



**BURNS AND ROE ENTERPRISES, INC.**

**FINAL REPORT for DELIVERY ORDER No. 08**

**Georgia: Critical Energy Needs**

**GEORGIA**

**April, 1998**

**Prepared by: Burns & Roe Enterprises, Inc.**

**Submitted to: U.S. Agency for International Development**

**Contract No.: CCN-0002-Q-00-3154-00**  
**Energy Efficiency and Market Reform Project**  
**Delivery Order No. 08,**  
**Final Report--Georgia: Critical Energy Needs**

---

## 1.0 INTRODUCTION

In 1994 the USAID established a strategy to provide technical assistance to The Government of Georgia (GOG), which would promote strong and sustainable economic growth in a market environment. The strategic objectives (SO) of USAID for 1994-1996 were as follows:

1. Provide emergency assistance.
2. Establish climate for an efficient, competitive private-sector market.
3. Provide energy to allow for economic growth by expanding non-nuclear energy supply and improving energy efficiency.

With these strategic objectives in mind USAID developed a Statement of Work (SOW) for Burns & Roe Enterprise, Inc. to implement, which addressed SO #3. The objective of the Delivery Order (DO) #08 was to be achieved by demonstrating visible and specific results which could be seen by the average person on the street as urgently needed.

All technical work, procurement, logistical support and overall management was performed by BREI. All technical work, procurement, logistical support and overall management was performed by BREI.

## 2.0 SCOPE OF WORK

Four main Tasks were defined in the initial SOW issued for BREI to prepare its proposal. These were:

- Task 1--Accelerated Energy Program
- Task 2--Urgently Needed Commodities for District Heating Plants and Thermal Electric Power Plants
- Task 3--Coal Resource Utilization and Development
- Task 4--EBRD Loan Assessment -Power Rehabilitation Water Treatment System

Initially, Douglas Tuckhorn, Ben Sherlock and Bill Dries went to Tbilisi, Georgia to collect data and establish our counterparts. During this trip it became apparent that the modifications would be needed. A summary of these changes are as follows:

### Task 1 – Accelerated Energy Program

- In Sept. 1994, the World Bank (WB) was initiating a Municipal Services loan and was performing weatherization and energy audits on about 200 schools and hospitals, which were already selected. The WB requested and USAID agreed that USAID would concentrate on the heating systems at schools and hospitals. The subtasks which

overlapped with the WB effort were Subtasks A.2 (weatherization), A.3 (energy audits), A.4 (reduction in energy losses), A.6 (improvement of thermal envelope), and B.2 (process energy reduction analysis). Based on discussions with the WB and approval of USAID these activities were deleted and all work focused on subtask A.5 Boiler improvements, subtask A.7 motor load analysis and subtask B.1 optimization of the district heating system in Tbilisi.

- Subtask A.1 was related to peat and coal utilization for home heating. Although there is coal in Georgia's Tskuli region, coal is not currently being used and to ensure that these activities would meet their objectives would require more funding than USAID had available. More importantly, the GOG requested that all support for this task be made available to Sakenergo for the power supply sector. After discussions with Sakenergo, the GOG, and USAID this activity was deleted from the SOW.

### **Task 2 – Commodities Procurement**

The GOG requested that all funds for the procurement of commodities be used for Sakenergo. This was specified as their highest priority. USAID agreed to this with the exception that the rehabilitation of heating systems at hospitals and schools in support of the WB loan would remain in the DO#08 SOW.

### **Task 3 – Coal Utilization and Resource Development**

This task was to address coal utilization and development of the coal mines in Georgia. This task was deleted for the same reasons mentioned above for subtask A.1.1.

### **Task 4 – EBRD Loan – Power Rehabilitation Water Treatment**

There were no changes to this SOW. This work was a follow-on the feasibility report prepared by BREI under USAID's DO#03 for a makeup water treatment plant and condenser tube cleaning system for Units 9 & 10 for the Tbilisi Thermal Electric Power Plant at Gardabani and for hydro turbines to be installed at the Rioni hydropower station. This task required development of the detailed design and tender documents to procure, and install these systems.

## **3.0 DESCRIPTION OF WORK PERFORMED**

In summary the following tasks were performed as part of DO#08.

- Prepared an assessment of the Tbilisi District Heating System (DHS).
  - Based on this assessment and work performed by the WB BREI selected hospitals and/or schools for heating system rehabilitation. The initial work evaluated all 48

heating districts. These evaluations were based on site visits, inspection by heating system specialists and review of design data. Phase I established the priorities for rehabilitation.

- More detailed studies of the DHS were done in Phase II, which provided the feasibility studies on 18 districts and 23 hospitals, which were part of the WB list of high priority schools and hospitals. Again this work relied on actual field walkdowns of each site with detailed designs and cost estimates for each projects.
- Prepared an assessment of the boiler controls and operation for Unit's 1-10 at the Gardabani power station.
- Prepared motor load and power factor analysis at selected power and industrial sites in Georgia.
- Procured commodities needed by Sakenergo for their thermal electric power, hydropower stations and the electric transmission & distribution system. Sakenergo prepared a list of what their needs were and BREI developed the specifications, suppliers list, requests for quotations, evaluated bids, issued purchase orders, expedited manufacture and delivery and verified the delivery to the proper end users. Sakenenergo provided input to the bid evaluations to ensure the adequacy of the commodity for its intended use. The task included the procurement and delivery of equipment. There was no formal monitoring of effects of the commodities provided.
- Prepare the detailed design, specifications, and tender documents for Sakenergo to go out for EBRD bidding on water treatment systems, condenser tube cleaning system and hydroturbines for Rioni hydropower station.

**Funding for Rehabilitation and Equipment--**

USAID funding for DO #08 provided for the procurement of commodities for Sakenergo and for the implementation of hospital and school heating system rehabilitation. A summary of the distribution of how these funds were actually spent is as follows:

ITEM No.	DESCRIPTION	AMOUNT, \$ (USD) (Approx. Values)
Task 1	Rehabilitation of four hospital's heating systems	\$207,000
Task 1	Local contractor prepared specifications, perform bid evaluations, oversaw construction & testing.	\$33,000
Task 2	Commodities bought within the NIS	\$2,332,000
Task 2	US supplied commodities	\$120,000
<b>TOTALS</b>		<b>\$2,692,000</b>

**4.0 SCHEDULE**

A milestone schedule for this DO is provided below:

<b>DATES</b>	<b>TASK</b>	<b>ACTIVITY</b>	<b>COMMENTS</b>
Sept. 26, 1994	All	DO Authorization	Initial trip was started under the Core contract since formal authorization was not available for this emergency work.
Sept. 29, 1994	2	Receive list of most needed commodities from Sakenergo.	
Oct. 1994	All	Evaluated and made adjustments to the SOW based on the initial field trip.	
Nov. 5, 1994	2	Started procurement of commodities with three procurement buyers on the ground in Tbilisi.	
Dec. 5, 1994	1	1) Started boiler efficiency improvement assessment. 2) Started motor load analysis	
Dec. 5, 1994	4	Started detailed design for the Makeup Water Treatment System (MWTS) and Condenser Tube Cleaning System (CTCS).	Sakenergo did not want to start the Hydroturbine work for Rioni because they wanted to have this done on a sole source basis.
Dec. 8, 1994	1 & 2	Issued Procurement Plan for Local Purchasing of Commodities.	

Dec. 1994	2	Signed first Purchase Order for \$779,000 for various chemicals, resins, oils and other commodities with the Rustavi Metallurgical Facility.	Rustavi was not able to deliver oils from Baku. Contract was modified and another supplier was found to deliver oils.
Dec. 20, 1994	All	Sign a lease to open office in Tbilisi at 27 Rustaveli Ave.	
January 22, 1995	2	Sakenergo burns down Unit 9 & 10 control rooms and all associated power and control systems.  All commodity procurements were put on HOLD, until the list of most needed item could be redefined..	This fire was the result of operating at low frequency, i.e. 43-45Hz.
March 22, 1995	2	Received a revised list of commodities based on the needs that resulted from the Jan. 22, 1995 fire.	This list was the result of BREI coordinating with the EBRD and KFW as to what aspects of the Gardabani Rehabilitation they would be funding.
May 19, 1995	4	Issued a complete package of draft tender documents to EBRD for their review.	
June 15, 1995	1	Final Report for Motor Load Analysis submitted to USAID.	Commodities were dropped from this activity
August 1995	1	Issued Phase I Report for the Tbilisi DHS Characterization: Audit, Analysis and Recommendations	
August 1995	2	Completed procurement of commodities for Sakenergo. Spent \$2.5million.	

Oct. 23, 1995	4	Received comment from EBRD water treatment tender documents.	
Nov. 10, 1995	4	Received comments from EBRD on Nov. 10, 1995 on CTCS documents.	
Dec. 28, 1995	4	Issued final tender documents for the MWTS to Sakenergo and EBRD.	
August - Dec. 31, 1995	1	Prepared specifications, tender documents, evaluated bids, and implemented rehabilitation at four hospital heating systems.	
March 1996	1	Since no comments were received from GOG on the DHS report reissued Final Phase II Report for the Tbilisi DHS. Design Solutions and Cost Estimates for recommended rehab projects.	
March 20, 1996	4	Submitted the Final Tender documents to Sakenergo and EBRD for the CTCS.	
March 29, 1996	4	Received comments on technical specifications from Rioni hydropower station director.	Sakenergo does not want to buy exciters in competitive tender. Goes to EBRD for approval.
April 8, 1996	4	Sakenergo submits a letter to EBRD agreeing with the tender documents for the MWTS and CTCS	
May 8, 1998	4	Sakenergo finalizes comments on the Hydroturbine tender documents.	

May 13, 1996	4	BREI holds a mandatory pre-bid meeting in Tbilisi for the MWTS and CTCS.	
May 17, 1996	4	Submitted the Final Tender documents to Sakenergo and EBRD for the Hydroturbines for Rioni.	
June 21, 1996	4	Bid opening for MWTS and CTCS held by Sakenergo's PIU.	
Dec. 31, 1996	All	DO Completion	

## 5.0 RESULTS AND CONCLUSIONS

### Results and Conclusions--

Some major results and conclusions are as follows:

#### Task 1: DHS

- Identified 18 district heating systems for rehabilitation
- Identified 23 hospitals for rehabilitation of their heating system.
- Rehabilitated four hospital heating systems: the burn center, maternity hospitals #4 & 5, and the psychiatric hospital. Total funds for this rehabilitation was \$240,000.

#### Task 1: Boiler Control Systems

- The Tbilisi Thermal Power Plant (TTPP) Units #1-8 are in such poor mechanical condition that automatic control systems are not considered viable or cost effective.
- TTPP Units #9 & 10 controls are being addressed by KfW and therefore are not considered further for this DO.
- The TTPP units appear stable in its present, sliding pressure, mode of operation and is easily controlled in the manual mode.
- The most promising area for improvements to boiler control were identified in the fuel flow and feedwater control loops.
- By adding and commissioning the A & B furnace oxygen analyzers in unit #10, 3 MW in plant output can be achieved.

### Task 1: Motor Load and Power Factor Analysis

- Data was collected from design information and field testing at three locations sites. TTPP, Rustavi Metallurgical Plant and the Metechi Palace Hotel
- Because of the current operating frequency in Georgia it is considered unlikely that the TTPP or Rustavi would benefit from static capacitors.
- Because of the significant margins in design and operating loads there are many opportunities for the use of variable frequency drive systems.
- A package of training material was assembled and provided to the Georgian counterparts.

### Task 2: Commodities for Sakenergo

- Supplied \$2,452,000 of commodities for Sakenergo.
- About 50% of the commodities were consumables, turbine lube oil, transformer oil, resins, chemicals, etc.
- Before the supply of commodities in 1994 the system was generating 83MW from 4 units 119 million Kwh and consumed 630 g/KWh. In 1996 the same four units were operating at 102 MW and generated 145.7 million Kwh and consumed fuel of 507.7 g/KWh.
- With respect to reliability before 1994 the plant had 23 unscheduled emergency shutdowns. By April 1996 the plant was had only 7 unscheduled emergency shutdowns.

### Task 3: Coal

None

### Task 4: EBRD Detailed Design and Tender Document Preparation

- Prepared all tender documents for three projects under an EBRD loan. These projects are as follows:
  - Makeup water treatment system for units 9 & 10.
  - Main condenser tube cleaning system
  - Three hydro turbines for the Rioni hydro station.
- All three projects were successfully bid and all projects are installed.
- The MWTS can supply state-of-the-art water for the steam cycle.
- The CTCS will improve tube cleanliness factors from 0.7 to 0.9
- The new hydro turbines will restore the Rioni station to its design condition..

## **6.0 RECOMMENDATIONS**

Some of the major recommendations are as follows:

### Task 1: DHS

- Rehabilitate 18 districts heating stations, which supply 35% of heating demand. The investment was estimated to be about \$20 million.
- Rehabilitate approximately 20 hospital boiler rooms.
- Implement a residential electric metering project based on the Shevardnadze Foundation design.
- Implement commercial power, heat and gas pilot metering project at Thermal Station No. 27 for central Tbilisi.
- Prepare decentralized heating system projects for large thermal loads -- apartment blocks, hospitals, government buildings, etc.
- Prepare solar hot water booster system project for the Republican Burn Hospital and other hospitals.
- Develop Lisi district geothermal well T-5 hot water direct use supply system.

### Task 1: Boiler Controls

- Stop operating the TTPP at less than 48 HZ.
- Automate two loops (fuel flow and feedwater) with a simple three code controller.
- Commission the existing Russian made boiler control computer.
- Install US supplied analyzers for unit 10.
- Install gas flow measurement system for each gas distribution station at Sakenergo.

### Task 1: Motor Load Analysis

- Variable frequency drives should be considered further for the condensate pumps in each of the 10 units at TTPP at Gardabani.
- Variable frequency drives should be considered further for the 1780Kw induced draft fans at TTPP at Gardabani.

### Task 2: Commodities Supply

- The damage to the plant due to operator error was substantial. USAID should consider substantial in-country training. BREI believes this should be a ghost management team in-country for about one year. This team would review procedures. Assist in writing procedures. Provide audits and consulting advise to Sakenergo plant management.
- Consumable commodities are difficult to monitor and over the long term do not have the effect of the other procurement programs that are linked to USAID's strategic objectives.

### Task 3: Coal Resource Development

- None

Task 4: EBRD Tender Documents

- Sakenergo kept asking for changes to all of the projects scopes that had already been approved by EBRD. This caused substantial delays. BREI should have immediately stopped work and informed EBRD rather than getting in the middle of Sakenergo's indecision.