we like to have them

Prepared by _____

Yuling Chang