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# EXECUTIVE SUMMARY
AND
# REPORT SUMMARY

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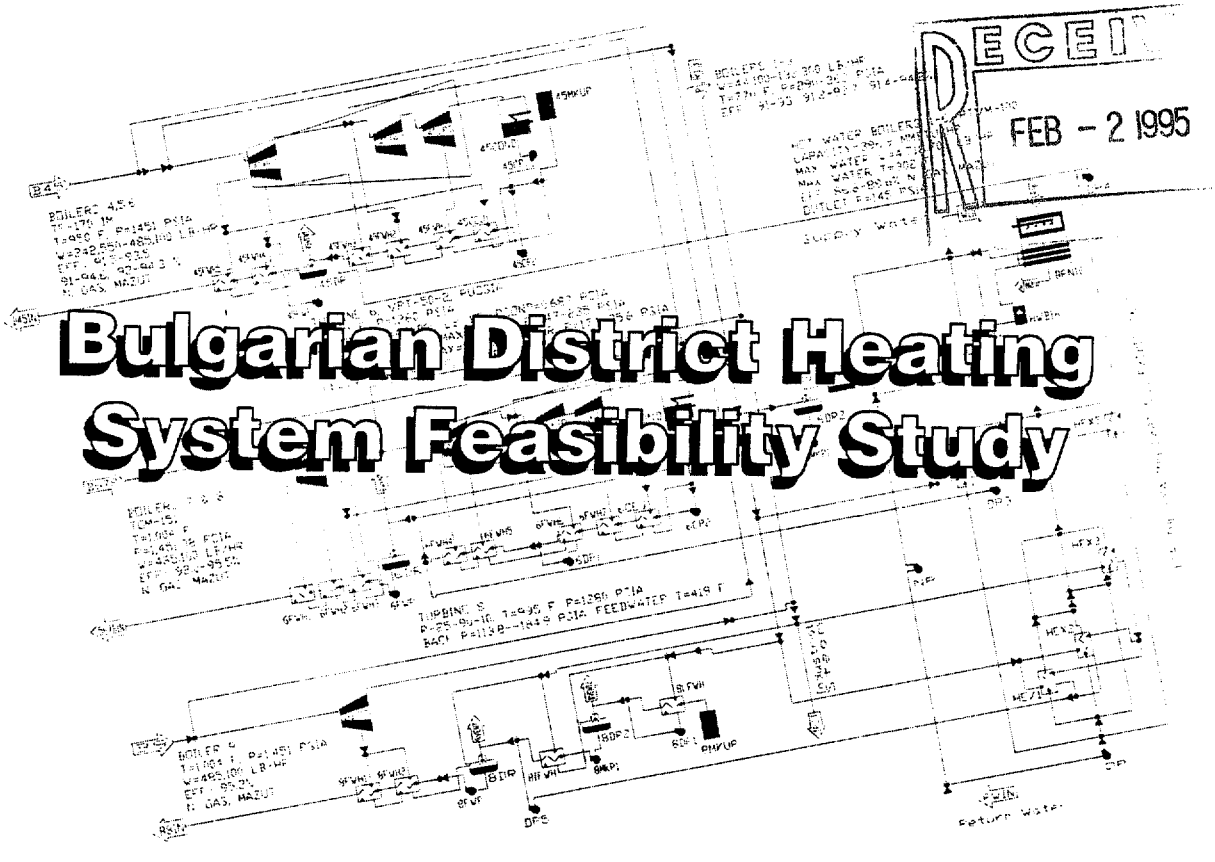

# Bulgarian District Heating System Feasibility Study

Gilbert/Commonwealth International, Inc.

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- Training Material




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## Report Summary and Section Summaries

# LIST OF EXHIBITS


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# EXECUTIVE SUMMARY

## E1. INTRODUCTION

This report describes services performed by Gilbert/Commonwealth International, Inc. (GC II) for the Committee of Energy of the Government of Bulgaria (COE). The services are performed in accordance with "Contract for Consulting Services, between Committee of Energy, Bulgaria and Gilbert International, Inc.", dated April 15, 1993. The contract required GC II to provide engineering services for a comprehensive study to upgrade the capacity, reliability and efficiency of the District Heating Systems in Sofia and Pernik Cities. This report presents the results achieved over the course of the study and discusses the methods and procedures used in performance of the work.

## E2. STUDY CONCLUSIONS

Based on input data provided by Bulgaria, plant walkdowns, and performed economic and financial analysis in the study the following conclusions regarding District Heating Systems in Sofia and Pernik are made:

### TECHNICAL ISSUES - SUPPLY SIDE

#### A. POWER PLANTS

**Equipment Design Issues:**

- When the district heating generating units were designed and installed, Bulgaria was highly integrated into the Eastern European Common Market. Accordingly, the selection of available equipment was limited due to constraints imposed by the: (1) distribution quotas among Eastern European countries; and (2) centrally planned economy. As a result, the



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installed equipment was not at the technological and quality level available at that time in the market.

- Today, the installed equipment does not meet Western requirements for the effective economical operations. The process controls and operational procedures can hardly meet the new European environmental regulations that will soon be implemented in Bulgaria. The operational and public safety is not near to those of Western standards and practices.

**Equipment Condition**

- In general, the equipment condition at the generation units is not adequate. The principal reason for such a situation is the: (1) lack of proper equipment maintenance; and (2) inadequate treatment of the equipment's specified resource time.

- Inadequate operational regimes (exhaust gases temperatures, chemical regime of the fluids, etc.) aggravate the already deteriorated condition of the equipment.

- Insufficient funding for the maintenance and operational activities combined with the organizational deficiency are the major contributors to the poor equipment condition.

**Installed Capacities**

- The installed capacities for the generating units are substantially higher than what the current demand requires. In a few cases, the installed capacities are more than twice the maximal registered peak load for the system.

- The over capacity is a result of an: (1) over conservative calculation methodology used for determining the design peak load; and (2) inadequate system load management schemes.

- This condition indicates that the current and new load demands combined with efficiency increase measures can be easily met without installing any new generating capacities for next decade.

- Artificially low fuel prices followed by extremely low prices of the supplied heat have not stimulated optimization of the generating capacities and have not encouraged application of conservative methodologies for determining the system peak load.

- Eventual introduction of combined cycle option will substantially improve load management and consequently reduce system operating cost.



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### Structure of the Power Generating Units

- Structure of the generating units at the "TPS Trajco Kostov", "TPS Sofia" and "TPS Republika" are in general good condition. They follow a concept of cogeneration (joint production of heat and electricity), even though the ratio between heat and electricity production is not fully optimized.

- "HWPS Zemliane" and "HWPS Liulin" are examples where lack of market and economic forces led to the creation of extremely suboptimal system. These two systems are best candidates for combined generation and substantial increase in the overall system efficiency.

## B. TRANSMISSION AND DISTRIBUTION SYSTEM

### Design Issues

- Systems use hot water as a heat transfer media,which is typical throughout Western Europe and Nordic countries.

- Control of the supplied heat is maintained by a change in a temperature of the supplied hot water. This control scheme is know as a "Quality Regulation".

- The implemented network system is based on a radial scheme with limited interconnection between branches. This arrangement is a typical system that is also implemented in most of the Western European and Nordic countries.

- The network system is characterized with minimum automation and control.

- Compensation for the terrain configuration is achieved through implementation of the pumping stations.

- The thermal expansion compensations are achieved by "gasket type" compensator which are difficult for maintenance and create a high volume of leakage.

- Technical specification of the network water chemistry does not meet contemporary requirements that are in regular use in Western countries.

### Piping Design and Status

- The implemented schemes for laying the network system piping is characterized with low reliability and thermal efficiency.

- The low quality of the used piping material and inappropriately selected insulation material (foam concrete) is the principal cause for the extremely high pipe failure rate.



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- The selection of the existing network design was mostly influenced by the low fuel and supplied heat prices which did not justify further investment in the thermally efficient and reliable piping systems.

**Temperature of the Supplied Hot Water**

- The system design supply temperature is extremely high. This high temperature conduction imposes special requirements for the installed equipment and drives the system prices up.

- High system design temperatures also leads to higher thermal loses from the system and force the steam boilers to work in a lower thermal efficiency regimes.

## C. SUBSTATION

**Design Issues**

- The system implements both direct and indirect substations with minimum of automation and control.

- Direct substation use elevators without additional pumps for mixing, while indirect substations use heat exchangers, pipe in pipe design.

**Equipment Status**

- The equipment quality and reliability is very low and creates intensive water leaks.

- The design of the substations and type of materials used leads to very high thermal losses.

- The design and constructive materials used require high level of maintenance which was not exercised in the past due, to an insufficient maintenance budgets.

## D. ENVIRONMENTAL ISSUES

The centralized heat supply as implemented in Sofia has big advantages for the environment. The pollution is minimized and can be controlled through an adequate installation of the pollution control equipment.

The Sofia City District Heating System uses mostly gas as a fuel. This is environmentally one of the most benign fuels for centralized heat supply.



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## TECHNICAL ISSUES - DEMAND SIDE

### A. HOUSING DESIGN AND INSULATION

During the period of a centrally planned economy, the industrial production of residential and commercial buildings did not take into the account for building thermal loses. As a result, the building of thermal loses in Bulgaria are twice the losses of the typical Western European building.

### B. HEAT METERING

The system is not designed to have a heat meter unit at end users or at the substation level. This will create additional financial difficulties if municipalities decide to control the heat usage at an apartment level.

### C. HEAT DISTRIBUTION

Heat distribution system in the houses follow the radial concept of heat distribution. The radiators are connected in series throughout rooms and apartments, making the heat measuring at the apparent level very complicated and costly.

### D. HEAT CONTROL

There is no control valves at the radiators. The absence of these valves make control of the temperature in the rooms impossible or only by opening a window.

## INSTITUTIONAL AND ORGANIZATIONAL ISSUES

### A. AUTHORITY AND RESPONSIBILITIES

- The relationship between Government, Committee for Energy, Municipality and District Heating company, particularly for City of Sofia, are not always clear and concise.
- Even though the ownership of Sofia City District Heating System is municipal, the funding allocations for company operation and maintenance are approved by the Committee of Energy (COE).
- To make the things even more complicated the heat prices are approved by the "Committee for Prices" which is responsible for approving all prices that are under government control. This highly distributed scheme of authorities and responsibilities makes management of the Sofia District Heating system a very difficult task.

## B. ORGANIZATION STRUCTURE OF THE DISTRICT HEATING ORGANIZATIONS

- The present basic structure of separate District Heating companies for each area in Sofia is appropriate. The separate issue is however; authorities and responsibilities delegated to the areas from the central organization.

- The District Heating companies are generally over staffed. They carry the organizational principals from the past when most of the supporting functions were performed by the companies itself. In particular this applies to the design division, maintenance division, collecting, etc.

## C. PRICING STRUCTURE AND PRICES POLICY

- The current prices of supplied heat in Bulgaria are highly subsidized. This subsidization minimizes: (1) the incentives for the District Heating companies to increase the efficiency; and (2) removes public motivation to start rationally to use provided heat.

- By the current subsidy program, Government tries to amortize eventual social tensions that could arise from a sudden heat price increase, particularly for the poorest part of population. However, through this approach Government dislocates eventual budget deficits to District Heating companies and holds them responsible for it. The program also subsidizes the affluent part of the population that can easily absorb the market prices of the heat. Therefore, a new structured program of subsidizes should be developed where subsidies will be given to direct recipients (part of the population that cannot immediately absorb the new heat prices). This program should be implemented and controlled either by Government or the Municipality. The program should be prepared as soon as possible, preferably during 1995. During this time the prices of the heat should rise to cover the marginal cost plus minimal profit, characteristic for publicly owned companies.

## D. OWNERSHIP AND PRIVATIZATION

- The current ownership of the District Heating companies is mostly Governmental. The only deviation is the district heating of City of Sofia which is municipally owned and some of the district heating systems in some smaller cities in Bulgaria.

- This setup makes these systems very protected and not interested in increasing their efficiency as would be the case if they were exposed to market forces.



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- One of the courses for increasing the in efficiency would be gradual privatization of system generating units and transformation of the district heating systems into tightly controlled, publicly owned companies.

## E3. STUDY RECOMMENDATIONS AND BASIS FOR IMPLEMENTATION PROGRAM

Based on the: (1) condition assessment; (2) engineering analysis, and (3) economic analysis, of the generating units equipment and transmission and distribution system the following recommendations are presented for the technical study:

### GENERAL

Under the current price structure, ownership/authority schemes, and District Heating companies staffing level, it is impossible to expect that the District Heating systems in Sofia and Pernik to economically operate and/or show any profit.

The disparity between the process of fuel (oil and gas) and the current sale prices of heat, steam and electrical cannot even cover the present system operating cost. In addition, equipment amortization is not properly determined and adjusted for an inflation so the allocated budges cannot cover even a necessary maintenance cost.

The low sale price of heat and particularly electricity makes combined cycle unrealistically uneconomical, even though it is the preferred approach for the Western and Nordic European countries who are characterized with the big central heating systems. It is doubtful, that before the price of electricity reaches its market value, the combined cycle generation of electricity will show substantial economic advantages in comparison with minimal rehabilitation approach.

The organization scheme of the District Heating companies are over-staffed. Further reorganization is extremely necessary in order to cut the cost and improve efficiency of operation. The service activities such as design, maintenance, construction, and collection should be privatized and detached from the company. This reorganization can easily reduce the present staffing for 1,000 people in Sofia City District Heating System. Further personnel reduction can be achieved through streamlining of operating staff and other supporting services such as cleaning and office maintenance. These types of supporting services should be contracted on an as needed bases from the outside.

It is evident that the present system has high loses in generation and transmission and distribution parts. Immediate reduction in piping loses and improvement in burning boiler processes should be performed on a soon as possible bases.



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SOFIA CITY GENERATING UNITS

- The least cost analysis for all cases and for the Sofia City generating sites reveal that obtained results are within the margin of accuracy which is expected from this level of analysis. It is therefore recommended to pursue the options which present the least capital cost at each station, since the availability of capital is a very important issue for Bulgarian Government, Committee for Energy and Sofia municipality.

  It should be kept in mind that this system optimization study and least-cost analysis was limited to the district heating systems boundaries. Their interface with the NEK/COE systems was only controlled by the price of electricity. Specifics of the NEK system, retirement of the existing units and their efficiencies, and eventual Government priorities, obligations, and strategic directions (Protocol with EBRD for instance) were not taken into the account. Eventual incorporation of these requirements can easily override conclusions of this least cost analysis.

- The Case 1 options represent the lowest capital expenditures for each of the power stations. This option includes:

  - necessary rehabilitation and upgrade of existing boilers and steam turbines

  - retirement of some of the oldest, least efficient boilers.

  The Case 1 options minimize initial capital outlay by rehabilitating and upgrading: (1) safety; (2) environmental impact; and (3) immediate reliability, while deferring items related to improvement in efficiency, long term reliability, and capacity improvements.

  Further reduction of initial capital can be achieved if equipment targeted for replacement by potential future cogeneration/combined cycle plant upgrades (i.e. Cases 2 and 3) is not rehabilitated at all. This recommendation has additional validity since the systems have over-capacity and the demand could be met in most load conditions without these units.

- In summary, Case 1 rehabilitation is only, to the degree, necessary to satisfy immediate safety and environmental requirements and reliability concerns; regular monitoring of this targeted equipment should be instituted until retirement to avoid catastrophic equipment failure.

- While the implementation of this "base case'" for the power station is recommended now, it is recognized that the Bulgarian electric power supply system is in a status of flux. A significant change in electricity price, demand or costs

resulting from, for example, the retirement of existing generating capacity, will greatly influence the economics of the analysis for these power stations. An update to the current analysis is recommended, should such a change be anticipated, at which time the combined cycle/cogeneration options may look quite favorable.

### PERNIK CITY GENERATING UNITS

- For Pernik District Heating System Case 3, involves installation of new fluidized bed boilers. This is by far the best option. The type and cost of fuel and minimization of environmental impact that fluidized bed technology brings are decisive for this case.

- The analysis in the study was based on an installation of two new fluidized bed boilers. However, the existing and anticipated future loads with minor shortfalls can be met with only one boiler. Therefore, we recommend to initiate the investment program with one boiler and decision for the second boiler to be postponed for a future time, when more reliable information on load demand will be available.

### TRANSMISSION AND DISTRIBUTION SYSTEMS

- The economic analysis of piping system rehabilitation treated: (1) the losses of the entire system; and (2) an extensive pipe replacement program to offset these losses.

- The economic analysis shows that implementation of the entire replacement program is not cost-effective. However, the reality of the loss characteristics is that high losses are generally concentrated in a smaller fraction of piping which are insulated by the foam concrete. Additionally, this piping is also the oldest in the system. Accordingly, replacement of this category of piping will bring the fastest return on investment.

- The piping section with extremely high losses and frequency of failure (due to variety of causes) will also have high return on investment.

- As these sections with the high losses and frequency of failure are replaced, diminishing returns will be realized for each successive replacement section. It is prudent to consider a cost-effective program of the remaining pipe replacement. This replacement program should be greater than the current maintenance program (emergency replacement rate), but less than the extensive program of replacement considered, as preliminary indicated in this report in Section 3, Engineering and Economic Analysis, and Section 7, Capital Cost Estimate.

- As piping is replaced, an option is available wherein the new section will feature instrumentation, permitting which will allow

losses to be closely monitored, thus improving the ability of the maintenance crews to keep the system integrity at high level.

- Introduction of variable speed control pumps for pumping station and an improved system flow control (reduced flow rate) that will better reflect requirements of the real system peak load will further reduce power to run the piping stations.

### INSTRUMENTATION AND CONTROL SYSTEMS

- The I&C engineering analysis considered sophisticated I&C SCADA system that is characterized with the complete system information computerization and on-line capabilities. This system is capital intensive. However, phasing in the system in parts, as capital is available, reduces the financial impact, but still provides the latest technology available to each District.

- To increase the level of system automation and provide for better control of consumed heat, an improvement in substation and system collection is recommended in Section 5 of the report.

- To minimize the cost of the installation of the data transmission system, it is recommended to lease the part of the capacities of the combined new telephone and TV optical cable system that is under construction in Bulgaria.

- Additionally, the installation of heat meters at the substations and insulation on the substation and un-insulated piping in chambers, is one of the most immediate tasks for the transmission and distribution systems.



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# REPORT SUMMARY

## R1 INTRODUCTION

Specifically, GC II team performed a general review of identified District Heating Systems, including the evaluation of the need for modernization or overall replacement of the heat generating capacities. In addition the GC II team evaluated possibilities for: (1) rehabilitation of the heat transmission and distribution network; and (2) increasing their efficiency. The study includes an investment program and a financial schedule to implement the recommended improvements and rehabilitation programs. Specific and more detailed scope is presented in Section 2 paragraph 2.2, of the original project Terms of References (TOR).

To successfully complete contracted work GC II assembled a strong team consisting of most prominent U.S. companies and Bulgarian engineering and financial specialists. The U.S. team consisted of Gilbert Commonwealth, Inc. Babcock and Wilcox, and KMGP Peat Marwick and independent U.S. economic and financial consultants. The activities in Bulgaria were coordinated through DIRECT Co. and the Bulgarian contribution consisted of various specialist intimately knowledgeable with the design and operation of the analyzed systems.

Several times the Sofia and Pernik City District Heating Systems upper management, and representatives from the Bulgarian Committee of Energy (COE) and National Electric Utility visited the GC II offices in Reading, Pennsylvania, U.S.A, and performed a review of the work completed by the GC II team. During this time visits to district heating systems in the U.S. and sites operating Fluidized Bed Boiler and Combined Cycle Gas Turbines were organized.

Over the course of the study GC II established and maintained close contact with the potential international funding organizations. Several meetings were held with the representatives of the World Bank (WB) from Washington DC, European Bank for Reconstruction and Development (EBRD) from London, and European Investment Bank (EIB) from Luxembourg. Comments and suggestions by then were incorporated in the analysis and the recommendations to the report. GC II is convinced that our joint Bulgarian/GC II team was exceedingly successful in attracting the attention of the international funding institutions for the project.



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Several US commercial banks (Wells Fargo from San Francisco and Citicorp from New York) and private investors were also contacted and their eventual willingness to finance the rehabilitation work at Sofia and Pernik District Heating Systems had been checked. Their responses were not negative but before taking on any major decisions, they wanted to see the results of the study and supporting project documentation ("Bankable Document").

## R1.1 STUDY GOALS AND OBJECTIVES

The COE primary objective for the study was to determine the extent of the rehabilitation required for the District Heating Systems for Sofia and Pernik Cities. Specifically, the study should perform a general review of the two district heating systems , including an evaluation of the need for modernization or overall replacement of the heat generating capacities. In addition, the study team should also evaluate the possibilities for rehabilitation of the heat transmission network and substations and increasing their efficiency. The final product of the study will be investment program and the financial schedule to implement the recommended improvements and rehabilitation programs.

## R1.2 STUDY SCOPE OF WORK AND LIMITATIONS

The scope of this project includes the following:

- Perform general review of the Bulgarian district heating systems to identify the major levels of investment required to improve the short-term and long-term efficiency of the sector and reduce the environmental impact of power and heat generation. The review is to include preliminary assessment of the power sector institutions, regulations, tariffs, and related issues and identify areas for further analysis

- Examine the existing system, equipment, and review available operation, maintenance, and inspection records with particular emphasis on three plants, Sofia and Trajco Kostov in Sofia and the Republika plant in Pernik. Establish present and anticipated growth in the thermal energy demand for Sofia and Pernik. Identify the systems current and projected electricity generation capacities.

- Evaluate the existing and planned hot water boiler systems (boilers adjacent to listed cogeneration plants) and identify one existing site where a cluster of these boilers has a potential for conversion to Gas Turbine/Waste Heat Boiler operation. The technical and economic study of this option should include integration of this system with the existing cogenerators to provide for combined cycle operation during non-heating seasons.

- Analyze existing losses in the district heating system, including losses in production, distribution, and the end user systems. Identify near-term, mid-term, and long-term remedies to reduce these losses. Evaluate existing heat dispatching centers and existing energy metering systems.

- Prepare preliminary plant layout and preliminary drawings.

- Prepare major equipment lists and preliminary specifications for major equipment for all options and obtain order of magnitude cost estimates.

- Conduct technical and economic optimization studies for each of the of the options to select the most promising alternatives. The selection should be based on the lowest total evaluated cost.

- Evaluate existing management methods, energy distribution, metering and pricing systems, operating and maintenance skills, economic methods for capital recovery, etc. and provide alternatives that reflect the free market system and yet are applicable to Bulgarian conditions.

## R2 PERFORMANCE OF THE WORK

Quality of the work and soundness of the proposed solutions were guarantees at the inception of the project by the: (1) selection of companies that will participate as a GC II team members; and (2) project management approach and organization that GC II adopted for this project.

The GC II team consists of several major U.S. corporations fully knowledgeable with project management and design, systems analysis, state-of-the-art instrumentation and control systems, and the latest boiler, turbine, and district heating system technologies.

To provide hands on knowledge of the Bulgarian engineering and environment, the GC II team included Bulgarian specialist and experts from Technical Universities and Architect/Engineering, and operation and maintenance organizations. These firms and individuals were intimately knowledgeable with the conditions at the "Sofia", "Trajco Kostov", and "Republika" power plants.

### R2.1 TEAM PARTICIPANTS

The team for this study was led by GC II. The project team additionally included Babcock & Wilcox (B&W), KPMG Peat Marwick, and independent U.S. economic and financial experts. To cover the specific of the Bulgarian engineering, operating, and maintenance practice, GC II incorporated into its team several Bulgarian participants from different organizations and institutions.

GC II is part of Gilbert/Commonwealth, Inc. (G/C), one of the larger architect/engineering companies in the world with more then 80 years of experience in the power industry and employs over 1,500 professionals worldwide. GC II professionals cover a broad range of scientific and project management skills. Most of GC II international experience is related to the power industry.

Babcock & Wilcox (B&W) is a company with over 100 years experience in design, manufacture, supply and servicing of steam generating and associated equipment. B&W leads the U.S. market for industrial and municipal boilers. B&W is a leading developer and supplier of environment control systems, including flue-gas desulfurization systems, and has pioneered clean coal technology with system such as pressurized fluidized-bed boilers, a technology that will produce electricity cleanly and efficiently by the combustion of coal.



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KPMG is the world's largest leading supplier of professional services to the finance and banking sector worldwide. KPMG has had significant experience in the financial plan development and fiscal analysis of many organizations including district heating companies. They will be responsible for the preliminary analyses of the financial portion assessment of the existing and proposed systems for the different plants. They will develop the financial elements of the program.

## R2.2 PROJECT MANAGEMENT ORGANIZATION AND IMPLEMENTATION

### R2.2.1 Project Management Approach

The organizational form of the GC II project team followed the concept of "Virtual Corporation." By the latest management theory "Virtual Corporation" is defined as a group of horizontally integrated companies teamed to accomplish a proposed project. This alliance is flexible and following the end of a project can be converted to implement a program or task or partially and completely dismantled. This approach, combined with integrated information systems allowed concentration of the best qualified people, across a vastly separated geographical area, to be mobilized around the COE District Heating System project in the shortest possible time.

### R2.2.2 Project Organization

This project was organized around seven logical, self-contained tasks with dedicated task leaders. Accordingly, a project manager/task leader form of management was used. The project manager was responsible for the entire project, including technical and financial performance. He served as an interface point for his counterpart at the COE.

A task leaders were responsible for overseeing activities within their respective task areas - including coordination of work by individuals from their own firm, or from other firms assigned to that task. The task leaders reported to the GC II project manager, and worked closely with him to ensure that work proceeds in accordance with the established quality standards and budgets.

Field activities were performed in Bulgaria, primarily in Sofia and to the lesser extent in Pernik. The majority of in-country work was performed by Bulgarian engineers, in accordance with the work plan and procedures developed by the responsible GC II team expert. The performance of these subtasks was regularly reviewed, according to established checkpoints for its quality and schedule. Before the subtask final acceptance, the work package was thoroughly checked by the GC II team for its format and quality.

To provide project management, controls and coordination of work performed in Bulgaria and in the home offices of the GC II teams' U.S. firms, GC II assigned an In-Country Coordinator which provide a direct interface between our Bulgarian team members and the U.S. firms.

A Project Organization Chart for the project is shown in Exhibit RS-1. The chart also identifies the leading and supporting organization(s) for appropriate tasks.



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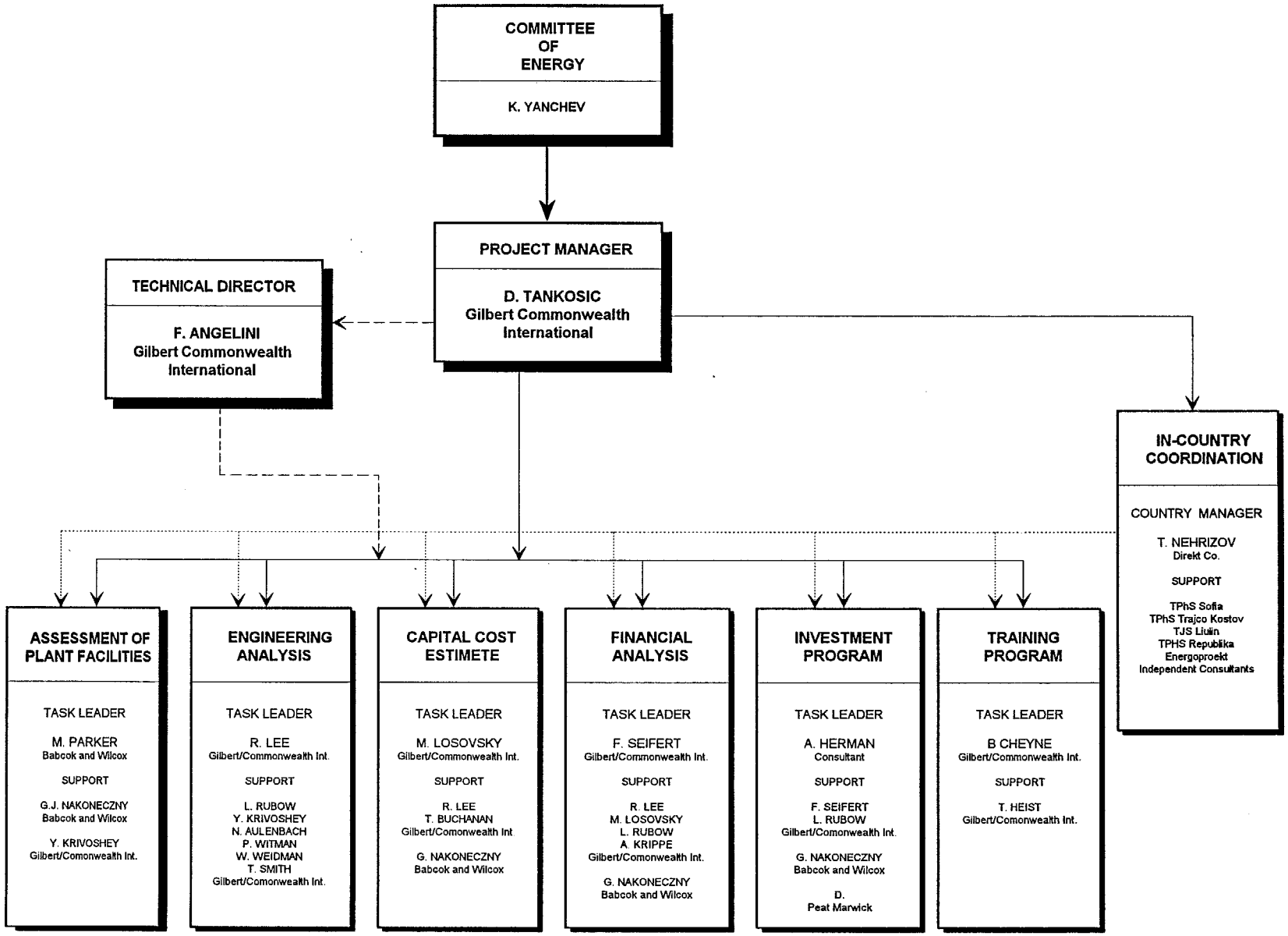
# Exhibit RS-1

## Project Organization



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### R2.2.3 Division of Responsibilities and Project Implementation

**GC II Responsibilities:** The GC II was responsible for the complete work, development of the bases for engineering and economic analysis, engineering analysis, capital cost estimate, economic analysis, and training program development. GC II personnel supported other team members and provided input to the equipment assessment analysis and preparation of the Project Investment Program.

The preparation of the final study report and information packaging into a Project Preliminary Implementation Program were also GC II's responsibilities.

**B&W Responsibilities:** The equipment assessment and preliminary rehabilitation program preparation were B&W's responsibility. B&W provided supporting information for engineering analysis, capital cost estimate, and economic analysis.

**Responsibilities of Independent U.S. Consultants:** The U.S. consultants were primarily responsible to analyze engineering, cost and economic analysis results, process them, and transform them into an affordable Project Investment Program.

**KPMG Peat Marwick Responsibilities:** KMPG Peat Marwick assisted the GC II team in analyzing the Bulgarian Institutional questions and provided information and input for development of the Project Investment Program.

**Responsibilities of the Bulgarian Side:** The in-country coordination of local consultants was performed by the privately owned Bulgarian company DIRECT under the GC II supervision and guidance. Additionally, the Direct Co. was responsible to organize input data gathering, converting data in the proper format for further analysis, and develop travel logistic for visits to the U.S. and Bulgaria.

Partial review and approval of study intermediate and draft final results was performed by the upper management personnel of Sofia and Pernik Cities District Heating Systems. The representatives of the COE and National Electric Utility also took part in partial review of the study approach and approval of the intermediate study results.

Work on the study proceeded smoothly and interface with the Bulgarian counterparts proved very efficient. The contribution of Bulgarian counterparts proved extremely valuable and without their direct involvement in the study, most of the identified solutions and presented recommendations would not have immediate application or would not fit local conditions and business environment.



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## R3 ORGANIZATION OF THE STUDY REPORT

This study report is organized into 10 semi-independent sections plus the Executive Summary, Report Summary, and Section Summaries. Each of the 10 sections describes: (1) the major activities performed over the course of the study; (2) identifies methodologies and analytical tools including computer programs; and (3) presents the major section findings and results. The presentation of the information in the sections is oriented by subject rather than by chronology. This approach allows reader/reviewer to concentrate on the study results and conclusions rather than the methodology and course of events that characterized development of the report.

The Report Summary is intended for the policy makers and upper management and contains all necessary information needed for decision making.

Section Summaries, which follow the Report Summary, allow the reader an overview of the contents of each section. This enables the reader to interpret the report findings without reviewing the detailed information contained in the sections of the report.

To allow easy reading, each of these report sections is prepared as a separate book and contain minimal number of cross references to other books. All essential information pertinent to the subject of the section is included in that particular section, keeping the cross-referencing with the other sections at minimum. Each section of the report contains detailed information and back-up data regarding inputs and used methodologies, and is intended for the specialist that will review the report and evaluate the presented results and conclusions.

### R3.1 REPORT ROAD FORMAT

Exhibit RS-2 provides a synopsis of the report content and represents the "road map" for the reviewers and readers. The road map is prepared to guide the reader to the specific section and provide him with the summary level information about the section.

The exhibit left side, titled "Input to Section" defines: (1) the input informations required for the section; (2) documentation and sources used for development for the input data; and (3) responsible parties providing input information. The cross referencing between sections and other sections used in the Report is also provided through this feature.

The "Report Section" contains: (1) section title; and (2) activities and analysis performed in the section. The exhibit right side, title "Section Results" define section outputs and results of the performed activities and analysis.

## Exhibit RS-2
## Report Road Map

| INPUT TO SECTION | REPORT SECTION | SECTION RESULTS |
|---|---|---|
| A. Results and Conclusions from all Sections<br>B. GC II team and Bulgarian Experts Input | **Report Summary**<br>• Compile all section into a single book<br>• Analyze overall results<br>• Prepare implementation plan | 1. Executive Summary<br>2. Summary of all Report Sections<br>3. Report Conclusions and Recommendations<br>4. Preliminary Implementation Program |
| A. Bulgarian Experts Input and Comments | **Section 1**<br>Existing Plant Facility Description<br>• Provide basic data on system organization<br>• Provide basic data on system operation<br>• Provide details on system design parameters | 1. Design, Operation and History data on System Performance<br>2. Background Information on Current Systems Status |
| A. Arrangement Drawings<br>B. Equipment Specifications<br>C. Performance<br>D. Test Results<br>E. Plant Walkdown(s)<br>F. Interviews with Plant Personnel<br>G. Input from Bulgarian Experts | **Section 2**<br>Assessment of Plant Facilities<br>• Equipment Data gathering and data sorting<br>• Plant walkdown and data evaluation<br>• Level 1 equipment assessment<br>• Rehabilitation program preparation | 1. Equipment Condition Status Report<br>2. Equipment Condition Assessment Charts<br>3. Preliminary Schedule for Equipment Rehabilitation |
| A. Meteorological Data from Sofia and Pernik<br>B. Daily Load Data and Logs<br>C. System Design and Licensing Requirements<br>D. The World Bank and EBRD Fuel Availability and Price Forecasts<br>E. Bulgarian Environmental Law(s) and Environmental Requirements | **Section 3**<br>Engineering and Economic Analysis<br>• Data gathering and analysis<br>• Load profile and peak load analysis<br>• Fuel availability and price selection<br>• Environmental issues analysis | 1. Peak Load Values for Each System<br>2. Monthly Load Profiles for Each System<br>3. Fuel Availability and Fuel Price Forecasts<br>4. Enviromental Impact Mitigation Schemes and Penalties |
| A. Arrangement Drawings<br>B. Equipment Specifications<br>C. Section 1 and 2 Results<br>D. Vendor Information<br>E. GC II inhouse Expertise<br>F. Input from Bulgarian Experts | **Section 4**<br>Engineering Analysis Supply Side<br>• Technology selection and ranking<br>• Develop a list of rehabilitation options<br>• Replacement equipment types and sizes<br>• Optimizing configuration efficiency<br>• Options heat balance analysis | 1. List of New Equipment Types and Sizes<br>2. List and Description of Proposed Rehabilitaion Option |
| A. Existing Measurement and Test Data<br>B. Existing Studies Performed in this Field<br>C. Preinsullating Piping Vendor Data<br>D. Bulgarian Experts Input and Comments | **Section 5**<br>Engineering Analysis T&D Systems<br>• Model Sofia and Pernik city systems loses<br>• Compare results with measured data<br>• Analyze loses with replacement piping<br>• Compare results for different technology | 1. Description of Proposed Technology for Piping<br>2. Description of Proposed Technology for Substation<br>3. Description of Proposed Technology for Pumping Station Equipment |
| A. System Drawings<br>B. Equipment Specifications<br>C. I&C System Design Features<br>D. GC II Inhouse Data and Expertise<br>E. Vendor Information<br>F. Input from Bulgarian Experts | **Section 6**<br>Engineering Analysis I&C<br>• Collect existing I&C system information<br>• Analyze possible system upgrade options<br>• Prepare I&C system upgrade conceptual design | 1. Conceptual I&C System Design<br>2. Major Equipment List<br>3. Major Equipment Conceptual Specifications |



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## Exhibit RS-2 (Cont'd)
## Report Road Map

| INPUT TO SECTION | REPORT SECTION | SECTION RESULTS |
|---|---|---|
| A. Equipment Rehabilitation Schedule (Section 2)<br>B. Proposed New System Configuration (Section 4)<br>C. Proposed New Piping System (Section 5)<br>D. Proposed New I&C System (Section 6)<br>E. Vendor Information<br>F. GC II Inhouse BOP Cost Data | **Section 7**<br>Capital Cost Estimate<br>• Gather cost related information<br>• Estimate project direct cost<br>• Estimate project indirect cost | 1. Capital Cost Estimate for All Systems<br>2. Cash Flow Estimate for All Systems |
| A. Monthly Load Duration Curves and Pick Load (Section 3)<br>B. Fuel Prices and Availability (Section 3)<br>C. Preposed New System Configuration (Section 4)<br>C. System Loses (Section 5)<br>D. Capital Cost and Cash Flow Data (Section 7)<br>E. Options Least Cost Data by Bulgarian Experts | **Section 8**<br>Economic Analysis<br>• Built a computer simulation of proposed system operation<br>• Developed present worth system of capital and operating and maintenance costs | 1. Least Cost Option Among Proposed New System Configurations |
| A. Bulgarian Financial Data<br>B. KP&G Input<br>C. Input by Bulgarian Financial Expert<br>D. Capital Cost and Cash Flow Data (Section 7)<br>E. Options Least Cost Data (Section 8)<br>F. US Operating Data | **Section 9**<br>Investment Program & Financial Strategy<br>• Built financial model for Bulgaria<br>• Performed review requir. analysis<br>• Analyzed funding options<br>• Analyzed loan condition | 1. New Rates<br>2. Loan Repayment Schedule and Morgages<br>3. Interest by Development Banks and Institutions<br>4. Program for Preparing a fully Bankable Document |
| A. Bulgarian Data<br>B. KP&G Input<br>C. Input by Bulgarian Experts<br>D. GC II Expertise and Inhouse Data | **Section 10**<br>Training Program Support<br>• Gather and sort training data sorting<br>• Interview Bulgarian managers and experts<br>• Prepare training program elements<br>• Discuss program with Bulgarian management | 1. Requirements for the Training Program<br>2. Preliminary Plan for Development of a Comprehensive Training Program |

## R3.2 ORGANIZATION AND SUMMARY OF REPORT SECTIONS

The 10 sections of this report can be classified by four major categories. The organization of the catagories is systematic; the results and conclusions from the sections of one category serve as the input to the following category.

FIRST CATEGORY: ESTABLISHMENT OF STUDY BASES

Section 1 - Existing Plant Facilities Descriptions

Section 2 - Assessment of Plant Facilities

Section 3 - Bases for Engineering and Economic Analysis

SECOND CATEGORY: ENGINEERING ANALYSIS OF SYSTEMS

Section 4 - Engineering Analysis - Supply Side

Section 5 - Engineering Analysis - Transmission and Distribution Systems

Section 6 - Engineering Anlaysis - Instrumentation and Controls

THIRD CATEGORY: COST AND ECONOMIC ANALYSIS

Section 7 - Capital Cost Estimate

Section 8 - Economic Analysis

FORTH CATEGORY: IMPLEMENTATION RECOMMENDATIONS

Section 9 - Investment Program and Financial Strategy

Section 10 - Training Program Support

The sections of the first category establish the foundation of the study analysis to follow. Section 1 provides a description of existing supply side, transmission and distribution, and instrumentation and controls equipment. Section 2 provides an assessment of the supply side equipment deficiencies as well as recommendations for the rehabilitation of existing equipment. Section 3 presents bases and criteria for the engineering and economic study analysis including load demand, economic, and emissions factors. The result from the sections of this category therefore serve as input to both the engineering and economic analysis sections in the categories which follow.

The sections of the second category describe the engineering analysis of the systems at the Sofia and Pernik facilities which yields recommended alternatives which will address current deficiencies. Section 4 examines the supply side facilities and, through a systematic screening process, identifies two to three technically sound alternatives at each power plant which address the key reliability, safety, and environmental issues at the facilities. Section 5 analyzes the system loses from the hot water distribution system, identifies a modernization of the system, and examines how system loses could be reduced by this

modernization. In Section 6 an instrumentation system is developed to measure and record hot water and steam use by industrial and domestic users. Specific recommendations for facilities improvements and additions result from the analyses in the sections of this second category.

To establish the economic viability of the recommended system improvements, the sections of the third category provide capital cost and present worth analysis. Section 7 provides capital cost estimates for the technically feasible improvements identified in the second category sections. Section 8 provides the present worth of each recommended facilities improvement "case" identified in Section 4. The initial capital costs and operating costs for each case include costs associated with each supply side alternative plus the costs for the recommended transmission and instrumentation improvements which were common for a given station regardless of the supply side alternative. The present worth analysis produced a least cost case for each power production station. Further analysis was conducted to determine if still better present worth could be obtained by systematically deleting component capital costs in the least cost cases and modifying system impacts to reflect the absence of these improvements. Final facilities improvements recommendations were presented based on the least cost conclusions of the Section 8 analysis.

Having identified the least cost alternatives for addressing the deficiencies of the district heating systems, the sections of the forth category, Implementation Recommendations, discuss the strategies to implement the recommended modifications/upgrades and provide for improved and more efficient operation and maintenance of these facilities in the future. Section 9 establishes a plan for investment and financial strategy to implement the recommended improvements. In Section 10, a plan for a comprehensive training program is developed to benefit the future operation and cost effectiveness of the district heating system.

Summaries of the objectives, methodologies, and results for each section above, are provided in the Section Summaries following this Report Summary.

## R3.3 SECTION FORMAT

For the consistency of the presented information and for ease of following the Report text for each section, excluding minor deviation, each section, is arranged in the following typical format. Brief descriptions of the elements of each section are:

- **Introduction:** Provides background information applicable for the section, introduces the main subject for the section, and summarizes the section's major milestones and events.

  The Introduction usually made up of three subsections: (1) Section Goals and Objectives; (2) Section Scope of Work; and (3) Organization of the section.

  - **Goals and Objectives:** This subsection specifies what is the main purpose of the work performed in the section and what kind of results the reader should expect.



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- **Scope of Work:** This subsection specifies in detail what kind of work should be accomplished in the section and what type of analysis should be performed to meet the section established Goals and Objectives.

- **Section Assumption and Limitation:** This is an optional subsection. It presents major assumption used in developing results for the section or spells-out limiting conditions imposed to the analysis or input data used for the section.

- **Section Organization:** This subsection describes how information is presented in the section. If applicable, it also discusses who was the lead for the section and who provided support.

- **Methodology Description:** Provides information on procedures and analytical (engineering, economic, financial, legal etc.) tools used in the section to perform the defined scope of work. The section also provide justification why the used procedure/tool was utilized and what are their limitations.

  Also specifies input data requirements and format and discusses the quality and consistency of the used input data

- **Presentation and Discussion of Results:** Presents obtained results and discusses its applicability.

## R4 DISCUSSION OF STUDY RESULTS

The following discusses, in brief, the study results for each station.

### R4.1 Supply Side Options

For the four thermal power and heating stations included in this study, a base case and at least one alternate case have been identified as viable technologies for implementation.

All of the base cases involved a rehabilitation and upgrade of major equipment at the plant in order to improve safety, environmental impact, performance, and reliability. Alternate cases include repowering with gas turbine cycles or fluidized bed boilers.

#### R4.1.1 SOFIA TPH STATION

At the Sofia station, the Base Case, S1, involves the retirement of steam boiler No. 1 and the shut down and mothballing of steam boiler 2 and hot water boilers No. 1 and No. 2. The remaining boilers as well as turbines 4, 5, 6, and 8, are to be upgraded and rehabilitated. In this Case, safety related items have been addressed, reliability will be greatly improved, and environmental emissions will be abated. Some minor improvement in plant efficiency will be realized through the upgrades; however, the electrical power generating capability will basically remain unchanged.

The Alternate Case S2 introduces a gas turbine and heat recovery steam generator (HRSG) to displace boiler No. 4 in a repowering configuration. The new equipment configuration will add about 74 MWe to the station's electric power generating capacity and will somewhat improve overall station efficiency. Cogeneration of hot water through steam turbine extraction or exhaust will not increase over the Base Case S2, since no new steam turbine capacity is added. Safety, reliability, and environmental emissions are all expected to improve to a degree similar to the Base Case; only one of the 10 Base Case operating boilers (steam and hot water) will be replaced with the new equipment configuration. The present worth of Case S2 is not significantly different than the present worth of the Base Case, considering the uncertainty associated with some of the input data used for the analysis. However, initial capital expenditure for Case S2 will be substantially higher than for Base Case S1, considering the major new equipment which will be purchased for this configuration. Given that the present worth of Cases S1 and S2 are similar, Base Case S1 would appear more attractive because on its lower initial capital requirements. However, if demand for electricity increased, or if fuel prices rose to favor more efficient cycles, Case S2 might become the preferred alternative.

Alternate Case S3 includes the gas turbine and HRSG and also adds a steam turbine to create a combined cycle repowering. In this Case, all steam boilers remain as in Base Case S1, but an additional hot water boiler would be removed from service and, displaced by a hot water heat exchanger served by extraction from the new steam turbine.

Electrical power production from the new equipment would add approximately 108 MWe to the station capacity. Plant efficiency will improve over Cases S1 and S2 and cogeneration will increase about 16% over the Base Case S1. Safety, reliability, and environmental emissions will all improve to a similar degree as the other two cases; no existing steam boilers and only one hot water boiler would be replaced. The present worth of Case S3 is not significantly different from that of the other two cases; however, initial capital requirements would be greater than both Base Case S1 and Alternate Case S2 as a result of the significant new equipment additions. Because of the higher initial capital cost, Alternate Case S3 ranks behind both Base Case S1 and Alternate Case S2. Again, anticipated increases in electric demand or significant changes in fuel cost might favor the more efficient Alternate Case S3 case with its 108 MWe power contribution.

### R4.1.2 TRAJCO KOSTOV TPH STATION

For the Base Case K1, all existing steam boilers (Nos. 1-7), hot water boilers (Nos. 1-8), and steam turbines (Nos. 1-5) would be kept in service and rehabilitated to address safety, reliability, and environmental issues. Upgrade and restoration of the major components will provide some minor efficiency improvement but electrical generating capacity will remain unchanged.

The Alternate Case K2 includes the addition of a gas turbine combined cycle system similar to that presented for Alternate Case S3. One hot water boiler would be displaced by the new system. Safety, reliability, and environmental impact would be improved similar to Base Case K1 while a significant improvement in station efficiency and an increase in electric power capacity of 108 MWe would be realized. The present worth of Alternate Case K2 is comparable to that of Base Case K1, considering the uncertainties in input

information. Capital investment for Alternate Case K2 would be far greater than for Base Case K1, however, favoring the implementation of Base Case K1. As was discussed for the options at Sofia station, the higher capital required for implementation of the Alternate Case K2 might be preferred if anticipated fuel prices or electrical demand rise significantly.

### R4.1.3 REPUBLIKA TPH STATION

The Base Case for the Republika Station includes the rehabilitation of steam boilers Nos. 1-5 and steam turbines 4, 5, and 6. The uncompleted boiler at this station would remain out of service for this Case. Safety, reliability, and environmental impact would all be greatly improved while only a minor improvement in station efficiency is expected. Electric power generating capacity would not be increased.

The Alternate Case examined for the Republika station, P3, entails the replacement of two of the existing coal fired boilers with two atmospheric fluidized bed combustion (AFBC) boilers. In addition, the sixth steam boiler would be completed and would replace thermal (steam) Boiler No. 3 which is old and requires considerable rehabilitation. Furthermore, a new steam turbine would be installed, displacing the need for turbine number 4. Since a substantial percentage of the existing equipment would be retired and replaced with new equipment, the safety, reliability, and environmental improvements are expected to exceed those of Base Case P1. Station efficiency would noticeably improve compared to Base Case P1, and electrical generation capacity would improve by about 10 MWe. While the tangible parameters yield a present worth which would fall between Base Case P1 and Alternate Case P3, the lower capital associated with Base Case P1 will, again, favor this option. If some of the less tangible issues of safety, reliability, and environmental impact are stressed and/or if electrical demand and fuel prices increase, the alternate Case P3 might prove the most prudent approach.

### R4.1.4 LIULIN AND ZEMLIANE TPH STATIONS

These stations currently produce exclusively hot water via five hot water boilers. The Base Case, L1, is simply rehabilitation of the existing units to meet the fundamental safety, reliability, and environmental objectives. The Alternate Case, L2, involves the incorporation of the gas turbine combined cycle discussed for the Sofia and Trajco Kostov plants. For this Alternate Case, one hot water boiler would be displaced. The combined cycle would add 108 MWe of electrical generating capacity to the station and would somewhat improve its overall efficiency. Also, the combined cycle addition would enable the plant to be self sufficient in supporting its steam and electrical power requirements. However, these benefits would be realized through considerable initial capitals expenditures, especially considering that there are no facilities at the plant, presently, for transmitting the electrical power. With present worth for these two cases being again, quite close, the additional capital outage required to pursue the alternate case for Liulin and Zemliane Stations would only be justified if there were anticipated increase in electrical demand.

## R4.2 TRANSMISSION SYSTEM

The analysis of the hot water transmission and distribution system included an engineering assessment of the existing heat losses in the Sofia network, a comparison of the calculated heat losses with losses reported by DHCS, and an assessment of the potential heat savings that could be realized by total piping replacement with modern pipe designed for hot water heating application.

Much of the data used in performing the calculations was supplied by the DHCS. Additional data required to perform the analyses was obtained from recognized sources.

Agreement between calculated heat losses in the existing network and losses reported by the DHCS was very good, thus validating the LOTUS 1-2-3 heat loss model of the network. When the heat loss analysis was performed assuming installation of new, efficient insulated piping designed for District Heating application, the results indicate that the heat losses through the pipe wall could potentially be reduced by as much as 51%. In addition, modern pipe can be purchased with a sophisticated leakage detection capability which could dramatically reduce losses by leakage assuming repairs are performed in a timely manner upon detection.

In conclusion, assuming leakage losses could be virtually eliminated and by reducing heat losses through the pipe wall by approximately 51%, the total system losses could potentially reduced from approximately 20.6% to 6.8% of the hot water produced.

## R4.3 INSTRUMENTATION SYSTEM

In each District the addition of the instrumentation and equipment to each substation will improve the overall hotwater control within the substation, and provide the data required for manually loading into the computer information and monitoring system. This system once installed will provide the ability to bill monthly each substation/user and industrial plants, and provide information for hotwater system maintenance.

Manual information loading of the computer system can be automated by inputting each substation and industrial user data via assigned RTU's feeding onto a fiber-optic data highway connected to the computer system. This fiber optic data highway can be stand alone or a leased arrangement using the telephone and TV fiber optic cable.

# R5 FINAL RECOMMENDATIONS, CONCLUSIONS

## R5.1 POWER PRODUCTION STATIONS

The economic analysis has demonstrated that for a given power station, the present worths of all of the various cases analyzed are fairly close. They are all within the margin of accuracy which is expected from this level of analysis. It is therefore recommended to pursue the options which present the least capital cost at each station, since the availability of capital is a very important issue to Bulgaria.

The Case 1 option represents the lowest capital expenditures for each of the power stations studied, with the exception of Republika station. This option includes the rehabilitation and upgrade of existing boilers and steam turbines as well as the retirement of some of the oldest, least efficient boilers. The Case 1 option minimizes initial capital outlay by rehabilitating and upgrading safety, environmental impact, and immediate reliability related items first, while deferring items related to improvement in efficiency, long term reliability, and capacity improvements. Further reduction of initial capital can be achieved if equipment targeted for replacement by potential future cogeneration/combined cycle plant upgrades (i.e. Cases 2 and 3) is rehabilitated. This rehabilitation is only to the degree necessary to satisfy immediate safety and environmental requirements and reliability concerns; regular monitoring of this targeted equipment should be instituted until retirement to avoid catastrophic equipment failure.

For Republika Station, the Case P3 option to repower with fluidized bed boilers is recommended based on the present worth analysis. This option demonstrated a higher present worth than the base case of existing equipment rehabilitation because of the severely deteriorated condition of much of the plant equipment and the need to add flue gas clean up equipment to meet environmental goals.

## R5.2 TRANSMISSION SYSTEM

- The economic analysis of piping system rehabilitation treated: (1) the losses of the entire system; and (2) an extensive pipe replacement program to offset these losses.

- The economic analysis shows that implementation of the entire replacement program is not cost-effective. However, the reality of the loss characteristics is that high losses are generally concentrated in a smaller fraction of piping which are insulated by the foam concrete. Additionally, this piping is also the oldest in the system. Accordingly, replacement of this category of piping will bring the fastest return on investment.

- The piping section with extremely high losses and frequency of failure (due to verity of causes) will also have high return on investment.

- As these sections with the high losses and frequency of failure are replaced, diminishing returns will be realized for each successive replacement section. It is prudent to consider a cost-effective program of the remaining pipe replacement. This replacement program should be greater than the current maintenance program (emergency replacement rate), but less than the extensive program of replacement considered, as preliminary indicated in this report in Section 3, Engineering and Economic Analysis, and Section 7, Capital Cost Estimate.

- As piping is replaced, an option is available wherein the new section will feature instrumentation, permitting which will allow losses to be closely monitored, thus improving the ability of the maintenance crews to keep the system integrity at high level.

- Introduction of variable speed control pumps for pumping station and an improved system flow control (reduced flow rate) that will better reflect

requirements of the real system peak load will further reduce power to run the piping stations.

## R5.3 INSTRUMENTATION SYSTEM

The economics of upgrading all the substations and installing the computer-based information and monitoring system, including the fiber optic data highway, in all five Districts at the same time is capital intensive, and therefore, not feasible.

However, it is feasible to do the upgrades and equipment installation in stages as capital becomes available to each Heating District, with total program being done over a period of time not to exceed five years per District.

Also entering into an agreement with the local TVA and telephone companies to lease their fiber optic highway for data transmission to each District's Computer System would reduce their capital cost considerably. Since this would be basically the last investment stage of the total project, capital costs may be reduced even further because of rapidly changing technology in this area.

Summarized information of each report section and is intended for the decision maker to review. These section summaries are included in the following pages.

## R6 SECTION SUMMARIES

Section summaries of the report is shown in the following section of this document.

# SECTION 1 SUMMARY

# Existing Plant Facilities Descriptions

## INTRODUCTION

Section 1 contains a detailed description and evolution of the district heating plant facilities of Pernik and Sofia. This description introduces the reader to the configuration of each plant located in Pernik, TPS `Republika' and TPS `Pernik' as well as those in Sofia, TPS `Sofia', TPS `Trajco Kostov', and heat stations Zemliane and Luilin. In addition, the transmission and distribution piping system is described in detail. System descriptions of each major plant component, e.g. turbine-generators, steam and hot-water boilers, transformers, switchgear and balance of electrical distribution system follow. Components which require prompt attention, or those that have ceased to function efficiently are noted along with recommended remedial action. A discussion of fuel is then introduced, including type, characteristics, source, calorific value, handling and specific problems with recommended remedial action.

## GOALS AND OBJECTIVES

To provide the reader with a summary description of the major plant systems for the production of heat and process steam in the cities of Sofia and Pernik.

## SCOPE DEFINITION

The scope of this section includes summaries of the following plants and major systems/components:

- Pernik System (TPS `Republika', TPS Pernik)
  1. plant system description and evolution; major plant apparatus
  2. fuel and fuel storage/distribution
  3. operation and maintenance
  4. emissions
  5. electrical systems
  6. system protection and control
  7 transmission and distribution (piping)

- Sofia System
  1. plant system description and evolution
     a) Sofia
     b) Sofia-East
     c) Zemliane
     d) Luilin
  2. fuels
  3. regulations
  4. economics and technical analysis

- Energy Policy

- Conclusions

## SECTION ORGANIZATION

This section is generally organized by region, that is it begins with a description of plant systems in the city of Pernik and proceeds with the city of Sofia as outlined above.

## METHODOLOGY DESCRIPTION

Prior to any rigorous evaluation of existing plant systems and recommendations for options, it was necessary to establish a base line condition of the plant systems in Pernik and Sofia, as well as their respective T&D (piping) networks.

Gilbert/Commonwealth International (GC II) in association with Babcock & Wilcox (B&W) and other Bulgarian associates conducted plant inspections, interviewed key plant personnel, and reviewed relevant plant records, e.g. drawings, maintenance records, etc. This information served as a basis for the detailed discussion and data presented in this section. From this basis our engineering team was able to explore options for the rehabilitations and repowering of each plant system.

## PRESENTATION AND DISCUSSION OF RESULTS

The material presented and discussed in this section of the report is outlined above under, "Scope Definition", and follows the order of each plant:

1. Pernik Plants and T&D Systems
   a) TPS 'Republika'
   b) TPS 'Pernik'
2. Sofia Plants and T&D Systems
   a) Sofia
   b) Sofia East
   c) Zemliane
   d) Luilin

# SECTION 2 SUMMARY

# Assessment of Plant Facilities

## INTRODUCTION

This section describes the methodology and procedures used by the GC II team for: (1) evaluating Sofia and Pernik District Heating Systems power generation equipment; (2) discussing and assessing current system equipment condition; and (3) indicating action required to bring the analyzed equipment safety and performance to Western standards.

The equipment condition assessment is based on an EPRI methodology and proprietary B&W procedures applicable for similar plant types and sizes. The methodology is an industry tested procedure wherein progressively more rigorous inspection, testing, and evaluations are undertaken only if the component or system in question fails to demonstrate the desired remaining life or reasonable efficiencies at the simpler level of evaluation.

## OBJECTIVE

The objective of this section was to gather sufficient raw data, knowledge and understanding of each plant and the overall heat distribution system to perform the following:

- Identify chronic and major plant problems.
- Prioritize each area on a time line based on the Committee of Energy's present and future needs.
- Develop a comprehensive plan to correct these problems.
- Integrate the plan with the needs of the entire system, financial analysis and final implementation plan.

Performing this type of review allows owner to determine the condition of plant equipment and infrastructure at each of the plants in order to make decisions regarding component and system rehabilitation.



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## SCOPE DEFINITION

The scope of this task was directly influenced with the GC II decision to use EPRI methodology on the project and included the following:

- Design, operation and maintenance data gathering for boiler island, turbine island and major balance of plant equipment at each generating power station in Sofia and Pernik city systems
- Major equipment data analysis and condition assessment
- Preparation of equipment (plants) life extension plans

The evaluation used in the study can be described as EPRI Level 1 assessment with some elements of Level 2 assessment . For this evaluation only design or overall service parameters need to be examined to ascertain if, on the basis of the most conservative considerations, the component or system has residual life greater than the anticipated extended service period.

## EVALUATED SYSTEM

Major systems evaluated in this study were the Boiler Island and auxiliaries and Turbine Island. The evaluation of the island was based on the equipment component level condition. That means that the equipment was broken down to its integral parts and condition of the whole was contingent on the component assessments.

The evaluation of the boilers included:

- heat transfer surfaces
- casing and insulation
- civil structures
- flues and ducts
- burners
- fans
- air heaters
- precipitators
- fuel prep and burner systems
- instrumentation and controls
- steam piping
- feedwater treatment

The equipment was evaluated through design and operation data sheets, and later confirmed by an walkdown inspection. Some equipment was inspected internally from man way doors, but, in general, an external walk through was conducted.

The areas of the steam turbine that were evaluated and targeted for inspection included:

- rotors
- blades



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- casing
- insulation

In only one instance was the turbine actually open for inspection and one instance the turbine rotor was actually removed from the housing for inspection only because the turbine had undergone an overspeed condition and the blades were physically damaged.

## DATA FOR ANALYSIS

The majority of study input data were collected and processed by the Bulgarian engineers and specialists. This data included equipment drawings, technical specifications, equipment data sheets, technical data, operations and maintenance logs and reports, and economic and financial information.

## LIMITATIONS AND ASSUMPTIONS

As the description of Level 1 assessment implies, the evaluation is greatly dependent upon the historical operating data test records and maintenance records of the plant. Since information was not always complete, assumptions were made and engineering judgment was used when necessary, based upon B&W experience.

In some instances, assumptions may have been made which impact certain conclusions Specific assumptions or clarifications relative to the data are placed in front of the applicable data or evaluation tables.

In performing the analysis, the GC II team assumed that units will be operated for the next 15 years (financial forecast period) at an average availability of 85%. This equates to approximately 110,000 hours of additional operating time. Therefore, all projects used a window of 110,000 hours as the minimum time line.

## MODEL DESCRIPTION

As indicated in Subsection 2.1, of the report, the analytical model is based on EPRI methodology and procedures for fossil power plant equipment assessment. The model is based on a equipment component level evaluation.

To expedite an evaluation process and allow for objective analysis, the GCII team used a computer program specially developed for such analysis. The program utilizes a series of weighted factors and engineering judgment to evaluate the components priority, upgradibility, and disposition.

The life-extension decisions used in this model are based on two major parameter groups: (1) component priority group; and (2) unit upgradibility group. In reality these two parameter groups are represented by a series of exhibits that define further actions on equipment and determine whether equipment could be repaired or should be retired. The component "priority group" determines the order of priority for equipment replacement/upgrade, while unit "upgradibility group" determines whether equipment is a candidate for replacement, rehabilitation, or repair.



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Following development of these two sets of exhibits, "Preliminary Disposition" exhibits are developed that represent synthesized equipment rehabilitation program.

## PERFORMED WORK AND RESULTS

The evaluation in this study includes a Level 1 analysis using Bulgarian supplied data; in some cases a Level 2 analysis was performed to the extent that actual on-site visual inspections could be made of the equipment. The step-by-step procedure used to perform these Level 1 and Level 2 evaluations involved the use of in-country engineering personnel to gather data, review of the data by Babcock & Wilcox, and an on-site inspection. Next the data was input into an analysis software which combined all the important factors of the methodology. Once a priority listing of the problem areas was determined, the life extension plan time line was developed with projects to correct the problems that were found. The procedure used is as follows:

- **Step 1: Data Gathering**

  Data was gathered by the District Heating plant personnel, Bulgarian consultants, and Committee of Energy personnel. This data included equipment drawings, technical specifications, equipment data sheets, technical data, operations and maintenance logs and reports, and economic and financial information.

- **Step 2: Problem Identification**

  A review of gathered data was done both prior to and after the on-site inspections. In this process, the identification of major or chronic problem areas were noted.

- **Step 3: On-site Inspection**

  An on-site inspection was performed at each plant to review the present physical condition of boilers, turbines, and balance of plant systems. This inspection was performed to establish a basis for the plants present condition. On-site inspections allowed review of areas in which major problems had been noted. During the on-site inspections, interviews were held with plant personnel. These interviews provided insight into information that had not been reported in step 1. Many times personnel interviews are more valuable than the documented data that can be found. The data gathering information and on-site inspection data were then compiled into summaries of historical and physical data to be used in the next step of the evaluation

- **Step 4: Data Analysis and Results**

  Following the data gathering, and verification, the collected data were used for development of the component "priority groups", unit "upgradibility groups' and finally "preliminary disposition groups".

Exhibit S2-1 presents summary results of the plant equipment condition assessment effort and lists necessary replacement required to bring the plants to a safer operation and higher efficiency.

# Exhibit S2-1

## Summary of Recommendations for

## Major Equipment Rehabilitation and Upgrade

**THERMAL BOILERS**

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN (%) | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| SOFIA 1,2,3 | TH | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMB. CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | FD FAN OPTION | 0 | REPLACE 5 YEARS | ENHANCEMENT |
| | | DUCT WORK FOR BURNERS | 0 | REPLACE NOW | NECESSITY |
| | | SOOTBLOWERS | 0-0.10 | REPLACE 5 YEARS | ENHANCEMENT |
| SOFIA 4,5,6 | TH | WATERWALLS | 0.1-0.25 | REPLACE 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMB. CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SUPERHEATER | 0 | REPLACE NOW | NECESSITY |
| | | SOOTBLOWERS | 0-0.10 | REPLACE 5-10 YEARS | ENHANCEMENT |
| | | MAINSTEAM LINE | 0 | REPLACE NOW | NECESSITY |
| | | AIRHEATER RETUBE | 0 | REPLACE 5-10 YEARS | ENHANCEMENT |
| SOFIA 7,8 | TH | WATERWALLS | 0.1-0.25 | REPLACE 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMB. CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SOOTBLOWERS | 0-0.10 | REPLACE 5-10 YEARS | ENHANCEMENT |
| | | AIRHEATER RETUBE | 0 | REPLACE 5-10 YEARS | ENHANCEMENT |
| SOFIA 9 | TH | BURNERS | 0-0.25 | REPLACE 10 YEARS | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $3960.0 CONTROLS + $525.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

BURNERS LISTED ARE OIL/GAS COMBINATION LOW NOX DESIGN.

**THERMAL BOILERS**

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| REPUBLIKA 1-4 | TH | ECONOMIZER | 0 | REPLACE NOW | NECESSITY |
| | | SUPERHEATER | 0 | REPLACE NOW | NECESSITY |
| | | WATERWALLS | 0.1-0.25 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | PULVERIZERS & FANS | 0 | REPLACE NOW | NECESSITY |
| | | CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SH HEADER OPTION | 0 | REPLACE NOW | NECESSITY |
| | | PRECIPITATORS | 0 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS & FANS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BACK END CLEANUP OPTIONS | | | |
| | | SNRB | 1.0-2.0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | DRY SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | WET SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | ESP SOX | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | SCR | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| REPUBLIKA 5 | TH | ECONOMIZER | 0 | REPLACE NOW | NECESSITY |
| | | SUPERHEATER | 0 | REPLACE NOW | NECESSITY |
| | | WATERWALLS | 0.1-0.25 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | PULVERIZERS & FANS | 0 | REPLACE NOW | NECESSITY |
| | | CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SH HEADER OPTION | 0 | REPLACE NOW | NECESSITY |
| | | PRECIPITATORS | 0 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS & FANS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BACK END CLEANUP OPTIONS | | | |
| | | SNRB | 1.0-2.0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | DRY SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | WET SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | ESP SOX | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | SCR | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $7722.0 CONTROLS + $815.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (WITHIN THE NEXT 5 YEARS).

BURNERS LISTED ARE COAL LOW NOX DESIGN.



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# Exhibit S2-1 (Cont'd)

## Summary of Recommendations for

## Major Equipment Rehabilitation and Upgrade

**HOT WATER BOILERS**

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| SOFIA 1-6 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| ZEMLIANE 1-5 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| LULIN 1-4 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| LULIN 5 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 10 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 10 YEARS | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $3444.6 CONTROLS + $390.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

** FOR ALL UNITS AT PLANT THE COST IS $2868.0 CONTROLS + $325.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

*** FOR ALL UNITS AT PLANT THE COST IS $2868.0 CONTROLS + $325.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

BURNERS LISTED ARE OIL/GAS COMBINATION LOW NOX DESIGN

**THERMAL AND HOT WATER BOILERS**

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| TRAJOC 1-4 | TH | BURNERS | 0-0.25 | REPLACE WITHIN 10 YEARS | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | COMBUSTION CONTROL | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | FD FAN | 0 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| | | DUCTS | 0 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| | | SOOTBLOWERS | 0-0.10 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| | | MAINSTEAM LINE | 0 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| TRAJOC 5-7 | TH | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMBUSTION CONTROL | 0 | REPLACE NOW | NECESSITY |
| TRAJOC 1-8 | HW | SOOTBLOWERS | 0-0.10 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $8604.0 CONTROLS + $975.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (WITHIN THE NEXT 5 YEARS).

BURNERS LISTED ARE OIL/GAS COMBINATION LOW NOX DESIGN.



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# Exhibit S2-1 (Cont'd)

## Summary of Recommendations for

## Major Equipment Rehabilitation and Upgrade

| STEAM TURBINES | | | | | |
|---|---|---|---|---|---|
| STATION, UNIT | SIZE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
| SOFIA 1,2,3 | 12.5 MW | REPLACEMENT | 3.32 | REPLACE NOW IF MW REQUIRED | |
| SOFIA 4,5 | 25 MW | REPLACEMENT | 3.32 | REPLACE NOW IF MW REQUIRED | |
| SOFIA 6 | 50 MW | HP CYLINDER REPLACEMENT | 3.0 | UPGRADE IN 2 YEARS | |
| SOFIA 7 | UNK. | NEVER USED | 0.0 | NONE | |
| SOFIA 8 | 25 MW | GENERAL MAIN'T OVERHAUL | 1.18 | REQUIRED IN 2 YEARS | |
| TRAJOC 1,2 | 30 MW | GENERAL MAIN'T OVERHAUL | 1.26 | REQUIRED IN 3 YEARS | |
| TRAJOC 3 | 30 MW | GENERAL MAIN'T OVERHAUL | 1.26 | REQUIRED NOW | |
| TRAJOC 4 | 30 MW | GENERAL MAIN'T OVERHAUL | 1.26 | REQUIRED IN 3 YEARS | |
| TRAJOC 5 | 60 MW | GENERAL MAIN'T OVERHAUL | 1.18 | REQUIRED IN 5 YEARS | |
| REPUB 1,2,3 | 25 MW | REPLACEMENT | 3.32 | REPLACE NOW IF MW REQUIRED | |
| REPUB 4 | 25 MW | REPLACEMENT | 3.17 | REPLACE NOW IF MW REQUIRED | |
| REPUB 5 | 55 MW | GENERAL MAIN'T OVERHAUL | 1.32 | REQUIRED IN 5 YEARS | |
| REPUB 6 | 25 MW | GENERAL MAIN'T OVERHAUL | 1.02 | REQUIRED IN 5 YEARS | |

* ALL COSTS ARE IN 000'S OF U.S. DOLLARS
APPROXIMATE COST TO REPLACE 50 MW T/G SET IS $6.5M - $7.0M DOLLARS

# SECTION 3 SUMMARY

# Bases for Engineering and Economic Analysis

## INTRODUCTION

The basis for engineering and economic analysis was developed in this section for the purpose of providing the Sofia and Pernik District Heatings systems sufficient information to make equipment selection, set unit sizes, and prepare cost estimates for future project energy demands. Also indicated are potential methods of emissions control in order to bring the City of Sofia and Pernik district heat systems in to compliance with the emissions regulations issued by the Ministry of Environment.

## OBJECTIVE

The objective was to establish and evaluate for each District Heating Company the basis for the size and characteristics of heat/electrical production units which are considered as options. Also, a secondary purpose was the "decision making" that was used to establish these values and how this study could be refined to meet future project implementation.

## SCOPE DEFINITION

To develop a sound basis for engineering and economic analysis, the following areas were studied:

- peak demand requirements
- associated margins for heat and steam
- month by month profiles

## METHODOLOGY

The peak demand requirements, and associated margins for heat and steam were established to facilitate selection of major equipment. The month by month load profiles through a typical year were presented for heat and steam. The



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load profiles were used directly in the economic analysis to simulate dispatch of operating units through the study period and calculate associated fuel and other operating costs.

The plant peak load and development load projection was developed to enable planning future new generation capabilities to meet system demands. Existing records showing heat production, heat losses, were used to arrive at plant peak loads for future growth and for system improvements.

Load duration curves were required to capture typical fuel requirements and operating costs, and therefore provide the most accurate comparison between alternatives. Daily, weekly, and monthly load duration curves, if available, provided the best representation of real plant operating characteristics so that the most accurate annual operating costs could be calculated.

Since historical data for all systems were provided only on a daily basis, it was not possible to represent demand levels other than as daily (24 hour) averages. However, given the relatively long reaction time of hot water loads, this was considered reasonable for purposes of this analysis.

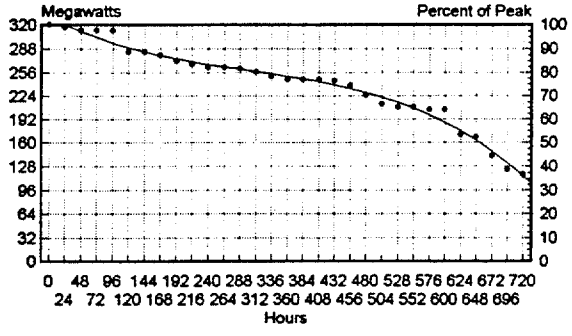
## RESULTS

Exhibit S3-1 shows load duration curve profiles for hot water utilized during the study period.

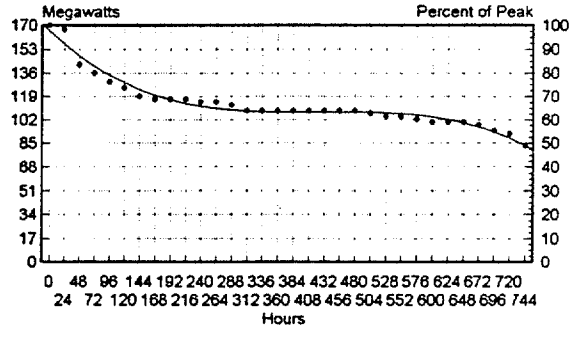
# Exhibit S3-1

## Load Duration Curves - Sofia
## Hot Water
## (April, 1992 - September, 1992)

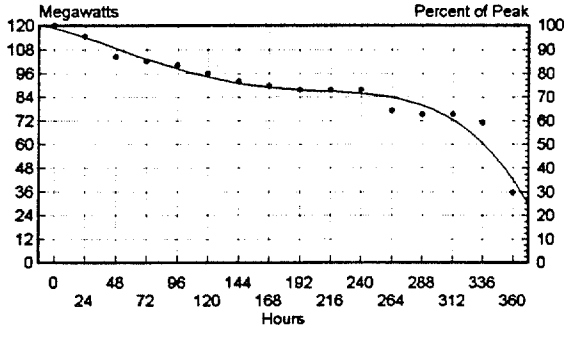
**APRIL**



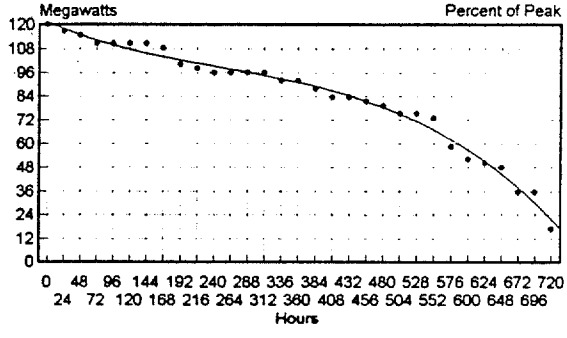

**MAY**



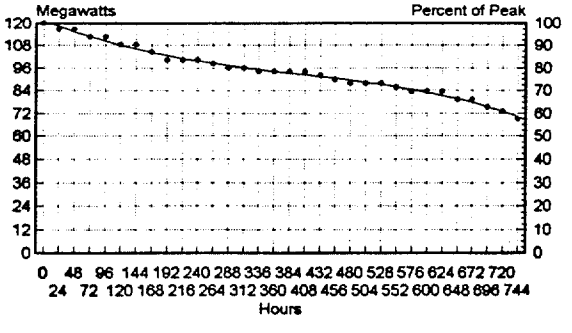

**JUNE**



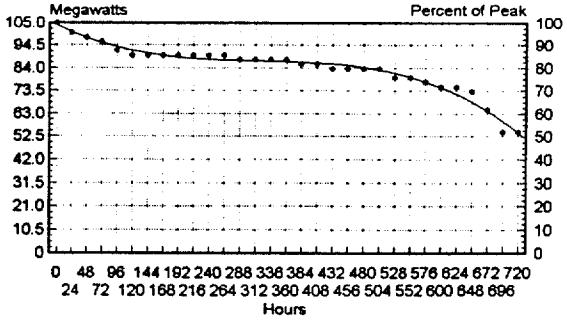

**JULY**




**AUGUST**




**SEPTEMBER**



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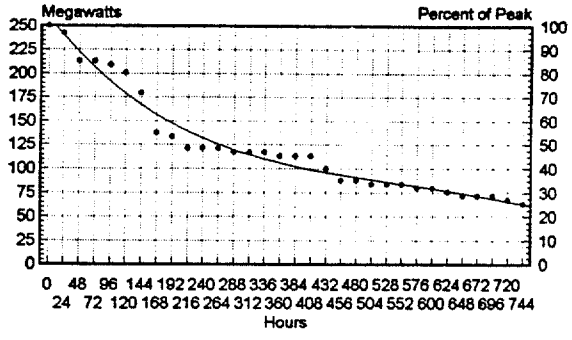
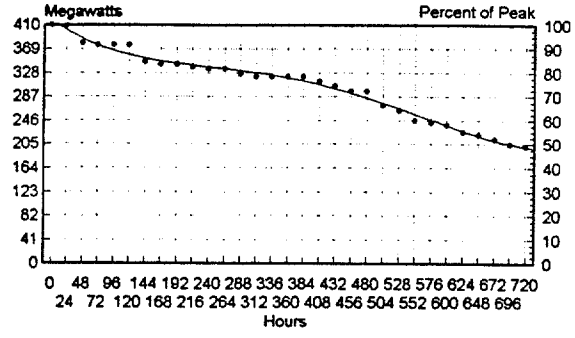
# Exhibit S3-1 (Cont'd)

## Load Duration Curves - Sofia
## Hot Water
## (October, 1992 - March, 1993)

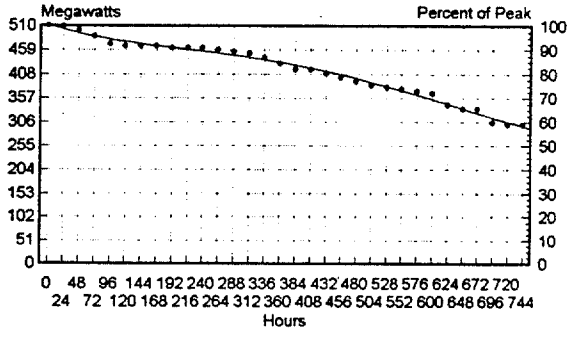
**OCTOBER**



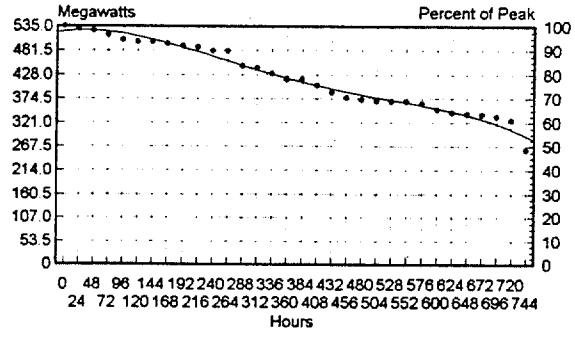

**NOVEMBER**



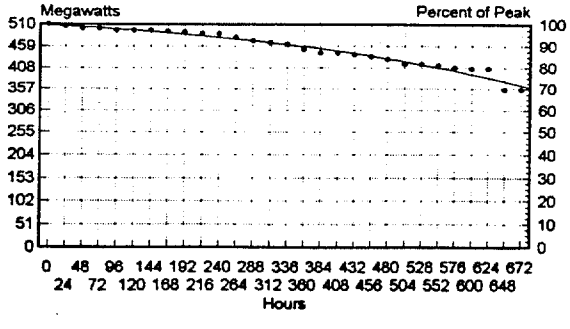

**DECEMBER**



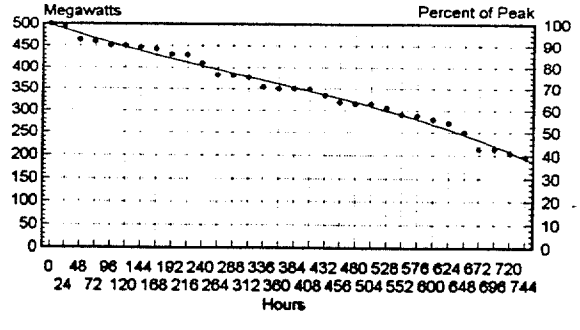

**JANUARY, 1993**




**FEBRUARY**




**MARCH**



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# SECTION 4 SUMMARY

# Engineering Analysis - Supply Side

## INTRODUCTION

Five thermal power heating (TPH) plants produce hot water for the Sofia and Pernik District Heating System; three of these plants also have cogeneration cycles where electricity is produced. These plants are not currently running reliably, safety, or efficiently. Equipment refurbishment, upgrade, or replacement is needed to improve the operation and performance of these plants, as discussed in Section 2.0 of this study. In addition, options to repower portions of these plants can be investigated as a means to improve operation, performance, and efficiency, as well as increase thermal and electrical power output.

## OBJECTIVE

It is desired to identify various options for rehabilitating and/or repowering at each plant and identify the options which provide fundamental improvements in safety, reliability, environmental impact, and performance while also providing the best improvement in station efficiency and power production for the least capital expenditure.

## SCOPE DEFINITION

The scope of this section will begin with the identification of available technologies and the screening of those technologies based on criteria agreed upon by Bulgaria and the GC II team. For the surviving technologies, equipment will be identified, sized, and configurations will be developed. The performance and efficiency of the resultant configurations will then be developed. Benefits of each case analyzed will then be summarized and used as input to the economic analysis to be presented in Section 8.0 of this study.



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## METHODOLOGY

The evaluation of alternatives for repowering the supply side systems is based on a structured and objective methodology which is used by U.S. utilities when they consider upgrade of their plants. This methodology consists of three phases:

- Phase 1: Technology Survey
- Phase 2: Technology Elimination
- Phase 3: Technology Ranking

Phase 1 list all technologies that potentially can be used for plant rehabilitation. Phase 2 eliminates technologies that do not fit acceptance criteria or can lead to unpredictable cost overruns. Phase 3 ranks the technologies remaining after the Phase 2 and retain several top ranking ones.

## SURVEYED AND ELIMINATED TECHNOLOGIES

The technologies considered were:

- Pulverized coal-fired boilers
- Natural gas steam plants
- Integrated gasification combined cycle (IGCC)
- Atmospheric fluidized bed combustion (AFBC)
- Pressurized fluidized bed combustion (AFBC)
- Gas turbine combined cycle (GTCC)
- Gas engine or gas turbine repowering
- Cheng cycle
- Waste incineration

Following the elimination screening, the Cheng cycle, pressurized fluidized bed combustion, integrated gasification combined cycle, pulverized coal-fired boilers were eliminated from further analysis. The following technologies remained for the technology ranking phase:

- Natural gas G/T combined cycle plant
- Natural gas G/T repowering
- Coal integrated gasification combined cycle plant
- AFBC steam plant
- Waste incineration plant

The ranking method used in the study was based on a system of assigning points to a technology in each of several areas. These areas were themselves weighted using "weighting factors" based on its relative importance with values ranging from 1 to 6. Factors included:

- Commercial and development status
- Technical considerations
- Licensing and lead time risks
- Environmental risks
- Cost uncertainty
- Capital costs
- Variable operating costs

The status/characteristic of each candidate technology was then evaluated with a relative ranking within each major criterion, with values ranging between 5 and 0. A relative ranking of 5 was awarded to the best technology ranking and 0 to the worst. The following were selected for further detailed investigation at each site:

- Natural gas: G/T combined cycle plant (Highest ranked)
- Natural gas: G/T repowering (Second ranked)
- Coal: FBC steam plant (Third ranked)

## RESULTS

A total of nine preferred technology cases were identified after the screening process. Three technology cases were evaluated for the Sofia plant and two cases for each of the Trajco Kostov, Republika, and Liulin plants. (Zemliane TPH station was not analyzed separately because it is a near-duplicate of the Liulin plant.) At all stations, preferred technology cases included rehabilitation of the existing equipment according to the recommendations of B&W in Section 2.0. In addition, repowering with gas turbines in a combined cycle arrangement (to displace one or more existing boilers) was identified as a preferred technology Sofia, Trajco Kostov, and Luilin stations. Repowering with an atmospheric fluidized bed combustor was a preferred case at the Republica plant.

# SECTION 5 SUMMARY

# Engineering Analysis - Transmission and Distribution Systems

## INTRODUCTION

An engineering analysis was performed to estimate existing losses (both radiative and leakage) from the District Heating transmission and distribution network. In addition, the analysis includes an assessment of the potential for upgrading the system with modern, efficient piping expressly designed for hot water district heating application.

## OBJECTIVE

High heat and leakage losses were reported in the Sofia TPS hot water distribution system. The purpose of the section was to analyze the system losses and examine the potential savings which could be realized by system modernization.

## SCOPE DEFINITION

The scope of this section is defined by the following activities:

- quantify through engineering calculations the existing losses from the Sofia TPS hot water transmission and distribution system
- compare the calculated losses to reported losses in order to provide an accuracy assessment of the methodologies used
- quantify through engineering calculations the effect of modernizing the system with efficient piping designed for District Heating application.



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## METHODOLOGY

The approach used in this engineering assessment consisted of the following three calculations:

1. Overall network energy balance.

2. Existing pipe heat loss calculation and comparison to reported losses.

3. Modern pipe heat loss calculation and comparison to existing (calculated) losses.

Much of the data (such as physical piping/insulation quantities, dimensions, properties, and installation methods; ambient conditions; quantities and temperatures of hot water produced, sold and madeup) used in performing the above calculations was supplied by the District Heating company of Sofia. Additional data required to perform the calculations were performed using LOTUS 1-2-3 spreadsheet technology and the classical relationships of thermodynamics and heat transfer. Results form the overall network energy balances (i.e., typical monthly average hot water supply and return temperatures) were used as input to the piping heat loss calculations.

Details of the above calculations are contained within Section 5.3.1 of this study.

## RESULTS

Agreement between calculated heat losses in the existing network and losses reported by the DHCS was very good, thus validating the LOTUS 1-2-3 heat loss model of the network. When the heat loss analysis was performed assuming installation of new, efficient insulated piping designed for district heating application, the results indicate that the heat losses through the pipe wall could potentially be reduced by as much as 51%. In addition, modern pipe can be purchased with a sophisticated leakage detection capability which could dramatically reduce losses by leakage assuming repairs are performed in a timely manner upon detection.

In conclusion, assuming leakage losses could be virtually eliminated and by reducing heat losses through the pipe wall be approximately 51%, the total system losses could potentially reduced from approximately 20.6% to 6.8% of the hot water produced.



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# SECTION 6 SUMMARY

## Engineering Analysis - Instrumentation and Controls

### INTRODUCTION

The Sofia and Pernik District Heating Systems provide hot water and steam to their commercial, industrial and domestic users. Based on an operating philosophy governed by a centrally planned economy, individual user costs were not optimized. Now based on a market economy, the four districts in Sofia and the one in Pernik must be able to measure and quantify the amount of steam and hot water being used with a cost applied to the total usage of each individual user, so as to offset each District Heating company's operating costs.

### OBJECTIVE

The objective of this section was to provide each District Heating company with a monitoring system for steam/hot water so that the actual commercial, industrial or domestic user quantity can be measured and recorded for each District's use.

### SCOPE DEFINITION

This section deals with the District Heating company's distribution system and measurement of the steam or hot water within that system. The scope includes the following:

- Steam measurement
- Hot water measurement
- Substation improvements



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- Monitoring system including software
- Data highway

## METHODOLOGY

Review of each District Heating company's distribution and measurement system was based on those in service in Western European countries and the US. Since various substation configurations exist, two generic types were used in the review. Instrumentation, etc. was added to improve and/or provide the information required to satisfy the District's need for data.

## SURVEYED TECHNOLOGIES

The technologies considered were divided into substation improvements and data collection.

- Substation Improvements:
  - Hot water flow measurement
  - Hot water filters
  - Temperature measurement
  - Improved heat exchangers
  - New control valves
  - Temperature controller
  - RTU (Remote Terminal Unit)
- Data Collection:
  - Hand gather the data required for billing purposes and manually calculate each substation/user bill.
  - Hand gather the data required from each substation and manually enter into a computer information and monitoring system.
  - Hard-wire the data required from each substation to the computer information and monitoring system.
  - Hard wire the data to an RTU located at each substation feeding onto a fiber optic data highway connected to the computer information and monitoring system.

## RESULTS

Reviewing the technologies presented, and the financial impact on each District in implementing the technologies, the recommendation would be as follows:

- Add the substation instrumentation listed except for the RTU
- Each District to purchase its computer information and monitoring system
- Hand gather the data required from each substation and manually enter it into the computer information and monitoring system to generate each substation/user bill and maintain information.

Upon completion of the above, each District can negotiate with the TV and telephone system companies to use their fiber optic cable to gather the substation data automatically. Connecting the computer to the fiber optic cable (data highway), and feeding each substation data via its RTU to the highway will complete the link. In addition, if so desired, the computer video wall for maintenance, etc. may be purchased and installed in each District's office.

# SECTION 7 SUMMARY
# Capital Cost Estimate

## INTRODUCTION

This section describes the estimating approach and provides order of magnitude cost estimates for all 11 cases developed in Section 4.0 of this report. The cost estimate for all cases was developed in three different categories. These categories are: (1) cost for a rehabilitation of the existing equipment or the cost of the new one; (2) cost for the transmission and distribution systems; and (3) cost for I&C equipment. Exhibit 7-1 attached provides comparison table for all analyzed cases according to the three estimating categories.

The provided equipment and material cost data was based on the vendor quotes that represent their budgetary (list) prices for the equipment. The order of magnitude estimates were based on the conceptual project data and are usually +/-30% off the final project cost estimate.

GC II's experience indicates, which was confirmed by the vendors contacted, that the final equipment prices could be substantially lower from the budgetary prices. This particularly applies if the contracts were based on a volume purchase. Therefore, for the contract negotiation phase, the investor (owner) should have the project in a relatively advanced design stage with most of the specifications in a final stage.

## GOALS AND OBJECTIVES

The goal for this section was to develop an order of magnitude estimate, based on a project conceptual design data. When available, project preliminary design data were also used. The developed cost data was used for: (1) input into the economic analysis; (2) project budgetary purposes; and (3) preparation of the final bankable document.

## SCOPE OF WORK AND LIMITATIONS

The scope of the work included preparation of an order of magnitude cost estimate and corresponding cash-flow for: (1) district heating plants; (2) distribution and

transmission piping and substations; and (3) I&C equipment for Sofia, Trajco Kostov, Liulin, and Republika plants district heating systems as identified below:

| | | |
|---|---|---|
| Sofia THPS | S1 | Necessary rehabilitation of the existing system |
| | S2 | Gas turbine/HRSG repowering option for retired steam boiler No. 4 |
| | S3 | Gas turbine/HRSG/steam turbine combined cycle option for retired hot water boilers No. 3 |
| Trajco Kostov THPS | K1 | Necessary rehabilitation of the existing system |
| | K2 | Gas turbine/HRSG/steam turbine combined cycle option for retired hot water boilers No. 8 |
| Liulin TPS | L1 | Necessary rehabilitation of the existing system |
| | L2 | Gas turbine/HRSG/steam turbine combined cycle option for retired hot water boilers No. 1 |
| Republika THPS | P1 | Necessary rehabilitation of the existing system |
| | P3 | Fluidized bed boiler option, for retired steam boilers No. 1, and No. 2 and retired steam turbines No. 1 No. 2 and No. 3 |

Due to the similarity of Liulin and Zemliane systems, the Liulin cost data was used for the Zemliane system.

The prepared order of magnitude cost estimates included a direct cost component, an indirect cost component, contingencies, and proposed cash flow.

The cash-flow for plant rehabilitation was based on B&W recommendations for equipment rehabilitation. Repowering/combined cycle options cash-flows were developed assuming as soon as possible replacement cases. The transmission and distribution component cash-flow was developed in accordance with the piping replacement schedule jointly developed by Bulgarian and CGII experts.

## ORGANIZATION OF THE SECTION

This section is divided into three (3) subsections including the introduction.

Subsection 7.2 describes methodology used by GC II team to gather required data, and prepare the order of magnitude estimate.

Subsection 7.3 presents the cost estimating results and briefly discuss the developed cost data.

## ESTIMATE APPROACH

The cost evaluation effort was directed at developing a conceptual cost estimate for each case at each site. The general approach consisted of evaluating each case separately in order to define the modification scope at each of the district heating plants, and to quantify significant commodities and work activities. The bases for the order of magnitude estimate were:

## DIRECT COSTS

A variety of approaches were utilized to develop the direct cost depending on the engineered system design at each District Heating System plant site.

Thermal/hot water boilers, turbine generator modifications, fluidized bed combustion (FBC), simple cycle and combined cycle plants were priced according to **vendor budget prices**. Budget prices exclude quantity discounts. Heating substation material and labor costs were inputs by the client.

Balance of Plant (B.O.P.) costs were derived from historical in-house data using as a bases similar GC II projects. Demolition of existing turbine generators, boilers, switchgear setup costs were derived from historical in-house data and anticipated local labor productivity.

Heating distribution piping was based on replacement rates of heating supply pipelines for all plants. Sofia, Kostov, Liulin, and Pernik. Heating distribution piping costs were based on total meters of pipe/District Heating System developed from piping lists showing meters of pipe. All pipe/substation quantities were provided by Bulgarian heating districts and Bulgarian experts.

All conceptual capital cost summary estimates are in 4th quarter 1993 U.S. dollars and Bulgarian Leva and are included in Appendix 7-1 of Section 7.

## INDIRECT COSTS

The following are indirect cost elements that were included in the development of the order of magnitude cost estimate:

- **Construction hours split:** The construction labor hours were distributed as 20% foreign and 80% Bulgarian labor productivity.
- **Hourly Rates:** Elliot Company stated that for the turbine rehabilitation work a Bulgarian mechanic receives $3.50/hour which includes food and transportation. GC II multiplied this hourly rate by 1.5 to include additional overhead costs which yielded a revised Bulgarian wage rate of $5.25/hour (U.S. $ equivalent).

  Foreign construction labor is based on the U.S. rate of $50/hour and local Bulgarian rate of $5.25/hour.
- **Plant Design Engineering:** An allowance of 7.5% of Total Direct Cost was added to cover normal engineering, drafting, scheduling, cost engineering, and expenses.
- **Owner's Cost:** An allowance of 3% of total direct cost was added to cover normal owner's interface engineering.
- **Freight:** Major equipment including freight (FAS to U.S. east coast port). An allowance of 15% for ocean freight, and 2% for inland freight was included.

## CONTINGENCY

A contingency was applied to direct and indirect costs in proportion to the level of information available. An allowance of 15% was applied to provide the unforeseen elements of cost within the current defined project scope. This contingency

provides for small changes, normal claims, omissions, profit levels, weather, etc. It is expected that by the end of the project the entire contingency will be spent on either direct or indirect accounts.

## CASH FLOW

The cash flow is shown on each District Heating System plant summary page in Appendix 7-1 of the report. This cash flow is a compilation of individual cash flows and is an estimate of expenditures on an annual basis.

## PRESENTATION AND DISCUSSION OF RESULTS

The cost estimating results for Sofia and Pernik District Heating Systems are presented in a series of tables attached in Appendix 7-1. The District Heating System capital costs for all cases/sites follow the designation developed in Section 4.3 of the report and are summarized below.

| | |
|---|---|
| S1 | Sofia THPS |
| S2 | Sofia THPS |
| S3 | Sofia THPS |
| K1 | Trajco Kostov THPS |
| K2 | Trajco Kostov THPS |
| L1 | Liulin HPS |
| L2 | Liulin HPS |
| P1 | Republika THPS |
| P3 | Republika THPS |

Each case/site includes capital costs (in U.S. $ and Bulgarian Leva), indirect costs, and annual cash flow. All costs are presented in current U.S. dollars with the exchange rates US$/Bulgarian Leva @ 32 Leva/U.S.$.

Derived cost estimate results are presented in a group of tables, with each group containing higher level of details. The following are three group of tables: (1) comparison table: (2) summary level tables; and (3) detailed estimate tables.

## COMPARISON TABLE

A Comparison Table is presented in Exhibit S7-1. This table presents a top level estimate data for three categories of improvements: (1) Plant Modifications; (2) Transmission and Distribution/Substation System upgrade; and (3) I&C system upgrade. Categories were developed to minimize interfaces among them and allow easier economic sensitivity analysis, i.e., where the future investment will make a fastest return and have a biggest impact.

The table is intended to provide quick insight on an anticipated level of investment for each site and each category. The information however do not contain any intelligence and their only purpose is to be used as a quick comparison between different options and different categories.

From the Exhibit S7-1 it is obvious that the least capital intensive cases are those involving only necessary improvements, followed by repowering cases. The capital most intensive are cases that include T/G/combined cycle option(s). The Exhibit S7-1 also shows that there is no difference between different cases in the same District Heating Area for "Transmission and Distribution/Substation Systems upgrade" or "I&C system upgrade" cost categories.

## SUMMARY LEVEL TABLES

Summary level tables, Appendix 7-1 provide more project cost insights then the comparison table. The purpose of these tables is to allow closer cost comparison between different options and equipment configurations. It also enhance control of obtained results and provide more data for analysis.

Each summary level table is divided into 11 categories. These categories are general definitions for all sites.

All listed categories include foreign and local equipment and labor costs.

Under Comparison Table above, it was concluded that only differences between various cases in the same District Heating Area comes form the equipment related costs. Below is the brief summary of the cost per installed kW of existing and new equipment for different sites and different cases:

| CASE | 1,000 U.S. $ | NEW MW | NEW $/kW | TOTAL MW | TOTAL $/kW |
|---|---|---|---|---|---|
| S1 | 46,035.50 | - | - | 111.00 | 414.73 |
| S2 | 97,068.40 | 74.40 | 1,304.68 | 185.40 | 523.56 |
| S3 | 109,547.70 | 107.55 | 1,018.57 | 218.40 | 501.59 |
| SA | 91,920.20 | 74.40 | 1,235.49 | 185.40 | 495.79 |
| K1 | 57,574.34 | - | - | 188.00 | 306.25 |
| K2 | 122,966.90 | 107.55 | 1,143.35 | 299.55 | 410.51 |
| L1 | 17,876.00 | - | - | - | - |
| L2 | 82,658.90 | 107.55 | 768.56 | 107.55 | 768.56 |
| P1 | 211,106.90 | - | - | 105.00 | 2,010.54 |
| P3 | 212,760.40 | - | - | 115.00 | 1,850.09 |

The presented costs per kW represent installed capacities and include 7.5% engineering cost, 3% owner's cost and 15% contingencies.

Costs represented as a $/kW of installed capacity are quick estimate values based on a similar installation. This method can yield significant differences depending on total plant scope, plant location (US versus foreign locations), labor source, labor cost, and productivity. Since these plants are located in Bulgaria where; (1) no construction track record exists; and (2) rapid change of labor cost is experienced in last few years, the provided information should be used as an indication of possible project cost or as a guideline with a substantial margin.

It should be noted also that simple $/kW ratio could be misleading if this project is compared with other green field projects. The principal reason for that is because one of the major goals in this study was to optimize system overall efficiency and come with the least - cost option rather than develop least - capital intensive configuration.

### DETAILED ESTIMATE TABLES

A Detailed Estimate Table provides detailed information on the GC II developed order of magnitude cost estimate. The tables account for each major piece of equipment, labor requirements related to the construction activities, and B.O.P. equipment, and transportation and custom issues. The information is intended for

Bulgarian cost estimators and Financial Institutions that will scrutinize and review the cost estimating data.

Appendix 7-2 in the report contains Detailed Estimate Tables for all sites and all engineering cases developed in Section 4 of the report.

# Exhibit S7-1

## Summary Comparisons for all Sites
## Bulgaria District Heating Plants

| SITE | PLANT DESCRIPTION | Total Local Expenditures Leva (x1000) | Total Foreign Expenditures US $ (x1000) | Total Expenditures US $ (x1000) |
|---|---|---|---|---|
| S1 | Rehabilitation of Existing Sofia Systems | | | |
| | Plant Modifications | 56,604.8 | 44,266.6 | 46,035.5 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | Heat Replacement Equip. (Elec. Heater) | – | – | – |
| | TOTAL | 723,241.6 | 136,462.5 | 159,063.8 |
| S2 | Combustion Turbine / HRSG Addition at Sofia | | | |
| | Plant Modifications | 122,785.2 | 93,231.4 | 97,068.4 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | TOTAL | 789,421.9 | 185,427.3 | 210,096.8 |
| S3 | Combustion Turbine Combined Cycle Addition at Sofia | | | |
| | Plant Modifications | 146,174.0 | 104,979.8 | 109,547.7 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | TOTAL | 812,810.8 | 197,175.7 | 222,576.1 |
| SA | Combustion Turbine Combined Cycle Addition at Sofia | | | |
| | Plant Modifications | 122,436.0 | 88,094.1 | 91,920.2 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | TOTAL | 789,072.7 | 180,290.0 | 204,948.6 |
| K1 | Rehabilitation of Existing Kostov Systems | | | |
| | Plant Modifications | 47,145.6 | 56,101.0 | 57,574.3 |
| | Heating Distribution Equip. & Piping | 750,024.7 | 79,012.2 | 102,450.5 |
| | Heating Distribution & Substation I & C | 256,282.4 | 54,453.6 | 62,462.5 |
| | TOTAL | 1,053,452.7 | 189,566.9 | 222,487.3 |
| K2 | Combustion Turbine Combined Cycle Addition at Kostov | | | |
| | Plant Modifications | 136,737.2 | 118,693.9 | 122,966.9 |
| | Heating Distribution Equip. & Piping | 750,024.7 | 79,012.2 | 102,450.5 |
| | Heating Distribution & Substation I & C | 256,282.4 | 54,453.6 | 62,462.5 |
| | TOTAL | 1,143,044.3 | 252,159.7 | 287,879.9 |
| L1 | Rehabilitation of Existing Lulin Systems | | | |
| | Plant Modifications | 16,368.7 | 17,364.5 | 17,876.0 |
| | Heating Distribution Equip. & Piping | 233,240.0 | 25,282.2 | 32,571.0 |
| | Heating Distribution & Substation I & C | 139,790.5 | 29,702.0 | 34,070.4 |
| | TOTAL | 389,397.1 | 72,348.8 | 84,517.4 |
| L2 | Combustion Turbine Combined Cycle Addition at Lulin | | | |
| | Plant Modifications | 105,275.1 | 79,369.1 | 82,658.9 |
| | Heating Distribution Equip. & Piping | 233,240.0 | 25,282.2 | 32,571.0 |
| | Heating Distribution & Substation I & C | 139,790.5 | 29,702.0 | 34,070.4 |
| | TOTAL | 478,305.5 | 134,353.3 | 149,300.3 |
| P1 | Rehabilitation of Existing Pernik (Republika) Systems | | | |
| | Plant Modifications | 218,890.8 | 204,266.5 | 211,106.9 |
| | Heating Distribution Equip. & Piping | 149,770.6 | 16,997.2 | 21,677.5 |
| | Heating Distribution & Substation I & C | 58,848.7 | 14,471.1 | 16,310.1 |
| | TOTAL | 427,510.1 | 235,734.9 | 249,094.5 |
| P3 | Fluidized Bed Boiler Addition at Pernik | | | |
| | Plant Modifications | 281,764.2 | 203,955.3 | 212,760.4 |
| | Heating Distribution Equip. & Piping | 149,770.6 | 16,997.2 | 21,677.5 |
| | Heating Distribution & Substation I & C | 58,848.7 | 14,471.1 | 16,310.1 |
| | TOTAL | 490,383.5 | 235,423.6 | 250,748.1 |

| SITE | Total Local Expenditures Leva (x1000) | Total Foreign Expenditures US $ (x1000) | Total Expenditures US $ (x1000) |
|---|---|---|---|
| S0 | | | |
| | 21,518.1 | 16,767.2 | 17,439.6 |
| | 4,724.8 | 509.4 | 657.1 |
| | 3,883.1 | 825.1 | 946.4 |
| | 286,759.9 | 0.0 | 8,961.2 |
| | 316,885.9 | 18,101.7 | 28,004.4 |

# SECTION 8 SUMMARY

# Economic Analysis

## INTRODUCTION

The economic analysis contained in Section 8 provides an economic perspective for the evaluation of the several production system configurations previously established as being technically feasible. The discussions and supporting materials presented in this Section describe the criteria and methodologies applied and set forth the results of this analysis.

## OBJECTIVE

The objective of the analysis was to establish a realistic basis for a comparison of the long term economic consequences of each system option considering both projected capital and operating expenditures as established in a simulated operating environment considered to be reasonably representative of alternative conditions.

## SCOPE DEFINITION

To accomplish the above objective, a comprehensive computer model was developed in order to simulate the dispatch of alternative facilities in meeting hot water and steam demands represented by monthly load duration curves for the respective service territories.

Through this medium, the prioritized duty cycle for each heat source was established as the basis for the calculation of fuel costs and other operating expenditures. These determinations give recognition to the operating efficiencies and other relevant criteria associated with the respective units.

By discounting the combined cost stream of capital and operating expenditures over a 20 year life cycle, the cumulative present worth of such costs was developed as the basis for a comparison between cases.

Except for Zemliane where the installed heat producing facilities are identical to those at Liuline, a base case, representing essentially a continuation of the status

quo, was established for each heating district in Sofia and for the Republika Station in Pernik.

Alternative cases employing gas turbine-combined cycle technology were developed for each of the Sofia City districts, and, additionally, a repowering case was explored for the Sofia heating district. In Pernik, where facilities are coal-fired, a fluidized bed alternative was evaluated.

## ANALYSIS RESULTS

For each heating district, alternative case costs were compared to those for the respective base cases in order to establish the level of cost savings, if any, potentially resulting from adoption of the alternative technology.

As summarized in the following table and based upon the results of this analysis, the least cost option for all Sofia City heating districts is a continuation of the status quo incorporating those modifications necessary to make that option feasible. However, primarily because continued operation of the Republika Station in its present configuration would require the conversion to a much high quality and substantially more costly grade of coal, the CFB alternative appears to be more cost effective.

### ECONOMIC ANALYSIS RESULTS

| Plant and Case | Present Worth of Total Cost | | | Present Worth of Cost Savings as Compared to Area Base Case | | |
|---|---|---|---|---|---|---|
| | Capital Requirement | Operating Expenses | Total Expenditure $ | Capital Requirement | Operation Expenses | Total Expenditure $ |
| Sofia | US $(000) | US $(000) | US $(000) | US $(000) | US $(000) | US $(000) |
| S1 (Base) | 115,769 | 383,927 | 499,695 | | | |
| S2 | 161,309 | 342,328 | 503,637 | (45,541) | 41,598 | (3,942) |
| S3 | 165,980 | 344,629 | 510,608 | (50,212) | 39,298 | (10,913) |
| Tr Kostov | | | | | | |
| L1 (Base) | 162,549 | 542,885 | 705,434 | | | |
| L2 | 213,784 | 508,347 | 722,132 | (51,236) | 34,538 | (16,698) |
| Liulin | | | | | | |
| L1 (Base) | 59,456 | 208,519 | 267,974 | | | |
| L2 | 110,117 | 163,732 | 273,848 | (50,661) | 44,787 | (5,874) |
| Pernik (Republika) | | | | | | |
| P1 (Base) | 155,529 | 122,408 | 277,936 | | | |
| P2 | 143,546 | 117,396 | 260,942 | 11,983 | 5,011 | 16,994 |

In each instance, costs developed above reflect, in addition to alternative heat source facility costs, the following cost components:

1. Production Plant restoration costs considered to be indispensable to continued operation.

2. Production Plant modifications leading to increased efficiencies and enhanced operations.

3. Transmission and Distribution piping improvements contributing to the reduction of system losses.

4. Control system upgrades (in the T&D system) aimed toward more efficient operations and metering of system sales.

Because the above costs were uniformly treated in all cases, they were considered to have no bearing on the evaluation of alternative production technologies. Ultimately, however, justification of each cost component (except the first without which continued operation is considered impossible) must be considered on its own economic merit.

Reanalysis, deleting individual component capital costs and modifying system demands or similar operating criteria in representation of the absence of such expenditure, were completed with respect to the least cost option initially determined for each location as summarized above. The efficacy of each component program was established only in those cases where the present worth of projected costs increased in its absence.

Applying this measure, the implementation of control system upgrades appears viable only at Tr. Kostov, and piping improvements only at Liulin (and by inference at Zemliane). Under the criteria applied, production plant modifications, other than those considered mandatory, appear not to be cost effective.

# SECTION 9 SUMMARY

# Investment Program and Financial Strategy

## INTRODUCTION

The current political trend in Bulgaria is a gradual movement from a socialistic to a capitalistic form of Government. During this transition, the Government of Bulgaria finds itself in a position of having to prioritize many of the programs required for the betterment of its citizens. This is especially true of the District Heating Companies of Sofia and Pernik.

The limited resources available require that a least-cost program of modernization be structured to maintain the ability of the systems to deliver steam and heat to the consumers in an environmentally sound fashion.

## GOALS AND OBJECTIVES

Having analyzed the systems from both a technical and economic viewpoint, it is now up to the management of the District Heating companies to review the recommended least-cost option from the standpoint of financial viability. Ownership options, including continued municipal ownership, private ownership, and project financing were evaluated from a qualitative viewpoint. Under current financial constraints faced by the District Heating companies, the only ownership option available for the foreseeable future is the continued municipal operation.

A computerized financial model was developed to present the projected results of the proposed implementation program. The objective of this analysis was to determine whether the companies could afford to carry out the modernization of the system. The intent of the financial analysis was then to structure a distinct investment program and financial strategy which would enable the District Heating companies to proceed with the program.

## SCOPE OF WORK

The financial model developed for use in the analysis was utilized in evaluating the four districts (TPS Sofia, Liulin, Trajco Kostov, and Zemliane) which comprise the District Heating areas of the City of Sofia, and the City of Pernik. While each was evaluated on a separate basis as suggested by the E.B.R.D., it must be understood that they are not stand alone instances from a total financial viewpoint. A number of basic assumptions were made as part of the analysis, and included the following:

1. Length of Study Period - 1994 through 2010.

2. Inflation Rates - Separate projections were made for domestic inflation and the world.

3. The ownership structure selected for the evaluation was the continuation of municipal operations.

4. Interest Rate of 8% for foreign loans and 40% for domestic loans were used for all debt instruments.

5. The terms of the foreign loans were for 20 years with a five year grace period from the initiation of the loan; domestic loans were for five years, with principal payments beginning the year after origination.

6. Depreciation was incorporated in the analysis assuming the balances from 1993 at a rate of 5% unless greater amounts were required to assist in the repayment of loans.

7. An income tax rate of 42% was assumed.

8. The analysis developed revenue requirements in current Leva which would be achieved through the collection of payments from consumers and subsidies from the Government. All amounts shown in the analysis were in thousands of Leva.

The work scope had to address the issue of rising inflation in Bulgaria and the continuation of the devaluation of the Leva to the marketable currencies of the world. Its purpose in presenting specific estimates of inflation and devaluation of the Leva was to present all aspects of the proposed operating and investment program in current Leva. Capital costs of the investment program were presented for both foreign and local investment, and operating costs were likewise estimated on an annual basis with specific expenses such as fuel projected on the basis of world pricing.

The model presents six distinct spreadsheets incorporating the following:

1. General Data Development - Includes the estimates of inflation, foreign exchange, and projections of capital and operating costs.

2. Projected Investment Program - For each district evaluated, a separate investment program is structured for both foreign and domestic borrowings

3. Debt Service Schedule - An overall debt service is calculated for each loan, whether foreign or domestic based on the individual annual investment requirements of the separate districts.

4. Income Statement - For each district, a separate and distinct income statement is calculated showing the revenues required to support the investment program and the operating expenses of the system.

5. Analysis of Cash and Cash Balances - From the previous spreadsheets amounts are transferred to the Cash Flow Statement to ensure that the calculated revenue amounts are sufficient to cover all cash requirements of the district.

6. Balance Sheet - A balance sheet is presented to show the assets and liabilities of each district.

## ANALYSIS AND RESULTS:

As part of the analysis, several specific analyses were carried out as part of this review and structuring of the investment program and financial strategy. These included: (1) Infrastructure review incorporating an assessment of the regulatory requirements, budgetary constraints, and establishment of environmental standards; (2) Organizational review which presents a discussion on Government interface, management responsibilities, and the need for training; and (3) a description of the three primary options regarding ownership, including municipal operation, private, and project financing.

The details of the investment program for each of the five districts is presented in the body of this Report. Suffice to say that the program as presented is considered to be the absolute minimum to ensure the continuation of heating supplies to the citizens of the two cities. In Pernik, the calculated revenue requirements are projected to increase from 770 million Leva in 1994 to over 15 billion Leva in 2010. The required increase in tariffs to consumers to meet these projections is subject to additional review by government and management. Income levels will have to be considered, as well as industrial development supported by the District Heating company. Specific structuring of tariffs for the various customer classifications should be undertaken to ensure that costs are recovered from those that impose those costs on the system.

In Sofia, the four districts are projected to need significant revenue increases throughout the study period. Revenue requirement projections increase from 6.5 billion Leva in 1994 to over 137 billion in 2010. While the investment program in Sofia is comparable to that of Pernik, the use of natural gas instead of indigenous coal within the Capital results in this distortion in the level of revenue requirements due to the deterioration of the exchange rate between the Leva and the dollar.

While efforts were made to relate individual tariff structures for the major customer classifications to the revenue projections, the uncertainty inherent in the load projections and customer projections prohibited an assessment of tariffs to revenues. This is a specific shortfall of this analysis and needs to be addressed in the subsequent development of a bankable document for review by potential lenders. The addition of consumers to the system in future years is limited to the amount of conservation resulting from increases in efficiencies in the operation and delivery of energy to the end users, and decreases in actual usage per consumer as a result of reactions to price increases and further implementations of conservation programs at the demand level.

## CONCLUSIONS AND RECOMMENDATIONS

Four specific recommendations have been made regarding the investment program presented herein:

1. Preparation of a bankable document, incorporating a detailed assessment of consumer ability to pay for services.

2. Technical and management training, with emphasis on the financial aspects of the business.

3. Open discussions with Government to begin the process of elimination of energy subsidies.

4. Begin structuring the legal and regulatory framework to promote privatization of the energy sector.

The establishment of priorities within the Bulgarian economy to support the investment program presented, and the securing of the necessary funds, both domestically and from foreign sources, needs to be initiated by the management team of the District Heating companies. Assistance from the development financial institutions is require in this initial program. However, as organizational strengths are developed from within, other resources will be identified over time for the benefit of the companies and the consumers they supply.

# SECTION 10 SUMMARY

# Training Program Support

## INTRODUCTION

This training program has been developed to support the establishment of organization and management programs that will enhance the operation of the district heating systems in a more competitive driven economy.

Reform of the Sofia and Pernik District Heating energy supply and demand management process is a focal point for the Governments plan for energy policy development and implementation in the buildings sector. This reform program will result in a transition from the current operation to one that will support increasing building sector energy efficiency. The implementation needed to support the development of the transition policy will occur at the local level.

Transition to a competitive business environment is based on the ability to identify issues that will affect operation in the future. This future operation will be impacted by the business and economic pressures that are driving changes in the country and, specifically, the need for change in the operation of the district heating systems. To address those changes, fundamental questions must be asked and answered . Specifically, "How must the business processes change?" and, "How must the organization change?"

Answers to these questions will require the identification of business strategies and practices that are needed to provide clear organizational direction. Skills needed to institute and then manage organizational changes are a fundamental part of the proposed training program. Training will address the need to equip the district heating staff members with the skills needed to perform in the planned organization.

Developing the administrative skills needed to perform in a market driven economy will be an integral part of the planned training program. The administration skills will address the need to operate in a market economy with an emphasis on the management of the financial and cost data. In addition, the skills needed to: develop revenue requirements, identify and establish rates for

supplying service, and effectively collecting revenues will be a significant part of the training effort.

## ISSUES THAT IMPACT TRAINING PROGRAM

The Bulgarian District Heating System is made up of the following power districts:

Sofia
Trajco Kostov
Liulin
Zemliane

It is the intention of the system to become independent power producers who will be responsible for the economic production and distribution of hot water and electricity. The power and hot water produced will be sold through distribution companies to the end user. The distributors will be responsible for the marketing the power and hot water and collecting the revenues generated by the sale of the hot water and electricity.

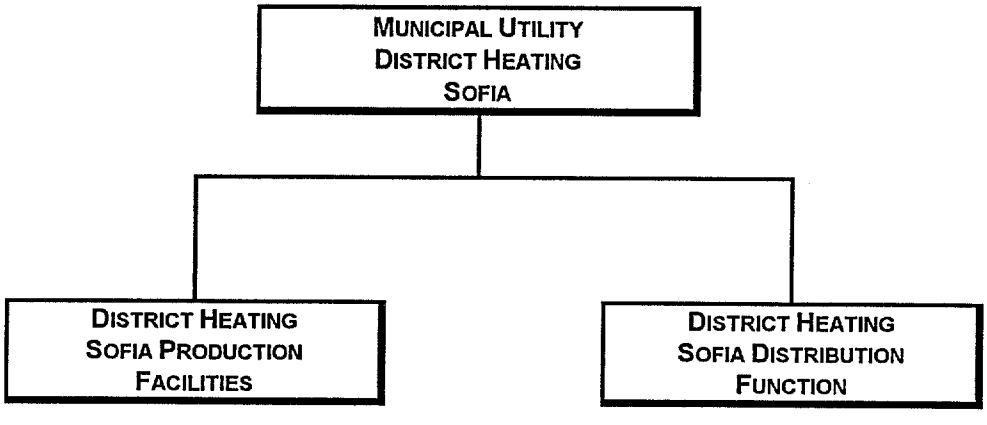
The suggested realignment of the system is shown in Exhibit S10-1. This organization would allow the groups to specialize and enhance their operations such that the cost elements of the program can be managed and controlled.

For the suggested realignment to be successful, the organization needs to identify areas for change and balance those areas against the strengths of the current organization.

For the appropriate changes to be made it is essential that the management team have a clear understanding of the functions that must be considered in the design of the organization. To develop a high performance organization for the District Heating organization, it is suggested that the current organization be broken down into a number of self sufficient operating units that can be operated such that they specialize and produce and/or distribute heat and electricity.

### Exhibit S10-1

### DISTRICT HEATING ORGANIZATION ALIGNMENT



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## GOALS AND OBJECTIVES

The purpose of the training program is to provide the existing management with the additional needed skills to identify the probable risks, improve management process, improve operation, and enhance controls. The areas that are looked at for accomplishing the objectives are structured in the following manner:

- Training that will effectively enhance the operation of the heating facilities
- Training directed at improving the existing management teams ability to operate in a competitive economy.
- Training directed to understanding the critical issues related to the privatization of the district heating system.

The training program addresses the following district heating activities:

- production and supply
- transmission and distribution

The objective of the training program is to assist the present management and lead personnel of these power districts to identify those obstacles that are in the way of improving the existing organizational performance. The training program will identify the need for, and skills required, to achieve the organizational upgrade that will enhance the operation of the district heating facilities.

## SCOPE OF WORK

Work shops by the GC II Training expert will be used to improve performance by identifying the organizational objectives and the management skills that need to be improved to achieve the objectives.

Some of the workshops training for this program will cover:

- Strategic Direction Planning - Provide a framework for management to establish a direction for the training program.
- Management and Organization Training - Provide a background to implement a consistent management approach.
- Technical Operations - Address cost and financial areas.
- Administrative Training - Address (1)operation training related to production and distribution, (2) maintenance training for electrical, mechanical, I&C, civil, and environmental protection.

The total list of GC II training courses are shown in Section 10 of the District Heating Report.

To meet the training goals, the GC II Team focuses on:

- Improving management's understanding of the competitive District Heating operating environment.
- Increase the understanding of the roles and responsibilities required to operate in the competitive environment.
- Develop a general management, multi-functional perspective for leadership and decision managers.
- Enhancing personnel effectiveness.

A key part of the training will be to provide the skills needed to identify and reduce operational risks through the establishment of an enhanced management process, improved operation, and enhanced administrative controls.

Organizational training will concentrate on developing the understanding that is needed to support the transition from a planned to a market driven operation of the district heating program. The training program will assist the management and supervisory team in identifying those things that are in the way of improving organizational performance. A critical part of the training will be the identification of the skills needed to design and then implement organizational change. The management techniques that are presented in the training program will support the managers in their efforts to remove obstacles to productivity.

The initial organizational part of the training program will be driven through a series of management and supervisory work shops that will support the need to restructure the organization. The skills needed to redesign the organization and to provide the individuals in the newly defined organization with the skills needed to manage in a competitive economic market environment are a planned part of the training. The program will provide the skills that are needed to help managers make employees more responsible for their own activities. In addition, the employees will be provided with an in depth understanding of the organizational objectives that will directly support increased performance.

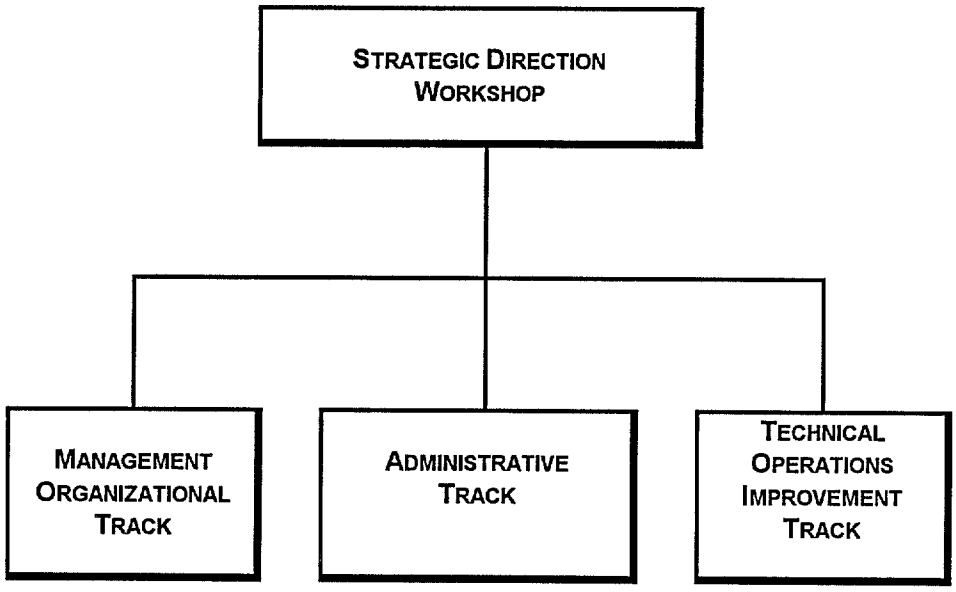
As a part of the training program development, an organizational review will be used to identify the current performance levels and to identify areas where improved organizational performance can contribute to enhanced service. If, for example, the plan is to privatize, organizational positions that are critical to future operations will need to be ready to accept responsibility. Training will be directed at changing the behavior of the management team in addition to ensuring that the management team has the applicable technical skill base.

Training for the management and first level supervisors will be designed to coordinate the technical, business, and financial elements that impact the overall business performance. As a part of the training process, the program will be adjusted to ensure those areas that are most critical to achieve the organization's strategic mission are a critical part of the training program.

The overview of the proposed training program is shown in Exhibit S10-2.

## Exhibit S10-2

## OVERVIEW OF PROPOSED TRAINING PROGRAM




### RESULTS

Some of the results that would be of a benefit from this training program are:

- Providing techniques to support District Heating Managers in the effort of increasing a cost-effective productivity program.
- Giving a more thorough understanding to the employees, the objectives directly related to performance.
- Changing the behavior of management so that they become aware of levels of responsibilities.

In conclusion, this training program is developed to support the Ministry of Regional Development, Housing and Buildings in it's objective to improve the existing operation and efficiency of the Sofia and Pernik District Heating System.

# SECTION 2

## Assessment of Plant Facilities

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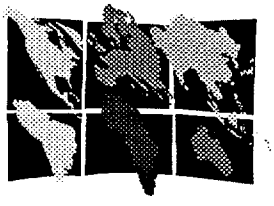
# Bulgarian District Heating System Feasibility Study



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# 2.0 ASSESSMENT OF PLANT FACILITIES

## 2.1 INTRODUCTION

This section describes the methodology and procedures used by the GCII team for: (1) evaluating Sofia and Pernik District Heating Systems power generation equipment; (2) discussing and assessing current system equipment condition; and (3) indicating action required to bring the analyzed equipment safety and performance to the Western standards.

Babcock & Wilcox (B&W) was responsible for identifying areas in the boiler, boiler auxiliaries, and steam turbine systems for plant modernization and upgrade. B&W was also responsible for helping to identify the environmental impact of the proposed life extension changes.

The equipment condition assessment is based on a the Electric Power Research Institute's (EPRI) methodology and proprietary B&W procedures applicable for similar plants type and size. The methodology developed by EPRI has been used in the United States for a number of years. It is based on using progressively more rigorous forms of evaluation as you move toward a more detailed evaluation. With some modifications, which reflects the experience base and engineering approach, most of the U.S. performed equipment assessments are directly guided by this methodology.

The methodology is an industry tested procedure wherein progressively more rigorous inspection, testing, and evaluations are undertaken only if the component or system in question fails to demonstrate the desired remaining life or reasonable efficiencies at the simpler level of evaluation. The decision to perform the next higher level of inspection and analysis involves judgment about the cost to perform the evaluation and the likely uncertainty in the results of that evaluation, as compared to the cost of replacement.



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### 2.1.1 OBJECTIVE

The objective of this section was to gather sufficient raw data, knowledge and understanding of each plant and the overall heat distribution system to perform the following:

- Identify chronic and major plant problems.
- Prioritize each area on a time line based on the Committee of Energy's present and future needs.
- Develop a comprehensive plan to correct these problems.
- Integrate the plan with the needs of the entire system, financial analysis, and final implementation plan.

The objective of this type of review was to determine the condition of plant equipment and infrastructure at each of the plants in order to make decisions regarding component and system rehabilitation. This information is a critical in defining future technology options considered for each of these components.

### 2.1.2 SCOPE DEFINITION

The plant evaluations performed in this feasibility study follow the methodology of the EPRI multi-level approach. Accordingly, the scope of this task was directly influenced with the GCII decision to use this methodology on the project.

Original terms of Reference required condition assessment only for supply side equipment. Transmission and distribution side systems equipment were not part of the studys scope.

The scope of work for this subtask included the following:

- Design, operation and maintenance data gathering for boiler island, turbine island and major balance of plant equipment at each generating power station in Sofia and Pernik city systems
- Major equipment data analysis and condition assessment
- Preparation of equipment (plants) life extension plans

The evaluation used in this study can be described as EPRI Level 1 assessment with some elements of Level 2 assessment. A Level 1 assessment helps balance overall plant evaluations so that the commitment of resources and time are not directed to one component or system only to find major problems in other systems in subsequent base line inspections. For this evaluation only design or overall service parameters need to be examined to ascertain if, on the basis of the most conservative considerations, the component or system has residual life greater than the anticipated extended service period. Although it is possible to conduct this evaluation without reference to measurements or service information, the effectiveness of the assessment will be enormously improved by incorporating such information from the outset.

Information is reviewed as part of the Level 1 process to answer the following key questions for the component to be analyzed:

- Has plant system operation exceeded the design parameters for significant periods of time?
- Will the desired future service exceed pertinent design parameters?
- Have the design philosophy or material choices been shown to be non-conservative since the unit went into operation?
- Has the failure history been excessive?
- Are steam temperature and pressure records inadequate or not available for assessment of those components that function at elevated temperatures?

If the answer to any of these questions is yes, or if the component is found to have, under Level 1 assessment, less remaining life then the desired amount, the evaluation will have to move to at least a Level 2 assessment to reach a definitive conclusion on component life. Information for this evaluation is obtained from operating records and from more detailed information about the components, assuming good historical and current records are available. Level 2 will typically require that new information be generated in an initial inspection, simple stress analysis, measured dimensions, or operating parameters. Level 3 analysis, which is geared toward very detail analysis and that require destructive and nondistructive analysis, goes well beyond the scope of this study and was not used.

### 2.1.3 EVALUATED SYSTEMS

Major systems evaluated in this study were the Boiler Island and auxiliaries and Turbine Island. Plants were physically inspected just after the winter heating season when a minimum amount of plant operation was ongoing. Cursory inspections were performed with a minimum amount of preparation by the Committee of Energy. This approach facilitated a quick turnaround considering the amount of in-country time. Even though the time in-country was short, a considerable amount of data was gathered by GCII from both plant files and plant personnel interviews.

The equipment evaluation was based on the equipment component level. That means that the equipment was broken down to its integral parts and condition of the whole was contingent on the component assessments.

The evaluation of the boilers included:

- heat transfer surfaces
- casing and insulation
- civil structures
- flues and ducts
- burners
- fans
- air heaters
- precipitators



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- fuel prep and burner systems
- instrumentation and controls
- steam piping
- feedwater treatment

Before condition assessment the targeted equipment was evaluated through design and operation data sheets, and later confirmed by an walkdown inspection. Some equipment was inspected internally from man way doors, but, in general, an external walk through was conducted. More time was spent on the major subsystems of the boiler and turbine island.

The areas of the steam turbine that were evaluated and targeted for inspection included:

- rotors
- blades
- casing
- insulation

In only one instance was the turbine actually open for inspection and one instance the turbine rotor was actually removed from the housing for inspection only because the turbine had undergone an overspeed condition and the blades were physically damaged.

### 2.1.4 Data for Analysis

Majority of study input data were collected and processed by the Bulgarian engineers and specialist. This data included equipment drawings, technical specifications, equipment data sheets, technical data, operations and maintenance logs and reports, and economic and financial information.

A review of gathered data was done both prior to and after the on-site inspections. In this process, the identification of major or chronic problem areas were noted.

To compare provided data with the real equipment condition, an on-site inspection was performed at each plant. This inspection was also performed to gain an overall for the plants present condition. During the on-site inspections interviews were held with plant personnel. These interviews provided insight into information documented on paper. Many times personnel interviews are more valuable than the documented data that can be found. The data gathering information and on-site inspection data were then compiled into summaries of historical and physical data to be used in the evaluation process.

### 2.1.5 Organization of the Subsections

In the following subsections, a more detailed discussion of the methodology used in this study and equipment conditions are presented.

This section is divided into five subsections including this introduction.

- Subsection 2.2 describes in general terms the methodology used by the GCII team to gather and analyze data, and propose the rehabilitation plan.

- Subsection 2.3 presents an overview of all the boilers considered in this study. The general boiler description is then followed by plant specific assessments of those boilers and suggested action.

- Subsection 2.4 discusses plant turbines assessment. The presented information follow the format of the boiler section, i.e., general description of all turbines followed by plant specific evaluations.

- Subsection 2.5, the final subsection, provides recommendations for rehabilitation or upgrades of the plants. It should be noted that these recommendations are based primarily upon technical considerations with a focus on production. In the larger context and scope of the study, GCII used this information as input to the economic and financial analyses which also considered the piping and hot water distribution system.

The bulk of the data and inputs to the evaluation were organized into a series of tables. This approach was used in order that the large volume of data could be categorized by plant and by unit. These tabulations are referenced in the text and placed after the recommendations discussion.

### 2.1.6 LIMITATIONS AND ASSUMPTIONS

Level 1 assessment implies that the evaluation is greatly dependent upon the historical operating data test records and maintenance records of the plant. Since information was not always complete, assumptions were made and engineering judgment was used when necessary, based upon B&W experience.

In some instances, assumptions may have been made which impact certain conclusions. Specific assumptions or clarifications relative to the data are placed in front of the applicable data or evaluation tables (exhibits).

In performing the analysis, the GCII team assumed that units will be operated for the next 15 years (financial forecast period) at an average availability of 85%. This equates to approximately 110,000 hours of additional operating hours. Therefore, all projects used a window of 110,00 hours as the minimum time line.

## 2.2 MODEL DESCRIPTION

In Subsection 2.2, an applied analytical model is based on EPRI's methodology and procedures for fossil power plant equipment assessment. The purpose of this methodology is to provide consistency in the plant evaluation and uniformity and objectivity in comparing different plant and equipment.

The model is based on a equipment component level evaluation. Accordingly, boiler and turbine are divided into smaller logical parts to allow for: (1) equipment more detailed evaluation; and (2) screening out the more severe problem areas. This helps the owner(s) concentrate on solving the big issues first while gradually addressing the less severe components further out in the time line of the plan.

To expedite an evaluation process and allow for objective analysis, the GCII team used a computer program specially developed for such analysis. The program utilizes a series of weighted factors and engineering judgment to evaluate the components priority, upgradibility, and disposition.



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The life-extension decisions used in this model are based on two major parameter groups: (1) component priority group; and (2) unit upgradibility group. In reality these two parameter groups are represented by a group of exhibits that define further actions on equipment and determine whether equipment could be repaired or retired. The component "priority group" determines the order of priority for equipment replacement/upgrade, while unit "upgradibility group" determines whether equipment is a candidate for replacement, rehabilitation, or repair.

Following development of these two sets of exhibits, "Preliminary Disposition" exhibits are developed that represent synthesized equipment rehabilitation program. Below is the brief discussion on the "component priority schedule" and the "unit upgradibility" exhibits development procedure and description of parameters and criterias that determines these two groups.

### 2.2.1 COMPONENT PRIORITY SCHEDULE

To determine a components priority in the time line several factors were used. These factors included safety, manufacturing lead time, shutdown issues, reliability issues, and performance issues. These factors were given a range from 0 to 5 based upon the data received and the on-site inspection. These ranges can be seen below.

| Range | Safety | Leadtime | Shutdown | Reliability | Performance |
|---|---|---|---|---|---|
| 0 | Low | Short | No | No | No |
| to | | | | | |
| 5 | High | Long | Yes | Yes | Yes |

These factors are defined as follows:

- **Safety Impact:** The potential hazard for either human loss of life or capital equipment damage.
- **Manufacturing Lead Time:** Should a component be damaged or fail, the amount of time to manufacture a replacement (from order to installation).
- **Shut Down Issue:** Would failure of this piece of equipment cause the overall shut down of the turbine or the boiler.
- **Reliability Issues:** Would the failure of this component directly result in a loss of reliability of the component or the unit.
- **Performance Issue:** Would a failure or the current condition of this system cause the performance of a boiler to be effected either on a component specific or overall unit basis.

### 2.2.2 UNIT UPGRADIBILITY

In order to determine the unit's upgradibility, factors concerning the state of technology, adaptability, and compatibility to upgrades were used. These factors were also given a range of 0 to 5. These ranges are shown below.

| Range | Technology | Adaptability | Compatibility |
|---|---|---|---|
| 0 | Low | Low | Low |
| to | | | |
| 5 | High | High | High |

The following definitions will apply to the factors concerning upgradibility:

- **State of Technology:** Considers the age of a component and overall design characteristics, to the extent known in B&W's knowledge and experience.
- **Adaptability:** Tied to the state of the technology in its current condition and considers the potential to upgrade the specific component itself.
- **Compatibility:** Considers how well the subject component would tie in with other upgrades considered. For example: is its state of technology, current condition, and design worth saving so that other unit upgrades can take place? Does it make sense in the context of considering unit upgrading?

Once the priority and upgradibility information are determined, this information is then combined with the expected remaining life and desired life of the project to develop its overall preliminary disposition. The preliminary disposition will then be the basis for decisions regarding if or when to replace/upgrade a potential component; or whether it should just be maintained and monitored. The following definitions apply to the preliminary disposition:

- **Original Life:** B&W's best estimate of the component life based upon unit design, fuel operating parameters, operating history, and experience with similar technology operating under similar conditions.
- **Hours Expired:** The best estimate of operating hours through 1992 based upon Bulgarian supplied data.
- **Remaining Life:** Simply the original life minus the hours expired; this is not necessarily the best estimate of remaining life; it is being used as a comparative parameter.
- **Desired Life:** Has been established at approximately 15 years at 85% availability based upon the financial model being used.
- **Remaining Life Less Than the Desired Life:** Comparison of above data - either yes or no.

- **Preliminary Disposition:** The initial recommendation for this specific component, in this specific unit with no consideration for other influencing factors.

### 2.2.3 REHABILITATION/LIFE EXTENSION PLAN

This step involves taking the boiler component dispositions generated by the assessment model and developing a logical rehabilitation plan to redirect the plant toward a more efficient and reliable operation that meets the future capacity and environmental limits as determined by the Committee of Energy.

In this step, GCII examined the possibility of upgrading the boiler by simply adding and/or replacing components and equipment. Included in this step would be identification of any new or advanced system or equipment that should be added. Identification of possible new operation, maintenance and efficiency improvements are made, as well as any limitations on upgrades.

In general, this is a simple yet logical analysis that pin points problem areas in the plant for resolution.

## 2.3 BOILER ASSESSMENT

This section covers the assessment of all steam and hot water generating boilers at plants Sofia, Liulin, Zemliane, Trajoc Kostov, and Republika. The total number of boilers is 46 (22 steam and 24 hot water).

### 2.3.1 BOILER DESIGN SUMMARY

The electric generating capacity of the steam boilers ranges from 25 to 66 megawatts. All the steam boilers are superheated design, however, none have a reheat cycle. The steam boilers at Republika burn coal while the remainder of the plants burn oil and natural gas as the primary fuel. The main oil used is called mazut and is a heavy oil similar to No. 6. These boilers were manufactured by the following companies:

| STEAM POWER BOILERS | | | |
|---|---|---|---|
| PLANT | MANUFACTURER | COUNTRY | NO. UNITS |
| Sofia | Babcock & Wilcox | USA | 3 |
| | TKZ | Russia | 5 |
| | PBS | Czech | 1 |
| Trajco Kostov | PBS | Czech | 7 |
| Republika | CKD | Czech | 6 |

**Steam Boilers:** The B&W design is a typical one drum design (1940's) utilizing a single pass horizontal superheater, slanted generating bank, and a vertical convection pass enclosing the economizer and tubular air heater.



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The TKZ designs are of two different vintages of technology. Both designs resemble early B&W Carolina style radiant boilers with a horizontal convection pass followed by a vertical convection pass. The early design (1950's) utilizes two drums with an upper furnace screen, pendant two stage superheater, and a vertical back pass enclosing the economizer and tubular air heater. The newer design (1960's) utilizes a single drum, pendant two stage superheater, and a vertical back pass enclosing the economizer followed by a regenerative type air heater which uses rotating surface (vertical shaft) as opposed to a tubular design.

The PBS designs are of two different vintages of technology. The newer design (1980's) is a typical one drum design very similar to a B&W El Paso style radiant boiler with vertical convection passes. The two stage horizontal superheater resides in the front vertical convection pass (gas flow up) and the economizer resides in the rear vertical convection pass (gas flow down). A division wall separates the two gas passes. The air heater is a regenerative rotating surface (vertical shaft) design. The early design (1960's) is a one drum design, very similar to a B&W Carolina style radiant boiler. This design utilizes a multi-stage pendant superheater with radiant platens, and a vertical back pass enclosing the economizer and large multi-pass tubular air heater. To reduce cold end corrosion the plant has added steam coil air heaters down stream of the FD fans.

The CKD designs involve two different ages of technology. Both resemble early B&W Carolina style radiant boilers. The early design (1950's) utilizes two drums, one of which is essentially the superheater inlet. The unit has a multi-stage pendant superheater and a vertical back pass enclosing the horizontal economizer and two pass tubular air heater. These units located at the Republika plant burn brown coal and have a complex ball mill pulverizing system. The burners are located on the furnace side walls and have an overfire air system. The newer design (1960's) utilizes one drum, a vertical multi-stage superheater, and a split vertical back pass enclosing the economizer and four pass tubular air heater. The tubular air heater is proceeded by steam coil air heaters to prevent cold end corrosion.

**Hot Water Boilers:** The nominal thermal output of the hot water boilers is 100 Gcal. There are two (2) basic designs that are nearly identical. The differences are in the furnace hopper design and the number of burners. The Bulgarian design utilizes a nearly flat furnace bottom and six burners. The Russian design utilizes a deeper furnace hopper and 16 burners. The Russian design allows for greater heat input control (turndown) due to the greater number of burners with individual fans. However, due to the lack of adequate functional controls, these boilers are very difficult to operate through the load range.



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Each design allows for two pass or four pass water flow operation, depending upon the load. Two pass operation is used during periods of peak load, while four pass operation is used at low load. Valving in the forced circulation system is used to switch from one mode of operation to the other. Four pass operation is seldom used due to the very high pressure drop experienced.

| HOT WATER BOILERS | | | |
|---|---|---|---|
| Plant | Manufacturer | Country | No. Units |
| Sofia | PTVM | Russia | 6 |
| Liulin | PTVM<br>VK | Russia<br>Bulgaria | 4<br>1 |
| Zemliane | PTVM | Russia | 5 |
| Trajco Kostov | VK | Bulgaria | 8 |

### 2.3.2 SOFIA PLANT BOILER ASSESSMENT

The plant is located in Sofia, Bulgaria's capital city. The plant generates hot water and steam for district heating and electrical supply to residents and industry in the region. The plant supplies the northern and central parts of the city. The plant was constructed in five phases.

| Stage | Year | Equipment |
|---|---|---|
| 1 | 1949 | Steam Boilers 1, 2 & 3, Turbines 1, 2 & 3 |
| 2 | 1956 | Steam Boilers 4, 5 & 6, Turbines 4 & 5 |
| 3 | 1962 | Steam Boilers 7 & 8, Turbine 6 |
| 4 | 1967-72 | Hot Water Boilers 1 & 2<br>Hot Water Boilers 3 & 4, Turbine 7 |
| 5 | 1981-85 | Steam Boiler 9, Turbine 8<br>Hot Water Boilers 5 & 6 |

#### 2.3.2.1 Thermal Boilers

General characteristics of this equipment can be found after Subsection 2.5.2.3 in Exhibit 2-1, listing the physical data. Each phase of steam boiler construction represents an identical set of newer design boilers. Each phase represents a higher level of design and sophistication.

In general, the thermal boilers are considered to be in fair condition for their age and years of service. Listed below is more unit specific assessments. The boilers are grouped based on their vintage since the data indicates that the history and operating conditions are very similar for boilers of the same age and type. A summary of the unit history can be found in Exhibits 2-2 through 2-8 .

**A. BOILERS No. 1, No. 2, AND No. 3**
**Assessment:**

Boilers 1, 2, and 3, being the oldest boilers at this plant, also have the oldest methods of construction and the lowest level of technology. The construction



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on the furnaces are of a non-membrane tube and tile design with external casing. Plant information indicates that the boilers and burners on these units are reliable. These boilers are used for backup purposes. No turbines are any longer in service in connection with these three boilers. Normally, when the boilers are held in stand-by they are stored in a flooded condition to help protect the heating surfaces from out of service corrosion. No significant problems were identified on these boilers.

**Suggested Actions:**

The engineering analysis determined that the combustion process could be improved to provide more flexibility in fuel choice (oil, as well as gas) and operate in a safe manner through the control range. However, it must be decided what the future use of these boilers will be since the turbines have been removed from service and the boilers are currently used in a stand by mode. Before proceeding with any upgrade project, a future use plan needs to be conceived.

### B. Boilers No. 4, No. 5, and No. 6

**Assessment:**

Boilers 4, 5, and 6, of Russian design, were commissioned in the mid-1950's. Each of these units has had parts of the main steam line replaced although the reason for the replacement are not clear. Data from an evaluation by the COE concluded that the steam lines for all three of these boilers should be replaced in the near future. Data supporting these conclusions were not included with the information provided, so B&W cannot comment on the need for this replacement. These boilers have had problems associated with the furnace waterwall tubes. Bulgarian data indicates that the waterwall tubes are distorted and have an excessive failure rate in all three units. The waterwall tubes are of a non-membrane design and are not gas tight. On all three units, the combustion controls and burner flame safety system have been identified as unreliable. All three of these units have had problems with backend corrosion in the air heaters, which has required replacement of sections in these areas. The burners which are the same on all three boilers were identified as having poor load following capability and are inadequate to meet emissions limits for $NO_X$.

**Suggested Actions:**

The engineering analysis determined that the combustion process must be improved to provide more flexibility in fuel choice (oil, as well as gas) and operate in a safe manner through the control range. The reliability and efficiency of these units can be greatly improved by updating the fuel combustion equipment and sootblowing capability. Further improvement to reduce in leakage of air and cold end corrosion would be to upgrade the furnace walls to membrane construction and retube the air heater with higher grade alloy metals. The main steam line and superheater must either be replaced per Bulgarian study conclusions or be given Levels 2 and 3 assessments to confirm remaining life. The remainder of the unit components should continue to operate properly with standard operating and maintenance practice.



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**C. Boilers No. 7 and No. 8**

**Assessment:**

Boilers 7 and 8, also Russian design, were commissioned in 1963 and 1964, respectively. Both boilers had burner upgrades in 1975 in which the 12 original burners were replaced by eight Babcock manufactured burners. Both of the boilers have had sections of the main steam piping replaced, as well as sections of the convection superheater. In 1982, one of the superheater headers was replaced on unit 7. The reason identified was degraded material, although no details from analyses of any kind was provided. As with the data provided for the earlier vintage boilers, Bulgarian condition assessment reports indicate that boilers 7 and 8 have furnace wall tubes that experience frequent leaks and are unreliable. The furnace construction on these two boilers is non-membrane and is not gas tight. The back end of the units have experienced problems with corrosion and require frequent replacement of sections of the air heater. The units have a history of poor steam temperature control and the conclusions of the 1987 study conducted by the Bulgarians recommended that major upgrades be made including new membrane walls, new superheaters, new economizer, new air heaters, addition of sootblowers, and addition of emissions control equipment, such as burners and backend equipment.

**Suggested Actions:**

The engineering analysis determined that the combustion process must be improved to provide more flexibility in fuel choice (oil, as well as gas) and operate in a safe manner through the control range. The reliability and efficiency of these units can be greatly improved by updating the fuel combustion equipment and sootblowing capability. Further improvement to reduce in leakage of air and cold end corrosion would be to upgrade the furnace walls to membrane construction and retube the air heater with higher grade alloy metal. High temperature components such as the main steam line and superheater should have more extensive condition assessment programs instituted.

**D. Boilers No. 9**

**Assessment:**

Boiler 9, commissioned in 1985, is of Czech manufacture. It has had a relatively low number of operating hours, as well as a low number of on/off cycles. To date, there have been no significant problems identified with this boiler.

**Suggested Actions:**

Because of its relatively young vintage, no actions would be anticipated on this unit, with the possible exception of upgrades to address emissions control requirements. The engineering analysis determined that the combustion process can be improved to address emissions control requirements.

### 2.3.2.2 Hot Water Boilers

General characteristics of this equipment can be found in Exhibit 2-9, listing the physical data. The hot water plant is located at the same site as the Thermal Power Plant but is located in a separate boiler house. The hot water plant houses

six hot water boilers which are of Russian design. All six are non-membrane waterwall construction; utilize a tight packed convection bank to maximize heating surface; and were built between 1967 and 1981. Each boiler has 16 burners - eight each in the front and rear walls in an opposed fired arrangement. The burners are designed with individuals blowers as contrasted to a more conventional plenum or windbox design. All boilers are balanced draft which utilize the natural draft from a common stack with an outlet damper providing draft control. Circulation is forced and there are no back end heat traps.

#### A. All Hot Water Boilers

**Assessment:**

In general, the hot water boilers are in fair condition. Since the boilers operate in the subcooled regime they are not subject to problems associated with higher temperatures and pressures. The major problems on the units are the poor operating characteristics. Burners are only partially instrumental and are unreliable - particularly when attempting to fire mazut. The controls are antiquated and unreliable. Only four of the 16 burners are monitored by flame scanners which poses an unnecessary safety risk. Because water for the distribution heating system is untreated and this water flows directly into the boiler circuits for heating, the heating surfaces have to be replaced at regular intervals due to fouling and overheat. The boilers are not gas tight which allows in-leakage and back end corrosion; and finally, there are not sootblowers for cleaning heating surfaces when firing mazut. Summary of the unit history is shown in Exhibit 2-10.

**Suggested Actions:**

The engineering analysis determine that these units need major rehabilitation to bring them up to reliable operation. This involves major work on combustion systems, furnace construction, sootblowing system, controls, and feedwater treatment.

### 2.3.3 Trajoc Kostov Plant Boiler Assessment

The plant is located in Sofia. The plant generates hot water and steam for district heating and electrical supply to residents and industry in the region. The plant was constructed in five stages.

| Stage | Year | Equipment |
|---|---|---|
| 1 | 1964 | Steam Boilers 1 & 2, Turbines 1 & 2 |
| 2 | 1967-1968 | Steam Boilers 3 & 4, Turbines 3 & 4 |
| 3 | 1972<br>1973<br>1975<br>1976 | Hot Water Boiler 1<br>Hot Water Boiler 2<br>Hot Water Boilers 3 & 4<br>Network Pump Station |
| 4 | 1977<br>1981<br>1982 | Hot Water Boiler<br>Hot Water Boiler 6<br>Hot Water Boilers 7 & 8 |
| 5 | 1988<br>1989 | Steam Boilers 5 & 6, Turbine 5<br>Steam Boiler |

### 2.3.3.1 Thermal Boilers

General characteristics of this equipment can be found in Exhibits 2-11 listing the physical data. Units 1 through 4 are identical design while units 5 through 7 are identical of a newer design.

In general, the thermal units are in good condition, in comparison to the other plants investigated. Many of the problems and more serious conditions were noted on units 1 through 4, which is what is expected from older units. There have been several major reconstructions performed, mostly in response to poor control and operation. A summary of the unit history can be found in Exhibits 2-12 through 2-16.

**A. Boilers No. 1, No. 2, No. 3 and No. 4**

**Assessment:**

Units 1 through 4 have had chronic problems including: ability to maintain firing capability on oil, automatic control of the boiler, out of service corrosion, cold end corrosion, casing and insulation leaks, inadequate sootblowing, water side deposits and pitting, defects in main steam line welds, reduced capacity due to inadequate feedwater heater temperature, and ID fan capacity limitations.

**Suggested Actions:**

The engineering analysis determined that the combustion process must be improved to provide more flexibility in fuel choice (oil, as well as gas) and operate in a safe manner through the control range. The reliability and efficiency of these units can be greatly improved by updating the fuel combustion equipment and sootblowing capability. Other components considered for upgrading or replacement is the main steam line. The remainder of the unit components are adequate to continue in operation with standard operating and maintenance practice.

**B. Boilers No. 5, No. 6 and No. 7**

**Assessment:**

Units 5 through 7, have only had one major problem; being unable to fire oil in a reliable and safe manner. This is mainly due to the use of mechanical atomizers with the heavy fuel oil used. The proper method to fire this fuel is with the use of steam atomization.

**Suggested Actions:**

Due to the number of complaints concerning the need to improve the firing capability of these units, the engineering analysis determined that the burners and controls need to be upgraded. The remainder of the unit components are in good shape and should continue to operate properly with standard operating and maintenance practice.



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### 2.3.3.2 Hot Water Boilers

General characteristics of this equipment can be found in Exhibits 2-17 listing the physical data. All eight units are of identical design. The only difference noted is that units 3 and 7 have been reconstructed with membrane furnace panels.

#### A. All Hot Water Boilers

**Assessment:**

In general, the hot water units are in very poor condition for the relatively low number of operating hours. All eight boilers have exhibited the same problems and deterioration. The deterioration is primarily due to the lack of state of the art design, i.e., non-gas tight furnace enclosures, and the harsh operating parameters. Summary of unit history is shown in Exhibits 2-18 through 2-21.

The units fire mostly natural gas because the combustion system is unreliable on heavy oil as well as difficult to control. Draft is maintained with flue dampers because the units are natural draft. Gas side deposits and ash are cleaned from the tubes using a water lance during shutdowns. This causes severe tube corrosion and washing out of the insulating brick work (non-membrane walls). In leakage of air is excessive through the casing and flues, which accelerates the low temperature corrosion. The inability to remove gas side deposits and the air leakage into the settings limits the boiler capacity to 85% MCR because of draft losses.

Feedwater for these units is not treated. This causes heavy deposits to accumulate mostly in the convection pass header orifices. Blockage of the orifice can lead to tube overheat and failure (current rate of 10-15 tubes per year). The convection pass is replaced on the average of every five to eight years. The structural steel supports were found to be in good condition.

**Suggested Actions:**

The engineering analysis determine that these units will need major rehabilitation to bring them up to reliable operation. This involves major work on combustion systems, furnace construction, sootblowing system, controls, and feedwater treatment.

### 2.3.4 Liulin Plants Boiler Assessment

The Liulin plant is located in Sofia. Liulin supplies hot water to the Northwestern part of the city. The hot water is used for district heating.

| Stage | Year | Equipment |
|---|---|---|
| 1 | 1977 | Hot Water Boilers 1 & 2 |
| 2 | 1979 | Hot Water Boilers 3 & 4 |
| 3 | 1989 | Hot Water Boilers 5 |



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### 2.3.4.1 Hot Water Boilers

General characteristics of this equipment can be found in Exhibit 2-9, listing the physical data. Four units are PTVM-100 (Soviet) design and one unit is VK-100 design (Bulgarian). The main design difference between the two designs is that the PTVM-100 has 16 small burners versus the VK-100 having six burners. Also, the VK-100 unit was constructed with a membrane furnace.

#### A. All Hot Water Boilers

**Assessment:**

In general, the four non-membrane hot water boilers are in very poor condition for the relatively low number of operating hours. All four (4) boilers exhibited the same problems and deterioration. The deterioration is associated with design deficiencies with the burners and furnace and the harsh operating parameters. A summary of unit history is shown in Exhibit 2-22.

The units fire mostly natural gas because the combustion system is unreliable on heavy oil as well as difficult to control. Draft is maintained with flue dampers because the units are natural draft. When required, deposits are cleaned from the tubes using a water spray system during shutdowns. This causes tube corrosion and deterioration of the insulating brick work (non-membrane walls). The external refractory (no casing) is deteriorating and large holes were noted. Leakage of air is excessive through the casing and flues, which accelerates the low temperature corrosion. Gas side deposits which cannot be removed during operation and in leakage of air limit the boiler capacity to 85% MCR because of limited draft control.

Although feedwater for these units is not treated, there was no mention of serious plugging similar to the hot water units at the Trajoc Kostov plant. It is assumed that deposit problems do exist at this plant and that they were not reported due to more concern over the burner problems. This keeps the assumption of design life for tubing consistent for these particular design boilers. It should be noted that boilers were under reconstruction during the on-site inspection and deposits were seen in the tubing that was removed. No deposit analysis was performed.

**Suggested Actions:**

The engineering analysis determined that the four non-membrane units will need major rehabilitation to bring them up to reliable operation. This involves major work on combustion systems, furnace construction, sootblowing system, controls, and feedwater treatment. The membrane boiler was adequate for continued operation.

### 2.3.5 Zemliane Plants Boiler Assessment

The Zemliane plant is located in Sofia. Zemliane supplies hot water to the Southwestern part of the city. The hot water is used for district heating.



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The plants were constructed in one stage:

| Stage | Year | Equipment |
|---|---|---|
| 1 | 1972 | Hot Water Boilers 1 through 5 |

### 2.3.5.1 All Hot Water Boilers

General characteristics of this equipment can be found in Exhibit 2-9, listing the physical data. All five units are PTVM-100 (Soviet) design.

**A. Hot Water Boilers**

**Assessment:**

In general, the hot water boilers are in very poor condition for the relatively low number of operating hours. All five boilers exhibited the same problems and deterioration. The deterioration is primarily due to poor combustion, non-membrane construction, and the harsh operating parameters. A summary of unit history is shown in Exhibit 2-23.

The units fire mostly natural gas because the combustion system is unreliable on heavy oil as well as difficult to control. Draft is maintained with flue dampers controlling stack draft, no ID fans. Deposits are cleaned from the tubes using a water wash system during shutdowns. This causes severe tube corrosion and washing out of the insulating brick work (non-membrane walls). The external refractory is deteriorating and holes were noted. In leakage of air is excessive through the casing and flues, which accelerates the low temperature corrosion. Gas side deposits which cannot be removed during operation and settings air leakage limits the boiler capacity to 85% MCR because of draft losses.

Although feedwater for these units is not treated, there was no mention of serious plugging as reported for to the hot water units at Trajoc Kostov plant. It is assumed that deposit problems exist and that they were not reported due to more concern over the burner problems. The assumption of design life for the tubing is consistent for these particular design boilers. It should be noted that boilers were under reconstruction during the on-site inspection.

**Suggested Actions:**

The engineering analysis determined that these units will need major rehabilitation to bring them up to reliable operation. This involves major work on combustion systems, furnace construction, sootblowing system, controls, and feedwater treatment.

### 2.3.6 Republika Plant Boiler Assessment

The plant is located in Pernik, which is Southwest of Sofia, the capital of Bulgaria. The plant produces both hot water and steam while cogenerating electricity. Hot water is used for the district heating system to the town of Pernik. Historically, steam was produced to supply industrial customers; however, due to the currently depressed business level for industry, steam production is minimal. The

Republika plant is unique in this study for two reasons. First, it is the sole source of energy supply for the heating of hot water for the district heating system of Pernik. Second, it is the only coal fired plant being considered in this feasibility study. The plant was constructed in three phases.

| Stage | Year | Equipment |
|---|---|---|
| 1 | 1951-52 | Steam Boilers 1 & 2, Turbines 1 & 2 |
| 2 | 1958-59 | Steam Boilers 3, 4, & R, Turbines 3 & 4 |
| 3 | 1967 | Steam Boilers 5, Turbine 5 |

General characteristics of this equipment can be found in Exhibits 2-24 listing the physical data. Units 1 through 4 and reserve (R) are of identical design while unit 5 is of newer design. All six of the boilers were designed for pulverized coal combustion. The original design fuel had a maximum ash content of 45% by weight.

The thermal boilers are in unsuitable condition for further service. Listed below is more unit specific assessments. The boilers are grouped based on their vintage since the data indicates that the history and operating conditions are very similar for boilers of the same age and type. A summary of the unit history can be found in Exhibits 2-25 through 2-30.

### A. Boilers No. 1, No. 2, No. 3, No. 4 and No. 5 Assessment:

In general, Republika Thermal Power Plant was concluded to be in poor condition. As noted in the data provided by The Committee of Energy, the coal supply for the Republika plant has deteriorated over the years to where the typical ash content in the supply today exceeds 60% by weight. The use of pulverized coal combustion technology with a high ash coal supply has accelerated the general deterioration of the boilers. Some systems can be considered on a plant basis and the comments apply to all six of the boilers. The boiler settings in all cases are in poor condition. Insulation is deteriorated, spalling off, and in a state of disrepair. The gas tightness and integrity of the settings is gone as witnessed by flue gas leakage and ash leakage from the settings while the boilers were in operation. Several inches of ash accumulation were common throughout the plant. The peripheral boiler steel, such as the stairways, platforms, their supports, and handrails, were all in a poor condition. The pulverizers and burner systems are obsolete and no longer supported by the original equipment manufacturer. Manufacturing of spare parts has to be maintained by the plant. In all cases, the pneumatic combustion controls and burner management system are unreliable, and do not operate. Boiler control is done manually. In general, the pressure boundaries of the boilers, including the furnace waterwall tubes, superheaters, and economizers are all questionable and would have to be considered for replacement or upgrade in the near future. The back end cleanup equipment, which consists of electrostatic precipitators, are not deemed adequate to meet projected emissions limits for particulates. The conclusion is that any plan for the continued use of these boilers into the future will require a major investment in capital to upgrade and replace key components within each of the boilers. There is a critical need to invest in upgrade of subsystems such

as the combustion controls and burner management systems for safe and reliable operation. It is anticipated the back end clean up equipment will be required to remove sulfur oxide if emissions are to comply with projected limits while using local coal supplies.

The boilers have had multiple precipitator replacements, as well as multiple replacements of the superheater and economizer. It is not clear whether the superheater replacement included the headers. While at the plant, interviews were conducted by Babcock & Wilcox with the maintenance and operations personnel and some important points were noted. The boilers have been experiencing out of service corrosion of the furnace waterwall tubes. The boiler waterwall tubes have also had failures that were attributed to thermal fatigue. The convection heating surfaces, such as the superheater tubing, are experiencing high rates of erosion, which is associated with the high ash content of the coal. A section of the steam line was tested following 150,000 hours of service. It included metallography and other tests done in a laboratory on material samples. Although the piping was generally concluded to have life remaining, complete data from the test reports was not included in the translated data made available for this study. In general, the number of operating hours on this piping system and the operating temperature of the steam would make the system susceptible to problems associated with creep and fatigue. The drums of the boilers were evaluated by Czech engineers to determine the condition of the material. Detailed data and reports were not provided; however, their conclusion was that the drums were not at end of life. In the absence of more comprehensive data, it is assumed that any problems existing with the steam drums can be repaired, and this component would not have to be replaced.

**Suggested Actions:**

The engineering analysis determined that this entire plant needs major rehabilitation work, not only to maintain general integrity but also to clean up the emissions. The many problems seen put into questions whether or not it would be economically feasible to correct everything that is wrong or whether it would be better to dismantle the plant and build a new one. A new plant would offer the chance to change fuel (limiting emissions) or stay with coal and burn it in a Circulating Fluidized Bed (CFB) boiler.

## 2.4 TURBINES ASSESSMENT

This section covers the assessment of the steam turbines at Sofia, Trajco Kostov and Republika plants.

### 2.4.1 TURBINES DESIGN SUMMARY

The total number of steam turbines is 19; eight in Sofia, five in Trajco Kostov, and six in Republika. The turbine sizes range between 12.5 MW and 66 MW. Fourteen of the turbines are a condensing design and the remaining five are back pressure design. These turbines were manufactured by the following companies:



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| Plant | Manufacturer | Country | No. Units |
|---|---|---|---|
| Sofia | unknown | unknown | 4 |
| | unknown | Hungarian | 1 |
| | unknown | Soviet | 3 |
| Trajco Kostov | unknown | Czech Republic | 5 |
| Republika | CKD | Czech Republic | 2 |
| | Skoda | Czech Republic | 3 |
| | PBS | Czech Republic | 1 |

Currently, there are four turbines out of service or permanently retired. These turbines are Sofia 1, 2, and 3, and Republika 3. Information concerning the turbines was limited to the data supplied by the COE.

### 2.4.2 SOFIA PLANT TURBINES ASSESSMENT

In total, the Sofia Thermal Power Plant has had eight turbine generators installed throughout its history. Turbine generators 1 and 2 were started up in 1949, along with boilers 1, 2, and 3. Turbine generator 2 experienced a failure due to an overspeed incident in 1977, and was retired. Turbine generator 1 was also retired and is only used for training purposes. Turbine generator 3, was started up in 1951 and has subsequently been retired. Turbine generators 4, 5, and 6 were started up between 1956 and 1962. All three are rated at 25 MW and are condensing type designs of Soviet manufacture. As of December 1992, the hours of operation varied between 211,000 and 215,000 for the three turbines. These are the main turbines at this plant. A turbine that was identified as 7 was started up in 1967. In the brief data available, turbine 7 operated only 300 hours after start-up and was retired from service. It is assumed that it experienced a major failure and was not put back into operation. Turbine generator 8 was started up in 1985, along with boiler 9. This turbine is rated for 25 MW and as of December 1992, it had accumulated approximately 75,000 operating hours. In summary, there are four turbines currently in operation at the Sofia Thermal Power Plant, turbine generator 4, 5, 6, and 8.

Because of its relatively young life and newer age, turbine generator 8 is assumed to be acceptable for continued operation with a remaining life greater than the desired life. Turbine generators 4 and 5 have been derated to 18 MW from their original 25 MW. They are still in use and they are expected to continue in use into the future. Turbine generator 6 is a larger turbine rated at 50 MW and is expected to be used into the future. Turbine generator 4, 5, and 6 have operated in excess of 200,000 and their performance has degraded. Data provided by the Bulgarians is inconclusive regarding the condition of the turbines. Reports indicate turbines 4 and 5 are near end of life; however, no data or description of the assessment methods were given. Summary information is provided in Exhibit 2-31.

It is recommended that if the feasibility study projects continued need for these turbines, then turbine generators 4, 5, and 6 should be further evaluated in a Level 2 condition assessment program. It is also recommended that the auxiliary equipment, such as the condensers, be tested to determine if their integrity is sufficient for long term operation. Maintenance and upgrading of the glands, seals, bearings and blades is assumed to have been done on a relatively routine



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basis. One area that is noticeably lacking is that of turbine supervisory systems that allow for better operating flexibility with load cycling, two-shift operation, fast recovery on load rejection and network stability. In order for these systems to be used, the entire controls package for the plant needs to integrate flexibility of turbine operation with the various boilers.

### 2.4.3 TRAJCO KOSTOV PLANT TURBINES ASSESSMENT

The Trajoc Kostov Thermal Power Plant has had five turbine generators installed throughout its history. Turbine generators 1 and 2 were started up in 1964, along with boilers 1 and 2. Both turbines 1 and 2 have undergone multiple repairs and replacements over the last 30 years. Turbine 2 underwent a rotor rebuild earlier this year due to an overspeed incident in 1992. Turbines 1 and 2 had the HP cylinder replaced in 1991. Both turbines are rated for 30 MW.

Turbine Generators 3 and 4 were started up in 1967, along with boilers 3 and 4. These turbines are identical to turbines 1 and 2. Turbine and boiler 3 are currently only used for peaking load. Turbine 4 also had the HP cylinder replaced in 1991. Turbines 3 and 4 are cycled on and off more than turbines 1 and 2.

Turbine Generator 5 is relatively new, being started up in 1988, along with boilers 5 and 6. This turbine requires that two steam boilers provide the required steam flow to produce 66 MW. Boiler 7 was added in 1989 to provide flexibility in boiler selection to make up the correct steam capacity to the turbine. Turbine 5 can be run off any of the following boiler combinations: 5 and 6, 5 and 7 or 6 and 7. Valving in the steam lines is used to isolate the non operating boiler from the rest of the system. Turbine 5, although relatively new, has experienced some cracking in the valve boxes. This cracking has been repaired. Summary information is provided in Exhibit 2-32.

In general, the turbines are in fair condition for the age, operating hours and cycles since start-up. Replacements in the last two years have taken care of the more serious problems. Maintenance and upgrading of the glands, seals, bearings and blades is assumed to have been done on a relatively routine basis. One area that is noticeably lacking is that of turbine supervisory systems that allow for better operating flexibility with load cycling, two-shift operation, fast recovery on load rejection and network stability. In order for these systems to be used, the entire controls package for the plant needs to be considered in planned upgrades.

### 2.4.4 REPUBLIKA PLANT TURBINES ASSESSMENT

The assessment of the turbine generators at the Republika TPP was limited to evaluation of data provided by the Bulgarians. Three of the turbines in operation today, turbine number 1, 2, and 4, were started up in the 1950's. These turbines each have total operating hours in excess of 240,000 hours with start-up cycles ranging from 641 to 1028. Turbine generator 3 of the same vintage was taken out of service due to a failure. The cause for the failure and the date it was removed from service is not known. Turbine generator 1, 2, and 4 are condensing turbines rated at 25 MW. Turbine generator 5, rated at 55 MW, was originally a condensing turbine; in 1989 it was converted from condensing type to back pressure type operation. Turbine generator 5 was started-up in 1967 and had accumulated 147,000 hours operation through the end of 1992. A new turbine generator, designated 6, is a back pressure turbine rated at 25 MW and is



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scheduled to go into operation in 1993. Turbine generator 6 is needed as a replacement for the lost capacity associated with turbine 3. In summary, five turbines are to be in operation at the end of 1993 to meet the requirements of Republika Thermal Power Plant. Three of the turbines are condensing type and two are back pressure type. Summary information is provided in Exhibit 2-33.

In general, it was concluded that the turbine generators can be upgraded and modified for continued operation into the future. The feasibility and economics of upgrading the turbines for future operation must be weighed against the other options for this plant. Based upon statements made by the Bulgarian Committee of Energy, turbine generator 5 has had condition assessment work performed and it was concluded that the remaining life is greater than the desired life of 15 years for this plant. No details were given on the condition assessment program performed. Turbine generators 1, 2, and 4 are questionable and it is recommended that these turbines have testing and condition assessment work performed on them to determine upgrades required for future operation. A consideration for the economic evaluation is the expected performance loss of these turbines due to their age and hours of operation. Additionally, it was stated that, today, the Republika Thermal Power Plant's primary function is to supply energy to district heating. Turbine extraction steam for process steam to industry is secondary. The role of cogeneration in the district heating plants is not clear and must also be evaluated.

## 2.5 REHABILITATION AND LIFE EXTENSION RECOMMENDATIONS

This section of the report deals with the proposed project solutions required to extend units life and bring the boilers/turbogenerators up to a more reliable and efficient operating condition. All the upgrade/replacement recommendations are a direct result of the data analysis, supplied information, personnel interviews, current commercially available state-of-the-art technology, and B&W's professional judgment concerning the viability of the project. In general, in all cases where an older boiler or turbine is to be operated long into the future, more aggressive condition assessment programs should be instituted as part of the annual maintenance of the plant.

The study evaluation is performed on a equipment component level in order to screen out the more severe problem areas. This will help the owner(s) concentrate on solving the big issues first while gradually addressing the less severe components further out in the time line of the plan.

In performing the study, projects were configured to have the maximum impact on three key areas:

- reliability and maintenance
- ease of operation through the load range
- control of combustion emissions to meet current/future limits.

The design of each configuration considers that the units will be operated for the next 15 years (financial forecast period) at an average availability of 85%. This equates to approximately 110,000 hours of additional operating hours. Therefore, all projects used a window of 110,000 hours as the minimum time line.



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When rehabilitation projects are going to be implemented, some components may be replaced or upgraded prior to their individual assessment time frame. This could done for a number of reasons: convenience of construction schedule, ease of operation or maintenance, economic considerations such as lower net present value (over time), mobilization of proper resources or incompatible component interfacing on an overall unit basis. Therefore, the results of this section should be treated as a guidelines for future actions. The development of a final rehabilitation plan(s) will require more detailed input data and Level 2 and Level 3 analysis.

The section results are presented in series of Tables according to descriptions presented in Subsection 2.2. Therefore each boiler and turbine at analyzed site is presented with: (1) component "Priority Group Charts"; (2) unit "Upgrade Ability Group Charts"; and (3) "Preliminary Disposition Charts" . The "Preliminary Disposition Charts" represent synthesized preliminary rehabilitation program for analyzed equipment. A table summarizing B&W's final recommendations considering preliminary disposition, emissions issues, and other input from Bulgarian plant representatives and the Committee of Energy is presented in Exhibit 2-1A.

### 2.5.1 BOILER PROJECTS

This section of the study contains descriptions of the proposed rehabilitation projects for the steam and hot water generating boilers. Included in the description is the expected efficiency gain, cost and its priority on the timeline.

#### 2.5.1.1 Sofia Plant Thermal Boilers

Exhibits 2-52 to 2-60 provide synthesized preliminary rehabilitation program for Sofia Plant thermal boilers. Supporting information "Upgradeability Group Charts" and "Component Priority Schedules" (as defined in Subsection 2.2) are provided in Exhibits 2-33 to 2-42 and Exhibits 2-43 to 2-51, respectively.

As stated in the summary for this plant, all nine of the boilers could be used in the future, provided it is economically justified to perform upgrades and replacements of key components to meet requirements for desired life.

In the case of boilers 1, 2, and 3, the oldest units at the plant, the primary requirements for replacement is to address long term reliability and availability of the boilers. The most critical component identified was the instrumentation and controls. Replacement has been recommended, primarily, to address problems with automatic control of the unit for more efficient and safe operation. Items such as the furnace, superheater, main steam piping, and fans are identified as requiring replacement now or some time during the remaining life of these components. In these instances the remaining life may be less than the desired life, so it is assumed that replacement will be required. It must be noted that because of the age and vintage of these boilers, they are likely to be less efficient than the newer vintage boilers.

For boilers 4, 5, and 6, one option is to upgrade the key components to meet the requirements of the desired life versus the calculated remaining life. Certain components have been identified as needing replacement in the immediate future. These include the superheater, main steam piping, and the instrumentation and



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result of data provided by the COE, which indicates that these systems have had reliability problems in the past. In addition, the remaining life is projected to be less than the desired life on these components. Both the combustion controls and the burner management systems are considered obsolete and unreliable. Consequently, replacement of these systems is required. An important consideration is upgrade of the burners; it is felt that the current burners will probably not be able to meet new standards for emissions of nitrogen oxides (NOx). As a consequence, upgrading to low NOx burner designs is likely as a near term upgrade to these units. Other components would have to be considered for upgrades or replacements sometime in the future. Systems included in this category are the waterwall tubes, the addition of sootblowers, and the retubing of the air heaters. Waterwall and air heater upgrades are required to minimize the infiltration of air which degrades the units overall performance and efficiency. Air leakage also has been identified as a source of corrosion. An adequate soot removal system will promote heat transfer throughout the boiler and increase efficiency when using mazut as a fuel.

For boilers 7 and 8, upgrades that are felt to be required in the immediate future are new burners, burner management system, and combustion controls. The replacement of the burner management system and combustion controls is to address safety and reliability of the unit since the existing controls are considered to be obsolete and unreliable. Burner upgrades are necessary to address emissions requirements for nitrogen oxides. It is assumed that it will be necessary to install later technology burners with staged combustion to minimize the production of these oxides in the combustion process. Longer term upgrades and replacements on Sofia 7 and 8 include waterwalls, the addition of sootblowers, retube of the air heater, superheater, and economizer on each of these units. Similar results, as described for units 4, 5, and 6, will be realized.

Boiler 9 is relatively new and no major replacements are deemed necessary. Future upgrade of the burners may be necessary for NOx control. Installation of later technology burners with staged combustion will minimize the production of these oxides in the combustion process.

### Hot Water Boilers

Exhibits 2-73 to 2-78 provide synthesized preliminary rehabilitation program for Sofia Plant hot water boilers. Supporting information "Upgradibility Group Charts" and "Component Priority Schedules" (as defined in Subsection 2.2) are provided in Exhibits 2-61 to 2-66 and Exhibits 2-67 to 2-72, respectively.

The upgrades required for the hot water boilers are common to all of the boilers of this design. The highest priority and requirement is for upgrading of the burners and controls. New burners are needed as well as controls and flame safety systems for all of these boilers. If mazut is to be fired in the boilers then modern sootblowing equipment is also necessary for keeping heating surfaces clean to maintain performance. In the longer term the boilers should be upgraded to a membrane type construction to eliminated furnace in-leakage and the back end corrosion problems. Lastly, Sofia TPP is in the process of installing a new water treatment plant to replace the aging facility now supporting the thermal boilers. Once complete, the old plant is to be used to treat water for the distribution system and hot water boilers. This project should proceed as part of the future operation

of the plant to maintain the cleanliness of the water boilers for better performance and less frequent heating surface replacement.

### 2.5.1.2 Trajoc Kostov Plant Thermal Boilers

Exhibits 2-93 to 2-99 provide synthesized preliminary rehabilitation program for Trajco Kostov Plant thermal boilers. Supporting information "Upgradibility Group Charts" and "Component Priority Schedules" (as defined in Subsection 2.2) are provided in Exhibits 2-79 to 2-85 and Exhibits 2-86 to 2-92, respectively.

Units 1 through 4 all have similar recommendations for the follow up program that is needed for rehabilitation and refurbishment. Although there are several projects listed for these units, the most important and near term is that for replacing the combustion controls, burner management, and feedwater controls. The other projects listed can be performed in a longer range plan. These projects include sootblowers and main steam line replacement. This would increase the efficiency and safety of these units. The overall goal of these projects is to bring these units back to highly reliable, safe and efficient operation that meets current and future emissions standards.

As part of the rehabilitation plan, the plant should consider instituting an aggressive plant on more proactive maintenance which includes a comprehensive condition assessment program. Many of the pressure part components in these units need to be inspected in more detail.

Units 5 through 7 are relatively new installation and are in good shape. The most important projects will consider replacing the combustion controls, burner management, and feedwater controls. The goal of these projects is to simply upgrade the combustion process to current standards for ease of operation while meeting the emission standards for the future.

#### Hot Water Boilers

Exhibits 2-116 to 2-123 provide synthesized preliminary rehabilitation program for Trajco Kostov Plant hot water boilers. Supporting information "Upgradibility Group Charts" and "Component Priority Schedules" (as defined in Subsection 2.2) are provided in Exhibits 2-100 to 2-107 and Exhibits 2-108 to 2-115.

The upgrades for the hot water boilers are common to all of the boilers of this design. The highest priority and requirement is for upgrading of the burners and controls. New burners are needed as well as controls and flame safety systems for all of these boilers. If mazut is to be fired in the boilers then modern sootblowing equipment is also necessary for keeping heating surfaces clean to maintain performance. In the longer term the nonmembrane boilers should be upgraded to a membrane type construction to eliminated furnace in-leakage and the back end corrosion problems. Lastly, Trajoc Kostov TPP is in the process of installing a new water treatment plant to replace the aging facility now supporting the Thermal Power Plant Boilers. Once complete the old plant is to be used to treat water for the distribution system and hot water boilers. This project should proceed as part of the future operation of the plant to maintain the cleanliness of the water boilers for better performance and less frequent heating surface replacement.

### 2.5.1.3 Republika Plant Thermal Boilers

Exhibits 2-136 to 2-141 provide synthesized preliminary rehabilitation program for Republika thermal boilers. Supporting information "Upgradibility Group Charts" and "Component Priority Schedules" (as defined in Subsection 2.2) are provided in Exhibits 2-124 to 2-129 and Exhibits 2-130 to 2-135, respectively.

Republika units 1 through 4 and reserve boiler, as well boiler 5 all have similar recommendations for the follow-up program that is needed for rehabilitation and refurbishment. Certain components have required repeated replacement on regular intervals during the life of the units. Components that have required regular replacement include the tubing of the economizer and the superheater. Due to the problems with out of service corrosion and thermal fatigue tube failures, the waterwall tubes are also suspect in all six of the boilers at this plant and would have to be considered for near term replacement. The pulverizers and their auxiliary equipment are considered to be obsolete and will need to be replaced or upgraded assuming that the existing technology is to be used into the future. The controls systems, including the combustion controls, the burner management systems, and feedwater controls, all are in need of replacement and upgrade and these would have to be included in an upgrade program for the immediate future. The high temperature headers and piping have not had sufficient evaluations to conclude whether they can be used into the future. Follow-up would require a condition assessment program be instituted and a contingency plan allow for these to be replaced if found to be at end of life. Because of the antiquated technology used in this unit for such a high ash content coal, consideration would have to be given to upgrading of the burners and fans in consideration of meeting modern NOx limits for gaseous NOx emissions. The precipitators should be replaced on all units to meet particulate emissions levels. Projected new standards for the emissions of sulfurous oxides indicate that it will be necessary to investigate backend clean up equipment to remove emissions associated with sulfur in the fuel. It is clear that for these boilers to remain in operation into the future a significant amount of capital is required for upgrading of all systems for both reliability and to meet future emissions standards. In light of these requirements and the extensive cost of system improvements for the six boilers at this plant, serious consideration would have to be given to the replacement of the existing plant with new capacity designed with modern technology more suited to this high ash content coal. Based on the current state of combustion technology, fluid bed combustion appears to be the best application for the use of this coal supply.

### 2.5.1.4 Liulin and Zemliane Plants Hot Water Boilers

Exhibits 2-152 to 2-156 and Exhibits 2-167 to 2-171 provide synthesized preliminary rehabilitation program for Liulin and Zemlaine Plant hot water boilers. Supporting information "Upgradibility Group Charts" and "Component Priority Schedules" (as defined in Subsection 2.2) are provided in Exhibits 2-142 to 2-146, Exhibits 2-147 to 2-151 and Exhibits 2-157 to 2-161, Exhibits 2-162 to 2-166, respectively.

The upgrades required for the hot water boilers are common to all of the boilers of the Russian design PTVM-100.

The highest priority and requirement is for upgrading of the burners and controls. New burners are needed as well as controls and flame safety systems for all of these boilers. If mazut is to be fired in the boilers then modern sootblowing equipment is also necessary for keeping heating surfaces clean to maintain performance. In the longer term the boilers should be upgraded to a membrane type construction to eliminate furnace in-leakage and the back end corrosion problems. Lastly, since Sofia and Trajoc Kostov TPP are in the process of installing new water treatment facilities to replace the existing facility now supporting the thermal boilers. This should clean up the hot water system to some extent, however, it is not foreseen how much it will effect these plants, if at all.

### 2.5.2 TURBINE PROJECTS

This section of the study contains descriptions of the proposed rehabilitation projects for the steam turbines. Included in the description is the expected efficiency gain, cost, and its priority on the time line.

#### 2.5.2.1 Sofia Plant

Sofia Plant has four operating turbines (4, 5, 6, and 8) and four retired turbines (1, 2, 3, and 7). Turbines 4 and 5 have been derated from 25 MW to 18 MW, but are forecast to be used into the future even though they are nearing the end of their useful life. Turbines 6 and 8 are still running at full output and are expected to be used in the future.

The overall plan for these turbines involves replacements, component upgrades, and general maintenance overhauls. It must be determined if the lost production of turbines 1, 2, and 3 should be replaced. Even though the boilers are old, they remain in sound, operable condition. Due to the age on turbines 1, 2, and 3, it is recommended that a complete replacement of the turbine generator sets be made if the power is needed. The same is true for turbines 4 and 5 due to the reported condition and hours of remaining useful life. Turbine 6 should under go a high pressure cylinder replacement. The turbine auxiliary equipment, such as the condenser, should also be included in any detailed inspection to determine if the integrity is sufficient for long term operation. Turbine 8 is in relatively good condition and should be scheduled for a general maintenance overhaul.

It was assumed from the plant data that standard turbine maintenance has been occurring on a five year major overhaul schedule. Information concerning the turbine was lacking in comparison to the boiler information received. During a standard maintenance overhaul, the following would be performed:

- Visual inspection with NDE testing
- Seal replacement
- Bearing and lube oil checks
- Deposit cleaning of the blades and other surfaces
- Rotor/bore inspection

General maintenance is required to return the turbines to efficient operation. Losses can occur due to solid particle erosion, deposits, increased clearances, and damage from foreign material.

Solid particle erosion, by exfoliating oxide, is typically most severe at the high temperature steam inlet points. Performance loss is due to the increased roughness of the steam path surfaces and damage to the nozzle and blade profiles. Losses typically vary linearly with the degree of erosion. Performance loss can range up to 2%.

Deposits build up on the steam path surfaces due to boiler carryover problems. This has a direct effect on the turbine efficiency, capacity, and reliability. Deposits cause a very noticeable loss in maximum capacity. Losses typically vary linearly with the reduction in nozzle area within a particular stage. Losses also depend on how much the aerodynamic shape of the blades has changed. Performance losses can range up to 20% if left unattended.

Increased clearances occur when rotating components contact stationary components. This condition increases steam leakage at these points. Typically, leakages occur at the diaphragm and shaft packings and the radial tip spill strips. Distortions in the diaphragm, inner shell, and inner casing are other areas where miscellaneous leakages can occur.

Foreign material, such as nuts, bolts, loose debris, and weld splatter may also cause damage that hinders performance. Performance loss occurs due to increased roughness and aerodynamic shape changes on the nozzles and blades. Performance losses can range up to 10%.

Restoring the overall performance of the turbine can be achieved by implementing a sound and consistently applied maintenance program that addresses the issues mentioned. In addition to this, updated supervisory controls should be seriously considered. Efficient use of computers can realistically increase the reliability and availability of the turbine generator. Such systems are in wide use and provide both monitoring and automated control functions. These systems allow for better operating flexibility with load cycling, two-shift operation, fast recovery on load rejection, and network stability.

#### 2.5.2.2 Trajoc Kostov Plant

Trajoc Kostov has five operating turbines presently (1 through 5). These turbines have had major replacements performed within the last two years and are generally in good condition. No major replacements are expected to be necessary throughout the next 15 years (financial consideration period). Maintenance overhauls should continue to be performed as scheduled except that a more proactive approach should be taken. Efficiency increases are expected whenever these overhauls are completed. It is also recommended that turbines 1 through 4 undergo a more detailed Level 2 inspection and capacity test to benchmark the performance profile. This will help determine future performance degradation and set future overhaul dates. The turbine auxiliary equipment, such as the condenser, should also be included in any detailed inspection to determine if the integrity is sufficient for long term operation.

It was assumed from the plant data that standard turbine maintenance has been occurring on a five year major overhaul schedule. Information concerning the turbine was lacking in comparison to the boiler information received. During a standard maintenance overhaul, the following would be performed:

- Visual inspection with NDE testing
- Seal replacement
- Bearing and lube oil checks
- Deposit cleaning from the blades
- Rotor/bore inspection

General maintenance is required to return the turbine to efficient operation. Losses can occur due to solid particle erosion, deposits, increased clearances, and damage from foreign material.

Solid particle erosion, by exfoliating oxide, is typically most severe at the high temperature steam inlet points. Performance loss is due to the increased roughness of the steam path surfaces and damage to the nozzle and blade profiles. Losses typically vary linearly with the degree of erosion. Performance loss can range up to 2%.

Deposits build up on the steam path surfaces due to boiler carryover problems. This has a direct effect on the turbine efficiency, capacity, and reliability. Deposits cause a very noticeable loss in maximum capacity. Losses typically vary linearly with the reduction in nozzle area within a particular stage. Losses also depend on how much the aerodynamic shape of the blades has changed. Performance losses can range up to 20% if left unattended.

Increased clearances occur when rotating components contact stationary components. This condition increases steam leakage at these points. Typically, leakages occur at the diaphragm and shaft packings and the radial tip spill strips. Distortions in the diaphragm, inner shell, and inner casing are other areas where miscellaneous leakages can occur.

Foreign material, such as nuts, bolts, loose debris, and weld splatter may also cause damage that hinders performance. Performance loss occurs due to increased roughness and aerodynamic shape changes on the nozzles and blades. Performance losses can range up to 10%. Restoring the overall performance of the turbine can be achieved by implementing a sound and consistently applied maintenance program that addresses the issues mentioned. In addition to this, updated supervisory controls should be considered. Efficient use of computers can realistically increase the reliability and availability of the turbine generator. Such systems are in wide use and provide both monitoring and automated control functions. These systems allow for better operating flexibility with load cycling, two-shift operation, fast recovery on load rejection, and network stability.

### 2.5.2.3 Republika Plant

The Republika plant has five operating turbines (1, 2, 4, 5, and 6) and one retired turbine (3). All five operating turbines are operating at rated capacity.

The overall plan for these turbines involves replacements and general maintenance overhauls. Further testing should be performed on turbines 1, 2, and 4, due to the number of operating hours and cycles, if they are to be used for an extended period. A Phase 2 detailed inspection and capacity test will help benchmark the actual condition and performance profile. The turbine auxiliary equipment, such as the condenser, should also be included in any detailed inspection to determine if the integrity is sufficient for long term operation. Considering the number of years and cycles, it is recommended that the turbines and generators be replaced. Turbines 5 and 6 are relatively new and will only require maintenance overhauls for continued operation. It should be noted that turbine 6 is a replacement for turbine 3, which was retired after a major failure.

The recommendations made assume that the plant will remain in operation in its current state. Should the plant be demolished in favor of a new Circulating Fluid Bed (CFB) boiler or alternative power source, the turbines should be kept for spares to be used at Sofia or Trajoc Kostov plants.

It was assumed from the plant data that standard turbine maintenance has been occurring on a five year major overhaul schedule. Information concerning the turbine was lacking in comparison to the boiler information received. During a standard maintenance overhaul, the following would be performed:

- Visual inspection with NDE testing
- Seal replacement
- Bearing and lube oil checks
- Deposit cleaning from the blades
- Rotor/bore inspection

General maintenance is required to return the turbine to efficient operation. Losses can occur due to solid particle erosion, deposits, increased clearances, and damage from foreign material.

Solid particle erosion, by exfoliating oxide, is typically most severe at the high temperature steam inlet points. Performance loss is due to the increased roughness of the steam path surfaces and damage to the nozzle and blade profiles. Losses typically vary linearly with the degree of erosion. Performance loss can range up to 2%.

Deposits build up on the steam path surfaces due to boiler carryover problems. This has a direct effect on the turbine efficiency, capacity, and reliability. Deposits cause a very noticeable loss in maximum capacity. Losses typically vary linearly with the reduction in nozzle area within a particular stage. Losses also depend on how much the aerodynamic shape of the blades has changed. Performance losses can range up to 20% if left unattended.



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Increased clearances occur when rotating components contact stationary components. This condition increases steam leakage at these points. Typically, leakages occur at the diaphragm and shaft packings and the radial tip spill strips. Distortions in the diaphragm, inner shell, and inner casing are other areas where miscellaneous leakages can occur.

Foreign material, such as nuts, bolts, loose debris, and weld splatter may also cause damage that hinders performance. Performance loss occurs due to increased roughness and aerodynamic shape changes on the nozzles and blades. Performance losses can range up to 10%.

Restoring the overall performance of the turbine can be achieved by implementing a sound and consistently applied maintenance program that addresses the issues mentioned. In addition to this, updated supervisory controls should be seriously considered. Efficient use of computers can realistically increase the reliability and availability of the turbine generator. Such systems are in wide use and provide both monitoring and automated control functions. These systems allow for better operating flexibility with load cycling, two-shift operation, fast recovery on load rejection, and network stability.



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# Exhibit 2-1A

## Summary of Recommendations for

## Major Equipment Rehabilitation and Upgrade

THERMAL BOILERS

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN (%) | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| SOFIA 1,2,3 | TH | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMB. CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | FD FAN OPTION | 0 | REPLACE 5 YEARS | ENHANCEMENT |
| | | DUCT WORK FOR BURNERS | 0 | REPLACE NOW | NECESSITY |
| | | SOOTBLOWERS | 0-0.10 | REPLACE 5 YEARS | ENHANCEMENT |
| SOFIA 4,5,6 | TH | WATERWALLS | 0.1-0.25 | REPLACE 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMB. CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SUPERHEATER | 0 | REPLACE NOW | NECESSITY |
| | | SOOTBLOWERS | 0-0.10 | REPLACE 5-10 YEARS | ENHANCEMENT |
| | | MAINSTEAM LINE | 0 | REPLACE NOW | NECESSITY |
| | | AIRHEATER RETUBE | 0 | REPLACE 5-10 YEARS | ENHANCEMENT |
| SOFIA 7,8 | TH | WATERWALLS | 0.1-0.25 | REPLACE 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMB. CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SOOTBLOWERS | 0-0.10 | REPLACE 5-10 YEARS | ENHANCEMENT |
| | | AIRHEATER RETUBE | 0 | REPLACE 5-10 YEARS | ENHANCEMENT |
| SOFIA 9 | TH | BURNERS | 0-0.25 | REPLACE 10 YEARS | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $3960.0 CONTROLS + $525.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

BURNERS LISTED ARE OIL/GAS COMBINATION LOW NOX DESIGN.

THERMAL BOILERS

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| REPUBLIKA 1-4 | TH | ECONOMIZER | 0 | REPLACE NOW | NECESSITY |
| | | SUPERHEATER | 0 | REPLACE NOW | NECESSITY |
| | | WATERWALLS | 0.1-0.25 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | PULVERIZERS & FANS | 0 | REPLACE NOW | NECESSITY |
| | | CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SH HEADER OPTION | 0 | REPLACE NOW | NECESSITY |
| | | PRECIPITATORS | 0 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS & FANS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BACK END CLEANUP OPTIONS | | | |
| | | SNRB | 1.0-2.0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | DRY SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | WET SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | ESP SOX | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | SCR | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| REPUBLIKA 5 | TH | ECONOMIZER | 0 | REPLACE NOW | NECESSITY |
| | | SUPERHEATER | 0 | REPLACE NOW | NECESSITY |
| | | WATERWALLS | 0.1-0.25 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | PULVERIZERS & FANS | 0 | REPLACE NOW | NECESSITY |
| | | CONTROLS | 0 | REPLACE NOW | NECESSITY |
| | | SH HEADER OPTION | 0 | REPLACE NOW | NECESSITY |
| | | PRECIPITATORS | 0 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS & FANS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BACK END CLEANUP OPTIONS | | | |
| | | SNRB | 1.0-2.0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | DRY SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | WET SCRUB | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | ESP SOX | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |
| | | SCR | 0 | ONE OF THESE OPTIONS NOW | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $7722.0 CONTROLS + $815.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (WITHIN THE NEXT 5 YEARS).

BURNERS LISTED ARE COAL LOW NOX DESIGN.



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# Exhibit 2-1A (Cont'd)

## Summary of Recommendations for

## Major Equipment Rehabilitation and Upgrade

HOT WATER BOILERS

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| SOFIA 1-6 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| ZEMLIANE 1-5 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| LULIN 1-4 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE IN 5-10 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| LULIN 5 | HW | SOOTBLOWERS | 0-0.10 | REPLACE IN 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 10 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 10 YEARS | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $3444.6 CONTROLS + $390.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

** FOR ALL UNITS AT PLANT THE COST IS $2868.0 CONTROLS + $325.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

*** FOR ALL UNITS AT PLANT THE COST IS $2868.0 CONTROLS + $325.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

BURNERS LISTED ARE OIL/GAS COMBINATION LOW NOX DESIGN.

THERMAL AND HOT WATER BOILERS

| STATION, UNIT | TYPE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| TRAJOC 1-4 | TH | BURNERS | 0-0.25 | REPLACE WITHIN 10 YEARS | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | COMBUSTION CONTROL | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | FD FAN | 0 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| | | DUCTS | 0 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| | | SOOTBLOWERS | 0-0.10 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| | | MAINSTEAM LINE | 0 | REPLACE WITHIN 10 YEARS | ENHANCEMENT |
| TRAJOC 5-7 | TH | BURNERS | 0-0.25 | REPLACE NOW | NECESSITY |
| | | BURNER MGM'T | 0 | REPLACE NOW | NECESSITY |
| | | COMBUSTION CONTROL | 0 | REPLACE NOW | NECESSITY |
| TRAJOC 1-8 | HW | SOOTBLOWERS | 0-0.10 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | WATERWALLS | 0.1-0.25 | REPLACE WITHIN 5 YEARS | ENHANCEMENT |
| | | BURNERS | 0-0.20 | REPLACE WITHIN 5 YEARS | NECESSITY |
| | | BURNER CONTROLS | 0 | REPLACE WITHIN 5 YEARS | NECESSITY |

* FOR ALL UNITS AT PLANT THE COST IS $8604.0 CONTROLS + $975.0 INSTALLATION AND START UP. SINCE THIS IS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (WITHIN THE NEXT 5 YEARS).

BURNERS LISTED ARE OIL/GAS COMBINATION LOW NOX DESIGN.

# Exhibit 2-1A (Cont'd)

## Summary of Recommendations for

## Major Equipment Rehabilitation and Upgrade

STEAM TURBINES

| STATION, UNIT | SIZE | PROJECT NAME | EFF. GAIN | ACTION | NECESSITY ? |
|---|---|---|---|---|---|
| SOFIA 1,2,3 | 12.5 MW | REPLACEMENT | 3.32 | REPLACE NOW IF MW REQUIRED | |
| SOFIA 4,5 | 25 MW | REPLACEMENT | 3.32 | REPLACE NOW IF MW REQUIRED | |
| SOFIA 6 | 50 MW | HP CYLINDER REPLACEMENT | 3.0 | UPGRADE IN 2 YEARS | |
| SOFIA 7 | UNK. | NEVER USED | 0.0 | NONE | |
| SOFIA 8 | 25 MW | GENERAL MAIN'T OVERHAUL | 1.18 | REQUIRED IN 2 YEARS | |
| TRAJOC 1,2 | 30 MW | GENERAL MAIN'T OVERHAUL | 1.26 | REQUIRED IN 3 YEARS | |
| TRAJOC 3 | 30 MW | GENERAL MAIN'T OVERHAUL | 1.26 | REQUIRED NOW | |
| TRAJOC 4 | 30 MW | GENERAL MAIN'T OVERHAUL | 1.26 | REQUIRED IN 3 YEARS | |
| TRAJOC 5 | 60 MW | GENERAL MAIN'T OVERHAUL | 1.18 | REQUIRED IN 5 YEARS | |
| REPUB 1,2,3 | 25 MW | REPLACEMENT | 3.32 | REPLACE NOW IF MW REQUIRED | |
| REPUB 4 | 25 MW | REPLACEMENT | 3.17 | REPLACE NOW IF MW REQUIRED | |
| REPUB 5 | 55 MW | GENERAL MAIN'T OVERHAUL | 1.32 | REQUIRED IN 5 YEARS | |
| REPUB 6 | 25 MW | GENERAL MAIN'T OVERHAUL | 1.02 | REQUIRED IN 5 YEARS | |

* ALL COSTS ARE IN 000'S OF U.S. DOLLARS
APPROXIMATE COST TO REPLACE 50 MW T/G SET IS $6.5M - $7.0M DOLLARS



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# PHYSICAL DATA EXHIBITS

**Comments on Physical Data Exhibit**

Nominal Output represents total heat leaving boiler in steam or water based upon flow, temperatures, and pressures. This is not a calculation of boiler capacity accounting for boiler efficiency and feedwater inlet temperature.

# Exhibit 2-1

## Boiler Summary - Physical - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | | | | PLANT TYPE: THERMAL POWER PLANT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr # | Origin/ Manf. | Start-up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effcncy | Nominal Output | Heat Traps |
| 1 | B&W | 1949 | 1 - Drum Nat. Circ. | Non-membrane tube & brick | 4 | 1-FD 1-ID | 65T/H (143.3 mlb/hr) MCR 75T/H (165.3 mlb/hr) peak | 2.5 M Pa (362 psi) | 410°C 770°F | 93.0 | 50 GCal/hr (200 mkb/hr) | Economizer Tubular AH |
| 2 | B&W | 1949 | 1 - Drum Nat. Circ. | Non-membrane tube & brick | 4 | 1-FD 1-ID | 65T/H (143.3 mlb/hr) MCR 75T/H (165.3 mlb/hr) peak | 2.5 M Pa (362 psi) | 410°C 770°F | 93.7 | 50 GCal/hr (200 mkb/hr) | Economizer Tubular AH |
| 3 | B&W | 1949 | 1 - Drum Nat. Circ. | Non-membrane tube & brick | 4 | 1-FD 1-ID | 65T/H (143.3 mlb/hr) MCR 75T/H (165.3 mlb/hr) peak | 2.5 M Pa (362 psi) | 410°C 770°F | 94.2 | 50 GCal/hr (200 mkb/hr) | Economizer Tubular AH |

General: Boilers 1, 2, 3

1. Boilers original coal fired converted to oil (mazut) and natural gas
2. Boilers have pneumatic controls and burner management
3. Burner management operable
4. Pneumatic combustion controls unreliable
5. FD Fan Data: Capacity 93,000 cmh, 300 mm $H_2O$, Motor 190 HP (500V), 30C
6. ID Fan Data: Capacity 190,000 cmh, 100 mm $H_2O$, 200C
7. Tubing (OD x Wall): Water wall 82.5 mm x 6 mm, Sat. Bank 100 mm x 6 mm, SH 51 mm x 5 mm, Economizer 48 mm x 4 mm, Airheater 40 mm x 1.5 mm
   Materials: Wall, Economizer, Saturated Bank - Carbon Steel, SH 1.2 Cr - 1 Mo Alloy
8. Cleaning Devices: Saturated Bank and Superheater - None, Economizer and Airheater - Shot Cleaning System



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## Exhibit 2-1 (Cont'd)

| PLANT NAME: SOFIA | | | | | | PLANT TYPE: THERMAL POWER PLANT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr No | Origin/ Manf. | Start-up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effcncy (note 9) | Nominal Output | Heat Traps |
| 4 | Russian (USSR) Taganrogski Kotlostroitelen Zaved | 1956 | 2 Drum Nat Circ | Non-membrane tube & brick | 4 (two each side) | 2-FD 2-ID | Original: Coal - 170 T/hr (374.8 mlb/hr) | 10 M Pa (1450 psi) | 510°C 950°F | 93.5 | 138 Gcal/hr (548 mkb/hr) | Economizer Tubular AH |
| 5 | | 1956 | 2 Drum Nat Circ | Non-membrane tube & brick | 4 (two each side) | 2-FD 2-ID | Original: Coal - 170 T/hr (374.8 mlb/hr) | 10 M Pa (1450 psi) | 510°C 950°F | 94.6 | 138 Gcal/hr (548 mkb/hr) | Economizer Tubular AH |
| 6 | | 1956 | 2 Drum Nat Circ | Non-membrane tube & brick | 4 (two each side) | 2-FD 2-ID | Original: Coal - 170 T/hr (374.8 mlb/hr) | 10 M Pa (1450 psi) | 510°C 950°F | 94.3 | 138 Gcal/hr (548 mkb/hr) | Economizer Tubular AH |

General: Boiler 4, 5, 6

1. Original capacity 170 T/hr on brown coal; converted to oil and gas with capacity 170 T/H Oil (Mazut), 200 T/H Natural Gas, 220 T/H Peak (NG)
2. Gas recirculation added to help steam temperature and FEGT at low loads on Mazut (rarely used)
3. FD Fan Data: Capacity 78,800 cmh, 485 mm $H_2O$, 30°C
4. ID Fan Data: Capacity 132,000 cmh, 130 mm $H_2O$, 200°C
5. Pneumatic combustion controls unreliable
6. Tubing (OD x wall) Waterwalls 76 mm x 5 mm, Superheater 32 mm x 4 mm, Economizer 38 mm x 4 mm
   Materials - low temperature - carbon steel, superheater - 1.2 Cr Alloy
7. Radiant superheater added to #4 only during 1972 modifications
8. Boilers have shot cleaning sysem for tube cleaning - ash cleaning ineffective
9. 1987 report for units give efficiencies of 88-92% natural gas and 85-90% oil for Unit #4, Unit #5, and Unit #6. Unit #4 interview info. maximum efficiency 91.5% on natural gas, lower on oil



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## Exhibit 2-1 (Cont'd)

| PLANT NAME: SOFIA | | | | | | PLANT TYPE: THERMAL POWER PLANT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr # | Origin/ Manf. | Start-up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effcncy (note 9) | Nominal Output | Heat Traps |
| 7 | Russian (USSR) Taganrogski Kotlostroitelen Zaved | 1963 | 1 Drum Nat Circ | Non-membrane Tangent Tube | 8 | 2-FD 2-ID | 220 T/H (485.0 mlb/hr) | 10 M Pa (1450 psi) | 540°C 1004°F | 95.1 | 183 Gcal/hr (725 mkb/hr) | Economizer Tubular Airheater |
| 8 | | 1964 | 1 Drum Nat Circ | Non-membrane Tangent Tube | 8 | 2-FD 2-ID | 220 T/H (485.0 mlb/hr) | 10 M Pa (1450 psi) | 540°C 1004°F | 93.5 | 183 Gcal/hr (725 mkb/hr) | Economizer Tubular Airheater |

General: Boiler 7, 8

1. Boiler originally oil fired - not designed for coal.
2. Original Ljungstrom Regenerative airheater's replaced with tubular airheaters in 1974.
3. FD Fan Data: Capacity 126,100 cmh, 308 mm $H_2O$, 30°C
4. ID Fan Data: Capacity 198,800 cmh, 207 mm $H_2O$, 200°C
5. Retrofitted burners similar to B&W on Unit 1, 2, and 3 only larger. Originally three rows of four burners, 1976 conversion changed to two rows of four burners.
6. Pneumatic combustion controls - not reliable.
7. Tubing (OD x wall) water walls 65 mm x 5 mm, superheater 32 mm x 4 mm.
8. Boiler 7 and 8 tied to common outlet supplying turbines.
9. Per 1987 report efficiency 87-93% gas firing, 86-91% oil firing.

| Blr # | Origin/ Manf. | Start-up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effcncy | Nominal Output | Heat Traps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | Czech Republic | 1985 | 1 - Drum Nat. Circ. | Membrane | 9 | 2-FD 2-ID | 220 T/H (485 mlb/hr) | 10 M Pa (1450 psi) | 540°C 1004°F | 95.2 | 183 GCal/hr (725 mkb/hr) | Economizer Ljungstrom AH |

General: Boiler 9

1. Designed for oil/gas firing
2. Tubing (OD x wall) water wall 65 mm x 5 mm, superheater 32 mm x 4 mm, economizer 38 mm x 4 mm



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# Exhibit 2-2

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | Unit 1 ~ 238,000 | Unit 2 ~ 235,000 | Unit 3 ~ 237,000 |
| 1, 2, 3 | Babcock & Wilcox via Babcock Ltd. U.K. | ~1949 | On/Off Cycles | 531 | 597 | 564 |
| | | | Operating Hours 1987 - 1992 | Unit 1 ~ zero hours | Unit 2 ~ 3491 | Unit 3 ~ 7272 |

1. Originally
   - Designed for coal with heat value range of 3600 KCal/kg (6480 BTU/lb) - 6000 Kcal/Kg (10800 BTU/lb)
   - Start-up on burners using steam atomized oil
   - Ash removed as dry bottom ash
   - Early operation - moderate slagging around burners and some convection pass surfaces
   - Originally boiler 1, 2, 3 to common steam line - drive two Brown-Baveri turbines
   - No ash cleaning equipment (sootblowers)
   - Unit originally had precipitator for coal firing operation. Very problematic in operation during years of coal operation.
2. 1970
   - Burner conversion - mechanical atomized Czechoslovak burners
   - Light off manual using torch
   - Airheater rebuilt (Retube ?)
   - Acid cleaned boiler
3. 1974
   - Added superheater surface
   - Desuperheater (attemperator drum type) added to help control steam temperature - note this became the second attemperator in the system
4. 1976
   - Burner conversion (oil and natural gas) - Babcock Ltd. steam atomized oil/natural gas burners - greatly improved performance
   - Superheater modified, gas recirculation introduced
   - Airheater replaced and modified - tubing changed to horizontal arrangement with air flow through tubes
5. 1977
   - Turbine 2 failure from uncontrolled over speed
   - Turbine 1 taken out of service and retired - training purposes only
6. Boilers have had minimal tube problems
7. Boilers normally stored flooded (including superheater) when in standby
8. Erosion in economizer occurred originally (coal firing) - tube shielding added
9. Fans require high maintenance



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# Exhibit 2-3

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | Unit 4 ~ 224,000 | | |
| 4 | Russian (TKZ) | 1956 | On/Off Cycles | 613 | | |
| | | | Operating Hours 1987 - 1992 | 32,018 | | |

1. Original
   - Designed for brown coal firing 3600 KCal/kg (6480 BTU/lb)
   - Dry bottom ash removal
   - Originally had precipitator for back end gas clean up
   - Gas recirculation originally in design to control furnace absorption when firing mazut (oil)
2. 1963
   - Low water incident due to loss of feedwater flow. Wall tube failures.
3. 1964
   - Main steam line flange leak at flow meter. Incorrect material found. Flange replaced.
4. 1971-1972
   - Converted to mechanically atomized oil firing
5. 1975
   - Burners converted to steam atomized oil or natural gas firing
6. 1972
   - Superheater replaced. *Reason:* (1) erosion during years of coal firing, (2) design upgraded for oil and gas firing
   - Superheater material ST 20 and 12 XMF
   - Additional radiant superheater sections added in furnace (#4 only)
   - Two stage attemperation used - sweet water condenser - used for spray water source with feedwater backup
   - Feedwater system reconstructed
   - Main steam line replaced (stop valve to second bend). Related to steam output increase
   - Drum internals replaced (steam quality considerations)
7. 1975
   - Convection pass modified - additional economizer surface installed
8. 1976
   - Rolled tubes on steam drum seal welded
9. 1985
   - Upper bank of economizer replaced

## Exhibit 2-3 (Cont'd)

| PLANT NAME: SOFIA | PLANT TYPE: THERMAL POWER PLANT |
|---|---|
| Boiler #4 (cont.): | |
| 10. 1982<br>- Failure of safety valve lead to over pressuring of boiler 20% and resulted in screen tube leak. | |
| 11. 1987<br>- Plant designed heat trap added in which flue gas passes through direct contact water heater (natural gas firing only). Preheat of district water and cleaning of flue gas (?) | |
| 12. 1983-1987<br>- Forced outages (14) - 3 economizer leaks, 3 attemperator (steam cooler) problems, 2 supply tube leaks at drums, 3 I&C related, 1 settings failure, 1 ID fan problem, 1 burner problem | |
| 13. Condition Assessment (Bulgarians)<br>- 1985 MT, UT of drums - no defects; weld on main steam lines examined - no defects.<br>- Main steam line creep swell measure unreliable - no confidence in results<br>- FD, ID fans in good condition (visual inspections)<br>- Main steam line NDE through 1987 - no defects found<br>- Furnace tubes (cage screen) deformed, high failure rate<br>- Enclosures (settings) not gas tight<br>- Main steam line replacement project identified - 1987 report advised replacement within 5 years | |
| 14. Additional conclusions of study<br>- Back end corrosion a problem with air heater requiring frequent replacement of section - cause sulfur in oil and in leakage at ambient air<br>- Environmental concerns - NOx and SOx<br>- Burners and controls have poor load following capability<br>- Commission recommended boiler replacement (1987 study) | |
| 15. Capacity/load<br>- Typical for summer 110-130 T/H<br>- Typical for winter 150-200 T/H<br>- Occasional peak load operation > 200 T/H<br>- Per interviews load limited to 210 T/H by fan capacity | |



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# Exhibit 2-4

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~ 217,000 | | |
| 5 | Russian (TKZ) | 1957 | On/Off Cycles | 679 | | |
| | | | Operating Hours 1987 - 1992 | 23,705 | | |

1. Original
   - Designed for brown coal firing 3600 KCal/kg (6480 BTU/lb)
   - Dry bottom ash removal
   - Originally had precipitator for back end gas clean up
   - Gas recirculation originally in design to control furnace absorption when firing mazut (oil)
2. 1963
   - Low water incident due to loss of feedwater flow. Wall tube failures.
3. 1964
   - Main steam line flange leak at flow meter. Incorrect material found. Flange replaced.
4. 1971-1972
   - Converted to mechanically atomized oil firing
5. 1975
   - Burners converted to steam atomized oil or natural gas firing
6. 1972
   - Superheater replaced. *Reason:* (1) erosion during years of coal firing, (2) design upgraded for oil and gas firing
   - Superheater material ST 20 and 12 XMF
   - Additional radiant superheater sections added in furnace (#4 only)
   - Two stage attemperation used - sweet water condenser - used for spray water source with feedwater backup
   - Feedwater system reconstructed
   - Main steam line replaced (stop valve to second bend). Related to steam output increase
   - Drum internals replaced (steam quality considerations)
7. 1975
   - Convection pass modified - additional economizer surface installed
8. 1983-1987
   - Forced outages (26) - 3 burner equipment problems, 9 I&C related, 5 electrical problems, 1 ID fan problem, 2 due to economizer leaks, 1 result of flow orifice problem, 1 problem with drum connection, 4 related to flame safety system



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## Exhibit 2-4 (Cont'd)

| PLANT NAME: SOFIA | PLANT TYPE: THERMAL POWER PLANT |
|---|---|
| Boiler #5 (cont.): | |
| 9. Condition Assessment (Bulgarians)<br>- 1985 MT, UT drums; creep tests main steam line - no damage/defects<br>- Auxiliaries in good condition<br>- In leakage of air considered problem to performance of boiler (efficiency) and ID fan<br>- Creep measurements unreliable for main steam lines<br>- 1987 metallurgical testing of sample from main steam lines<br>- FD and ID fans in good condition (visual inspection)<br>- Burners old - cannot be staged for NOx control<br>- Excess air and heat loss high<br>- Furnace tubes distorted - have had excessive failure rate | |
| 10. Conclusions on main steam assessment 1987 report stated as unnecessary due to planned replacements in near term, 5-6 years. Also interview note indicates management at plant considers boiler main steam line at end of life. | |
| 11. Data/Summary Conclusions (Bulgarian)<br>- Construction out-of-date (not tight - non-membrane)<br>- Poor load response<br>- Leakage causes excessive back end corrosion (airheater)<br>- Drums have remaining life | |
| 12. Capacity/load<br>- Typical for summer 110-130 T/H<br>- Typical for winter 150-200 T/H<br>- Occasional peak load operation > 200 T/H | |
| 13. Report 1987<br>- Indicates frequent replacement of airheater sections due to corrosion.<br>- Steam drum has 1/3 life expended, 2/3 life remaining | |



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## Exhibit 2-5

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~ 207,000 | | |
| 6 | Russian (TKZ) | 1957 | On/Off Cycles | 592 | | |
| | | | Operating Hours 1987 - 1992 | 16,351 | | |

1. Original
   - Designed for brown coal firing 3600 KCal/kg (6480 BTU/lb)
   - Dry bottom ash removal
   - Originally had precipitator for back end gas clean up
   - Gas recirculation originally in design to control furnace absorption when firing mazut (oil)
2. 1963
   - Low water incident due to loss of feedwater flow. Wall tube failures.
3. 1964
   - Main steam line flange leak at flow meter. Incorrect material found. Flange replaced.
4. 1971-1972
   - Converted to mechanically atomized oil firing
5. 1975
   - Burners converted to steam atomized oil or natural gas firing
6. 1983
   - Main steam line - third bend replaced due to cracking
   - Interview note: ID fan experienced shaft break - poor foundations lead to break from dynamic loads
7. 1983-1987
   - Forced outages (32) - 12 due to I&C problems, 15 in electrical system, 1 from drum safety valve problem, 4 resulting from economizer leaks
8. 1985
   - Upper bank of economizer replaced
9. Condition Assessment (Bulgarians)
   - 1985 cracks in larger drum - concluded to be a lap - manufacturing defect - no repair required
   - Auxiliaries in good condition
   - Creep swell measurements unreliable for main steam lines
   - Furnace water wall tubes distorted and have excessive failure rate
   - Enclosures/settings not tight - detrimentally affects performance and back end corrosion
   - Burners old and cannot be staged for NOx control
   - FD and ID fans in good condition



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## Exhibit 2-5 (Cont'd)

| PLANT NAME: SOFIA | PLANT TYPE: THERMAL POWER PLANT |
|---|---|
| Boiler #6 (cont.): | |
| 10. Main steam expected to be replaced. 1987 report indicates replacement in near term 5-6 years. Interview note confirms line considered to be at end of life as result of earlier assessments. | |
| 11. Data/Summary Conclusions (Bulgarian)<br>- Construction out-of-date (not tight - non-membrane)<br>- Poor load response<br>- Leakage causes excessive back end corrosion (airheater)<br>- Drums have remaining life | |
| 12. Capacity/load<br>- Typical for summer 110-130 T/H<br>- Typical for winter 150-200 T/H<br>- Occasional peak load operation > 200 T/H | |
| 13. Report 1987<br>- Indicates frequent replacement of airheater sections due to corrosion | |



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## Exhibit 2-6

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~ 171,000 | | |
| 7 | Russian (TKZ) | 1963 | On/Off Cycles | 994 | | |
| | | | Operating Hours 1987 - 1992 | 23,969 | | |

1. Original
   - Oil firing only
   - Regenerative (Ljungstrom airheater)

2. 1971
   - Header superheater outlet replaced due to cracks and creep

3. 1974
   - Regenerative airheaters replaced by tubular type (*Reason: Poor* operation of original regenerative type)

4. 1975
   - New burners installed 8 instead of 12, Babcock steam atomized oil and natural gas type
   - Economizer section added
   - 18 bends removed from radiant platens (replaced)

5. 1977
   - Pipe section(s) in main steam line, one section replaced near flow orifice
   - Main gas valve replaced

6. 1979
   - Convection superheater replaced - tubing only. Degradation partly due to poor steam temperature control.

7. 1982
   - Interview note: attemperator liner failed - slid down blocked flow and caused high temperature degradation to headers
   - Header of first sage superheater replaced - degraded material
   - Fourth bend in main steam line replaced

8. 1984
   - Rewelded circular weld in main steam line adjacent to fifth bend
   - Replaced roof pass of superheater
   - Header of first stage superheater replaced - note second of the headers replaced in this superheater

9. 1985
   - Steam riser tube off outlet of superheater replaced due to leak



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## Exhibit 2-6 (Cont'd)

| PLANT NAME: SOFIA | PLANT TYPE: THERMAL POWER PLANT |
|---|---|

Boiler #7 (cont.):

10. 1986
    - Two steam risers right wall outlet and one riser of left wall were replaced
    - Support steel for second stage convection superheater failed

11. 1987
    - Header (location ?) replaced for second time
    - Radiant superheater replaced (second time)

12. 1980's (Capital Repairs)
    - All attemperator spray heads in convection superheater were replaced

13. Condition Assessment (Bulgarians)
    - Visuals - furnace tube distorted. Construction makes removal/repair extremely difficult
    - Front wall, bottom of unit - heavy external corrosion of tubes and leaks (water) observed
    - Steam risers - history of leaks affects unit reliability and poses personnel danger
    - MT - 23 cracks found in drum: 4 in drum itself, 16 in tube connections, other 3 not specified. Defects ranged from 3 to 10 mm deep and removed by grinding
    - FD and ID fans in good condition
    - Oil and gas burners operate well
    - Steam line material ductility testing inconclusive
    - Furnace wall tubes not gas tight. Also, experience frequent tube leaks
    - Severe low temperature corrosion back end (airheater) - typical problem and requires frequent replacement of sections.

14. Capacity/load
    - Typical load for summer 110-140 T/H
    - Typical load for winter 150-210 T/H
    - Occasional load up to 220 T/H

15. General Notes:
    - History of poor steam temperature control
    - 1987 study recommended complete upgrade - membrane walls, new superheaters, new economizer, new airheater, sootblowers, and emissions control (NOx)
    - Interview note: boiler main steam line - boiler to turbine - needs to be replaced after 1993. OEM recommendation based upon expanded life
    - Boiler has been recently acid cleaned
    - All down take tubes and supplies to root superheater to be replaced (thinning poses personnel hazard)

## Exhibit 2-7

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~ 162,000 | | |
| 8 | Russian (TKZ) | 1964 | On/Off Cycles | 772 | | |
| | | | Operating Hours 1987 - 1992 | 21,014 | | |

1. Original
   - Oil firing only
   - Regenerative (Ljungstrom airheater)
2. 1974
   - Steam collecting chamber (header ?) replaced due to defects
3. 1975
   - Regenerative airheaters replaced by tubular type (*Reason: Poor* operation of original regenerative type)
   - New burners installed 8 instead of 12, babcock steam atomized oil and natural gas type
   - Economizer section added
   - 18 bends removed from radiant platens (replaced)
4. 1976
   - First bend of steam line replaced due to cracking
5. 1977
   - Two riser tube bends replaced - rear wall circuit - cracking
6. 1978
   - Second stage convective superheater replaced
7. 1982
   - Roof superheater replaced
   - Hydrostatic test at approximately 1.4 nominal pressure (2000 psi) - leak in rear wall riser
8. 1983
   - Weld adjacent to main steam line orifice removed and rewelded
   - Third bend in main steam line replaced due to crack
9. 1985
   - Fifth bend in main steam line replaced
10. 1986
    - Fourth and sixth bends in main steam replaced
    - Radiant superheater replaced



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## Exhibit 2-7 (Cont'd)

| PLANT NAME: SOFIA | PLANT TYPE: THERMAL POWER PLANT |
|---|---|
| Boiler #8 (cont.): | |
| 11. Condition Assessment (Bulgarians)<br>- Visual: furnace tubes distorted. Construction (tangent tube) makes removal/repair difficult<br>- Front wall, bottom of unit - heavy external corrosion and leaks observed<br>- MT - defect (cracks) discovered on drum around tube openings - removed by grinding<br>- FD and ID fans in good condition<br>- Steam line ductility tests inconclusive<br>- Furnace tubes have high failure rate<br>- Back end corrosion a problem, particularly in airheater requires frequent charges of airheater sections | |
| 12. General notes:<br>- Burners operate well<br>- 1987 study recommended complete rebuild including membrane walls, superheaters, economizer, regenerative airheater, sootblowers, and emissions control for NOx<br>- 1987 study recommended destructive tests on the steam drum material | |
| 13. Capacity/load/performance<br>- Typical load for summer 110-140 T/H<br>- Typical load for winter 150/210 T/H<br>- Occasional load up to 220 T/H | |



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## Exhibit 2-8

## Boiler Summary - History - Sofia, Thermal Power Plant

| PLANT NAME: SOFIA | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~ 47,000 | | |
| 9 | Czech Republic | 1985 | On/Off Cycles | 135 | | |
| | | | Operating Hours 1987 - 1992 | 38,575 | | |

General:

1. New vintage boiler in early stages of operating life - no significant problems



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## Exhibit 2-9

## Boiler Summary - Physical - Sofia, Zemliane, Lulin, Hot Water Plant

| PLANT NAME: | SOFIA, ZEMLIANE, LULIN | | | | | PLANT TYPE: HOT WATER PLANT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler No. | Origin/ Manf. | Start-up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Water Oper. Pressure | Water Outlet Temp. | Max. Effcncy | Nominal Output | Heat Traps |
| Sofia 1-6 | Russian (PTVM-100) | 1967-1981 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 86.8 oil 88.6 gas | 100 GCal (397 mkb/hr) | None |
| Zemliane 1 | Russian (PTVM-100) | 1972 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 89.2 oil 92.8 gas | 100 GCal (397 mkb/hr) | None |
| Zemliane 2 | Russian (PTVM-100) | 1972 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 89.6 oil 91.8 gas | 100 GCal (397 mkb/hr) | None |
| Zemliane 3 | Russian (PTVM-100) | 1972 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 87.6 oil 91.8 gas | 100 GCal (397 mkb/hr) | None |
| Zemliane 4 | Russian (PTVM-100) | 1972 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 88.5 oil 92.5 gas | 100 GCal (397 mkb/hr) | None |
| Zemliane 5 | Russian (PTVM-100) | 1972 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 88.9 oil 93.7 gas | 100 GCal (397 mkb/hr) | None |
| Lulin 1 | Russian (PTVM-100) | 1977 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 94.5 oil 86.8 gas | 100 GCal (397 mkb/hr) | None |
| Lulin 2 | Russian (PTVM-100) | 1977 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 94.6 oil 86.8 gas | 100 GCal (397 mkb/hr) | None |
| Lulin 3 | Russian (PTVM-100) | 1979 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 94.4 oil 86.8 gas | 100 GCal (397 mkb/hr) | None |
| Lulin 4 | Russian (PTVM-100) | 1979 | Forced Circulation | Non-membrane | 16 8 front 8 back | 16, 1 per burner | 2140 T/H (4716 mlb/hr) | 1.0 MPa 145 psi | 150°C 302°F | 94.4 oil 86.8 gas | 100 GCal (397 mkb/hr) | None |
| Lulin 5 | Bulgarian (VK-100) | 1989 | Forced Circulation | Membrane | 6 | 2 FD | 250 T/H (4959 mlb/hr) | 1.0 MPa 145 psi | 180°C 356°F | 95.1 oil 89.0 gas | 100 GCal (397 mkb/hr) | None |



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## Exhibit 2-9 (Cont'd)

| PLANT NAME: SOFIA, ZEMLIANE, LULIN | PLANT TYPE: HOT WATER PLANT |
|---|---|
| General Notes: **Russian Designed PTVM-100 Type** | |
| 1. The 16 small burners each are designed for oil or natural gas and have a blower with 10,000 cmh capacity | |
| 2. Four of 16 burners have lighters and scanners - remainder are lit from the four monitored burners | |
| 3. Boilers are top supported | |
| 4. Boiler water is not treated | |
| 5. Boilers are natural draft damper controlled - high draft loss limits boiler load for multiple boiler operation | |
| 6. Unit has no sootblowers, water spray system is available for off line water wash | |
| 7. Non-membrane walls are subject to in leakage | |
| 8. Tubing (OD x wall) - Waterwalls: 60 mm x 3 mm, Convection Pass: 8 m x 3 mm | |
| 9. Boiler Controls are unreliable and outdated | |
| General Notes: Bulgarian Designed VK-100 Type | |
| 1. Six burners designed for oil or natural gas - three each on left and right wall | |
| 2. All burners automated with flame safety system | |
| 3. Two forced draft fans have capacity of 80,000 cmh | |
| 4. Units are natural draft with outlet damper control | |
| 5. Boiler is top supported | |
| 6. Tubing (OD x wall) - Waterwalls: 57 mm x 4.5 mm, Convection Pass: 32 mm x 3 mm | |



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## Exhibit 2-10

## Boiler Summary - History - Sofia, Hot Water

| PLANT NAME: SOFIA | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operation Hours between 1987-1992 |
| HWB-1 | Russian (PTVM-100) | 1967 | 32,688 | N/A | 13,181 |
| HWB-2 | Russian (PTVM-100) | 1967 | 34,068 | N/A | 8,928 |
| HWB-3 | Russian (PTVM-100) | 1973 | 34,461 | N/A | 13,580 |
| HWB-4 | Russian (PTVM-100) | 1973 | 44,802 | N/A | 19,064 |
| HWB-5 | Russian (PTVM-100) | 1983 | 32,251 | N/A | 19,462 |
| HWB-6 | Russian (PTVM-100) | 1981 | 26,038 | N/A | 13,253 |



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# Exhibit 2-11

## Boiler Summary - Physical - Trajco Kostov, Thermal Power

| PLANT NAME: TRAJCO KOSTOV | | | | | | PLANT TYPE: THERMAL POWER | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr # | Origin/ Manf. | Start up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effcncy | Nominal Output | Heat Traps |
| 1 | Czech (PSB-Brno) | 1964 | 1-Drum Nat Circ | Non-membrane tube & brick | 6 | 2-FD 2-ID 1-GR | 220 T/H (485.0 mlb/hr) MCR | 9.6 MPa (1410 psi) | 540°C 1005°F | 91.0 | 183 GCal/hr (725 mkb/hr) | Economizer Tubular AH |
| 2 | Czech (PSB-Brno) | 1964 | 1-Drum Nat Circ | Non-membrane tube & brick | 6 | 2-FD 2-ID 1-GR | 220 T/H (485.0 mlb/hr) MCR | 9.6 MPa (1410 psi) | 540°C 1005°F | 91.0 | 183 GCal/hr (725 mkb/hr) | Economizer Tubular AH |
| 3 | Czech (PSB-Brno) | 1967 | 1-Drum Nat Circ | Non-membrane tube & brick | 6 | 2-FD 2-ID 1-GR | 220 T/H (485.0 mlb/hr) MCR | 9.6 MPa (1410 psi) | 540°C 1005°F | 91.0 | 183 GCal/hr (725 mkb/hr) | Economizer Tubular AH |
| 4 | Czech (PSB-Brno) | 1968 | 1-Drum Nat Circ | Non-membrane tube & brick | 6 | 2-FD 2-ID 1-GR | 220 T/H (485.0 mlb/hr) MCR | 9.6 MPa (1410 psi) | 540°C 1005°F | 91.0 | 183 GCal/hr (725 mkb/hr) | Economizer Tubular AH |

General Units 1, 2, 3, 4:

1. Boilers originally designed for oil (mazut), converted to oil and natural gas.
2. Boilers have pneumatic controls and burner management.
3. Burner Management operable.
4. Pneumatic controls unreliable.
5. FD Fan Data: not available.
6. ID Fan Data: not available.
7. Tube Data: not available.
8. Cleaning Devices: saturated bank and superheater - not operational. Economizer and airheater - shot cleaning system.
9. Units 1 and 2 supply turbine generators 1 and 2. Units 3 and 4 supply turbine generators 3 and 4.
10. Geological reports show water table is 2.2 - 2.8 m (5.59 - 7.11 ft.) below surface and is aggressive on concrete.
11. Plant design was for earthquake level 8 and current standard is level 9 in this area.
12. Steam coil airheaters on each FD prior to tubular airheater. Replaced 2 and 3, have purchased 1 and 4.
13. Safety valves on 1, 2, and 3 replaced, valves on 4 purchased.
14. General boiler arrangement is similar to B&W Carolina style radiant boiler. No reheat.



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## Exhibit 2-11 (Cont'd)

| PLANT NAME: TRAJOC KOSTOV | | | | | | PLANT TYPE: THERMAL POWER | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr # | Origin/ Manf. | Start -up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effcncy | Nominal Output | Heat Traps |
| 5 | Czech (PBS-Brno) | 1988 | 1-Drum Nat Circ | Membrane | 9 | 2-FD 2-ID | 220 T/H (485 mlb/hr) MCR | 13.63 MPa (2000 psi) | 535°C 996°F | 92.0 | 183 GCal/hr (725 mkb/hr) | Economizer Ljungstrum Airheater |
| 6 | Czech (PBS-Brno) | 1988 | 1-Drum Nat Circ | Membrane | 9 | 2-FD 2-ID | 220 T/H (485 mlb/hr) MCR | 13.63 MPa (2000 psi) | 535°C 996°F | 92.0 | 183 GCal/hr (725 mkb/hr) | Economizer Ljungstrum Airheater |
| 7 | Czech (PBS-Brno) | 1989 | 1-Drum Nat Circ | Membrane | 9 | 2-FD 2-ID | 220 T/H (485 mlb/hr) MCR | 13.63 MPa (2000 psi) | 535°C 996°F | 92.0 | 183 GCal/hr (725 mkb/hr) | Economizer Ljungstrum Airheater |



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# Exhibit 2-12

## Boiler Summary - History - Trajco Kostov, Thermal Power

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: THERMAL POWER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 1 | Czech (PBS-BRNO) | 1964 | 156,032 | 458 | 16,744 |

1. Original
   - Designed for oil firing (mazut), natural circulation, one drum

2. 1975
   - Conversion to oil/natural gas firing using Deutche Babcock burners, atomizing steam (Y-Jet)
   - First stage superheat surface removed due to absorption problem
   - Attemperators added to control temperature
   - Gas recirculation added to control superheater temperature on oil (mazut)
   - SCAH added to stop low temperature corrosion

3. 1975-1979
   - Platen superheater materials changed to stainless steel due to multiple failures

4. 1984
   - UT test of drum welds indicates no defects

5. 1986-1987
   - NDE of tee section in platen superheater showed defects
   - Tee sections replaced with material 12 KIMF (?)

6. 1992
   - Unit was chemically cleaned

7. General
   - First and second stage superheater loops replaced due to out of service corrosion (sulfur)
   - Sootblowers not functional
   - Oxygen pitting internal to tubing
   - Shot cleaning system in economizer is ineffective and wearing tubes
   - General corrosion on lower tubes
   - Limited boiler capacity (200-205 T/H) due to feedwater heater temperature < 215°C
   - High draft loss due to lack of cleaning; ID fan limited on capacity
   - Drum downcomers have microcracking in bore, axial orientation
   - Visual exams of auxiliaries by Energetica indicate all satisfactory
   - Unit was chemically cleaned
   - Chemical treatment plant lacks proper automatic controls, spare parts, reliability of pumps and measuring devices. Leaks are prevalent in the "H" filter system, desalinated water system and the reagent handling system
   - Tube samples taken July 22, 1991, show average 193.3 g/ft$^2$ (2080 g/m$^2$) in furnace
   - Performed 7 capital projects and 23 intermediate repair projects up to 1987



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## Exhibit 2-13

## Boiler Summary - History - Trajco Kostov, Thermal Power

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: THERMAL POWER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 2 | Czech (PBS-BRNO) | 1964 | 147,724 | 456 | 10,075 |

1. Original
   - Designed for oil firing (mazut), natural circulation, one drum

2. 1975
   - Conversion to oil/natural gas firing using Deutche Babcock burners, atomizing steam (Y-Jet)
   - First stage superheat surface removed due to absorption problem
   - Attemperators added to control temperature
   - Gas recirculation added to control superheater temperature on oil (mazut)
   - SCAH added to stop low temperature corrosion

3. 1975-1979
   - Platen superheater materials changed to stainless steel due to multiple failures

4. 1984
   - UT test of drum welds indicates no defects

5. 1986-1987
   - NDE of tee section in platen superheater showed defects
   - Tee sections replaced with material 12 KIMF (?)

6. 1992
   - Unit was chemically cleaned

7. General
   - First and second stage superheater loops replaced due to out of service corrosion (sulfur)
   - Sootblowers not functional
   - Oxygen pitting internal to tubing
   - Shot cleaning system in economizer is ineffective and wearing tubes
   - General corrosion on lower tubes
   - Limited boiler capacity (200-205 T/H) due to feedwater heater temperature < 215°C
   - High draft loss due to lack of cleaning; ID fan limited on capacity
   - Drum downcomers have microcracking in bore, axial orientation
   - Visual exams of auxiliaries by Energetica indicate all satisfactory
   - Unit was chemically cleaned
   - Chemical treatment plant lacks proper automatic controls, spare parts, reliability of pumps and measuring devices. Leaks are prevalent in the "H" filter system, desalinated water system and the reagent handling system
   - Tube samples taken July 22, 1991, show average 193.3 g/ft$^2$ (2080 g/m$^2$) in furnace
   - Performed 7 capital projects and 23 intermediate repair projects up to 1987



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# Exhibit 2-14

## Boiler Summary - History - Trajco Kostov, Thermal Power

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: THERMAL POWER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 3 | Czech (PBS-BRNO) | 1967 | 153,661 | 426 | 25,688 |

1. Original
   - Designed for oil firing (mazut), natural circulation, one drum

2. 1975
   - Conversion to oil/natural gas firing using Deutche Babcock burners, atomizing steam (Y-Jet)
   - First stage superheat surface removed due to absorption problem
   - Attemperators added to control temperature
   - Gas recirculation added to control superheater temperature on oil (mazut)
   - SCAH added to stop low temperature corrosion

3. 1975-1979
   - Platen superheater loops only changed to stainless steel due to multiple failures

4. 1985
   - Boat sample removed from pipe D273/28. Results indicate. . . *(later)*

5. 1986
   - Boat sample removed from pipe D273/28. Results indicate. . . *(later)*

6. 1988
   - Blow down tank exploded during start-up. Tank flooded, no capacity to dump steam. Designed for 10 bars and 150°C. Actual conditions 10.5-12 bars and 280-330°C

7. Prior to 1991
   - Unit was chemically cleaned

8. General
   - First and second stage superheater loops replaced due to out of service corrosion (sulfur)
   - Sootblowers not functional
   - Oxygen pitting internal to tubing
   - Shot cleaning system in economizer is ineffective and wearing tubes
   - General corrosion on lower tubes
   - Limited boiler capacity (200-205 T/H) due to feedwater heater temperature < 215°C
   - High draft loss due to lack of cleaning; ID fan limited on capacity
   - Drum downcomers have microcracking in bore, axial orientation
   - Visual exams of auxiliaries by Energetica indicate all satisfactory
   - Unit was chemically cleaned
   - Chemical treatment plant lacks proper automatic controls, spare parts, reliability of pumps and measuring devices. Leaks are prevalent in the "H" filter system, desalinated water system and the reagent handling system
   - Tube samples taken July 22, 1991, show average 29.8 g/ft$^2$ (320 g/m$^2$) in furnace
   - Performed 5 capital projects and 18 intermediate repair projects up to 1987
   - Economizer has been changed out

# Exhibit 2-15

## Boiler Summary - History - Trajco Kostov, Thermal Power

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: THERMAL POWER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 4 | Czech (PBS-BRNO) | 1968 | 144,035 | 360 | 25,062 |

1. Original
   - Designed for oil firing (mazut), natural circulation, one drum
2. 1975
   - Conversion to oil/natural gas firing using Deutche Babcock burners, atomizing steam (Y-Jet)
   - First stage superheat surface removed due to absorption problem
   - Attemperators added to control temperature
   - Gas recirculation added to control superheater temperature on oil (mazut)
   - SCAH added to stop low temperature corrosion
3. 1975-1979
   - Platen superheater loops only changed to stainless steel due to multiple failures
4. 1981
   - Cables under control room for Boiler #1 caught fire (electrical short). System replaced with "Orion" monitoring system.
5. Prior to 1991
   - Unit was chemically cleaned
6. General
   - First and second stage superheater loops replaced due to out of service corrosion (sulfur)
   - Sootblowers not functional
   - Oxygen pitting internal to tubing
   - Shot cleaning system in economizer is ineffective and wearing tubes
   - General corrosion on lower tubes
   - Limited boiler capacity (200-205 T/H) due to feedwater heater temperature < 215°C
   - High draft loss due to lack of cleaning; ID fan limited on capacity
   - Drum downcomers have microcracking in bore, axial orientation
   - Visual exams of auxiliaries by Energetica indicate all satisfactory
   - Unit was chemically cleaned
   - Chemical treatment plant lacks proper automatic controls, spare parts, reliability of pumps and measuring devices. Leaks are prevalent in the "H" filter system, desalinated water system and the reagent handling system
   - Tube samples taken July 22, 1991, show average 29.8 g/ft$^2$ (320 g/m$^2$) in furnace
   - Performed 5 capital projects and 18 intermediate repair projects up to 1987
   - Economizer has been changed out



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## Exhibit 2-16

## Boiler Summary - History - Trajco Kostov, Thermal Power

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: THERMAL POWER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 5 | Czech (PBS-BRNO) | 1988 | 21,939 | 117 | 21,939 |
| 1. Original<br>- Designed for oil firing (mazut), natural circulation, one drum | | | | | |
| 2. 1992<br>- Controls and automation equipment for burners was replaced | | | | | |
| 3. General<br>- Plant indicates serious burner problems when firing oil. Stems from mechanical atomizers requiring 588 psi (40 bars). Should upgrade to steam atomization | | | | | |
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 6 | Czech (PBS-BRNO) | 1988 | 21,169 | 136 | 21,169 |
| 1. Original<br>- Designed for oil firing (mazut), natural circulation, one drum | | | | | |
| 2. General<br>- Plant indicates serious burner problems when firing oil. Stems from mechanical atomizers requiring 588 psi (40 bars). Should upgrade to steam atomization | | | | | |
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| 7 | Czech (PBS-BRNO) | 1989 | 18,933 | 78 | 18,933 |
| 1. Original<br>- Designed for oil firing (mazut), natural circulation, one drum | | | | | |
| 2. General<br>- Plant indicates serious burner problems when firing oil. Stems from mechanical atomizers requiring 588 psi (40 bars). Should upgrade to steam atomization | | | | | |



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## Exhibit 2-17

## Boiler Summary - Physical - Trajco Kostov, Hot Water

| PLANT NAME: TRAJCO KOSTOV | | | | | | PLANT TYPE: HOT WATER | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler No. | Origin/ Manf. | Start -up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Water Oper. Pressure | Water Outlet Temp. | Max. Effcncy | Nominal Output | Heat Traps |
| HW-1 | Bulgarian (VVK-100) | 1974 | Forced Circulation | Non-membrane tube & refractory | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-2 | Bulgarian (VVK-100) | 1974 | Forced Circulation | Non-membrane tube & refractory | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-3 | Bulgarian (VVK-100) | 1975 | Forced Circulation | Membrane | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-4 | Bulgarian (VVK-100) | 1975 | Forced Circulation | Non-membrane tube & refractory | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-5 | Bulgarian (VVK-100) | 1977 | Forced Circulation | Non-membrane tube & refractory | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-6 | Bulgarian (VVK-100) | 1981 | Forced Circulation | Non-membrane tube & refractory | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-7 | Bulgarian (VVK-100) | 1982 | Forced Circulation | Membrane | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |
| HW-8 | Bulgarian (VVK-100) | 1982 | Forced Circulation | Non-membrane tube & refractory | 6 3-front 3-rear | 2-FD | 2500 T/H (5511 mlb/hr MCR) | 1.8 MPa (265 psi) | 150°C 302°F | 93.3 | 100 GCal/hr (397 mkb/hr) | None |



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## Exhibit 2-17 (Cont'd)

| PLANT NAME: TRAJCO KOSTOV | PLANT TYPE: HOT WATER |
|---|---|
| General Units 1 through 8: | |
| 1. Boilers originally designed for oil (mazut) and natural gas, except Unit 1 which is gas only. | |
| 2. Boilers have pneumatic controls and burner management (lighters and scanners). | |
| 3. FD Fan Data: 80,000 $m^3$/hr, 160 KW motor. | |
| 4. Tubing Data: Waterwall - 57 mm x 4.5 mm x 75 mm (OD x thk x spacing). Convection pass - 28 mm x 3.0 mm (OD x thk).<br>Convection pass spacing - parallel = 70 mm, perpendicular = 75 mm | |
| 5. Boilers are natural draft, control is done with dampers at the boiler exit flue. | |
| 6. Burner Data: 2400 $m^3$/hr gas and 2200 T/H oil (mazut). | |
| 7. Each unit is supported by a steel structure consisting of columns and beams. The units are top supported. | |
| 8. Units 3, 4, 5 have "Babcock" burners (copy of Babcock, Ltd.). | |
| 9. Units 1, 2, 6, 7, 8 have Polish made burners. | |
| 10. Each unit can be run in a two or four loop scheme (water pass). Four loop scheme is not used because of high pressure drop. | |
| 11. There is no water treatment in these boilers. | |
| 12. Measurements:<br>- Combustion chamber - 6130 mm x 6230 x 7200 (WxDxH), volume = 268 $m^3$, surface = 241 $m^2$<br>- Convection pass - surface = 3645 $m^2$<br>- Overall boiler - 6800 m x 6900 x 15,200 (WxDxH) | |



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## Exhibit 2-18

## Boiler Summary - History - Trajco Kostov, Hot Water

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| HW-1 | Bulgarian VVK-100 | 1974 | 46,118 | N/A | 18,639 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Firing system, controls and automation replaced
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)

| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
|---|---|---|---|---|---|
| HW-2 | Bulgarian VVK-100 | 1974 | 39,123 | N/A | 22,782 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - Firing system, controls and automation replaced
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)



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# Exhibit 2-19

## Boiler Summary - History - Trajco Kostov, Hot Water

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| HW-3 | Bulgarian VVK-100 | 1975 | 30,906 | N/A | 14,752 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)
   - Boiler reconstructed to incorporate membrane construction

| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
|---|---|---|---|---|---|
| HW-4 | Bulgarian VVK-100 | 1975 | 33,544 | N/A | 18,557 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)



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# Exhibit 2-20

## Boiler Summary - History - Trajco Kostov, Hot Water

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| HW-5 | Bulgarian VVK-100 | 1977 | 38,348 | N/A | 14,245 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)

| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
|---|---|---|---|---|---|
| HW-6 | Bulgarian VVK-100 | 1981 | 31,117 | N/A | 21,759 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)
   - Mechanical atomized oil (mazut) firing is unreliable and plant prefers to not use it in this unit



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# Exhibit 2-21

## Boiler Summary - History - Trajco Kostov, Hot Water

| PLANT NAME: TRAJCO KOSTOV | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
| HW-7 | Bulgarian VVK-100 | 1982 | 37,588 | N/A | 17,720 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)
   - Boiler reconstructed to incorporate membrane construction

| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operating Hours (1987-1992) |
|---|---|---|---|---|---|
| HW-8 | Bulgarian VVK-100 | 1982 | 30,110 | N/A | 14,449 |

1. Original
   - Designed for natural gas firing, forced circulation

2. General
   - Oil and natural gas firing
   - First row convection pass tubes overheat due to radiant absorption. Failures are plugged at rate of 10-15 per year. Full tube bank replacement averages every 5-8 years
   - Convection pass header orifices become blocked with waterside contaminates causing the header to overheat
   - Top row of convection pass corrode due to low exit temperatures
   - No sootblower exists. Cleaning is performed using wash system. Water infiltration behind wall tubes causes corrosion. Wash system is ineffective so plant uses handheld water jets to clean tubes during outages
   - Plant relates many problems firing oil (mazut)
   - Mechanical atomized oil (mazut) firing is unreliable and plant prefers to not use it in this unit



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## Exhibit 2-22

## Boiler Summary - History - Lulin, Hot Water

| PLANT NAME: LULIN | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operation Hours between 1987-1992 |
| HWB-1 | Russian (PTVM-100) | 1977 | 51,567 | N/A | 18,712 |
| HWB-2 | Russian (PTVM-100) | 1977 | 67,560 | N/A | 26,591 |
| HWB-3 | Russian (PTVM-100) | 1979 | 45,861 | N/A | 17,553 |
| HWB-4 | Russian (PTVM-100) | 1979 | 54,178 | N/A | 26,726 |
| HWB-5 | Bulgarian (VK-100) | 1989 | 12,846 | N/A | 12,845 |

Notes:

1. Unit 1, 2, and 4 - burners modification for staged combustion.



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## Exhibit 2-23

## Boiler Summary - History - Zemliane, Hot Water

| PLANT NAME: ZEMLIANE | | | PLANT TYPE: HOT WATER | | |
|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | On/Off Cycles | Operation Hours between 1987-1992 |
| HWB-1 | Russian (PTVM-100) | 1972 | 89,362 | N/A | 29,699 |
| HWB-2 | Russian (PTVM-100) | 1972 | 82,407 | N/A | 30,170 |
| HWB-3 | Russian (PTVM-100) | 1972 | 62,489 | N/A | 31,644 |
| HWB-4 | Russian (PTVM-100) | 1972 | 53,415 | N/A | 19,038 |
| HWB-5 | Russian (PTVM-100) | 1972 | 24,820 | N/A | 11,213 |

Notes:

1. Controls replaced on all units for gas firing.



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## Exhibit 2-24

## Boiler Summary - Physical - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA, PERNIK | | | | | | PLANT TYPE: THERMAL POWER PLANT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr # | Origin/ Manf. | Start up Date | Type | Wall Type | No. of Burner | Fans | Boiler Rating | Steam Oper. Pressure | Steam Outlet Temp. | Max. Effency | Nominal Output | Heat Traps |
| 1 | CKD Dukla Czech | 1952 | 2-Drum Nat Circ | Non-membrane | 8 | 2 FD 2 ID | Original 110 T/H (242.5 mlb/hr) Reconst 130 T/H (286.6 mlb/hr) | 7.8 MPa (1131 psi) | 500°C 932°F | design 85% | 355 mkb/hr | Economizer Tubular AH |
| | | | | | | | Recent 76 T/H (167.5 mlb/hr) | 6.6 MPa (957 psi) | 482°C 900°F | present 84.5% | 243 mkb/hr | |
| 2 | CKD Dukla Czech | 1951 | 2-Drum Nat Circ | Non-membrane | 8 | 2 FD 2 ID | Original 110 T/H (242.5 mlb/hr) Reconst 130 T/H (286.6 mlb/hr) | 7.8 MPa (1131 psi) | 500°C 932°F | design 85% | 355 mkb/hr | Economizer Tubular AH |
| | | | | | | | Recent 90 T/H (198.4 mlb/hr) | 7.0 MPa (1015 psi) | 496°C 926°F | present 81.8% | 291 mkb/hr | |
| 3 | CKD Dukla Czech | 1959 | 2-Drum Nat Circ | Non-membrane | 8 | 2 FD 2 ID | Original 125 T/H (275.6 mlb/hr) | 7.7 MPa (1117 psi) | 500°C 932°F | design 83% | 404 mkb/hr | Economizer Tubular AH |
| | | | | | | | Recent 104 T/H (229.3 mlb/hr) | 6.9 MPa (995 psi) | 494°C 921°F | present 83% | 335 mkb/hr | |
| 4 | CKD Dukla Czech | 1958 | 2-Drum Nat Circ | Non-membrane | 8 | 2 FD 2 ID | Original 125 T/H (275.6 mlb/hr) | 7.7 MPa (1117 psi) | 500°C 932°F | design 83% | 404 mkb/hr | Economizer Tubular AH |
| | | | | | | | Recent 102 T/H (224.9 mlb/hr) | 7.1 MPa (1030 psi) | 495°C 924°F | present 82% | 328 mkb/hr | |
| 5 | CKD Dukla Czech | 1967 | 1-Drum Nat Circ | Non-membrane | 12 | 2 FD 3 ID | Original 220 T/H (485.0 mlb/hr) | 9.4 MPa (1363 psi) | 540°C 1004F | design 86% | 726 mkb/hr | Economizer Tubular AH |
| | | | | | | | Recent 205 T/H (451.9 mlb/hr) | 8.8 MPa (1281 psi) | 526°C 979°F | present 82% | 636 mkb/hr | |
| Re sv | CKD Dukla Czech | 1958 | 2-Drum Nat Circ | Non-membrane | 8 | 2 FD 1 ID | Original 125 T/H (275.6 mlb/hr) | 7.7 MPa (1117 psi) | 500°C 932°F | design 83% | 404 mkb/hr | Economizer Tubular AH |
| | | | | | | | Recent 95 T/H (209.4 mlb/hr) | 6.9 MPa (995 psi) | 500°C 932°F | present 84.1% | 307 mkb/hr | |

## Exhibit 2-24 (Cont'd)

| PLANT NAME: REPUBLIKA - PERNIK | PLANT TYPE: THERMAL POWER PLANT |
|---|---|
| General: Boilers 1, 2, 3, 4, Reserve, 5 | |
| 1. Boilers all coal fired. | |
| 2. Coal quality has degraded over time: Design fuel 45% ash, 17% $H_2O$, 2500 kcal/kg as received. Current fuel 53% ash, 15% $H_2O$, 1860 kcal/kg guaranteed. | |
| 3. Sootblowers on #5 boiler only. Not used. | |
| 4. FD Fan Data: (Boiler 1-4, Reserve) 90,000 Cu M/hr, 380 mm $H_2O$, 30°C, (Boiler 5) 126,000 Cu M/hr, 450 mm $H_2O$, 30°C. | |
| 5. ID Fan Data: (Boiler 1-5, Reserve) 468,000 Cu M/hr, 300 mm $H_2O$, 100°C. | |

# Exhibit 2-25

## Boiler Summary - History - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA - PERNIK | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~223,000 | | |
| 1 | CKD Dukla Czech | 1952 | On/Off Cycles | 1066 | | |
| | | | Operating Hours 1990 - 1992 | 12,134 | | |

1. 1954
   - Burner/coal feeder modifications to improve fuel system safety and to stabilize combustion.

2. 1960-1962
   - Wall tubes replaced (?). A cast iron type air heater is removed, added economizer surface and replaced precipitator. Flue gas coal drying instead of air instituted to decrease explosion hazard. Settings modified to make boiler tighter and stop leakage.

3. 1965-1970
   - Second precipitator replacement

4. 1983-1984
   - Superheater and economizer installed. Cracks found in second stage superheater header in area of outlet nozzle saddle weld - the header is replaced.
   - *Meeting Note 10/1/93 C.O.E.* - Superheater and economizer have required replacement approximately every 10 years.

5. 1987
   - Air heater replaced (interview note)

6. Equipment failure rate recent years (1988-1992) - failures in economizer (57), superheater/attemperator (5), steam drum related (6), leading edge convection pass tube (12), piping related (9), auxiliary system other than fans (20), fans (5), I&C (2)

7. Interview Notes:
   - Boilers experiencing out of service corrosion (internal) in furnace waterwall tubes as well as thermal fatigue damage
   - Convection heating surface tubes are subjected to high erosion rates due to ash content in coal
   - Tests done on a section of steam line with 150,000 hours service time including metallography, chemical composition, and mechanical property tests - material test reports on steam piping indicates material not at end of life
   - Condition assessment of drums by Czechoslovakian engineers indicates material is not at end of life
   - High temperature headers are examined by magnetic particle testing (MT). Cracked headers are replaced. Examination repeated every 3-4 years
   - Condition assessment of high temperature tubing is limited to swell measurements and evaluation of thinning due to erosion - no sampling is performed - superheater last replaced 1984
   - Superheater material purchased to begin replacement on boilers generally - stopped due to funding and uncertain future for units
   - Current plans include annual repairs/maintenance - no major upgrades
   - Coal mill capacity limited by high ash content in coal; mills difficult to maintain - parts no longer available
   - Precipitator unable to meet environmental limits
   - Boiler has pneumatic controls and burner management system which are old and unreliable - most systems operated in manual



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# Exhibit 2-26

## Boiler Summary - History - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA - PERNIK | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~198,000 | | |
| 2 | CKD Dukla Czech | 1951 | On/Off Cycles | 1149 | | |
| | | | Operating Hours 1990 - 1992 | 7727 | | |

1. 1954
   - Rotary coal feeders replaced with rubber conveyer belts type burners and drying methods modified
2. 1960-1962
   - Wall tubes replaced, cast iron type air header removed, brick work refractory and casing overhauled to reduce furnace leakage, economizer surface increased
3. 1965-1970
   - Precipitators replaced
4. 1984
   - Top supported superheater surface installed, wall-mounted economizer installed, outlet header of second stage superheater replaced
   - *Meeting Note 10/1/93 C.O.E.* - Superheater and economizer have required replacement approximately every 10 years.
5. 1988
   - Airheater replaced (interview note)
6. Equipment failure rate (1988-1992) - failures in economizer (33), superheater/attemperator (6), steam drum related (2), leading edge convection pass tubes (2), piping related (2), auxiliary systems other than fans (10), fans (6), and I&C related (3)
7. Interview Notes:
   - Major drum failure due to thinning from steam erosion occurred and required weld repair and PWHT (date unknown)
   - Boilers experiencing out of service corrosion (internal) and thermal fatigue in water wall tubes
   - Erosion due to excessive ash in coal causing wear on convection pass tubes
   - Material testing on piece of main steam line with 150,000 hours (metallography, material composition, mechanical properties) indicated material not at end of life
   - Condition assessment of drums by Czechoslovakian engineers indicated it is not at end of life - no major problems since repair of failure
   - High temperature headers examined by MT every 3-4 years - no problems currently
   - High temperature tubing assessed by measurement for creep swell known and thinning - no sampling. Plant has some material for superheater replacement program but work has not processed pending future and status for units and limited funding.
   - Current plans include annual maintenance and repairs. Any upgrades are on hold pending decisions on future of plant/boilers and on funding
   - Coal mill capacity limited by high ash content of coal, mills difficult to maintain and parts not available
   - Precipitator unable to meet environmental limits
   - Pneumatic boiler combustion controls and burner management system unreliable - most systems operational in manual



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## Exhibit 2-27

## Boiler Summary - History - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA - PERNIK | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~190,000 | | |
| 3 | CKD Dukla Czech | 1959 | On/Off Cycles | 826 | | |
| | | | Operating Hours 1990 - 1992 | 12,682 | | |

1. 1963-1968
   - Economizer surface increased, cast iron type air heater replaced with tubular type, settings modified with brick work and change of refractory and casing to reduce leakage.
   - Flue gas drying instead of air drying of coal installed
2. 1970-1972
   - Precipitator replaced
3. 1981
   - Top supported superheater installed, wall mounted economizers installed
   - *Meeting Note 10/1/93 C.O.E.* - Superheater and economizer have required replacement approximately every 10 years.
4. 1985
   - Part of steam piping replaced (note: extent of replacement not indicated), first stage superheater replaced
5. Future:
   - Airheater scheduled for 1994 replacement (interview note)
6. Equipment failures rate recent years (1988-1992): economizer (10), superheater/attemperator related (6), drum related (2), leading edge convection pass tube failures (5), piping related (2), auxiliaries less fans (8), fans (2), I&C (3)
7. Interview Notes:
   - Boiler experiencing out of service internal water wall tube corrosion, thermal fatigue has also been experienced
   - Erosive wear on convection pass due to excessive flyash a problem
   - Material tests generally run on section of main steam line after 150,000. Unit 3 steam lines not identified as current problem to continued operation
   - Condition assessment of drums by Czechoslovakian engineers indicated they are not at end of life
   - High temperature headers examined by MT every 3-4 years - no problems currently
   - High temperature tubing assessed by dimensional checks for swell and erosion (thinning). Plant has material for superheater replacement work on boilers generally but work on hold pending funding and decisions on future of plant/boiler
   - Coal mills capacity limited to high content of coal, mills difficult to maintain and parts not available
   - Precipitators unable to meet environmental limits
   - Pneumatic combustion controls and burner management unreliable - most systems operated in manual
   - Current plans include annual maintenance/repairs with no upgrades pending decisions on future of plant



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# Exhibit 2-28

## Boiler Summary - History - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA - PERNIK | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~194,000 | | |
| 4 | CKD Dukla Czech | 1958 | On/Off Cycles | 853 | | |
| | | | Operating Hours 1990 - 1992 | 6558 | | |

1. 1963-1968
   - Economizer surface increased, cast iron type airheater replaced with tubular type, settings modified by new brick work and casing to reduce flue gas leakage
   - Flue gas drying instead of air dying of coal instituted for safety - less explosion hazard
2. 1970-1972
   - Precipitators replaced
3. 1979
   - Top supported steam superheater and wall mounted economizers added
   - *Meeting Note 10/1/93 C.O.E.* - Superheater and economizer have required replacement approximately every 10 years.
4. 1982
   - First stage steam superheater replaced because of swelling
5. 1991
   - Air heater replaced
6. Equipment failure rate recent years (1988-1992): Economizer (34), superheater/attemperator (5), drum related (3), leading edge tubes (12), piping related (4), auxiliaries less fans (20), fans (0), I&C (1)
7. Interview Notes:
   - All boiler waterwalls experiencing internal corrosion and thermal fatigue
   - Erosive wear on convection pass tubes a problem due to ash content of coal
   - Material test done on piping spool piece with 150,000 hours service - piping believed to be OK
   - Condition assessment of drums by Czechoslovakian engineers indicates they are not near end of life
   - High temperature headers examined by MT every 3-4 years. Headers are not known to be a problem
   - High temperature tubing assessed by dimensional measurements to assess swelling, erosion wear. General program for superheater tubing replacement was in progress when status of plant and funds postponed effort pending future of plant
   - Coal mill capacity is limited by high ash coal and mills are difficult to maintain - parts no longer available
   - Precipitators are identified as inadequate to meet current/new emission limits
   - Pneumatic boiler and burner controls are old and unreliable. Boilers are operated manually
   - Current plans limited to annual maintenance/repairs. Any upgrades are contingent upon future decisions for plant



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## Exhibit 2-29

## Boiler Summary - History - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA - PERNIK | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~190,000 | | |
| Reserve | CKD Dukla Czech | 1958 | On/Off Cycles | 843 | | |
| | | | Operating Hours 1990 - 1992 | 3523 | | |

1. 1963-1968
   - Economizer surface increased, cast iron type airheater replaced with tubular type, setting modified with new brick work refractory and casing to reduce flue gas leakage
   - flue gas drying instead of air drying installed for coal for safer system
2. 1965-1970
   - Precipitator replaced
3. 1982
   - Top supported superheater and wall mounted economizers installed
   - *Meeting Note 10/1/93 C.O.E.* - Superheater and economizer have required replacement approximately every 10 years.
4. 1989
   - Airheater replaced (interview note)
5. Equipment failure rate recent years (1988-1992): Economizer (5), superheater/attemperator related (7), drum related (1), leading edge tubes (12), piping related (4), auxiliaries less fans (1), fans (0), I&C (1)
6. Interview notes:
   - Boiler experiencing internal corrosion and thermal fatigue in waterwall tubes
   - Erosive wear on tubes of convection pass a problem due to fly ash
   - Material tests run on section of steam line with 150,000 service - they have concluded that the steam piping for reserve boiler near end of life and should be replaced
   - Condition assessment of drums by Czechoslovakian engineers indicates they are not at end of life
   - High temperature headers examined by MT every 3-4 years and are believed to be OK
   - High temperature tubing evaluated by dimensional checks to assess well and erosion wear (thinning). Superheater tubing replacement program identified for plant. Work on hold pending plant future and funding.
   - Coal mill capacity limited by high ash coal, mills difficult to maintain and parts are no longer available from Czech's
   - Precipitators unable to meet emission limits
   - Pneumatic combustion controls and burner management are old and unreliable. Boilers operated manually.
   - Current plans include annual repair/maintenance - no major upgrades pending decisions on future of plant



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## Exhibit 2-30

## Boiler Summary - History - Republika, Pernik, Thermal Power Plant

| PLANT NAME: REPUBLIKA - PERNIK | | | PLANT TYPE: THERMAL POWER PLANT | | | |
|---|---|---|---|---|---|---|
| Boiler # | Origin/Manufacturer | Commission Date | Total Operating Hours | ~140,000 | | |
| 5 | CKD Dukla Czech | 1967 | On/Off Cycles | 674 | | |
| | | | Operating Hours 1990 - 1992 | 14,074 | | |

1. 1983-1984
   - PC burners reconstructed, mill fans overhauled to increase capacity
2. Future:
   - Economizer replacement scheduled for 1994 (interview note)
3. Equipment failure rate in recent years (1988-1992): Economizer (46), superheater/attemperator (7), drum related (3), leading edge tubes (10), piping related (7), auxiliaries less fans (9), fan related (1), I&C (3)
4. Interview Notes:
   - All boilers including 5 have experienced corrosion in waterwall tubes as well as thermal fatigue damage
   - Erosion and wear on convection pass tubes a problem due to high ash coal
   - Not clear whether section of steam line has been testing (should be due at 150,000 hours based upon plants criteria)
   - High temperature headers examined by MT every 3-4 years. No problems noted. First stage superheater outlet given as 1½ Cr alloy
   - High temperature tubing examined by dimensional measurement to assess creep swell and erosion thinning. Superheater of Unit 5 is assumed to be part of plants replacement program for future pending funding and future status
   - Many of the rolled tube joints on drum have been seal welded
   - Precipitators are inadequate for new emissions limits
   - Pneumatic boiler and burner controls are old and unreliable. Most systems ar operated in manual

General Note:
- Airheater not noted as replaced recently - should be in bad shape.
- *Meeting Note 10/1/93 C.O.E.* - Superheater and economizer require replacement approximately every 10 years. Last replacment in 1977.



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## Exhibit 2-31

## Boiler Summary - History - Sofia, Turbine/Generators

| SOFIA - Turbine/Generators | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Manufacturer | Type | Rating MW | Hours-12/92 | Start-ups | Last Overhaul | Hours 87-92 | Start-up | Comments |
| 1&2 | Unknown | Back Press. | * | * | * | | * | 1949 | 1977 - T/G 2 failed due to overspeed. T/G 1 retired and used for training only. |
| 3 | Hungarian | Not Given | 12.6 | 260,000 | 136 | | * | 1951 | T/G retired. |
| 4 | Soviet | Condensing | 25 (30 peak) | 215,000 | 239 | | 15,378 | 1956 | Bulgarians project at end of life (metal evaluation). Derated to 18 MW and still in use. |
| 5 | Soviet | Condensing | 25 (30 peak) | 213,000 | 282 | | 27,075 | 1957 | Bulgarians project at end of life (metal evaluation). Derated to 18 MW and still in use. |
| 6 | Soviet | Condensing | 50 (55 peak) | 211,000 | 187 | | 38,076 | 1962 | No comments. |
| 7 | * | * | * | 300 | * | | * | 1967 | Operated only 300 hours after start up. |
| 8 | * | * | 25 | 75,000 | 87 | | 32,292 | 1985 | No comments. |

**Bulgarian Conclusions:**

1. T/G 4 & 5 at end of life and should be retired.
2. Numerous sections of piping at end of life based on original projected life.

**B&W Preliminary Conclusions:**

1. T/G 1, 2, 3, & 7 retire. Perform condition assessment and testing on 4, 5, and 6 to evaluate remaining life and upgrade potential. Continued operation currently planned.
2. T/G 8 newer. RL > DL.
3. Condition assessment and testing of condensers recommended.

* Information not provided.

RL = Remaining Life

DL = Desired Life



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## Exhibit 2-32

## Boiler Summary - History - Trajco Kostov, Turbine/Generators

| TRAJCO KOSTOV - Turbine/Generators | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Manufacturer | Type | Rating MW | Hours-12/92 | Start-ups | Last Overhaul | Hours 87-92 | Start-up | Comments |
| 1 | Czech | Condensing | 30 | 164,000 | 558 | | | 1964 | 1991 - HP cylinder replaced.<br>1993 - Turbine in service as of September |
| 2 | Czech | Condensing | 30 | 140,000 | 455 | | | 1964 | 1991 - HP cylinder replaced.<br>1993 - Major damage due to overspeed incident.<br>- Rotor sent to manufacturer for rebuild. Scheduled return for turbine rebuild and restart summer of 1994. |
| 3 | Czech | Condensing | 30 | 167,000 | 663 | | | 1967 | - T/G only used for peak.<br>- Annually cracks in valve box repaired. |
| 4 | Czech | Condensing | 30 | 151,000 | 617 | | | 1967 | 1991 - HP cylinder replaced. |
| 5 | Czech | Condensing | 66 | 31,000 | 110 | | | 1988 | 1992 - Cracks in left valve box repaired.<br>- Valve box replacement completed. |

**Bulgarian Conclusions:**

1. Steam piping for T/G 1 & 2 OK until 180,000 hours; no steam piping replacement to date but may be nearing end of life.
2. Should consider replacing T/G 3&4 with single larger turbine (meeting 10/1/93).

**B&W Preliminary Conclusions:**

1. All T/G have RL. Must perform condition assessment and testing to evaluate RL vs. DL on T/G 1, 2, 3, 4.
2. T/G 5 newer. RL > DL.

RL = Remaining Life

DL = Desired Life



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# Exhibit 2-33

## Boiler Summary - History - Republika, Turbine/Generators

| REPUBLIKA - Turbine/Generators | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Manufacturer | Type | Rating MW | Hours-12/92 | Start-ups | Last Overhaul | Hours 90-92 | Start-up | Comments |
| 1 | CKD Dukla | Condensing | 25 | 249,000 | 971 | 1986 | 2400 | 1952 | 1969 - Rotor & stator blades replaced.<br>1978 - T Section steam pipe replaced.<br>1982 - Studs replaced. |
| 2 | CKD Dukla | Condensing | 25 | 250,000 | 1028 | 1983 | 6519 | 1951 | 1982 - Rotor & stator blades replaced.<br>- Studs replaced. |
| 3 | Skoda | Back press. | 25 | | | | | | Out of Service - (failed) date unknown. |
| 4 | Skoda | Condensing | 25 | 255,000 | 641 | | 20181 | 1958 | - High failure rate of rotor blades noted. |
| 5 | Skoda | Cond./ Back press. (see comments) | 55 | 147,000 | 446 | 1989 | 10496 | 1967 | 1989 - Conv. to back pressure T/G - HP cylinder replaced.<br>1990 - Blades last row LP replaced.<br>1992 - Labyrinth glands of LP rotor replaced. |
| 6 | 1st BRNO | Back press. | 25 | | | | | 1993 | New replacement of T/G 3. Started up in June 1993. |

**Bulgarian Conclusions:**

1. T/G 1 & 2 have exceeded specified life; T/G are inefficient with high specific heat loss.
2. T/G 4 has exceeded specified life but is critical to supply low pressure steam. Meeting 10/1/93 C.O.E. confirmed T/G 4 expected to be used in future and condition assessment work has been done. (No data given)

**B&W Preliminary Conclusions:**

1. T/G 1, 2, 4 Questionable - require condition assessment and testing if further operation planned current RL < DL probable.
2. T/G 5 requires condition assessment and testing. RL vs. DL unknown.
3. Condenser condition assessment and testing recommended.

RL = Remaining Life

DL = Desired Life

**Upgradibility Group Chart**

**SOFIA - THERMAL**

**UNITS 1 TO 9**

**Exhibit 2-34 to 2-42**

**Upgradibility Group Exhibit Comments/Assumptions**

1. "State of Technology" considers age of component, overall design characteristics to the extent known and B&W knowledge and experience.

2. "Adaptability" is tied to the state of the technology and current condition of the component and considers the potential to upgrade the specific component itself.

3. "Compatibility" considers how well the subject component would tie in with other upgrades considered. For example: Is it's state of technology, current condition, and design worth saving so that other unit upgrades can go forth? Does it make sense in the context of unit upgrading?

**Sofia Thermal Power Plant: Evaluation Factors**

1. Plant oil or natural gas fired - no coal.

2. Main steam piping seamless.

3. Units 1, 2, and 3 have single fans. All others have multiple fans.

4. State of burner technology questionable in consideration of emissions.

## Exhibit 2-34

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - THERMAL<br>UNIT : 1 | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 1 | 2 | 1.50 | 1 | REPLACE COMPONENT |
| ECONOMIZER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 3 | 3 | 2.40 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-35

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - THERMAL<br>UNIT : 2 | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 1 | 2 | 1.50 | 1 | REPLACE COMPONENT |
| ECONOMIZER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 3 | 3 | 2.40 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |

## Exhibit 2-36

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - THERMAL<br>UNIT : 3 | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 1 | 2 | 1.50 | 1 | REPLACE COMPONENT |
| ECONOMIZER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 3 | 3 | 2.40 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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## Exhibit 2-37

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - THERMAL<br>UNIT : 4 | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 1 | 2 | 1.50 | 1 | REPLACE COMPONENT |
| ECONOMIZER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 1 | 1 | 1.20 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 2 | 1 | 1.30 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-38

| UPGRADIBILITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 5 | | | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 1 | 2 | 1.50 | 1 | REPLACE COMPONENT |
| ECONOMIZER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 1 | 1 | 1.20 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 2 | 1 | 1.30 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-39

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - THERMAL<br>UNIT : 6 | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 1 | 2 | 1.50 | 1 | REPLACE COMPONENT |
| ECONOMIZER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 1 | 1 | 1.20 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 2 | 1 | 1.30 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-40

| UPGRADIBILITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 7 | | | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 1 | 1 | 1.20 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 3 | 1 | 1.80 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 1 | 2.20 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |

# Exhibit 2-41

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - THERMAL<br>UNIT : 8 | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 1 | 1 | 1.20 | 1 | REPLACE COMPONENT |
| BRIL | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 3 | 1 | 1.80 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 1 | 2.20 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 0 | 0.70 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-42

| UPGRADIBILITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 9 | | | DATE : 15-Dec-93<br>TIME : 03:34 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| SUPERHEATER | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| ECONOMIZER | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DRUM | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BRIL | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 1 | 2 | 1 | 1.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FD FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| AIRHEATER | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |

**Priority Group Chart**

**SOFIA - THERMAL**

**UNITS 1 TO 9**

**Exhibit 2-43 to 2-51**

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**Priority Group Exhibit - Comments/Assumptions**

1. Main Steam Piping - Not seam welded type.

2. Instrument and Controls - Assume burner flame safety system is not reliable. Also automatic burner modulation not dependable. Poses combustion/explosion hazard in worse case.

3. Categories "Safety", "Leadtime", and "Cause Shutdown" are generic ratings by type of component and type of boiler. Categories "Reliability Problems" and "Performance Problems" are unit/component specific and are based on the best data available from Bulgaria or are based on B&W experience and assumptions for type of unit and component.

## Exhibit 2-43

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 1 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 0 | 2.85 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 0 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 3 | 0 | 2.70 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 3 | 0 | 2.70 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 3 | 3.45 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-44

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 2 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 0 | 2.85 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 0 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 3 | 0 | 2.70 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 3 | 0 | 2.70 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 3 | 3.45 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |

# Exhibit 2-45

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 3 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 0 | 2.85 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 0 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 3 | 0 | 2.70 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 3 | 0 | 2.70 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 3 | 3.45 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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## Exhibit 2-46

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 4 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 3 | 3.15 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 3 | 2.45 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 3 | 3 | 2.50 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |

# Exhibit 2-47

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 5 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 3 | 3.15 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 0 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 3 | 3 | 2.50 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-48

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 6 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 3 | 3.15 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 3 | 3 | 2.50 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |

## Exhibit 2-49

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 7 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 3 | 3.15 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 3 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 3 | 3 | 2.50 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 3 | 3.45 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |

# Exhibit 2-50

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 8 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 3 | 3.15 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 3 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 3 | 3 | 2.50 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 3 | 3.45 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |

# Exhibit 2-51

| PRIORITY GROUP CHART | | | PLANT : SOFIA - THERMAL<br>UNIT : 9 | | | | DATE : 15-Dec-93<br>TIME : 03:34 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 0 | 0 | 2.00 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 0 | 0 | 2.35 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 0 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 0 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 0 | 0 | 1.35 | 3 | LOW PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 0 | 0 | 2.40 | 2 | MEDIUM PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 0 | 1.65 | 2 | MEDIUM PRIORITY |

**Preliminary Disposition Chart**

**SOFIA - THERMAL**

**UNITS 1 TO 9**

**Exhibit 2-52 to 2-60**

## Preliminary Disposition Exhibit - Comments/Assumptions

1. The "Original Life" is B&W's best estimate of the component life based upon unit design, fuel, operating parameters, operating history, and B&W experience with similar technology.

2. "Hours Expired" is the best estimate of operating hours through 1992 based upon Bulgarian supplied data.

3. "Remaining Life" as used here is simply the Original Life minus the hours expired. This is not necessarily a best estimate of Remaining Life; it is being used as a comparative parameter.

4. "Desired Life" has been established at approximately 15 years at 85% availability.

5. RL < DL. A "1" listed if Yes, a "0" if No.

6. Group priority is derived from previous Priority chart.

7. Group Upgradibility is derived from previous chart.

8. Disposition category is a numerical representation of the previous three columns.

9. Preliminary disposition is the initial recommendation for the specific component in the specific unit with no consideration of other influencing factors.

# Exhibit 2-52

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : SOFIA - THERMAL<br>UNIT : 1 | DATE : 15-Dec-93<br>TIME : 04:24 PM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 238000 | 62000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 225000 | 238000 | -13000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ECONOMIZER | 225000 | 238000 | -13000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 238000 | 62000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 238000 | 62000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| BRIL | 300000 | 238000 | 62000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 238000 | 62000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 238000 | 62000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 225000 | 90000 | 135000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 238000 | 62000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 238000 | 62000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 225000 | 238000 | -13000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 238000 | 62000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 238000 | 62000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |

# Exhibit 2-53

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - THERMAL
UNIT : 2

DATE : 15-Dec-93
TIME : 04:24 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 235000 | 65000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 225000 | 235000 | -10000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ECONOMIZER | 225000 | 235000 | -10000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 235000 | 65000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 235000 | 65000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| BRIL | 300000 | 235000 | 65000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 235000 | 65000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 235000 | 65000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 225000 | 90000 | 135000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 235000 | 65000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 235000 | 65000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 225000 | 235000 | -10000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 235000 | 65000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 235000 | 65000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |

# Exhibit 2-54

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - THERMAL
UNIT : 3

DATE : 15-Dec-93
TIME : 04:24 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 237000 | 63000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 225000 | 237000 | -12000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ECONOMIZER | 225000 | 237000 | -12000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 237000 | 63000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 237000 | 63000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| BRIL | 300000 | 237000 | 63000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 237000 | 63000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 237000 | 63000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 225000 | 90000 | 135000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 237000 | 63000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 237000 | 63000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 225000 | 237000 | -12000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 237000 | 63000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 237000 | 63000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |

# Exhibit 2-55

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - THERMAL
UNIT : 4

DATE : 15-Dec-93
TIME : 04:24 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 224000 | 76000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. 5 |
| SUPERHEATER | 200000 | 125000 | 75000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW 0 |
| ECONOMIZER | 225000 | 224000 | 1000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 224000 | 76000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 224000 | 76000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW 0 |
| BRIL | 300000 | 224000 | 76000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 224000 | 76000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 224000 | 76000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 225000 | 110000 | 115000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 224000 | 76000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| FD FAN(S) | 300000 | 224000 | 76000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| AIRHEATER | 225000 | 224000 | 1000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 224000 | 76000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 224000 | 76000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-56

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - THERMAL
UNIT : 5

DATE : 15-Dec-93
TIME : 04:24 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 217000 | 83000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 200000 | 125000 | 75000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| ECONOMIZER | 225000 | 217000 | 8000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 217000 | 83000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 217000 | 83000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| BRIL | 300000 | 217000 | 83000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 217000 | 83000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 217000 | 83000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 225000 | 110000 | 115000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 217000 | 83000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| FD FAN(S) | 300000 | 217000 | 83000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| AIRHEATER | 225000 | 217000 | 8000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 217000 | 83000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 217000 | 83000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-57

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - THERMAL
UNIT : 6

DATE : 15-Dec-93
TIME : 04:24 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 207000 | 93000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 200000 | 207000 | -7000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| ECONOMIZER | 225000 | 207000 | 18000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 207000 | 93000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 207000 | 93000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| BRIL | 300000 | 207000 | 93000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 207000 | 93000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 207000 | 93000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 225000 | 105000 | 120000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 207000 | 93000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| FD FAN(S) | 300000 | 207000 | 93000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| AIRHEATER | 225000 | 207000 | 18000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 207000 | 93000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 207000 | 93000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |

# Exhibit 2-58

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : SOFIA - THERMAL<br>UNIT : 7 | DATE : 15-Dec-93<br>TIME : 04:24 PM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 171000 | 129000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| SUPERHEATER | 200000 | 125000 | 75000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ECONOMIZER | 225000 | 171000 | 54000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 171000 | 129000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 171000 | 129000 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| BRIL | 300000 | 171000 | 129000 | 110000 | 0 | 3 | 1 | 31 | MONITOR & MAINTAIN |
| FLUES | 300000 | 171000 | 129000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 171000 | 129000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 225000 | 100000 | 125000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 171000 | 129000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FD FAN(S) | 300000 | 171000 | 129000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| AIRHEATER | 225000 | 106000 | 119000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 171000 | 129000 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 171000 | 129000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-59

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - THERMAL
UNIT : 8

DATE : 15-Dec-93
TIME : 04:24 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 162000 | 138000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| SUPERHEATER | 200000 | 162000 | 38000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ECONOMIZER | 225000 | 162000 | 63000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 162000 | 138000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 162000 | 138000 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| BRIL | 300000 | 162000 | 138000 | 110000 | 0 | 3 | 1 | 31 | MONITOR & MAINTAIN |
| FLUES | 300000 | 162000 | 138000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 162000 | 138000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 225000 | 98000 | 127000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 162000 | 138000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FD FAN(S) | 300000 | 162000 | 138000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| AIRHEATER | 225000 | 98000 | 127000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 162000 | 138000 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 162000 | 138000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |

# Exhibit 2-60

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : SOFIA - THERMAL<br>UNIT : 9 | DATE : 15-Dec-93<br>TIME : 04:24 PM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 47000 | 253000 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | 200000 | 47000 | 153000 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| ECONOMIZER | 225000 | 47000 | 178000 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| DRUM | 300000 | 47000 | 253000 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 225000 | 47000 | 178000 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 300000 | 47000 | 253000 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| FLUES | 300000 | 47000 | 253000 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 47000 | 253000 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 225000 | 47000 | 178000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 47000 | 253000 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| FD FAN(S) | 300000 | 47000 | 253000 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| AIRHEATER | 225000 | 47000 | 178000 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 47000 | 253000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FW TREATMENT | 300000 | 47000 | 253000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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**Ungradibility Group Chart**

**SOFIA - HOT WATER**

**UNITS 1 TO 6**

**Exhibit 2-61 to 2-66**

# Exhibit 2-61

| UPGRADIBILITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 1 | | | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 1 | 1 | 1.40 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 1 | 0 | 1.10 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 0 | 0 | 0.40 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |

# Exhibit 2-62

| UPGRADIBILITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 2 | | | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 1 | 1 | 1.40 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 1 | 0 | 1.10 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 0 | 0 | 0.40 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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# Exhibit 2-63

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - HOT WATER<br>UNIT : 3 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 1 | 1 | 1.40 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 1 | 0 | 1.10 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 0 | 0 | 0.40 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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## Exhibit 2-64

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - HOT WATER<br>UNIT : 4 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 1 | 1 | 1.40 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 1 | 0 | 1.10 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 0 | 0 | 0.40 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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# Exhibit 2-65

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - HOT WATER<br>UNIT : 5 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 1 | 1 | 1.40 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 1 | 0 | 1.10 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 0 | 0 | 0.40 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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# Exhibit 2-66

| UPGRADIBILITY GROUP CHART | PLANT : SOFIA - HOT WATER<br>UNIT : 6 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 1 | 1 | 1.40 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 1 | 0 | 1.10 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 0 | 0 | 0.40 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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**Priority Group Chart**

**SOFIA - HOT WATER**

**Exhibit 2-67 to 2-72**

## Exhibit 2-67

| PRIORITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 1 | | | | DATE : 15-Dec-93<br>TIME : 02:16 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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## Exhibit 2-68

| PRIORITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 2 | | | | DATE : 15-Dec-93<br>TIME : 02:16 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



216

## Exhibit 2-69

| PRIORITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 3 | | | | DATE : 15-Dec-93<br>TIME : 02:16 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-70

| PRIORITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 4 | | | | DATE : 15-Dec-93<br>TIME : 02:16 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



212

# Exhibit 2-71

| PRIORITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 5 | | | | DATE : 15-Dec-93<br>TIME : 02:16 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



219

# Exhibit 2-72

| PRIORITY GROUP CHART | | | PLANT : SOFIA - HOT WATER<br>UNIT : 6 | | | | DATE : 15-Dec-93<br>TIME : 02:16 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



220

**Preliminary Disposition Chart**

**SOFIA - HOT WATER**

**Exhibit 2-73 to 2-78**

# Exhibit 2-73

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - HOT WATER
UNIT : 1

DATE : 15-Dec-93
TIME : 02:16 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 32688 | 267312 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 688 | 15312 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 32688 | 167312 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 32688 | 267312 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 32688 | 267312 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 32688 | 77312 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 32688 | 267312 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 32688 | 267312 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 32688 | 267312 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



222

# Exhibit 2-74

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : SOFIA - HOT WATER<br>UNIT : 2 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 34068 | 265932 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 2068 | 13932 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 34068 | 165932 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 34068 | 265932 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 34068 | 265932 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 34068 | 75932 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 34068 | 265932 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 34068 | 265932 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 34068 | 265932 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



223

# Exhibit 2-75

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : SOFIA - HOT WATER<br>UNIT : 3 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 34461 | 265539 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 2461 | 13539 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 34461 | 165539 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 34461 | 265539 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 34461 | 265539 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 34461 | 75539 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 34461 | 265539 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 34461 | 265539 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 34461 | 265539 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



224

# Exhibit 2-76

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - HOT WATER
UNIT : 4

DATE : 15-Dec-93
TIME : 02:16 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 44802 | 255198 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 12802 | 3198 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 44802 | 155198 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 44802 | 255198 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 44802 | 255198 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 44802 | 65198 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 44802 | 255198 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 44802 | 255198 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 44802 | 255198 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



225

# Exhibit 2-77

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : SOFIA - HOT WATER<br>UNIT : 5 | DATE : 15-Dec-93<br>TIME : 02:16 PM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 32251 | 267749 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 251 | 15749 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 32251 | 167749 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 32251 | 267749 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 32251 | 267749 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 32251 | 77749 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 32251 | 267749 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 32251 | 267749 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 32251 | 267749 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-78

PRELIMINARY DISPOSITION CHART

PLANT : SOFIA - HOT WATER
UNIT : 6

DATE : 15-Dec-93
TIME : 02:16 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 26038 | 273962 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 10038 | 5962 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 26038 | 173962 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 26038 | 273962 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 26038 | 273962 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 26038 | 83962 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 26038 | 273962 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 26038 | 273962 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 26038 | 273962 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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**Upgradibility Group Chart**

**TRAJOC KOSTOV - THERMAL**

**Exhibit 2-79 to 2-85**

## Exhibit 2-79

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 1 | DATE : 15-Dec-93<br>TIME : 02:59 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | 2 | 4 | 3 | 3.30 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| DRUM | 3 | 4 | 5 | 4.10 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 4 | 5 | 3.90 | 3 | KEEP COMPONENT |
| BRIL | 1 | 1 | 2 | 1.30 | 1 | REPLACE COMPONENT |
| FLUES | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| DUCTS | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 4 | 2 | 3.20 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-80

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 2 | DATE : 15-Dec-93<br>TIME : 02:59 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | 2 | 4 | 3 | 3.30 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| DRUM | 3 | 4 | 5 | 4.10 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 4 | 5 | 3.90 | 3 | KEEP COMPONENT |
| BRIL | 1 | 1 | 2 | 1.30 | 1 | REPLACE COMPONENT |
| FLUES | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| DUCTS | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 4 | 2 | 3.20 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT. |
| FD FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |

# Exhibit 2-81

| UPGRADIBILITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 3 | | | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | 2 | 4 | 3 | 3.30 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| DRUM | 3 | 4 | 5 | 4.10 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 4 | 5 | 3.90 | 3 | KEEP COMPONENT |
| BRIL | 1 | 1 | 2 | 1.30 | 1 | REPLACE COMPONENT |
| FLUES | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| DUCTS | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 4 | 2 | 3.20 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-82

| UPGRADIBILITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 4 | | | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | 2 | 4 | 3 | 3.30 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| DRUM | 3 | 4 | 5 | 4.10 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 4 | 5 | 3.90 | 3 | KEEP COMPONENT |
| BRIL | 1 | 1 | 2 | 1.30 | 1 | REPLACE COMPONENT |
| FLUES | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| DUCTS | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| BURNERS | 3 | 4 | 2 | 3.20 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| FD FAN(S) | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| AIRHEATER | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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## Exhibit 2-83

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 5 | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| SUPERHEATER | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| ECONOMIZER | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| DRUM | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| BRIL | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FLUES | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| DUCTS | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 1 | 1.70 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FD FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| AIRHEATER | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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## Exhibit 2-84

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 6 | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| SUPERHEATER | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| ECONOMIZER | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| DRUM | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| BRIL | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FLUES | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| DUCTS | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 1 | 1.70 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FD FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| AIRHEATER | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-85

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 7 | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| SUPERHEATER | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| ECONOMIZER | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| DRUM | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| BRIL | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FLUES | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| DUCTS | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 1 | 1.70 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| FD FAN(S) | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| AIRHEATER | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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**Priority Group Chart**

**TRAJOC KOSTOV - THERMAL**

**UNITS 1 to 7**

**Exhibit 2-86 to 2-92**

# Exhibit 2-86

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 1 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 3 | 2.55 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 3 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 3 | 2.25 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 5 | 2.90 | 2 | MEDIUM PRIORITY |

# Exhibit 2-87

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 2 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 3 | 2.55 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 3 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 3 | 2.25 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 5 | 2.90 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-88

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 3 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 3 | 2.55 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 3 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 3 | 2.25 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 5 | 2.90 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-89

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 4 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 0 | 3.10 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 3 | 2.55 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 3 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 0 | 0 | 2.15 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 3 | 2.25 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 5 | 3.65 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 5 | 2.90 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-90

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 5 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 0 | 0 | 2.35 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 0 | 2.25 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 0 | 0 | 2.40 | 2 | MEDIUM PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 0 | 2.40 | 2 | MEDIUM PRIORITY |



241

# Exhibit 2-91

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 6 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 0 | 0 | 2.35 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 0 | 2.25 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 0 | 0 | 2.40 | 2 | MEDIUM PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 0 | 2.40 | 2 | MEDIUM PRIORITY |



242

## Exhibit 2-92

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 7 | | | | DATE : 15-Dec-93<br>TIME : 11:49 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 0 | 0 | 2.35 | 2 | MEDIUM PRIORITY |
| ECONOMIZER | 2 | 1 | 3 | 3 | 0 | 2.25 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 5 | 5 | 5 | 0 | 0 | 3.25 | 2 | MEDIUM PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 0 | 0.60 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| ID FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 1 | 3 | 3 | 0 | 0 | 1.45 | 3 | LOW PRIORITY |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 0 | 0 | 2.40 | 2 | MEDIUM PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 0 | 2.40 | 2 | MEDIUM PRIORITY |



243

**Preliminary Disposition Chart**

**TRAJOC KOSTOV - THERMAL**

**UNITS 1 TO 7**

**Exhibit 2-93 to 2-99**

# Exhibit 2-93

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 1 | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 156032 | 143968 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | 200000 | 156032 | 43968 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ECONOMIZER | 223000 | 156032 | 66968 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 156032 | 143968 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 156032 | 143968 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 156032 | 43968 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 156032 | 143968 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 156032 | 143968 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 156032 | -46032 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 156032 | 143968 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FD FAN(S) | 300000 | 156032 | 143968 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | 223000 | 156032 | 66968 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 156032 | 143968 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 156032 | 143968 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



245

# Exhibit 2-94

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - THERMAL
UNIT : 2

DATE : 15-Dec-93
TIME : 11:49 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 147724 | 152276 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | 200000 | 147724 | 52276 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ECONOMIZER | 223000 | 147724 | 75276 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 147724 | 152276 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 147724 | 152276 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 147724 | 52276 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 147724 | 152276 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 147724 | 152276 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 147724 | -37724 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 147724 | 152276 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FD FAN(S) | 300000 | 147724 | 152276 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | 223000 | 147724 | 75276 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 147724 | 152276 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 147724 | 152276 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



246

# Exhibit 2-95

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - THERMAL
UNIT : 3

DATE : 15-Dec-93
TIME : 11:49 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 153661 | 146339 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | 200000 | 153661 | 46339 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ECONOMIZER | 223000 | 37000 | 186000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 153661 | 146339 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 153661 | 146339 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 153661 | 46339 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 153661 | 146339 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 153661 | 146339 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 153661 | -43661 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 153661 | 146339 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FD FAN(S) | 300000 | 153661 | 146339 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | 223000 | 153661 | 69339 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 153661 | 146339 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 153661 | 146339 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-96

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - THERMAL
UNIT : 4

DATE : 15-Dec-93
TIME : 11:49 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 144035 | 155965 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | 200000 | 144035 | 55965 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ECONOMIZER | 223000 | 37000 | 186000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 144035 | 155965 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 144035 | 155965 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 144035 | 55965 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 144035 | 155965 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 144035 | 155965 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 144035 | -34035 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | 300000 | 144035 | 155965 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FD FAN(S) | 300000 | 144035 | 155965 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | 223000 | 144035 | 78965 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 144035 | 155965 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 144035 | 155965 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-97

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - THERMAL
UNIT : 5

DATE : 15-Dec-93
TIME : 11:49 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | 200000 | 21939 | 178061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| ECONOMIZER | 223000 | 21939 | 201061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| DRUM | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 21939 | 178061 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| FLUES | 300000 | 21939 | 278061 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 21939 | 278061 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 21939 | 88061 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| ID FAN(S) | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| FD FAN(S) | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| AIRHEATER | 223000 | 21939 | 201061 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FW TREATMENT | 300000 | 21939 | 278061 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-98

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : TRAJOC KOSTOV - THERMAL<br>UNIT : 6 | DATE : 15-Dec-93<br>TIME : 11:49 AM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | 200000 | 21169 | 178831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| ECONOMIZER | 223000 | 21169 | 201831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| DRUM | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 21169 | 178831 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| FLUES | 300000 | 21169 | 278831 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 21169 | 278831 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 21169 | 88831 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| ID FAN(S) | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| FD FAN(S) | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| AIRHEATER | 223000 | 21169 | 201831 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FW TREATMENT | 300000 | 21169 | 278831 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



259

# Exhibit 2-99

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - THERMAL
UNIT : 7

DATE : 15-Dec-93
TIME : 11:49 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | 200000 | 18933 | 181067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| ECONOMIZER | 223000 | 18933 | 204067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| DRUM | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| BRIL | 200000 | 18933 | 181067 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| FLUES | 300000 | 18933 | 281067 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 18933 | 281067 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 18933 | 91067 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| ID FAN(S) | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| FD FAN(S) | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| AIRHEATER | 223000 | 18933 | 204067 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| FW TREATMENT | 300000 | 18933 | 281067 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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**Upgradibility Chart Group**

**TRAJOC KOSTOV - HOT WATER**

**UNITS 1 to 8**

**Exhibit 2-100 to 2-107**

252

# Exhibit 2-100

| UPGRADIBILITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 1 | | | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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## Exhibit 2-101

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 2 | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



254

# Exhibit 2-102

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 3 | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



255

# Exhibit 2-103

| UPGRADIBILITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 4 | | | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



256

# Exhibit 2-104

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 5 | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



257

## Exhibit 2-105

| UPGRADIBILITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 6 | | | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



288

## Exhibit 2-106

| UPGRADIBILITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 7 | | | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



259

## Exhibit 2-107

| UPGRADIBILITY GROUP CHART | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 8 | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



260

**Priority Group Chart**

**TRAJOC KOSTOV - HOT WATER**

**UNITS 1 to 8**

**Exhibit 2-108 to 2-115**

## Exhibit 2-108

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 1 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



262

# Exhibit 2-109

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 2 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



263

# Exhibit 2-110

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 3 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



264

# Exhibit 2-111

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 4 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



265

# Exhibit 2-112

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 5 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



266

# Exhibit 2-113

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 6 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



267

# Exhibit 2-114

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 7 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



268

# Exhibit 2-115

| PRIORITY GROUP CHART | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 8 | | | | DATE : 15-Dec-93<br>TIME : 08:28 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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**Preliminary Disposition Chart**

**TRAJOC KOSTOV - HOT WATER**

**UNITS 1 TO 8**

**Exhibit 2-116 to 2-123**

# Exhibit 2-116

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 1

DATE : 15-Dec-93
TIME : 11:09 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 46118 | 253882 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 14118 | 1882 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 46118 | 153882 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 46118 | 253882 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 46118 | 253882 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 46118 | 63882 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 46118 | 253882 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 46118 | 253882 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 46118 | 253882 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-117

| PRELIMINARY DISPOSITION CHART | | | | | | | | PLANT : TRAJOC KOSTOV - HOT WATER<br>UNIT : 2 | DATE : 15-Dec-93<br>TIME : 08:28 AM |
|---|---|---|---|---|---|---|---|---|---|
| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
| FURNACE | 300000 | 39123 | 260877 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 7123 | 8877 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 39123 | 160877 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 39123 | 260877 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 39123 | 260877 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 39123 | 70877 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 39123 | 260877 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 39123 | 260877 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 39123 | 260877 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-118

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 3

DATE : 15-Dec-93
TIME : 08:28 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 30906 | 269094 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 14906 | 1094 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 30906 | 169094 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 30906 | 269094 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 30906 | 269094 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 30906 | 79094 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 30906 | 269094 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 30906 | 269094 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 30906 | 269094 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-119

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 4

DATE : 15-Dec-93
TIME : 08:28 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 33544 | 266456 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 1544 | 14456 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 33544 | 166456 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 33544 | 266456 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 33544 | 266456 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 33544 | 76456 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 33544 | 266456 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 33544 | 266456 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 33544 | 266456 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-120

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 5

DATE : 15-Dec-93
TIME : 08:28 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 38348 | 261652 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 6348 | 9652 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 38348 | 161652 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 38348 | 261652 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 38348 | 261652 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 38348 | 71652 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 38348 | 261652 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 38348 | 261652 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 38348 | 261652 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-121

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 6

DATE : 15-Dec-93
TIME : 08:28 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 31117 | 268883 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 15117 | 883 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 31117 | 168883 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 31117 | 268883 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 31117 | 268883 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 31117 | 78883 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 31117 | 268883 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 31117 | 268883 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 31117 | 268883 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-122

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 7

DATE : 15-Dec-93
TIME : 08:28 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 37588 | 262412 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 5588 | 10412 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 37588 | 162412 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 37588 | 262412 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 37588 | 262412 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 37588 | 72412 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 37588 | 262412 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 37588 | 262412 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 37588 | 262412 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-123

PRELIMINARY DISPOSITION CHART

PLANT : TRAJOC KOSTOV - HOT WATER
UNIT : 8

DATE : 15-Dec-93
TIME : 08:28 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 30110 | 269890 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 14110 | 1890 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 30110 | 169890 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 30110 | 269890 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 30110 | 269890 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 30110 | 79890 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 30110 | 269890 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 30110 | 269890 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 30110 | 269890 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



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**Upgradibility Group Chart**

**REPUBLIKA - THERMAL**

**UNITS 1 to 5**

**Exhibit 2-124 to 2-129**

# Exhibit 2-124

| UPGRADIBILITY GROUP CHART | PLANT : REPUBLIKA - THERMAL<br>UNIT : 1 | DATE : 16-Dec-93<br>TIME : 11:20 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| BRIL | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 2 | 4 | 2.60 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | 1 | 2 | 0 | 1.20 | 1 | REPLACE COMPONENT |
| PULVERIZERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| INSTR. & CONTROLS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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## Exhibit 2-125

| UPGRADIBILITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 2 | | | DATE : 16-Dec-93<br>TIME : 11:20 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 3 | 3 | 0 | 2.10 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| BRIL | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 2 | 4 | 2.60 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | 1 | 2 | 0 | 1.20 | 1 | REPLACE COMPONENT |
| PULVERIZERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| INSTR. & CONTROLS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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## Exhibit 2-126

| UPGRADIBILITY GROUP CHART | PLANT : REPUBLIKA - THERMAL<br>UNIT : 3 | DATE : 16-Dec-93<br>TIME : 11:20 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 3 | 3 | 0 | 2.10 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| BRIL | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 2 | 0 | 1.40 | 1 | REPLACE COMPONENT |
| PRECIPITATOR | 1 | 2 | 0 | 1.20 | 1 | REPLACE COMPONENT |
| PULVERIZERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| INSTR. & CONTROLS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-127

| UPGRADIBILITY GROUP CHART | PLANT : REPUBLIKA - THERMAL<br>UNIT : 4 | DATE : 16-Dec-93<br>TIME : 11:20 AM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 3 | 3 | 0 | 2.10 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| BRIL | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 2 | 4 | 2.60 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | 1 | 2 | 0 | 1.20 | 1 | REPLACE COMPONENT |
| PULVERIZERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| INSTR. & CONTROLS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-128

| UPGRADIBILITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 5 | | | DATE : 16-Dec-93<br>TIME : 11:20 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 3 | 3 | 0 | 2.10 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| BRIL | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 2 | 1 | 1.70 | 1 | REPLACE COMPONENT |
| PRECIPITATOR | 1 | 2 | 1 | 1.50 | 1 | REPLACE COMPONENT |
| PULVERIZERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| INSTR. & CONTROLS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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# Exhibit 2-129

| UPGRADIBILITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : R | | | DATE : 16-Dec-93<br>TIME : 11:20 AM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| SUPERHEATER | 3 | 2 | 2 | 2.20 | 2 | UPGRADE COMPONENT |
| ECONOMIZER | 3 | 3 | 1 | 2.40 | 2 | UPGRADE COMPONENT |
| DRUM | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| CONV. SURFACE | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| BRIL | 1 | 2 | 2 | 1.80 | 1 | REPLACE COMPONENT |
| FLUES | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| DUCTS | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |
| BURNERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| ID FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FD FAN(S) | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| AIRHEATER | 2 | 2 | 4 | 2.60 | 2 | UPGRADE COMPONENT |
| PRECIPITATOR | 1 | 2 | 0 | 1.20 | 1 | REPLACE COMPONENT |
| PULVERIZERS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| INSTR. & CONTROLS | 0 | 1 | 0 | 0.50 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 2 | 3 | 3 | 2.80 | 2 | UPGRADE COMPONENT |



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**Priority Group Chart**

**REPUBLIKA - THERMAL**

**UNITS 1 TO 5 & RESERVE**

**Exhibit 2-130 to 2-135**

## Exhibit 2-130

| PRIORITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 1 | | | | DATE : 16-Dec-93<br>TIME : 11:20 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 5 | 3 | 3.65 | 1 | HIGH PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 3 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 3 | 0 | 2.10 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 0 | 3 | 3 | 0 | 0 | 1.20 | 3 | LOW PRIORITY |
| PRECIPITATOR | 2 | 5 | 3 | 3 | 5 | 3.15 | 2 | MEDIUM PRIORITY |
| PULVERIZERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 3 | 1.95 | 2 | MEDIUM PRIORITY |

# Exhibit 2-131

| PRIORITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 2 | | | | DATE : 16-Dec-93<br>TIME : 11:20 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 5 | 3 | 3.65 | 1 | HIGH PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 3 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 3 | 0 | 2.10 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 0 | 3 | 3 | 0 | 0 | 1.20 | 3 | LOW PRIORITY |
| PRECIPITATOR | 2 | 5 | 3 | 3 | 5 | 3.15 | 2 | MEDIUM PRIORITY |
| PULVERIZERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 3 | 1.95 | 2 | MEDIUM PRIORITY |



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## Exhibit 2-132

| PRIORITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 3 | | | | DATE : 16-Dec-93<br>TIME : 11:20 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 5 | 3 | 3.65 | 1 | HIGH PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 3 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 3 | 0 | 2.10 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 0 | 3 | 3 | 5 | 5 | 2.95 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | 2 | 5 | 3 | 3 | 5 | 3.15 | 2 | MEDIUM PRIORITY |
| PULVERIZERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 3 | 1.95 | 2 | MEDIUM PRIORITY |



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## Exhibit 2-133

| PRIORITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 4 | | | | DATE : 16-Dec-93<br>TIME : 11:20 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 5 | 3 | 3.65 | 1 | HIGH PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 3 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 3 | 0 | 2.10 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 0 | 3 | 3 | 0 | 0 | 1.20 | 3 | LOW PRIORITY |
| PRECIPITATOR | 2 | 5 | 3 | 3 | 5 | 3.15 | 2 | MEDIUM PRIORITY |
| PULVERIZERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 3 | 1.95 | 2 | MEDIUM PRIORITY |

# Exhibit 2-134

| PRIORITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : 5 | | | | DATE : 16-Dec-93<br>TIME : 11:20 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 5 | 3 | 3.90 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 5 | 3 | 3.65 | 1 | HIGH PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 3 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 3 | 0 | 2.10 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 0 | 3 | 3 | 3 | 3 | 2.25 | 2 | MEDIUM PRIORITY |
| PRECIPITATOR | 2 | 5 | 3 | 3 | 5 | 3.15 | 2 | MEDIUM PRIORITY |
| PULVERIZERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 3 | 1.95 | 2 | MEDIUM PRIORITY |

## Exhibit 2-135

| PRIORITY GROUP CHART | | | PLANT : REPUBLIKA - THERMAL<br>UNIT : R | | | | DATE : 16-Dec-93<br>TIME : 11:20 AM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 5 | 3.25 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | 3 | 1 | 5 | 3 | 3 | 3.40 | 1 | HIGH PRIORITY |
| ECONOMIZER | 2 | 1 | 5 | 3 | 3 | 3.15 | 2 | MEDIUM PRIORITY |
| DRUM | 2 | 5 | 5 | 0 | 0 | 2.50 | 2 | MEDIUM PRIORITY |
| CONV. SURFACE | | | | | | 0.00 | 0 | NOT APPLICABLE |
| MAIN STEAM PIPING | 3 | 5 | 5 | 3 | 0 | 3.50 | 1 | HIGH PRIORITY |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | 1 | 2 | 3 | 3 | 3 | 2.40 | 2 | MEDIUM PRIORITY |
| FD FAN(S) | 1 | 2 | 3 | 3 | 0 | 2.10 | 2 | MEDIUM PRIORITY |
| AIRHEATER | 0 | 3 | 3 | 0 | 0 | 1.20 | 3 | LOW PRIORITY |
| PRECIPITATOR | 2 | 5 | 3 | 3 | 5 | 3.15 | 2 | MEDIUM PRIORITY |
| PULVERIZERS | 3 | 5 | 3 | 5 | 5 | 3.90 | 1 | HIGH PRIORITY |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 0 | 3 | 1.95 | 2 | MEDIUM PRIORITY |



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**Preliminary Disposition Chart**

**REPUBLIKA - THERMAL**

**UNITS 1 to 5**

**Exhibit 2-136 to 2-141**

# Exhibit 2-136

PRELIMINARY DISPOSITION CHART

PLANT : REPUBLIKA - THERMAL
UNIT : 1

DATE : 16-Dec-93
TIME : 11:20 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 223000 | 77000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 100000 | 45000 | 55000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| ECONOMIZER | 100000 | 45000 | 55000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| DRUM | 300000 | 223000 | 77000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 223000 | 77000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| BRIL | 300000 | 223000 | 77000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 223000 | 77000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 223000 | 77000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 200000 | 223000 | -23000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | 300000 | 223000 | 77000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 223000 | 77000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 100000 | 30000 | 70000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | 200000 | 12000 | 188000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| PULVERIZERS | 200000 | 223000 | -23000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| INSTR. & CONTROLS | 300000 | 223000 | 77000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 223000 | 77000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-137

PRELIMINARY DISPOSITION CHART

PLANT : REPUBLIKA - THERMAL
UNIT : 2

DATE : 16-Dec-93
TIME : 11:20 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 200000 | 100000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 100000 | 40000 | 60000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| ECONOMIZER | 100000 | 40000 | 60000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| DRUM | 300000 | 200000 | 100000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 200000 | 100000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| BRIL | 300000 | 200000 | 100000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 200000 | 100000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 200000 | 100000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 200000 | 200000 | 0 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | 300000 | 200000 | 100000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 200000 | 100000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 100000 | 15000 | 85000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | 200000 | 105000 | 95000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PULVERIZERS | 200000 | 200000 | 0 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| INSTR. & CONTROLS | 300000 | 200000 | 100000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 200000 | 100000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-138

PRELIMINARY DISPOSITION CHART

PLANT : REPUBLIKA - THERMAL
UNIT : 3

DATE : 16-Dec-93
TIME : 11:20 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 100000 | 70000 | 30000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| ECONOMIZER | 100000 | 70000 | 30000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| DRUM | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 190000 | 110000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| BRIL | 300000 | 190000 | 110000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 190000 | 110000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 190000 | 110000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 200000 | 190000 | 10000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 100000 | 190000 | -90000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PRECIPITATOR | 200000 | 115000 | 85000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PULVERIZERS | 200000 | 190000 | 10000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| INSTR. & CONTROLS | 300000 | 190000 | 110000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



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# Exhibit 2-139

PRELIMINARY DISPOSITION CHART

PLANT : REPUBLIKA - THERMAL
UNIT : 4

DATE : 16-Dec-93
TIME : 11:20 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 195000 | 105000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 100000 | 75000 | 25000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| ECONOMIZER | 100000 | 75000 | 25000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| DRUM | 300000 | 195000 | 105000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 195000 | 105000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| BRIL | 300000 | 195000 | 105000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 195000 | 105000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 195000 | 105000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 200000 | 195000 | 5000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | 300000 | 195000 | 105000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 195000 | 105000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 100000 | 3000 | 97000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | 200000 | 115000 | 85000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PULVERIZERS | 200000 | 195000 | 5000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| INSTR. & CONTROLS | 300000 | 195000 | 105000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 195000 | 105000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



287

# Exhibit 2-140

PRELIMINARY DISPOSITION CHART

PLANT : REPUBLIKA - THERMAL
UNIT : 5

DATE : 16-Dec-93
TIME : 11:20 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 140000 | 160000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| SUPERHEATER | 100000 | 140000 | -40000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| ECONOMIZER | 100000 | 140000 | -40000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| DRUM | 300000 | 140000 | 160000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 140000 | 160000 | 110000 | 0 | 1 | 2 | 12 | POSSIBLY UPGRADE NOW |
| BRIL | 300000 | 140000 | 160000 | 110000 | 0 | 3 | 1 | 31 | MONITOR & MAINTAIN |
| FLUES | 300000 | 140000 | 160000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 140000 | 160000 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| BURNERS | 200000 | 45000 | 155000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| ID FAN(S) | 300000 | 140000 | 160000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| FD FAN(S) | 300000 | 140000 | 160000 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | 100000 | 140000 | -40000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PRECIPITATOR | 200000 | 140000 | 60000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PULVERIZERS | 200000 | 140000 | 60000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| INSTR. & CONTROLS | 300000 | 140000 | 160000 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 140000 | 160000 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |



298

# Exhibit 2-141

PRELIMINARY DISPOSITION CHART

PLANT : REPUBLIKA - THERMAL
UNIT : R

DATE : 16-Dec-93
TIME : 11:20 AM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| SUPERHEATER | 100000 | 55000 | 45000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| ECONOMIZER | 100000 | 55000 | 45000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| DRUM | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| CONV. SURFACE | | | 0 | | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| MAIN STEAM PIPING | 300000 | 190000 | 110000 | 110000 | 1 | 1 | 2 | 112 | UPGRADE NOW |
| BRIL | 300000 | 190000 | 110000 | 110000 | 1 | 3 | 1 | 131 | MONITOR & REPLACE IF FUNDS AVAILABLE WITHIN R.L. |
| FLUES | 300000 | 190000 | 110000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| DUCTS | 300000 | 190000 | 110000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| BURNERS | 200000 | 190000 | 10000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| FD FAN(S) | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| AIRHEATER | 100000 | 4000 | 96000 | 110000 | 1 | 3 | 2 | 132 | MONITOR & UPGRADE IF FUNDS AVAILABLE WITHIN R.L. |
| PRECIPITATOR | 200000 | 125000 | 75000 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| PULVERIZERS | 200000 | 190000 | 10000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| INSTR. & CONTROLS | 300000 | 190000 | 110000 | 110000 | 1 | 1 | 1 | 111 | REPLACE NOW |
| FW TREATMENT | 300000 | 190000 | 110000 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |



299

**Upgradibility Group Chart**

**LIULIN - HOT WATER**

**UNITS 1 TO 5**

**Exhibit 2-142 to 2-146**

## Exhibit 2-142

| UPGRADIBILITY GROUP CHART | | | PLANT : LIULIN - HOT WATER<br>UNIT : 1 | | | DATE : 16-Dec-93<br>TIME : 02:21 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



301

## Exhibit 2-143

| UPGRADIBILITY GROUP CHART | PLANT : LIULIN - HOT WATER<br>UNIT : 2 | DATE : 16-Dec-93<br>TIME : 02:21 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



302

## Exhibit 2-144

| UPGRADIBILITY GROUP CHART | PLANT : LIULIN - HOT WATER<br>UNIT : 3 | DATE : 16-Dec-93<br>TIME : 02:21 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



303

## Exhibit 2-145

| UPGRADIBILITY GROUP CHART | PLANT : LIULIN - HOT WATER<br>UNIT : 4 | DATE : 16-Dec-93<br>TIME : 02:21 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



304

## Exhibit 2-146

| UPGRADIBILITY GROUP CHART | PLANT : LIULIN - HOT WATER<br>UNIT : 5 | DATE : 16-Dec-93<br>TIME : 02:21 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 4 | 4 | 4 | 4.00 | 3 | KEEP COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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**Priority Group Chart**

**LIULIN - HOT WATER**

**UNITS 1 to 5**

**Exhibit 2-147 to 2-151**

# Exhibit 2-147

| PRIORITY GROUP CHART | | | PLANT : LIULIN - HOT WATER<br>UNIT : 1 | | | | DATE : 16-Dec-93<br>TIME : 02:21 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



309

## Exhibit 2-148

| PRIORITY GROUP CHART | | | PLANT : LIULIN - HOT WATER<br>UNIT : 2 | | | | DATE : 16-Dec-93<br>TIME : 02:21 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



308

# Exhibit 2-149

| PRIORITY GROUP CHART | | | PLANT : LIULIN - HOT WATER<br>UNIT : 3 | | | | DATE : 16-Dec-93<br>TIME : 02:21 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



301

## Exhibit 2-150

| PRIORITY GROUP CHART | | | PLANT : LIULIN - HOT WATER<br>UNIT : 4 | | | | DATE : 16-Dec-93<br>TIME : 02:21 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



310

# Exhibit 2-151

| PRIORITY GROUP CHART | | | PLANT : LIULIN - HOT WATER<br>UNIT : 5 | | | | DATE : 16-Dec-93<br>TIME : 02:21 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 0 | 2.75 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 3 | 3 | 3.45 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



311

**Preliminary Disposition Chart**

**LIULIN - HOT WATER**

**UNITS 1 TO 5**

**Exhibit 2-152 to 2-156**

# Exhibit 2-152

PRELIMINARY DISPOSITION CHART

PLANT : LIULIN - HOT WATER
UNIT : 1

DATE : 16-Dec-93
TIME : 02:21 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 51567 | 248433 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 28000 | 23567 | 4433 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 51567 | 148433 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 51567 | 248433 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 51567 | 248433 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 51567 | 58433 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 51567 | 248433 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 51567 | 248433 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 51567 | 248433 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-153

PRELIMINARY DISPOSITION CHART

PLANT : LIULIN - HOT WATER
UNIT : 2

DATE : 16-Dec-93
TIME : 02:21 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 67560 | 232440 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 28000 | 11560 | 16440 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 67560 | 132440 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 67560 | 232440 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 67560 | 232440 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 67560 | 42440 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 67560 | 232440 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 67560 | 232440 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 67560 | 232440 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-154

PRELIMINARY DISPOSITION CHART

PLANT : LIULIN - HOT WATER
UNIT : 3

DATE : 16-Dec-93
TIME : 02:21 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 45861 | 254139 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 28000 | 17861 | 10139 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 45861 | 154139 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 45861 | 254139 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 45861 | 254139 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 45861 | 64139 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 45861 | 254139 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 45861 | 254139 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 45861 | 254139 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-155

PRELIMINARY DISPOSITION CHART

PLANT : LIULIN - HOT WATER
UNIT : 4

DATE : 16-Dec-93
TIME : 02:21 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 54178 | 245822 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 28000 | 26178 | 1822 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 54178 | 145822 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 54178 | 245822 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 54178 | 245822 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 54178 | 55822 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 54178 | 245822 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 54178 | 245822 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 54178 | 245822 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-156

PRELIMINARY DISPOSITION CHART

PLANT : LIULIN - HOT WATER
UNIT : 5

DATE : 16-Dec-93
TIME : 02:21 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 12846 | 287154 | 110000 | 0 | 2 | 3 | 23 | MONITOR & MAINTAIN |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 28000 | 12846 | 15154 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 12846 | 187154 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 12846 | 287154 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 12846 | 287154 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 12846 | 97154 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 12846 | 287154 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 12846 | 287154 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 12846 | 287154 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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**Upgradibility Group Chart**

**ZEMLIANE - HOT WATER**

**UNITS 1 to 5**

**Exhibit 2-157 to 2-161**

## Exhibit 2-157

| UPGRADIBILITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 1 | | | DATE : 16-Dec-93<br>TIME : 02:00 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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## Exhibit 2-158

| UPGRADIBILITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 2 | | | DATE : 16-Dec-93<br>TIME : 02:00 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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# Exhibit 2-159

| UPGRADIBILITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 3 | | | DATE : 16-Dec-93<br>TIME : 02:00 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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## Exhibit 2-160

| UPGRADIBILITY GROUP CHART | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 4 | DATE : 16-Dec-93<br>TIME : 02:00 PM |
|---|---|---|

| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
|---|---|---|---|---|---|---|
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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## Exhibit 2-161

| UPGRADIBILITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 5 | | | DATE : 16-Dec-93<br>TIME : 02:00 PM |
|---|---|---|---|---|---|---|
| COMPONENT | STATE OF TECHNOLOGY | ADAPTABILITY | COMPATIBILITY | WEIGHTED SCORE | UPGRADE GROUP | PRELIMINARY UPGRADE DESCRIPTION |
| FURNACE | 2 | 3 | 2 | 2.50 | 2 | UPGRADE COMPONENT |
| SUPERHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 3 | 3 | 3 | 3.00 | 2 | UPGRADE COMPONENT |
| MAIN STEAM PIPING | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 2 | 3 | 2.30 | 2 | UPGRADE COMPONENT |
| FLUES | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| DUCTS | 3 | 4 | 4 | 3.80 | 3 | KEEP COMPONENT |
| BURNERS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| ID FAN(S) | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 3 | 2 | 0 | 1.60 | 1 | REPLACE COMPONENT |
| AIRHEATER | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 2 | 2 | 2 | 2.00 | 1 | REPLACE COMPONENT |
| FW TREATMENT | 1 | 1 | 1 | 1.00 | 1 | REPLACE COMPONENT |



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**Priority Group Chart**

**ZEMLIANE - HOT WATER**

**UNITS 1 TO 5**

**Exhibit 2-162 to 2-166**

## Exhibit 2-162

| PRIORITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 1 | | | | DATE : 16-Dec-93<br>TIME : 02:00 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-163

| PRIORITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 2 | | | | DATE : 16-Dec-93<br>TIME : 02:00 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-164

| PRIORITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 3 | | | | DATE : 16-Dec-93<br>TIME : 02:00 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-165

| PRIORITY GROUP CHART | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 4 | DATE : 16-Dec-93<br>TIME : 02:00 PM |
|---|---|---|

| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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# Exhibit 2-166

| PRIORITY GROUP CHART | | | PLANT : ZEMLIANE - HOT WATER<br>UNIT : 5 | | | | DATE : 16-Dec-93<br>TIME : 02:00 PM | |
|---|---|---|---|---|---|---|---|---|
| COMPONENT | SAFETY | LEADTIME | CAUSE SHUTDOWN | RELIABILITY PROBLEMS | PERFORMANCE PROBLEMS | WEIGHTED SCORE | PRIORITY GROUP | PRELIMINARY PRIORITY DESCRIPTION |
| FURNACE | 2 | 0 | 5 | 3 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| SUPERHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| ECONOMIZER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| DRUM | | | | | | 0.00 | 0 | NOT APPLICABLE |
| CONV. SURFACE | 2 | 1 | 3 | 5 | 3 | 3.05 | 2 | MEDIUM PRIORITY |
| MAIN STEAM PIPING | | | | | | 0.00 | 0 | NOT APPLICABLE |
| BRIL | 2 | 1 | 0 | 0 | 3 | 0.90 | 3 | LOW PRIORITY |
| FLUES | 1 | 1 | 0 | 0 | 3 | 0.65 | 3 | LOW PRIORITY |
| DUCTS | 1 | 1 | 0 | 0 | 0 | 0.35 | 3 | LOW PRIORITY |
| BURNERS | 3 | 5 | 3 | 3 | 3 | 3.20 | 2 | MEDIUM PRIORITY |
| ID FAN(S) | | | | | | 0.00 | 0 | NOT APPLICABLE |
| FD FAN(S) | 1 | 2 | 5 | 0 | 0 | 1.95 | 2 | MEDIUM PRIORITY |
| AIRHEATER | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PRECIPITATOR | | | | | | 0.00 | 0 | NOT APPLICABLE |
| PULVERIZERS | | | | | | 0.00 | 0 | NOT APPLICABLE |
| INSTR. & CONTROLS | 4 | 5 | 3 | 5 | 5 | 4.15 | 1 | HIGH PRIORITY |
| FW TREATMENT | 1 | 5 | 3 | 3 | 3 | 2.70 | 2 | MEDIUM PRIORITY |



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**Preliminary Disposition Chart**

**ZEMLIANE - HOT WATER**

**UNITS 1 to 5**

**Exhibit 2-167 to 2-171**

# Exhibit 2-167

PRELIMINARY DISPOSITION CHART

PLANT : ZEMLIANE - HOT WATER
UNIT : 1

DATE : 16-Dec-93
TIME : 02:49 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 89362 | 210638 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 28000 | 5364 | 22638 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 89362 | 110638 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 89362 | 210638 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 89362 | 210638 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 89362 | 20638 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 89362 | 210638 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 89362 | 210638 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 89362 | 210638 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-168

PRELIMINARY DISPOSITION CHART

PLANT : ZEMLIANE - HOT WATER
UNIT : 2

DATE : 16-Dec-93
TIME : 02:49 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 82407 | 217593 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 26407 | -10407 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 82407 | 117593 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 82407 | 217593 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 82407 | 217593 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 82407 | 27593 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 82407 | 217593 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 82407 | 217593 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 82407 | 217593 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-169

PRELIMINARY DISPOSITION CHART

PLANT : ZEMLIANE - HOT WATER
UNIT : 3

DATE : 16-Dec-93
TIME : 02:49 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 62489 | 237511 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 4489 | 11511 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 62489 | 137511 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 62489 | 237511 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 62489 | 237511 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 62489 | 47511 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 62489 | 237511 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 62489 | 237511 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 62489 | 237511 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-170

PRELIMINARY DISPOSITION CHART

PLANT : ZEMLIANE - HOT WATER
UNIT : 4

DATE : 16-Dec-93
TIME : 02:49 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 53415 | 246585 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 25415 | -9415 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 53415 | 146585 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 53415 | 246585 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 53415 | 246585 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 53415 | 56585 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 53415 | 246585 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 53415 | 246585 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 53415 | 246585 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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# Exhibit 2-171

PRELIMINARY DISPOSITION CHART

PLANT : ZEMLIANE - HOT WATER
UNIT : 5

DATE : 16-Dec-93
TIME : 02:49 PM

| COMPONENT | ORIGINAL LIFE | HOURS EXPIRED | REMAINING LIFE (RL) | DESIRED LIFE (DL) | RL<DL ? | GROUP PRIORITY | UPGRADE GROUP | DISPOSITION CATEGORY | PRELIMINARY DISPOSITION |
|---|---|---|---|---|---|---|---|---|---|
| FURNACE | 300000 | 24820 | 275180 | 110000 | 0 | 2 | 2 | 22 | MONITOR & UPGRADE WITHIN R.L. |
| SUPERHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| ECONOMIZER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| DRUM | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| CONV. SURFACE | 16000 | 3180 | 12820 | 110000 | 1 | 2 | 2 | 122 | MONITOR & UPGRADE WITHIN R.L. |
| MAIN STEAM PIPING | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| BRIL | 200000 | 24820 | 175180 | 110000 | 0 | 3 | 2 | 32 | MONITOR & MAINTAIN |
| FLUES | 300000 | 24820 | 275180 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| DUCTS | 300000 | 24820 | 275180 | 110000 | 0 | 3 | 3 | 33 | MONITOR & MAINTAIN |
| BURNERS | 110000 | 24820 | 85180 | 110000 | 1 | 2 | 1 | 121 | REPLACE NOW THRU R.L. |
| ID FAN(S) | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| FD FAN(S) | 300000 | 24820 | 275180 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |
| AIRHEATER | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PRECIPITATOR | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| PULVERIZERS | | | 0 | 110000 | 1 | 0 | 0 | 100 | NOT APPLICABLE |
| INSTR. & CONTROLS | 300000 | 24820 | 275180 | 110000 | 0 | 1 | 1 | 11 | POSSIBLY REPLACE NOW |
| FW TREATMENT | 300000 | 24820 | 275180 | 110000 | 0 | 2 | 1 | 21 | MONITOR & REPLACE WITHIN R.L. |



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PN-ACC 222

# SECTION 3

## Bases for Engineering and Economic Analysis

Vol 4

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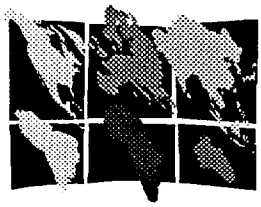
# Bulgarian District Heating System Feasibility Study

3237



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- Training Material




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# 3.0 BASES FOR ENGINEERING AND ECONOMIC ANALYSIS

## 3.1 INTRODUCTION

It is recognized at the outset that although a district heating plant is basically a cogeneration plant, it differs from a utility type cogen plant in that its main purpose is to provide heat, not electricity. This is especially true under current environment in Bulgaria, where selling of electricity is not necessary profitable. Refurbishment of existing facilities will improve efficiency, as well as their replacement with more modern design, thus creating trade-off between capital investment, reduced operating cost, and varying ratio of heat to electricity production. Additional dimension of the study is provided by the requirement to consider present and future Bulgarian emission limits. This section sets the stage for the technical and subsequent economic analysis by establishing the demand requirements on each district heating system. With this information, unit size can be set, equipment selected, and cost estimates can be prepared to match projected future requirements.

### 3.1.1 OBJECTIVE

The objective of this section is to establish a basis for the size and characteristics of heat/electrical production units which are considered as options, and then evaluated for each district heating system. A secondary purpose is to establish a method for making these decisions and facilitate future refinement of this study which may occur as the project is implemented.

### 3.1.2 SCOPE DEFINITION

In this section, the peak demand requirements, and associated margins for heat and steam are established to facilitate selection of major equipment. The month by month load profiles through a typical year are presented for heat and steam. The load profiles are used directly in the economic analysis to simulate dispatch of operating units through the study period and calculate associated fuel and other operating costs.

### 3.1.3 ORGANIZATION OF THE SECTION

This section is divided into five subsection including this introduction.

- Subsection 3.2 discusses district heating systems peak loads and provide methodology how the peak loads were developed. The future heat demand for each district system will be presented with a detailed description on rational and logic used to develop peak systems load and future demands.
- Subsection 3.3 discusses load profiles and load duration curves for each one of the plants. Description of the methodology and how the district heating systems hourly loads were translated into monthly load duration curves will also be provided in this subsection.
- Subsection 3.4 describes properties, availability and cost for solid, liquid and gas fuels.
- Subsection 3.5 presents the Environmental Limits for plant operations and describes penalties for non-compliance as well as means to reduce such.
- Subsection 3.6 provides conclusion for this section.

## 3.2 PEAK LOAD DEMAND PROJECTIONS

A main reason for developing a plant peak load and load demeaned projection is to allow for an timely planning and orderly introduction of new generating capacities to meet new system demands. In a new plant design, the peak load demand is usually estimated by method involving degree-days, empirical relationships for heating loads, estimation of losses, and analysis of load types/coincidence (Reference 3.1). However, in an existing plant, peak loads can best be determined by utilizing existing heat production, heat losses, records, and taking into account of future growth and possible system improvements.

In Bulgaria today, hot water heating is of primary importance, while process steam is secondary due to declining demand. Based on calculated demand, actual production, and required margins (Reference 3.2 through 3.5), it has been agreed among the Bulgaria delegation, Bulgaria consultant (Direct Company), and G/C, the following are the design peak loads for hot water:

| PLANT | HEAT LOAD, MWt |
|---|---|
| Sofia TPHs | 800 |
| Trajco Kostova TPHs | 1180 |
| Zemliane Hs | 513 |
| Liulin Hs | 385 |
| Republika TPHs | 275 |

### 3.2.1 SOFIA DISTRICT HEATING SYSTEM PEAK LOAD AND FUTURE DEMAND

Demand estimates for the Sofia and neighboring systems are required to support the program for unit reconstruction, purchase of new equipment, and



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also decisions regarding the allocation of capital expenditures. With limited capital resources, funding must be appropriated for repairs to energy supply equipment, distribution system repairs/upgrades, or even end-use conservation. This appropriation should be done on the basis of a free-market approach, i.e. what investment provides the best return on investment? This subject is treated in more detail in the "Economic Analysis" (Section 8.0).

In the United States, considerable emphasis is being placed on what is called "Demand-Side Management" (DSM). In an analysis of DSM, energy demands are met through either a supply-side source, or a demand-side source (through conservation). This approach may be effective when operating in a fairly efficient system where improvements are incrementally small, and judgment decisions must be made between these small differences.

In the Bulgarian situation, however, there are some very basic needs that must be fulfilled on both the supply - (including distribution) and demand -side that transcend the evaluation of incremental improvements. Once these basic needs are met, then a more sophisticated analysis can take place in a "Phase II" program which fine tunes the system to optimize efficiency and conservation in a true market economy. These basic needs include emissions control improvements, heat/steam distribution network improvements, and end-use conservation to bring Sofia from a presently unacceptable situation to some reasonably acceptable level in a ten year correlated program. In this context, a peak demand projection was made which accounts for:

- system growth
- distribution system repair/improvement
- end-use conservation.

The purpose of this analysis is only to determine the size of supply necessary to provide a reliable source of heat/steam. The economic model will use a reduced "typical" average peak demand and load duration curve. This section presents this projection, presents the method of calculation, and provides support for each of the assumptions.

Exhibit 3-1 presents the demand projection. As shown on Line 17 the total gross (plant sendout) peak heat demand starts at 800 MWt, rises slightly in the early years, and then settles back to approximately the same level in the year 2010. A similar analysis is prepared for steam demand. Existing and planned plant capacities, designed to meet this projected demand, are shown in a combination of retirements, "mothballed" plants (held in inactive status), and new facilities. A margin, accounting for system needs, coincident hot water/steam demand, and unit reliability is required in addition to the value shown on Line 17.

A brief explanation of the development of the results follows:

**Line 1:** Peak hot water demand is calculated by back-calculating from the value of 800 MWt shown in Line 17. This demand represents the "end-use" value of required heat, and should correlate with a calculation of heat requirements of individual dwellings, commercial and public buildings.

# Exhibit 3-1

## Sofia District Heating System Peak Load and Future Demand Projection

| | SOFIA TPS Parameter | Units | Year 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Peak Hot Water Demand (plant sendout, historical) | | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 | 541 |
| 2 | Adj. for design ambient (-15C) | 17% | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| 3 | Maximum Expected End-Use Demand | MWt | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 | 630.58 |
| 4 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| 5 | Cumulative Expected Connection of New Consumers | MWt | 0.0 | 0.0 | 6.0 | 12.0 | 18.0 | 24.0 | 30.0 | 35.9 | 41.9 | 47.9 | 53.9 | 59.9 | 65.9 | 71.8 | 77.9 | 83.9 | 89.9 | 95.8 | 101.8 |
| 6 | Expected DH Growth with New Housing | %/year | 0.00% | 0.00% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% |
| 7 | Expected DH Growth with New Public/Commercial | %/year | 0.00% | 0.00% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% |
| 8 | Cumulative DH Growth with New Public/Commercial | % | 0.0% | 0.0% | 0.7% | 1.3% | 2.0% | 2.7% | 3.4% | 4.1% | 4.8% | 5.5% | 6.2% | 6.9% | 7.6% | 8.3% | 9.0% | 9.7% | 10.5% | 11.2% | 12.0% |
| 9 | | MWt | 0.0 | 0.0 | 4.2 | 8.6 | 13.1 | 17.6 | 22.3 | 27.1 | 32.0 | 37.0 | 42.2 | 47.4 | 52.8 | 58.3 | 63.9 | 69.7 | 75.5 | 81.5 | 87.6 |
| 10 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 10.2 | 20.6 | 31.0 | 41.6 | 52.3 | 63.1 | 74.0 | 85.0 | 96.1 | 107.3 | 118.7 | 130.2 | 141.8 | 153.5 | 165.4 | 177.3 | 189.4 |
| 11 | Total Anticipated HW Dem. (sendout) w/o Cons. | MWt | 630.6 | 630.6 | 640.8 | 651.2 | 661.6 | 672.2 | 682.8 | 693.6 | 704.5 | 715.6 | 726.7 | 737.9 | 749.3 | 760.8 | 772.4 | 784.1 | 795.9 | 807.9 | 820.0 |
| 12 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.50% | 0.75% | 1.00% | 1.50% | 2.00% | 2.50% | 2.50% | 2.00% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.25% | 0.15% | 0.12% | 0.10% |
| 13 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.5% | 1.3% | 2.3% | 3.8% | 5.9% | 8.5% | 11.2% | 13.5% | 15.2% | 16.6% | 17.8% | 18.7% | 19.2% | 19.5% | 19.7% | 19.9% | 20.0% |
| 14 | Total Expected Peak HW Demand | MWt | 630.6 | 630.6 | 637.6 | 643.0 | 646.6 | 646.6 | 642.7 | 634.5 | 625.4 | 619.2 | 616.5 | 615.4 | 616.2 | 618.8 | 623.7 | 630.9 | 639.0 | 647.4 | 656.1 |
| 15 | Distribution Heat Loss as HL are repaired (gross) | % | 20.00% | 20.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.50% | 12.25% | 12.00% | 11.75% | 11.50% | 11.25% | 10.00% |
| 16 | In-Plant Heat Exchanger Loss | % | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% |
| 17 | Total Gross HW Peak Demand (from plant), MWt | MWt | 800 | 800 | 809 | 806 | 801 | 791 | 777 | 758 | 743 | 731 | 724 | 716 | 715 | 716 | 720 | 726 | 733 | 741 | 740 |
| 18 | Peak Steam Demand | | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 |
| 19 | Adj. for design ambient (-15C) | 17% | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| 20 | Maximum Expected End-Use Demand | | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 | 126.12 |
| 21 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | (2.5) | (5.0) | (5.0) | (2.5) | 0.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| 22 | Expected DH Growth with New Industry | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 3.8 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| 23 | Cumulative DH Growth | MWt | 0.0 | 0.0 | -2.5 | -7.6 | -12.6 | -15.1 | -15.1 | -10.1 | -3.8 | 3.8 | 11.4 | 18.9 | 26.5 | 34.1 | 41.8 | 49.2 | 56.8 | 64.3 | 71.9 |
| 24 | Total Anticipated Steam Dem. (sendout) w/o Cons. | MWt | 126.1 | 126.1 | 123.8 | 118.5 | 113.5 | 111.0 | 111.0 | 116.0 | 122.3 | 129.9 | 137.5 | 145.0 | 152.6 | 160.2 | 167.7 | 175.3 | 182.9 | 190.4 | 198.0 |
| 25 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.15% | 0.25% | 0.50% | 0.75% | 1.00% | 1.25% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.20% | 0.10% | 0.10% | 0.10% | 0.10% | 0.10% |
| 26 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.2% | 0.4% | 0.9% | 1.7% | 2.7% | 4.0% | 5.5% | 6.8% | 7.9% | 8.7% | 9.3% | 9.5% | 9.6% | 9.7% | 9.8% | 9.9% | 10.0% |
| 27 | Total Anticipated Steam Peak Demand | MWt | 126.1 | 126.1 | 123.4 | 118.1 | 112.5 | 109.1 | 108.0 | 111.4 | 115.6 | 121.0 | 126.6 | 132.4 | 138.5 | 145.0 | 151.7 | 158.3 | 164.9 | 171.6 | 178.2 |
| 28 | Percent Heat Loss as HL are repaired | % | 25.00% | 25.00% | 25.00% | 23.00% | 21.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.75% | 12.50% | 12.25% | 12.00% |
| 29 | Total Gross Steam Peak Demand (from plant), MWt | MWt | 168 | 168 | 165 | 153 | 142 | 136 | 133 | 136 | 139 | 144 | 149 | 155 | 161 | 168 | 174 | 181 | 188 | 196 | 202 |
| 30 | Reduction (steam) for Coincidence | -15.0% | (19) | (19) | (19) | (18) | (17) | (16) | (16) | (17) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) | (26) | (27) |
| 31 | Coincident Net Steam Peak Demand | | 149 | 149 | 146 | 136 | 126 | 120 | 117 | 119 | 122 | 126 | 130 | 135 | 140 | 146 | 152 | 158 | 164 | 170 | 176 |
| 32 | Total Gross HW and Steam Coincident Demand | | 949 | 949 | 955 | 942 | 926 | 911 | 894 | 877 | 864 | 857 | 854 | 853 | 855 | 862 | 871 | 883 | 897 | 910 | 916 |



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The 800 MWt value was determined from experience based on a maximum peak of 533 MWt experienced in 1992, where the minimum outside temperature was -10°C. To provide a reasonable operating margin, this value must be increased according to the minimum expected outside temperature of -15°C.

The overall adjustment takes place in Line 2 of Exhibit 3-1, resulting in the maximum end-use demand shown in Line 3. This is shown as a constant for all years and any adjustments are taken in other lines of the exhibit.

**Line 4:** This line shows the expected connection of new consumers. This demand is drawn from a pool of consumers currently served by small decentralized boilers, which now represent approximately 30% of the area served by Sofia. Of course, the connection of all consumers may not be practical due to an excessive distance from primary lines or incompatible systems. The potential to connect consumers to an existing district heating system is usually determined by an "economic distance," an accounts for the price differential in fuels, capital cost associated with the DH installation, the number of such consumers in close proximity, and available capacity on existing substations. In this case, judgment was used to make an estimate that approximately one-half of these available consumers would actually be connected over the entire study period.

**Line 5:** This line shows the cumulative effect of consumer growth.

**Lines 6 and 7:** These lines show the effect of new growth in housing and public/commercial buildings. This represents new construction. Growth in Sofia was based on data for volume (m3) of buildings served in 1992 and 1993 (12,549,145 to 12,797,794 respectively. This growth represents nearly a 2% growth during a single year, but includes both new construction and connections of existing buildings. This growth is a carryover from better economic times, and it has been assumed for this study that this kind of growth, at least in new housing, will not be duplicated in the near future. For this reason, a more conservative growth for new housing of 0.5%/year has been assumed, and one-third of this value assumed for public/commercial buildings. These assumptions result in a cumulative growth of 93.8 MWt by the end of the study period, as shown in Lines 8 and 9.

**Line 10:** The line sums the cumulative growth of DH requirements, without accounting yet for system losses or conservation. The resulting value at the end of the study period is very significant at 201.8.

**Line 11:** This line sums this growth with the assumed baseline to represent the total anticipated HW demand.

**Line 12:** This line identifies a percentage deduction attributed to "end-use" conservation, which does not yet include heat distribution to dwellings. Line 13 shows the cumulative effect, and Line 14 shows the total resulting demand. Residential, commercial, and public building consumers are expected to conserve significantly from their present level. The potential of this conservation effort is in the 35-40% range as identified in several studies of typical eastern Europe

buildings connected to district heating systems. This potential reduction could take place for many reasons, but includes the following:

- improved incentive according to higher heat prices based on metered delivery of heat,
- improved ability to control heat,
- improved insulation in buildings,
- improved construction methods to new buildings, and
- lowered indoor temperatures due to more acceptable comfort levels in dwellings.

The current method controlling heat by opening windows will be replaced through the use of individual metering and control of heat. It is understood that this change will not happen immediately, even if metering/control legislation is enacted. Also, all buildings may not lend themselves to individual control. Controls and metering are expensive and it is likely that the expense cannot be borne by the consumer alone, but should be shared with the district heating company and possibly encouraged through some form of government tax incentive. This subject is treated in more detail in Section 8.0.

It is assumed that a realistic level of conservation will eventually result in a reduction of 20% from current levels over the study period. The change shown according to year is achievable. As shown in Exhibit 3-1, the impact is greater in early years since many of the savings can be realized with minimal capital expenditure. This objective is reasonable and must be met if Bulgaria's energy economy is to approach European standards.

**Line 15:** Line 15 presents our assumption for losses in the distribution network. A value of 20% is assumed for the current year through 1994. This value is supported in a separate analysis presented in Section 5.0. A program of distribution line and substation repair is presented in Section 5.0 in which a reasonable length of primary heat line is replaced/repaired with state-of-the-art piping (with leak detection) per year, reaching a peak of 100 km/y (compared to the present "emergency repair" quantity of 20 km/y). If this program is implemented, a significant savings in demand is possible in a short period of time, and this savings provides a direct impact on the bottom line. As seen in Line 15, large savings are assumed in early years, with some diminishing returns in later years, approaching the 10% loss shown at the end of the study period.

**Line 16:** Line 16 shows losses associated with in-plant heat exchangers. This value should be approximately 1 percent with heat exchangers in good repair; we have assumed 1.5% for the Sofia system.

**Lines 18 through 29:** These lines show a similar exercise for steam demands, with two differences. First, less conservation is shown because much of this steam is for process use, assumed to be constant. To support this assumption, it is further assumed that more efficient use of the steam resulting from process improvements would be offset by increased productivity.

**Lines 30 and 31:** These lines provide a reduction to the steam which is based on coincident demand of heat and steam, meaning heat and steam do not peak at the same time.

**Line 32:** The total heat (heat and steam) required to be supplied is shown in this line

At the peak condition, in the case of a unit outage, there is actually a reduced load requirement. This is established by taking a reasonable percentage of the total load requirement. This physically represents a situation as follows: If at the peak load condition (probably a few days per year) the largest unit is out of service, less heat may be supplied to the system until the unit can be brought back on line. This means that houses will be a little colder for this period, but certainly presents no threat to health or comfort. A conservative 90% was considered.

The existing peak capacity margin is very large, which still indicates that this system has a tremendous over capacity. It is somewhat overstated because the large number of hot water boilers, while adding capacity, may not be of economical capacity because they do not provide any electricity to offset operating costs. In spite of this large number, there is a question of how this demand will be met, which units will be retired or placed on standby, and which new/repowered units may be added to provide a system which operates more economically and presents the least cost solution to operations and emissions compliance problems.

As part of the evaluation of alternatives, older units are retired, significantly reducing the capital required to bring these units up to standard or to meet emissions requirements. Other units are placed on standby, providing an inexpensive source of backup capacity in the case of unit outages, and also as a source of supply during construction periods of new and retrofitted equipment. Through the study period, the margin is reduced to a more reasonable number.

The above discussion illustrates that this system exceeds the required peak demand. The peak heat load can be met even with assumed retirement and 'mothballing' of some of the existing equipment and without addition of any new facilities.

### 3.2.2 Trajco Kostov TPHs Peak Demand

Peak load requirements for the Trajco Kostov TPH system were determined in the same fashion as the Sofia system. A value of 1180 MWt was agreed as the design peak requirement, relating to an experienced peak load of 797 MWt during 1992. Assumptions regarding load growth, heat distribution loss improvement, conservation, and margin requirements were the same as in the Sofia system. The analysis showing peak demand requirements through the study period is shown in Exhibit 3-2.

### 3.2.3 Zemliane District Heating System Peak Load and Future Demand

Peak load requirements for the Zemliane HS system were determined in the same fashion as the Sofia system. A value of 513 MWt was agreed as the design peak requirement, relating to an experienced peak load of 347 MWt during 1992. Assumptions regarding load growth, heat distribution loss improvement, conservation, and margin requirements were the same as in the Sofia



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# Exhibit 3-2

## Trajco Kostov TPH System Future Demand Projection

| | *TRAJCO KOSTOV TPHs* | | Year | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parameter | Units | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 1 | Peak Hot Water Demand (plant sendout, historical) | | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 |
| 2 | Adj. for design ambient (-15C) | 17% | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 | 133 |
| 3 | Maximum Expected End-Use Demand | MWt | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 | 929.83 |
| 4 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 |
| 5 | Cumulative Expected Connection of New Consumers | MWt | 0.0 | 0.0 | 8.8 | 17.7 | 26.5 | 35.3 | 44.2 | 53.0 | 61.8 | 70.7 | 79.5 | 88.3 | 97.2 | 106.0 | 114.8 | 123.7 | 132.5 | 141.3 | 150.2 |
| 6 | Expected DH Growth with New Housing | %/year | 0.00% | 0.00% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% |
| 7 | Expected DH Growth with New Public/Commercial | %/year | 0.00% | 0.00% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% |
| 8 | Cumulative DH Growth with New Public/Commercial | % | 0.0% | 0.0% | 0.7% | 1.3% | 2.0% | 2.7% | 3.4% | 4.1% | 4.8% | 5.5% | 6.2% | 6.9% | 7.6% | 8.3% | 9.0% | 9.7% | 10.5% | 11.2% | 12.0% |
| 9 | | MWt | 0.0 | 0.0 | 6.3 | 12.7 | 19.3 | 26.0 | 32.9 | 40.0 | 47.2 | 54.6 | 62.2 | 70.0 | 77.9 | 86.0 | 94.2 | 102.7 | 111.3 | 120.2 | 129.2 |
| 10 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 15.1 | 30.3 | 45.8 | 61.3 | 77.1 | 93.0 | 109.0 | 125.3 | 141.7 | 158.3 | 175.0 | 192.0 | 209.1 | 226.4 | 243.8 | 261.5 | 279.3 |
| 11 | Total Anticipated HW Dem. (sendout) w/o Cons. | MWt | 929.8 | 929.8 | 944.9 | 960.2 | 975.6 | 991.2 | 1006.9 | 1022.8 | 1038.9 | 1055.1 | 1071.5 | 1088.1 | 1104.9 | 1121.8 | 1138.9 | 1156.2 | 1173.7 | 1191.3 | 1209.2 |
| 12 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.50% | 0.75% | 1.00% | 1.50% | 2.00% | 2.50% | 2.50% | 2.00% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.25% | 0.15% | 0.12% | 0.10% |
| 13 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.5% | 1.3% | 2.3% | 3.8% | 5.9% | 8.5% | 11.2% | 13.5% | 15.2% | 16.6% | 17.8% | 18.7% | 19.2% | 19.5% | 19.7% | 19.9% | 20.0% |
| 14 | Total Expected Peak HW Demand | MWt | 929.8 | 929.8 | 940.2 | 948.1 | 953.5 | 953.5 | 947.7 | 935.6 | 922.1 | 913.1 | 909.1 | 907.5 | 908.6 | 912.8 | 919.7 | 930.2 | 942.2 | 954.7 | 967.5 |
| 15 | Distribution Heat Loss as HL are repaired (gross) | % | 20.00% | 20.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.50% | 12.25% | 12.00% | 11.75% | 11.50% | 11.25% | 10.00% |
| 16 | In-Plant Heat Exchanger Loss | % | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% |
| 17 | Total Gross HW Peak Demand (from plant), MWt | MWt | 1,180 | 1,180 | 1,193 | 1,188 | 1,180 | 1,166 | 1,145 | 1,118 | 1,095 | 1,078 | 1,067 | 1,059 | 1,054 | 1,056 | 1,061 | 1,070 | 1,081 | 1,092 | 1,091 |
| 18 | Peak Steam Demand | | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 | 128 |
| 19 | Adj. for design ambient (-15C) | 17% | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| 20 | Maximum Expected End-Use Demand | | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 | 148.77 |
| 21 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | (3.0) | (6.0) | (6.0) | (3.0) | 0.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| 22 | Expected DH Growth with New Industry | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 4.5 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| 23 | Cumulative DH Growth | MWt | 0.0 | 0.0 | -3.0 | -8.9 | -14.9 | -17.9 | -17.9 | -11.9 | -4.5 | 4.5 | 13.4 | 22.3 | 31.2 | 40.2 | 49.1 | 58.0 | 66.9 | 75.9 | 84.8 |
| 24 | Total Anticipated Steam Dem. (sendout) w/o Cons. | MWt | 148.8 | 148.8 | 145.8 | 139.8 | 133.9 | 130.9 | 130.9 | 136.9 | 144.3 | 153.2 | 162.2 | 171.1 | 180.0 | 188.9 | 197.9 | 206.8 | 215.7 | 224.6 | 233.6 |
| 25 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.15% | 0.25% | 0.50% | 0.75% | 1.00% | 1.25% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.20% | 0.10% | 0.10% | 0.10% | 0.10% | 0.10% |
| 26 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.2% | 0.4% | 0.9% | 1.7% | 2.7% | 4.0% | 5.5% | 6.6% | 7.9% | 8.7% | 9.3% | 9.5% | 9.6% | 9.7% | 9.8% | 9.9% | 10.0% |
| 27 | Total Anticipated Steam Peak Demand | MWt | 148.8 | 148.8 | 145.8 | 139.3 | 132.7 | 128.7 | 127.4 | 131.5 | 136.3 | 142.8 | 149.3 | 156.2 | 163.3 | 171.0 | 178.9 | 186.7 | 194.6 | 202.4 | 210.2 |
| 28 | Percent Heat Loss as HL are repaired | % | 25.00% | 25.00% | 25.00% | 23.00% | 21.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.75% | 12.50% | 12.25% | 12.00% |
| 29 | Total Gross Steam Peak Demand (from plant), MWt | MWt | 198 | 198 | 194 | 181 | 166 | 161 | 157 | 160 | 164 | 170 | 176 | 183 | 190 | 196 | 206 | 214 | 222 | 231 | 239 |
| 30 | Reduction (steam) for Coincidence | -15.0% | (22) | (22) | (22) | (21) | (20) | (19) | (19) | (20) | (20) | (21) | (22) | (23) | (25) | (26) | (27) | (28) | (29) | (30) | (32) |
| 31 | Coincident Net Steam Peak Demand | | 176 | 176 | 172 | 160 | 146 | 142 | 138 | 141 | 144 | 149 | 153 | 159 | 165 | 172 | 179 | 186 | 193 | 200 | 207 |
| 32 | Total Gross HW and Steam Coincident Demand | | 1,356 | 1,356 | 1,365 | 1,348 | 1,329 | 1,308 | 1,284 | 1,258 | 1,239 | 1,226 | 1,220 | 1,218 | 1,220 | 1,228 | 1,240 | 1,256 | 1,274 | 1,292 | 1,299 |



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system. The analysis showing peak demand requirements through the study period is shown in Exhibit 3-3.

### 3.2.4 LIULIN DISTRICT HEATING SYSTEM PEAK LOAD AND FUTURE DEMAND

Peak load requirements for the Liulin HS system were determined in the same fashion as the Sofia system. A value of 385 MWt was agreed as the design peak requirement, relating to an experienced peak load of 280 MWt during 1992. Assumptions regarding load growth, heat distribution loss improvement, conservation, and margin requirements were the same as in the Sofia system. The analysis showing peak demand requirements through the study period is shown in Exhibit 3-4.

### 3.2.5 REPUBLIKA DISTRICT HEATING SYSTEM PEAK LOAD AND FUTURE DEMAND

Peak load requirements for the Republika TPS system were determined in the same fashion as the Sofia system. A value of 275 MWt was agreed as the design peak requirement, relating to an experienced peak load of 186 MWt during 1992. Assumptions regarding load growth, heat distribution loss improvement, conservation, and margin requirements were the same as in the Sofia system. The analysis showing peak demand requirements through the study period is shown in Exhibit 3-5.

## 3.3 DEVELOPMENT OF HOT WATER AND STEAM LOAD PROFILES

While design peak load information is normally required to make decisions whether to add or remove capacity from a system, it is not useful as a direct indicator of annual operating costs, or in anticipating the dispatch requirements of base and peaking units. Further, design peak loads represent the coldest anticipated ambient situation rather than a "typical" or average ambient situation.

Load duration curves are required to capture typical fuel requirements and operating costs, and therefore provide the most accurate comparison between alternatives. Daily, weekly, and monthly load duration curves, if available, provide the best representation of real plant operating characteristics so that the most accurate annual operating costs can be calculated.

Daily summaries of "Round-the-Clock" quantities of hot water, steam and electric energy produced by TPS Sofia and TPS Trajco Kostov were provided in chart for the period April, 1992 through March, 1993. From these data, a table summarizing daily production of both hot water and steam was transcribed and rearranged initially in order of ascending daily hot water loads as illustrated with Sofia data in Exhibit 3-6.

Since all demands in excess of the monthly minimum demand "pass through" that minimum level, it follows that hot water requirements of at least that minimum level are represented in each day of the current month. Demands at the next higher level are imposed on all but the minimum load day, and so forth until the maximum load is represented only on the maximum day or days.

# Exhibit 3-3

## Zemliane HS System Peak Load and Future Demand Projection

| | ZEMLIANE HS | | Year | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parameter | Units | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 1 | Peak Hot Water Demand (plant sendout, historical) | | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 | 347 |
| 2 | Adj. for design ambient (−15C) | 17% | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 | 58 |
| 3 | Maximum Expected End−Use Demand | MWt | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 | 404.25 |
| 4 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 |
| 5 | Cumulative Expected Connection of New Consumers | MWt | 0.0 | 0.0 | 3.8 | 7.7 | 11.5 | 15.4 | 19.2 | 23.0 | 26.9 | 30.7 | 34.6 | 38.4 | 42.2 | 46.1 | 49.9 | 53.8 | 57.6 | 61.4 | 65.3 |
| 6 | Expected DH Growth with New Housing | %/year | 0.00% | 0.00% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% |
| 7 | Expected DH Growth with New Public/Commercial | %/year | 0.00% | 0.00% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% |
| 8 | Cumulative DH Growth with New Public/Commercial | % | 0.0% | 0.0% | 0.7% | 1.3% | 2.0% | 2.7% | 3.4% | 4.1% | 4.8% | 5.5% | 6.2% | 6.9% | 7.6% | 8.3% | 9.0% | 9.7% | 10.5% | 11.2% | 12.0% |
| 9 | | MWt | 0.0 | 0.0 | 2.7 | 5.5 | 8.4 | 11.3 | 14.3 | 17.4 | 20.5 | 23.7 | 27.0 | 30.4 | 33.9 | 37.4 | 41.0 | 44.7 | 48.4 | 52.2 | 56.1 |
| 10 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 6.6 | 13.2 | 19.9 | 26.7 | 33.5 | 40.4 | 47.4 | 54.5 | 61.6 | 68.8 | 76.1 | 83.5 | 90.9 | 98.4 | 106.0 | 113.7 | 121.4 |
| 11 | Total Anticipated HW Dem. (sendout) w/o Cons. | MWt | 404.3 | 404.3 | 410.8 | 417.4 | 424.1 | 430.9 | 437.8 | 444.7 | 451.7 | 458.7 | 465.9 | 473.1 | 480.4 | 487.7 | 495.2 | 502.7 | 510.3 | 517.9 | 525.7 |
| 12 | Reduction for End−Use Conservation | %/year | 0.00% | 0.00% | 0.50% | 0.75% | 1.00% | 1.50% | 2.00% | 2.50% | 2.50% | 2.00% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.25% | 0.15% | 0.12% | 0.10% |
| 13 | Cumulative End−Use Conservation Effect | % | 0.0% | 0.0% | 0.5% | 1.3% | 2.3% | 3.8% | 5.9% | 8.5% | 11.2% | 13.5% | 15.2% | 16.6% | 17.8% | 18.7% | 19.2% | 19.5% | 19.7% | 19.9% | 20.0% |
| 14 | Total Expected Peak HW Demand | MWt | 404.3 | 404.3 | 408.8 | 412.2 | 414.5 | 414.5 | 412.0 | 406.8 | 400.9 | 397.0 | 395.2 | 394.5 | 395.0 | 396.7 | 399.9 | 404.4 | 409.6 | 415.0 | 420.6 |
| 15 | Distribution Heat Loss as HL are repaired (gross) | % | 20.00% | 20.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.50% | 12.25% | 12.00% | 11.75% | 11.50% | 11.25% | 10.00% |
| 16 | In−Plant Heat Exchanger Loss | % | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% |
| 17 | Total Gross HW Peak Demand (from plant), MWt | MWt | 513 | 513 | 519 | 517 | 513 | 507 | 498 | 486 | 476 | 469 | 464 | 460 | 458 | 459 | 461 | 465 | 470 | 475 | 474 |
| 18 | Peak Steam Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Adj. for design ambient (−15C) | 17% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Maximum Expected End−Use Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | Expected DH Growth with New Industry | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | Total Anticipated Steam Dem. (sendout) w/o Cons. | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | Reduction for End−Use Conservation | %/year | 0.00% | 0.00% | 0.15% | 0.25% | 0.50% | 0.75% | 1.00% | 1.25% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.20% | 0.10% | 0.10% | 0.10% | 0.10% | 0.10% |
| 26 | Cumulative End−Use Conservation Effect | % | 0.0% | 0.0% | 0.2% | 0.4% | 0.9% | 1.7% | 2.7% | 4.0% | 5.5% | 6.8% | 7.9% | 8.7% | 9.3% | 9.5% | 9.6% | 9.7% | 9.8% | 9.9% | 10.0% |
| 27 | Total Anticipated Steam Peak Demand | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28 | Percent Heat Loss as HL are repaired | % | 25.00% | 25.00% | 25.00% | 23.00% | 21.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.75% | 12.50% | 12.25% | 12.00% |
| 29 | Total Gross Steam Peak Demand (from plant), MWt | MWt | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | Reduction (steam) for Coincidence | −15.0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | Coincident Net Steam Peak Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | Total Gross HW and Steam Coincident Demand | | 513 | 513 | 519 | 517 | 513 | 507 | 498 | 486 | 476 | 469 | 464 | 460 | 458 | 459 | 461 | 465 | 470 | 475 | 474 |



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# Exhibit 3-4

## Liulin HS System Peak Load and Future Demand Projection

| | LIULIN HS Parameter | Units | Year 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Peak Hot Water Demand (plant sendout, historical) | | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 | 260 |
| 2 | Adj. for design ambient (-15C) | 17% | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| 3 | Maximum Expected End-Use Demand | MWt | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 | 303.33 |
| 4 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 |
| 5 | Cumulative Expected Connection of New Consumers | MWt | 0.0 | 0.0 | 2.9 | 5.8 | 8.8 | 11.5 | 14.4 | 17.3 | 20.2 | 23.1 | 25.9 | 28.8 | 31.7 | 34.6 | 37.5 | 40.3 | 43.2 | 46.1 | 49.0 |
| 6 | Expected DH Growth with New Housing | %/year | 0.00% | 0.00% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% |
| 7 | Expected DH Growth with New Public/Commercial | %/year | 0.00% | 0.00% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% |
| 8 | Cumulative DH Growth with New Public/Commercial | % | 0.0% | 0.0% | 0.7% | 1.3% | 2.0% | 2.7% | 3.4% | 4.1% | 4.8% | 5.5% | 6.2% | 6.9% | 7.6% | 8.3% | 9.0% | 9.7% | 10.5% | 11.2% | 12.0% |
| 9 | | MWt | 0.0 | 0.0 | 2.0 | 4.1 | 6.3 | 8.5 | 10.7 | 13.0 | 15.4 | 17.8 | 20.3 | 22.8 | 25.4 | 28.0 | 30.7 | 33.5 | 36.3 | 39.2 | 42.1 |
| 10 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 4.9 | 9.9 | 14.9 | 20.0 | 25.1 | 30.3 | 35.6 | 40.9 | 46.2 | 51.6 | 57.1 | 62.6 | 68.2 | 73.8 | 79.5 | 85.3 | 91.1 |
| 11 | Total Anticipated HW Dem. (sendout) w/o Cons. | MWt | 303.3 | 303.3 | 308.3 | 313.2 | 318.3 | 323.3 | 328.5 | 333.7 | 338.9 | 344.2 | 349.6 | 355.0 | 360.4 | 366.0 | 371.5 | 377.2 | 382.9 | 388.6 | 394.5 |
| 12 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.50% | 0.75% | 1.00% | 1.50% | 2.00% | 2.50% | 2.50% | 2.00% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.25% | 0.15% | 0.12% | 0.10% |
| 13 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.5% | 1.3% | 2.3% | 3.8% | 5.9% | 8.5% | 11.2% | 13.5% | 15.2% | 16.6% | 17.8% | 18.7% | 19.2% | 19.5% | 19.7% | 19.9% | 20.0% |
| 14 | Total Expected Peak HW Demand | MWt | 303.3 | 303.3 | 306.7 | 309.3 | 311.0 | 311.1 | 309.2 | 305.2 | 300.8 | 297.9 | 296.6 | 296.0 | 296.4 | 297.7 | 300.0 | 303.5 | 307.4 | 311.4 | 315.6 |
| 15 | Distribution Heat Loss as HL are repaired (gross) | % | 20.00% | 20.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.50% | 12.25% | 12.00% | 11.75% | 11.50% | 11.25% | 10.00% |
| 16 | In-Plant Heat Exchanger Loss | % | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% |
| 17 | Total Gross HW Peak Demand (from plant), MWt | MWt | 385 | 385 | 389 | 388 | 385 | 380 | 374 | 365 | 357 | 352 | 348 | 345 | 344 | 344 | 346 | 349 | 353 | 356 | 358 |
| 18 | Peak Steam Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Adj. for design ambient (-15C) | 17% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Maximum Expected End-Use Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | Expected DH Growth with New Industry | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | Total Anticipated Steam Dem. (sendout) w/o Cons. | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.15% | 0.25% | 0.50% | 0.75% | 1.00% | 1.25% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.20% | 0.10% | 0.10% | 0.10% | 0.10% | 0.10% |
| 26 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.2% | 0.4% | 0.9% | 1.7% | 2.7% | 4.0% | 5.5% | 6.8% | 7.9% | 8.7% | 9.3% | 9.5% | 9.6% | 9.7% | 9.8% | 9.9% | 10.0% |
| 27 | Total Anticipated Steam Peak Demand | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28 | Percent Heat Loss as HL are repaired | % | 25.00% | 25.00% | 25.00% | 23.00% | 21.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.75% | 12.50% | 12.25% | 12.00% |
| 29 | Total Gross Steam Peak Demand (from plant), MWt | MWt | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | Reduction (steam) for Coincidence | -15.0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | Coincident Net Steam Peak Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | Total Gross HW and Steam Coincident Demand | | 385 | 385 | 389 | 388 | 385 | 380 | 374 | 365 | 357 | 352 | 348 | 345 | 344 | 344 | 346 | 349 | 353 | 356 | 358 |



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# Exhibit 3-5

## Republika TPS System Peak Load and Future Demand Projection

| | REPUBLIKA TPHs | | Year | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parameter | Units | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 1 | Peak Hot Water Demand (plant sendout, historical) | | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 | 186 |
| 2 | Adj. for design ambient (-15C) | 17% | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| 3 | Maximum Expected End-Use Demand | MWt | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 | 217 |
| 4 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| 5 | Cumulative Expected Connection of New Consumers | MWt | 0.0 | 0.0 | 2.1 | 4.1 | 6.2 | 8.2 | 10.3 | 12.4 | 14.4 | 16.5 | 18.6 | 20.6 | 22.7 | 24.7 | 26.8 | 28.9 | 30.9 | 33.0 | 35.0 |
| 6 | Expected DH Growth with New Housing | %/year | 0.00% | 0.00% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% | 0.50% |
| 7 | Expected DH Growth with New Public/Commercial | %/year | 0.00% | 0.00% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% | 0.17% |
| 8 | Cumulative DH Growth with New Public/Commercial | % | 0.0% | 0.0% | 0.7% | 1.3% | 2.0% | 2.7% | 3.4% | 4.1% | 4.8% | 5.5% | 6.2% | 6.9% | 7.6% | 8.3% | 9.0% | 9.7% | 10.5% | 11.2% | 12.0% |
| 9 | | MWt | 0.0 | 0.0 | 1.5 | 3.0 | 4.5 | 6.1 | 7.7 | 9.3 | 11.0 | 12.7 | 14.5 | 16.3 | 18.2 | 20.1 | 22.0 | 24.0 | 26.0 | 28.0 | 30.1 |
| 10 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 3.5 | 7.1 | 10.7 | 14.3 | 18.0 | 21.7 | 25.4 | 29.2 | 33.1 | 36.9 | 40.9 | 44.8 | 48.8 | 52.8 | 56.9 | 61.0 | 65.2 |
| 11 | Total Anticipated HW Dem. (sendout) w/o Cons. | MWt | 217.0 | 217.0 | 220.5 | 224.1 | 227.7 | 231.3 | 235.0 | 238.7 | 242.4 | 246.2 | 250.1 | 253.9 | 257.9 | 261.8 | 265.8 | 269.8 | 273.9 | 278.0 | 282.2 |
| 12 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.50% | 0.75% | 1.00% | 1.50% | 2.00% | 2.50% | 2.50% | 2.00% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.25% | 0.15% | 0.12% | 0.10% |
| 13 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.5% | 1.3% | 2.3% | 3.8% | 5.9% | 8.5% | 11.2% | 13.5% | 15.2% | 16.6% | 17.8% | 18.7% | 19.2% | 19.5% | 19.7% | 19.9% | 20.0% |
| 14 | Total Expected Peak HW Demand | MWt | 217.0 | 217.0 | 219.4 | 221.3 | 222.5 | 222.5 | 221.2 | 218.4 | 215.2 | 213.1 | 212.2 | 211.8 | 212.0 | 213.0 | 214.6 | 217.1 | 219.9 | 222.8 | 225.8 |
| 15 | Distribution Heat Loss as HL are repaired (gross) | % | 20.00% | 20.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.50% | 12.25% | 12.00% | 11.75% | 11.50% | 11.25% | 10.00% |
| 16 | In-Plant Heat Exchanger Loss | % | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% |
| 17 | Total Gross HW Peak Demand (from plant), MWt | MWt | 275 | 275 | 278 | 277 | 275 | 272 | 267 | 261 | 256 | 252 | 249 | 247 | 246 | 246 | 248 | 250 | 252 | 255 | 255 |
| 18 | Peak Steam Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Adj. for design ambient (-15C) | 17% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Maximum Expected End-Use Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Expected Connection of New DH Consumers | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | Expected DH Growth with New Industry | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | Cumulative DH Growth | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | Total Anticipated Steam Dem. (sendout) w/o Cons. | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | Reduction for End-Use Conservation | %/year | 0.00% | 0.00% | 0.15% | 0.25% | 0.50% | 0.75% | 1.00% | 1.25% | 1.50% | 1.25% | 1.00% | 0.75% | 0.50% | 0.20% | 0.10% | 0.10% | 0.10% | 0.10% | 0.10% |
| 26 | Cumulative End-Use Conservation Effect | % | 0.0% | 0.0% | 0.2% | 0.4% | 0.9% | 1.7% | 2.7% | 4.0% | 5.5% | 6.8% | 7.9% | 8.7% | 9.3% | 9.5% | 9.6% | 9.7% | 9.8% | 9.9% | 10.0% |
| 27 | Total Anticipated Steam Peak Demand | MWt | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28 | Percent Heat Loss as HL are repaired | % | 25.00% | 25.00% | 25.00% | 23.00% | 21.00% | 20.00% | 19.00% | 18.00% | 17.00% | 16.00% | 15.00% | 14.50% | 14.00% | 13.50% | 13.00% | 12.75% | 12.50% | 12.25% | 12.00% |
| 29 | Total Gross Steam Peak Demand (from plant), MWt | MWt | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | Reduction (steam) for Coincidence | -15.0% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | Coincident Net Steam Peak Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | Total Gross HW and Steam Coincident Demand | | 275 | 275 | 278 | 277 | 275 | 272 | 267 | 261 | 256 | 252 | 249 | 247 | 246 | 246 | 248 | 250 | 252 | 255 | 255 |



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# Exhibit 3-6

## Hot Water and Steam Demand Data
## (April, 1992 through March, 1993)

MW – (24 Hours)

| | April, 1992 | | May | | June | | July | | August | | September | | October | | November | | December | | January, 1993 | | February | | March | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam | HW | Steam |
| 1 | 6250 | 2350 | 2600 | 300 | 2100 | 1000 | | 1250 | 2200 | 300 | 2100 | 1200 | 1500 | 1000 | 4900 | 600 | 8800 | 2400 | 11800 | 1500 | 11800 | 2500 | 10300 | 2300 |
| 2 | 6300 | 2300 | 2350 | 350 | 2400 | 1100 | 400 | 1250 | 2350 | 350 | 1800 | 1150 | 2100 | 300 | 4800 | 1000 | 9400 | 2400 | 12000 | 1700 | 12000 | 2900 | 10700 | 2300 |
| 3 | 6150 | 2350 | 2450 | 300 | 2750 | 1350 | 1200 | 950 | 2800 | 650 | 2000 | 1150 | 2100 | 300 | 5100 | 1300 | 10300 | 2500 | 12100 | 1500 | 11900 | 2800 | 10800 | 2000 |
| 4 | 6400 | 1000 | 2400 | 800 | 2500 | 1300 | 2100 | 1100 | 2800 | 650 | 1750 | 1000 | 2000 | 200 | 5300 | 1300 | 9800 | 2300 | 12800 | 1750 | 10800 | 2700 | 10800 | 2400 |
| 5 | 6800 | 750 | 2600 | 1100 | 2300 | 1500 | 2300 | 450 | 2700 | 900 | 2000 | 300 | 1700 | 700 | 5400 | 1300 | 7200 | 1900 | 10000 | 1800 | 9700 | 2500 | 10800 | 2400 |
| 6 | 5700 | 1600 | 2800 | 1050 | 2200 | 600 | 850 | 200 | 2600 | 900 | 1900 | 150 | 1800 | 1200 | 5700 | 1200 | 7200 | 1900 | 6200 | 1900 | 8500 | 1600 | 8500 | 2350 |
| 7 | 5400 | 1750 | 2200 | 1050 | 2450 | 350 | 2300 | 1000 | 2700 | 900 | 2150 | 1000 | 1600 | 1200 | 6300 | 650 | 7300 | 1350 | 12700 | 2100 | 8500 | 1550 | 11800 | 2000 |
| 8 | 5000 | 1700 | 2000 | 950 | 2150 | 1000 | 2300 | 1000 | 2500 | 300 | 1850 | 1000 | 1700 | 1200 | 5800 | 500 | 8000 | 2200 | 12400 | 2400 | 9900 | 2200 | 11000 | 2500 |
| 9 | 4000 | 1700 | 3100 | 500 | 2100 | 1500 | 2650 | 900 | 2300 | 300 | 1800 | 900 | 1700 | 1200 | 5900 | 1100 | 9100 | 2750 | 12000 | 2000 | 9950 | 2400 | 11100 | 2800 |
| 10 | 3400 | 1750 | 3400 | 400 | 1800 | 1450 | 2650 | 900 | 2400 | 850 | 2000 | 900 | 1900 | 300 | 6500 | 1500 | 8900 | 2400 | 11500 | 1900 | 9700 | 2350 | 8000 | 2600 |
| 11 | 4100 | 1300 | 2600 | 1000 | 1650 | 1350 | 2600 | 300 | 2400 | 850 | 2000 | 900 | 1900 | 200 | 7700 | 2000 | 8000 | 1500 | 11700 | 2200 | 9750 | 2450 | 10250 | 2600 |
| 12 | 7500 | 1000 | 2550 | 1600 | 2100 | 900 | 2750 | 250 | 2600 | 850 | 2150 | 200 | 2000 | 800 | 7100 | 2200 | 8200 | 2000 | 10300 | 2400 | 10250 | 2450 | 9800 | 2200 |
| 13 | 7600 | 1000 | 2600 | 1650 | 1800 | 100 | 2800 | 700 | 2150 | 850 | 2200 | 200 | 2000 | 1400 | 7700 | 2300 | 9000 | 1700 | 11900 | 2500 | 11200 | 2000 | 9150 | 1900 |
| 14 | 7500 | 1150 | 2600 | 1750 | 1700 | | 2650 | 900 | 2250 | 800 | 2150 | 700 | 2400 | 1500 | 7700 | 1400 | 10000 | 2000 | 8800 | 2400 | 10800 | 1950 | 8500 | 1500 |
| 15 | 6300 | 2000 | 3250 | 1650 | 850 | | 850 | 950 | 2250 | 200 | 2050 | 1000 | 2900 | 1550 | 9000 | 1250 | 9200 | 2700 | 8700 | 1800 | 10500 | 2500 | 8400 | 2000 |
| 16 | 5850 | 1800 | 2600 | 750 | | | 1800 | 850 | 2300 | 200 | 2400 | 1000 | 2800 | 1600 | 9800 | 2000 | 10000 | 2500 | 7800 | 1750 | 12100 | 3000 | 8350 | 2250 |
| 17 | 5900 | 1250 | 2750 | 450 | | | 2650 | 850 | 2400 | 450 | 2050 | 1100 | 2700 | 700 | 9000 | 2400 | 10900 | 2500 | 8900 | 1700 | 11850 | 3000 | 9100 | 2100 |
| 18 | 6000 | 750 | 2800 | 1250 | | 900 | 2350 | 300 | 2250 | 900 | 2150 | 700 | 2700 | 500 | 7500 | 2300 | 11100 | 2300 | 8200 | 2000 | 11900 | 2900 | 7500 | 2300 |
| 19 | 6800 | 650 | 2250 | 1800 | | 900 | 2400 | 200 | 2100 | 900 | 1900 | 200 | 2800 | 1000 | 7300 | 2200 | 11100 | 2100 | 6100 | 2400 | 11700 | 2600 | 7600 | 1500 |
| 20 | 6500 | 1250 | 2500 | 1800 | | 1000 | 1750 | 700 | 2250 | 850 | 2150 | 150 | 2900 | 1600 | 8200 | 2000 | 11300 | 1800 | 8400 | 2500 | 10400 | 2000 | 8000 | 1100 |
| 21 | 6700 | 2250 | 2800 | 1500 | | 950 | 1400 | 900 | 2050 | 800 | 2100 | 700 | 2900 | 1500 | 9000 | 1800 | 11700 | 2500 | 9300 | 2500 | 10800 | 1900 | 7500 | 850 |
| 22 | 7500 | 3000 | 2850 | 1400 | | | 1250 | 900 | 2000 | 200 | 2100 | 1000 | 2700 | 1200 | 9100 | 1400 | 11100 | 2600 | 8800 | 2000 | 9950 | 2500 | 6700 | 1400 |
| 23 | 5900 | 1900 | 2750 | 500 | | 1300 | 1150 | 900 | 1650 | 250 | 2100 | 1000 | 2800 | 2000 | 8000 | 2000 | 10800 | 2400 | 6850 | 1800 | 11500 | 2950 | 5100 | 1450 |
| 24 | 5100 | 1750 | 3000 | 350 | | 1400 | 1950 | 1000 | 2000 | 600 | 1300 | 1000 | 3200 | 800 | 8000 | 2500 | 11000 | 1800 | 8150 | 1600 | 11100 | 2900 | 4900 | 120 |
| 25 | 5900 | 500 | 4000 | 1050 | | 1350 | 1800 | 700 | 2100 | 850 | 1300 | 900 | 3300 | 500 | 6300 | 2400 | 10800 | 1800 | 6000 | 2000 | 11300 | 2800 | 4700 | 1250 |
| 26 | 4900 | 300 | 2600 | 1600 | | 1550 | 1900 | 300 | 1750 | 1000 | 1550 | 250 | 4300 | 1300 | 8200 | 2300 | 11200 | 1300 | 9000 | 2400 | 11900 | 2850 | 5100 | 1200 |
| 27 | 5000 | 300 | 2600 | 1600 | | 800 | 2000 | 850 | 1800 | 1050 | 2300 | 200 | 5100 | 2200 | 7100 | 2100 | 11200 | 1500 | 10000 | 2500 | 11700 | 2200 | 6950 | 700 |
| 28 | 4900 | 1000 | 2500 | 1450 | | 450 | 2000 | 1100 | 2000 | 850 | 2350 | 750 | 5800 | 1600 | 7700 | 1600 | 9800 | 1500 | 10700 | 2400 | 12000 | 2100 | 6900 | 750 |
| 29 | 2800 | 1300 | 2400 | 1400 | | 800 | 2200 | 1050 | 2100 | 350 | 2150 | 1050 | 4800 | 1300 | 7800 | 1400 | 11200 | 1400 | 10800 | 2350 | | | 7300 | 1150 |
| 30 | 2950 | 1150 | 2400 | 500 | | 1100 | 2200 | 1150 | 1900 | 300 | 2150 | 1100 | 5100 | 1100 | 6100 | 2000 | 12000 | 1500 | 9700 | 2000 | | | 8400 | 1400 |
| 31 | | | 2700 | 400 | | | 2300 | 950 | 1900 | 650 | | | 5000 | 500 | | | 12200 | 1500 | 11500 | 1800 | | | 9000 | 1400 |
| | 171100 | 42850 | 83000 | 32250 | 31050 | 26000 | 59500 | 24800 | 69550 | 19950 | 59950 | 22850 | 86200 | 32450 | 218000 | 50200 | 307400 | 63000 | 310700 | 63550 | 303050 | 68550 | 258800 | 54770 |
| | 30 | 30 | 31 | 31 | 15 | 25 | 30 | 31 | 31 | 31 | 30 | 30 | 31 | 31 | 30 | 30 | 31 | 31 | 31 | 31 | 28 | 28 | 31 | 31 |
| Rearrange in Ascending Order – Steam Follows | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 2000 | 950 | | | 0 | 1250 | 1650 | 250 | | | 1500 | 1000 | | | 7200 | 1900 | 6200 | 1900 | | | 4700 | 1250 |
| | 2800 | 1300 | 2200 | 1050 | | 1350 | 400 | 1250 | 1750 | 1000 | 1300 | 1000 | 1800 | 1200 | 4800 | 1000 | 7200 | 1900 | 7800 | 1750 | | | 4900 | 120 |
| | 2950 | 1150 | 2250 | 1800 | | | 850 | 200 | 1800 | 1050 | 1300 | 900 | 1700 | 1200 | 4900 | 600 | 7300 | 1350 | 8000 | 2000 | | | 5100 | 1450 |
| | 3400 | 1750 | 2350 | 350 | | 1400 | 850 | 950 | 1900 | 300 | 1550 | 250 | 1700 | 700 | 5100 | 1300 | 8000 | 2200 | 8100 | 2400 | 8500 | 1600 | 5100 | 1200 |
| | 4000 | 1700 | 2400 | 500 | | 800 | 1150 | 900 | 1900 | 650 | 1750 | 1000 | 1700 | 1200 | 5300 | 1300 | 8000 | 1500 | 8150 | 1600 | 8500 | 1550 | 6000 | 2600 |
| | 4100 | 1300 | 2400 | 800 | | 450 | 1200 | 950 | 2000 | 850 | 1800 | 900 | 1800 | 1200 | 5400 | 1300 | 8200 | 2000 | 8200 | 2000 | 9700 | 2350 | 6500 | 1500 |
| | 4900 | 300 | 2400 | 1400 | | 800 | 1250 | 900 | 2000 | 200 | 1800 | 1150 | 1900 | 300 | 5700 | 1200 | 8800 | 2400 | 8400 | 2500 | 9700 | 2500 | 6700 | 1400 |
| | 4900 | 1000 | 2450 | 300 | | 1550 | 1400 | 900 | 2000 | 600 | 1850 | 1000 | 1900 | 200 | 5800 | 500 | 8900 | 2400 | 8700 | 1800 | 9750 | 2450 | 6900 | 750 |
| | 5000 | 300 | 2500 | 1800 | | 1300 | 1750 | 700 | 2050 | 800 | 1900 | 200 | 2000 | 200 | 5900 | 1100 | 9000 | 1700 | 8800 | 2400 | 9900 | 2200 | 6950 | 700 |
| | 5000 | 1700 | 2500 | 1450 | | 1100 | 1800 | 700 | 2100 | 900 | 1900 | 150 | 2000 | 1400 | 6300 | 650 | 9100 | 2750 | 8800 | 2000 | 9950 | 2500 | 7300 | 1150 |
| | 5100 | 1750 | 2550 | 1600 | | | 1800 | 850 | 2100 | 850 | 2000 | 1150 | 2000 | 800 | 6500 | 1500 | 9200 | 2700 | 8850 | 1800 | 9950 | 2400 | 7500 | 850 |
| | 5400 | 1750 | 2600 | 750 | | 900 | 1900 | 300 | 2100 | 350 | 2000 | 300 | 2100 | 300 | 7100 | 2100 | 9400 | 2400 | 8900 | 1700 | 10250 | 2450 | 7500 | 2300 |
| | 5700 | 1600 | 2600 | 1600 | | 900 | 1950 | 1000 | 2150 | 850 | 2000 | 900 | 2100 | 300 | 7100 | 2200 | 9600 | 2300 | 9000 | 2400 | 10400 | 2000 | 7600 | 1500 |
| | 5850 | 1800 | 2600 | 1600 | | | 2000 | 1100 | 2200 | 300 | 2000 | 900 | 2400 | 1500 | 7300 | 2200 | 9800 | 1500 | 9300 | 2500 | 10500 | 2500 | 8000 | 1100 |
| | 5900 | 1250 | 2600 | 300 | | 1000 | 2000 | 850 | 2250 | 850 | 2050 | 1100 | 2700 | 700 | 7500 | 2300 | 10000 | 2500 | 9700 | 2000 | 10600 | 1950 | 8350 | 2250 |
| | 5900 | 1900 | 2600 | 1100 | | 950 | 2100 | 1100 | 2250 | 200 | 2050 | 1000 | 2700 | 1200 | 7700 | 2300 | 10000 | 2000 | 10000 | 1800 | 10600 | 1900 | 8400 | 1400 |
| | 5900 | 500 | 2600 | 1750 | 850 | | 2200 | 1150 | 2250 | 900 | 2100 | 1000 | 2700 | 500 | 7700 | 1400 | 10300 | 2500 | 10000 | 2500 | 10800 | 2700 | 8400 | 2000 |
| | 6000 | 750 | 2600 | 1650 | 1700 | | 2200 | 1050 | 2250 | 800 | 2100 | 1000 | 2800 | 2000 | 7700 | 2000 | 10800 | 1800 | 10300 | 2400 | 11100 | 2900 | 8500 | 2350 |
| | 6150 | 2350 | 2600 | 1000 | 1800 | 1450 | 2300 | 450 | 2300 | 300 | 2100 | 700 | 2800 | 1600 | 7700 | 1800 | 10800 | 2400 | 10800 | 2350 | 11200 | 2000 | 9000 | 1400 |
| | 6250 | 2350 | 2700 | 400 | 1800 | 100 | 2300 | 1000 | 2300 | 200 | 2100 | 1200 | 2800 | 1000 | 7800 | 1400 | 10900 | 2500 | 10700 | 2400 | 11300 | 2800 | 9100 | 2100 |
| | 6300 | 2300 | 2750 | 450 | 1850 | 1350 | 2300 | 950 | 2350 | 350 | 2150 | 700 | 2900 | 1500 | 8000 | 2000 | 11000 | 1800 | 11500 | 1800 | 11500 | 2950 | 9150 | 1900 |
| | 6300 | 2000 | 2750 | 500 | 2100 | 1000 | 2300 | 1000 | 2400 | 850 | 2150 | 200 | 2900 | 1600 | 8000 | 2500 | 11100 | 2300 | 11500 | 1900 | 11700 | 2200 | 9800 | 2200 |
| | 6400 | 1000 | 2800 | 1500 | 2100 | 1500 | 2350 | 300 | 2400 | 650 | 2150 | 1050 | 2900 | 1550 | 8100 | 2000 | 11100 | 2100 | 11700 | 2200 | 11700 | 2600 | 10250 | 2600 |
| | 6500 | 1250 | 2800 | 1050 | 2100 | 900 | 2400 | 200 | 2400 | 450 | 2150 | 1000 | 3200 | 800 | 8200 | 2300 | 11100 | 2600 | 11800 | 1500 | 11800 | 2500 | 10300 | 2300 |
| | 6700 | 2250 | 2800 | 1250 | 2150 | 1000 | 2600 | 300 | 2500 | 300 | 2150 | 150 | 3300 | 500 | 8200 | 2000 | 11200 | 1400 | 11900 | 2500 | 11850 | 3000 | 10600 | 2000 |
| | 6800 | 650 | 2850 | 1400 | 2200 | 600 | 2650 | 900 | 2600 | 850 | 2150 | 700 | 4300 | 1300 | 8300 | 2400 | 11200 | 1300 | 12000 | 1700 | 11900 | 2900 | 10700 | 2300 |
| | 6800 | 750 | 3000 | 350 | 2300 | 1500 | 2650 | 850 | 2600 | 900 | 2150 | 1100 | 4800 | 1300 | 9000 | 1800 | 11200 | 1500 | 12000 | 2000 | 11900 | 2850 | 10800 | 2400 |
| | 7500 | 1000 | 3100 | 500 | 2400 | 1100 | 2650 | 900 | 2700 | 900 | 2200 | 200 | 5000 | 500 | 9000 | 2400 | 11300 | 1800 | 12100 | 1500 | 11900 | 2800 | 10800 | 2400 |
| | 7500 | 3000 | 3250 | 1650 | 2450 | 350 | 2650 | 900 | 2700 | 900 | 2300 | 200 | 5100 | 2200 | 9000 | 1250 | 11700 | 2500 | 12400 | 2400 | 12000 | 2900 | 11000 | 2500 |
| | 7500 | 1150 | 3400 | 400 | 2500 | 1300 | 2750 | 250 | 2800 | 850 | 2350 | 750 | 5100 | 1100 | 9100 | 1400 | 12000 | 1500 | 12800 | 1750 | 12000 | 2100 | 11100 | 2800 |
| | 7600 | 1000 | 4000 | 1050 | 2750 | 1350 | 2800 | 700 | 2800 | 850 | 2400 | 1000 | 5800 | 1600 | 9800 | 2000 | 12200 | 1500 | 12700 | 2100 | 12100 | 3000 | 11800 | 2000 |



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This progression is developed in Page 1 of Exhibit 3-7 both as cumulative megawatt hours and subsequently as average megawatts over 24 hour decrements from maximum hours in the month through the 24 hour peak. Finally, in Page 2 of Exhibit 3-7, data are reorganized in a matrix with X axis coordinates from zero to maximum hours in the month and Y axis coordinates in descending order from maximum to minimum levels of hot water demand. Hot water load duration curves representative of these data are developed for each test month in the two pages of Exhibit 3-8.

Since historical data were provided only on a daily basis, it was not possible to represent demand levels other than as daily (24 hour) averages. However, given the relatively long reaction time of hot water loads, this was considered not unreasonable for purposes of this analysis.

Since one of the principal functions of the economic analysis model applied in Section 8.0 is to establish a reasonable approximation of fuel costs under alternative system configurations, it is essential also to access data representing total megawatt hours through various load levels, i. e., the area under the respective monthly load duration curves. Exhibit 3-9 illustrates the development of MWH relationships (% of total monthly MWH) at each tenth percentile of peak hot water demand, the basis utilized within the model to interpolate production levels.

While hot water load criteria have been controlling in the development of demand data described above, simultaneous steam requirements have been represented as well. Since in most cases, heat in the form of hot water and steam is served from the same facilities, it is inappropriate to consider independent load profiles for each commodity. On the other hand, as demonstrated in the two pages of Exhibit 3-10, it is difficult to establish a meaningful pattern of steam loads coincident with hot water demands. Consequently, in the table of load simulation model inputs summarized in Exhibit 3-10, steam loads are treated uniformly through all time periods. Total monthly production of hot water and steam and average electric internal use based on provided statistics are shown at the bottom of this exhibit. Where minor differences with detail data occur, these reported statistics are assumed to prevail.

In a manner similar to that illustrated for TPS Sofia, demand criteria was also established from information provided for Trajco Kostova. The resultant load duration curves are shown in the two pages of Exhibit 3-11. A comparison of Sofia and Trajco Kostova load profiles is shown in Exhibit 3-12. Since necessary detail was not available for either Liulin or Pernik, Sofia load profiles were applied as a surrogate.

In each case, however, such generalized load shapes were related to actual monthly production totals available for both locations.



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# Exhibit 3-7

## Hot Water and Steam MW at 24 Hour Use Intervals

Total MWH over # Days

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 0 | 62000 | 0 | 0 | 51150 | 0 | 46500 | 0 | 223200 | 192200 | 0 | 145700 |
| 30 | 84000 | 66000 | 0 | 12000 | 52500 | 39000 | 48000 | 144000 | 0 | 234000 | 0 | 147000 |
| 29 | 85550 | 65250 | 0 | 24650 | 52200 | 0 | 49300 | 142100 | 211700 | 232000 | 0 | 147900 |
| 28 | 95200 | 65800 | 0 | 0 | 53200 | 43400 | 0 | 142800 | 224000 | 226800 | 238000 | 0 |
| 27 | 106000 | 64800 | 0 | 31050 | 0 | 47250 | 0 | 143100 | 0 | 220050 | 0 | 162000 |
| 26 | 106600 | 0 | 0 | 31200 | 52000 | 46800 | 46800 | 140400 | 213200 | 213200 | 252200 | 169000 |
| 25 | 122500 | 0 | 0 | 31250 | 0 | 0 | 47500 | 142500 | 220000 | 210000 | 0 | 167500 |
| 24 | 0 | 58800 | 0 | 33600 | 0 | 44400 | 0 | 139200 | 213600 | 206800 | 234000 | 165600 |
| 23 | 115000 | 57500 | 0 | 40250 | 47150 | 43700 | 46000 | 135700 | 207000 | 202400 | 227700 | 159850 |
| 22 | 0 | 0 | 0 | 39600 | 46200 | 0 | 0 | 138600 | 200200 | 0 | 218900 | 160600 |
| 21 | 107100 | 53550 | 0 | 0 | 0 | 42000 | 0 | 136500 | 193200 | 185850 | 0 | 157500 |
| 20 | 108000 | 52000 | 0 | 38000 | 0 | 0 | 42000 | 142000 | 188000 | 178000 | 205000 | 0 |
| 19 | 108300 | 0 | 0 | 37050 | 40850 | 0 | 0 | 0 | 182400 | 171000 | 197600 | 144400 |
| 18 | 105300 | 0 | 0 | 36000 | 39600 | 0 | 43200 | 131400 | 176400 | 167400 | 189000 | 144000 |
| 17 | 100300 | 0 | 0 | 0 | 38250 | 34850 | 45800 | 127500 | 170000 | 164900 | 180200 | 141950 |
| 16 | 0 | 0 | 0 | 33600 | 0 | 0 | 0 | 123200 | 0 | 160000 | 0 | 134400 |
| 15 | 0 | 0 | 12750 | 33000 | 0 | 31500 | 0 | 0 | 154500 | 0 | 162000 | 0 |
| 14 | 84000 | 0 | 23800 | 0 | 0 | 0 | 39200 | 0 | 148400 | 144200 | 155400 | 119000 |
| 13 | 79950 | 0 | 23400 | 29900 | 29900 | 0 | 0 | 0 | 140400 | 137800 | 145600 | 117000 |
| 12 | 75000 | 32400 | 0 | 0 | 0 | 0 | 0 | 93600 | 130800 | 128400 | 135600 | 109200 |
| 11 | 69300 | 30250 | 20350 | 0 | 25850 | 23650 | 31900 | 88000 | 121000 | 126500 | 126500 | 100650 |
| 10 | 0 | 0 | 21000 | 0 | 24000 | 0 | 0 | 0 | 111000 | 0 | 117000 | 98000 |
| 9 | 57800 | 25200 | 0 | 21150 | 0 | 0 | 0 | 72900 | 0 | 105300 | 0 | 92250 |
| 8 | 52000 | 0 | 0 | 19200 | 0 | 0 | 25600 | 65600 | 0 | 94400 | 94400 | 82400 |
| 7 | 46900 | 0 | 15050 | 18200 | 17500 | 0 | 23100 | 0 | 78400 | 83300 | 82950 | 74200 |
| 6 | 40600 | 17100 | 13200 | 15900 | 15600 | 0 | 25800 | 49800 | 0 | 72000 | 71400 | 64200 |
| 5 | 0 | 15000 | 11500 | 0 | 0 | 0 | 24000 | 45000 | 0 | 0 | 0 | 54000 |
| 4 | 30000 | 12400 | 9600 | 0 | 10600 | 8800 | 20000 | 0 | 45200 | 48400 | 0 | 0 |
| 3 | 0 | 9750 | 7350 | 0 | 0 | 6900 | 15300 | 0 | 35100 | 37200 | 36000 | 33000 |
| 2 | 0 | 6800 | 5000 | 5500 | 5600 | 4700 | 0 | 18200 | 24000 | 25200 | 0 | 22200 |
| 1 | 7600 | 4000 | 2750 | 2800 | 0 | 2400 | 5800 | 9800 | 12200 | 12700 | 12100 | 11800 |

Hot Water MW at Hours Use Levels – (Steam Follows)

| Hrs | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 744 | 0.0 | 0.0 | 83.3 | 39.6 | 0.0 | 0.0 | 0.0 | 52.1 | 68.8 | 10.4 | 0.0 | 0.0 | 62.5 | 41.7 | 0.0 | 0.0 | 300.0 | 79.2 | 258.3 | 79.2 | 0.0 | 0.0 | 195.8 | 52.1 |
| 720 | 116.7 | 54.2 | 91.7 | 43.8 | 0.0 | 56.3 | 16.7 | 52.1 | 72.9 | 41.7 | 54.2 | 41.7 | 66.7 | 50.0 | 200.0 | 41.7 | 300.0 | 79.2 | 325.0 | 72.9 | 0.0 | 0.0 | 204.2 | 5.0 |
| 696 | 122.9 | 47.9 | 93.8 | 75.0 | 0.0 | 0.0 | 35.4 | 8.3 | 75.0 | 43.8 | 54.2 | 37.5 | 70.8 | 50.0 | 204.2 | 25.0 | 304.2 | 56.3 | 333.3 | 83.3 | 0.0 | 0.0 | 212.5 | 60.4 |
| 672 | 141.7 | 72.9 | 97.9 | 14.6 | 0.0 | 58.3 | 35.4 | 39.6 | 79.2 | 12.5 | 64.6 | 10.4 | 70.8 | 29.2 | 212.5 | 54.2 | 333.3 | 91.7 | 337.5 | 100.0 | 354.2 | 66.7 | 212.5 | 50.0 |
| 648 | 166.7 | 70.8 | 100.0 | 20.8 | 0.0 | 33.3 | 47.9 | 37.5 | 79.2 | 27.1 | 72.9 | 41.7 | 70.8 | 50.0 | 220.8 | 54.2 | 333.3 | 62.5 | 339.6 | 66.7 | 354.2 | 64.6 | 250.0 | 106.3 |
| 624 | 170.8 | 54.2 | 100.0 | 33.3 | 0.0 | 18.8 | 50.0 | 39.6 | 83.3 | 35.4 | 75.0 | 37.5 | 75.0 | 50.0 | 225.0 | 54.2 | 341.7 | 83.3 | 341.7 | 83.3 | 404.2 | 97.9 | 270.8 | 62.5 |
| 600 | 204.2 | 12.5 | 100.0 | 58.3 | 0.0 | 33.3 | 52.1 | 37.5 | 83.3 | 8.3 | 75.0 | 47.9 | 79.2 | 12.5 | 237.5 | 50.0 | 366.7 | 100.0 | 350.0 | 104.2 | 404.2 | 104.2 | 279.2 | 58.3 |
| 576 | 204.2 | 41.7 | 102.1 | 12.5 | 0.0 | 64.6 | 58.3 | 37.5 | 83.3 | 25.0 | 77.1 | 41.7 | 79.2 | 8.3 | 241.7 | 20.8 | 370.8 | 100.0 | 362.5 | 75.0 | 406.3 | 102.1 | 287.5 | 31.3 |
| 552 | 208.3 | 12.5 | 104.2 | 75.0 | 0.0 | 54.2 | 72.9 | 29.2 | 85.4 | 33.3 | 79.2 | 8.3 | 83.3 | 8.3 | 245.8 | 45.8 | 375.0 | 70.8 | 366.7 | 100.0 | 412.5 | 91.7 | 289.6 | 29.2 |
| 528 | 208.3 | 70.8 | 104.2 | 60.4 | 0.0 | 45.8 | 75.0 | 29.2 | 87.5 | 37.5 | 79.2 | 6.3 | 83.3 | 58.3 | 262.5 | 27.1 | 379.2 | 114.6 | 366.7 | 83.3 | 414.6 | 104.2 | 304.2 | 47.9 |
| 504 | 212.5 | 72.9 | 106.3 | 66.7 | 0.0 | 0.0 | 75.0 | 35.4 | 87.5 | 35.4 | 83.3 | 47.9 | 83.3 | 33.3 | 270.8 | 62.5 | 383.3 | 112.5 | 368.8 | 75.0 | 414.6 | 100.0 | 312.5 | 35.4 |
| 480 | 225.0 | 72.9 | 108.3 | 31.3 | 0.0 | 37.5 | 79.2 | 12.5 | 87.5 | 14.6 | 83.3 | 12.5 | 87.5 | 12.5 | 295.8 | 87.5 | 391.7 | 100.0 | 370.8 | 70.8 | 427.1 | 102.1 | 312.5 | 95.8 |
| 456 | 237.5 | 66.7 | 108.3 | 66.7 | 0.0 | 37.5 | 81.3 | 41.7 | 89.6 | 35.4 | 83.3 | 37.5 | 87.5 | 12.5 | 295.8 | 91.7 | 400.0 | 95.8 | 375.0 | 100.0 | 433.3 | 83.3 | 316.7 | 62.5 |
| 432 | 243.8 | 75.0 | 108.3 | 66.7 | 0.0 | 0.0 | 83.3 | 45.8 | 91.7 | 12.5 | 83.3 | 37.5 | 100.0 | 62.5 | 304.2 | 91.7 | 408.3 | 62.5 | 387.5 | 104.2 | 437.5 | 104.2 | 333.3 | 45.8 |
| 408 | 245.8 | 52.1 | 108.3 | 12.5 | 0.0 | 41.7 | 83.3 | 35.4 | 93.8 | 35.4 | 85.4 | 45.8 | 112.5 | 29.2 | 312.5 | 95.8 | 416.7 | 104.2 | 404.2 | 83.3 | 441.7 | 81.3 | 347.9 | 93.8 |
| 384 | 245.8 | 79.2 | 108.3 | 45.8 | 0.0 | 39.6 | 87.5 | 45.8 | 93.8 | 8.3 | 85.4 | 41.7 | 112.5 | 50.0 | 320.8 | 95.8 | 416.7 | 83.3 | 416.7 | 75.0 | 441.7 | 79.2 | 350.0 | 58.3 |
| 360 | 245.8 | 20.8 | 108.3 | 72.9 | 35.4 | 0.0 | 91.7 | 47.9 | 93.8 | 37.5 | 87.5 | 41.7 | 112.5 | 20.8 | 320.8 | 58.3 | 429.2 | 104.2 | 416.7 | 104.2 | 450.0 | 112.5 | 350.0 | 83.3 |
| 336 | 250.0 | 31.3 | 108.3 | 68.8 | 70.8 | 0.0 | 91.7 | 43.8 | 93.8 | 33.3 | 87.5 | 41.7 | 116.7 | 83.3 | 320.8 | 83.3 | 441.7 | 75.0 | 429.2 | 100.0 | 462.5 | 120.8 | 354.2 | 97.9 |
| 312 | 256.3 | 97.9 | 108.3 | 41.7 | 75.0 | 60.4 | 95.8 | 18.8 | 95.8 | 12.5 | 87.5 | 29.2 | 116.7 | 66.7 | 320.8 | 75.0 | 450.0 | 100.0 | 441.7 | 97.9 | 466.7 | 83.3 | 375.0 | 58.3 |
| 288 | 260.4 | 97.9 | 112.5 | 16.7 | 75.0 | 4.2 | 95.8 | 41.7 | 95.8 | 8.3 | 87.5 | 50.0 | 116.7 | 41.7 | 325.0 | 58.3 | 454.2 | 104.2 | 445.8 | 100.0 | 470.8 | 116.7 | 379.2 | 87.5 |
| 264 | 262.5 | 95.8 | 114.6 | 18.8 | 77.1 | 56.3 | 95.8 | 39.6 | 97.9 | 14.6 | 89.6 | 29.2 | 120.8 | 62.5 | 333.3 | 83.3 | 458.3 | 75.0 | 479.2 | 75.0 | 479.2 | 122.9 | 381.3 | 79.2 |
| 240 | 262.5 | 83.3 | 114.6 | 20.8 | 87.5 | 41.7 | 95.8 | 41.7 | 100.0 | 35.4 | 89.6 | 8.3 | 120.8 | 66.7 | 333.3 | 104.2 | 462.5 | 95.8 | 479.2 | 79.2 | 487.5 | 91.7 | 408.3 | 91.7 |
| 216 | 266.7 | 41.7 | 116.7 | 62.5 | 87.5 | 62.5 | 97.9 | 12.5 | 100.0 | 27.1 | 89.6 | 43.8 | 120.8 | 64.6 | 337.5 | 83.3 | 462.5 | 87.5 | 487.5 | 91.7 | 487.5 | 106.3 | 427.1 | 106.3 |
| 192 | 270.8 | 52.1 | 116.7 | 43.8 | 87.5 | 37.5 | 100.0 | 8.3 | 100.0 | 18.8 | 89.6 | 41.7 | 133.3 | 33.3 | 341.7 | 95.8 | 462.5 | 106.3 | 491.7 | 62.5 | 491.7 | 104.2 | 429.2 | 95.8 |
| 168 | 279.2 | 93.8 | 116.7 | 52.1 | 89.6 | 41.7 | 106.3 | 12.5 | 104.2 | 12.5 | 89.6 | 6.3 | 137.5 | 20.8 | 341.7 | 83.3 | 466.7 | 58.3 | 495.8 | 104.2 | 493.8 | 125.0 | 441.7 | 83.3 |
| 144 | 283.3 | 27.1 | 116.8 | 56.3 | 91.7 | 25.0 | 110.4 | 37.5 | 106.3 | 35.4 | 89.6 | 29.2 | 179.2 | 54.2 | 345.8 | 100.0 | 466.7 | 54.2 | 500.0 | 70.8 | 495.8 | 120.8 | 445.8 | 95.8 |
| 120 | 283.3 | 31.3 | 125.0 | 14.6 | 95.8 | 62.5 | 110.4 | 35.4 | 106.3 | 37.5 | 89.6 | 45.8 | 200.0 | 54.2 | 375.0 | 75.0 | 466.7 | 62.5 | 500.0 | 83.3 | 495.8 | 116.8 | 450.0 | 100.0 |
| 96 | 312.5 | 41.7 | 129.2 | 20.8 | 100.0 | 45.8 | 110.4 | 37.5 | 112.5 | 37.5 | 91.7 | 8.3 | 208.3 | 20.8 | 375.0 | 100.0 | 470.8 | 75.0 | 504.2 | 62.5 | 495.8 | 116.7 | 450.0 | 100.0 |
| 72 | 312.5 | 125.0 | 135.4 | 68.8 | 102.1 | 14.6 | 110.4 | 37.5 | 112.5 | 37.5 | 95.8 | 8.3 | 212.5 | 91.7 | 375.0 | 52.1 | 487.5 | 104.2 | 516.7 | 100.0 | 500.0 | 120.8 | 458.3 | 104.2 |
| 48 | 312.5 | 47.9 | 141.7 | 16.7 | 104.2 | 54.2 | 114.6 | 10.4 | 116.7 | 35.4 | 97.9 | 31.3 | 212.5 | 45.8 | 379.2 | 58.3 | 500.0 | 62.5 | 525.0 | 72.9 | 500.0 | 87.5 | 462.5 | 116.7 |
| 24 | 316.7 | 41.7 | 166.7 | 43.8 | 114.6 | 56.3 | 116.7 | 29.2 | 116.7 | 27.1 | 100.0 | 41.7 | 241.7 | 66.7 | 408.3 | 83.3 | 508.3 | 62.5 | 529.2 | 87.5 | 504.2 | 125.0 | 491.7 | 83.3 |
| 0 | 316.7 | 0.0 | 166.7 | 0.0 | 114.6 | 0.0 | 116.7 | 0.0 | 116.7 | 0.0 | 100.0 | 0.0 | 241.7 | 0.0 | 408.3 | 0.0 | 508.3 | 0.0 | 529.2 | 0.0 | 504.2 | 0.0 | 491.7 | 0.0 |



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# Exhibit 3-7 (Cont'd)

## Hot Water and Steam MW at 24 Hour Use Intervals

Descending Order

| Hrs | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW | HW MW | Stm MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 316.7 | 0.0 | 166.7 | 0.0 | 114.6 | 0.0 | 116.7 | 0.0 | 116.7 | 0.0 | 100.0 | 0.0 | 241.7 | 0.0 | 408.3 | 0.0 | 508.3 | 0.0 | 529.2 | 0.0 | 504.2 | 0.0 | 491.7 | 0.0 |
| 24 | 316.7 | 41.7 | 166.7 | 43.8 | 114.6 | 56.3 | 116.7 | 29.2 | 116.7 | 27.1 | 100.0 | 41.7 | 241.7 | 66.7 | 408.3 | 83.3 | 508.3 | 62.5 | 529.2 | 87.5 | 504.2 | 125.0 | 491.7 | 83.3 |
| 48 | 312.5 | 47.9 | 141.7 | 16.7 | 104.2 | 54.2 | 114.6 | 10.4 | 116.7 | 35.4 | 97.9 | 31.3 | 212.5 | 45.8 | 379.2 | 58.3 | 500.0 | 62.5 | 525.0 | 72.9 | 500.0 | 87.5 | 462.5 | 116.7 |
| 72 | 312.5 | 125.0 | 135.4 | 68.8 | 102.1 | 14.6 | 110.4 | 37.5 | 112.5 | 37.5 | 95.8 | 8.3 | 212.5 | 91.7 | 375.0 | 52.1 | 487.5 | 104.2 | 516.7 | 100.0 | 500.0 | 120.8 | 458.3 | 104.2 |
| 96 | 312.5 | 41.7 | 129.2 | 20.8 | 100.0 | 45.8 | 110.4 | 37.5 | 112.5 | 37.5 | 91.7 | 8.3 | 208.3 | 20.8 | 375.0 | 100.0 | 470.8 | 75.0 | 504.2 | 62.5 | 495.8 | 116.7 | 450.0 | 100.0 |
| 120 | 283.3 | 31.3 | 125.0 | 14.6 | 95.8 | 62.5 | 110.4 | 35.4 | 108.3 | 37.5 | 89.6 | 45.8 | 200.0 | 54.2 | 375.0 | 75.0 | 466.7 | 62.5 | 500.0 | 83.3 | 495.8 | 118.8 | 450.0 | 100.0 |
| 144 | 283.3 | 27.1 | 118.8 | 58.3 | 91.7 | 25.0 | 110.4 | 37.5 | 108.3 | 35.4 | 89.6 | 29.2 | 179.2 | 54.2 | 345.8 | 100.0 | 466.7 | 54.2 | 500.0 | 70.8 | 495.8 | 120.8 | 445.8 | 95.8 |
| 168 | 279.2 | 93.8 | 116.7 | 52.1 | 89.6 | 41.7 | 108.3 | 12.5 | 104.2 | 12.5 | 89.6 | 6.3 | 137.5 | 20.8 | 341.7 | 83.3 | 466.7 | 58.3 | 495.8 | 104.2 | 493.8 | 125.0 | 441.7 | 83.3 |
| 192 | 270.8 | 52.1 | 116.7 | 43.8 | 87.5 | 37.5 | 100.0 | 8.3 | 100.0 | 18.8 | 89.6 | 41.7 | 133.3 | 33.3 | 341.7 | 95.8 | 462.5 | 108.3 | 491.7 | 62.5 | 491.7 | 104.2 | 429.2 | 95.8 |
| 216 | 266.7 | 41.7 | 116.7 | 62.5 | 87.5 | 62.5 | 97.9 | 12.5 | 100.0 | 27.1 | 89.6 | 43.8 | 120.8 | 64.6 | 337.5 | 83.3 | 462.5 | 87.5 | 487.5 | 91.7 | 487.5 | 108.3 | 427.1 | 108.3 |
| 240 | 262.5 | 83.3 | 114.6 | 20.8 | 87.5 | 41.7 | 95.8 | 41.7 | 100.0 | 35.4 | 89.6 | 8.3 | 120.8 | 66.7 | 333.3 | 104.2 | 462.5 | 95.8 | 479.2 | 79.2 | 487.5 | 91.7 | 408.3 | 91.7 |
| 264 | 262.5 | 95.8 | 114.6 | 18.8 | 77.1 | 56.3 | 95.8 | 39.6 | 97.9 | 14.6 | 89.6 | 29.2 | 120.8 | 62.5 | 333.3 | 83.3 | 458.3 | 75.0 | 479.2 | 75.0 | 479.2 | 122.9 | 381.3 | 79.2 |
| 288 | 260.4 | 97.9 | 112.5 | 16.7 | 75.0 | 4.2 | 95.8 | 41.7 | 95.8 | 8.3 | 87.5 | 50.0 | 116.7 | 41.7 | 325.0 | 58.3 | 454.2 | 104.2 | 445.8 | 100.0 | 470.8 | 116.7 | 379.2 | 87.5 |
| 312 | 256.3 | 97.9 | 108.3 | 41.7 | 75.0 | 60.4 | 95.8 | 18.8 | 95.8 | 12.5 | 87.5 | 29.2 | 116.7 | 66.7 | 320.8 | 75.0 | 450.0 | 100.0 | 441.7 | 97.9 | 466.7 | 83.3 | 375.0 | 58.3 |
| 336 | 250.0 | 31.3 | 108.3 | 68.8 | 70.8 | 0.0 | 91.7 | 43.8 | 93.8 | 33.3 | 87.5 | 41.7 | 116.7 | 83.3 | 320.8 | 83.3 | 441.7 | 75.0 | 429.2 | 100.0 | 462.5 | 120.8 | 354.2 | 97.9 |
| 360 | 245.8 | 20.8 | 108.3 | 72.9 | 35.4 | 0.0 | 91.7 | 47.9 | 93.8 | 37.5 | 87.5 | 41.7 | 112.5 | 20.8 | 320.8 | 58.3 | 429.2 | 104.2 | 416.7 | 104.2 | 450.0 | 112.5 | 350.0 | 83.3 |
| 384 | 245.8 | 79.2 | 108.3 | 45.8 | 0.0 | 39.6 | 87.5 | 45.8 | 93.8 | 8.3 | 85.4 | 41.7 | 112.5 | 50.0 | 320.8 | 95.8 | 416.7 | 83.3 | 416.7 | 75.0 | 441.7 | 79.2 | 350.0 | 58.3 |
| 408 | 245.8 | 52.1 | 108.3 | 12.5 | 0.0 | 41.7 | 83.3 | 35.4 | 93.8 | 35.4 | 85.4 | 45.8 | 112.5 | 29.2 | 312.5 | 95.8 | 416.7 | 104.2 | 404.2 | 83.3 | 441.7 | 81.3 | 347.9 | 93.8 |
| 432 | 243.8 | 75.0 | 108.3 | 66.7 | 0.0 | 0.0 | 83.3 | 45.8 | 91.7 | 12.5 | 83.3 | 37.5 | 100.0 | 62.5 | 304.2 | 91.7 | 408.3 | 62.5 | 387.5 | 104.2 | 437.5 | 104.2 | 333.3 | 45.8 |
| 456 | 237.5 | 66.7 | 108.3 | 66.7 | 0.0 | 37.5 | 81.3 | 41.7 | 89.6 | 35.4 | 83.3 | 37.5 | 87.5 | 12.5 | 295.8 | 91.7 | 400.0 | 95.8 | 375.0 | 100.0 | 433.3 | 83.3 | 316.7 | 62.5 |
| 480 | 225.0 | 72.9 | 108.3 | 31.3 | 0.0 | 37.5 | 79.2 | 12.5 | 87.5 | 14.6 | 83.3 | 12.5 | 87.5 | 12.5 | 295.8 | 87.5 | 391.7 | 100.0 | 370.8 | 70.8 | 427.1 | 102.1 | 312.5 | 95.8 |
| 504 | 212.5 | 72.9 | 106.3 | 66.7 | 0.0 | 0.0 | 75.0 | 35.4 | 87.5 | 35.4 | 83.3 | 47.9 | 83.3 | 33.3 | 270.8 | 62.5 | 383.3 | 112.5 | 368.8 | 75.0 | 414.6 | 100.0 | 312.5 | 35.4 |
| 528 | 208.3 | 70.8 | 104.2 | 60.4 | 0.0 | 45.8 | 75.0 | 29.2 | 87.5 | 37.5 | 79.2 | 6.3 | 83.3 | 58.3 | 262.5 | 27.1 | 379.2 | 114.6 | 366.7 | 83.3 | 414.6 | 104.2 | 304.2 | 47.9 |
| 552 | 208.3 | 12.5 | 104.2 | 75.0 | 0.0 | 54.2 | 72.9 | 29.2 | 85.4 | 33.3 | 79.2 | 6.3 | 83.3 | 8.3 | 245.8 | 45.8 | 375.0 | 70.8 | 366.7 | 100.0 | 412.5 | 91.7 | 289.6 | 29.2 |
| 576 | 204.2 | 41.7 | 102.1 | 12.5 | 0.0 | 64.6 | 58.3 | 37.5 | 83.3 | 25.0 | 77.1 | 41.7 | 79.2 | 8.3 | 241.7 | 20.8 | 370.8 | 100.0 | 362.5 | 75.0 | 406.3 | 102.1 | 287.5 | 31.3 |
| 600 | 204.2 | 12.5 | 100.0 | 58.3 | 0.0 | 33.3 | 52.1 | 37.5 | 83.3 | 8.3 | 75.0 | 47.9 | 79.2 | 12.5 | 237.5 | 50.0 | 366.7 | 100.0 | 350.0 | 104.2 | 404.2 | 104.2 | 279.2 | 58.3 |
| 624 | 170.8 | 54.2 | 100.0 | 33.3 | 0.0 | 18.8 | 50.0 | 39.6 | 83.3 | 35.4 | 75.0 | 37.5 | 75.0 | 50.0 | 225.0 | 54.2 | 341.7 | 83.3 | 341.7 | 83.3 | 404.2 | 97.9 | 270.8 | 62.5 |
| 648 | 166.7 | 70.8 | 100.0 | 20.8 | 0.0 | 33.3 | 47.9 | 37.5 | 79.2 | 27.1 | 72.9 | 41.7 | 70.8 | 50.0 | 220.8 | 54.2 | 333.3 | 62.5 | 339.6 | 66.7 | 354.2 | 64.6 | 250.0 | 108.3 |
| 672 | 141.7 | 72.9 | 97.9 | 14.6 | 0.0 | 58.3 | 35.4 | 39.6 | 79.2 | 12.5 | 64.6 | 10.4 | 70.8 | 29.2 | 212.5 | 54.2 | 333.3 | 91.7 | 337.5 | 100.0 | 354.2 | 66.7 | 212.5 | 50.0 |
| 696 | 122.9 | 47.9 | 93.8 | 75.0 | 0.0 | 0.0 | 35.4 | 8.3 | 75.0 | 43.8 | 54.2 | 37.5 | 70.8 | 50.0 | 204.2 | 25.0 | 304.2 | 56.3 | 333.3 | 83.3 | 0.0 | 0.0 | 212.5 | 60.4 |
| 720 | 116.7 | 54.2 | 91.7 | 43.8 | 0.0 | 56.3 | 16.7 | 52.1 | 72.9 | 41.7 | 54.2 | 41.7 | 66.7 | 50.0 | 200.0 | 41.7 | 300.0 | 79.2 | 325.0 | 72.9 | 0.0 | 0.0 | 204.2 | 5.0 |
| 744 | 0.0 | 0.0 | 83.3 | 39.6 | 0.0 | 0.0 | 0.0 | 52.1 | 68.8 | 10.4 | 0.0 | 0.0 | 62.5 | 41.7 | 0.0 | 0.0 | 300.0 | 79.2 | 258.3 | 79.2 | 0.0 | 0.0 | 195.8 | 52.1 |



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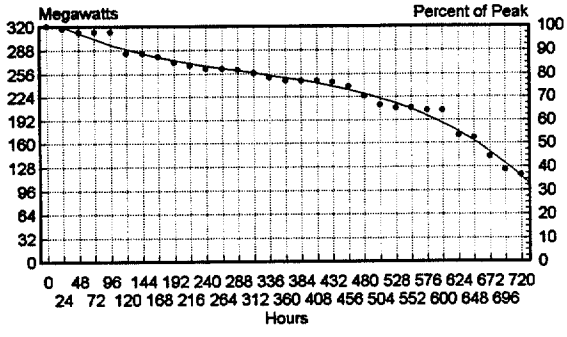
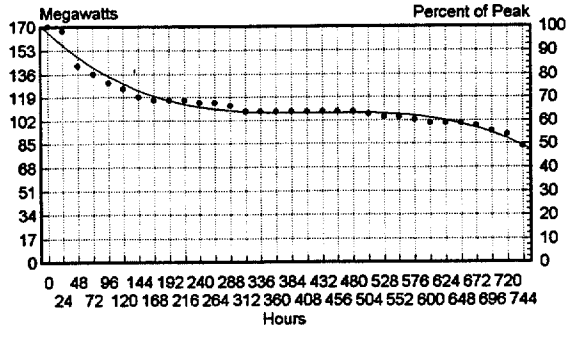
# Exhibit 3-8

## Load Duration Curves - Sofia
## Hot Water
## (April, 1992 - September, 1992)

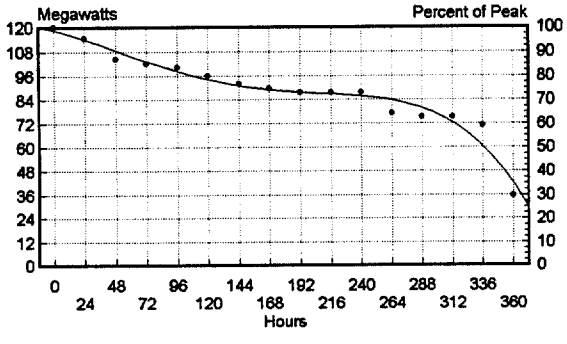
**APRIL**



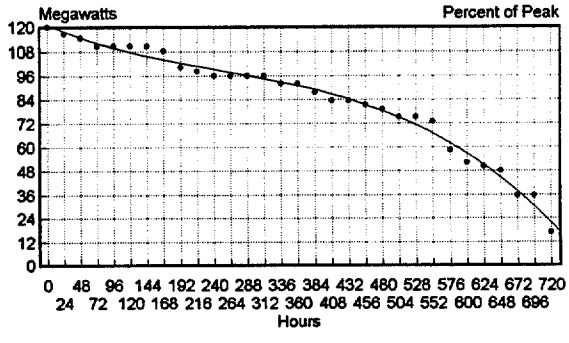

**MAY**



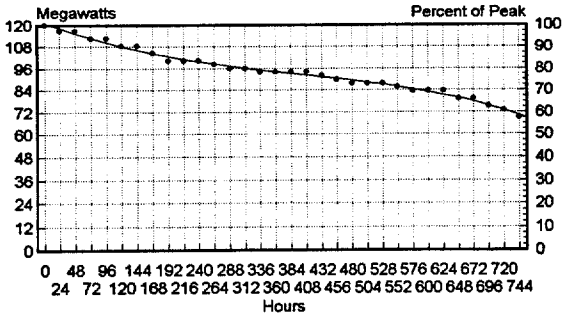

**JUNE**



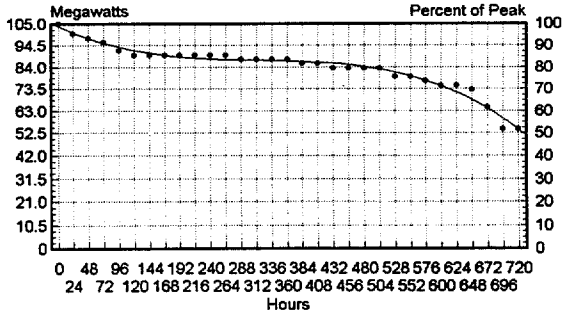

**JULY**




**AUGUST**




**SEPTEMBER**



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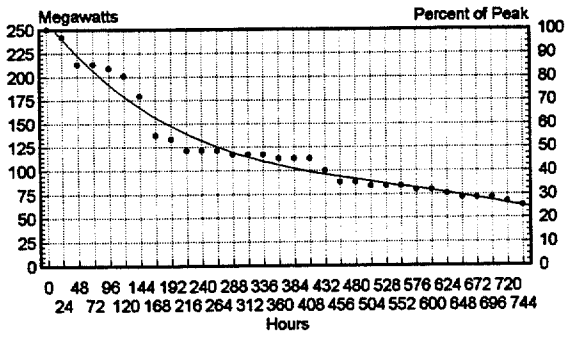
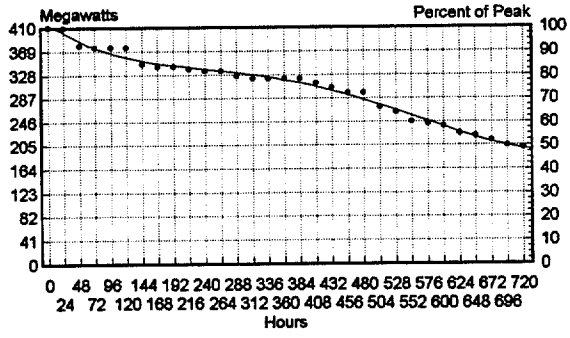
# Exhibit 3-8 (Cont'd)

## Load Duration Curves - Sofia
## Hot Water
## (October, 1992 - March, 1993)

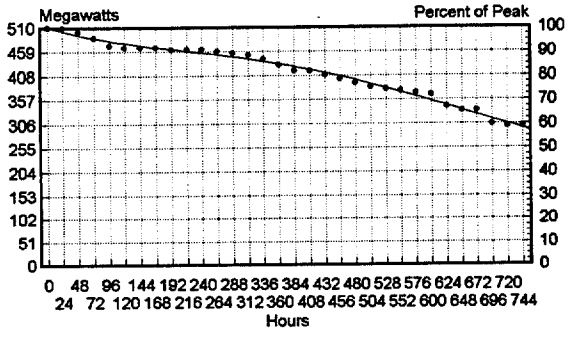
**OCTOBER**



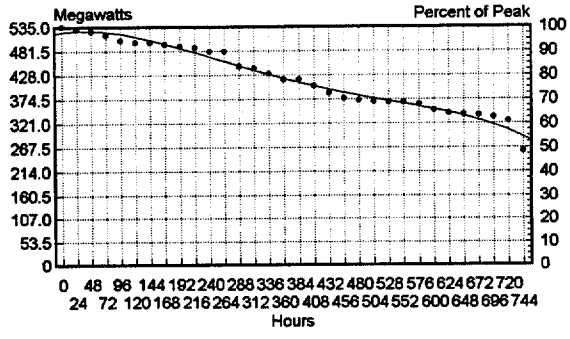

**NOVEMBER**



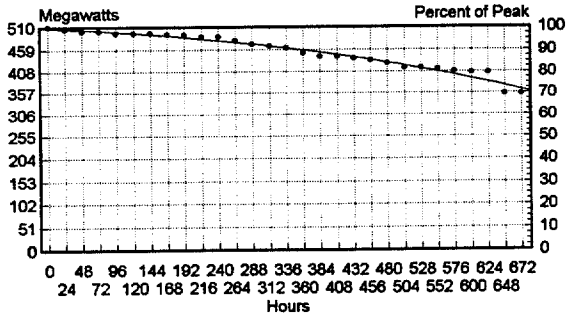

**DECEMBER**



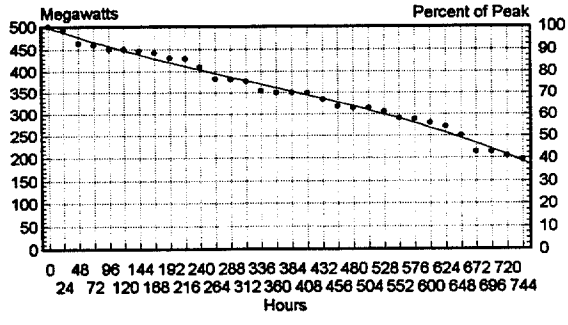

**JANUARY, 1993**




**FEBRUARY**




**MARCH**



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# Exhibit 3-9

## Cumulative Hot Water MWH at Peak Load Percentiles

Cumulative MWH at % of Peak Load – Hot Water Only

| Days | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH | % of Peak | MWH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 0.000 | 0 | 0.500 | 62000 | 0.000 | 0 | 0.000 | 0 | 0.569 | 51150 | 0.000 | 0 | 0.259 | 46500 | 0.000 | 0 | 0.590 | 223200 | 0.468 | 192200 | 0.000 | 0 | 0.398 | 145700 |
| 30 | 0.368 | 84000 | 0.550 | 68000 | 0.000 | 0 | 0.143 | 12000 | 0.625 | 54150 | 0.542 | 39000 | 0.276 | 49500 | 0.490 | 144000 | 0.590 | 223200 | 0.614 | 240200 | 0.000 | 0 | 0.415 | 151700 |
| 29 | 0.368 | 88350 | 0.563 | 69450 | 0.000 | 0 | 0.304 | 25050 | 0.643 | 55600 | 0.542 | 39000 | 0.293 | 52400 | 0.500 | 146900 | 0.598 | 226100 | 0.630 | 246000 | 0.000 | 0 | 0.432 | 157500 |
| 28 | 0.447 | 100950 | 0.588 | 72250 | 0.000 | 0 | 0.304 | 25050 | 0.679 | 58400 | 0.646 | 46000 | 0.293 | 52400 | 0.520 | 152500 | 0.656 | 245700 | 0.638 | 248800 | 0.702 | 238000 | 0.432 | 157500 |
| 27 | 0.526 | 117150 | 0.600 | 73600 | 0.000 | 0 | 0.411 | 33150 | 0.679 | 58400 | 0.729 | 51400 | 0.293 | 52400 | 0.541 | 157900 | 0.656 | 245700 | 0.642 | 250150 | 0.702 | 238000 | 0.508 | 181800 |
| 26 | 0.539 | 119750 | 0.600 | 73600 | 0.000 | 0 | 0.429 | 34450 | 0.714 | 61000 | 0.750 | 52700 | 0.310 | 55000 | 0.551 | 160500 | 0.672 | 250900 | 0.646 | 251450 | 0.802 | 269200 | 0.551 | 194800 |
| 25 | 0.645 | 139750 | 0.600 | 73600 | 0.000 | 0 | 0.446 | 35700 | 0.714 | 61000 | 0.750 | 52700 | 0.328 | 57500 | 0.582 | 168000 | 0.721 | 265900 | 0.661 | 256450 | 0.802 | 269200 | 0.568 | 199800 |
| 24 | 0.645 | 139750 | 0.613 | 74800 | 0.000 | 0 | 0.500 | 39300 | 0.714 | 61000 | 0.771 | 53900 | 0.328 | 57500 | 0.592 | 170400 | 0.730 | 268300 | 0.685 | 263650 | 0.806 | 270400 | 0.585 | 204600 |
| 23 | 0.658 | 142050 | 0.625 | 75950 | 0.000 | 0 | 0.625 | 47350 | 0.732 | 62150 | 0.792 | 55050 | 0.345 | 59800 | 0.602 | 172700 | 0.738 | 270600 | 0.693 | 265950 | 0.816 | 273850 | 0.589 | 205750 |
| 22 | 0.658 | 142050 | 0.625 | 75950 | 0.000 | 0 | 0.643 | 48450 | 0.750 | 63250 | 0.792 | 55050 | 0.345 | 59800 | 0.643 | 181500 | 0.746 | 272800 | 0.693 | 265950 | 0.822 | 274950 | 0.619 | 213450 |
| 21 | 0.671 | 144150 | 0.638 | 77000 | 0.000 | 0 | 0.643 | 48450 | 0.750 | 63250 | 0.833 | 57150 | 0.345 | 59800 | 0.663 | 185700 | 0.754 | 274900 | 0.697 | 267000 | 0.822 | 274950 | 0.636 | 217650 |
| 20 | 0.711 | 150150 | 0.650 | 78000 | 0.000 | 0 | 0.679 | 50450 | 0.750 | 63250 | 0.833 | 57150 | 0.362 | 61800 | 0.724 | 197700 | 0.770 | 278900 | 0.701 | 268000 | 0.847 | 280950 | 0.636 | 217650 |
| 19 | 0.750 | 155850 | 0.650 | 78000 | 0.000 | 0 | 0.696 | 51400 | 0.768 | 64200 | 0.833 | 57150 | 0.362 | 61800 | 0.724 | 197700 | 0.787 | 282700 | 0.709 | 269900 | 0.860 | 283800 | 0.644 | 219550 |
| 18 | 0.770 | 158550 | 0.650 | 78000 | 0.000 | 0 | 0.714 | 52300 | 0.786 | 65100 | 0.833 | 57150 | 0.414 | 67200 | 0.745 | 201300 | 0.803 | 286300 | 0.732 | 275300 | 0.868 | 285800 | 0.678 | 226750 |
| 17 | 0.776 | 159400 | 0.650 | 78000 | 0.000 | 0 | 0.714 | 52300 | 0.804 | 65950 | 0.854 | 58000 | 0.466 | 72300 | 0.765 | 204700 | 0.820 | 289700 | 0.764 | 282100 | 0.876 | 287300 | 0.706 | 232700 |
| 16 | 0.776 | 159400 | 0.650 | 78000 | 0.000 | 0 | 0.750 | 53900 | 0.804 | 65950 | 0.854 | 58000 | 0.466 | 72300 | 0.786 | 207900 | 0.820 | 289700 | 0.787 | 286900 | 0.876 | 287300 | 0.712 | 233500 |
| 15 | 0.776 | 159400 | 0.650 | 78000 | 0.309 | 12750 | 0.786 | 55400 | 0.804 | 65950 | 0.875 | 58750 | 0.466 | 72300 | 0.786 | 207900 | 0.844 | 294200 | 0.787 | 286900 | 0.893 | 290300 | 0.712 | 233500 |
| 14 | 0.789 | 160600 | 0.650 | 78000 | 0.618 | 24650 | 0.786 | 55400 | 0.804 | 65950 | 0.875 | 58750 | 0.483 | 73700 | 0.786 | 207900 | 0.869 | 296400 | 0.811 | 291100 | 0.917 | 294500 | 0.720 | 234900 |
| 13 | 0.809 | 162750 | 0.650 | 78000 | 0.655 | 25950 | 0.821 | 56700 | 0.821 | 66600 | 0.875 | 58750 | 0.483 | 73700 | 0.786 | 207900 | 0.885 | 301000 | 0.835 | 295000 | 0.926 | 295800 | 0.763 | 241400 |
| 12 | 0.822 | 163950 | 0.675 | 79200 | 0.655 | 25950 | 0.821 | 56700 | 0.821 | 66600 | 0.875 | 58750 | 0.483 | 73700 | 0.796 | 209100 | 0.893 | 302200 | 0.843 | 296200 | 0.934 | 297000 | 0.771 | 242600 |
| 11 | 0.829 | 164500 | 0.688 | 79750 | 0.673 | 26500 | 0.821 | 56700 | 0.839 | 67150 | 0.896 | 59300 | 0.500 | 74600 | 0.816 | 211300 | 0.902 | 303300 | 0.906 | 305000 | 0.950 | 299200 | 0.775 | 243150 |
| 10 | 0.829 | 164500 | 0.688 | 79750 | 0.764 | 29000 | 0.821 | 56700 | 0.857 | 67650 | 0.896 | 59300 | 0.500 | 74600 | 0.816 | 211300 | 0.910 | 304300 | 0.906 | 305000 | 0.967 | 301200 | 0.831 | 249650 |
| 9 | 0.842 | 165400 | 0.700 | 80200 | 0.764 | 29000 | 0.839 | 57150 | 0.857 | 67650 | 0.896 | 59300 | 0.500 | 74600 | 0.827 | 212200 | 0.910 | 304300 | 0.921 | 306800 | 0.967 | 301200 | 0.869 | 253700 |
| 8 | 0.855 | 166200 | 0.700 | 80200 | 0.764 | 29000 | 0.857 | 57550 | 0.857 | 67650 | 0.896 | 59300 | 0.552 | 77200 | 0.837 | 213000 | 0.910 | 304300 | 0.929 | 307600 | 0.975 | 302000 | 0.873 | 254100 |
| 7 | 0.882 | 167600 | 0.700 | 80200 | 0.782 | 29350 | 0.929 | 58950 | 0.893 | 68350 | 0.896 | 59300 | 0.569 | 77900 | 0.837 | 213000 | 0.918 | 305000 | 0.937 | 308300 | 0.979 | 302350 | 0.896 | 256200 |
| 6 | 0.895 | 168200 | 0.713 | 80500 | 0.800 | 29650 | 0.946 | 59250 | 0.929 | 68950 | 0.896 | 59300 | 0.741 | 83900 | 0.847 | 213600 | 0.918 | 305000 | 0.945 | 308900 | 0.983 | 302650 | 0.907 | 256800 |
| 5 | 0.895 | 168200 | 0.750 | 81250 | 0.836 | 30150 | 0.946 | 59250 | 0.929 | 68950 | 0.896 | 59300 | 0.828 | 86400 | 0.918 | 217100 | 0.918 | 305000 | 0.945 | 308900 | 0.983 | 302650 | 0.915 | 257300 |
| 4 | 0.987 | 171000 | 0.775 | 81650 | 0.873 | 30550 | 0.946 | 59250 | 0.964 | 69350 | 0.917 | 59500 | 0.862 | 87200 | 0.918 | 217100 | 0.928 | 305400 | 0.953 | 309300 | 0.983 | 302650 | 0.915 | 257300 |
| 3 | 0.987 | 171000 | 0.813 | 82100 | 0.891 | 30700 | 0.946 | 59250 | 0.964 | 69350 | 0.958 | 59800 | 0.879 | 87500 | 0.918 | 217100 | 0.959 | 306600 | 0.976 | 310200 | 0.992 | 302950 | 0.932 | 257900 |
| 2 | 0.987 | 171000 | 0.850 | 82400 | 0.909 | 30800 | 0.962 | 59450 | 1.000 | 69550 | 0.979 | 59900 | 0.879 | 87500 | 0.929 | 217300 | 0.964 | 307200 | 0.992 | 310600 | 0.992 | 302950 | 0.941 | 258100 |
| 1 | 1.000 | 171100 | 1.000 | 83000 | 1.000 | 31050 | 1.000 | 59500 | 1.000 | 69550 | 1.000 | 59950 | 1.000 | 88200 | 1.000 | 218000 | 1.000 | 307400 | 1.000 | 310700 | 1.000 | 303050 | 1.000 | 258800 |

Demand Level and Cumulative MWH at Top of Bin – First Pass

| % | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH | MW (24 H | MWH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0% | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.0% | 767.7 | 23030 | 404.0 | 12525 | 277.8 | 4167 | 282.8 | 8485 | 282.8 | 8768 | 242.4 | 7273 | 565.9 | 18162 | 989.9 | 29697 | 1232.3 | 38202 | 1282.8 | 39768 | 1222.2 | 34222 | 1191.9 | 36949 |
| 20.0% | 1535.4 | 46061 | 808.1 | 25051 | 555.6 | 8333 | 565.7 | ERR | 565.7 | 17535 | 484.8 | 14545 | 1171.7 | 36323 | 1979.8 | 59394 | 2464.6 | 76404 | 2565.7 | 79535 | 2444.4 | 68444 | 2383.8 | 73899 |
| 30.0% | 2303.0 | 69091 | 1212.1 | 37576 | 833.3 | 12500 | 848.5 | 24760 | 848.5 | 26303 | 727.3 | 21818 | 1757.6 | 53340 | 2969.7 | 89091 | 3697.0 | 114606 | 3848.5 | 119303 | 3666.7 | 102667 | 3575.8 | 110848 |
| 40.0% | 3070.7 | 90870 | 1616.2 | 50101 | 1111.1 | ERR | 1131.3 | 32045 | 1131.3 | 35071 | 969.7 | 29091 | 2343.4 | 65375 | 3959.6 | 118788 | 4929.3 | 152808 | 5131.3 | 159071 | 4888.9 | 136889 | 4767.7 | 146290 |
| 50.0% | 3838.4 | 111693 | 2020.2 | 62000 | 1388.9 | ERR | 1414.1 | ERR | 1414.1 | 43838 | 1212.1 | 36364 | 2929.3 | 74800 | 4949.5 | 146900 | 6161.6 | 191010 | 6414.1 | ERR | 6111.1 | 171111 | 5958.6 | 178365 |
| 60.0% | 4606.1 | 130974 | 2424.2 | 73600 | 1666.7 | 23750 | 1697.0 | 45460 | 1697.0 | 52020 | 1454.5 | 42920 | 3515.2 | ERR | 5939.4 | 172149 | 7393.9 | 226851 | 7697.0 | 232282 | 7333.3 | 205333 | 7151.5 | 208350 |
| 70.0% | 5373.7 | 148220 | 2828.3 | 80200 | 1944.4 | 27175 | 1979.8 | 51560 | 1979.8 | 59740 | 1697.0 | 49361 | 4101.0 | 82460 | 6929.3 | 192180 | 8626.3 | 258623 | 8979.8 | 267692 | 8555.6 | 239556 | 8343.4 | 230458 |
| 80.0% | 6141.4 | 161540 | 3232.3 | 81900 | 2222.2 | 29650 | 2262.6 | 55830 | 2262.6 | 65533 | 1939.4 | 55390 | 4686.9 | 85430 | 7919.2 | 209460 | 9858.6 | 285100 | 10262.6 | 289026 | 9777.8 | 264832 | 9535.4 | 245760 |
| 90.0% | 6909.1 | 168345 | 3636.4 | 82600 | 2500.0 | 30729 | 2545.5 | 58135 | 2545.5 | 68430 | 2181.8 | 59326 | 5272.7 | 87620 | 8909.1 | 215125 | 11090.9 | 302520 | 11545.5 | 301493 | 11000.0 | 291183 | 10727.3 | 256243 |
| 100.0% | 7676.8 | 171100 | 4040.4 | 83000 | 2777.8 | 31050 | 2828.3 | 59500 | 2828.3 | 69550 | 2424.2 | 59950 | 5858.6 | 88200 | 9899.0 | 218000 | 12323.2 | 307400 | 12828.3 | 310700 | 12222.2 | 303050 | 11919.2 | 258800 |

Cumulative MWH at Top of Bin – Adjusted

| % | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | | MWH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0% | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.0% | 23030 | | 12525 | | 4167 | | 8485 | | 8768 | | 7273 | | 18162 | | 29697 | | 38202 | | 39768 | | 34222 | | 36949 | |
| 20.0% | 46061 | | 25051 | | 8333 | | 16822 | | 17535 | | 14545 | | 36323 | | 59394 | | 76404 | | 79535 | | 68444 | | 73899 | |
| 30.0% | 69091 | | 37576 | | 12500 | | 24760 | | 26303 | | 21818 | | 53340 | | 89091 | | 114606 | | 119303 | | 102667 | | 110848 | |
| 40.0% | 90870 | | 50101 | | 16250 | | 32045 | | 35071 | | 29091 | | 65375 | | 118788 | | 152808 | | 159071 | | 136889 | | 146290 | |
| 50.0% | 111693 | | 62000 | | 20000 | | 38753 | | 43838 | | 36364 | | 74800 | | 146900 | | 191010 | | 195676 | | 171111 | | 178365 | |
| 60.0% | 130974 | | 73600 | | 23750 | | 45460 | | 52020 | | 42920 | | 78630 | | 172149 | | 226851 | | 232282 | | 205333 | | 208350 | |
| 70.0% | 148220 | | 80200 | | 27175 | | 51560 | | 59740 | | 49361 | | 82460 | | 192180 | | 258623 | | 267692 | | 239556 | | 230458 | |
| 80.0% | 161540 | | 81900 | | 29650 | | 55830 | | 65533 | | 55390 | | 85430 | | 209460 | | 285100 | | 289026 | | 264832 | | 245760 | |
| 90.0% | 168345 | | 82600 | | 30729 | | 58135 | | 68430 | | 59326 | | 87620 | | 215125 | | 302520 | | 301493 | | 291183 | | 256243 | |
| 100.0% | 171100 | | 83000 | | 31050 | | 59500 | | 69550 | | 59950 | | 88200 | | 218000 | | 307400 | | 310700 | | 303050 | | 258800 | |

Cumulative MWH at Top of Bin as % of Total MWH

| % of Peak | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | | % of MWH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0% | | | | | | | | | | | | | | | | | | | | | | | | |
| 10.0% | 13.46% | | 15.09% | | 13.42% | | 14.26% | | 12.61% | | 12.13% | | 20.59% | | 13.62% | | 12.43% | | 12.80% | | 11.29% | | 14.26% | |
| 20.0% | 26.92% | | 30.18% | | 26.84% | | 27.94% | | 25.21% | | 24.26% | | 41.18% | | 27.24% | | 24.85% | | 25.60% | | 22.59% | | 26.55% | |
| 30.0% | 40.38% | | 45.27% | | 40.26% | | 41.61% | | 37.82% | | 36.39% | | 60.48% | | 40.87% | | 37.26% | | 38.40% | | 33.88% | | 42.83% | |
| 40.0% | 53.11% | | 60.36% | | 52.33% | | 53.86% | | 50.43% | | 48.53% | | 74.12% | | 54.49% | | 49.71% | | 51.20% | | 45.17% | | 56.53% | |
| 50.0% | 65.28% | | 74.70% | | 64.41% | | 65.13% | | 63.03% | | 60.66% | | 84.81% | | 67.39% | | 62.14% | | 62.98% | | 56.46% | | 68.92% | |
| 60.0% | 76.55% | | 88.67% | | 76.49% | | 76.40% | | 74.80% | | 71.59% | | 89.15% | | 78.97% | | 73.73% | | 74.76% | | 67.76% | | 80.51% | |
| 70.0% | 86.63% | | 96.63% | | 87.52% | | 86.66% | | 85.90% | | 82.34% | | 93.49% | | 88.16% | | 84.13% | | 86.16% | | 79.05% | | 89.05% | |
| 80.0% | 94.41% | | 98.67% | | 95.49% | | 93.83% | | 94.22% | | 92.39% | | 99.86% | | 96.06% | | 92.75% | | 93.02% | | 87.39% | | 94.96% | |
| 90.0% | 98.39% | | 99.52% | | 98.97% | | 97.71% | | 98.30% | | 98.98% | | 99.34% | | 98.68% | | 98.41% | | 97.04% | | 96.06% | | 99.01% | |



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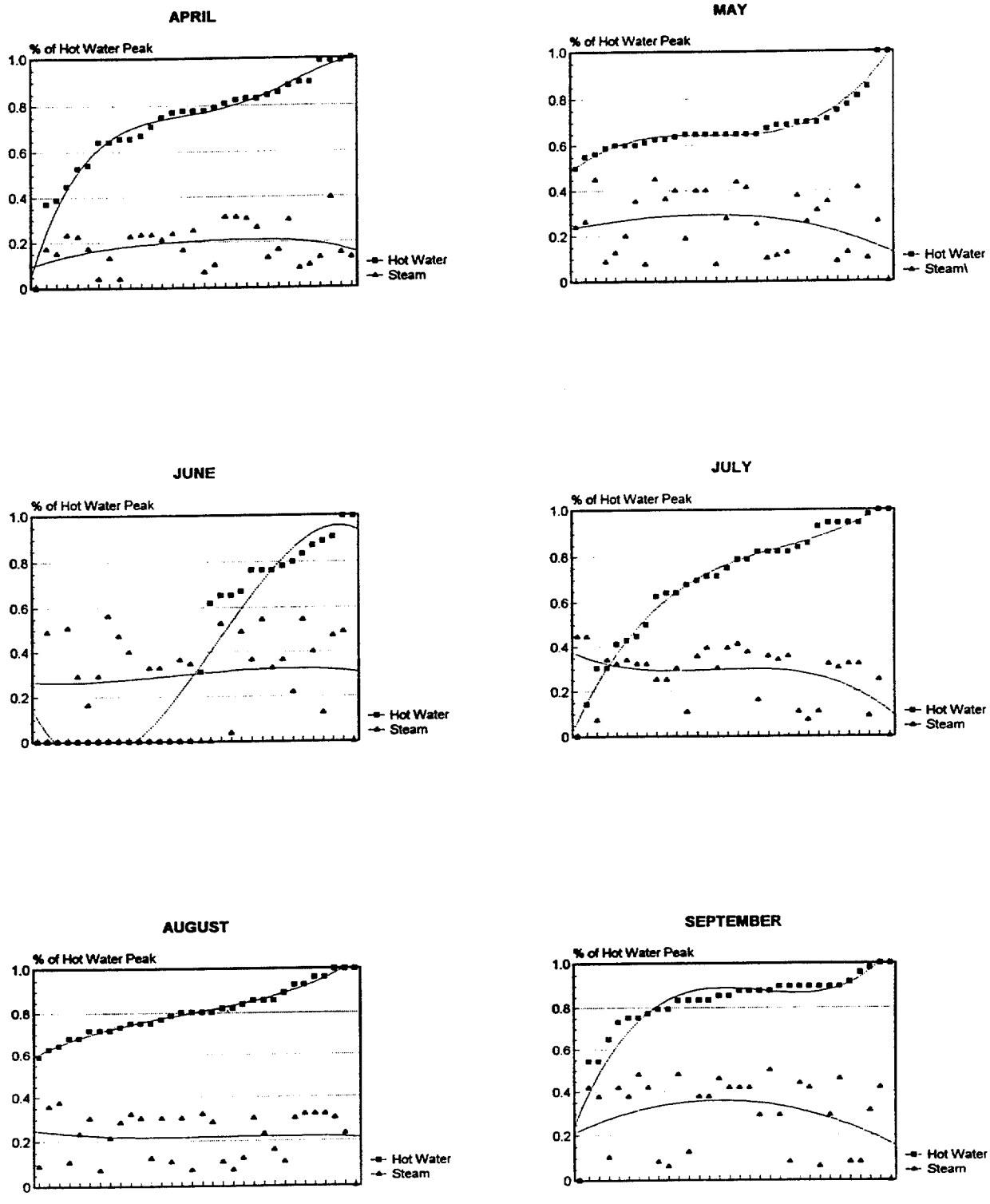
## Exhibit 3-10

## Coincident Hot Water and Steam Demands
## Sofia
## (April, 1992 - September, 1992)



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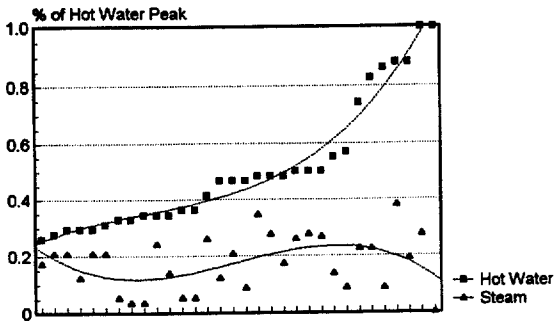
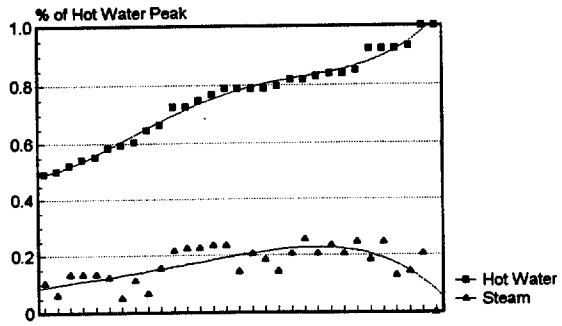
## Exhibit 3-10 (Cont'd)

## Coincident Hot Water and Steam Demands
## Sofia
## (October, 1992 - March, 1993)

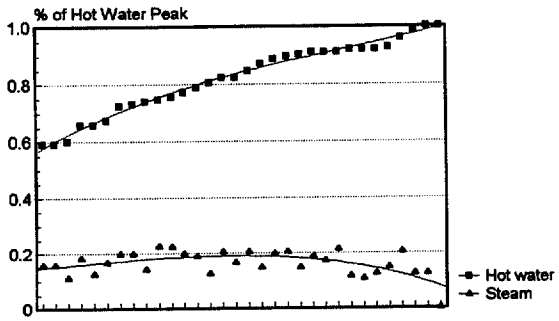
**OCTOBER**



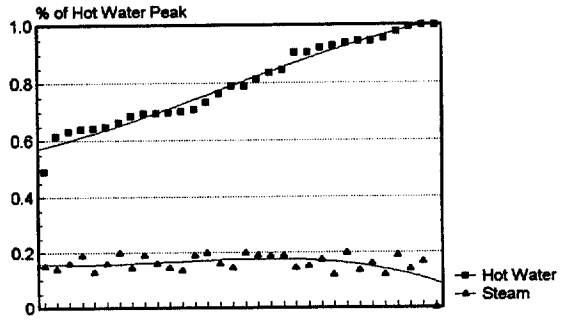

**NOVEMBER**



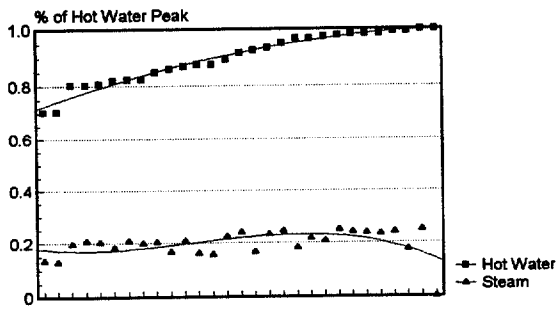

**DECEMBER**



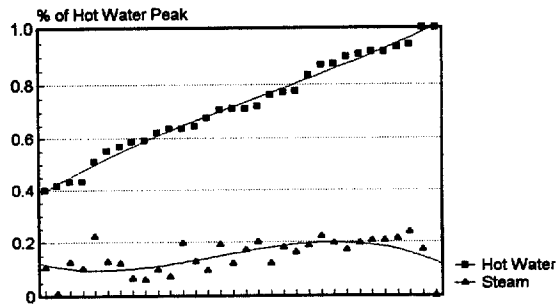

**JANUARY**




**FEBRUARY**

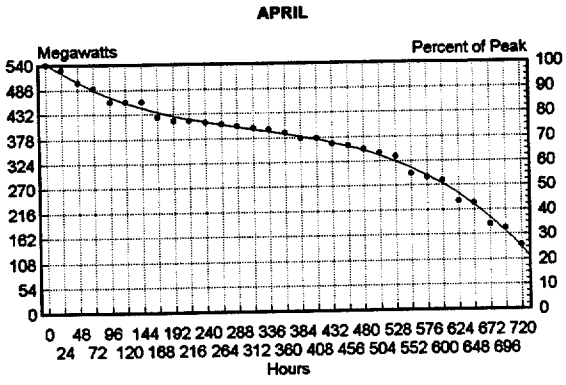


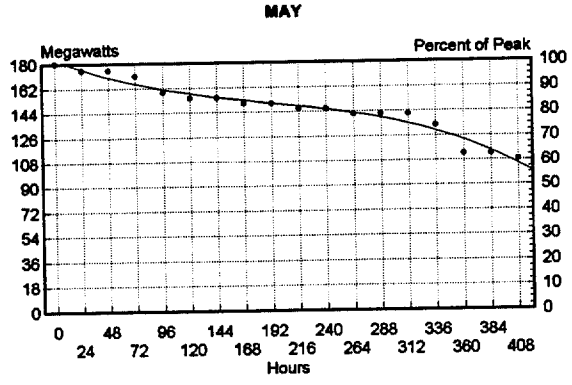

**MARCH**

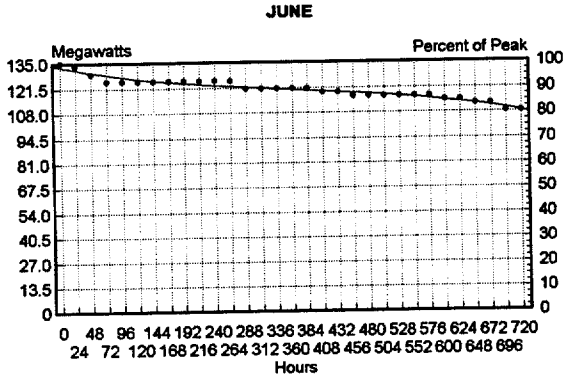


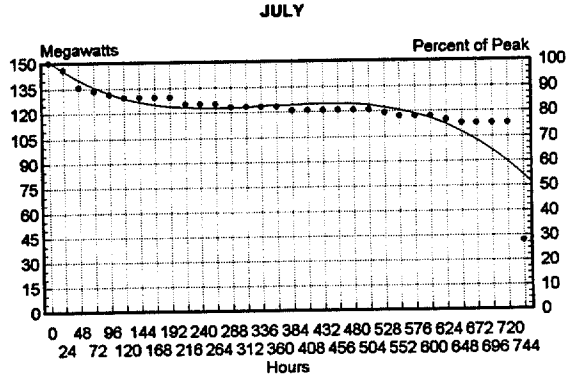
# Exhibit 3-11

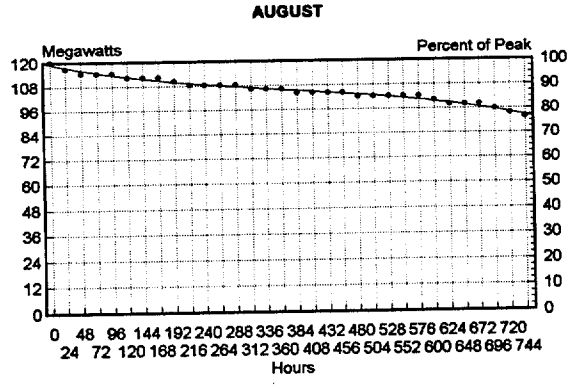
## Load Duration Curves - Trajco Kostov
## Hot Water
## (April, 1992 - September, 1992)

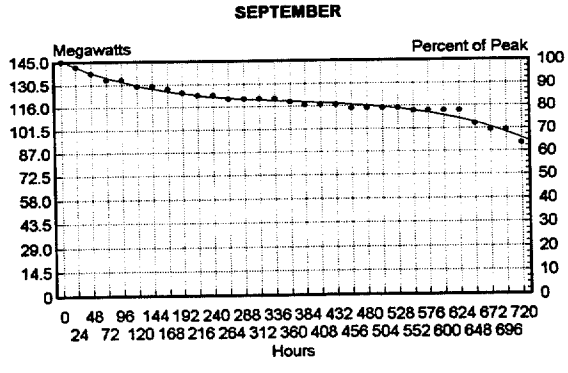


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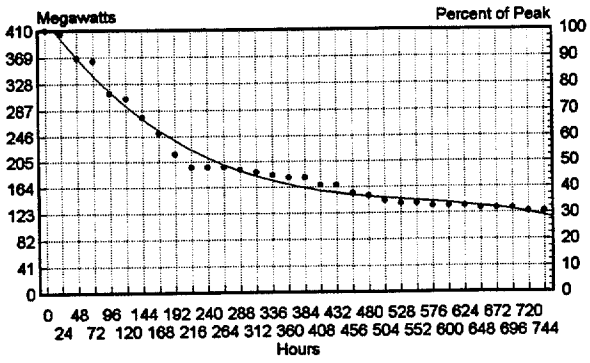
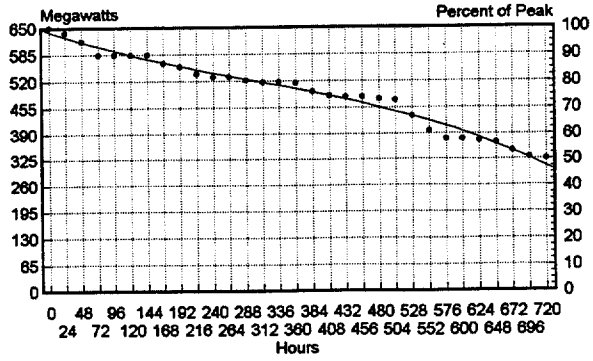
# Exhibit 3-11 (Cont'd)

## Load Duration Curves - Trajco Kostov
## Hot Water
## (October, 1992 - March, 1993)

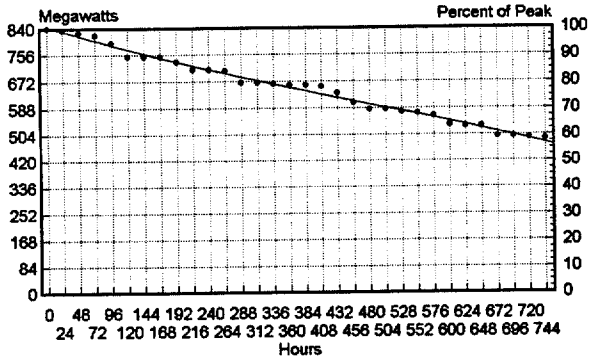
**OCTOBER**



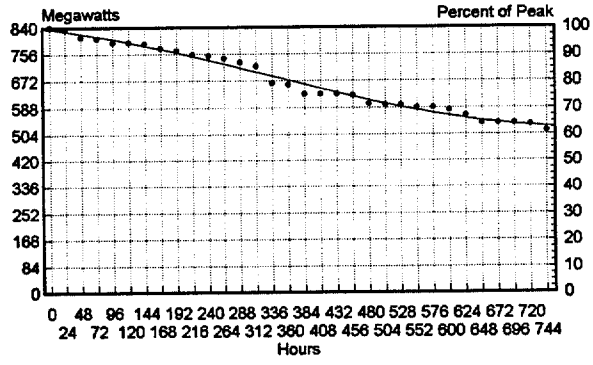

**NOVEMBER**



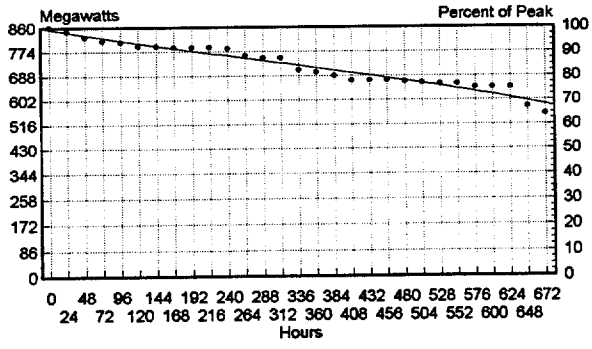

**DECEMBER**



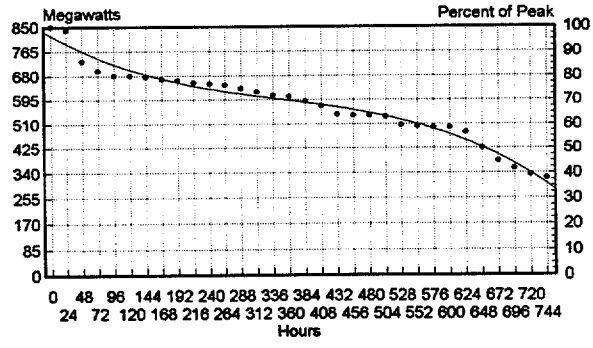

**JANUARY**




**FEBRUARY**



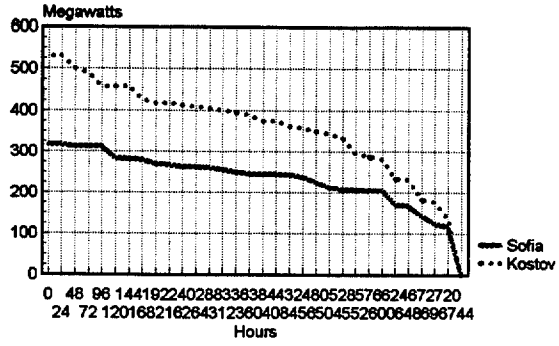

**MARCH**



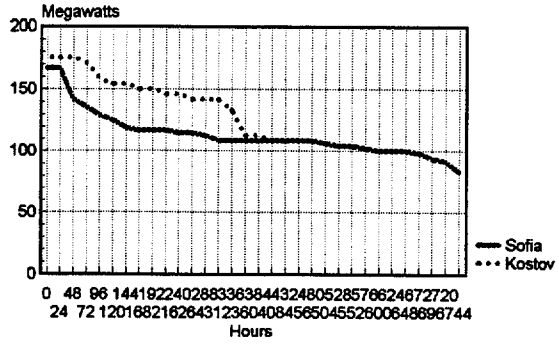
# Exhibit 3-12

## Comparative Hot Water Load Duration Curves
## Sofia vs. Trajco Kostov
## (April, 1992 - September, 1992)

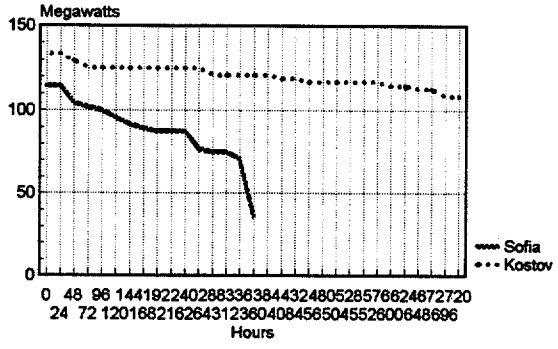
APRIL



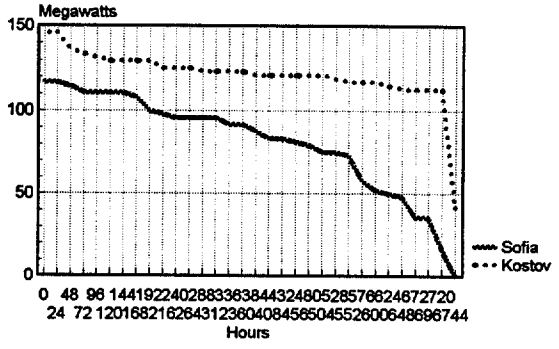

MAY



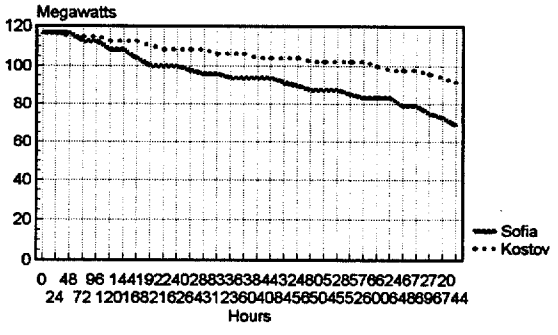

JUNE



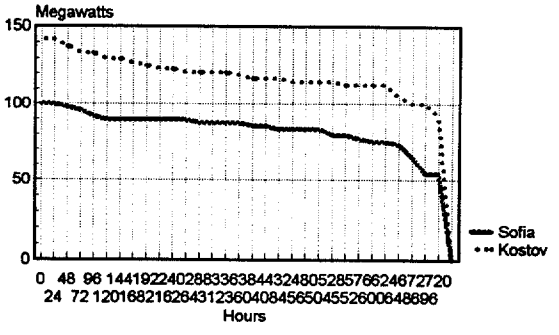

JULY




AUGUST




SEPTEMBER



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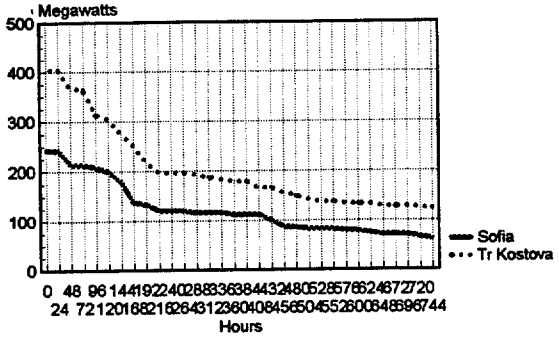
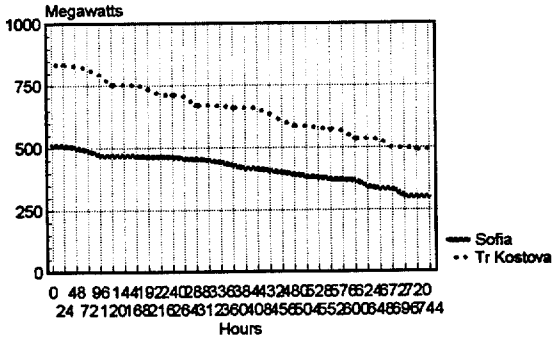
## Exhibit 3-12 (Cont'd)

## Comparative Hot Water Load Duration Curves
## Sofia vs. Trajco Kostova
## (October, 1992 - March, 1993)

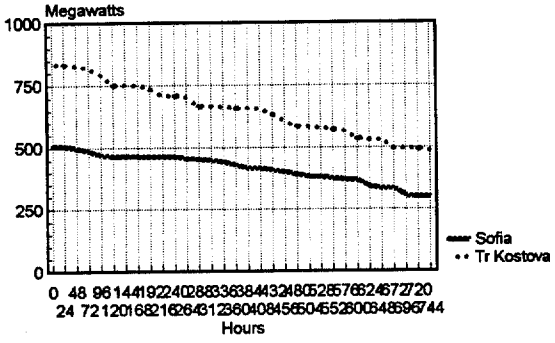
**OCTOBER**



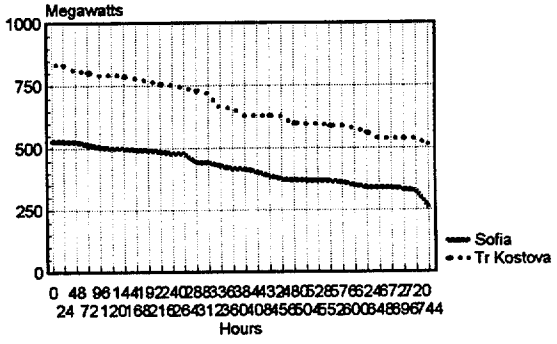

**NOVEMBER**



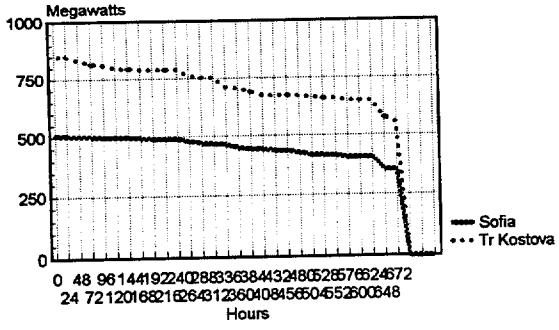

**DECEMBER**



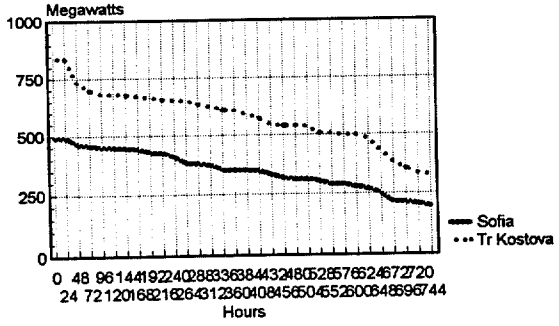

**JANUARY**




**FEBRUARY**




**MARCH**



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## 3.4 FUEL PROPERTIES, AVAILABILITY AND COST

In the City of Sofia today, the fuels burned are 95% natural gas and 5% Mazut. Natural gas has rather standard properties and Matuz is essentially a heavy oil with properties close to a No. 6 oil (Exhibit 3-13). While the latter is available from direct importation or from local refinery which processes imported oil, the former comes from Russia. It is supplied at a low price as a compensation to Bulgaria's contribution in the construction of the "friendship pipe line". This arrangement is to expire by 1997.

Only local coal is being burned in the City of Republika. This coal from local mine is of poor quality. It has high ash content (over 60%) and low heat value (about 3780 Btu/lb-LHV, Exhibit 3-14). It is estimated that the local mine will be exhausted in about 15 years.

Current prices for the fuels are as follows: (Exhibit 3-15 at 32 Leva/U.S.$):

- Natural gas U.S. $2.03/10$^6$ BTU
- Mazut (heavy oil) U.S. $2.41/10$^6$ BTU
- Gazol (light oil) U.S. $4.93/10$^6$ BTU
- Coal U.S. $0.67/10$^6$ BTU

In the economic analysis following, it is assumed that the fuel prices will catch up to the free market world prices in five years.

## 3.5 ENVIRONMENTAL LIMITS AND PENALTIES

Emissions reduction is one of the primary reasons for upgrade of the Cities of Sofia and Pernik district heat systems. The Ministry of Environment has issued regulations which are strict by any standards, and place an extreme burden/challenge upon organizations who must comply. In summary, new plants must now meet strict standards shown in Exhibit 3-16. These standards are equivalent to or more strict than current western European and U.S. standards. For example, compare to European Community standards, limit on $SO_2$ is more than 60% lower for solid and liquid fuels; limit on $NO_x$ is more than 7% and 14% lower for solid and gas fuel respectively.

Plants placed in service prior to the end of 1992 must meet these standards prior to 31 December 1995.

Penalties for non-compliance are shown in Exhibit 3-17.

(Text follows on page 3-34.)



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## Exhibit 3-13

## Bulgaria Feasibility Study
## Fuel Properties
## (Natural Gas and Oil)

NATURAL GAS

| Natural gas composition: | | LHV of the gas supplied |
|---|---|---|
| $CH_4$ | - | 92.96% '85-8072 kcal/m3 |
| $C_2H_6$ | - | 2.97% '86-8074 kcal/m3 |
| $C_3H_8$ | - | 0.83% '87-7933 kcal/m3 |
| $C_4H_{10}$ | - | 0.33% '88-7916 kcal/m3 |
| $C_5H_{12}$ | - | 0.366% '89-7919 kcal/m3 |
| $N_2$ | - | 2.4% '90-7917 kcal/m3 |
| $CO_2$ | - | 0.14% '91-7946 kcal/m3 |
| Specific gravity - 0.725 kg/m$^3$ | | '92-7939 kcal/m$^3$ |

LIQUID FUELS

| | | Mazut | Gazol |
|---|---|---|---|
| 1. | Kinematic viscosity, sqm/s | 115 | |
| | Conditional viscosity, degrees | 15 | 8 |
| 2. | Ash content, % | 0.14 | 0.02 |
| 3. | Sulfur content, % | 3.5 | 1.0 |
| 4. | Particulates, % | 0.5 | 0.1 |
| 5. | Acids and alkalis able to be solved in water | Not Allowed | Not Allowed |
| 6. | Water, % | 1.0 | Not Allowed |
| 7. | Specific gravity, g/cm$^3$ | 0.96 | 0.84 |
| 8. | Freezing temperature, C | No higher than 25 | No higher than 10 |
| 9. | Temperature of supplying to the burner, C | No less than 110 | No less than 60 |
| 10. | Heat value, kcal/kg | No less than 9550 | No less than 9995 |
| | or kJ/kg | 40,015 | 41,880 |



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## Exhibit 3-14

## Bulgaria Feasibility Study
## Coal Properties

| No. | Indicator | Unit | Guaranteed | Max Moisture | Max Ash (dry) | Max Heat Value |
|---|---|---|---|---|---|---|
| 1. | Ash (dry) | % | 62.0 | 60.0 | 65.0 | 58.0 |
| 2. | Moisture | % | 14.5 | 16.0 | 13.0 | 15.0 |
| 3. | Ash, A.R. | % | 53.0 | 50.4 | 56.5 | 49 |
| 4. | Carbon | % | 21.4 | 22.3 | 19.6 | 23.8 |
| 5. | Hydrogen | % | 2.1 | 2.1 | 2.0 | 2.2 |
| 6. | Oxygen | % | 7.2 | 7.3 | 7.1 | 7.6 |
| 7. | Nitrogen | % | 0.5 | 0.6 | 0.5 | 0.6 |
| 8. | Sulfur | % | 1.3 | 1.3 | 1.3 | 1.3 |
| 9. | Specific heat of combustion | kcal/kg<br>kJ/kg | 1860<br>7786 | 1950<br>8163 | 1690<br>7074 | 2100<br>8790 |
| 10. | Volatiles | % | 49-52 | | | |
| 11. | Grindability factor by VTK | | 1-1.2 | | | |
| 12. | Ash composition | | | | | |
| | - $SiO_2$ | % | 58-62 | | | |
| | - $Al_2O_3$ | % | 25-32 | | | |
| | - $Fe_2O_3$ | % | 4-8 | | | |
| | - CaO | % | 1-4 | | | |
| | - MgO | % | 0.4-1.8 | | | |
| | - $SO_3$ | % | 0.5-3.5 | | | |



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## Exhibit 3-14 (Cont'd)

## Bulgaria Feasibility Study
## Coal Properties

| | | | |
|---|---|---|---|
| 13. | Temperature of ash melting: | | |
| | - beginning of deformation, $t_1$ | °C | 1050-1200 |
| | - beginning of melting, $t_2$ | °C | 1150-1350 |
| | - beginning of flow, $t_3$ | °C | 1250-1400 |
| 14. | Density of dry mass | $g/cm^3$ | 1.85-2.0 |
| 15. | Specific weight | $kg/m^3$ | 800-1250 |

## Exhibit 3-15

## Prices of Fuels, Established by the Cabinet for 1993

LEVA

| PERIODS | 1000 N.CUB.M. NATURAL GAS | 1 TON MAZUT 1 | TON INDUSTR. FUEL OIL | 1 TON DIESEL OIL |
|---|---|---|---|---|
| 01.01 - 15.01 | 1771 | 2530 | 4550 | 7530 |
| 16.01 - 31.01 | 1715 | 2450 | 4410 | 7760 |
| 01.02 - 15.02 | 1729 | 2470 | 4440 | 8060 |
| 16.02 - 29.02 | 1848 | 2640 | 4750 | 8970 |
| 01.03 - 15.03 | 1890 | 2700 | 4860 | 9210 |
| 16.03 - 31.03 | 1967 | 2810 | 5060 | 9700 |
| 01.04 - 15.04 | 2016 | 2880 | 5180 | 9400 |
| 16.04 - 30.04 | 2044 | 2920 | 6260 | 9880 |
| 01.05 - 15.05 | 2002 | 2860 | 5150 | 9880 |
| 16.05 - 31.05 | 2009 | 2870 | 5170 | 10120 |
| 01.06 - 15.06 | 1848 | 2640 | 4750 | 9640 |
| 16.06 - 30.06 | 1701 | 2430 | 4370 | 9160 |
| 01.07 - 15.07 | | | | |
| 16.07 - 31.07 | | | | |
| 01.08 - 15.08 | | | | |
| 16.08 - 31.08 | | | | |
| 01.09 - 15.09 | | | | |
| 16.09 - 30.09 | | | | |
| 01.10 - 15.10 | | | | |
| 16.10 - 31.10 | | | | |
| 01.11 - 15.11 | | | | |
| 16.11 - 30.11 | | | | |
| 01.12 - 15.12 | | | | |
| 16.12 - 31.12 | | | | |



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## Exhibit 3-16

## Bulgarian Emission Standards for Existing and New Plants[a]

| Fuel Type | Plants in use prior to end of 1994 | New Sites | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Local Coal[a] | 200 | 3500 | 1000 | 250 | 100 | 650 | 600 | 250 |
| Imported Coal[a] | 150 | 2000 | 1300 | 250 | 80 | 650 | 600 | 250 |
| Oil Fuel[b] | 50 | 1700 | 700 | 170 | 50 | 650 | 450 | 170 |
| Gas Fuel[b] | 10 | - | 500 | 100 | 10 | - | 300 | 100 |

Notes:
a. Solid fuels based on 7% $O_2$ for stoker boilers, 6% for dry bottom boilers, and 5% for wet bottom boilers.
b. Oil and gas fuels based on 3% $O_2$.

## Exhibit 3-17

## Bulgarian Parliament Emission Penalties

| Emission | Penalty in Leva/tonne |
|---|---|
| Particulate (dust) | 200 |
| $SO_x$ | 300 |
| $NO_x$ | 400 |
| CO | 0 |

### 3.5.1 EMISSION REDUCTION SCHEMES

It is indeed a challenge to meet the stringent environmental limits with old and outdated equipment in Bulgaria. Several backend clean up devices must be considered. Appendix 3A provide information on available technologies for $NO_X$, $SO_X$, and particulated emission reduction and control.

### 3.5.2 EMISSION SUMMARY AND EMISSION FACTORS

To summarize and to facilitate calculations of emissions in the economic model, Exhibit 3-18 was prepared. The procedures are discussed in the following paragraphs. Gas factors associated with each fuel were also calculated. Estimates were made for each emission using the best available basis. A single emission factor was prepared for each boiler "situation," that is, a specific boiler/fuel/emissions control situation. Emission values and compliance limits are shown in both $mg/m^3$ and $lb/10^6Btu$. A single factor for emissions and emission penalties is used, as shown in Exhibit 3-18. Potential methods of emissions control are discussed further here.

Particulate (dust) emissions for Republika TPH station in Pernik were based on emissions measurements provided, which gave an indication of the poor performance of existing electrostatic precipitators. Clearly, emission limits are not met, and either an upgrade to the ESP, a new baghouse, fuel switch, or retirement of the boilers is required to avoid penalties. Particulate emissions for Sofia also result in a compliance problem for heavy oil, which is used only a small fraction of the time. If emissions are measured continuously, however, controls must be applied, or a switch must be made to a lower ash liquid or gas fuel.

$SO_2$ emissions are based on fuel composition, adjusted by methods suggested in AP42 (EPA method of emissions estimating). For Republika, $SO_2$ limits are not met, and the addition of a flue gas scrubber is required if the present fuel mix is maintained. In such case, either wet scrubber or dry scrubber may be employed. Limestone is used as a sorbent in the former cleanup system, while lime is used in the later. Due to the short residence time associated with the dry process, it requires a more chemically reactive sorbent in lime. While the cost of the dry scrubber is about 30% lower, the cost of the lime is about five times higher than limestone. On the other hand, a dry scrubber with less removal efficiency may be adequate to bring the particulate emission to within compliance in some cases. Repowering with fluidized bed combustion (FBC) technology would also resolve this problem. The comparative cost of each solution is the subject of this study. For all plants burning heavy Mazut oil, as with particulate, a change is required. Even with the light oil which is currently used, there is a compliance problem. If oil is to be used in the future, then the specification must be such that emissions levels are met. This specification must limit fuel sulfur to approximately 0.4%.

Due to lack of test data from Bulgaria, $NO_X$ emissions were estimated based on experience with similar boilers where emissions measurements were available. When data became available for the Sofia boilers, comparisons were made to verify the emissions factors, and they were found to be accurate to within 5 percent. The nature of the high ash fuel with relatively low volatile content used at Republika results in lower $NO_X$ emissions. However, the Republika coal-fired plants still exceed the strict Bulgaria limits. To achieve compliance, $NO_X$ reduction equipment will be required. Recent extensive work by Gilbert in

# Exhibit 3-18

## Emission Factors

| CODE | Boiler Size/Type/Fuel | Limeston Required lb/MMBTU | Ash Disposal lb/MMBTU | Emission Factor Summary Particulate lb/MMBTU | $SO_2$ lb/MMBTU | NOx lb/MMBTU | CO lb/MMBTU | Emission Penalties Particulate $/MMBTU | SO2 $/MMBTU | NOx $/MMBTU | CO $/MMBTU | Composite |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Individual Boilers 50 to 300 MWt** | | | | | | | | | | | | |
| PC2–A1 | PC–brown coal w/o particulate control | | 85.09 | 45.817 | 6.532 | 0.594 | 0.018 | $0.1296 | $0.0253 | $0.0003 | – | $0.1551 |
| PC2–AL1 | PC–brown coal w/o particulate control & LNB | | 85.09 | 45.817 | 6.532 | 0.594 | 0.018 | $0.1296 | $0.0253 | – | – | $0.1549 |
| PC2–E1 | PC–brown coal w/ existing ESP | | 128.94 | 1.961 | 6.532 | 0.594 | 0.018 | $0.0053 | $0.0253 | $0.0003 | – | $0.0308 |
| PC2–EL1 | PC–brown coal w/ existing ESP & LNB | | 128.94 | 1.961 | 6.532 | 0.357 | 0.018 | $0.0053 | $0.0253 | – | – | $0.0306 |
| PC2–EF1 | PC–brown coal w/ existing ESP & wet FGD | 10.41 | 136.44 | 1.961 | 0.523 | 0.594 | 0.018 | $0.0053 | – | $0.0003 | – | $0.0056 |
| PC2–EFL1 | PC–brown coal w/ existing ESP, wet FGD & LNB | 10.41 | 135.44 | 1.961 | 0.523 | 0.357 | 0.018 | $0.0053 | – | – | – | $0.0053 |
| PC2–E2F1 | PC–brown coal w/ upgrade ESP & wet FGD | 10.41 | 138.12 | 0.229 | 0.523 | 0.594 | 0.018 | $0.0004 | – | $0.0003 | – | $0.0007 |
| PC2–E2FL1 | PC–brown coal w/ upgrade ESP, wet FGD & LNB | 10.41 | 135.17 | 0.229 | 0.523 | 0.357 | 0.018 | $0.0004 | – | – | – | $0.0004 |
| PC2–B1 | PC–brown coal w/ baghouse | | 130.81 | 0.092 | 6.532 | 0.594 | 0.016 | – | | $0.0003 | – | $0.0003 |
| PC2–BL1 | PC–brown coal w/ baghouse & LNB | | 130.81 | 0.092 | 6.532 | 0.357 | 0.015 | – | $0.0253 | – | – | $0.0253 |
| PC2–BF1 | PC–brown coal w/ baghouse & wet FGD | 10.41 | 138.35 | 0.046 | 0.523 | 0.594 | 0.018 | – | – | $0.0003 | – | $0.0003 |
| PC2–BFL1 | PC–brown coal w/ baghouse, wet FGD & LNB | 10.41 | 138.35 | 0.046 | 0.523 | 0.357 | 0.018 | – | – | – | – | – |
| PC2–BF21 | PC–brown coal w/ baghouse & dry FGD | 11.18 | 138.86 | 0.092 | 0.98 | 0.594 | 0.018 | – | $0.0018 | $0.0003 | – | $0.0021 |
| PC2–BF2L1 | PC–brown coal w/ baghouse, dry FGD & LNB | 11.18 | 138.86 | 0.092 | 0.98 | 0.357 | 0.018 | – | $0.0018 | – | – | $0.0018 |
| FB2–E1 | CFB–brown coal w/ new ESP | 38.14 | 158.04 | 0.327 | 0.588 | 0.307 | 0.018 | $0.0007 | – | – | – | $0.0007 |
| FB2–BL1 | CFB–brown coal w/ baghouse | 38.14 | 158.29 | 0.082 | 0.588 | 0.307 | 0.018 | – | – | – | – | – |
| ST2–A6 | Heavy oil w/o particulate control | | 0.10 | 0.276 | 3.863 | 0.495 | 0.073 | $0.0007 | $0.0146 | $0.0011 | – | $0.0164 |
| ST2–AL6 | Heavy oil w/o particulate cntrl & low NOx burners | | 0.1 | 0.276 | 3.863 | 0.321 | 0.073 | $0.0007 | $0.0146 | $0.0001 | – | $0.0154 |
| ST2–E6 | Heavy Oil w/ existing ESP | | 0.37 | 0.006 | 3.863 | 0.495 | 0.073 | – | $0.0146 | $0.0011 | – | $0.0157 |
| ST2–EL6 | Heavy oil w/ existing ESP & low NOx burners | | 0.37 | 0.006 | 3.863 | 0.321 | 0.073 | – | $0.0146 | $0.0001 | – | $0.0148 |
| ST2–B6 | Heavy Oil w/ baghouse | | 0.38 | 0.001 | 3.863 | 0.495 | 0.073 | – | $0.0146 | $0.0011 | – | $0.0157 |
| ST2–BL6 | Heavy Oil w/ baghouse & low NOx burners | | 0.38 | 0.001 | 3.863 | 0.321 | 0.073 | – | $0.0146 | $0.0001 | – | $0.0148 |
| ST2–A7 | Light oil | | 0.05 | 0.016 | 1.055 | 0.156 | 0.013 | – | $0.0026 | – | – | $0.0026 |
| ST2–AL7 | Light Oil w/ low NOx burners | | 0.05 | 0.016 | 1.055 | 0.093 | 0.013 | – | $0.0026 | – | – | $0.0026 |
| ST2–A8 | Light oil – low sulfur | | 0.04 | 0.016 | 0.422 | 0.156 | 0.013 | – | – | – | – | – |
| ST2–AL8 | Light oil – low sulfur & low NOx burners | | 0.04 | 0.016 | 0.422 | 0.093 | 0.013 | – | – | – | – | – |
| ST2–A9 | Natural Gas | | – | – | – | 0.140 | 0.014 | – | – | – | – | – |
| ST2–AL9 | Natural Gas w/ low NOx burners | | – | – | – | 0.077 | 0.014 | – | – | – | – | – |
| ST2–A95 | 95% Gas/5% Mazut | | 0.01 | 0.014 | 0.193 | 0.158 | 0.017 | $0.0000 | $0.0007 | $0.0001 | – | $0.0008 |
| **Individual Boilers 5 to 50 MWt** | | | | | | | | | | | | – |
| ST3–C1 | Grate–brown coal wo particulate cntrl | | 129.44 | 1.463 | 6.532 | 0.438 | 0.229 | $0.0038 | $0.0200 | – | – | $0.0238 |
| ST3–E1 | Grate–brown coal w/ cyclones | | 130.17 | 0.732 | 6.532 | 0.438 | 0.229 | $0.0018 | $0.0200 | – | – | $0.0218 |
| ST3–B1 | Grate–brown coal w/ baghouse | | 130.90 | 0.007 | 6.532 | 0.438 | 0.229 | – | $0.0200 | – | – | $0.0200 |
| ST3–A6 | Heavy oil w/o particulate control | | 0.10 | 0.276 | 3.863 | 0.495 | 0.073 | $0.0007 | $0.0136 | $0.0011 | – | $0.0154 |
| ST3–E6 | Heavy oil w/ existing ESP | | 0.37 | 0.003 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0011 | – | $0.0147 |
| ST3–EL6 | Heavy oil w/ existing ESP & low NOx burners | | 0.37 | 0.003 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0001 | – | $0.0138 |
| ST3–B6 | Heavy Oil w/ baghouse | | 0.38 | 0.001 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0011 | – | $0.0147 |
| ST3–BL6 | Heavy Oil w/ baghouse & low NOx burners | | 0.38 | 0.001 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0001 | – | $0.0138 |
| ST3–A7 | Light oil | | 0.05 | 0.016 | 1.055 | 0.156 | 0.013 | – | $0.0017 | – | – | $0.0017 |
| ST3–A8 | Light oil – low sulfur | | 0.04 | 0.016 | 0.422 | 0.156 | 0.013 | – | – | – | – | – |
| ST3–AL8 | Light oil – low sulfur & low NOx burners | | 0.04 | 0.016 | 0.422 | 0.156 | 0.013 | – | – | – | – | – |
| ST3–A9 | Natural Gas | | – | – | – | 0.120 | 0.014 | – | – | – | – | – |
| ST3–AL9 | Natural Gas w/ low NOx burners | | – | – | – | 0.120 | 0.014 | – | – | – | – | – |
| GT–251 | W251 on Natural Gas | | – | – | – | 0.092 | 0.012 | – | – | – | – | – |
| GT–643 | Siemens 64.3 on Natural Gas | | – | – | – | 0.092 | 0.012 | – | – | – | – | – |
| GT–B13 | BBC Type 13 on Natural Gas | | – | – | – | 0.092 | 0.012 | – | – | – | – | – |
| GT–LM6 | GE LM6000 | | – | – | – | 0.102 | 0.062 | – | – | – | – | – |
| GT–6FA | GE 6FA | | – | – | – | 0.102 | 0.030 | – | – | – | – | – |



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the area of $NO_X$ reduction has shown that low $NO_X$ burners will be the most cost-effective solution when moderate reduction is required; therefore, this technology was selected, as required. Since the existing burners are in poor condition, and in need of replacement, changing to the low $NO_X$ burners will not result in additional, otherwise unneeded expenditures. All boilers using heavy oil are estimated to require $NO_X$ reduction, even though this fuel is only used for a small percentage of the time. Controls are not needed when burning gas fuel, and so some consideration for offsetting the occasionally higher emissions with heavy oil would be suggested, if this would be acceptable to the state.

CO emissions are caused by incomplete combustion of the fuel. There is currently no penalty for exceeding CO compliance limits; however, there is a regulation. CO emissions for large plants are usually relatively low, compared to smaller boilers, especially home furnaces. If a boiler experiences high CO emissions, it is usually related to a problem with the method of boiler operation, a deteriorated condition of the boiler or fuel delivery systems, or a boiler controls problem. An assumption was made that CO emissions will be in compliance because boiler upgrades will include checkout and improvement of these systems.

Emissions from gas turbines with dry low $NO_X$ combustors at 15% $O_2$ are also included therein, based on manufacturer's data.

Historical emissions measurements and calculations received from Bulgaria are shown. These values were compared to the factors presented in Exhibit 3-18 and found to have reasonable agreement.



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# 3A DISCUSSION ON THE ENVIRONMENTAL CONTROL TECHNOLOGIES

## 3A.1 EMISSION REDUCTION SCHEMES

It is indeed a challenge to meet the stringent environmental limits with old and outdated equipment in Bulgaria. Several backend clean up devices must be considered. This section discusses these devices.

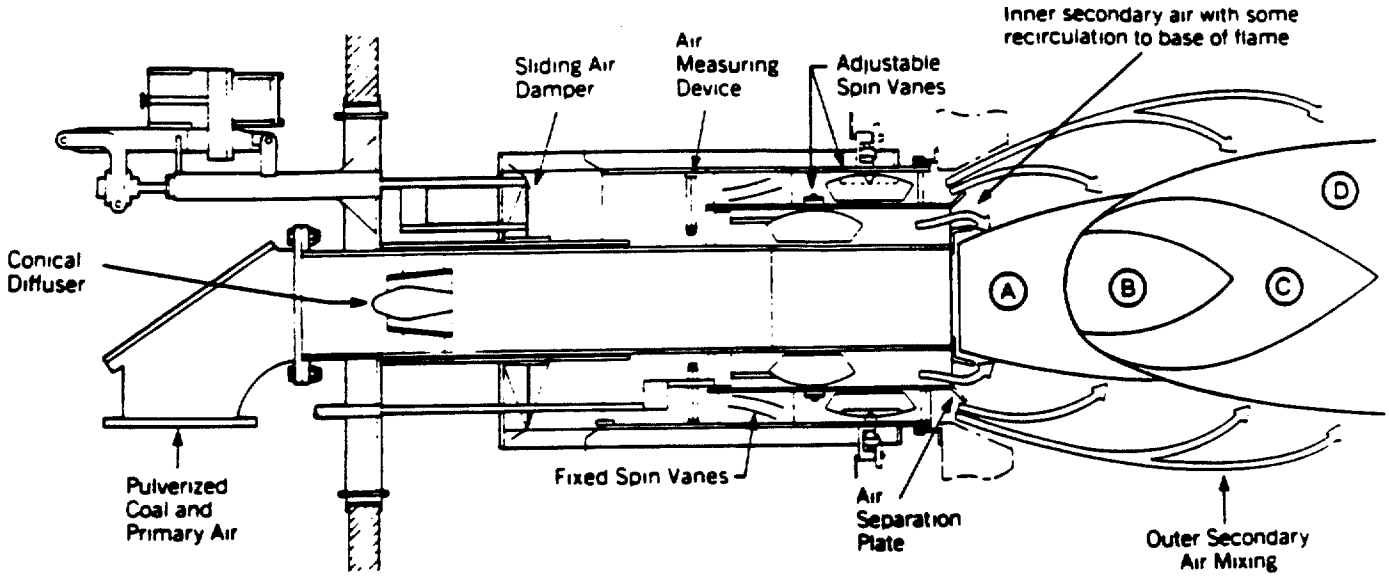
- **$NO_X$ REDUCTION**

## 3A.2 LOW $NO_X$ BURNER

To meet ever increasingly stringent requirements on $NO_X$ emissions, Babcock & Wilcox (B&W) has developed Dual register burners (DRB) - type XCL to provide greater $NO_X$ emission reductions for new and retrofit applications. These burners rely on slow and controlled mixing between fuel and air in order to minimize the availability of oxygen to the high temperature part of the combustion process. This minimizes the production of $NO_X$. The XCL burner (Exhibit 3A-1) uses a slide damper to control total secondary air to each burner. A pilot grid is used to measure and balance secondary air among the burners. Downstream of the pilot grid are the inner and outer air zones. Adjustable vanes in the inner zone are positioned to stabilize ignition at the tip of the nozzle. The outer zone, the main air path, is equipped with two stages of vanes. The upstream set are curved and fixed in position, and used to improve peripheral air distribution within the burner. The down stream set are positioned to provide proper mixing of this secondary air into the flame. The design of the XCL burner enables its use in open windbox configurations. This facilitates usage in retrofit applications where use of a compartmented windbox would be difficult or expensive. Some of the functional

## Exhibit 3A-1

## XCL Low NOx Burner




(A) High temperature - fuel rich devolatization zone

(B) Production of reducing species

(C) $NO_x$ decomposition zone

(D) Char oxidizing zone



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attributes of the XCL burner are derived from another low $NO_X$ burner HT-NR burner. Consequently, the functional sizing and some mechanical features, design. The result is a reduction of $NO_X$ about 25% below that of earlier DRB design. (Exhibit 3A-2)

Modifications to the combustion process is the most effective first step toward reduction of $NO_X$ emissions. Other systems can be employed downstream of the combustion process to reduce $NO_X$. However, catalysts are required to promote reaction at flue gas temperature available downstream of the boiler. Capital costs to retrofit these downstream systems are at least twice as much as those for combustion modifications. Operating costs are also lowest for combustion modifications and result in the lowest cost per ton of $NO_X$ removal. Consequently, combustion modifications are usually called on to control $NO_X$ emissions. Severe NOx restrictions may require use of downstream systems in combination with combustion process modifications.

## 3A.3 SELECTIVE CATALYTIC REDUCTION (SCR)

SCR is a post-combustion technology in which ammonia ($NH_3$) is injected into the gas turbine or boiler exhaust to reduce $NO_X$ to $N_2$ and water. A catalyst is used to accelerate the reaction and achieve high removal efficiencies. In cases where water or steam injection or low $NO_X$ combustors cannot meet pollution discharge requirements, SCR is an available option. Combined with steam injection into the combustor and low $NO_X$ combustor, SCR reportedly can achieve emission levels of less than 10 ppm. Several operating parameters influence catalyst performance, including gas temperature, gas flow distribution, the presence of sulfur compounds, and catalyst age. High $NO_X$ removal efficiencies require uniform distribution of the $NH_3$ across the gasflow cross section. In addition the catalyst must operate below a maximum temperature to prevent degradation and possible sintering, and above a minimum temperature to provide the required removal efficiency. The optimum operating temperature range is 570°F to 770°F. Also, as removal efficiency increases, the residence time in the catalyst module, the catalyst volume, and/or the $NH_3$-to-$NO_X$ feed ratio must increase as well. The result is that space velocity and pressure drop to parameters that affect steam generator operation - must be optimized for the most cost-effective design.

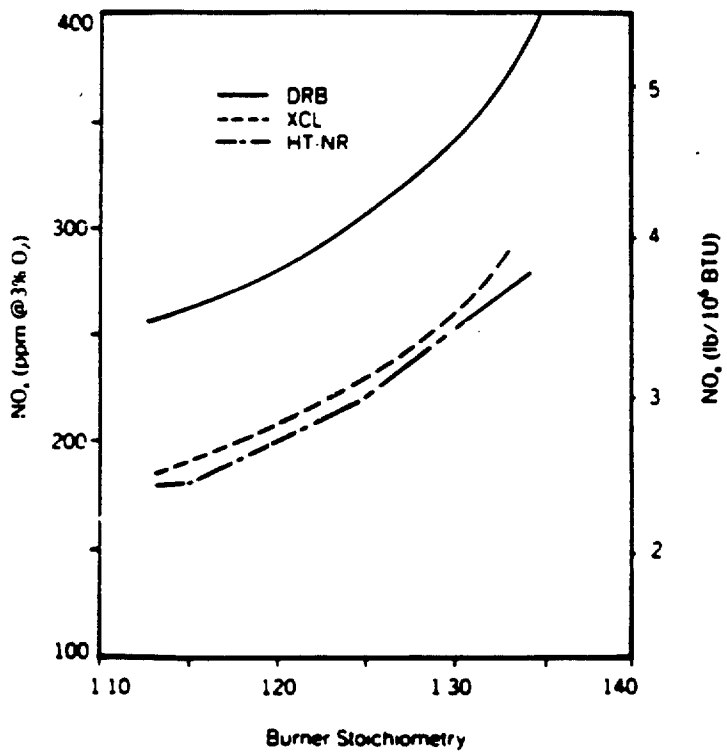
- **$SO_X$ REDUCTION**

## 3A.4 FLUE GAS DESULFURIZATION RETROFIT

Flue Gas Desulfurization (FGD) retrofit was considered for the Bulgaria units to reduce $SO_2$ emissions to or below compliance levels. While FGD has become much more cost competitive in recent years, with the development of dry systems, and wet systems with fewer major vessels, the FGD system still requires an extensive reconstruction of the facility, and the cost is expected to be prohibitive.

## Exhibit 3A-2

## NOx Performance Comparison - DRB



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## 3A.5 DUCT SORBENT INJECTION

Duct Sorbent Injection (DSI) technology was developed as a low capital cost alternative to conventional FGD scrubber systems. In addition to low initial investment, other significant advantages of a duct injection system are its simplicity and that it may be applied at plants with limited available space and/or difficult construction access because the exiting duct(s) is used as the reaction vessel. Modifications to the duct(s) are required to install the injection equipment (humidification and/or sorbent injection nozzles), but no large reactor vessels are required. A duct injection process results in few changes to the existing flue gas system, and minimal plant real estate is required. The retrofit of a duct injection system is relatively simple, and it can be accomplished quickly.

Additional advantages to using a duct injection system include:

- minimal operation and maintenance personnel requirements,
- generation of a dry solid waste product,
- no requirement for a gas reheat system, and
- will not affect unit operation and heat transfer surface requirements.

Few O&M personnel are required for a duct injection system due to its simplicity and limited new equipment requirements. The dry solid waste produced is an advantage because it can typically be handled by the existing fly ash handling system. No dewatering equipment such as thickeners or vacuum filters are needed. A flue gas reheat system is not required in the system design because the temperature of the gas after sorbent injection/humidification is sufficiently above the saturation temperature as to minimize corrosion potential in the duct leading to the ID fans and chimney and in the ID fans and chimney themselves.

Disadvantages of duct injection technology are:

- $SO_2$ removal is limited to 50-70%
- low reagent utilization efficiency
- use of relatively expensive reagents
- an increase in particulate loading to the ESP
- the potential for solids deposition in the ductwork and ESP

little full-scale operating experience in the U.S.

Duct injection technology has been successfully demonstrated at the pilot plant scale. However, full scale applications of this technology are limited.

Although lower in capital cost than conventional scrubber systems, the inherently moderate $SO_2$ removal and low sorbent utilization tend to drive the levelized cost

of duct injection (in terms of dollars per ton of $SO_2$ removed) relatively high. Factors which favor a low capital cost, high levelized cost technology are:

- low sulfur coal
- requirement for a moderate $SO_2$ removal
- small to medium-sized plants
- low plant capacity factors
- short remaining plant life

Exhibit 3A-3 is a flow sheet for a lime slurry injection system. Exhibit 3A-4 and Exhibit 3A-5 show $/ton of $SO_2$ removal as a function of % sulfur removal based on U.S. economics.

These are the general plant criteria which should be considered when evaluating the application of duct injection technology to a specific plant.

DSI technology provides a viable option to the fuel switch for Bulgaria. However, due to lack of operating experience, this option should be considered only as a possible native in the event the fuel switching option fails.

## 3A.6 FUEL SWITCHING

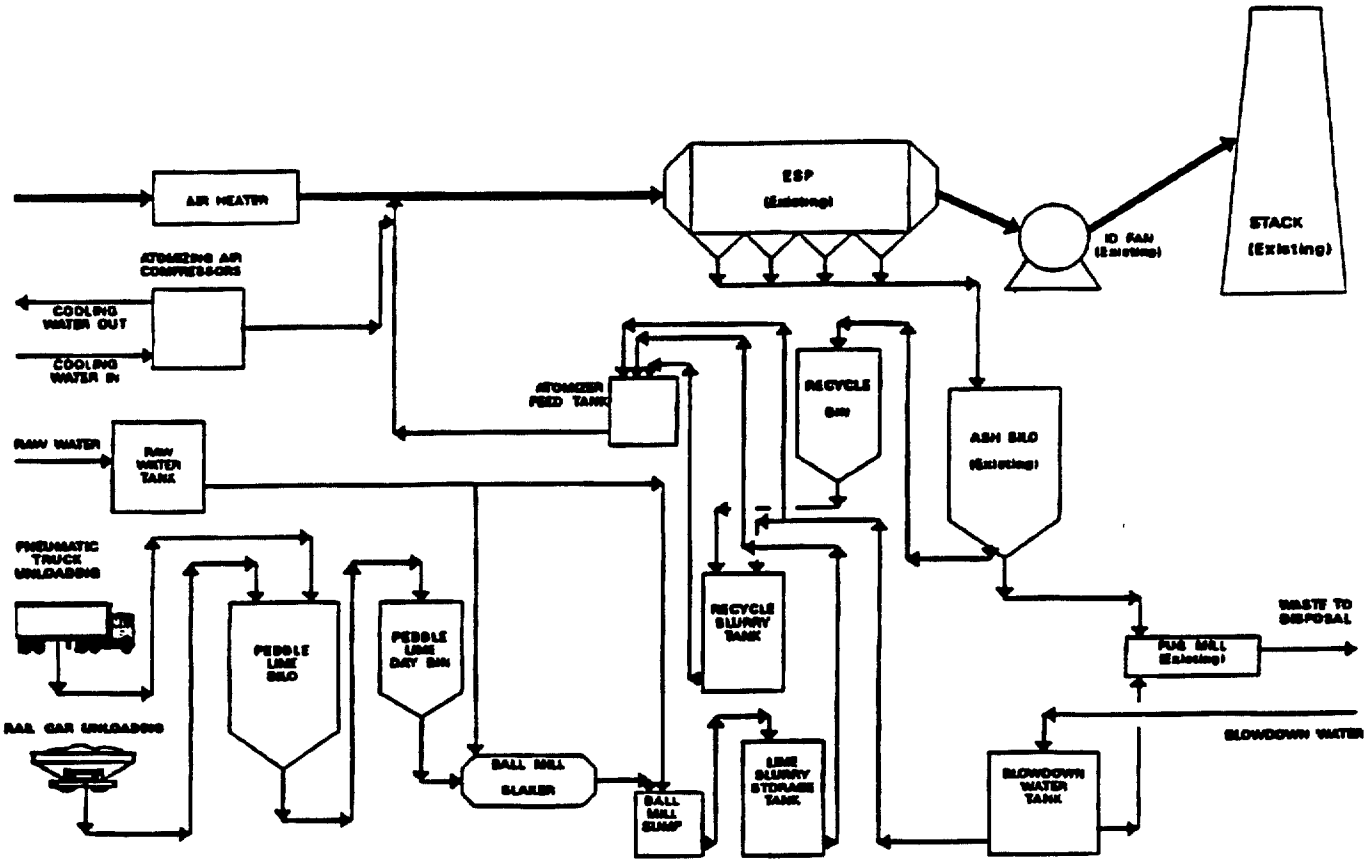
Fuel switching is a common option which can be used to meet environmental regulations. Units designed to burn high- or medium-sulfur coal or matzu can be successfully switched to low-sulfur coal or low sulfur light oil in order to meet $SO_2$ environmental regulations. The effects of fuel switching on the existing unit are dependent on the unit's design and the characteristic of the proposed fuel. For proposed fuels that are similar in nature to the design fuel, the impact on the plant performance and facilities is low. Conversely, when the proposed fuel is considerably different from the design fuel, the changes may require extensive modifications and result in a loss in generating capacity.

In evaluating a potential fuel switch, consideration must be given to the effect of the proposed fuel on the following areas:

- steam generator, (burners, superheaters, economizers, sootblowers, etc.)
- balance of plant equipment, (pulverizers, ESP, air heaters, fans, etc.),
- plant facilities, (coal and ash handling, fire protection, etc.),
- effects on performance/operation, (auxiliary load changes, boiler efficiency, minimum load, etc.), and
- effects on capacity (slagging, erosion, fouling, corrosion, throughput limitations, etc.).

## Exhibit 3A-3

## Duct Sorbent Injection Process Flowsheet



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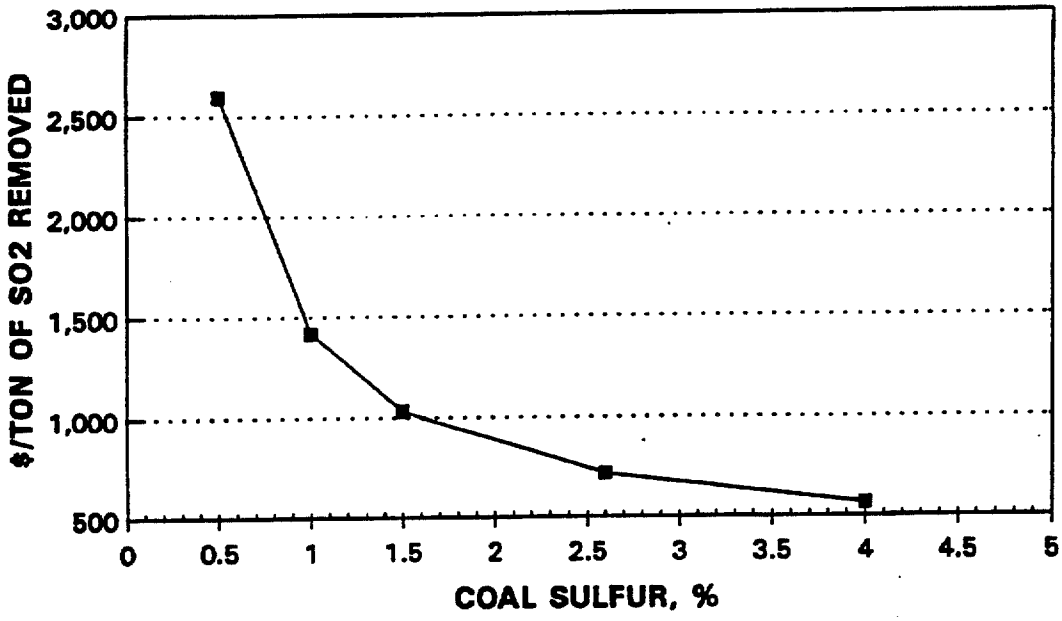
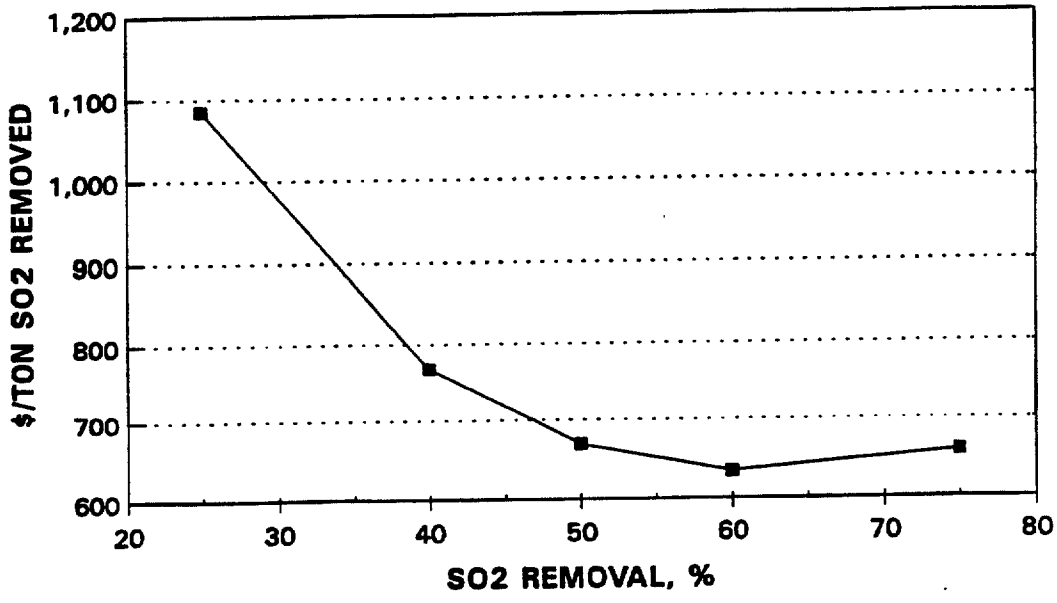
## Exhibit 3A-4

### U.S. Levelized Control Cost vs. Coal Sulfur % with Duct Sorbent Injection




## Exhibit 3A-5

### U.S. Levelized Control Cost vs. $SO_2$ Removed with Duct Sorbent Injection



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Any coal switching program which proceeds beyond the initial study phase should utilize long and short term test burns to verify design and operational impacts.

The advantages of fuel switching to a low -impact low-sulfur coal include:

- potentially limited capital costs,
- no additional reagent handling required, and
- no additional real estate is required.

The advantages of switching to low sulfur light oil are similar to those for the low-impact low-sulfur coal, except that the capital cost will sometimes be higher. The disadvantages of fuel switching include:

- likely higher fuel costs, and
- potential unit derating, performance loss, or impact to minimum load capability.

Factors which may favor fuel seitching include:

- availability of low sulfur fuel at a reasonable cost,
- small to medium-plant size,
- low plant capacity factor, and
- short remaining plant life.

For the Republika units, the boiler was originally designed for a low grade lignite fuel. Switching to low sulfur coal will present design problems that must be overcome. First, pulverization of the harder import coal will require rework or replacement of the coal mills on each unit. Second, the unit must be retrofitted with additional particulate control, since the existing electrostatic precipitator (ESP) performance will be reduced with the lower sulfur coal due to an anticipated change in ash resistivity. While this can sometimes be accommodated through ESP modification or flue gas conditioning with $SO_3$ or $NH_3$, projected performance improvements are not quantifiable without a detailed analysis. Therefore, a baghouse was specified in this study for particulate control. If capital requirements are too high, the ESP modification alternate approach should be investigated further.

- **PARTICULATE REMOVAL**

## 3A.7 ELECTROSTATIC PRECIPITATOR (ESP)

Electrostatic precipitators produce an electric charge on the particles to be collected and then propel the charged particles by electrostatic forces to the collecting curtains. The collection efficiency of the electrostatic precipitator is related to the time exposure to the electrostatic field, the strength of the field, and the resistivity of the dust particle. An efficiency of 99% plus is obtained at a cost generally favorable in comparison with other types of equipment.

Hence, a very high percentage of particulate-removal units installed in commercial boiler plants are electrostatic precipitators.

## 3A.8 BAGHOUSE FOR PARTICULATE REMOVAL

Baghouses are gaining in popularity because of their capability to routinely reduce particulate emissions to extremely low levels. In the past, their cost has been higher than comparable ESP installations, but recent trends toward extremely low particulate emission standards have made the cost more competitive. Also, the recent trend toward fuel switching has increased the popularity of baghouses because of their reduced sensitivity to coal type.

A switch to low sulfur coal will generally cause problems in an ESP because the original design plate area and electrical equipment is sized to correspond to a particular ash resistivity and other ash characteristics. Lower sulfur coals generally have higher ash resistivities and require additional surface area, which is not a simple retrofit. While performance can be enhanced by flue gas conditioning, the baghouse offers a reasonable solution, especially for a small to medium sized plant.

An equipment which removes all three pollutants is described next:

## 3A.9 $SO_X$ $NO_X$ $RO_X$ BOX (SNRB)

SNRB or the Hot Catalytic Scrubbing Baghouse is an advanced, air pollution control system for the combined removal of sulfur oxides ($SO_X$), nitrogen oxides ($NO_X$), and particulates emitted from fossil-fired boilers or processes (Exhibit 3A-6, 3A-7). All three of these removal processes are combined into a single, major device - a high temperature baghouse. $SO_X$ removal is accomplished by using either a calcium - or sodium - based sorbent injected into the hot flue gas downstream of an economizer. $NO_X$ removal is accomplished in part by ammonia injection with a selective $NO_X$- reduction catalyst.

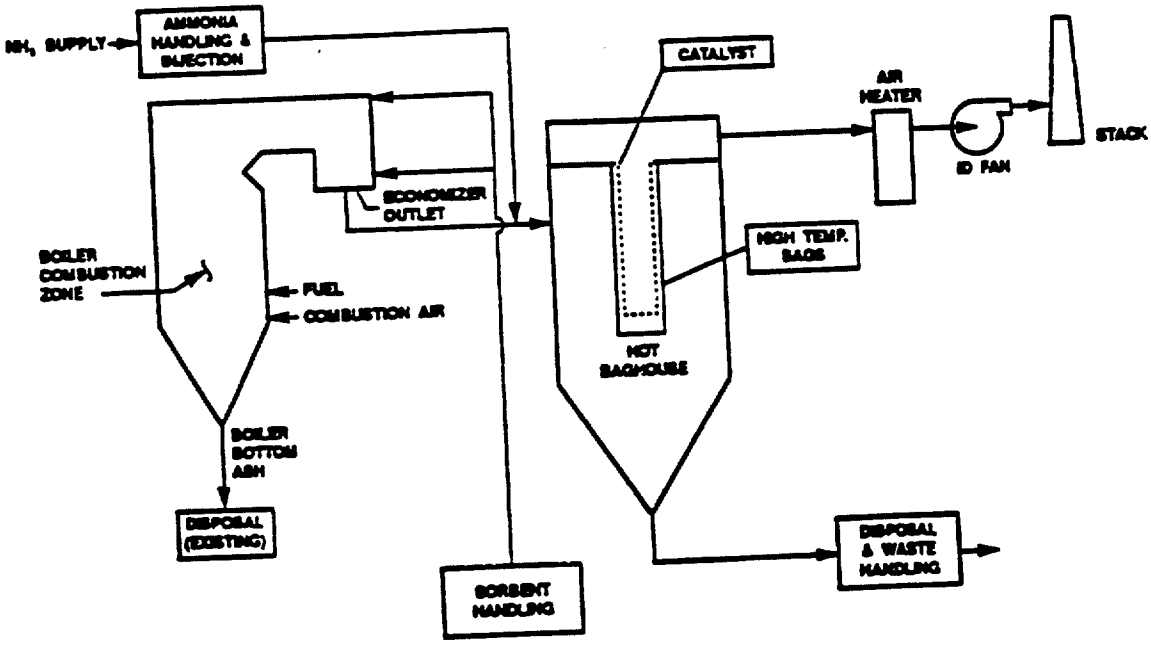
Finally, the particulate and spent $SO_X$ sorbent are collected upstream of the air heater with high - temperature, woven - ceramic - fiber bags. The sorbent selection depends on plant location.

Advantages of SNRB includes:

- Longer catalyst life - $SO_X$ and particulates are removed prior to contact with the selective $NO_X$ - reduction catalyst. Catalyst plugging, poisoning, and erosion are minimized.
- Dry material handling - Sorbent and waste streams are dry. Preparation and disposal costs are minimized.
- No reheat required - NOx removal upstream of the air heater eliminates reheating and cooling the flue gas stream to optimize NOx removal.

## Exhibit 3A.6

## Schematic of the SNRP Process (Calcium-Based)



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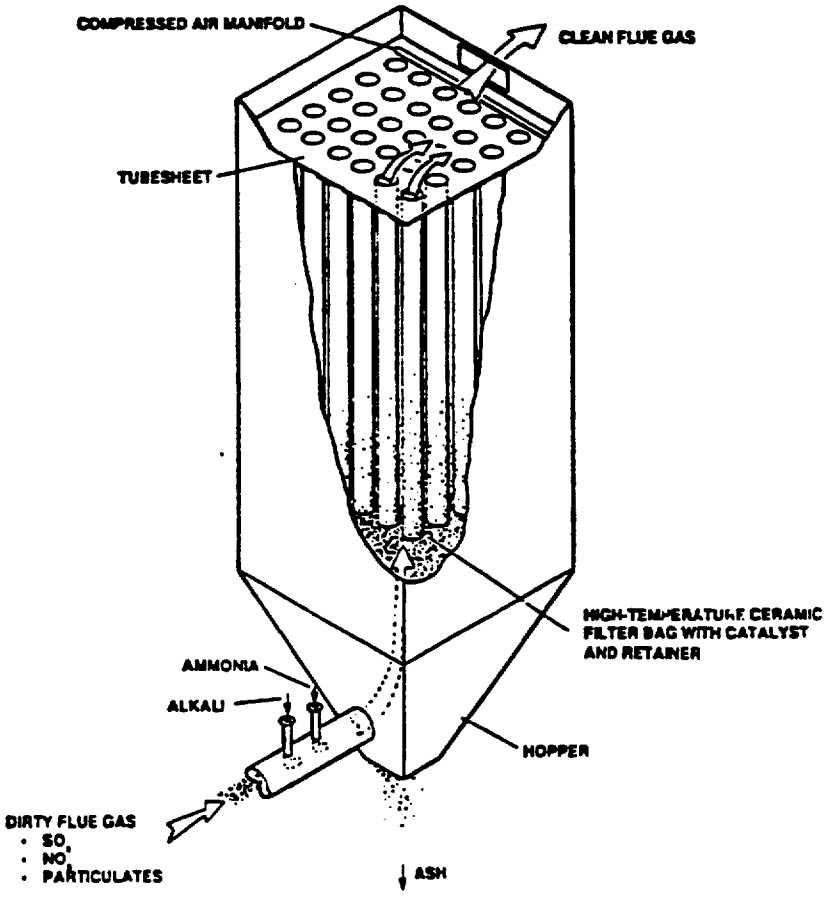
# Exhibit 3A-7

## SNRB Technology



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- More plant power output - $SO_3$ removal prior to the final boiler heat trap or air heater permits significant reductions in flue gas temperature. Overall power system efficiency increases of 1% to 3% are possible. Therefore, the boiler system may be able to produce more power than before.

Reduction and removal efficiency range are as follows:

- $SO_X$ - 70% - 90%
- $NO_X$ - 90%
- Particulate - 99%

Costwise, SNRB is 3 - 25% less expensive than adding three pieces of equipment together for $NO_X$, $SO_X$ and particulates removal. But in view of the relatively new technology in high temperature scrubbing, recommendation of employment of this device should be delayed for the time being.



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**SECTION 4**

**Engineering Analysis - Supply Side**

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# 4.0 ENGINEERING ANALYSIS - SUPPLY SIDE

## 4.1 INTRODUCTION

This Section describes the engineering analysis used to:

(1) define the preferred District Heating Systems supply side technologies;

(2) define the optimal District Heating Systems supply side equipment configuration;

(3) analyze the proposed equipment configuration performance and efficiencies; and

(4) size and optimize parameters of the proposed configuration equipment at each district heating generation site.

The results of this Section augment an equipment rehabilitation program, developed in Section 2.0, and elaborate on findings and results developed in Section 3.0.

The Sofia and Pernik District Heating systems produce hot water by several multi-fuel fired thermal plants. Due to a different design and operating philosophy, the analyzed District Heating systems are not optimized and do not use enough cogeneration to maximize the overall system efficiency. As a result, an unjustifiably high percentage of hot water boilers is used to cover the base and peaking system loads. To increase efficiency of the District Heating systems several configurations were proposed and analyzed in this section. These configurations which replaced existing steam and hot water peaking boilers with the other viable technologies are currently available and used in the West.

A number of suitable technologies for application to the district heating systems supply side were analyzed and evaluated for performance. An identification of suitable technologies is mainly governed by the: (1) high efficiency of new technologies; (2) its integration with the existing plant equipment configurations; and (3) plant design features and operating parameters.

From the list of suitable technologies several preferred technologies were selected through an elimination and ranking process. The preferred technologies selection was based on an objective, structured decision making process applicable for these type of tasks. The basic plant technologies selected for further analysis and equipment configurations optimizations are:

- Existing boilers and steam turbine – equipment rehabilitation option
- Gas turbine – combined cycle options
- Gas turbine – repowering options
- Fluidized bed combustion (FBC) and steam turbine – repowering option

The preferred technologies were analyzed for their efficiencies. Based on the performance analysis and applicable equipment configuration arrangements, a final equipment configuration and sizing for each site was selected.

### 4.1.1 OBJECTIVE

The objective of this task was to analyze the existing generating plants and evaluate equipment upgrades and alternate system configurations to provide reliable, safe service with high efficiency but at a minimized capital expenditure.

While improvements in overall system efficiency were pursued through an increase of cogeneration and electric power production, the maximization of the electric power generation was not the priority for this study.

### 4.1.2 SCOPE DEFINITION

This Section deals with the District Heating systems supply side management portion (power generation). The demand side management portion that deals with the demand optimization and savings was not considered a part of this section.

The scope of the Section is defined by the following six groups of activities:

- Identification of available technologies
- Selection of preferred option(s)
- Definition of equipment configuration
- Configuration equipment selection and preliminary equipment sizing
- Analysis of the proposed equipment configuration efficiencies
- Selection of the equipment configuration design parameters at each site

In executing the defined scope, the GCII team ensured that the new equipment configuration meets following criteria:

- proposed technologies are proven and reliable in operation;
- technology can be easily integrated with the existing operating equipment at the sites; and
- added equipment should lead to substantial overall district heating efficiency gains.



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### 4.1.3 ORGANIZATION OF SUBSECTIONS

In the following Subsections, a more detailed discussion of the methodology used in this study and the proposed equipment configuration structure and performance are presented.

This Section is divided into seven main Subsections including this introduction.

Subsection 4.2 describes the methodology used by the GCII team to identify suitable technologies for the District Heating systems rehabilitation and select preferred technologies for further analysis. The Subsection provides information on the: (1) design and operating details of surveyed technologies; and (2) discusses elimination and ranking criteria used for selection of the preferred technologies.

Subsection 4.3 presents the approach used to integrate the preferred technologies with the District Heating existing equipment into a workable and efficient configuration. The Subsection discusses components of each configuration and the interfaces between new and existing equipment at site.

Subsection 4.4 discusses equipment selection and equipment sizing to allow performance evaluation of different proposed configurations. Information on equipment sizing and efficiency, as provided by the equipment manufacturers, is also presented in this Subsection.

Subsection 4.5 discusses the basis of the comparison between different equipment configuration efficiencies. The comparison was performed to determine which of the proposed new equipment configuration promises the highest overall efficiency and eventually the best return on investment.

Subsection 4.6 defines the equipment configuration at each site in detail and the optimized design parameters of the proposed new equipment for the maximum efficiency gain. Heat balance calculations and methodologies and computer codes used to optimize design and flow parameters are also presented in this Subsection. The equipment configuration design and operating parameters developed in this Section are a direct input into Section 8.0, "Economic Analysis."

Subsection 4.7 provides recommendations for rehabilitation or upgrades of the plants. It should be noted that these recommendations are based primarily upon technical considerations with a focus on production. In the larger context and scope of the study, GCII used this information as input for the economic and financial analyses which also considered the piping and hot water distribution system configurations.



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## 4.2 TECHNOLOGY SELECTION PROCESS AND PRODUCTS

### 4.2.1 METHODOLOGY DESCRIPTION

The technology evaluation process used to review existing and potential supply side options for the Sofia and Pernik District Heating systems is based on a structured and objective methodology that is used by US utilities when they consider rehabilitation of their plants. The methodology used in this analysis consisted of three phases:

- Technology Survey – Phase 1
- Technology Elimination – Phase 2
- Technology Ranking – Phase 3

A schematic representation of the evaluation process and the products of each step of the process are shown in Exhibit 4-1. To develop consistency in the terminology used, the following convention was established throughout the study:

- Technologies included in the Phase 1 are called "suitable Technologies"
- Technologies left after the Phase 2 elimination process are called "Screened Technologies"
- Technologies left after Phase 3 ranking process for further technical and economic analysis are called "Preferred Technologies"

Below is a brief discussion on each of the three technology selection phases.

#### Technology Survey – Phase 1

During the survey Phase suitable technologies are identified, briefly analyzed, and compatibility with the existing district heating systems is checked. The compiled list of suitable technologies serves as a base for further screening and ranking and final selection of preferred options. Both commercial and emerging technologies are included in the list during the technology survey phase.

#### Technology Elimination – Phase 2

Technology elimination Phase serves to exclude technologies that violate some of the basic criteria established by the scope of work or that strongly interfere with an established public opinion. The elimination process is performed during the brain storming engineering sessions. Client participation is desirable during these sessions to convey to the review team specifics of the technical, business and social environment important for technology acceptance.

#### Technology Ranking – Phase 3

The ranking system compares, on a relative basis, the available technology options remaining in the process after the elimination phase. The main objective of the evaluation is to rank, identify and recommend those technologies that should be evaluated more thoroughly. The results of the quantitative assessment form the basis for the acceptance or rejection of technologies. Technologies recommended for further evaluation are those considered most likely to be able to improve efficiency and contribute to capacity.

The evaluation procedure employs formal rules for ranking. A "***major criterion***" is given a **weighting factor** of from 1 to 6, with 6 representing the most significant



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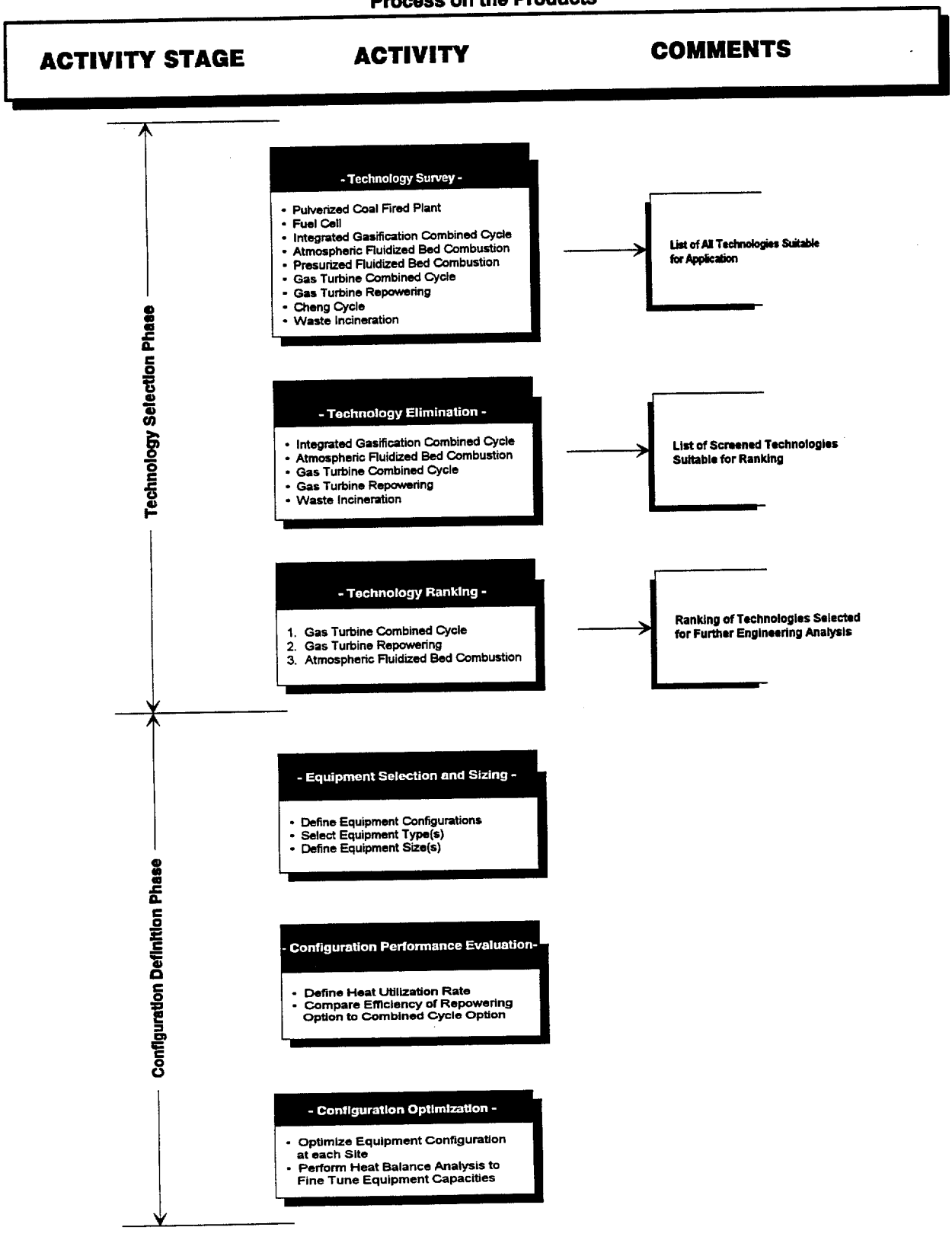
## Exhibit 4-1

### A Schematic Representation of the Evaluation Process on the Products



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criterion. The status/characteristic of each candidate technology is then evaluated with a **relative ranking** within each major criterion, values between 5 and 0. A relative ranking of 5 is awarded to the best ranking technology, and 0 to the lowest. With the system chosen, the maximum possible score for a technology is 100 points. Exhibit 4-2 illustrates the evaluation weighting for the procedure used here. These weights were used to rank the evaluated technologies.

### 4.2.2 Survey of Suitable Technologies

A review of suitable technologies for the district heating systems resulted in a selection of the basic technologies similar to those usually investigated by a utility company for cogeneration plants. Both commercial and emerging technologies were included for further evaluation to determine their potential applicability.

Technologies being considered can be divided into three groups: (1) operations improvement; (2) emissions reduction; and (3) emissions reduction/system upgrade. This study quantitatively addresses emissions reduction/system upgrade technologies and qualitatively addresses all other options. Cycle technologies which were considered for the Bulgaria district heating plants include the following:

- Pulverized Coal Fired Boilers
- Fuel Cells
- Integrated Gasification Combined Cycle (IGCC)
- Atmospheric Fluidized Bed Combustion (AFBC)
- Pressurized Fluidized Bed Combustion (PFBC)
- Natural Gas, Gas Turbine (GT) Combined Cycle
- Natural Gas, Gas Turbine (GT) Repowering
- Cheng Cycle
- Waste Incineration Plant

More information and technical details on surveyed technologies is presented in Appendix 4-1 of this section.

### 4.2.3 Technology Elimination Phase

To limit the amount of engineering analysis and screening for the technologies that are applicable to Bulgarian cases, the GCII team together with the Bulgarian experts performed preliminary elimination of the technologies identified in Subsection 4.2.2.

In order to understand the benefits that might be perceived for various methods of generation and cogeneration, it was important to discriminate between technologies that are ready for commercial service with little technical risk, and to screen out those that are not sufficiently proven as reliable energy sources, although they might become so at some time in the future. These screening procedures help show those technologies that are most suited for service at the present time.

# Exhibit 4-2

## Evaluation Criteria and Characteristics for Relative Ranking of Technologies

| MAJOR CRITERION | CRITERION WEIGHTING | STATUS/ CHARACTERISTIC | RELATIVE RANKING | MAXIMUM POSSIBLE POINTS |
|---|---|---|---|---|
| COMMERCIAL AND DEVELOPMENTAL STATUS | 6 | Utility integration<br>Engineering demonstration<br>Development<br>Pilot<br>Hypothetical | 5<br>4<br>3<br>2<br>1 | 30 |
| TECHNICAL CONSIDERATIONS | 5 | Technically mature<br>Technically demonstrated<br>Technically viable<br>Technically developed<br>Technically inadequate | 5<br>4<br>3<br>2<br>0 | 25 |
| LICENSING AND LEAD TIME RISKS | 3 | Low<br>Moderate<br>High<br>Unknown | 5<br>4<br>3<br>0 | 15 |
| ENVIRONMENTAL | 3 | Evaluate all Table 3<br>Lowest is ranked 5,<br>highest ranks 0.<br>Rest ranked by percentage difference relative to these two. | 5 | 15 |
| COST UNCERTAINTY | 1 | Low<br>Moderate<br>Uncertain<br>High<br>Unknown | 5<br>4<br>3<br>2<br>0 | 5 |
| CAPITAL COSTS | 1 | Evaluate all per EPRI TAG.<br>Lowest is ranked 5,<br>highest ranks 0.<br>Rest ranked by percentage difference relative to these two. | 5 | 5 |
| VARIABLE OPERATING COSTS | 1 | Evaluate variable operating cost and maintenance per EPRI TAG.<br>Lowest is ranked 5,<br>highest ranks 0.<br>Rest ranked by percentage difference relative to these two. | 5 | 5 |
| MAXIMUM POSSIBLE TOTAL: | | | | 100 |



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The screening provided a preliminary evaluation of the performance, technical readiness, economics and environmental performance. Several technologies were eliminated as a result of the screening process. The following is the list of the eliminated technologies:

- Pulverized Coal Fired Boilers
- Fuel Cells
- Pressurized Fluidized Bed Combustion (PFBC)
- Cheng Cycle

Pulverized-coal (PC) fired boiler technology, while feasible, was estimated to be higher in cost for locally available fuels when flue gas desulfurization must be included for $SO_2$ removal. PC boilers were not considered for new additions and are not included in the selection process.

Fuel Cells, PFBC and Cheng Cycle were eliminated from further considerations because these technologies are still in development Phase and no proven, full scale plant with sufficient operating experience exists to justify its application in Bulgaria.

After the screening phase, the following technologies remained for further evaluation:

- Natural gas G/T combined cycle plant
- Natural gas G/T Repowering
- Coal integrated gasification combined cycle plant
- AFBC steam plant
- Waste incineration plant

These technologies would undergo further evaluated and subjected to the ranking process to select those suitable for the detailed economic analysis.

### 4.2.4 TECHNOLOGY RANKING PHASE

The technology ranking Phase judged a number of subjective and qualitative factors for each of the technologies evaluated. This ranking allowed the selection of the short list of final technologies that were given detailed evaluations. This Subsection describes the preliminary ranking methods and results, leading to the technologies chosen for detailed review.

The result of the ranking is a table with points associated with each technology, ranked from most to least, shown in Exhibit 4-3 (see page 4-82). Those technologies with the highest rankings were selected for more detailed study, eventually leading to the selection of the new plant addition recommendations.

In this evaluation, results from one eastern U.S. electric utility company's technology ranking were used for the majority of the data. Those pieces that were missing were developed consistent with their evaluation basis by the GCII team and by the Bulgarian specialists during their study review trips to U.S.

It is evident from the Exhibit 4-2 ranking criteria that some of the technologies considered are not quite ready for commercial use. This is due to the high value that should be placed on prior demonstrations on a scale similar to the intended



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use in Bulgaria. For example, a record of reliable service is a critical weighting factor. Even though coal gasification has been demonstrated, coal gasification-based plants for this application remain to be demonstrated in full scale and in operation in an integrated system, before being accepted as a proven technology.

A low score in this type of ranking does not necessarily indicate a long term view of the potential for a technology, only its lack of suitability for purchase today. These technologies, even the rejected ones, need to be retained as potential choices as emerging technologies suited as future generation candidates or if current effort prolongs long enough to allow maturation of these technologies.

### 4.2.5 Results of the Ranking Process

Exhibit 4-3 shows the results of the ranking process. Of the initial technologies considered, only those with the highest rankings were selected for detailed evaluation. Those selected for further detailed investigation are the following:

- Natural gas: G/T combined cycle plant (Highest ranked)
- Natural gas: G/T repowering (Second ranked)
- Coal: AFBC steam plant (Third ranked)

Those rejected from further consideration at this time were the following:

- Coal: integrated gasification combined cycle plant (IGCC)
- Waste: incineration plant

The technologies that were rejected from consideration were deleted because their selection would not be prudent in an application that is to be built in the near future. Either the experience base with the rejected technologies is not sufficient, or the preliminary assessment of their other benefits are not sufficiently attractive to warrant detailed assessment.

## 4.3 DEFINITION OF EQUIPMENT CONFIGURATION

In Subsection 4.2 only preferred technologies for new power generation options were selected. The equipment configuration that integrates the new technologies to the existing district heating generation stations was not addressed in the selection. However, an optimal equipment configuration that leads to the least-cost option depends on several parameters that go beyond the generation technology component.

The parameters that govern the least-cost option(s) are both technical and economic and are influenced by the equipment configuration and how the new generating unit integrates with the existing equipment at the site. The equipment configuration design, construction, operation, and maintenance features can have dramatic impact on a fuel consumption and man power requirements, driving certain operating cost components upward or downward. The technically most advanced and efficient option will therefore not necessarily be the most economically attractive option when evaluated on a life-cycle basis.

To address the uncertainties that each capital project brings and to determine the least-cost option, GCII team developed several different equipment configurations for each site. The configurations are developed in accordance with:

(1) the technical requirements of the preferred technologies, selected in Subsection 4.2.3;

(2) integration requirements to optimize interfaces between preferred technologies to the existing equipment at the site

(3) gradual increase in configuration capital cost and efficiency.

The following are the proposed general configurations:

- Rehabilitation of existing equipment including components identified in Section 2 as requiring replacement or upgrade now or within the next 10 years
- Repowering option with the gas turbine and heat recovery steam generator (HRSG)
- Combined cycle with introduction of gas turbine, heat recovery steam boiler, and new steam turbine
- Repowering option with the AFBC steam plant

Of the 16 potential options at each of four stations, a total of nine (9) cases were fully developed for the Sofia Thermal Power Station (S cases), Republika Thermal Power Station (P cases), Trajco Kostov Thermal Power Station (K cases), and Liulin Heating Station (L cases). Some of the potential options were not developed due to factors such as unavailability of natural gas and public opposition to coal firing in the cities.

Minimal rehabilitation of the existing systems are evaluated as cases S1, P1, K1 and L1 for Sofia, Republika, Trajco Kostov and Liulin plants, respectively. Repowering of the existing system with the gas turbine/HRSG is analyzed as Case S2. Operation with gas turbine combined cycle is investigated as Case S3, K2, and L2, and fluidized bed combustors are evaluated as Case P3. The gas turbine/HRSG option was not evaluated at any of the other plants since the analysis at Sofia proved the gas turbine combined cycle option and the gas turbine/HRSG option to be of comparable present worth.

The identified cases will be discussed in detail in Subsection 4.6 and each equipment configuration will be fine tuned for each site.

The extent of repowering/combined cycle was limited by the criteria requiring optimization of District Heating systems for heat production and limitation of capital expenditure for the new equipment. Therefore only one new equipment combination with a highest expected efficiency and the least life-cycle cost was anticipated for each generating site.



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## 4.4 EQUIPMENT SELECTION AND SIZING

To conduct a technology performance evaluation the GCII team contacted most of the major equipment manufactures to obtain design and operating data on gas turbines, AFBC, boiler components (burners and I&C), and heat recovery boilers. This initial information was further analyzed and processed to prepare data for performance assessment of the selected equipment and for design optimization performed in Subsection 4.6.

### 4.4.1 STEAM BOILERS

#### Boiler Selection

Rehabilitation of the existing steam boilers will be performed in accordance with the recommendations and schedules presented in Section 2. All performance analysis for the rehabilitation is based on the information and efficiency data provided by B&W.

For the AFBC, several manufacturers were contacted. However, the most complete data and best AFBC performance was provided by Foster Wheeler. Therefore, for the technology performance evaluations, the Foster Wheeler AFBC is used.

#### Boiler Efficiency Data

Exhibit 4-4 provides B&W calculated boiler efficiencies for the three thermal power and heating (TPH) stations burning natural gas and compares them with the efficiencies reported by the Committee of Energy (COE). The more recent COE reported efficiencies are much higher than those reported for previous years. Since use of natural gas (as used today) is expected to result in a lower efficiency than use of oil (used earlier) due to the loss associated with formation of water from hydrogen in the fuel, it is believed that the COE supplied data may not accurately reflect the Bulgarian situation. After several discussions, the efficiencies shown in Exhibit 4-4 were determined to be reasonable for existing conditions used in this study for thermal boilers as well as hot water boilers firing natural gas and oil fuel.

Exhibit 4-5 gives the existing boiler efficiencies for the coal firing units at Republika plant.

Efficiency for the new fluidized bed combustor is based on Foster Wheeler's data provided in Exhibit 4-6.

### 4.4.2 GAS TURBINES

#### Gas Turbine Selection

Only advanced gas turbine designs of high efficiency are considered for rehabilitation. Power output should be in the range of 40 MW - 70 MW in order to suit the Bulgaria plants load curves developed in Section 3.

For the performance evaluation and further optimization and design analysis, Stewart & Stevenson LM6000 and General Electric Frame 6FA gas turbines were selected for repowering and combined cycle options, respectively. Several 50Hz advanced gas turbines by General Electric, Westinghouse, Siemens, and ABB Power Generation were originally considered for selection. Based on the International Standards Organization (ISO) performance on natural gas, the



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## Exhibit 4-4

## Boiler Efficiency (B&W)

| | SOFIA | KOSTOV | PERNIK | LULIN | ZEMLIANE |
|---|---|---|---|---|---|
| STEAM GENERATOR | | | | | |
| | #1-9 | #1-7 | #1-5 | | |
| Natural Gas | 84 (91.1-95.2) | 84 (92.3-94.1) | | | |
| #6 Oil | 87 (90.4-92.) | 87 (91.1-92.9) | | | |
| Coal | | | 87 (81.3-83.7) | | |
| HOT WATER BOILER | | | | | |
| | #1-6 | #1-8 | | #1-4, 5 | #1-6 |
| Natural Gas | 84 (88.6) | 84 (92.7-94.1) | | 84,86.4 --- | 84 --- |
| #6 Oil | 87 (86.8) | 87 (86.4) | | --- | --- |
| (Efficiency Per Bulgaria) | | | | | |

## Exhibit 4-5

## Existing Boiler Efficiency [%]

## Republika Thermal Power Station

| BOILER | DESIGNED | REALIZED PER YEAR | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1991 PER 9 MONTH |
| No. 1 | 1985 | 76 | 81 | 82 | 81 | 76 | 82 | 81 | 81 | 83 | 83 | - |
| No. 2 | 1985 | 78 | 80 | 78 | 76 | 77 | 81 | 82 | 81 | 81 | 81 | 81 |
| Reserve | 1983 | 79 | 82 | 82 | 82 | 77 | 81 | 82 | Repair | Repair | 82 | 82 |
| No. 3 | 1983 | 75 | 81 | 78 | 82 | 80 | 82 | Repair | 82 | 81 | 82 | 82 |
| No. 4 | 1983 | 78 | 82 | 82 | 78 | 79 | 79 | 80 | 83 | 82 | 82 | 82 |
| No. 5 | 1986 | 81 | 83 | 82 | 84 | 83 | 83 | 85 | 85 | 83 | 84 | 84 |



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## Exhibit 4-6

### Summary Performance Sheet
### Efficiency Data
### 100% MCR

| | | | |
|---|---|---|---|
| FUEL | Bituminous Coal | | |
| STEAM FLOW | 458,600 lb/hr (208 Tone/hr) | | |
| HEAT LOSSES | | | |
| DRY GAS | - 5.09 | % | HHV |
| HYDROGEN & MOISTURE IN FUEL & LIMESTONE | -10.16 | % | HHV |
| MOISTURE IN AIR | - 0.12 | % | HHV |
| UNBURNED COMBUSTIBLE | - 2.84 | % | HHV |
| RADIATION | - 0.28 | % | HHV |
| CALCINATION | - 2.24 | % | HHV |
| ASH SENSIBLE HEAT | - 1.24 | % | HHV |
| UNACCOUNTED | - 0.15 | % | HHV |
| MANUFACTURER'S MARGIN | - 1.00 | % | HHV |
| FAN CREDIT | 0.74 | % | HHV |
| SULFATION CREDIT | 2.08 | % | HHV |
| NET LOSSES | 20.3 | % | HHV |
| EFFICIENCY | 79.70 | % | HHV |
| DESIGN PARAMETERS | | | |
| CALCIUM TO SULFUR RATION (CA/S) | 2.42 | | |
| BED OPERATING TEMPERATURE | 1600°F | | |
| EXCESS AIR | 20% | | |



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LM6000 clearly has the best simple cycle heat rate for a repowering application, and Frame 6FA, a scaled down version of GE's state-of-the-art Frame 7FA, is the most efficient for combined cycle application.

From an emissions point of view, both proposed gas turbines employ dry low $NO_X$ burners, guarantee 25 ppmv $NO_X$ at 15% $O_2$, and meet Bulgaria's future emissions requirements. Exhibit 4-7 shows LM6000 power output as a function of ambient temperature. Unlike a typical industrial type gas turbine, whose power increases as ambient temperature decreases, this aero-derivative engine's power peaks near 48°F. To compensate for this shortcoming, a chiller and a heater are added to maintain a constant 48°F temperature to the compressor inlet regardless of the ambient. Thus, peak power is maintained throughout the ambient range at the expense of 1.5% loss in auxiliary power. Similarly, power output of Frame 6FA at high ambient temperature can be improved as much as 4 MW by adding a chiller.

#### Gas Turbine Performance Data

Standard gas turbine performance, supplied by a gas turbine manufacturer (Exhibit 4-8), is corrected by the site conditions, inlet and exhaust duct losses, gear loss, etc. and is used for the performance comparison performed in Subsection 4.5.

### 4.4.3 HEAT RECOVERY STEAM GENERATOR

#### HRSG Design Selection

For most combined cycles with an advanced gas turbine, exhaust energy recovery is maximized with a triple pressure HRSG design. The highest pressure level is used for throttle steam. Medium pressure steam is generated for injection to the gas turbine for power augmentation or induction to the steam turbine. Lowest pressure is usually used for induction, thereby generating additional power from the low pressure stages of the steam turbine. The Frame 6FA turbine even employs a reheat steam cycle to further improve steam turbine performance and hence enhance overall plant heat rate.

In this study, however, a single pressure HRSG was chosen with no induction and a non-reheat steam turbine, leaving the triple pressure - reheat cycle for further analysis.

#### HRSG Performance Data

Standard HRSG design and performance data, supplied by a Deltak Corporation, is used for performance comparison performed in Subsection 4.5.

### 4.4.4 STEAM TURBINES

#### Steam Turbine Selection

For electric utility applications, a condensing steam turbine is generally chosen. The plant is loaded to the maximum capacity factor. In a cogeneration plant for heat and power, where the first priority is to produce heat, a back pressure steam turbine may be a better choice. But, in such case, the plant would run only during a few cold winter months, and the investment is not justifiable with a low capacity factor. A condensing turbine would allow the plant to generate electricity all year long and the revenue from the sale of electricity may offset part of the operating expenses. Only a small percentage, about 5%, of the steam flow may need to go



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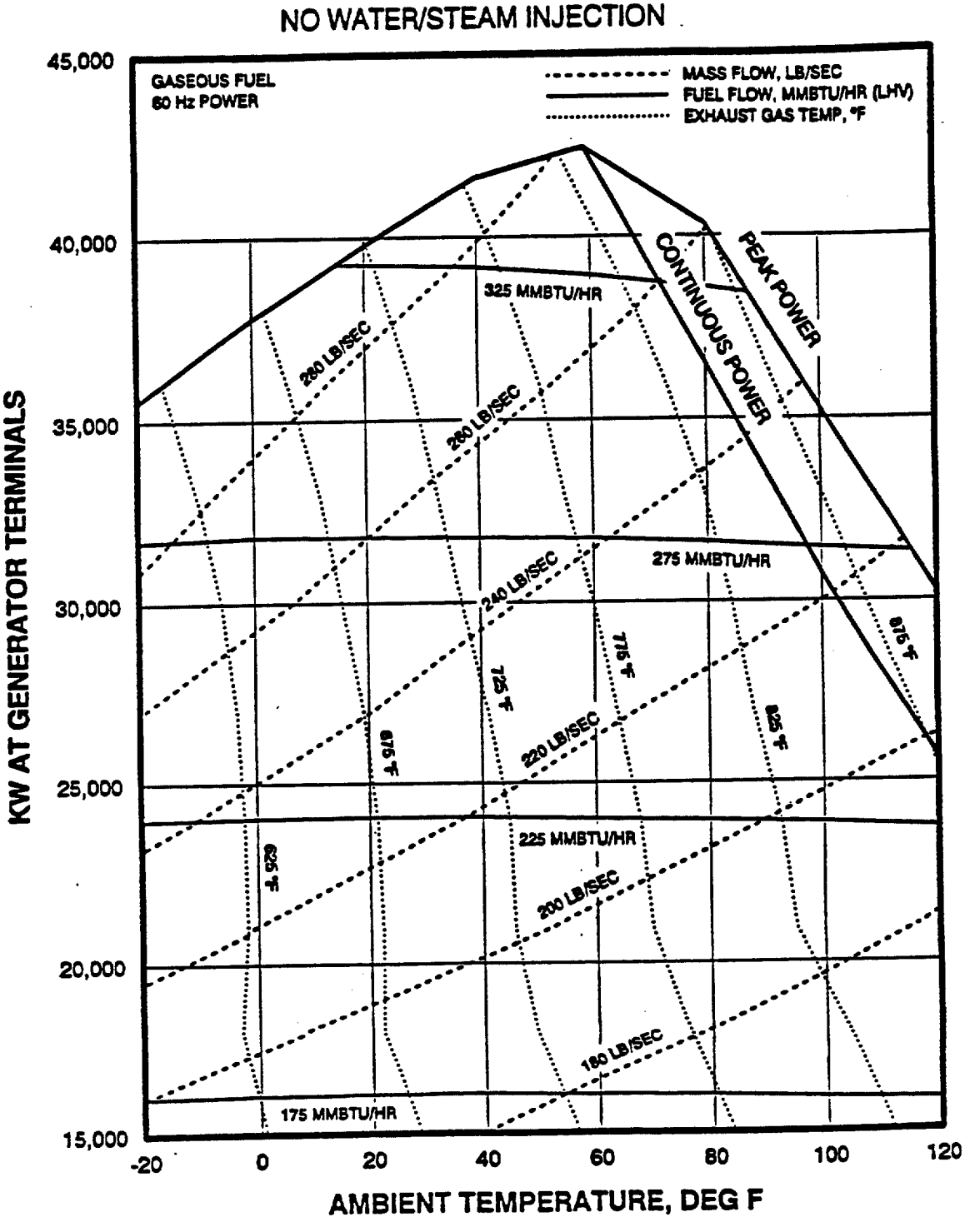
## Exhibit 4-7

## GE LM6000 Gas Turbine



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# Exhibit 4-8
## Gas Turbine Performance Data

STEWART & STEVENSON/GE LM6000-PA, INTRODUCTORY RATING; NOT GUARANTEED NAT GAS
BULGARIA DISTRICT HEATING SYSTEM REPOWERING PROJECT - GILBERT/COMMONWEALTH - DLN MARGINES APPLIED - 100% TO 10% LOAD

| CASE # | 1007 | 1009 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 |
|---|---|---|---|---|---|---|---|---|---|---|
| LOAD % | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| AMBIENT COND | | | | | | | | | | |
| DEG, F | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 |
| RH, % | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| ALT, FT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ENGINE INLET | | | | | | | | | | |
| DEG, F | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 | 48.0 |
| RH, % | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| CONDITIONING | NONE | NONE | NONE | NONE | NONE | NONE | NONE | NONE | NONE | NONE |
| 60 HERTZ | | | | | | | | | | |
| KW, GEN TERM | 41,623 | 37.439 | 33.250 | 29.056 | 24.858 | 20,656 | 16,448 | 12,236 | 8.019 | 3,798 |
| BTU/KW-HR | 8,745 | 8,794 | 8,917 | 9,191 | 9,576 | 10,131 | 11,072 | 12,724 | 16,126 | 27,097 |
| FUEL | | | | | | | | | | |
| MMBTU/HR, LHV | 364,00 | 329.24 | 296.47 | 267.07 | 238.05 | 209.26 | 182.11 | 155.69 | 129.32 | 102.91 |
| FUEL, PPH | 19.158 | 17,329 | 15,604 | 14,056 | 12,529 | 11,014 | 9,585 | 8,194 | 6,806 | 5,416 |
| WATER, PPH | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WATER/FUEL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WATER TEMP DEG F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NOZ STEAM | | | | | | | | | | |
| PPH | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MANIFOLD, F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MANIFOLD, PSIA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| STEAM/FUEL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL HP, PPH | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HP % AIR FLOW | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FILTER IN H2O | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| VOLUTE IN H2O | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| EXHAUST IN H2O | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| PT, RPM | 3,600 | 3,600 | 3,600 | 3,600 | 3,600 | 3,600 | 3,600 | 3,600 | 3,600 | 3,600 |
| HP COMP, RPM | 10,448 | 10,145 | 9,925 | 9,771 | 9,635 | 9,471 | 9,309 | 9,135 | 8,932 | 8,709 |
| COMP DISCH, PSIA | 436 | 408 | 378 | 349 | 317 | 292 | 267 | 240 | 213 | 183 |
| COMP DISCH, F | 1,005 | 970 | 936 | 907 | 876 | 844 | 812 | 767 | 730 | 688 |
| BORESCOPE, PSIA | 419 | 393 | 363 | 335 | 304 | 280 | 155 | 230 | 203 | 175 |
| T48, R | 2,049 | 1,982 | 1,926 | 1,881 | 1,838 | 1,765 | 1,698 | 1,627 | 1,553 | 1,464 |
| EXHAUST | | | | | | | | | | |
| DEG, F | 880 | 843 | 817 | 803 | 796 | 766 | 739 | 716 | 692 | 666 |
| PPS | 283.46 | 270.45 | 254.29 | 237.41 | 218.16 | 204.92 | 191.20 | 175.80 | 159.76 | 142.19 |
| PPH | 1020443 | 973606 | 915442 | 854659 | 785364 | 737699 | 688316 | 632864 | 575138 | 511873 |

NOTES:
1. POWER SHOWN IS 98% OF B&W LOAD POWER (DRY LOW NOx MARGIN)
2. HEAT RATE SHOWN IS 101% OF BASE HEAT RATE (DRY LOW NOx MARGIN)



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through the condensing section in order to reduce the windage and friction losses in the low pressure end of the bladings during maximum extraction.

For the combined cycle option, new ABB turbines were selected with the Ecolaire supplied condensers.

**Steam Turbine Performance Data**

Steam turbine performance is based upon miscellaneous information from Bulgaria such as performance diagrams, expansion lines, correction curves and test results whenever available. A 5% degradation is assumed for all old turbines. Performance of new turbines is calculated by computer programs.

Performance parameters for the rehabilitated existing turbines was based on the Eliot Company data. The new ABB turbine data were based on the manufacturers guaranteed parameters.

Performance parameters were calculated by a model specifically developed for this study. The process that describes how the turbine is modeled and how performance parameters are derived is presented in Appendix 4A.2.

## 4.5 CONFIGURATION PERFORMANCE EVALUATION

To compare overall efficiencies of the preferred technologies and equipment configuration selected in Subsections 4.2.5 and 4.3, and analyze its technical merits, GCII team performed performance analysis of repowering and combined cycle options with the selected equipment defined in Subsection 4.4. This performance evaluation also helped to fine tune the proposed equipment configuration. The performance evaluation was based on a Heat Utilization Factor (HUF).

The performance analysis described in this Subsection is not intended to be rigorous and detailed to the point of providing guaranteed performance, but rather is intended to provide a basis of efficiency comparison for the various configurations examined.

### 4.5.1 HEAT UTILIZATION FACTOR

A HUF, used to measure the efficiency of different cycle configurations in this study, is defined as follows:

$$HUF = \frac{3413}{\text{Heat Rate (Btu/kWh)}}$$

## 4.6 OPTIMIZATION OF CONFIGURATION DESIGN PARAMETERS AT EACH SITE

General equipment configurations for the Sofia and Pernik District Heating systems were defined in Subsection 4.3. These configurations, however, only provide a guidance for further optimization at each generating site. The final selection will be based on the heat balance analysis and integration requirements

imposed by the existing equipment design and operating parameters. The following Subsections provide:

(1) description of the equipment configuration at each generating site with the supporting flow diagrams

(2) heat balance calculation for heat and mass optimization between existing and added equipment

(3) preliminary design and operating parameters for each configuration

4) preliminary equipment arrangement drawings.

A summary of the selected configurations is shown in Exhibit 4-9.



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## Exhibit 4-9

## Plan Cycle Evaluation - Case Study

| CASE | TECHNOLOGY | FUEL TYP | % | PLANT | COMMENTS |
|---|---|---|---|---|---|
| S1 | Existing plant with usable boiler/steam turbine | natural gas | 95 | SOFIA | Minimum boiler upgrade |
| | | mazut | 5 | | |
| S2 | Gas turbine/combined cycle – Repowering | natural gas | 100 | SOFIA | Replace existing boiler |
| S3 | Gas turbine/combined cycle – New Unit | natural gas | 100 | SOFIA | Replace existing boiler |
| S4 | Fluidized bed (FBC) boiler/cogen | coal | 100 | SOFIA | Replace existing boiler Scale from Republika's FBC |
| P1 | Existing plant with usable boiler/steam turbine | coal | 100 | REPUBLIK | Minimum boiler upgrade |
| P2 | Select from Sofia results – Conventional steam cycle or combined cycle | coal / natural gas | | REPUBLIK | Compare to FBC Case P3 Pending Sofia results |
| P3 | Fluidized bed (FBC) boiler/cogen | coal | 100 | REPUBLIK | Replace existing boiler |
| K1 | Existing plant with modification | natural gas | 95 | KOSTOV | Minimum boiler upgrade |
| | | mazut | 5 | | |
| K2 | Select from Soifia results – Conventional steam cycle or combined cycle | natural gas or mixture | | KOSTOV | Pending Sofia results |
| L1 | Existing plant with modification | natural gas | 95 | LIULIN | Minimum boiler upgrade |
| | | mazut | 5 | | |
| L2 | Gas Turbine with HRSG | natural gas | 100 | LIULIN | Supplementary firing option |

**SOFIA TPH STATION**

**CASE S1**

### 4.6.1 SOFIA POWER AND HEAT STATION CONFIGURATIONS

This plant was built in 1948. It has been reconstructed in stages in 1958, 1963 and 1985. It was the first heat energy source for the centralized district heating system in the City of Sofia.

Much of the Sofia Thermal Station equipment is old, inoperable and has been retired. A site plan is presented in Exhibits 4-10. Exhibit 4-11 (see page 4-89) lists the station major equipment, based on B&W's assessment, and historical data provided by Bulgarian specialists. Technical data at rated design conditions as well as operating conditions in 1992 were assembled through available information from Bulgaria. For the purpose of this study, it is believed that this will provide consistent performance data, at least for relative comparison, among the various cases.

#### 4.6.1.1 Sofia TPH Station - Case S1

Summary of the proposed activities for the Case S1 is presented in Exhibit 4-12. This is the "minimum rehabilitation" Case also defined as a "Base Case" for the economic analysis. Case S1 is defined by the B&W recommendations "Necessity and Enhancement" presented in Subsection 2.5. Simplified schematic of this case is shown in Exhibit 4-13.

Excluding some efficiency gains due to new burners, better boiler firing control, refurbished auxiliary equipment, and slightly improved turbine performance this option does not provide any increase in electric power generation nor bring an increase in overall station efficiency.

**Thermal and Hot Water Boilers Modification:** Due to the reduced industrial steam demand, caused by the current recession and restructuring, only one of the three industrial steam producing boilers should be rehabilitated for further use. Considering that Boiler No. 3 is newest and in best condition, the recommendation is to rehabilitate this boiler. Boiler No. 2 should remain mothballed and eventualy rehabilitated if steam demend increases in the future beond the production capacity of the Boiler No. 3. The Boiler No. 1 should be retired and eventually dismantled. Hot water boilers No. 1 and 2 should be removed from service, but mothballed for eventual future demand.

Thermal Boiler Nos. 4 through 8 and Hot Water Boiler (HWB) Nos. 3 through 6 will be rehabilitated according to the "necessity" and "enhancement" schedule by B&W recommendation.

**Steam Turbines Modification:** Steam Turbine Nos. 4 and 5, 6 and 8 will be rehabilitated starting from year 1994 and inspected and overhauled every five years to maintain operability and efficiency as described in Subsection 2.4 of this study.

The facility data sheet (Exhibit 4-14) summarizes boiler efficiency and turbine performance formulated for the economics model in accordance with Section 6.3.9. Boiler efficiency is based on a 95% natural gas and 5% Mazut oil mixture. Turbine performance is based upon curves in Exhibits 4-15 and 4-16 for Turbine Nos. 4 and 5, and for No. 6, respectively.

Performance of Turbine No. 8 is estimated from the operating conditions during 1992 and the performance curve (Exhibit 4-17).

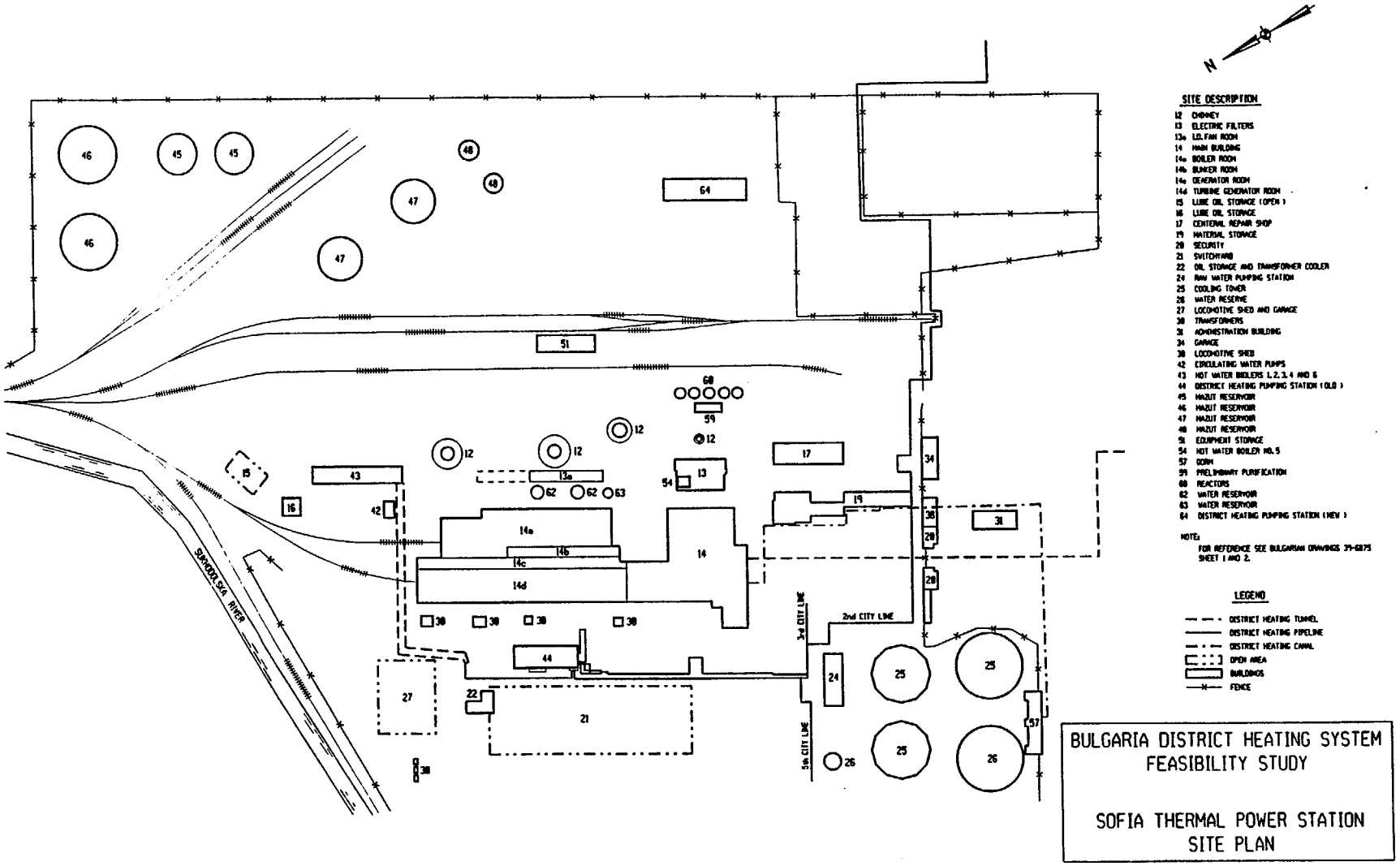
The turbines can be dispatched to follow the hot water heating demand load duration curves. Turbine No. 6 is dispatched first and covers 20% of the peak demand (533 MWt) followed by Turbine Nos. 4 and 5, each contributing 31.5 MWt. Turbine No. 8 is mainly used to fulfill the process steam requirement, but can be called upon to deliver 41 MWt by throttling to provide heat via high pressure heater. The rest of the demand is made up by the hot water boilers.

Total contribution of the cogeneration facilities in Case S1 is about 40% in this case.

Cogeneration percentage is defined here as a ratio of the thermal megawatts of heat available for hot water through turbine extractions versus the peak thermal demand for hot water from the plant.

## Exhibit 4-10

## Sofia Thermal Power Station Site Plant



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## Exhibit 4-12

## Summary of Case S1

| BOILERS TYPE | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| **Boiler No. 1** | Retire |
| **Boiler No. 2** | Retire (Mothball for eventual future demand increase) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Hot Water Boilers:** | |
| Boiler No. 1 | Retire (Mothball for eventual future demand increase) |
| Boiler No. 2 | Retire (Mothball for eventual future demand increase) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Steam Turbines:** | |
| Turbine No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |



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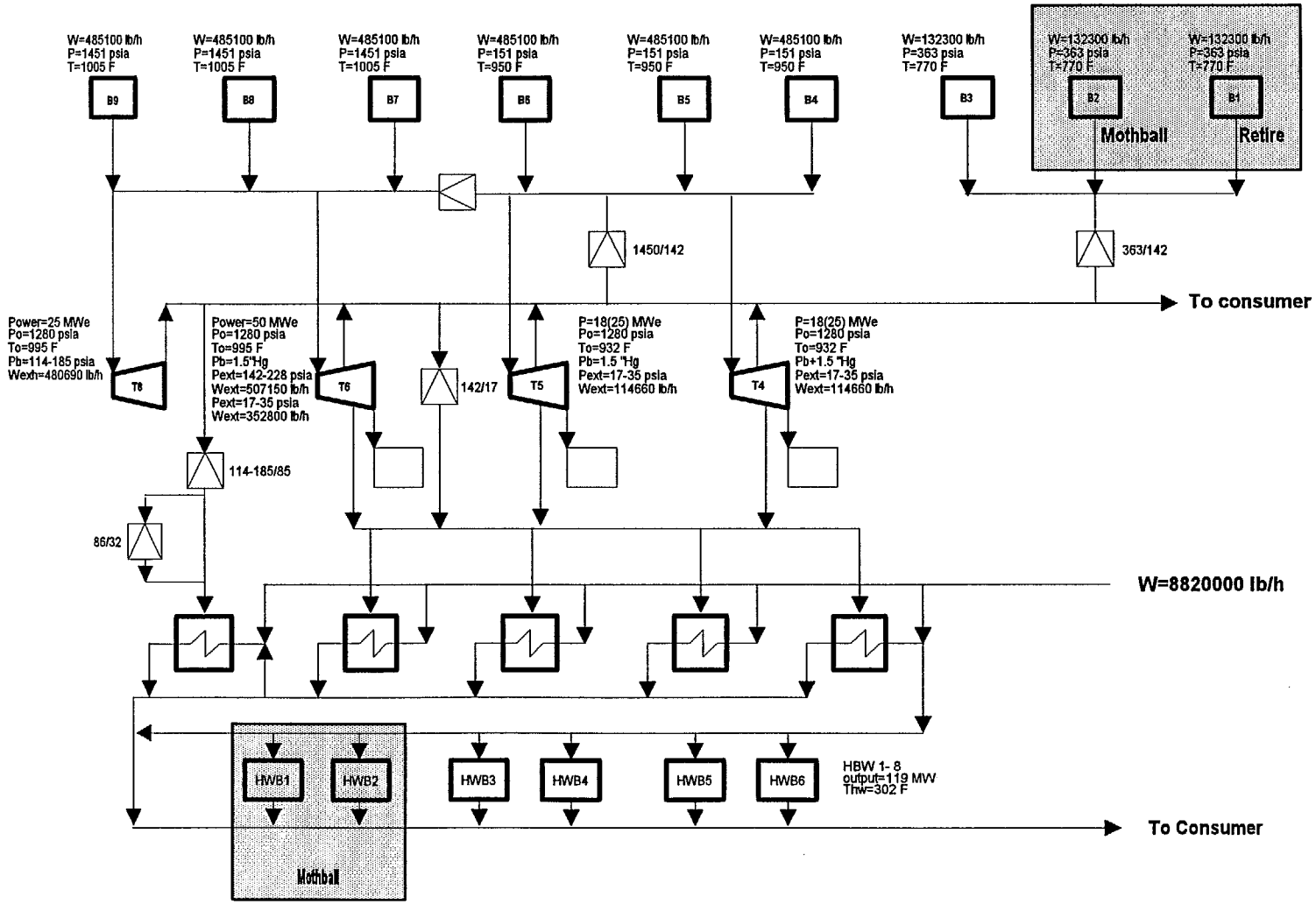
# Exhibit 4-13

## Sofia TPH Station - Case S1



# Exhibit 4-14

## Facilities Data Sheet and Simulated Results - Year 2010
## TPS Sofia - Case S1

CASE S1 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | | | |
| | | | | | Brs 4-5 | | Brs 5-6 | | | Boiler #7 | Boiler #8 | | | | Br #9 | Br #3 | HWB 3-6 |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency - 80% to Full Load | %1 | | | | 84.8% | | 84.8% | | | 84.8% | 84.8% | | | | 84.4% | 84.4% | 84.5% |
| Half Load | %2 | | | | 84.8% | | 84.8% | | | 84.8% | 84.8% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Load | %3 | | | | 84.8% | | 84.8% | | | 84.8% | 84.8% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Operation | % | | | | 26.7% | | 26.7% | | | 40.0% | 40.0% | | | | 40.0% | 40.0% | 10.0% |
| Feedwater Temp | | | | | 419° | | 419° | | | 419° | 419° | | | | 439° | 212° | 158° |
| Operation Adjustment Factor | Factor | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | | | 8 | 7 | | | | | | |
| Capacity | MWt | | | | 50.000 | | 50.000 | | | 135.000 | 135.000 | | | | | | |
| Quantity | Mlb/Hr | | | | 727.65 | | 727.65 | | | 485.1 | 485.1 | | | | 485.1 | | |
| Pressure | PSIA | | | | 1451 | | 1451 | | | 1451 | 1451 | | | | 1451 | | |
| Temperature | Temp °F | | | | 950° | | 950° | | | 1004° | 1004° | | | | 1004° | | |
| Enthalpy | MBTU/lb | | | | 1.458 | | 1.458 | | | 1.496 | 1.496 | | | | 1.496 | | |
| PRODUCT - LP STEAM | Priority | | | | | | | | | | | 5 | | | 2 | | |
| Quantity | Mlb/Hr | | | | | | | | | | | 507.15 | | | 430.000 | 132.300 | |
| | MWts | | | | | | | | | | | 166.700 | | | 159.000 | 53.000 | |
| Pressure | PSIA | | | | | | | | | | | 185 | | | 142.25 | 363 | |
| Temperature | Temp °F | | | | | | | | | | | 559.4° | | | - | 770° | |
| Enthalpy | MBTU/lb | | | | | | | | | | | 1.302 | | | 1.266 | 1.403 | |
| PRODUCT - HOT WATER | Priority | | | Cooling | 4 | | 3 | | | | | | 1 | | 2 | | 6 |
| Quantity | MWhr | | | 200.000 | 35.190 | | 35.190 | | | | | | 101.300 | | 41.000 | | 464.000 |
| Temperature - Supply | Temp °F | | | | 240° | | 240° | | | | | | 240° | | 240° | | 302° |
| Return | Temp °F | | | | 140° | | 140° | | | | | | 140° | | 140° | | 158° |
| TURBINE DATA | UNITs | | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | | | Turb 6a | Turb 6b | Turb 6c | Turb 8 | | |
| | Priority | | | | | | | | | | | | | 55000 | 25000 | | |
| Rated Capacity-Electric | KW | | | | | 25000 | | 25000 | | | | | | 50000 | 25000 | | |
| Capability - Max Steam | KW1 | | | | 12540 | 18000 | 12540 | 18000 | | | | 29227 | 34727 | | 18375 | | |
| 75 % Steam | KW75 | | | | 9405 | | 9405 | | | | | 21920 | 26046 | | 11875 | | |
| 50 % Steam | KW50 | | | | 6270 | | 6270 | | | | | 14613 | 17364 | | 4375 | | |
| 25% Steam | KW25 | | | | 3135 | | 3135 | | | | | 7307 | 8682 | | 480.640 | | |
| Steam Required - Maximum | M#/Hr Max | | | | 114.650 | | 114.650 | | | | | 507.150 | 352.800 | | 192.260 | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | 142.2 | | |
| Outlet Steam Pressure | PSI | | | | 22.75 | 0.498 | 22.75 | 0.498 | | | | 185 | 22.75 | | 0.228 | | |
| Enthalpy Drop - Turbine | MBTU/lbt | | | | 0.293 | | 0.293 | | | | | 0.1849 | 0.307 | | 0.9790 | | |
| Sink | MBTU/lbs | | | | 1.0475 | | 1.0475 | | | | | 1.1218 | 0.9801 | | 97.5% | | |
| Generator Efficiency | %g | | | | 97.4% | 97.4% | 97.4% | 97.4% | | | | 96.6% | 96.6% | 96.6% | | | |
| Power/Rejection Factor | Factor | | | | | 0.360 | | 0.360 | | | | | | 0.357 | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | | Gas | | Gas | | | Gas | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | | | $2.03 | | $2.03 | | | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | | | 95.0% | | 95.0% | | | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fuel | Type | | | | Mazut | | Mazut | | | Mazut | Mazut | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | | | $2.41 | | $2.41 | | | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | | | 5.0% | | 5.0% | | | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 740 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 3.0 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $296.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.34 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $0.75 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | - | | | | | | | | | | | | | | |
| Emissions Code -Fuel 1 | CODEe1 | | | | ST2-A9 | | ST2-A9 | | | ST2-A9 | ST2-A9 | | | | ST2-A9 | | ST2-A9 |
| Emissions Code -Fuel 2 | CODEe2 | | | | ST2-A6 | | ST2-A6 | | | ST2-A6 | ST2-A6 | | | | ST2-A6 | | ST2-A6 |
| Scheduled Maintenance | CODE m | | | | SB4 | ST4 | SB5 | ST5 | | SB7 | SB8 | | ST6 | | SB9T8 | | SHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge-Winter | Cents/KWHw | | $0.0289 | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | | $0.0233 | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | AVAILABILITY | | | | | | | | | | | | US$ |
| Jan | -1.7 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Feb | 0.8 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mar | 4.8 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Apr | 10.8 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% |
| May | 15.6 | | | | 33% | 33% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - |
| June | 19.0 | | | | 67% | 67% | 67% | 67% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - |
| July | 21.2 | | | | 100% | 100% | 33% | 33% | | 100% | - | 50% | 50% | 50% | 100% | 100% | - |
| Aug | 20.6 | | | | 100% | 100% | 100% | 100% | | - | 100% | 50% | 50% | 50% | 100% | 100% | - |
| Sept | 16.7 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | - | 100% | - |
| Oct | 11.3 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Nov | 5.9 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dec | 0.8 | | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

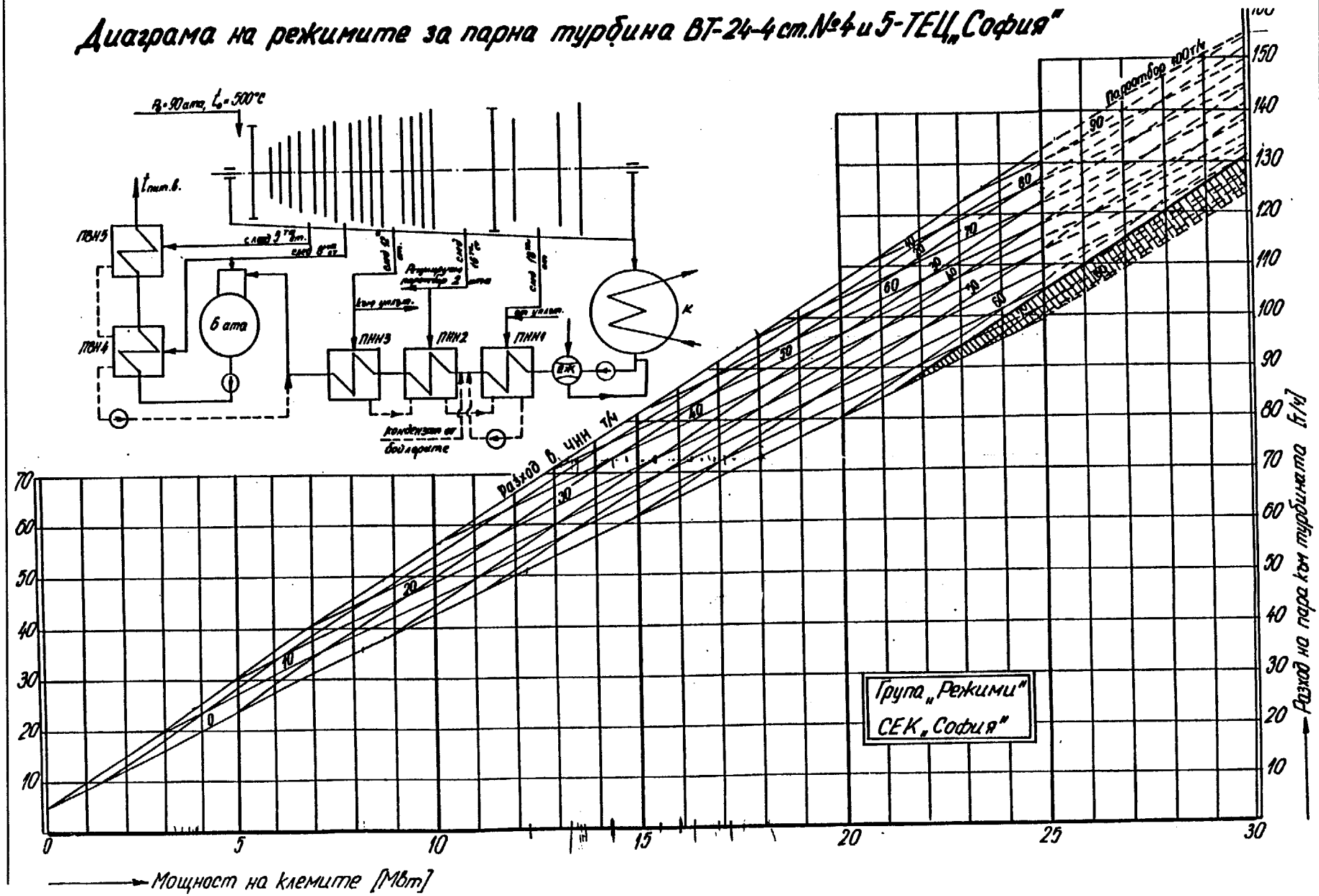
| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,068 | 3,864 | 3,049 | 2,163 | 1,220 | 862 | 863 | 780 | 967 | 1,369 | 2,896 | 3,099 | 25,040 |
| Oil | 254 | 229 | 191 | 135 | 76 | 55 | 54 | 49 | 62 | 86 | 181 | 194 | 1,565 |
| Lignite | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Black Coal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Fuel Cost | 4,322 | 3,893 | 3,240 | 2,299 | 1,296 | 937 | 917 | 828 | 1,049 | 1,454 | 3,077 | 3,293 | 26,605 |
| Supplemental Cost-Shortfall Penalty) | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Purchased Power Cost | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for Power Sales | (1,546) | (1,431) | (1,563) | (1,180) | (680) | (575) | (399) | (323) | (566) | (891) | (1,433) | (1,528) | (12,117) |
| Net Power Interchange Cost | (1,546) | (1,431) | (1,563) | (1,180) | (680) | (575) | (399) | (323) | (566) | (891) | (1,433) | (1,528) | (12,117) |
| Other O&M - Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,518 |
| Variable | 464 | 421 | 351 | 256 | 147 | 115 | 101 | 90 | 119 | 164 | 330 | 358 | 2,917 |
| Limestone Injection & Ash Removal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for By-Product Sales | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Emissions Penalties | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 11 |
| Total Excluding Maintenance | 3,456 | 3,078 | 2,243 | 1,583 | 978 | 684 | 833 | 810 | 807 | 942 | 2,182 | 2,338 | 19,935 |



4-36

**Exhibit 4-15**

**Turbine Performance**



## Exhibit 4-16

### Turbine Performance Curves

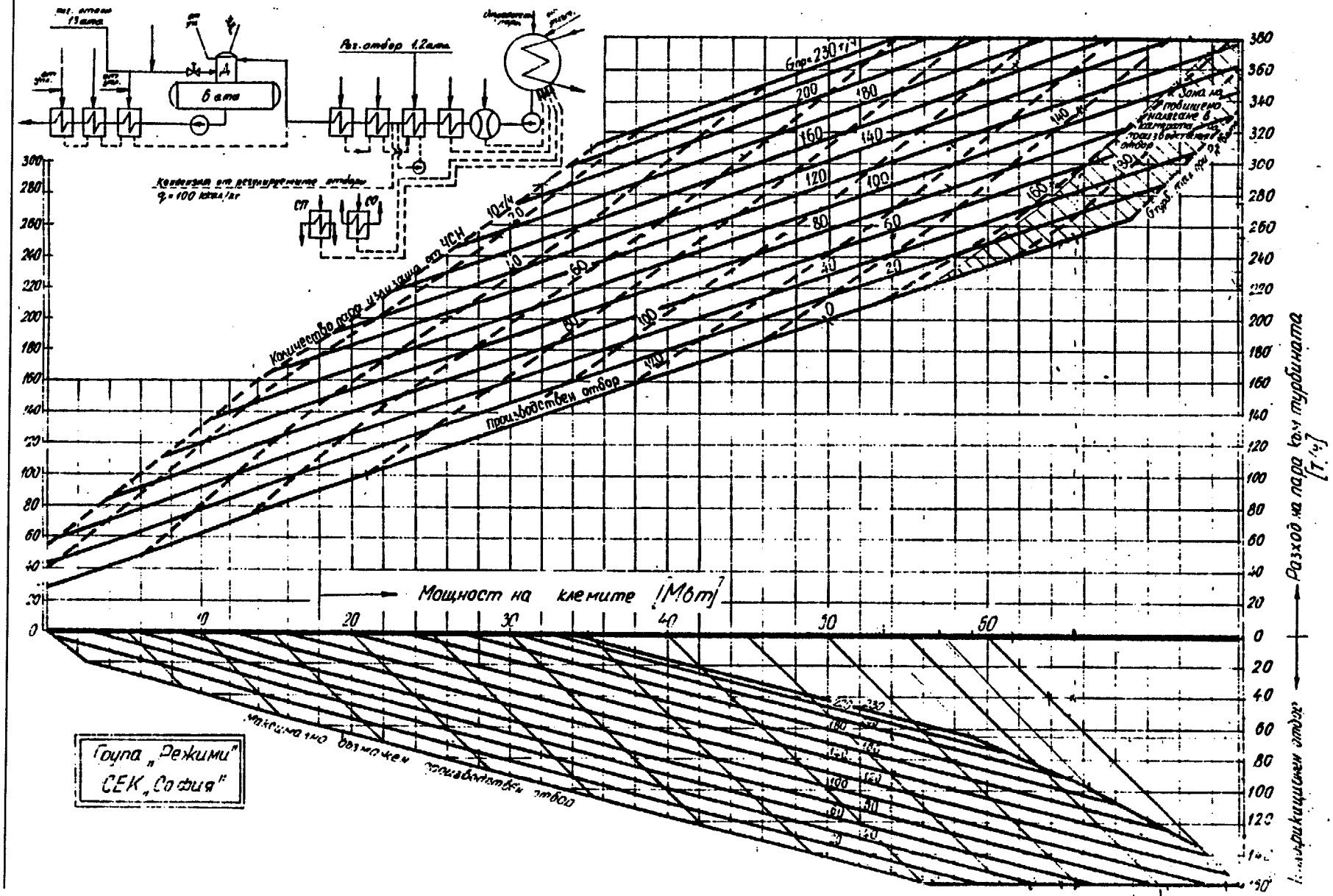



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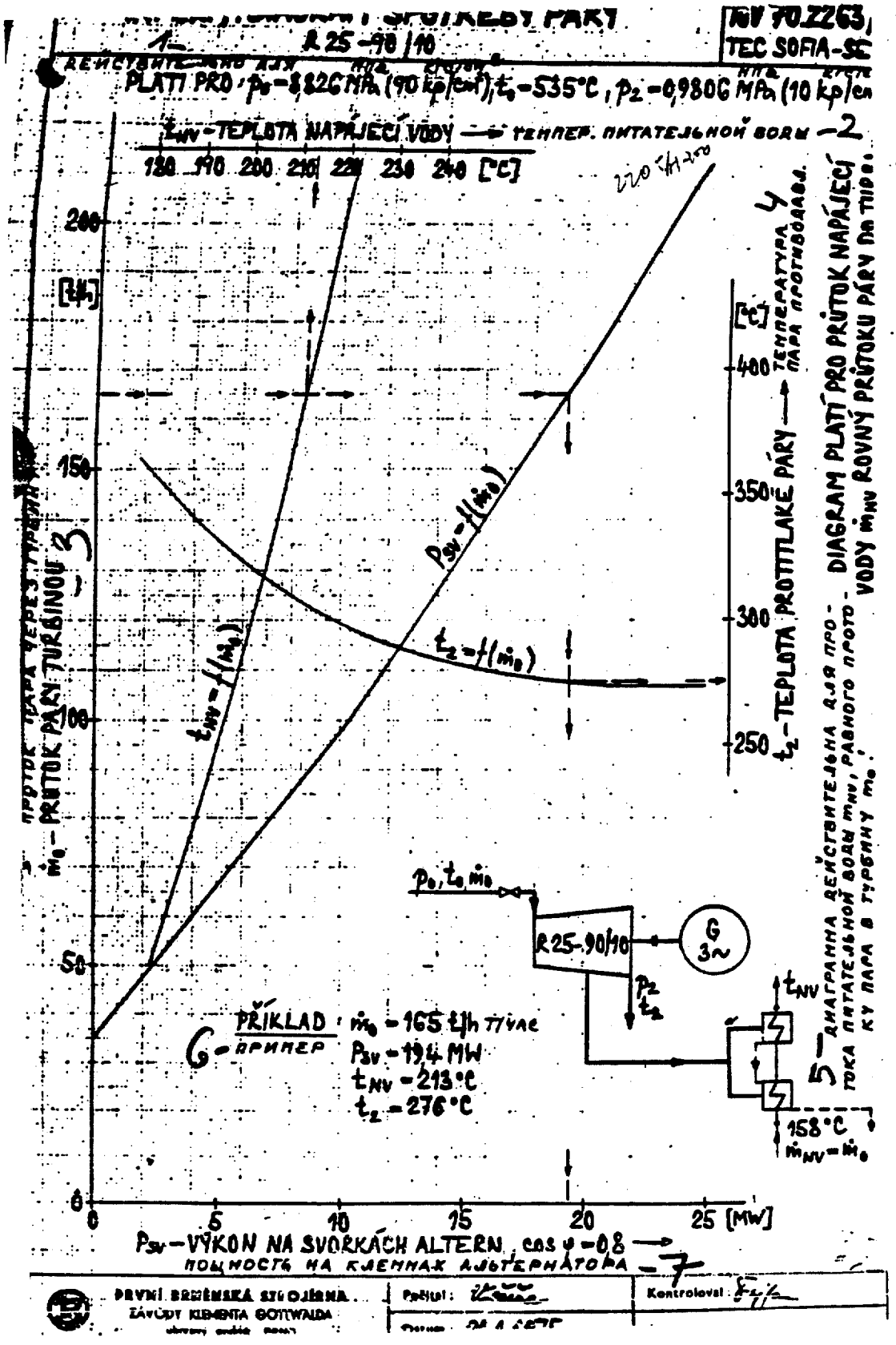
Exhibit 4-17

Turbine No. 8 1992 Performance Curve



# SOFIA TPH STATION

# CASE S2 GT REPOWERING

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### 4.6.1.2 Sofia TPH Station - Case S2 (GT Repowering) Configuration Description

Summary of the proposed Case S2 configuration is presented in Exhibit 4-18. This option considers replacing one of the thermal boilers with the combination of Gas Turbine and HRSG. A simplified schematic of this Case is shown in Exhibit 4-19.

**Repowering Modification:** Thermal boiler No. 4 (the oldest among the boilers at this station), rated at 212 MWt with 220 tons/hr (481,000 pph) steam flow, is replaced by two LM6000 gas turbines. Each GT is followed by a Heat Recovery Steam Generator (HRSG). Supplementary firing is initiated to match the design steam flow. With afterburner efficiency near 100%, this HRSG is definitely more fuel efficient than the conventional boiler. At lower loads, firing may be reduced to match the required load, thus allowing more flexibility.

By introducing the Gas Turbine/HRSG, the overall system efficiency increases and additional electric power generating capacity of 74.4 MWe will be introduced into the system. The new generating capacity comes from two LM6000 gas turbines, each at 37.2 MWe capacity (Exhibit 4-20 Facility Data Sheet).

**Thermal Boilers Modification:** Due to the decreased demand for an industrial steam, caused by a current recession and industrial base restructuring, only one boiler should be retained for further operation. Boiler No. 3 is the newest among three industrial steam boilers and should be rehabilitated in accordance with B&W recommendations, presented in Subsection 2.5.1.1. Boiler No. 2 should be mothballed to serve as a backup if future industrial steam demand increases while Boiler No. 1 should be retired and eventually dismantled.

**Hot Water Boilers Modification:** Hot Water Boilers No. 1 and 2 should be removed from service and mothballed for future demand increases. Hot Water Boilers No. 3 to No. 6 should be reconditioned in accordance with recommendations summarized in Exhibit 4-18 (details of recommendation are presented in Subsection 2.5.1.1).

**Steam Turbines Modification:** All steam turbines should be reconditioned in accordance with recommendations presented in Subsection 2.5.2.1 of the study.

Assuming that project funding will be available during 1994 and considering the normal gas turbine project three year lead time, this system could start operation by year 1997.

#### Heat Balance Analysis

A heat balance analysis was performed to simulate repowering a portion of Sofia TPH by the replacement of an existing boiler with a modern GT/HRSG system. The system arrangement and resultant heat balance is shown in Exhibit 4-21. The boiler chosen for replacement was PGST No. 4 (or its twin PGST No. 8) with the following mainstream production conditions:

- Pressure 1451.4 psia (10 MPa)
- Temperature 950.00°F (510°C)
- Mass Flow 485,100.0 lb/hr (220 t/h)



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In order to simulate the performance of this system, a computer program was used to model the HRSG and perform the heat balance calculations. Principal input included the following:

- GT exhaust conditions are based upon gas turbine Model LM6000 manufacturer data.
- Supplementary firing was performed assuming the use of natural gas with the following molar composition:

| | | |
|---|---|---|
| $CH_4$ | 92.960 | % |
| $C_2H_6$ | 2.970 | % |
| $C_3H_8$ | 0.830 | % |
| $C_4H_{10}$ | 0.330 | % |
| $C_5H_{12}$ | 0.336 | % |
| $N_2$ | 2.400 | % |
| $CO_2$ | 0.140 | % |

- Feedwater inlet to the HRSG was assumed at 230°F from a feedpump taking suction from a 20 psia deaerator.
- HRSG steam exit conditions were set to match those of the replaced No. 4 boiler.
- Duct burning fuel flow was calculated to achieve a 20°F differential between the HRSG gas exit temperature and the feedwater inlet temperature.

It should be noted that two LM6000 GT turbines with HRSG are required to produce the desired steam flowrate (485,100 lb/hr).



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## Exhibit 4-18

## Sofia Power and Heat Station
## Case S2

| BOILERS TYPE | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| **Boiler No. 1** | Retire |
| **Boiler No. 2** | Retire (Mothball for eventual future demand increase) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Boiler No. 4** | Retire and replace with two (2) LM6000 Gas Turbine and two (2) HRSGs |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Hot Water Boilers:** | |
| Boiler No. 1 | Retire (Mothball for future demand increase) |
| Boiler No. 2 | Retire (Mothball for future demand increase) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Steam Turbines:** | |
| Turbine No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |



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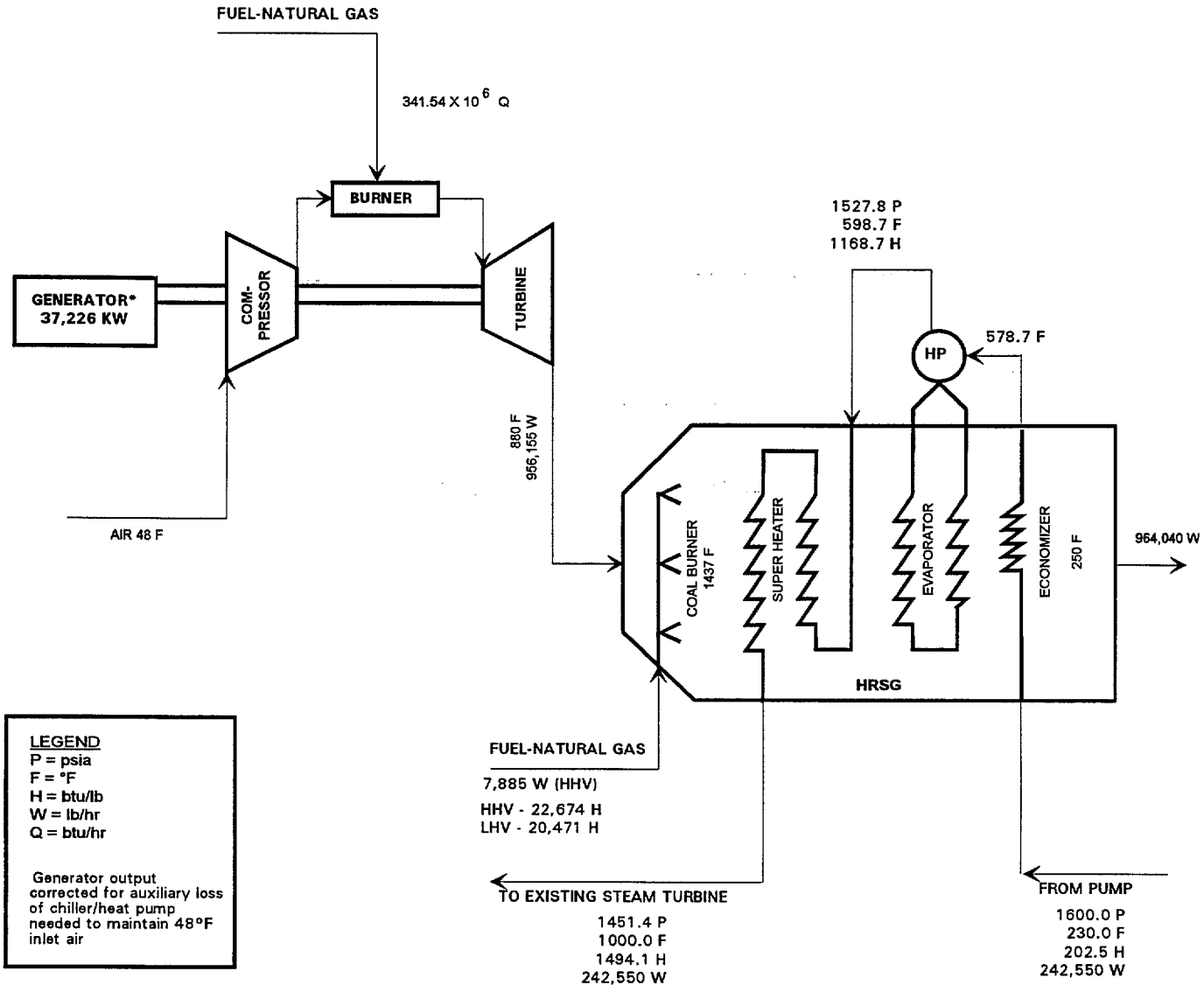
# Exhibit 4-19

## New Gas Turbine/HRSG/Existing Steam Turbine

## Sofia TPS Case S2






1444

# Exhibit 4-20
## Facilities Data Sheet and Simulated Results
## Year 2010 Sofia - Case S2

CASE S2 — Test Year = 2010

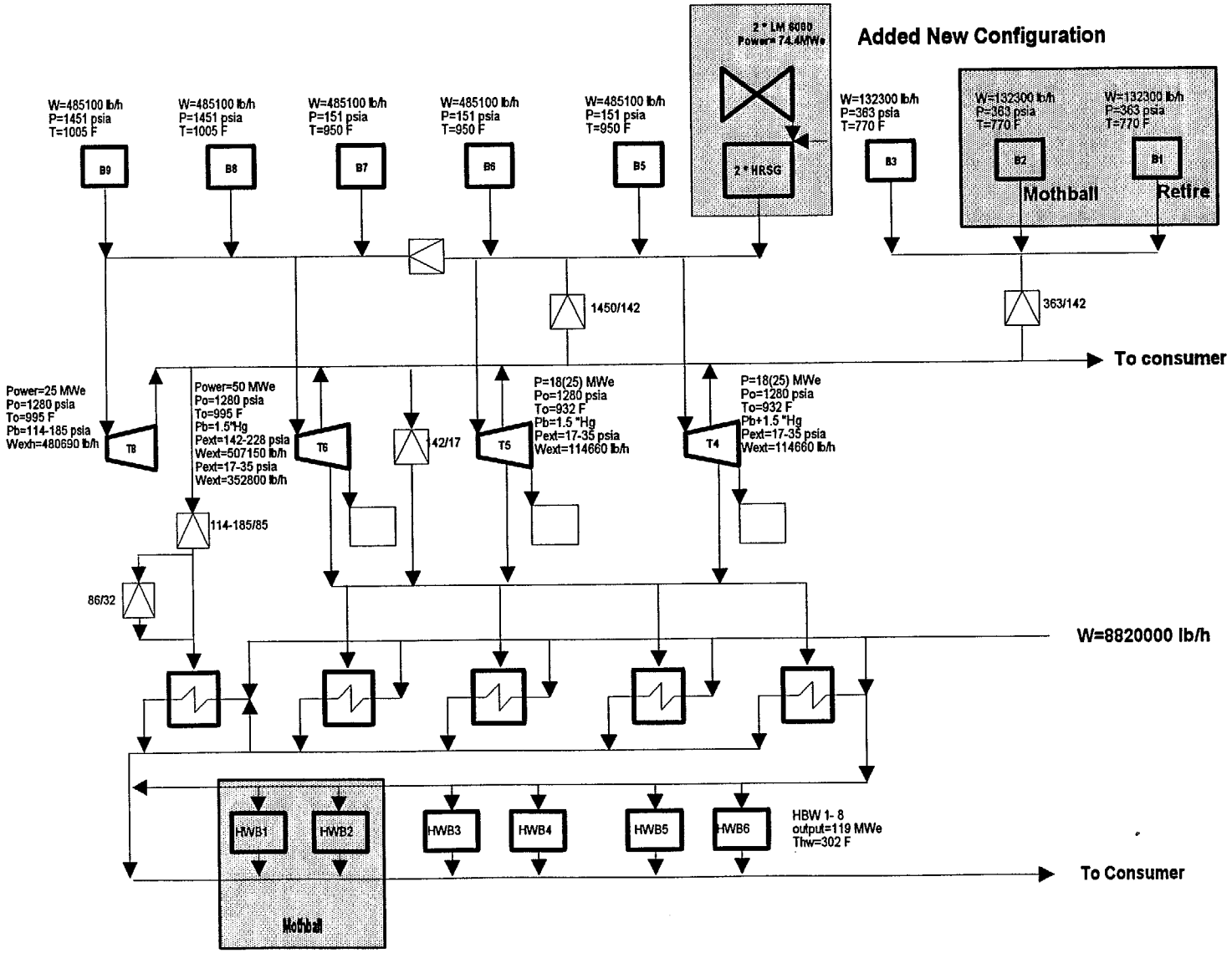
Facilities Data

| DESCRIPTION | UNIT | | | EXISTING FACILITIES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | | Blrs 4-5 | | Blrs 5-6 | | Boiler #8 | HRSG #1 | HRSG #2 | | | | Blr #9 | Blr #3 | HWB 3-6 |
| THERMAL DATA | | | | | | | | | | | | | | | | |
| Efficiency - 80% to Full Load | %1 | | | 84.8% | | 84.8% | | 84.8% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Half Load | %2 | | | 84.8% | | 84.8% | | 84.8% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Load | %3 | | | 84.8% | | 84.8% | | 84.8% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Operation | % | | | 13.3% | | 13.3% | | 40.0% | 20.0% | 20.0% | | | | 40.0% | 40.0% | 10.0% |
| Feedwater Temp | | | | 419° | | 419° | | 419° | | | | | | 439° | 212° | 158° |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | 8 | 1 | 5 | | | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | 135.000 | 67.500 | 67.500 | | | | | | |
| Quantity | Mlb/Hr | | | 485.1 | 52.292 | 485.1 | 52.292 | 485.1 | | | | | 142 | 485.1 | | |
| Pressure | PSIA | | | 1451 | - | 1451 | - | 1451 | | | | | 115.751 | 1451 | | |
| Temperature | Temp °F | | | 950° | 12.333 | 950° | 12.333 | 1004° | | | | | 36.906 | 1004° | | |
| Enthalpy | MBTU/lb | | | 1.458 | 48.685 | 1.458 | 48.685 | 1.496 | | | | | 115.342 | 1.496 | | |
| PRODUCT - LP STEAM | Priority | * | | | | | | | | | 5 | | | 2 | | |
| Quantity | Mlb/Hr | | | | | | | | | | 507.15 | | | 430.000 | 132.300 | |
| | MWts | | | | | | | | | | 166.700 | | | 159.000 | 63.000 | |
| Pressure | PSIA | | | | | | | | | | 185 | | | 142.25 | 363 | |
| Temperature | Temp °F | | | | | | | | | | 559.4° | | | - | 770° | |
| Enthalpy | MBTU/lb | | | | | | | | | | 1.302 | | | 1.266 | 1.403 | |
| PRODUCT - HOT WATER | Priority | | Cooling | 4 | | 3 | | | | | | 1 | | 2 | | 6 |
| Quantity | MWtw | | 200.000 | 35.190 | | 35.190 | | | | | | 101.300 | | 41.000 | | 464.000 |
| Temperature - Supply | Temp °F | | | 240° | | 240° | | | | | | 240° | | 240° | | 302° |
| Return | Temp °F | | | 140° | | 140° | | | | | | 140° | | 140° | | 158° |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | GT-LM6000 | GT-LM6000 | Turb 6a | Turb 6b | Turb 6c | Turb 8 | | |
| | Priority | | | | | | | | 1 | 2 | | | | | | |
| Rated Capacity-Electric | KW | | | | 25000 | | 25000 | | | | | | 55000 | 25000 | | |
| Capability - Max Steam | KW1 | | | 12540 | 18000 | 12540 | 18000 | | | | 29227 | 34727 | 50000 | 25000 | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | | 21920 | 26046 | | 18375 | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | | 14613 | 17364 | | 11875 | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | | 7307 | 8682 | | 4375 | | |
| Steam Required - Maximum | M#/Hr_Max | | | 114.660 | | 114.660 | | | | | 507.150 | 352.800 | | 480.640 | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | | 192.260 | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | | 185 | 22.75 | | 142.2 | | |
| Enthalpy Drop - Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | | 0.1849 | 0.307 | | 0.228 | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | | 1.1218 | 0.9801 | | 0.9790 | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | | 98.6% | 98.6% | 98.6% | 97.5% | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | | 0.357 | | | |
| FUELS DATA | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | Gas | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | 100.0% | 100.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | | | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 740 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $298.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | - | | | | | | | | | | | | | | |
| Emissions Code -Fuel 1 | CODEe1 | | | ST2-A9 | | ST2-A9 | | ST2-A9 | GT-LM6 | GT-LM6 | | | | ST2-A9 | | ST2-A9 |
| Emissions Code -Fuel 2 | CODEe2 | | | ST2-A6 | | ST2-A6 | | ST2-A6 | | | | | | ST2-A6 | | ST2-A6 |
| Scheduled Maintenance | CODE m | | | SB4 | ST4 | SB5 | ST5 | SB8 | GT-LM6 | HRSG | | ST6 | | SB9T8 | | SHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | |
| Energy Charge-Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | Max GT? | | AVAILABILITY | | | | | | | | | | | | US$ |
| Jan | -1.7 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Feb | 0.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Mar | 4.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Apr | 10.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| May | 15.6 | Yes | | 33% | 33% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | - |
| June | 19.0 | Yes | | 67% | 67% | 67% | 67% | - | 100% | 100% | 50% | 50% | 50% | 100% | | - |
| July | 21.2 | Yes | | 100% | 100% | 33% | 33% | 100% | 100% | - | 75% | 75% | 75% | 100% | | - |
| Aug | 20.6 | Yes | | 100% | 100% | 100% | 100% | 100% | - | 100% | 75% | 75% | 75% | 100% | | - |
| Sept | 16.7 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | | - |
| Oct | 11.3 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Nov | 5.9 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Dec | 0.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,556 | 4,097 | 3,542 | 2,641 | 1,717 | 1,354 | 1,162 | 1,068 | 1,455 | 1,868 | 3,372 | 3,591 | 30,422 |
| Oil | 213 | 188 | 152 | 98 | 40 | 22 | 40 | 35 | 20 | 51 | 143 | 155 | 1,157 |
| Lignite | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Black Coal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Fuel Cost | 4,769 | 4,285 | 3,694 | 2,739 | 1,757 | 1,376 | 1,203 | 1,103 | 1,475 | 1,919 | 3,515 | 3,746 | 31,579 |
| Supplemental Cost-Shortfall Penalty | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Purchased Power Cost | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for Power Sales | (2,990) | (2,735) | (3,007) | (2,391) | (1,931) | (1,403) | (1,007) | (964) | (1,174) | (2,335) | (2,831) | (2,972) | (25,742) |
| Net Power Interchange Cost | (2,990) | (2,735) | (3,007) | (2,391) | (1,931) | (1,403) | (1,007) | (964) | (1,174) | (2,335) | (2,831) | (2,972) | (25,742) |
| Other O&M - Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,518 |
| Variable | 464 | 421 | 351 | 256 | 147 | 65 | 86 | 69 | 119 | 164 | 330 | 358 | 2,863 |
| Limestone Injection & Ash Removal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for By-Product Sales | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Emissions Penalties | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |
| Total Excluding Maintenance | 2,458 | 2,165 | 1,253 | 812 | 187 | 244 | 506 | 442 | 627 | (39) | 1,223 | 1,347 | 11,226 |

# Exhibit 4-21

## Sofia Power and Heat Station
## Case S2



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# SOFIA TPH STATION

# CASE S3 GT COMBINED CYCLE

447

### 4.6.1.3 Sofia TPH Station - Case S3 (GT Combined Cycle)
**Configuration Description**

Summary of the proposed Case S3 configuration is presented in Exhibit 4-22. This option considers: (1) replacing one existing hot water boiler with the combination of Gas Turbine/HRSG; and (2) adding a condensing steam turbine with one extraction for hot water production. A layout of this Case inside the turbine building is shown in Exhibit 4-23.

**Combined Cycle Modification:** Three existing hot water Boilers PTVM - 100, each rated at 396.90 MBtu/h, are replaced with a General Electric state-of-the-art gas turbine (Frame 6FA) in a combined cycle, one-on-one configuration. An ABB non-reheat condensing steam turbine (1450 PSIG, 1000°F) with one controlled extraction, bottoms the cycle and provides the energy for hot water heating (Exhibit 4-24). On a 0°F day, the combined plant will produce a total electric output of 118.2 MWe.

The steam turbine contributes a third of the electric power output plus 86.6 MWt steam for hot water heating (Exhibit 4-25 Facility Data Sheet). Supplementary firing, through new HRSG, is again used to bring the throttle steam to 339,090 lbs/hr. Unlike a back pressure turbine, which would run only during the heating season, a condensing turbine allows the plant to run all year, producing electricity and maximizing the capacity factor.

This configuration increases cogeneration to 56.2%.

**Thermal Boiler Modifications:** Due to the decreased demand for an industrial steam, caused by a current recession and industrial base restructuring, two of the industrial steam boilers should be removed from service. Boiler No. 3 is the newest among three industrial steam boilers and should be rehabilitated in accordance with B&W recommendations, presented in Section 2. Boiler No. 2 should be mothballed to serve as a backup if future industrial steam demand increases while Boiler No. 1 should be retired and eventually dismantled.

Bolier Nos. 4-9 should be rehabilitated in accordance with the B&W recommendations, presented in Subsection 2.5.1.1

**Hot Water Boiler Modifications:** Hot Water Boilers No. 1 and 2 should be removed from service and mothballed for future use because of lack of demand. Hot Water Boiler 3 is to be removed from service and mothballed because the new combined cycle is displacing its need. Hot Water Boilers No. 4 to No. 6 should be reconditioned in accordance with recommendations summarized in Exhibit 4-22 (details of recommendation are presented in Subsection 2.5.1.1).

**Steam Turbine Modifications:** Turbines No. 4, No. 5, No. 6 and No. 8 should be reconditioned in accordance with recommendations presented in Subsection 2.5.2.1 of Section 2.

Assuming that the investment starts in 1994, considering a 5 year lead time, the plant could be operational in 1999.

### Heat Balance Analysis

A heat balance analysis was performed to simulate the addition of a modern gas turbine heat recovery steam generator steam turbine (GT/HRSG/ST) combined cycle to the Sofia TPH. The combined cycle arrangement and resultant heat balance are shown in Exhibit 4-26.

In order to simulate the performance of the combined cycle, computer programs were used to model the HRSG and the steam turbine/generator.

Principal input to the HRSG/ST models included the following:

- GT exhaust conditions are based upon the data from General Electric for the model PG6101 (6FA)
- Supplementary firing was performed assuming the use of natural gas with the following molar composition:

| | | |
|---|---|---|
| $CH_4$ | 92.960 | % |
| $C_2H_6$ | 2.970 | % |
| $C_3H_8$ | 0.830 | % |
| $C_4H_{10}$ | 0.330 | % |
| $C_5H_{12}$ | 0.336 | % |
| $N_2$ | 2.400 | % |
| $CO_2$ | 0.140 | % |

- Feedwater inlet to the HRSG was assumed at 230°F from a feed pump taking suction from a 20 psia deaerator.
- HRSG steam exit conditions were set to match those of the existing boiler.
- Duct burning fuel flow was calculated to achieve a 20°F differential between the HRSG gas exit temperature and the feedwater inlet temperature.

It should be noted that HRSG with supplementary firing is required to produce the desired steam flow rate (485,100 lb/hr).

### 4.6.1.4 Sofia TPH Station - Case S4 (AFBC Repowering)

All the Sofia TPH boilers were originally designed for coal firing. They have been converted to natural gas and Mazut. All coal handling equipment has been abandoned and has deteriorated or is inoperable. To return to coal firing, all new equipment will have to be installed and coal will have to be imported. In view of the massive new capital investment required for this case, it was decided not to study the feasibility of this option at this time.



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An additional factor that makes this Case unattractive is that the generating station is located in the city and introduction of coal firing can have adverse effect on pollution, transportation, and public opinion. The option was seriously considered during the engineering Phase but was finally rejected due to listed option drawbacks and strong resistance from the Bulgarian District Heating Management.

The same logic was used to reject AFBC repowering option for other power stations in Sofia.



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## Exhibit 4-22

## Sofia Power and Heat Station
## Case S3

| BOILERS TYPE | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| **Boiler No. 1** | Retire |
| **Boiler No. 2** | Retire (Mothball for eventual future demand increase) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Hot Water Boilers:** | |
| Boiler No. 1 | Retire (Mothball for future demand increase) |
| Boiler No. 2 | Retire (Mothball for future demand increase) |
| Boiler No. 3 | Retire (Mothball for future demand increase) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Steam Turbines:** | |
| Turbine No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |



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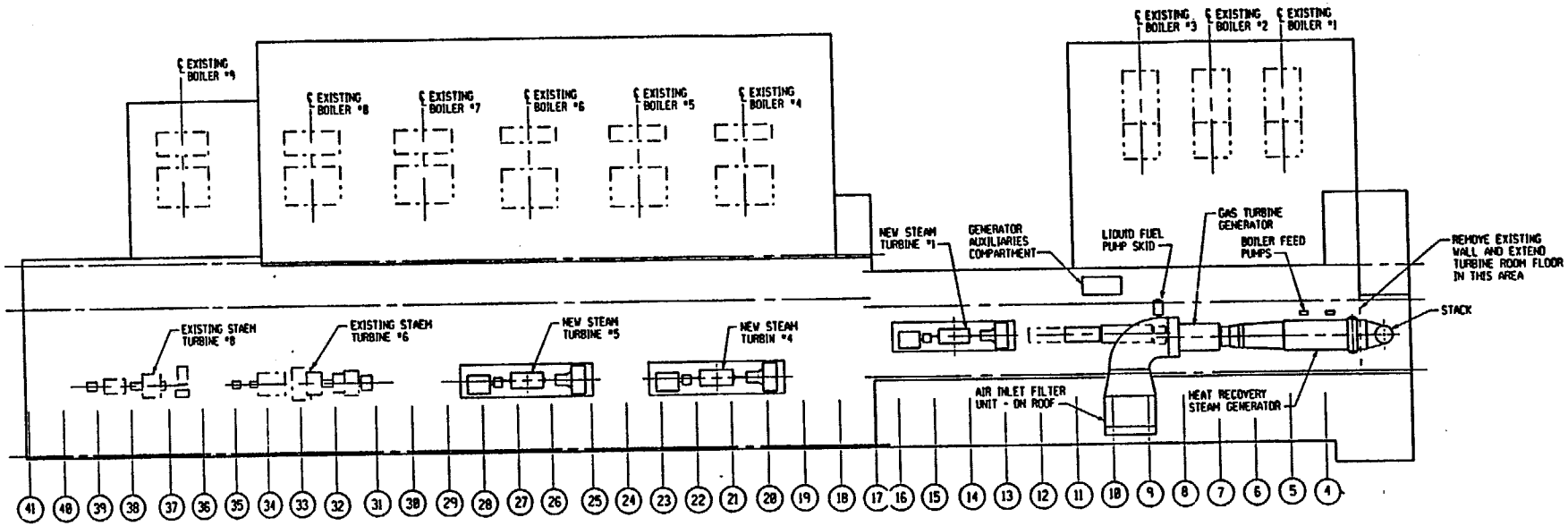
# Exhibit 4-23

## Sofia Thermal Power Station
## Combined Cycle Configuration




PLAN VIEW
EXISTING BOILER / TURBINE BUILDING

BULGARIA DISTRICT HEATING SYSTEM
FEASIBILITY STUDY

SOFIA THERMAL POWER STATION
COMBINED CYCLE CONFIGURATION



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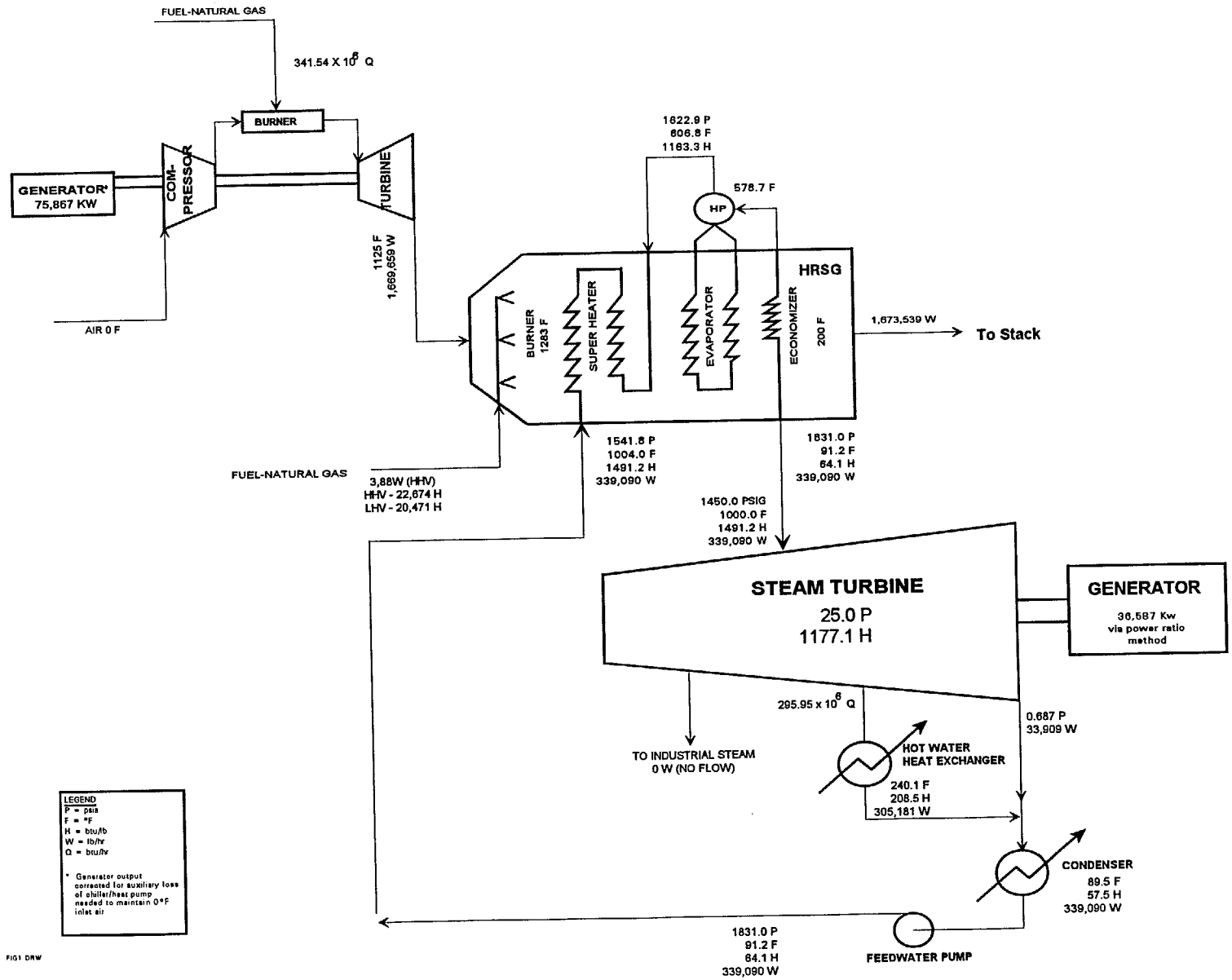
# Exhibit 4-24

## Sofia TPH Station
## Case S3 GT Combined Cycle



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# Exhibit 4-25

## Facilities Data Sheet and Simulated Results - Year 2020 Sofia - Case S3

CASE S3 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | | | | | |
| | | | | Blrs 4-5 | | Blrs 5-6 | | Boiler #7 | Boiler #8 | | | | | HRSG #1 | | Blr #9 | Blr #3 | HWB 4-6 | |
| THERMAL DATA | | | | | | | | | | | | | | | | | | | |
| Efficiency - 80% to Full Load | %1 | | | 84.8% | | 84.8% | | 84.8% | 84.8% | | | | | 100.0% | | 84.4% | 84.4% | 84.5% | |
| Half Load | %2 | | | 84.8% | | 84.8% | | 84.8% | 84.8% | | | | | 100.0% | | 84.4% | 84.4% | 84.5% | |
| Minimum Load | %3 | | | 84.8% | | 84.8% | | 84.8% | 84.8% | | | | | 100.0% | | 84.4% | 84.4% | 84.5% | |
| Minimum Operation | % | | | 26.7% | | 26.7% | | 40.0% | 40.0% | | | | | | | 40.0% | 40.0% | 13.3% | |
| Feedwater Temp | | | | 419° | | 419° | | 419° | 419° | | | | | | | 439° | 212° | 158° | |
| Operation Adjustment Factor | Factor | | | | | | | | | | | | | | | | | | |
| BOILER OUTPUT - | Priority | | | | | | | 8 | 8 | | | | | | | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | 135.000 | 135.000 | | | | | 141.786 | 141.786 | | | | |
| Quantity | Mlb/Hr | | | 727.65 | | 727.65 | | 485.1 | 485.1 | | | | | 339.09 | | 485.1 | | | |
| Pressure | PSIA | | | 1451 | | 1451 | | 1451 | 1451 | | | | | 1541.8 | | 1451 | | | |
| Temperature | Temp °F | | | 950° | | 950° | | 1004° | 1004° | | | | | 1004 | | 1004° | | | |
| Enthalpy | MBTU/lb | | | 1.458 | | 1.458 | | 1.496 | 1.496 | | | | | 1492.2 | | 1.496 | | | |
| PRODUCT - LP STEAM | Priority | * | | | | | | | | 6 | | | | | | 3 | | | |
| Quantity | Mlb/Hr | | | | | | | | | 507.15 | | | | | | 430.000 | 132.3 | | |
| | MWts | | | | | | | | | 196.700 | | | | | | 159.000 | 53 | | |
| Pressure | PSIA | | | | | | | | | 185 | | | | | | 142.25 | 363 | | |
| Temperature | Temp °F | | | | | | | | | 559.4° | | | | | | - | 770° | | |
| Enthalpy | MBTU/lb | | | | | | | | | 1.302 | | | | | | 1.266 | 1.403 | | |
| PRODUCT - HOT WATER | Priority | Cooling | | 5 | | 4 | | | | | 2 | | | 1 | | 3 | | 7 | |
| Quantity | MWhw | 200.000 | | 36.190 | | 36.190 | | | | | 101.300 | | | 86.607 | | 41.000 | | 348.000 | |
| Temperature - Supply | Temp °F | | | 240° | | 240° | | | | | 240° | | | | | 240° | | 302° | |
| Return | Temp °F | | | 140° | | 140° | | | | | 140° | | | | | 140° | | 158° | |
| TURBINE DATA | UNITs | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | | Turb 6a | Turb 6b | Turb 6c | GT-6FA | Turb S3a | Turb S3c | Turb 8 | | | |
| | Priority | | | | | | | | | | | | 1 | | | | | | |
| Rated Capacity-Electric | KW | | | | 25000 | | 25000 | | | | | 55000 | | 27865 | 36590 | 25000 | | | |
| Capability - Max Steam | KW1 | | | 12540 | 18000 | 12540 | 18000 | | | 29227 | 34727 | 50000 | | 27865 | 36590 | 25000 | | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | 21920 | 26046 | | | 19752 | | 18375 | | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | 14613 | 17364 | | | 11821 | | 11675 | | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | 7307 | 8682 | | | 3898 | | 4375 | | | |
| Steam Required - Maximum | M#/Hr Max | | | 114.850 | | 114.850 | | | | 507.150 | 352.800 | | | 305.181 | | 480.640 | | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | | 192.260 | | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | 185 | 22.75 | | | 25.0 | | 142.2 | | | |
| Enthalpy Drop - Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | 0.1849 | 0.307 | | | 0.3141 | | 0.228 | | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | 1.1218 | 0.9801 | | | 0.9886 | | 0.9790 | | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | 98.6% | 98.6% | 98.6% | | 98.5% | 98.5% | 97.5% | | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | 0.357 | | | 0.3292 | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | Gas | | | | Gas | | | Gas | Gas | Gas | |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | $2.03 | | | | $2.03 | | | $2.03 | $2.03 | $2.03 | |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | 95.0% | | | | 100.0% | | | 95.0% | 95.0% | 95.0% | |
| Secondary/Supplemental Fue | Type | | | Mazut | | Mazut | | Mazut | Mazut | | | | | | | Mazut | Mazut | Mazut | |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | $2.41 | | | | | | | $2.41 | $2.41 | $2.41 | |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | 5.0% | | | | | | | 5.0% | 5.0% | 5.0% | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 740 | | | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $298.0 | | | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | - | | | | | | | | | | | | | | | | | |
| Emissions Code -Fuel 1 | CODEe1 | | | ST2-A9 | | ST2-A9 | | ST2-A9 | ST2-A9 | | | | | | | ST2-A9 | ST2-A9 | ST2-A9 | |
| Emissions Code -Fuel 2 | CODEe2 | | | ST2-A6 | | ST2-A6 | | ST2-A6 | ST2-A6 | | | | | | | ST2-A6 | ST2-A6 | ST2-A6 | |
| Scheduled Maintenance | CODE m | | | SB4 | ST4 | SB5 | ST5 | SB7 | SB8 | | ST6 | | GT-6FA | STS3 | | SB9/T6 | SB3 | SHWB | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | | | |
| Energy Charge-Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | | | AVAILABILITY | | | | | | | | | | | |
| Jan | -1.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Mar | 4.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% | |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | |
| May | 15.6 | | | 33% | 33% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | |
| June | 19.0 | | | 67% | 67% | 67% | 67% | 100% | - | 100% | 100% | 100% | - | - | - | 100% | 100% | - | |
| July | 21.2 | | | 100% | 100% | 33% | 33% | - | 100% | 50% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | - | |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 50% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | - | |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% | - | |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Nov | 6.9 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Dec | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,817 | 4,333 | 3,742 | 2,729 | 2,109 | 862 | 1,543 | 1,449 | 1,835 | 2,089 | 3,575 | 3,826 | 33,010 |
| Oil | 223 | 201 | 157 | 67 | 56 | 55 | 22 | 16 | 46 | 63 | 149 | 162 | 1,239 |
| Lignite | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Black Coal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Fuel Cost | 5,040 | 4,534 | 3,899 | 2,826 | 2,165 | 937 | 1,565 | 1,465 | 1,884 | 2,122 | 3,724 | 3,987 | 34,248 |
| Supplemental Cost-Shortfall Penalty/ | - | - | - | - | - | - | - | - | - | - | - | (0) | (0) |
| Purchased Power Cost | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for Power Sales | (3,624) | (3,314) | (3,495) | (2,554) | (2,289) | (575) | (1,627) | (1,739) | (2,206) | (2,546) | (3,338) | (3,533) | (31,038) |
| Net Power Interchange Cost | (3,624) | (3,314) | (3,495) | (2,554) | (2,289) | (575) | (1,627) | (1,739) | (2,206) | (2,546) | (3,338) | (3,533) | (31,038) |
| Other O&M - Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,518 |
| Variable | 509 | 462 | 391 | 281 | 217 | 115 | 144 | 131 | 200 | 206 | 370 | 401 | 3,427 |
| Limestone Injection & Ash Removal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for By-Product Sales | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Emissions Penalties | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |
| Total Excluding Maintenance | 2,141 | 1,876 | 1,010 | 760 | 308 | 684 | 95 | 71 | 186 | (3) | 964 | 1,071 | 8,164 |



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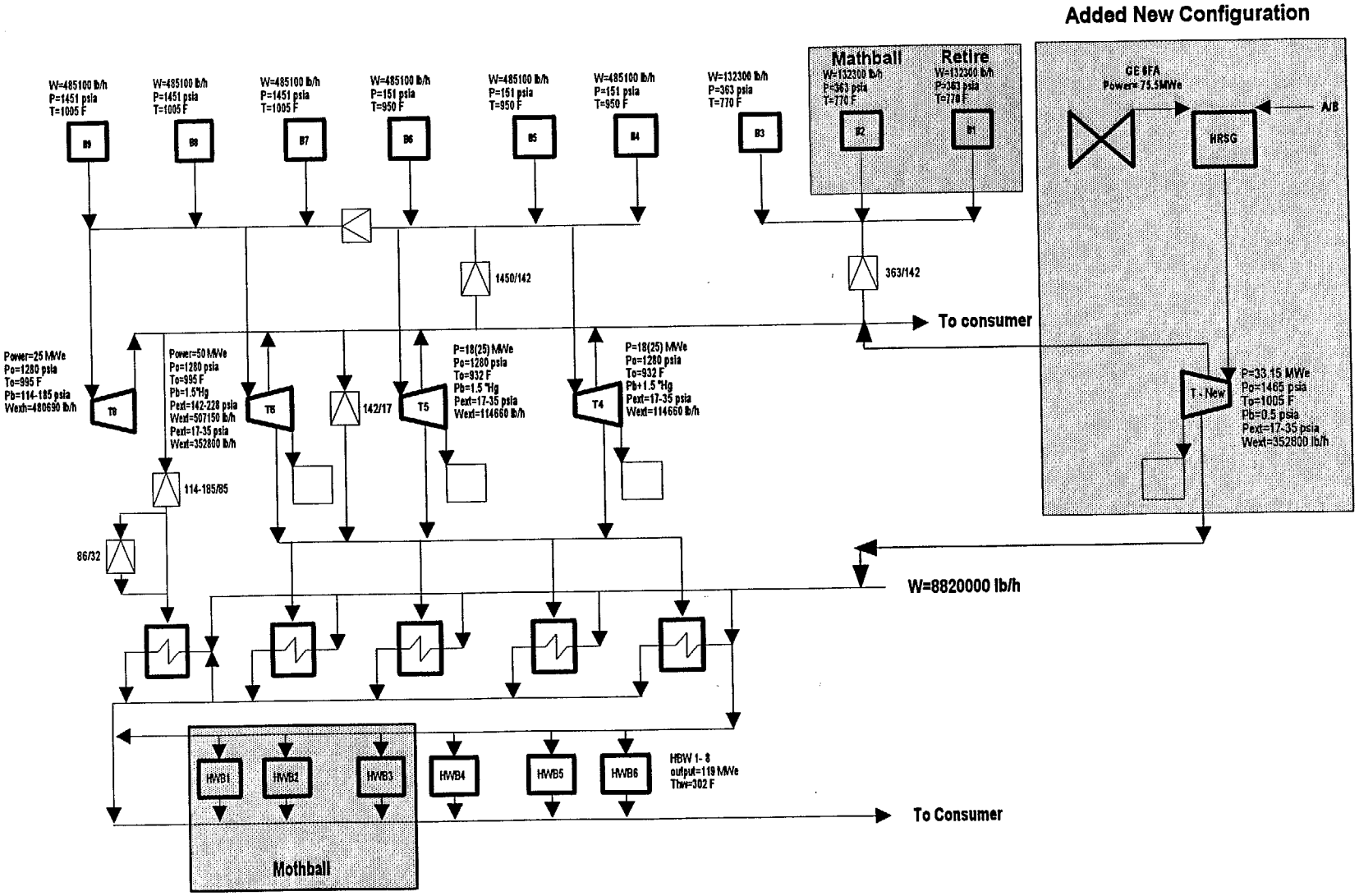
# Exhibit 4-26

## Sofia TPH Station - Case S3



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# TRAJCO KOSTOV TPH STATION

## CASE K1 - BASE CASE

### 4.6.2 TRAJCO KOSTOV POWER AND HEAT STATION CONFIGURATIONS

While Sofia TPH station supplies the northern sector of the Sofia heating district, Tr. Kostov TPH station supplies the eastern sector. This station was also built in stages in 1964 and 1967.

A site plan of this station is displayed in Exhibit 4-27. Design conditions and listing of major equipment are summarized in Exhibit 4-28 (see page 4-92).

Technical data at rated design conditions as well as operating conditions in 1992 were assembled through available information from Bulgaria. For the purpose of this study, it is believed that this will provide consistent performance data, at least for relative comparison among the various cases (K1 through K2).

#### 4.6.2.1 Trajco Kostov TPH Station - Case K1 (Base Case)

As in Sofia Case S1, K1 is a minimum rehabilitation case. A summary of the Case K1 is presended in Exhibit 4-29. Schematic of the plants is presented in Exhibit 4-30. An equipment layout of the boiler/turbine building is shown in Exhibit 4-31.

Boiler and turbine performance are summarized in Exhibit 4-32 based on the curves of Exhibit 4-33 and Exhibit 4-34 (Turbine No. 4 and 5, respectively). Cogeneration in this Case is about 34.3%.

Excluding some efficiency gains due to new burners, better boiler firing control, refurbished auxiliary equipment, and slightly improved turbine performance this option does not provide any increase in electric power generation nor bring an increase in cogeneration percentage.

**Thermal and Hot Water Boiler Modifications:** Thermal Boiler Nos. 1 through 7 and Hot Water Boiler (HWB) Nos. 1 through 8 will be rehabilitated according to the "necessity" and "enhancement" schedule prepared by B&W as presented in Section 2 of this study.

**Steam Turbines Modification:** Steam Turbine Nos. 1 through 5 will be rehabilitated starting from year 1994 and inspected and overhauled every five years to maintain operability and efficiency as described in Subsection 2.5 of this study.

The facility data sheet (Exhibit 4-34) summarizes boiler efficiency and turbine performance formulated for the economics model in accordance with Section 6.3.9. Boiler efficiency is based on a 95% natural gas and 5% Mazut oil mixture. Turbine performance is based upon curves in Exhibits 4-33 and 4-34 for Turbine Nos. 4 and 5, and for No. 6, respectively.



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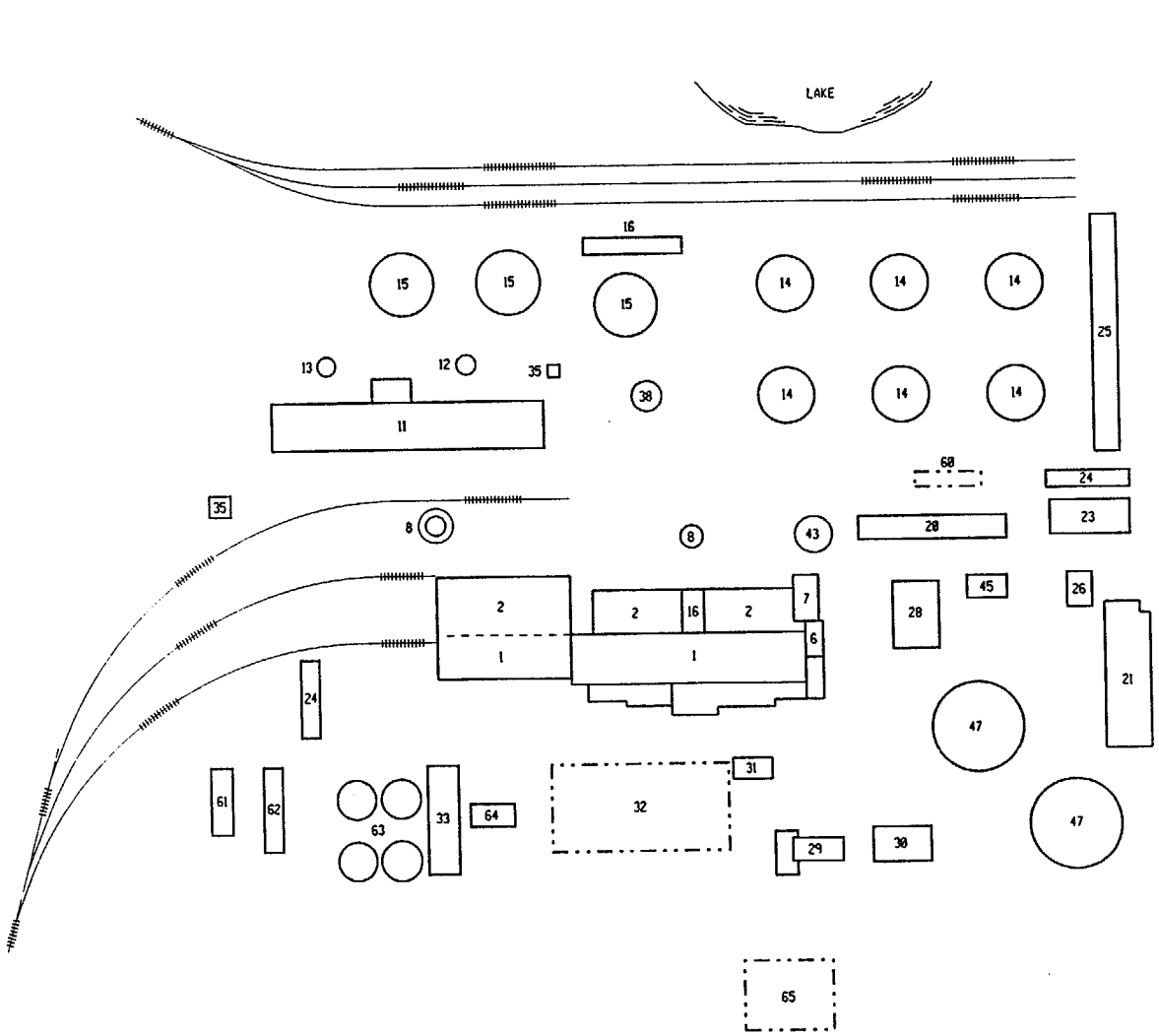
# Exhibit 4-27

## Trajco Kostov Thermal Power Station Site Plan




SITE DESCRIPTION

| | |
|---|---|
| 1 | TURBINE ROOM |
| 2 | BOILER ROOM |
| 6 | BUILDING |
| 7 | MECHANICAL SHOP |
| 8 | CHIMNEY |
| 11 | HOT WATER BOILERS |
| 12 | CHIMNEY |
| 13 | CHIMNEY |
| 14 | MAZUT RESERVOIRS |
| 15 | MAZUT RESERVOIRS |
| 16 | MAZUT PUMPING STATION |
| 20 | CHEMICAL WATER TREATMENT |
| 21 | CHEMICAL WATER TREATMENT (NEW) |
| 23 | WAREHOUSE |
| 24 | WAREHOUSE |
| 25 | EQUIPMENT STORAGE |
| 26 | LUBE OIL STORAGE |
| 28 | AUXILIARY BUILDING |
| 29 | ADMINISTRATION |
| 30 | ADMINISTRATION |
| 31 | 35 KV |
| 32 | SWITCHYARD |
| 33 | DISTRICT HEATING PUMPING STATION |
| 35 | COMPRESSOR STATION |
| 38 | WATER RESERVOIR |
| 43 | DEMINERALIZED WATER RESERVOIR |
| 45 | LABORATORY |
| 47 | COOLING TOWER |
| 60 | STORAGE |
| 61 | GARAGE |
| 62 | DINING ROOM |
| 63 | RESERVOIR |
| 64 | SWITCHING STATION |
| 65 | PARKING LOT |

NOTE:
FOR REFERENCE SEE BULGARIAN DRAWING 210-15123 SHEETS 1 AND 2.

LEGEND

OPEN AREA
BUILDINGS

BULGARIA DISTRICT HEATING SYSTEM
FEASIBILITY STUDY

TR. KOSTOV THERMAL POWER STATION
SITE PLAN





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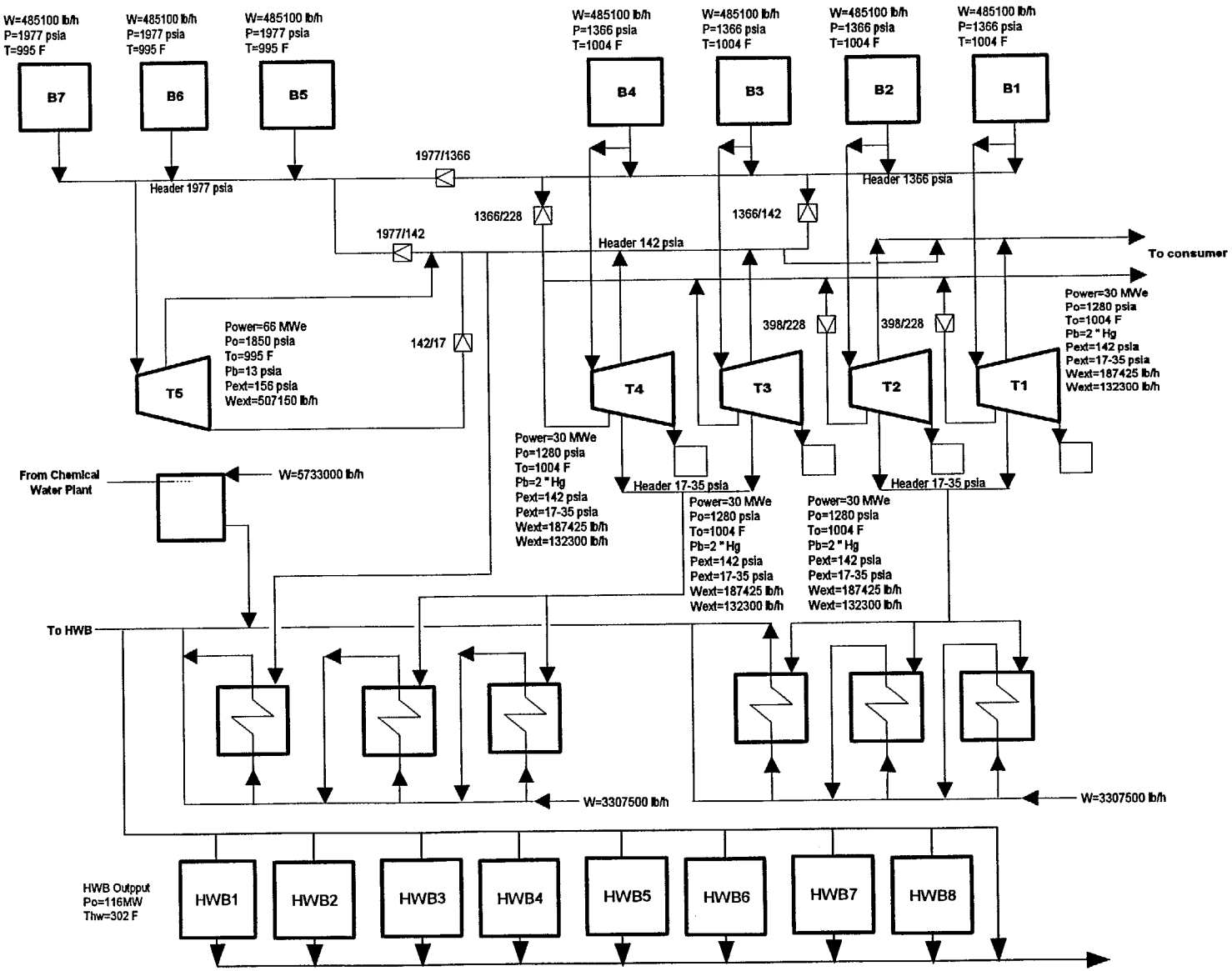
## Exhibit 4-29

## Summary of Case K1

| BOILERS TYPE | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| Boiler No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Hot Water Boilers:** | |
| Boiler No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 8 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Steam Turbines:** | |
| Turbine No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |

# Exhibit 4-30

## Trajco Kostov Thermal Power Station
## Case K1 Configuration



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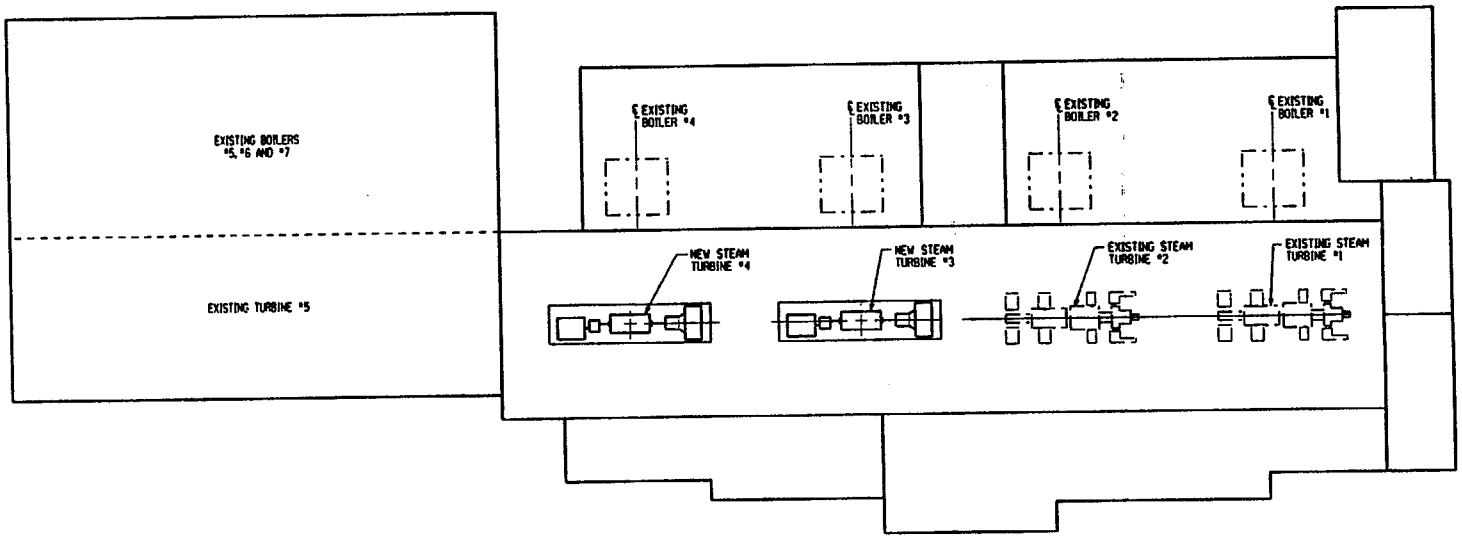
## Exhibit 4-31

### Trajco Kostov Thermal Power Station
### Case K1 Boiler Turbine Building




PLAN VIEW
EXISTING BOILER / TURBINE BUILDING

BULGARIA DISTRICT HEATING SYSTEM
FEASIBILITY STUDY
EXHIBIT 6.3.3-2

TR. KOSTOV THERMAL POWER STATION
BOILER/TURBINE BUILDING



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# Exhibit 4-32

## Facilities Data Sheet and Simulated Results - Trajco Kostov Case K1

CASE K1 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EXISTING FACILITIES | | | | | | | | | | | | | | | |
| | | | | | Br #1 | Br #2 | Br #3 | Br #4 | | | | Br #5 | Br #6 | Br #7 | | | HWB 1-6 |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | | 84.5% | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% |
| Half Load | %2 | | | | 84.5% | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% |
| Minimum Load | %3 | | | | 84.5% | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% |
| Minimum Operation | % | | | | 40.0% | 40.0% | 40.0% | 40.0% | | | | 40.0% | 40.0% | 40.0% | | | 5.0% |
| Feedwater Temp | | | | | | | | | | | | | | | | | |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | 8 | 7 | 6 | 4 | | | | 3 | 2 | 1 | | | |
| Capacity | MWt | | | | 130.930 | 130.930 | 130.930 | 130.930 | | | 298.008 | 142.040 | 142.040 | 142.040 | | | |
| Quantity | Mlb/Hr | | | | 407.925 | 407.925 | 407.925 | 407.925 | | | 208.292 | 418.950 | 418.950 | 418.950 | | | |
| Pressure | PSIA | | | | 1393 | 1393 | 1393 | 1393 | | | 85.432 | 1978 | 1978 | 1978 | | | |
| Temperature | Temp °F | | | | 1004$^{\circ}$ | 1004$^{\circ}$ | 1004$^{\circ}$ | 1004$^{\circ}$ | | | 298.008 | 975$^{\circ}$ | 975$^{\circ}$ | 975$^{\circ}$ | | | |
| Enthalpy | MBTU/lb | | | | 1.499 | 1.499 | 1.499 | 1.499 | | | | 1.471 | 1.471 | 1.471 | | | |
| PRODUCT – LP STEAM | Priority | | | | | | | | 4 | | | | | | 3 | | |
| Quantity | Mlb/Hr | | | | | | | | 793.800 | | | | | | 441.000 | | |
| | MWts | | | | | | | | 274.000 | | | | | | 147.040 | | |
| Pressure | PSIA | | | | | | | | 156.5 | | | | | | 142 | | |
| Temperature | Temp °F | | | | | | | | 556$^{\circ}$ | | | | | | 930$^{\circ}$ | | |
| Enthalpy | MBTU/lb | | | | | | | | 1.309 | | | | | | 1.240 | | |
| PRODUCT – HOT WATER | Priority | | Cooling | | | | | | | 2 | | | | | | 1 | 5 |
| Quantity | MWhr | | 200.000 | | | | | | | 177.200 | | | | | | 113.100 | 928.000 |
| Temperature – Supply | Temp °F | | | | | | | | | 310$^{\circ}$ | | | | | | 185$^{\circ}$ | 302$^{\circ}$ |
| Return | Temp °F | | | | | | | | | 158$^{\circ}$ | | | | | | 118$^{\circ}$ | 158$^{\circ}$ |
| TURBINE DATA | UNITe | | | | | | | | Turb 1-4a | Turb 1-4b | Turb 1-4c | | | | Turb 5a | Turb 5b | |
| | Priority | | | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | | | | | | | 120000 | | | | | 68000 | |
| Capability – Max Steam | KWt | | | | | | | | 56740 | 58294 | 108000 | | | | 29394 | 46620 | |
| 75 % Steam | KW75 | | | | | | | | 42556 | 43716 | | | | | 22045 | 33483 | |
| 50 % Steam | KW50 | | | | | | | | 28372 | 29144 | | | | | 14697 | 16941 | |
| 25% Steam | KW25 | | | | | | | | 14184 | 14572 | | | | | 7167 | 6237 | |
| Steam Required – Maximum | M#/Hr Max | | | | | | | | 793.800 | 154.350 | | | | | 441.000 | 410.130 | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | | | | 156.5 | 17 | | | | | 142 | 11.38 | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | | | | | 0.165 | 0.293 | | | | | 0.231 | 0.343 | |
| Sink | MBTU/lbs | | | | | | | | 1.178 | 0.979 | | | | | 1.1380 | 0.9410 | |
| Generator Efficiency | %g | | | | | | | | 97.4% | 97.4% | 97.4% | | | | 98.5% | 98.5% | |
| Power/Rejection Factor | Factor | | | | | | | | | | 0.424 | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | | Gas | Gas | Gas | Gas | | | | Gas | Gas | Gas | | | Gas |
| Cost | $/MMBTU | | | | $2.03 | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 | | | $2.03 |
| Percent Use | % Use | | | | 95.0% | 95.0% | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% | | | 95.0% |
| Secondary/Supplemental Fuel | Type | | | | Mazut | Mazut | Mazut | Mazut | | | | Mazut | Mazut | Mazut | | | Mazut |
| Cost | $/MMBTU | | | | $2.41 | $2.41 | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 | | | $2.41 |
| Percent Use | % Use | | | | 5.0% | 5.0% | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% | | | 5.0% |
| COST DATA (1993 Base) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 652 | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $256.0 | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | | ST2-A9 | ST2-A9 | ST2-A9 | ST2-A9 | | | | ST2-A9 | ST2-A9 | ST2-A9 | | | ST2-A9 |
| Emissions Code – Fuel 2 | CODEe2 | | | | ST2-A8 | ST2-A8 | ST2-A8 | ST2-A8 | | | | ST2-A8 | ST2-A8 | ST2-A8 | | | ST2-A8 |
| Scheduled Maintenance | CODE m | | | | | | | KB1-4 | | | KT1-4 | | | KB5-7 | | KT5 | KHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge – Winter | Cents/KWHw | $0.0289 | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | AVAILABILITY | | | | | | | | | | | | |
| Jan | -1.7 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Feb | 0.8 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mar | 4.8 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Apr | 10.8 | | | | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| May | 15.6 | | | | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – |
| June | 19.0 | | | | 100% | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – |
| July | 21.2 | | | | 100% | 100% | 100% | 100% | 100% | 100% | – | – | 100% | 100% | 100% | 100% | – |
| Aug | 20.6 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | 100% | – |
| Sept | 16.7 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Oct | 11.3 | | | | 100% | 100% | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Nov | 5.9 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dec | 0.8 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 6,599 | 5,740 | 5,554 | 4,612 | 2,001 | 2,187 | 1,203 | 1,281 | 2,110 | 3,282 | 5,301 | 6,513 | 48,374 |
| Oil | 412 | 388 | 347 | 288 | 125 | 137 | 75 | 80 | 132 | 204 | 331 | 407 | 2,888 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 7,012 | 6,098 | 5,901 | 4,900 | 2,126 | 2,335 | 1,278 | 1,361 | 2,242 | 3,486 | 5,632 | 6,920 | 49,271 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (4,305) | (3,628) | (4,008) | (3,567) | (2,213) | (2,248) | (1,077) | (1,058) | (2,194) | (3,715) | (4,179) | (4,353) | (36,544) |
| Net Power Interchange Cost | (4,305) | (3,628) | (4,008) | (3,567) | (2,213) | (2,248) | (1,077) | (1,058) | (2,194) | (3,715) | (4,179) | (4,353) | (36,544) |
| Other O&M – Fixed, OH & Other | 188 | 170 | 188 | 182 | 188 | 182 | 188 | 188 | 182 | 188 | 182 | 188 | 2,211 |
| Variable | 770 | 670 | 659 | 561 | 280 | 280 | 142 | 154 | 266 | 410 | 631 | 761 | 5,565 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By-Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 20 |
| Total Excluding Maintenance | 3,668 | 3,313 | 2,741 | 2,077 | 361 | 549 | 532 | 646 | 499 | 350 | 2,299 | 3,518 | 20,523 |



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# Exhibit 4-33

## Trajco Kostov T.P.H. Boiler and Turbine Performance

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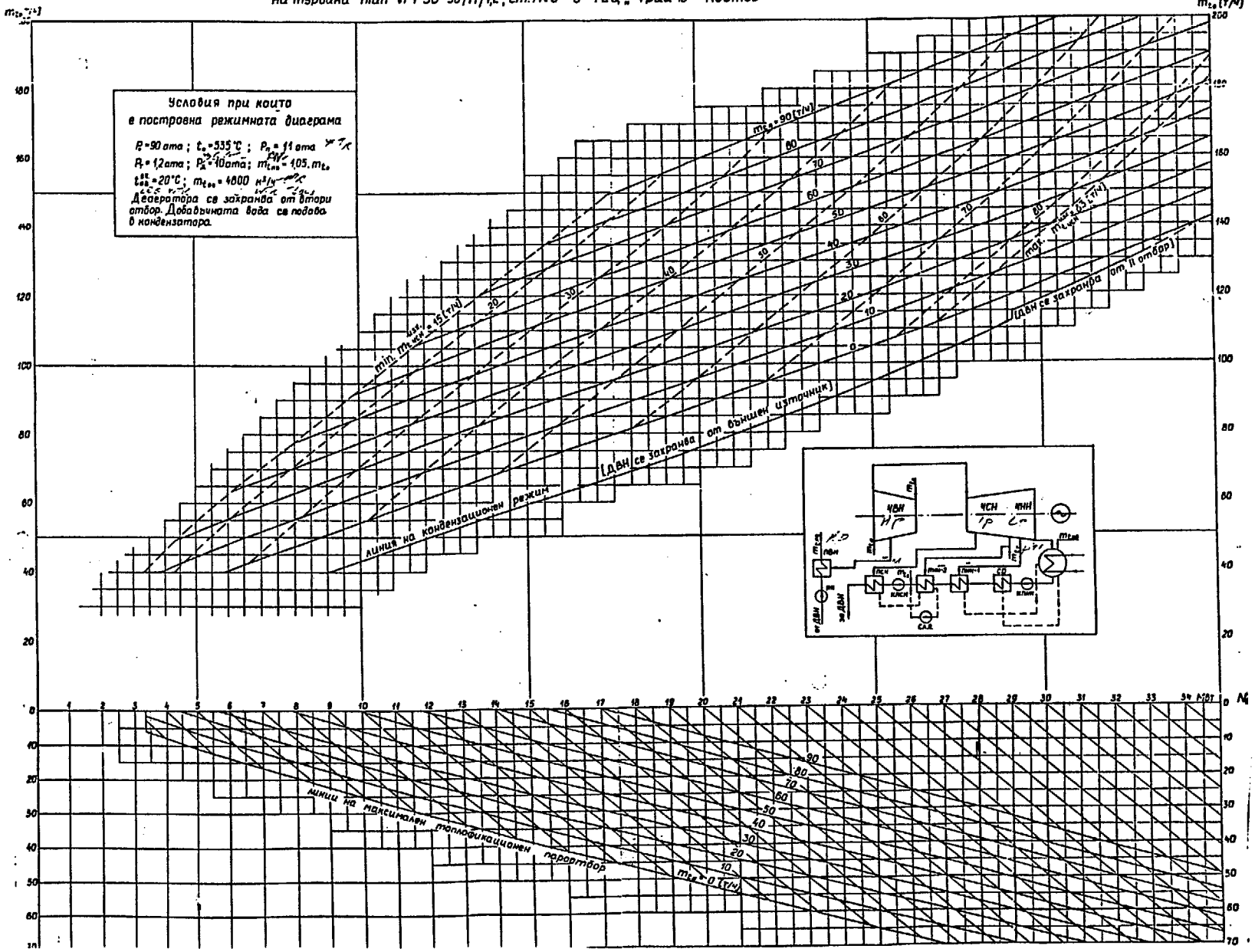
на турбина тип VPT 30-90/11/1,2, ст. М3 в ТЕЦ „Трайчо Костов"



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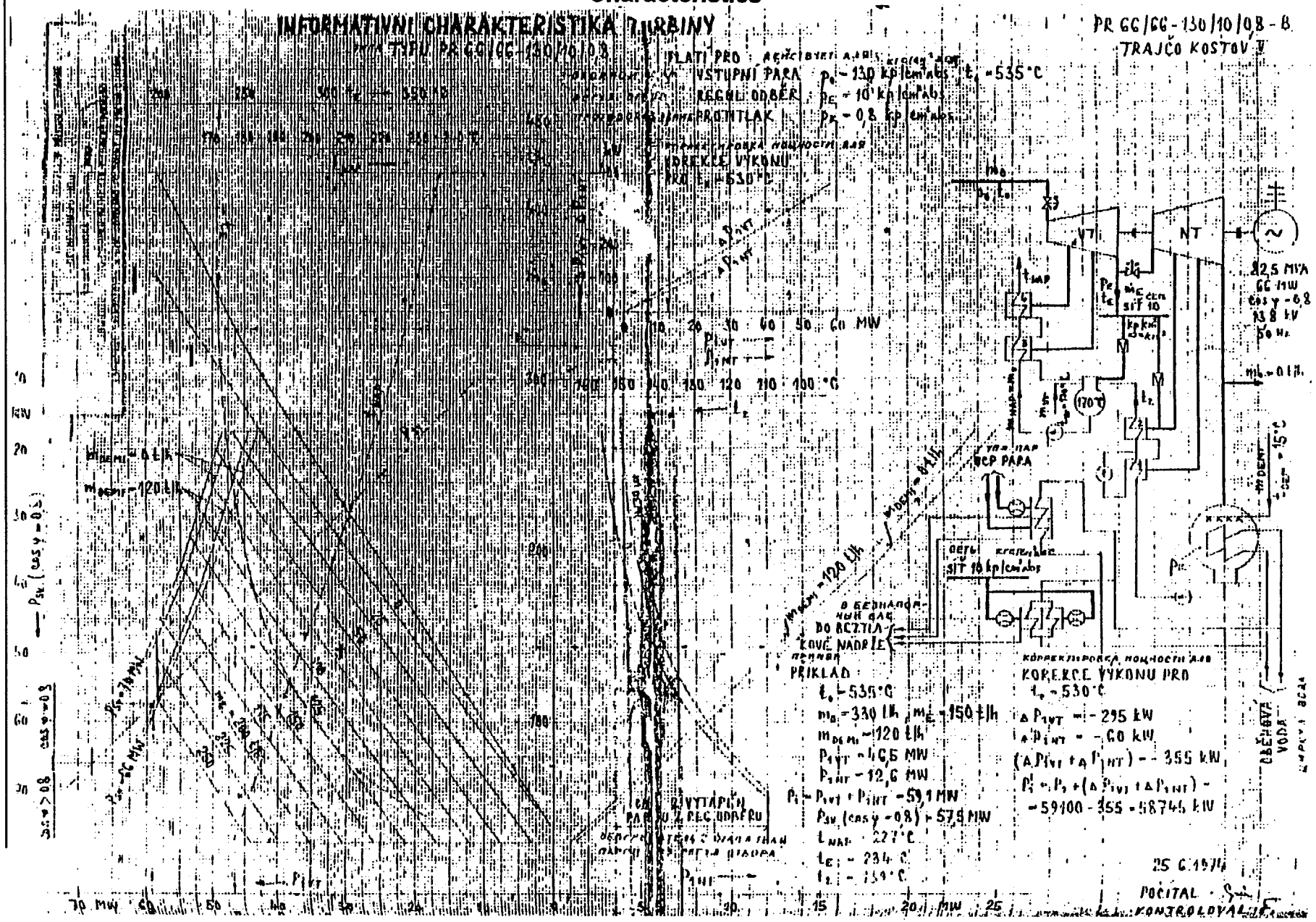
## Exhibit 4-34

### Trajco Kostov Boiler and Turbine Characteristics



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# TRAJCO KOSTOV TPH STATION

# CASE K2 - GT COMBINED CYCLE

### 4.6.2.2 Trajco Kostov TPH Station - Case K2 (GT Combined Cycle)

For this case, a gas turbine combined cycle system would be installed to supplement existing thermal and power generating equipment while displacing one hot water boiler. Exhibit 4-35A presents the summary of Case K2. A schematic of the system is provided in Exhibit 4-35 while the station layout and site plans are depicted in Exhibits 4-36 and 4-37, respectively.

**Combined Cycle Modification:** General Electric's state-of-the-art gas turbine (Frame 6FA) combined cycle, with a one-on-one configuration is to be installed. An ABB non-reheat condensing steam turbine (1450 PSIG, 1000 F) with one controlled extraction, bottoms the cycle and provides the energy for hot water heating (Exhibit 4-35). On a 0 F day, the combined plant will produce a total electric output of 108.2 MWe.

The steam turbine contributes a third of the electric power output plus 86.6 MWt steam for hot water heating (Exhibit 4-38 Facility Data Sheet). Supplementary firing, through new HRSG, is again used to bring the throttle steam to 339,090 lbs/hr. Unlike a back pressure turbine, which would run only during the heating season, a condensing turbine allows the plant to run all year, producing electricity and maximizing the capacity factor.

**Thermal and Hot Water Boiler Modifications:** Thermal Boilers Nos. 1 through 7 and Hot Water Boilers Nos. 1 through 7 will be rehabilitated according to the "necessity" and "enhancement" schedule prepared by B&W as presented in Section 2 of this study. Hot Water Boiler No. 8 will be retired and mothballed for future hot water demand.

**Steam Turbine Modifications:** Steam Turbine Nos. 1 through 5 will be rehabilitated starting from year 1994 and inspected and overhauled every five years to maintain operability and efficiency as described in Subsection 2.5 of this study.

The facility data sheet (Exhibit 4-38) summarizes boiler efficiency and turbine performance formulated for the economics model in accordance with Section 6.3.9. Boiler efficiency is based on a 95% natural gas and 5% Mazut oil mixture. Turbine performance is based upon curves in Exhibits 4-39 and 4-40 for Turbine Nos. 4 and 5, and for No. 6, respectively.

By introducing the Gas Turbine/HRSG/stem turbine overall system efficiency is increased and additional electric power generating capacity of 108.2 MWe is introduced into the system. Gas Turbine power rating is 71.76 MWe and condensing turbine power rating is 36.44 MWe.

Cogeneration improved to 44.6% for this case. Economic results will show whether this is beneficial from a rate-of-return viewpoint.



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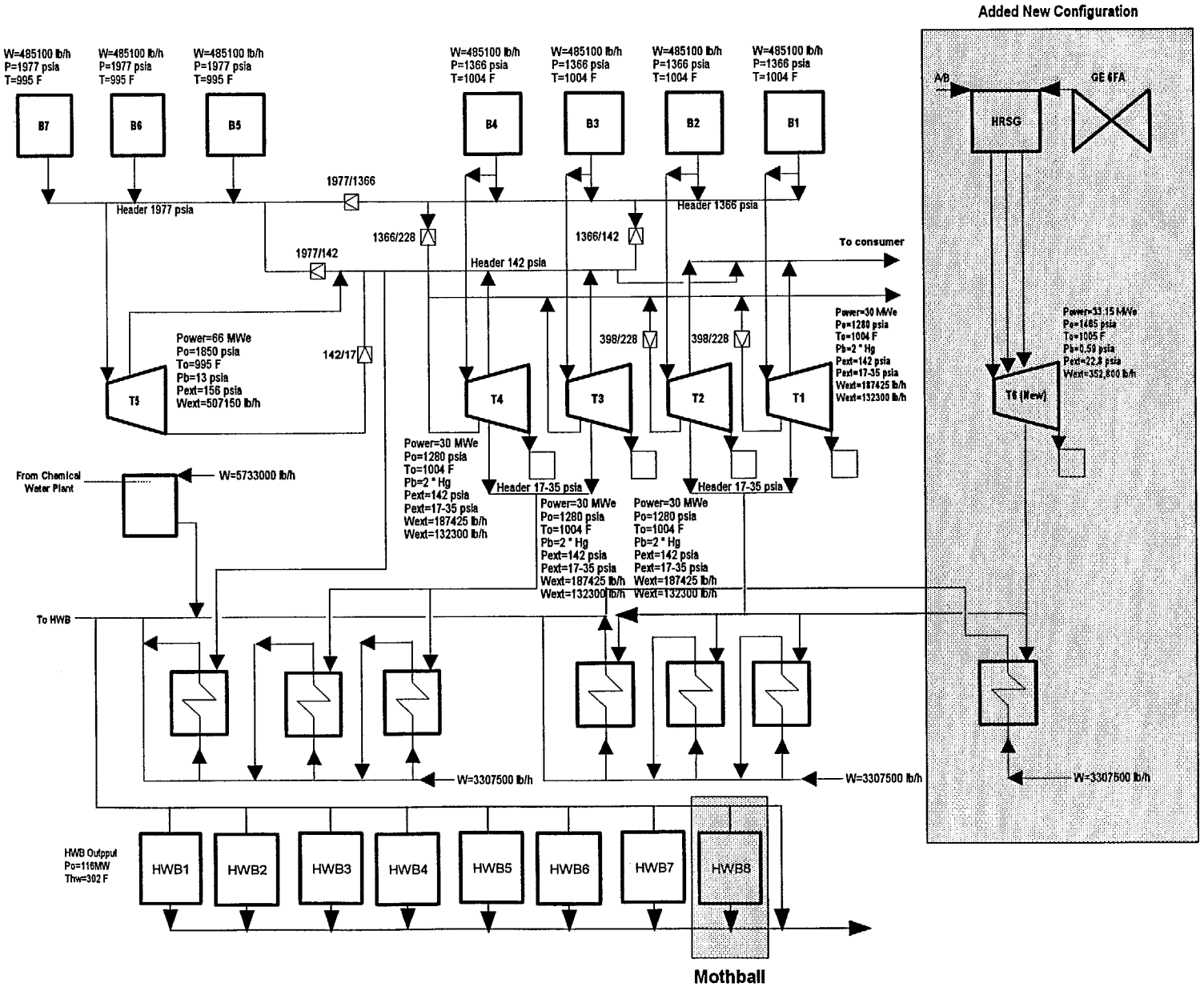
## Exhibit 4-35A

## Summary of Case K2

| BOILERS TYPE | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| Boiler No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Hot Water Boilers:** | |
| Boiler No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 7 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 8 | Retire (Mothball for future demand increase) |
| **Steam Turbines:** | |
| Turbine No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |
| Turbine No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.2.1) |

# Exhibit 4-35

## Trajco Kostov Power and Heat Station
## Case K2 CGT Combined Cycle



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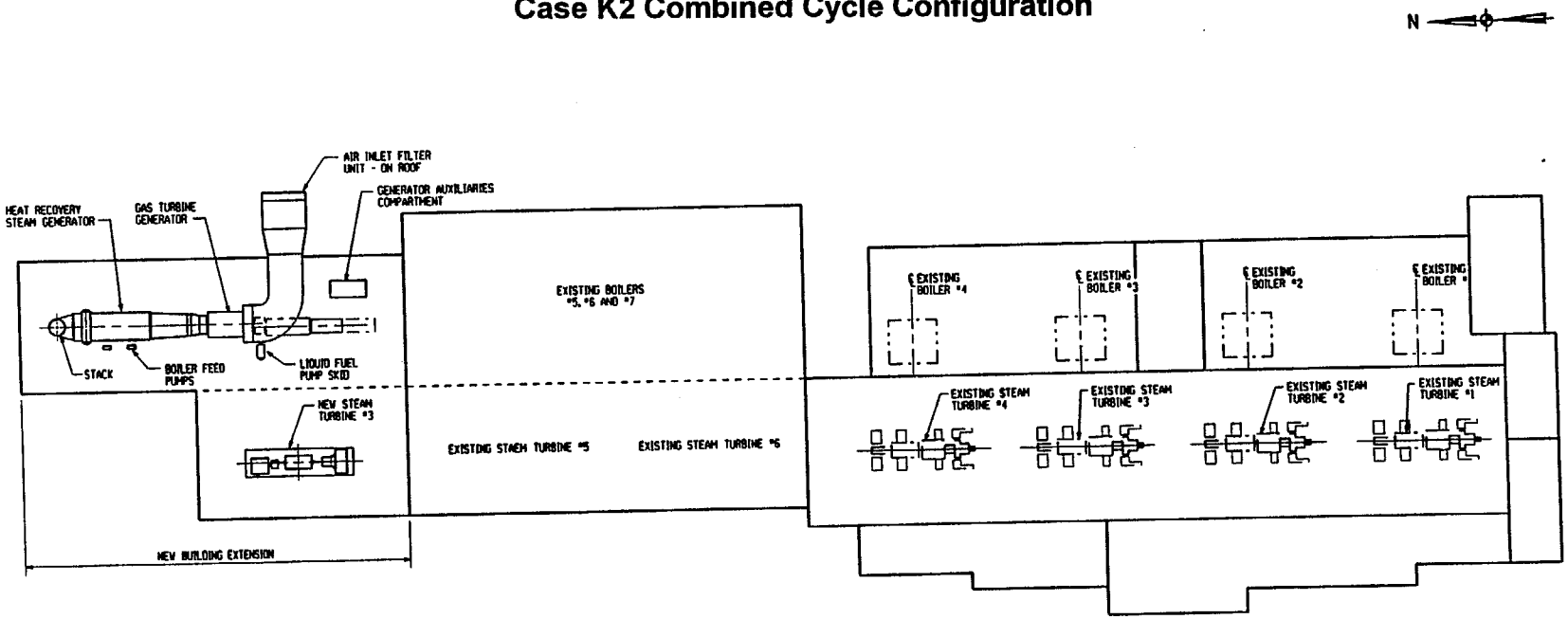
## Exhibit 4-36

## Trajco Kostov Thermal Power Station
## Case K2 Combined Cycle Configuration




PLAN VIEW
EXISTING BOILER / TURBINE BUILDING

BULGARIA DISTRICT HEATING SYSTEM
FEASIBILITY STUDY

TR. KOSTOV THERMAL POWER STATION
COMBINED CYCLE CONFIGURATION



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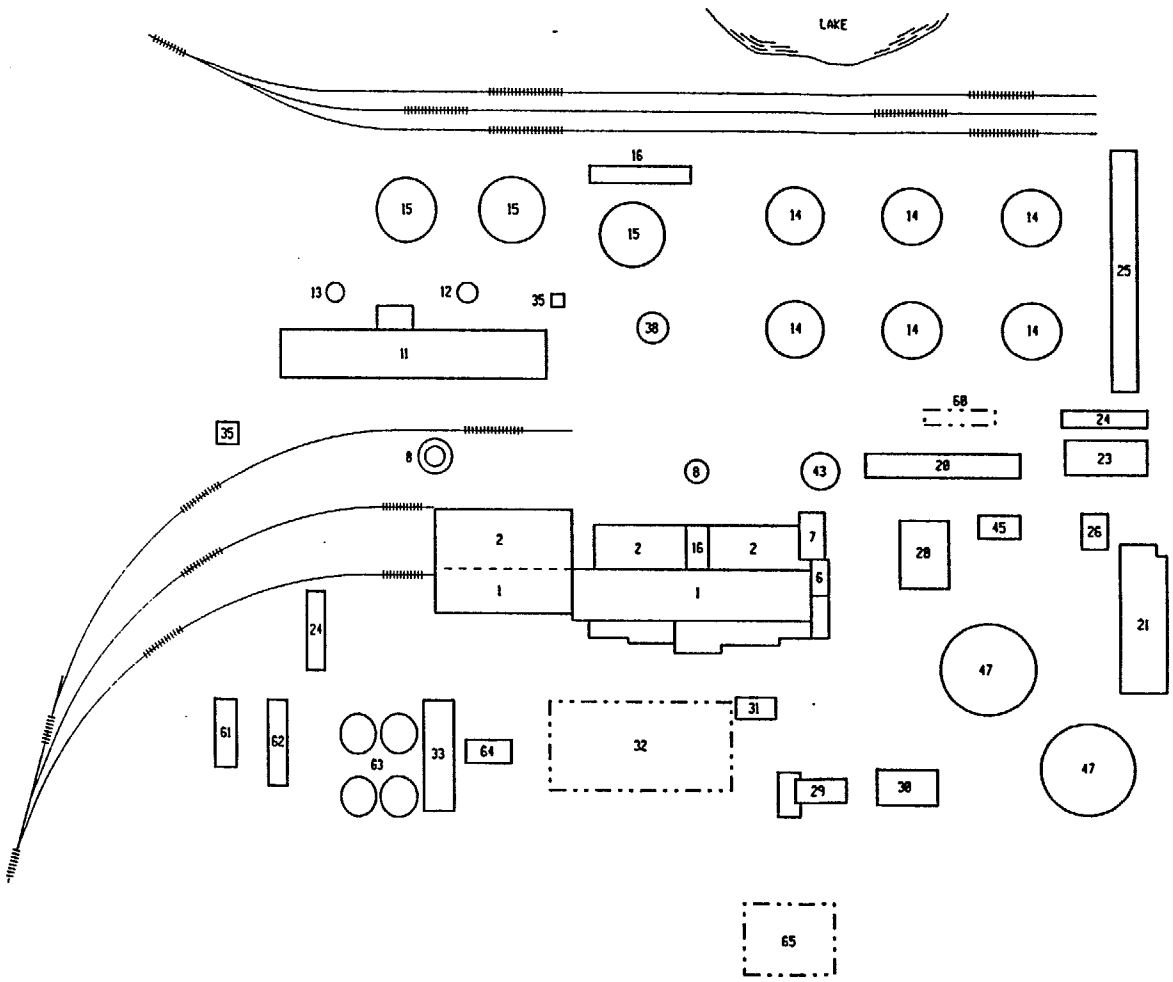
# Exhibit 4-37

## Trajco Kostov Thermal Power Station Site Plan
## Case K2 Combine Cycle Configuration



# Exhibit 4-38

## Facilities Data Sheet and Simulated Results - Trajco Kostov Case K2

CASE K2 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EXISTING FACILITIES | | | | | | | | | | | | | | | |
| | | | Blr #1&2 | Blr #3 | Blr #4 | | | | Blr #5 | Blr #6 | Blr #7 | | | HWB 1-7 | | HRSG #1 | |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% | | 100.0% | |
| Half Load | %2 | | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% | | 100.0% | |
| Minimum Load | %3 | | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% | | 100.0% | |
| Minimum Operation | % | | 20.0% | 40.0% | 40.0% | | | | 40.0% | 40.0% | 40.0% | | - | 5.0% | | | |
| Feedwater Temp | | | | | | | | | | | | | | | | | |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | 8 | 7 | 5 | | | | 4 | 3 | 2 | | | | | | |
| Capacity | MWt | | 261.860 | 130.930 | 130.930 | | | | 142.040 | 142.040 | 142.040 | | | | | 141.786 | 141.786 |
| Quantity | Mlb/Hr | | 815.85 | 407.925 | 407.925 | | | | 418.950 | 418.950 | 418.950 | | | | | 339.09 | |
| Pressure | PSIA | | 1393 | 1393 | 1393 | | | | 1978 | 1978 | 1978 | | | | | 1541.6 | |
| Temperature | Temp °F | | 1004° | 1004° | 1004° | | | | 975° | 975° | 975° | | | | | 1004° | |
| Enthalpy | MBTU/lb | | 1.499 | 1.499 | 1.499 | | | | 1.471 | 1.471 | 1.471 | | | | | 1.492 | |
| PRODUCT – LP STEAM | Priority | * | | | | 5 | | | | | | 4 | | | | | |
| Quantity | Mlb/Hr | | | | | 793.800 | | | | | | 441.000 | | | | | |
| | MWs | | | | | 274.000 | | | | | | 147.040 | | | | | |
| Pressure | PSIA | | | | | 156.5 | | | | | | 142 | | | | | |
| Temperature | Temp °F | | | | | 550° | | | | | | 930° | | | | | |
| Enthalpy | MBTU/lb | | | | | 1.309 | | | | | | 1.240 | | | | | |
| PRODUCT – HOT WATER | Priority | Cooling | | | | | 3 | | | | | | 2 | 6 | | 1 | |
| Quantity | MWw | 200.000 | | | | | 177.200 | | | | | | 113.100 | 612.000 | | 86.607 | |
| Temperature – Supply | Temp °F | | | | | | 310° | | | | | | 185° | 302° | | | |
| Return | Temp °F | | | | | | 158° | | | | | | 118° | 158° | | | |
| TURBINE DATA | UNIT# | | | | | Turb 1-4a | Turb 1-4b | Turb 1-4c | | | | Turb 5a | Turb 5b | | GT-6FA | Turb K2b | Turb K2c |
| | Priority | | | | | | | | | | | | | | 1 | | |
| Rated Capacity-Electric | KW | | | | | | | 120000 | | | | | 66000 | | | 27665 | 36580 |
| Capability – Max Steam | KW1 | | | | | 56740 | 58294 | 108000 | | | | 28384 | 46620 | | | 27665 | 36580 |
| 75 % Steam | KW75 | | | | | 42556 | 43718 | | | | | 22045 | 33483 | | | 19762 | |
| 50 % Steam | KW50 | | | | | 28372 | 29144 | | | | | 14697 | 18841 | | | 11821 | |
| 25% Steam | KW25 | | | | | 14184 | 14572 | | | | | 7167 | 6237 | | | 2898 | |
| Steam Required – Maximum | M#/Hr Max | | | | | 793.800 | 154.360 | | | | | 441.000 | 410.130 | | | 305.181 | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | 156.5 | 17 | | | | | 142 | 11.38 | | | 25 | |
| Enthalpy Drop – Turbine | MBTU/lb1 | | | | | 0.185 | 0.293 | | | | | 0.231 | 0.343 | | | 0.3141 | |
| Sink | MBTU/lbs | | | | | 1.178 | 0.978 | | | | | 1.1360 | 0.9410 | | | 0.9686 | |
| Generator Efficiency | %g | | | | | 97.4% | 97.4% | 97.4% | | | | 98.5% | 98.5% | | | 98.5% | 0.985 |
| Power/Rejection Factor | Factor | | | | | | | 0.424 | | | | | | | | | 0.3292 |
| FUELS DATA | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | Gas | Gas | Gas | | | | Gas | Gas | Gas | | | Gas | Gas | | |
| Cost | $/MMBTU | | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 | | | $2.03 | $2.03 | | |
| Percent Use | % Use | | 95.0% | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% | | | 95.0% | 100.0% | | |
| Secondary/Supplemental Fue | Type | | Mazut | Mazut | Mazut | | | | Mazut | Mazut | Mazut | | | Mazut | | | |
| Cost | $/MMBTU | | $2.41 | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 | | | $2.41 | | | |
| Percent Use | % Use | | 5.0% | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% | | | 5.0% | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 652 | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $255.0 | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | - | | | | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | ST2-A8 | ST2-A9 | ST2-A8 | | | | ST2-A9 | ST2-A9 | ST2-A9 | | | ST2-A8 | | | |
| Emissions Code –Fuel 2 | CODEe2 | | ST2-A6 | ST2-A6 | ST2-A6 | | | | ST2-A6 | ST2-A6 | ST2-A6 | | | ST2-A6 | | | |
| Scheduled Maintenance | CODE m | | | | KB1-4 | | KT1-4 | | | | KB5-7 | | KT5 | KHWB | GT-6FA | STS3 | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge –Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | Max GT7 | AVAILABILITY | | | | | | | | | | | | | | |
| Jan | -1.7 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Feb | 0.8 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mar | 4.8 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Apr | 10.8 | No | - | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| May | 15.6 | No | 100% | - | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% | 100% | 100% |
| June | 19.0 | No | 100% | 100% | - | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | - | - | - |
| July | 21.2 | No | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% | 100% | 100% | 100% | - | 100% | 100% | 100% |
| Aug | 20.6 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% | 100% | 100% | - | 100% | 100% | 100% |
| Sept | 16.7 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | 100% | 100% | - | 100% | 100% | 100% |
| Oct | 11.3 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Nov | 5.9 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dec | 0.8 | No | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 7,382 | 6,527 | 6,376 | 5,116 | 2,630 | 2,197 | 2,582 | 2,566 | 2,600 | 2,670 | 5,964 | 7,250 | 53,970 |
| Oil | 362 | 338 | 321 | 246 | 89 | 137 | 87 | 95 | 63 | 103 | 298 | 376 | 2,548 |
| Lignite | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Black Coal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Fuel Cost | 7,745 | 6,864 | 6,696 | 5,361 | 2,728 | 2,335 | 2,679 | 2,664 | 2,663 | 2,874 | 6,263 | 7,635 | 56,518 |
| Supplemental Cost – Shortfall Penalty | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Purchased Power Cost | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for Power Sales | (6,416) | (5,600) | (6,125) | (4,979) | (3,133) | (2,248) | (2,969) | (2,961) | (2,862) | (3,664) | (6,108) | (6,443) | (53,537) |
| Net Power Interchange Cost | (6,416) | (5,600) | (6,125) | (4,979) | (3,133) | (2,248) | (2,969) | (2,961) | (2,862) | (3,664) | (6,108) | (6,443) | (53,537) |
| Other O&M – Fixed, OH & Other | 188 | 170 | 188 | 182 | 186 | 182 | 188 | 186 | 182 | 186 | 182 | 188 | 2,211 |
| Variable | 618 | 727 | 716 | 578 | 296 | 260 | 284 | 261 | 270 | 300 | 669 | 606 | 6,023 |
| Limestone Injection & Ash Removal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for By-Product Sales | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Emissions Penalties | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 17 |
| Total Excluding Maintenance | 2,337 | 2,164 | 1,479 | 1,144 | 76 | 549 | 183 | 142 | 154 | (202) | 1,007 | 2,188 | 11,233 |



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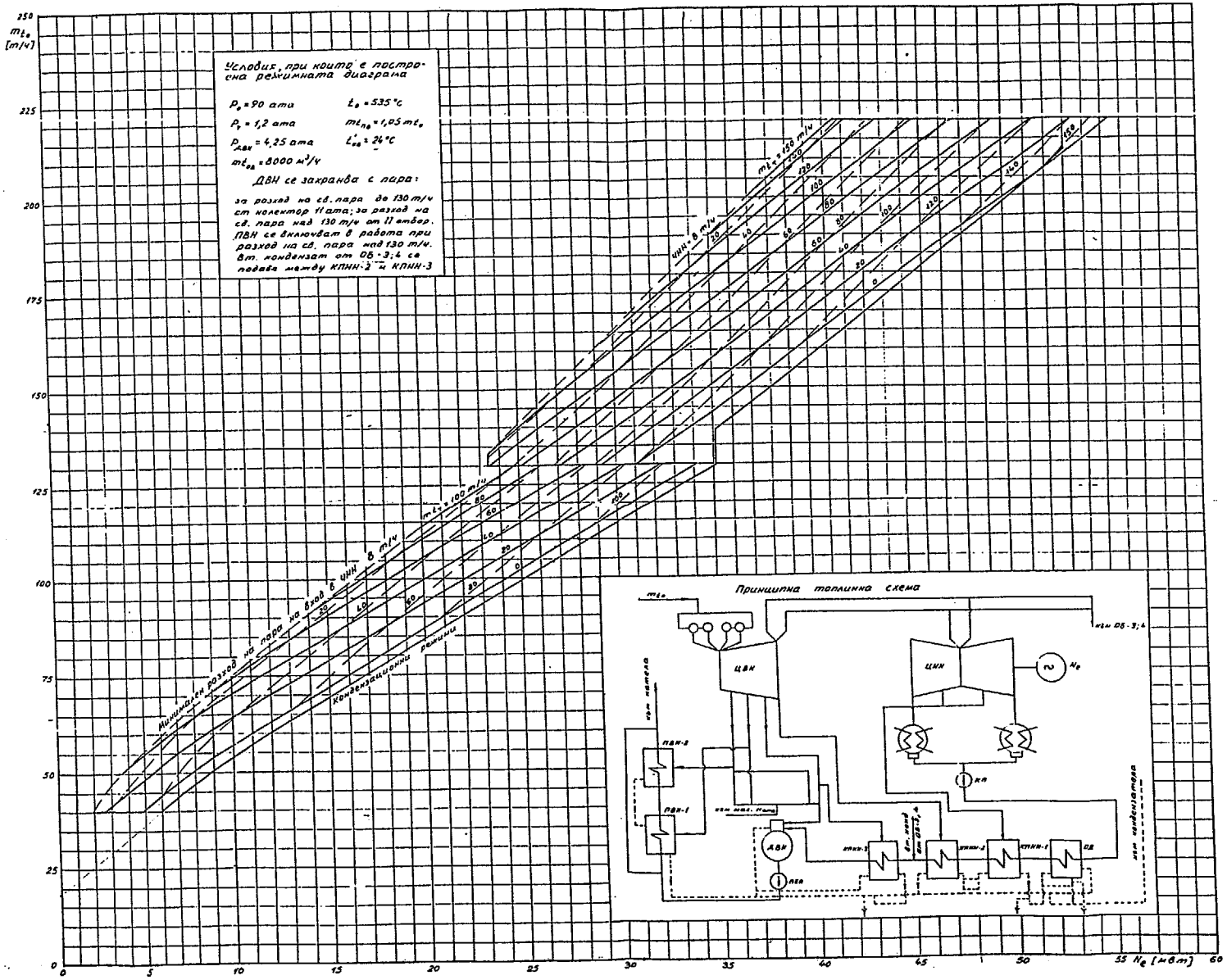
# Exhibit 4-39

## Trajco Kostov T.P.H. Boiler and Turbine Performance

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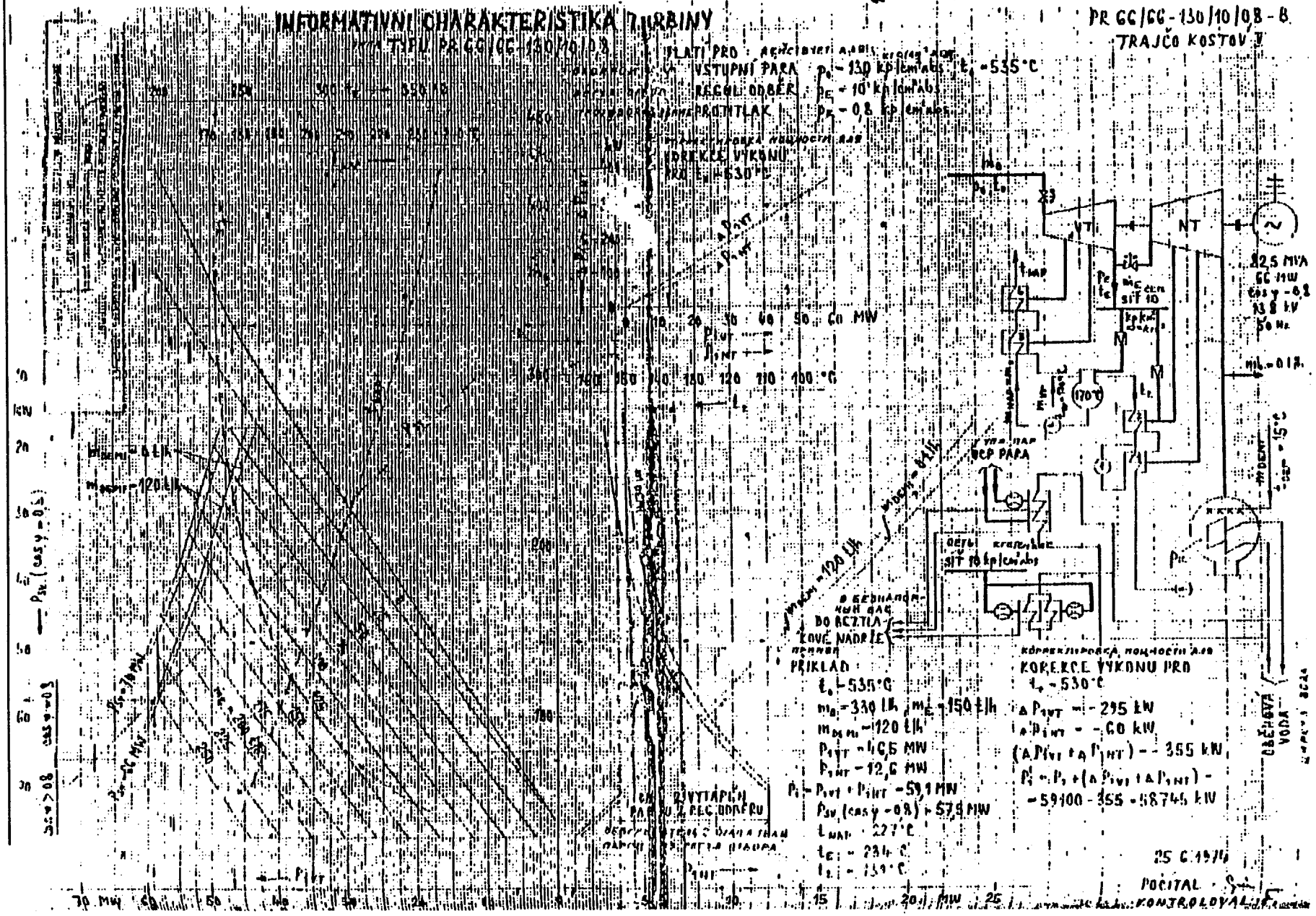
## Exhibit 4-40

## Trajco Kostov Boiler and Turbine Characteristics



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# REPUBLIKA TPH STATION

## CASE P1 - BASE CASE

### 4.6.3 REPUBLIKA POWER AND HEAT STATION CONFIGURATIONS

Republika TPH station is one of the oldest power plants in Bulgaria. It burns local coal of high ash content (60%). Construction of thermal boiler No. 6 was left incomplete due to lack of funds.

Turbine No. 6, intended to form one unit with boiler No. 6, replaced turbine No. 3. The major equipment list (Exhibit 4-41, see page 4-95) summarizes the design conditions along with operating conditions in 1992.

#### 4.6.3.1 Republika TPH Station - Case P1 (Base Case)

Summary of the proposed activities for the Case P1 is presented in Exhibit 4-41A.

This is the minimum rehabilitation Case for the Republika TPH station. The station schematic is presented in Exhibit 4-42. Boiler efficiency and turbine performance (Exhibit 4-43, Facility Data Sheet) is based on performance data shown in Exhibits 4-44 and 4-45.

At maximum realized peak hot water demand of 165 MWt (Exhibit 4-46), cogeneration equipment capacity in this Case exceeds 100% (Exhibit 4-47).

There are six coal fired thermal boilers. All are of Czech design. The boilers are connected to a common high pressure header which supplies steam for turbine No. 4. The high pressure common header is connected with the intermediate pressure header via a pressure reducer, and can receive throttled steam from Boiler No. 5.

**Thermal Boiler Modifications:** The five existing thermal boilers and the reserve boiler will be rehabilitated per B&W recommendations in Section 2. The sixth boiler, presently incomplete, will remain out of service.

**Steam Turbine Modifications:** Existing turbines 4, 5, and 6 are to be rehabilitated per B&W recommendations in Section 2.

Turbine Nos. 1, 2 and 3 have been retired. Turbine No. 4, at 25 MWe, has two controlled extractions. Turbine No. 5 is a 55 MWe turbine with one controlled extraction. It is connected to boiler No. 5. Turbine No. 6 is a 25 MWe back pressure turbine with one controlled extraction and a condenser where district heating water serves as a cooling medium.

Process steam comes from Turbine Nos. 4 and 6. Since there is no hot water boiler in this plant, peaking demand may be available through the high pressure heater.

#### 4.6.3.2 Republika TPH Station - Case P2 (GT Combined Cycle)

This Case was not investigated due to the unavailability of natural gas fuel at this site.

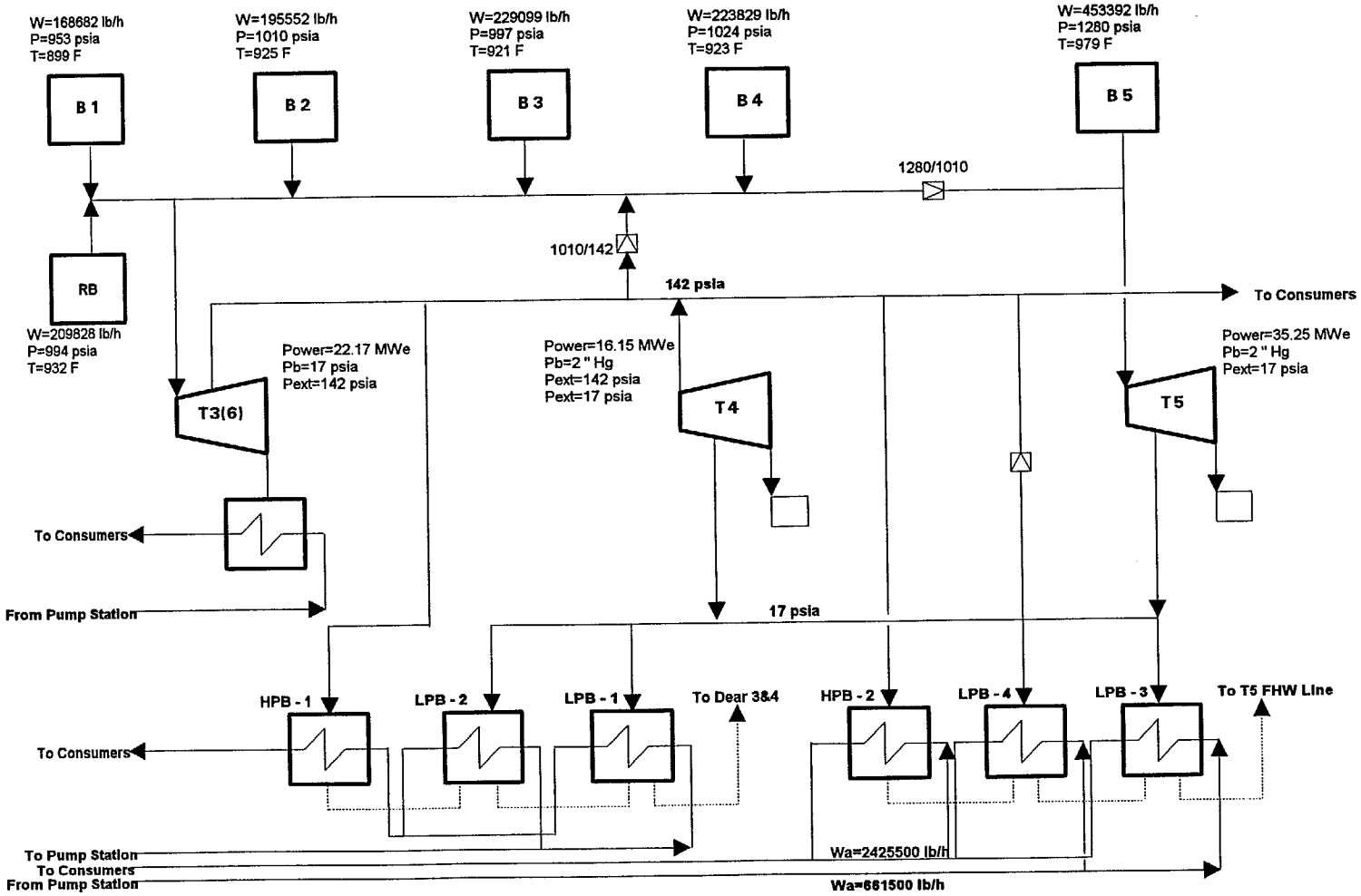
## Exhibit 4-41A

## Summary of Case P1

| EQUIPMENT | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| Boiler No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Inoperable |
| Reserve Boiler | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| **Steam Turbines:** | |
| Turbine 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Turbine 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Turbine 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |

# Exhibit 4-42

## Republika Power and Heat Station
## Case P1



# Exhibit 4-43

## Facilities Data Sheet and Simulated Results - Year 2010
## Republika TPH Station - P1

CASE P1 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EXISTING FACILITIES | | | | | | | | | | | | | | | |
| | | | | Br #4 | | | | Br #5 | | | Br #3 | | | Br #1 | Br #2 | | |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 85.3% | | | | 87.3% | | | 85.3% | | | 84.3% | 84.3% | | |
| Half Load | %2 | | | 85.3% | | | | 87.3% | | | 85.3% | | | 84.3% | 84.3% | | |
| Minimum Load | %3 | | | 85.3% | | | | 87.3% | | | 85.3% | | | 84.3% | 84.3% | | |
| Minimum Operation | % | | | 40.0% | | | | 40.0% | | | 40.0% | | | 10.0% | 40.0% | | |
| Feedwater Temp | | | | 397° | | | | 413° | | | 410° | | | 320° | 320° | | |
| Operation Adjustment Factor | Factor | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | 5 | | | | 4 | | | 6 | | | 7 | 8 | | |
| Capacity | MWt | | | 70.960 | | | | 144.800 | | | 71.690 | | | 57.200 | 66.400 | | |
| Quantity | Mlb/Hr | | | 223.830 | | | 77.878 | 453.390 | | 147.723 | 229.100 | | | 188.68 | 199.550 | | |
| Pressure | PSIA | | | 1024 | | | 35.303 | 1060 | | – | 997.2 | | | 953 | 1010 | | |
| Temperature | Temp °F | | | 923.5° | | | 18.169 | 956° | | 36.9705 | 921° | | | 900° | 925° | | |
| Enthalpy | MBTU/lb | | | 1.455 | | | 77.869 | 1.460 | | 161.121 | 1.457 | | | 1.450 | 1.463 | | |
| PRODUCT – LP STEAM | Priority | * | | | 4 | | | | | | | 5 | | | | | |
| Quantity | Mlb/Hr | | | | 176.4 | | | | | | | 110.250 | | | | | |
| | MWts | | | | 54.890 | | | | | | | 35.7 | | | | | |
| Pressure | PSIA | | | | 142 | | | | | | | 142 | | | | | |
| Temperature | Temp °F | | | | 527° | | | | | | | 540° | | | | | |
| Enthalpy | MBTU/lb | | | | 1.285 | | | | | | | 1.293 | | | | | |
| PRODUCT – HOT WATER | Priority | | | | | 2 | | | 1 | | | | 3 | | | Cooling | |
| Quantity | MWtw | | | | | 48.210 | | | 97.100 | | | | 67.780 | | | 300.000 | |
| Temperature – Supply | Temp °F | | | | | 302° | | | 302° | | | | 248° | | | | |
| Return | Temp °F | | | | | 227° | | | 227° | | | | 227° | | | | |
| TURBINE DATA | UNITs | | | | Turb 4a | Turb 4b | Turb 4c | | Turb 5b | Turb 5c | | Turb 6a | Turb 6b | | | | |
| | Priority | | | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | | | 25000 | | | 55000 | | | 25000 | | | | |
| Capability – Max Steam | KW1 | | | | 10406 | 12162 | 25000 | | 38861 | 55000 | | 6113 | 22174 | | | | |
| 75 % Steam | KW75 | | | | 7804 | 9121 | | | 27510 | | | 4584 | 15386 | | | | |
| 50 % Steam | KW50 | | | | 5205 | 6081 | | | 18340 | | | 3056 | 8598 | | | | |
| 25% Steam | KW25 | | | | 2601 | 3040 | | | 9170 | | | 1528 | 1069 | | | | |
| Steam Required – Maximum | M#/Hr_Max | | | | 176.400 | 154.350 | | | 330.750 | | | 110.250 | 242.990 | | | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | 54.180 | | | | |
| Outlet Steam Pressure | PSI | | | | 142.0 | 15.5 | | | 17.0 | | | 142.0 | 17.6 | | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | 0.17 | 0.24 | | | 0.325 | | | 0.164 | 0.284 | | | | |
| Sink | MBTU/lbs | | | | 1.062 | 1.066 | | | 1.002 | | | 1.105 | 0.952 | | | | |
| Generator Efficiency | %g | | | | 97.4% | 97.4% | 97.4% | | 97.6% | 97.6% | | 97.4% | 97.4% | | | | |
| Power/Rejection Factor | Factor | | | | | | 0.338 | | | 0.392 | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Coal | | | | Coal | | | Coal | | | Coal | Coal | | |
| Cost | $/MMBTU | | | $2.39 | | | | $2.39 | | | $2.39 | | | $2.39 | $2.39 | | |
| Percent Use | % Use | | | 100.0% | | | | 100.0% | | | 100.0% | | | 100.0% | 100.0% | | |
| Secondary/Supplemental Fue | Type | | | | | | | | | | | | | | | | |
| Cost | $/MMBTU | | | | | | | | | | | | | | | | |
| Percent Use | % Use | | | | | | | | | | | | | | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 983 | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 2.6 | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $568.0 | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.30 | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $1.98 | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | $5.00 | | | | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | | PC2–B2 | | | | PC2–B2 | | | PC2–B2 | | | PC2–B2 | PC2–B2 | | |
| Emissions Code –Fuel 2 | CODEe2 | | | | | | | | | | | | | | | | |
| Scheduled Maintenance | CODE m | | | PB4 | ST4 | | | PB5 | ST5 | | PB3 | ST6 | | PB1 | PB2 | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | | AVAILABILITY | | | | | | | | | | |
| Jan | –1.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Mar | 4.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| May | 15.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | | |
| June | 19.0 | | | 100% | 100% | 100% | 100% | – | 50% | 50% | 100% | 100% | 100% | 100% | 100% | | |
| July | 21.2 | | | – | 50% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 50% | 50% | 100% | 100% | | |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | | |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Nov | 5.9 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Dec | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | 1,766 | 1,622 | 1,653 | 1,360 | 994 | 560 | 704 | 660 | 646 | 753 | 1,360 | 1,663 | 13,783 |
| Total Fuel Cost | 1,766 | 1,622 | 1,653 | 1,360 | 994 | 560 | 704 | 660 | 646 | 753 | 1,360 | 1,663 | 13,783 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (917) | (853) | (968) | (735) | (574) | (196) | (398) | (373) | (331) | (405) | (774) | (853) | (7,361) |
| Net Power Interchange Cost | (917) | (853) | (968) | (735) | (574) | (196) | (398) | (373) | (331) | (405) | (774) | (853) | (7,361) |
| Other O&M – Fixed, OH & Other | 265 | 240 | 265 | 257 | 265 | 257 | 265 | 265 | 257 | 265 | 257 | 265 | 3,124 |
| Variable | 404 | 371 | 378 | 320 | 236 | 129 | 167 | 157 | 153 | 177 | 314 | 384 | 3,192 |
| Limestone Injection & Ash Removal | 4 | 4 | 4 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 4 | 33 |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 178 | 163 | 186 | 139 | 100 | 56 | 71 | 66 | 65 | 76 | 137 | 169 | 1,364 |
| Total Excluding Maintenance | 1,701 | 1,545 | 1,498 | 1,364 | 1,026 | 805 | 811 | 777 | 791 | 868 | 1,296 | 1,653 | 14,135 |



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# Exhibit 4-44

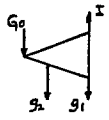
## Performance Data
## Case P1

**Republika TPHS - Turbine #4**

Turbine 4a

G0 = mt0, g1 = mtnbh1, g2 = mtnbh2

1st iteration.



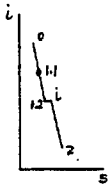

G0 = 160 t/h, I = 80 t/h
g1 = 7.3 t/h, g2=17.6 t/h (Fig 33)
in condensing mode, at G0 = 80 t/h,
g1 = 3 t/h, g2 = 4 t/h (Fig 32)
17.6 - 4 = 13.6 t/h, 7.3 - 3 = 4.3 t/h

Turbine 4a flow = 80 + 13.6 +4.3 = 97.9 t/h

2nd iteration :

160 - 97.9 = 62.1 t/h, g1 = 1.55 t/h, g2 = 2.3 t/h
17.6 - 2.3 = 15.3 t/h, 7.3 - 1.55 = 5.75 t/h
G04A = 80 + 15.3 + 5.75 = 101.05 t/h

From Fig 23,



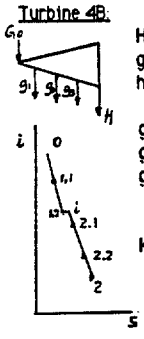

h1.2 = 714 kcal/kg = 1285.2 Btu/lb
h1.1 = 757 kcal/kg = 1362.6

p0 = 1024 psia, t0 = 923.5 F, h0 = 1455 Btu/lb
KWA = (g2(h0-h1.1) + (I + g1)(h0 - h1.2))/3413x0.974

| | | |
|---|---|---|
| = 10406 KW | 101.05 t/h | 100 % |
| = 7804 KW | | 75 % |
| = 5203 KW | | 50 % |
| = 2601 KW | | 25 % |

Makeup to the deaerator. tmu = 121.7 C = 251 F,
hmu = 223.4 Btu/lb. h sink = 1285.2 - 223.4 = 1061.8 Btu/lb

Turbine 4B:




H = 70 t/h, G0 = 118 t/h
g1 = mtnbh2, g2 = mtnbh1, g3 = mtnhh3 (Fig 32)
h1 = h1.1, h2 = h1.2, h3 = h2.1, h4 = h2.2

| | |
|---|---|
| g1 = 8.2 t/h, | h1.1 = 751 kcal/kg = 1352 Btu/lb |
| g2 = 7.2 t/h, | h1.2 = 728 kcal/kg = 1310 Btu/lb |
| g3 = 3.1 t/h, | h2.1 = 694 kcal/kg = 1249 Btu/lb |
| | h2.2 = 675 kcal/kg = 1215 Btu/lb |

KWB = (g3(h0-h2.1)+g2(h0-h1.2) + g1(h0-h1.1)+H(h0-h2.2))
x2205x0.974/3413
= (3.1(1455-1249)+7.2(1455-1310)+8.2(1455-1352)
+70(1455-1215))x2205x0.974/3413

| | |
|---|---|
| = 12162 | 100 % |
| 9121 | 75 |
| 6081 | 50 % |
| 3040 | 25 |

pH = 1.089 ata = 15.5 psi, hf = 148.6 Btu/lb, hsink = 1212 - 148.6 = 1066 Btu/lb

Turbine C:

p2 = 2.06 psia, hFW = 373 Btu/lb, tFW = 203 C = 397 F
r = (h0 - h2) / (h0 - hFW) = (1455 -1080) / (1455 -373)
= 0.346

Feed water heating cporrection:
G = G0 - Gidle = 122 - 10.587 = 111.413 t/h
W/O feed water heating,
MWe = 111.413 x 2205 (1455 - 1080) x 0.974 / 3413=26290
With feed water heating,
MWe = 25000
correction factor = 25000/26290 = 0.951
Power/Heat ratio = 0.951 x r = 0.951x0.346 = 0.329



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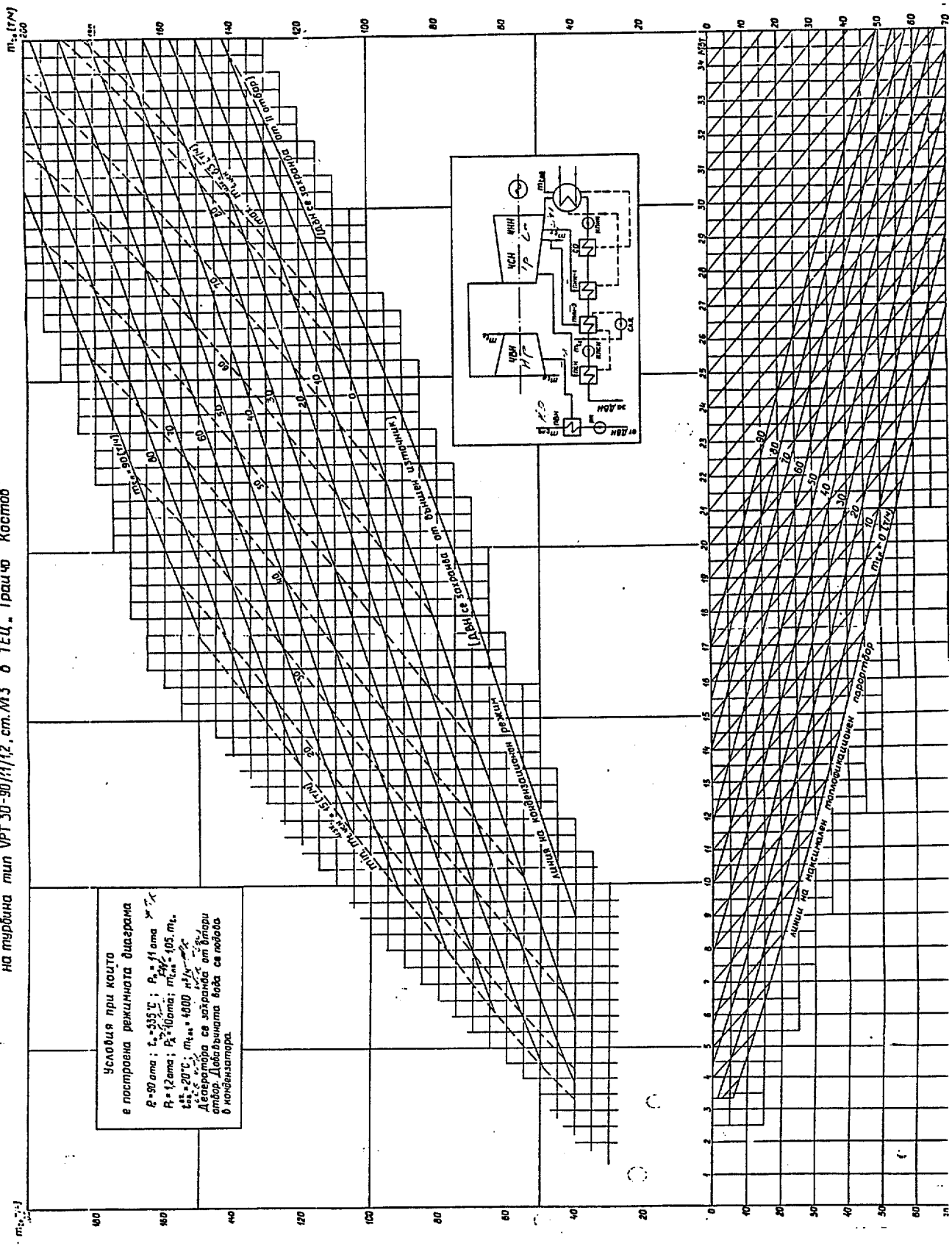
# Exhibit 4-45

## Performance Curves
## Case P1

Режимна диаграма
на турбина тип VPT 30-90/1/1/12, ст.М3 в ТЕЦ „Трайчо Костов"



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# Exhibit 4-46

## Republika TPH Station
## Case P1

Design peak loss - 366 MW

Maximum realized peak load - 165 MW

Proposed by Pernik variation - 275 MW under the same conditions as have been decided for Sofia.

February 1993 - the month with the greatest amount of thermal energy produced in 1992-1993

| Direct set water temperature °C | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 95 | 93 | 94 | 97 | 91 | 90 | 93 | 91 | 93 | 93 | 81 | 82 | 100 | 94 | 92 | 101 | 98 | 102 | 95 | 100 | 97 | 93 | 93 | 101 | 106 | 99 | 102 | 100 |
| Revers set water temperature °C | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Date | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 69 | 62 | 67 | 68 | 67 | 65 | 66 | 66 | 66 | 66 | 60 | 60 | 69 | 67 | 66 | 71 | 69 | 72 | 68 | 71 | 68 | 68 | 67 | 69 | 74 | 71 | 72 | 71 |
| Average hourly tereal load [Bcal/h] | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Date | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 111 | 131 | 115 | 123 | 104 | 106 | 116 | 111 | 116 | 118 | 91 | 99 | 136 | 117 | 115 | 133 | 128 | 132 | 115 | 127 | 129 | 110 | 116 | 138 | 139 | 123 | 131 | 129 |



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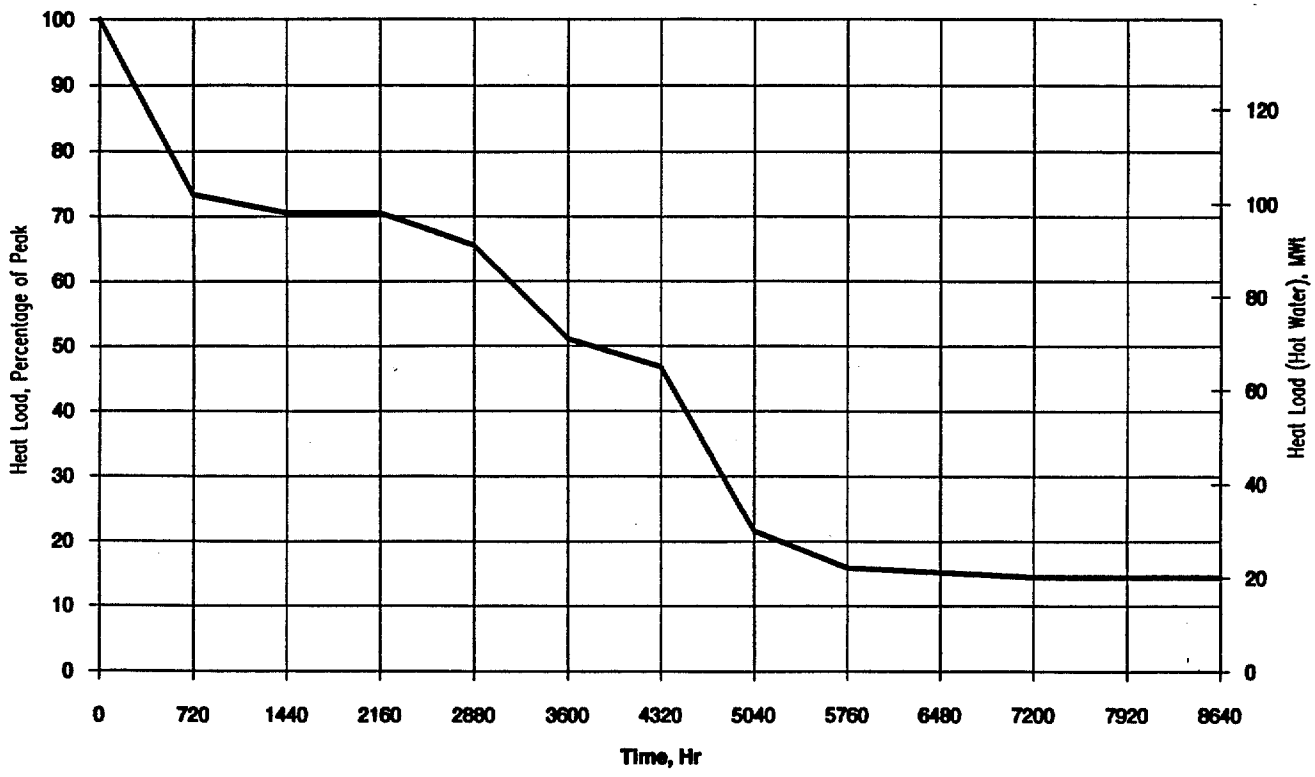
## Exhibit 4-47

## Republika TPHS
## Heat Load (Hot Water) Duration



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# REPUBLIKA TPH STATION

# CASE P3 - AFBC REPOWERING

#### 4.6.3.3 Republika TPH Station - Case P3 (AFBC Repowering)

The summary of this case is presented in Exhibit 4-48.

In this case, an AFBC replaces thermal boiler No. 1 and No. 2. Thermal boiler 6 will be completed and placed in service. A new-35 MWe steam turbine will be added to the system and the existing 25 MWe steam turbine No. 4 will be retired. Turbine 6 will then operate at near-design conditions. A summary of the efficiency and performance is presented in the facility data sheet, Exhibit 4-49. Total cogeneration increase about 10% compared to Case P1. A schematic of the system is provided in Exhibit 4-50, the station layout is shown in Exhibit 4-51 and the station site plan is shown in Exhibit 4-52..

**Thermal Boilers:** Boilers No. 1 and No. 2 and the reserve boiler are retired since the AFBC is displacing them. Boiler 3 is retired since Boiler 6, expected to be much more reliable, is to be completed and brought into service. Boilers No. 4 and No. 5 will be rehabilitated per B&W recommendations in Section 2.

**Steam Turbine Modifications:** Turbine 4 will be retired, as discussed above.

Turbines 5 and 6 will be rehabilitated per B&W recommendations presented in Section 2.



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## Exhibit 4-48

## Summary of Case P3

| EQUIPMENT | ACTIVITY |
|---|---|
| **Thermal Boilers:** | |
| Boiler No. 1 | Retire |
| Boiler No. 2 | Retire |
| Boiler No. 3 | Retire |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 6 | Complete Boiler and Place in Service |
| Reserve Boiler | Retire |
| **Steam Turbines:** | |
| Turbine 4 | Retire |
| Turbine 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Turbine 6 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |

# Exhibit 4-49

## Facilities Data Sheet and Simulated Results - Year 2010
## Republika - Case P3

CASE P3 — Test Year = 2010

Facilities Data — EXISTING FACILITIES

| DESCRIPTION | UNIT | BASE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Br #4 | | | | Br #5 | | | | | | Br #6 | CFB #1 | CFB #2 | |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 85.3% | | | | 87.3% | | | | | | 87.3% | 79.7% | 79.7% | |
| Half Load | %2 | | | 85.3% | | | | 87.3% | | | | | | 87.3% | 79.7% | 79.7% | |
| Minimum Load | %3 | | | 85.3% | | | | 87.3% | | | | | - | 87.3% | 79.7% | 79.7% | |
| Minimum Operation | % | | | 40.0% | | | | 40.0% | | | | | - | 40.0% | 30.0% | 40.0% | |
| Feedwater Temp | | | | 397° | | | | 413° | | | | | | 413° | | | |
| Operation Adjustment Factor | Factor | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | 8 | | | | 6 | | | | | | 7 | 4 | 5 | |
| Capacity | MWt | | | 70.960 | | | | 144.800 | | | | | | 144.800 | 112.640 | 112.640 | |
| Quantity | Mlb/Hr | | | 223.830 | | | 98.15 | 453.390 | | 144.141 | | | | 453.390 | | | |
| Pressure | PSIA | | | 1024 | | | 27.444 | 1060 | | | | | | 1060 | | | |
| Temperature | Temp °F | | | 923.9° | | | 25.871 | 958° | | 36.092 | | | | 958° | | | |
| Enthalpy | MBTU/lb | | | 1.455 | | | 97.786 | 1.480 | | 157.305 | | | | 1.480 | | | |
| PRODUCT – LP STEAM | Priority | | | | 4 | | | | | | | 5 | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | | | |
| | MWts | | | | 57.070 | | | | | | | 106.6 | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | | | |
| PRODUCT – HOT WATER | Priority | Cooling | | | | 2 | | | 1 | | | | 3 | | | | |
| Quantity | MWtw | 300.000 | | | | 65.680 | | | 87.100 | | | | 68.000 | | | | |
| Temperature – Supply | Temp °F | | | | | | | | 302° | | | | 248° | | | | |
| Return | Temp °F | | | | | | | | 227° | | | | 227° | | | | |
| TURBINE DATA | UNITs | | | | Turb 2a | Turb 2b | Turb 2c | | Turb 5b | Turb 5c | | Turb 6a | Turb 6b | | | | |
| | Priority | | | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | | | 35000 | | | 55000 | | | 25000 | | | | |
| Capability – Max Steam | KW1 | | | | 8639 | 21611 | 35000 | | 37235 | 85000 | | 24825 | 24400 | | | | |
| 75 % Steam | KW75 | | | | 6500 | 16155 | | | 27926 | | | 19392 | 16947 | | | | |
| 50 % Steam | KW50 | | | | 4363 | 10730 | | | 18617 | | | 13122 | 9628 | | | | |
| 25% Steam | KW25 | | | | 2194 | 5345 | | | 9309 | | | 6633 | 2040 | | | | |
| Steam Required – Maximum | M#/Hr_Max | | | | 154.350 | 218.000 | | | 330.750 | | | 330.750 | 243.800 | | | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | 54.180 | | | | |
| Outlet Steam Pressure | PSI | | | | | | | | 17.0 | | | 142.0 | 17.8 | | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | 0.189 | 0.903 | | | 0.94 | | | 0.19 | 0.909 | | | | |
| Sink | MBTU/lbs | | | | 1.262 | 1.026 | | | 1.001 | | | 1.100 | 0.955 | | | | |
| Generator Efficiency | %g | | | | 97.6% | 97.6% | 97.6% | | 97.6% | 97.6% | | 97.4% | 97.4% | | | | |
| Power/Rejection Factor | Factor | | | | | | 0.359 | | | 0.375 | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Coal | | | | Coal | | | | | | Coal | Lignite | Lignite | |
| Cost | $/MMBTU | | | $2.39 | | | | $2.39 | | | | | | $2.39 | $0.67 | $0.67 | |
| Percent Use | % Use | | | 100.0% | | | | 100.0% | | | | | | 100.0% | 100.0% | 100.0% | |
| Secondary/Supplemental Fue | Type | | | | | | | | | | | | | | | | |
| Cost | $/MMBTU | | | | | | | | | | | | | | | | |
| Percent Use | % Use | | | | | | | | | | | | | | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 963 | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 2.6 | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $568.0 | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.30 | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $1.98 | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | $5.00 | | | | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | | PC2–B2 | | | | PC2–B2 | | | | | | PC2–B2 | FB2–BL1 | FB2–BL1 | |
| Emissions Code –Fuel 2 | CODEe2 | | | | | | | | | | | | | | | | |
| Scheduled Maintenance | CODE m | | | PB4 | ST4 | | | PB5 | ST5 | | | ST6 | | PB6 | CFB1 | CFB2 | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | AVAILABILITY | | | | | | | | | | | | | |
| Jan | -1.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Mar | 4.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| May | 15.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | - | 100% | 100% | |
| June | 19.0 | | | 100% | 100% | 100% | 100% | - | 50% | 50% | | 100% | 100% | 100% | 100% | 100% | |
| July | 21.2 | | | - | 50% | 50% | 50% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 50% | 50% | 100% | 100% | - | |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | - | 100% | |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Nov | 5.9 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Dec | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Oil | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lignite | 412 | 377 | 384 | 421 | 314 | 134 | 215 | 199 | 194 | 227 | 419 | 383 | 3,888 |
| Black Coal | 389 | 363 | 377 | - | - | - | - | - | - | - | - | 391 | 1,519 |
| Total Fuel Cost | 800 | 739 | 762 | 421 | 314 | 134 | 215 | 199 | 194 | 227 | 419 | 784 | 5,208 |
| Supplemental Cost–Shortfall Penalty | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Purchased Power Cost | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for Power Sales | (907) | (847) | (974) | (735) | (592) | (130) | (360) | (354) | (311) | (368) | (795) | (871) | (7,285) |
| Net Power Interchange Cost | (907) | (847) | (974) | (735) | (592) | (130) | (360) | (354) | (311) | (368) | (795) | (871) | (7,285) |
| Other O&M – Fixed, OH & Other | 265 | 240 | 265 | 257 | 265 | 257 | 265 | 265 | 257 | 265 | 257 | 265 | 3,124 |
| Variable | 401 | 368 | 378 | 321 | 346 | 102 | 167 | 154 | 180 | 174 | 319 | 396 | 3,166 |
| Limestone Injection & Ash Removal | 257 | 235 | 240 | 262 | 195 | 83 | 134 | 124 | 121 | 141 | 261 | 245 | 2,299 |
| Credit for By–Product Sales | (72) | (66) | (67) | (73) | (55) | (23) | (38) | (35) | (34) | (40) | (73) | (69) | (644) |
| Emissions Penalties | 0 | 0 | 0 | - | - | - | - | - | - | - | - | 0 | 0 |
| Total Excluding Maintenance | 744 | 669 | 604 | 452 | 373 | 422 | 364 | 353 | 377 | 361 | 367 | 741 | 5,867 |



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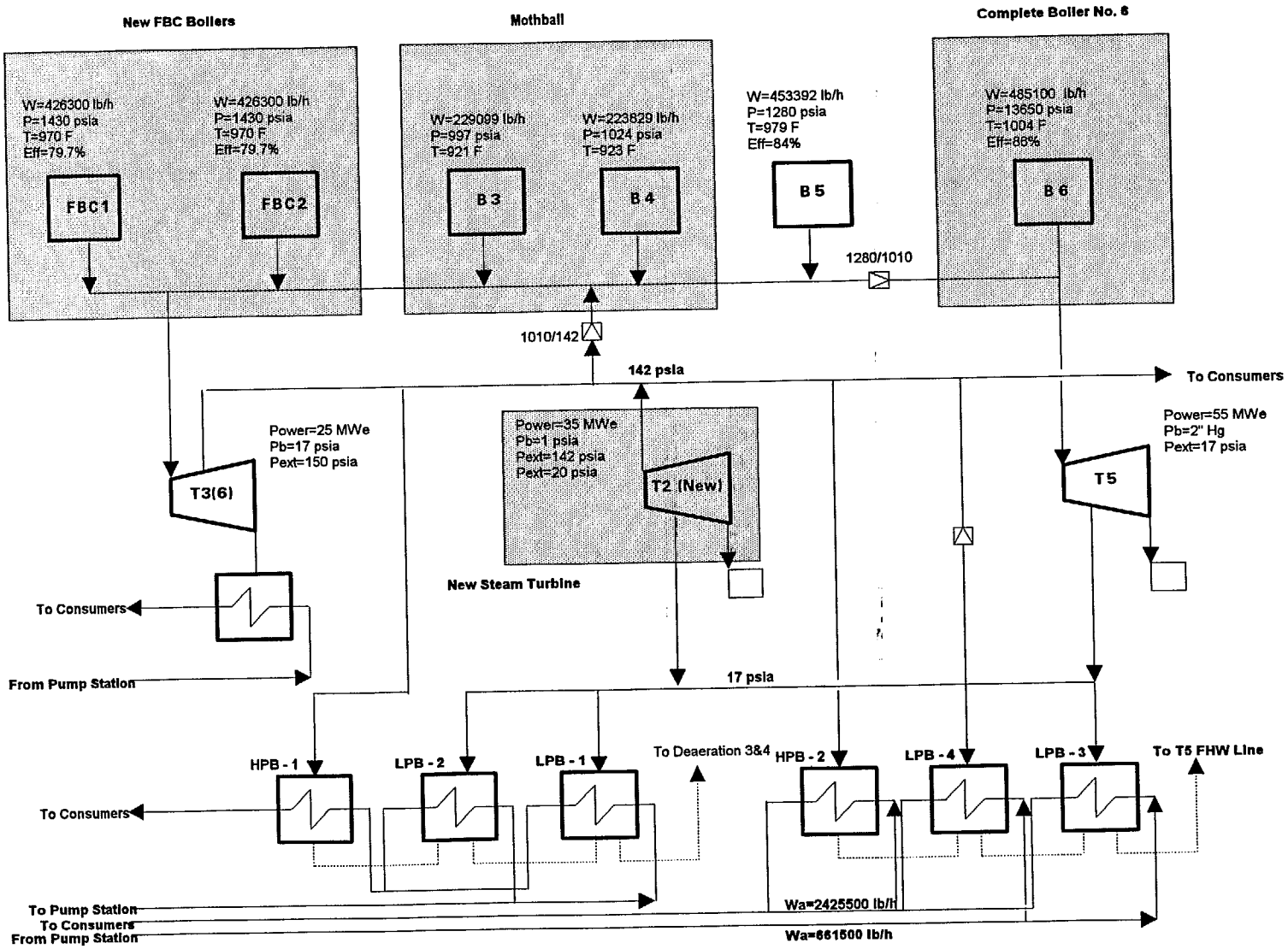
# Exhibit 4-50

## Republika Power and Heat Station
## Case P3 Configuration



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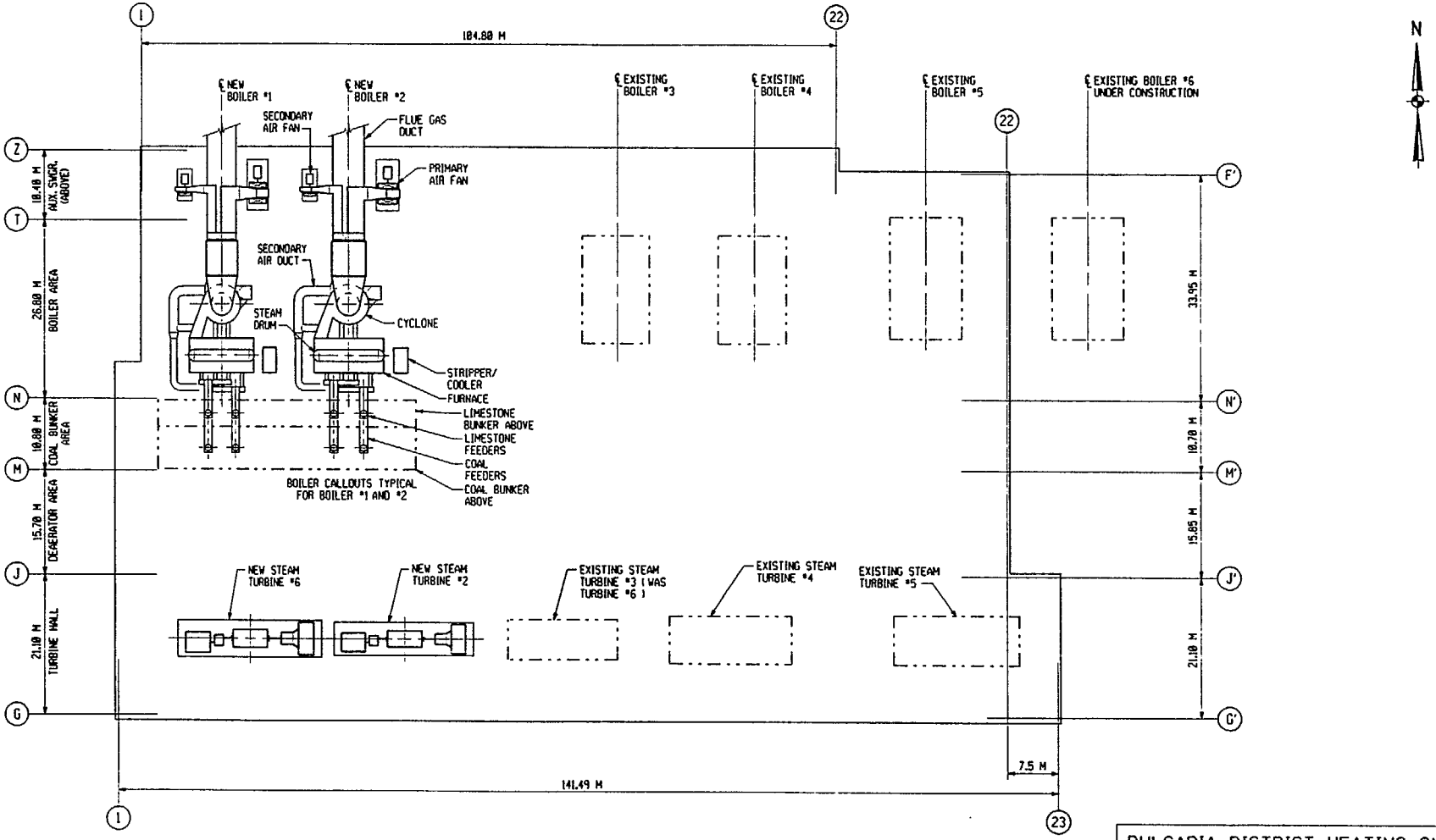
# Exhibit 4-51

## Republika Thermal Power Station Boiler/Turbine Building




PLAN VIEW
EXISTING BOILER / TURBINE BUILDING

BULGARIA DISTRICT HEATING SYSTEM
FEASIBILITY STUDY

REPUBLIKA THERMAL POWER STATION
BOILER/TURBINE BUILDING



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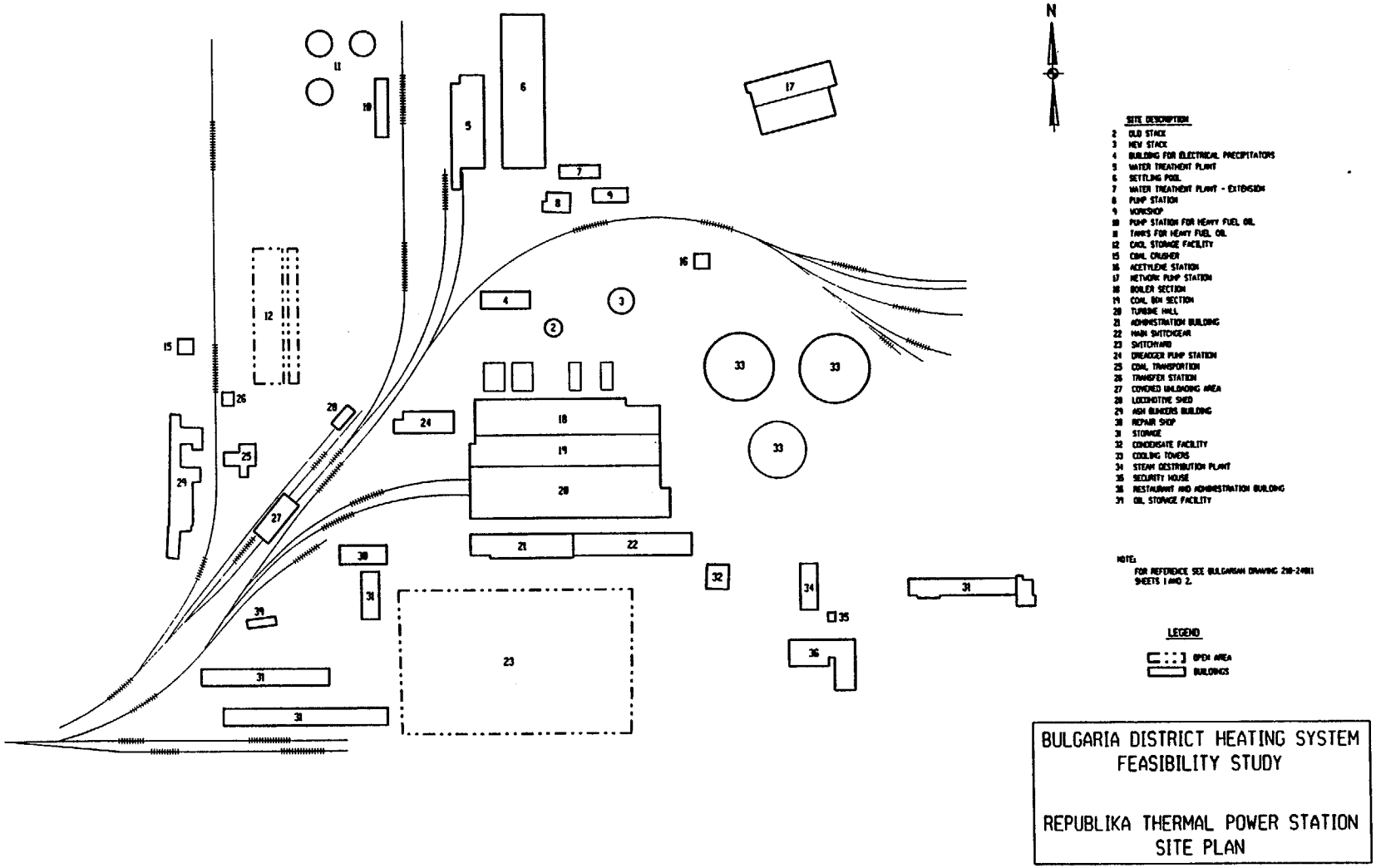
# Exhibit 4-52

## Republika Thermal Power Station Site Plan



# LIULIN/ZEMLINE HEAT STATION

## CASE L1 - BASE CASE

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### 4.6.4 LIULIN/ZEMLINE HEAT STATION CONFIGURATIONS

Liulin and Zemline are the main heat sources for their heating district. They both rely on hot water boilers to meet heating demands and are very much alike. Therefore, only one of them, Liulin, will be treated in this study.

#### 4.6.4.1 Liulin Heat Station - Case L1 (Base Case)

The summary of proposed activities for this case is presented in Exhibit 4- 53.

A summary of the efficiency and performance is presented in Exhibit 4-54, the facility data sheet.

Major equipment of the Liulin station consists of a total of five hot water boilers (HWB): four PTVM-100, and one VK-100 HWB, and two KM-12 steam boilers. A third steam boiler, PKM-12 was never completed.

The HWBs have a capacity of 100 Gcal/h (116 MWt) each. They can burn either natural gas or mazut. The two steam boilers were designed for dual fuel firing, but they have been converted to burn natural gas only. The steam boilers were not included in the study evaluation because they are a very small capacity.

For Case L1, all five hot water boilers will be rehabilitated per the recommendations by B&W presented in Section 2.

Exhibit 4-55 shows a schematic for the L1 configuration.



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## Exhibit 4-53

## Summary of Case L1

| EQUIPMENT | ACTIVITY |
|---|---|
| **Hot Water Boilers:** | |
| Boiler No. 1 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |



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# Exhibit 4-54

## Facilities Data Sheet and Simulated Results - Year 2010 Liulin - Case L1

CASE L1 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | |
| | | | | HWB #1 | | HWB #2 | | HWB #3 | | HWB #4 | | HWB #5 | | | |
| THERMAL DATA | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | | |
| Half Load | %2 | | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | | |
| Minimum Load | %3 | | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | | |
| Minimum Operation | % | | | 40.0% | | 40.0% | | 40.0% | | 40.0% | | 40.0% | | | |
| Feedwater Temp | | | | 156° | | 156° | | 156° | | 156° | | 156° | | | |
| Operation Adjustment Factor | Factor, | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | | | | | | | | |
| Capacity | MWt | | | | | | | | | | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – LP STEAM | Priority | | | | | | | | | | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – HOT WATER | Priority | | | 5 | | 4 | | 3 | | 2 | | 1 | | | |
| Quantity | MWtw | | | 116.000 | | 116.000 | | 116.000 | | 116.000 | | 116.000 | | | |
| Temperature – Supply | Temp °F | | | 302° | | 302° | | 302° | | 302° | | 302° | | | |
| Return | Temp °F | | | 156° | | 156° | | 156° | | 156° | | 156° | | | |
| TURBINE DATA | UNITs | | | | | | | | | | | | | | |
| | Priority | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | | | | | | | | | | | |
| Capability – Max Steam | KW1 | | | | | | | | | | | | | | |
| 75 % Steam | KW75 | | | | | | | | | | | | | | |
| 50 % Steam | KW50 | | | | | | | | | | | | | | |
| 25% Steam | KW25 | | | | | | | | | | | | | | |
| Steam Required – Maximum | M#/Hr Max | | | | | | | | | | | | | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | | | | | | | | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | | | | | | | | | | | |
| Sink | MBTU/lbs | | | | | | | | | | | | | | |
| Generator Efficiency | %g | | | | | | | | | | | | | | |
| Power/Rejection Factor | Factor | | | | | | | | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | | Gas | | Gas | | | |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | | |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | | 95.0% | | 95.0% | | | |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | | Mazut | | Mazut | | | |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | $2.41 | | $2.41 | | | |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | 5.0% | | 5.0% | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 237 | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 3.0 | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $81.0 | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.34 | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $0.75 | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.26 | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | – | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | | ST2–A9 | | ST2–A9 | | | |
| Emissions Code – Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | | ST2–A6 | | ST2–A6 | | | |
| Scheduled Maintenance | CODE m | | | | | | | | | LHWB | | LHWB5 | | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | $0.0269 | | | | | | | | | | | | |
| Summer | Cents/KWHs | | $0.0233 | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | AVAILABILITY | | | | | | | | | |
| Jan | –1.7 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Feb | 0.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Mar | 4.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Apr | 10.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| May | 15.6 | | | – | | 100% | | 100% | | 100% | | 100% | | | |
| June | 19.0 | | | 100% | | – | | 100% | | 100% | | 100% | | | |
| July | 21.2 | | | 100% | | 100% | | – | | 100% | | 100% | | | |
| Aug | 20.6 | | | 100% | | 100% | | 100% | | – | | 100% | | | |
| Sept | 16.7 | | | 100% | | 100% | | 100% | | 100% | | – | | | |
| Oct | 11.3 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Nov | 5.9 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Dec | 0.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 1,463 | 1,312 | 1,158 | 743 | 206 | 342 | 338 | 306 | 331 | 521 | 1,016 | 1,416 | 9,174 |
| Oil | 93 | 82 | 72 | 46 | 13 | 21 | 21 | 19 | 21 | 33 | 64 | 89 | 573 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 1,576 | 1,394 | 1,230 | 789 | 219 | 364 | 359 | 325 | 352 | 553 | 1,080 | 1,507 | 9,747 |
| Supplemental Cost–Shortfall Penalty | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 115 | 101 | 106 | 83 | 25 | 29 | 39 | 34 | 42 | 50 | 84 | 88 | 797 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange Cost | 115 | 101 | 106 | 83 | 25 | 29 | 39 | 34 | 42 | 50 | 84 | 88 | 797 |
| Other O&M – Fixed, OH & Other | 67 | 61 | 67 | 65 | 67 | 65 | 67 | 67 | 65 | 67 | 65 | 67 | 792 |
| Variable | 148 | 131 | 116 | 74 | 21 | 34 | 34 | 31 | 33 | 52 | 101 | 141 | 915 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| Total Excluding Maintenance | 1,906 | 1,687 | 1,520 | 1,011 | 332 | 492 | 499 | 458 | 493 | 723 | 1,331 | 1,904 | 12,256 |



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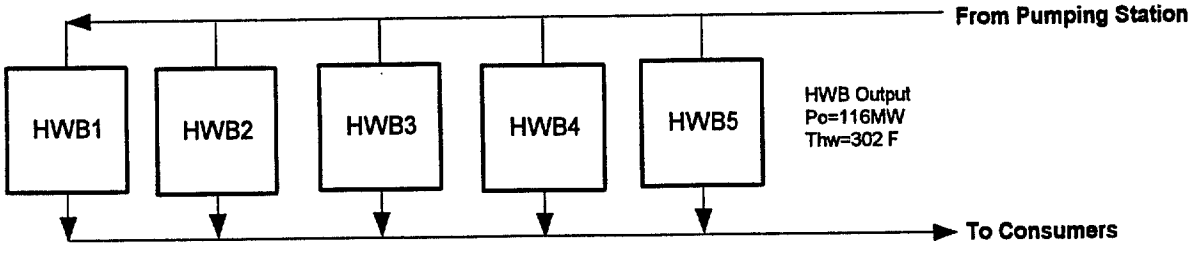
## Exhibit 4-55

## Heat Station Liulin
## Case L1 Configuration



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# LIULIN HEAT STATION

# CASE L2 - GT COMBINED CYCLE

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### 4.6.4.2 Liulin Heat Station - Case L2 (GT Combined Cycle)

The summary of proposed activities for this case is presented in Exhibit 4-56.

A summary of the efficiency and performance is presented in Exhibit 4-57.

Hot Water Boiler No. 1 is retired and replaced by the Frame 6FA combined cycle. Since there is no electric facility here, capital investment for a power station is required. Exhibit 4-58 illustrates this plant.

All other Hot Water Boilers, Nos. 2-5, will be rehabilitated per the recommendations by B&W, presented in Section 2.

By introducing the Gas Turbine/HRSG/steam turbine the overall system efficiency is increased and additional electric power generating capacity of 1108.2 MWe is introduced into the system. Gas Turbine power rating is 71.76 MWe and condensing turbine power rating is 36.44 MWe.



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## Exhibit 4-56

## Summary of Case L2

| EQUIPMENT | ACTIVITY |
|---|---|
| **Hot Water Boilers:** | |
| Boiler No. 1 | Retire |
| Boiler No. 2 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 3 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 4 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |
| Boiler No. 5 | Minimum rehabilitation per B&W recommendations (Subsection 2.5.1.1) |



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# Exhibit 4-57

## Facilities Data sheet and Simulated Results - Year 2010
## Liulin Heat Station - Case L2

CASE L2 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | |
| THERMAL DATA | | | | HWB #2 | | HWB #3 | | HWB #4 | | HWB #5 | | | HRSG #1 | | |
| Efficiency – 80% to Full Load | %1 | | | 85.7% | | 85.7% | | 85.7% | | 85.7% | | | 100.0% | | |
| Half Load | %2 | | | 85.7% | | 85.7% | | 85.7% | | 85.7% | | | 100.0% | | |
| Minimum Load | %3 | | | 85.7% | | 85.7% | | 85.7% | | 85.7% | | | 100.0% | | |
| Minimum Operation | % | | | 40.0% | | 40.0% | | 40.0% | | 40.0% | | | | | |
| Feedwater Temp | | | | 156° | | 156° | | 156° | | 156° | | | | | |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | | | | | | | | |
| Capacity | MWt | | | | | | | | | | | | 141.786 | 141.786 | |
| Quantity | Mlb/Hr | | | | | | | | | | | | 339.09 | | |
| Pressure | PSIA | | | | | | | | | | | | 1541.8 | | |
| Temperature | Temp °F | | | | | | | | | | | | 1004° | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | 1.492 | | |
| PRODUCT – LP STEAM | Priority | | | | | | | | | | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – HOT WATER | Priority | Cooling | | 5 | | 4 | | 3 | | 2 | | | 1 | | |
| Quantity | MWhw | 200.000 | | 116.000 | | 116.000 | | 116.000 | | 116.000 | | | 86.607 | | |
| Temperature – Supply | Temp °F | | | 302° | | 302° | | 302° | | 302° | | | | | |
| Return | Temp °F | | | 156° | | 156° | | 156° | | 156° | | | | | |
| TURBINE DATA | UNITe | | | | | | | | | | | GT-6FA | Turb #1b | Turb #1c | |
| | Priority | | | | | | | | | | | 1 | | | |
| Rated Capacity–Electric | KW | | | | | | | | | | | | 27665 | 36590 | |
| Capability – Max Steam | KW1 | | | | | | | | | | | | 27665 | 36590 | |
| 75 % Steam | KW75 | | | | | | | | | | | | 19752 | | |
| 50 % Steam | KW50 | | | | | | | | | | | | 11821 | | |
| 25% Steam | KW25 | | | | | | | | | | | | 3896 | | |
| Steam Required – Maximum | M#/Hr Max | | | | | | | | | | | | 305.161 | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | | | | | | | | 25.0 | | |
| Enthalpy Drop – Turbine | MBTU/lbl | | | | | | | | | | | | 0.3141 | | |
| Sink | MBTU/lbs | | | | | | | | | | | | 0.9686 | | |
| Generator Efficiency | %g | | | | | | | | | | | | 98.5% | 98.5% | |
| Power/Rejection Factor | Factor | | | | | | | | | | | | | 0.3292 | |
| FUELS DATA | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | | Gas | | Gas | | | |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | | |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | | 95.0% | | 100.0% | | | |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | | Mazut | | | | | |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | $2.41 | | | | | |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | 5.0% | | | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | |
| Number of Personnel | Number | 237 | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $81.0 | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.26 | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | | ST2–A9 | | | | | |
| Emissions Code –Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | | ST2–A6 | | | | | |
| Scheduled Maintenance | CODE m | | | | | | | LHWB | | LHWB5 | | GT–6FA | STS3 | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | Max GT? | | | | AVAILABILITY | | | | | | | | | |
| Jan | –1.7 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Feb | 0.6 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Mar | 4.6 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Apr | 10.8 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| May | 15.6 | No | | 100% | | 100% | | 100% | | 100% | | – | – | – | |
| June | 19.0 | No | | – | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| July | 21.2 | No | | 100% | | – | | 100% | | 100% | | 100% | 100% | 100% | |
| Aug | 20.6 | No | | 100% | | 100% | | – | | 100% | | 100% | 100% | 100% | |
| Sept | 16.7 | No | | 100% | | 100% | | 100% | | – | | 100% | 100% | 100% | |
| Oct | 11.3 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Nov | 5.9 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Dec | 0.8 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 2,217 | 1,971 | 1,810 | 1,491 | 203 | 1,305 | 1,195 | 1,196 | 1,166 | 1,373 | 1,730 | 2,146 | 17,904 |
| Oil | 61 | 53 | 42 | 19 | 13 | 9 | – | – | – | 10 | 34 | 57 | 298 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 2,277 | 2,025 | 1,952 | 1,510 | 216 | 1,315 | 1,195 | 1,196 | 1,166 | 1,383 | 1,764 | 2,203 | 18,202 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | 4 | – | – | – | 0 | – | 4 |
| Purchased Power Cost | – | – | – | – | 25 | – | – | – | – | – | – | – | 25 |
| Credit for Power Sales | (1,986) | (1,787) | (1,973) | (1,642) | – | (1,711) | (1,719) | (1,733) | (1,677) | (2,023) | (1,920) | (2,001) | (20,172) |
| Net Power Interchange Cost | (1,986) | (1,787) | (1,973) | (1,642) | 25 | (1,711) | (1,719) | (1,733) | (1,677) | (2,023) | (1,920) | (2,001) | (20,147) |
| Other O&M – Fixed, OH & Other | 67 | 61 | 67 | 65 | 67 | 65 | 67 | 67 | 65 | 67 | 65 | 67 | 792 |
| Variable | 193 | 171 | 154 | 125 | 21 | 115 | 101 | 102 | 96 | 116 | 147 | 160 | 1,541 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | 0 | 0 | 0 | 2 |
| Total Excluding Maintenance | 552 | 470 | 211 | 58 | 329 | (214) | (351) | (367) | (348) | (457) | 57 | 456 | 394 |



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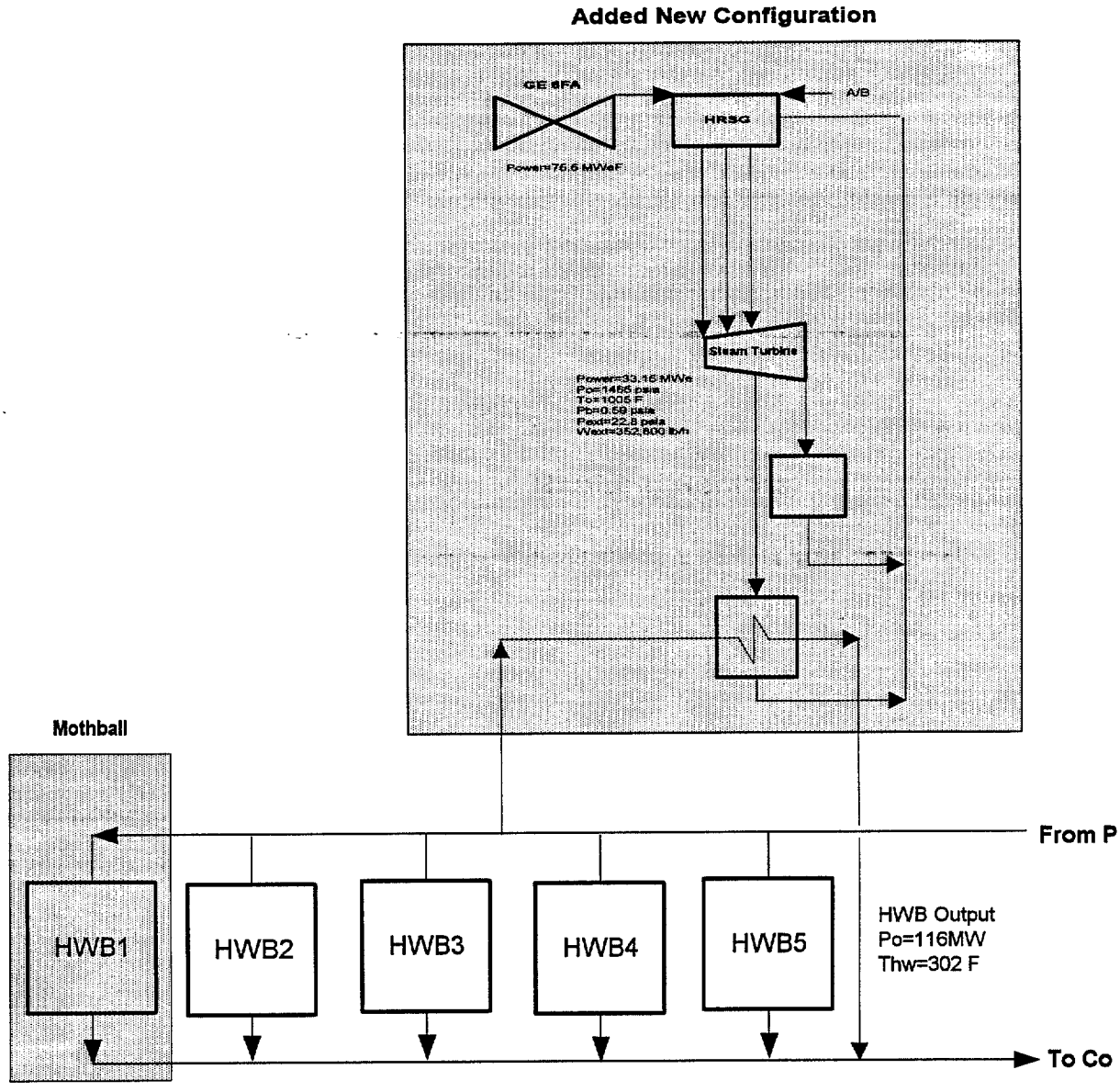
## Exhibit 4-58

## Liulin Heat Station
## Case L2 GT Combined Cycle Configuration



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## 4.7 CONCLUSIONS

1. Current district heating systems in the City of Sofia and City of Pernik are adequate with existing equipment and without addition of any new facilities. Peak demand heat load should follow the actual produced heating energy recorded in 1992 and 1993. System design should emphasize rehabilitation and promote cogeneration of heat and power with minimum capital expenditure and best rate of return on investment.

2. A heat utilization factor (HUF) has been defined to 'measure' the efficiency of a system configuration. However, associated economic results are required to make a fair comparison.

3. Combined cycle performance should be optimized by further study. A chiller should be added to enhance the power output in hot ambient days. Estimated gain would be about 4 MWe. Also, triple pressure level HRSG with steam induction should be considered.

4. For further study, thermal energy storage should be considered. This technology allows the turbine to operate during non-peaking period and store the heat energy produced in a nearby storage tank. Heat is recalled from the tank when peak heat demand requires it (Reference 6.9). Cost of heat will be low since it is produced during non-peaking period. Capital expenditure will be reduced since there is no need to invest in additional heat producing equipment.

5. Repowering (Case S2) has the same advantage as Case S3 (combined cycle) over Case S1, except that the power gain would be less.

6. Similarly, Case P3 (FBC) has the same advantage as Case S3 (combined cycle).

## 4.8 REFERENCES

The following references were utilized supporting this study.

1. Analyses of Heat Supply System of Sofia City.

2. Comments on the Future Technological and Economical Development of Heat Energy Sources on District Heating System of Sofia - Tzoko Nehrizov.

3. District Heating System in Sofia - Condition and Forecast - Prof. D. Sc.e Konstantin Schushulov, Technical University.

4. District Heating Company Sofia, Bulgaria - Data Transmittal from Alexandar Oboushtarov to F. Angelini dated July 13, 1993.

5. Program for Reconstruction of the District Heating Networks in the Centralized District Heating System in Bulgaria - Tzoko Nehrizov et al, December, 1993.

6. ASPEN/SP (Advanced System for Process Engineering) A Software System for Process Design Developed by MIT. For Complex Configurations



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(e.g., Integrated Coal Gasification Combined Cycle (IGCC) and Pressurized Fluidized Bed Combustion (PFBC).

7. PROTEUS (Program for Optimal Thermal Energy Utilization in Systems) - A Gilbert Developed Computer Program for Cycle Optimization.

8. GATE/CYCLE, A Computer Program Developed by Enter Company and Patented by EPRI for Gas Turbine/Combined Cycle Power Plant System Analysis.

9. Combined Thermal Storage and Transport for Utility Applications, Mausz, W., prepared by GE Tempo for EPRI, RP1199-3, 1979.



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# Exhibit 4-3

## Technology Ranking Results

# Exhibit 4-3

## Technology Ranking Results

### PLANT RANKING ROLLUP

eVOLVE™ Technology Ranking Procedures

| TECHNOLOGY | Average Weight | Criterion Weighting | Criterion Points | |
|---|---|---|---|---|
| **Commercial and Development Status Page 2** | 5.00 | 6.00 | 30.00 | |
| Nat gas G/T combined cycle plant | 4.50 | 6.00 | 27.00 | *higest ranked* |
| Natural gas G/T repowering | 4.50 | 6.00 | 27.00 | *higest ranked* |
| Coal integrated gasification combined cycle plant | 4.00 | 6.00 | 24.00 | |
| Coal FBC steam plant | 4.00 | 6.00 | 24.00 | |
| Waste incineration plant | 2.00 | 6.00 | 12.00 | *lowest ranked* |
| **Technical Considerations Page 3** | 5.00 | 5.00 | 25.00 | |
| Nat gas G/T combined cycle plant | 4.50 | 5.00 | 22.50 | *higest ranked* |
| Natural gas G/T repowering | 4.50 | 5.00 | 22.50 | *higest ranked* |
| Coal integrated gasification combined cycle plant | 4.00 | 5.00 | 20.00 | |
| Coal FBC steam plant | 3.00 | 5.00 | 15.00 | |
| Waste incineration plant | 2.00 | 5.00 | 10.00 | *lowest ranked* |
| **Licensing and Lead Time Risks Page 4** | 5.00 | 3.00 | 15.00 | |
| Nat gas G/T combined cycle plant | 4.80 | 3.00 | 14.40 | *higest ranked* |
| Natural gas G/T repowering | 4.30 | 3.00 | 12.90 | |
| Coal integrated gasification combined cycle plant | 4.10 | 3.00 | 12.30 | |
| Coal FBC steam plant | 3.50 | 3.00 | 10.50 | *lowest ranked* |
| Waste incineration plant | 3.50 | 3.00 | 10.50 | *lowest ranked* |
| **Environmental Page 5** | 5.00 | 3.00 | 15.00 | |
| Nat gas G/T combined cycle plant | 4.63 | 3.00 | 13.88 | *higest ranked* |
| Natural gas G/T repowering | 2.69 | 3.00 | 8.08 | |
| Coal integrated gasification combined cycle plant | 1.86 | 3.00 | 5.59 | |
| Coal FBC steam plant | 1.67 | 3.00 | 5.01 | |
| Waste incineration plant | 1.62 | 3.00 | 4.85 | *lowest ranked* |
| **Cost Uncertainty Page 6** | 5.00 | 1.00 | 5.00 | |
| Nat gas G/T combined cycle plant | 4.80 | 1.00 | 4.80 | *higest ranked* |
| Natural gas G/T repowering | 4.50 | 1.00 | 4.50 | |
| Coal integrated gasification combined cycle plant | 4.60 | 1.00 | 4.60 | |
| Coal FBC steam plant | 2.50 | 1.00 | 2.50 | |
| Waste incineration plant | 2.00 | 1.00 | 2.00 | *lowest ranked* |
| **Technical Consideration Page 7** | 5.00 | 1.00 | 5.00 | |
| Nat gas G/T combined cycle plant | 5.00 | 1.00 | 5.00 | *higest ranked* |
| Natural gas G/T repowering | 3.97 | 1.00 | 3.97 | |
| Coal integrated gasification combined cycle plant | 3.59 | 1.00 | 3.59 | |
| Coal FBC steam plant | 3.66 | 1.00 | 3.66 | |
| Waste incineration plant | 0.00 | 1.00 | 0.00 | *lowest ranked* |
| **Variable Operating Costs Page 8** | 5.00 | 1.00 | 5.00 | |
| Nat gas G/T combined cycle plant | 0.82 | 1.00 | 0.82 | |
| Natural gas G/T repowering | 0.00 | 1.00 | 0.00 | *lowest ranked* |
| Coal integrated gasification combined cycle plant | 1.01 | 1.00 | 1.01 | |
| Coal FBC steam plant | 0.10 | 1.00 | 0.10 | |
| Waste incineration plant | 5.00 | 1.00 | 5.00 | *higest ranked* |

### OVERALL ROLL-UP

| All Criterion | maximum possible score: | 100.00 | |
|---|---|---|---|
| **Nat gas G/T combined cycle plant** | highest | **88.40** | *higest ranked* |
| **Natural gas G/T repowering** | | **78.95** | |
| **Coal integrated gasification combined cycle plant** | | **71.10** | |
| **Coal FBC steam plant** | | **60.77** | |
| **Waste incineration plant** | lowest | **44.35** | *lowest ranked* |



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# Exhibit 4-3 (Cont'd)

## Technology Ranking Results

### Commercial and Development Status

eVOLVE™ Technology Ranking Procedures

| Evaluation Criterion | | | Weight |
|---|---|---|---|
| Utility integration | | | 5.00 |
| Engineering demonstration | | | 4.00 |
| Development | | | 3.00 |
| Pilot | | | 2.00 |
| Hypothetical | | | 1.00 |

| Technology | Evaluator | Evaluator's Weight | Average Weight |
|---|---|---|---|
| Nat gas G/T combined cycle plant | Eastern U.S. Utilit | 4.50 | 4.50 |
| Natural gas G/T repowering | Eastern U.S. Utilit | 4.50 | 4.50 |
| Coal integrated gasification combined cycle plant | Eastern U.S. Utilit | 4.00 | 4.00 |
| Coal FBC steam plant | Eastern U.S. Utilit | 4.00 | 4.00 |
| Waste incineration plant | G/C | 2.00 | 2.00 |

### Technical Considerations

eVOLVE™ Technology Ranking Procedures

| Evaluation Criterion | | | Weight |
|---|---|---|---|
| Technically mature | | | 5.00 |
| Technically demonstrated | | | 4.00 |
| Technically viable | | | 3.00 |
| Technically developed | | | 2.00 |
| Technically inadequate | | | |

| Technology | Evaluator | Evaluator's Weight | Average Weight |
|---|---|---|---|
| Nat gas G/T combined cycle plant | Eastern U.S. Utilit | 4.50 | 4.50 |
| Natural gas G/T repowering | Eastern U.S. Utilit | 4.50 | 4.50 |
| Coal integrated gasification combined cycle plant | Eastern U.S. Utilit | 4.00 | 4.00 |
| Coal FBC steam plant | Eastern U.S. Utilit | 3.00 | 3.00 |
| Waste incineration plant | G/C | 2.00 | 2.00 |



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## Exhibit 4-3 (Cont'd)

## Technology Ranking Results

### Licensing and Lead Time Risks

eVOLVE™ Technology Ranking Procedures

| Evaluation Criterion | | | Weight |
|---|---|---|---|
| Low | | | 5.00 |
| Moderate | | | 4.00 |
| High | | | 3.00 |
| Unknown | | | 0.00 |

| Technology | Evaluator | Evaluator's Weight | Average Weight |
|---|---|---|---|
| Nat gas G/T combined cycle plant | PEPCO | 4.80 | 4.80 |
| Natural gas G/T repowering | PEPCO | 4.30 | 4.30 |
| Coal integrated gasification combined cycle plant | PEPCO | 4.10 | 4.10 |
| Coal FBC steam plant | PEPCO | 3.50 | 3.50 |
| Waste incineration plant | G/C | 3.50 | 3.50 |



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# Exhibit 4-3 (Cont'd)

## Technology Ranking Results

### Environmental

eVOLVE™ Technology Ranking Procedures

| Evaluation Criterion | | | | | | Weight |
|---|---|---|---|---|---|---|
| Lowest emissions | | | | | | 5.00 |
| Highest emissions | | | | | | 0.00 |
| | | | | | | |

| Technology | $SO_2$ 30.0% | $NO_x$ 20.0% | VOC 10.0% | $CO_2$ 5.0% | Solid Wast 35.0% | Average weight |
|---|---|---|---|---|---|---|
| Nat gas G/T combined cycle plant | 1.50 | 1.00 | 0.27 | 0.11 | 1.75 | 4.63 |
| Natural gas G/T repowering | 1.50 | 0.33 | 0.19 | 0.00 | 0.67 | 2.69 |
| Coal integrated gasification combined cycle plant | 0.00 | 0.88 | 0.21 | 0.02 | 0.75 | 1.86 |
| Coal FBC steam plant | 0.04 | 0.90 | 0.22 | 0.02 | 0.48 | 1.67 |
| Waste incineration plant | 1.37 | 0.00 | 0.00 | 0.25 | 0.00 | 1.62 |

| Heat Rate Btu/kWh | Page 8 | | | |
|---|---|---|---|---|
| Nat gas G/T combined cycle plant | 7,360 | | | Eastern U.S. Utility |
| Natural gas G/T repowering | 9,647 | | | Eastern U.S. Utility |
| Coal integrated gasification combined cycle plant | 8,950 | | | Eastern U.S. Utility |
| Coal FBC steam plant | 8,714 | | | Eastern U.S. Utility |
| Waste incineration plant | 15,666 | | | G/C |

### All Emissions per kWh

| $SO_2$ | $SO_2$/Btu | $SO_2$/kWh | 5.00 | |
|---|---|---|---|---|
| Nat gas G/T combined cycle plant | 0.000E+00 | 0.0000 | 5.00 | no sulfur |
| Natural gas G/T repowering | 0.000E+00 | 0.0000 | 5.00 | 5% S 14,000 Btu/lb 90% removal |
| Coal integrated gasification combined cycle plant | 1.889E-06 | 0.0169 | 0.00 | 5% S 14,000 Btu/lb 90% removal |
| Coal FBC steam plant | 1.889E-06 | 0.0165 | 0.13 | 5% S 14,000 Btu/lb 90% removal |
| Waste incineration plant | 9.500E-08 | 0.0015 | 4.56 | refuse at 3,654 Btu/lb |

| $NO_x$ | $NO_x$/Btu | $NO_x$/kWh | 5.00 | |
|---|---|---|---|---|
| Nat gas G/T combined cycle plant | 4.000E-07 | 0.0029 | 5.00 | GPU: Gilbert STAG Units 4,5,6, & 7 |
| Natural gas G/T repowering | 6.800E-07 | 0.0066 | 1.64 | GPU: Conemaugh 1&2 |
| Coal integrated gasification combined cycle plant | 4.000E-07 | 0.0036 | 4.41 | equals G/T combined cycle |
| Coal FBC steam plant | 4.000E-07 | 0.0035 | 4.50 | equals G/T combined cycle |
| Waste incineration plant | 5.310E-07 | 0.0083 | 0.00 | SELCHP, London |

| VOC | | | 5.00 | |
|---|---|---|---|---|
| Nat gas G/T combined cycle plant | | | 2.65 | proportional by heat rate |
| Natural gas G/T repowering | | | 1.92 | proportional by heat rate |
| Coal integrated gasification combined cycle plant | | | 2.14 | proportional by heat rate |
| Coal FBC steam plant | | | 2.22 | proportional by heat rate |
| Waste incineration plant | | | 0.00 | proportional by heat rate |

| $CO_2$ | $CO_2$/Btu | $CO_2$/kWh | 5.00 | |
|---|---|---|---|---|
| Nat gas G/T combined cycle plant | 1.148E-04 | 0.84 | 2.21 | 100 % $CH_4$ 23,875 Btu/lb |
| Natural gas G/T repowering | 1.569E-04 | 1.51 | 0.00 | 60%C 14,000 Btu/lb |
| Coal integrated gasification combined cycle plant | 1.569E-04 | 1.40 | 0.36 | 60%C 14,000 Btu/lb |
| Coal FBC steam plant | 1.569E-04 | 1.37 | 0.48 | 60%C 14,000 Btu/lb |
| Waste incineration plant | 9.500E-08 | 0.00 | 5.00 | refuse at 3,654 Btu/lb |

| Solid Waste | xHR | proport | 5.00 | |
|---|---|---|---|---|
| Nat gas G/T combined cycle plant | 0.00 | 0.00 | 5.00 | no ash |
| Natural gas G/T repowering | 1.00 | 0.62 | 1.92 | proportional by heat rate |
| Coal integrated gasification combined cycle plant | 1.00 | 0.57 | 2.14 | proportional by heat rate |
| Coal FBC steam plant | 1.30 | 0.72 | 1.38 | 1.3*proportion by heat rate |
| Waste incineration plant | 1.00 | 1.00 | 0.00 | assume no ash |



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# Exhibit 4-3 (Cont'd)

## Technology Ranking Results

### Cost Uncertainty

eVOLVE™ Technology Ranking Procedures

| Evaluation Criterion | | | Weight |
|---|---|---|---|
| Low | | | 5.00 |
| Moderate | | | 4.00 |
| Uncertain | | | 3.00 |
| High | | | 2.00 |
| Unknown | | | 0.00 |

| Technology | Evaluator | Evaluator's Weight | Average Weight |
|---|---|---|---|
| Nat gas G/T combined cycle plant | Eastern U.S. Utilit | 4.80 | 4.80 |
| Natural gas G/T repowering | Eastern U.S. Utilit | 4.50 | 4.50 |
| Coal integrated gasification combined cycle plant | Eastern U.S. Utilit | 4.60 | 4.60 |
| Coal FBC steam plant | Eastern U.S. Utilit | 2.50 | 2.50 |
| Waste incineration plant | G/C | 2.00 | 2.00 |

### Technical Consideration

eVOLVE™ Technology Ranking Procedures

| Evaluation criterion | | | Weight |
|---|---|---|---|
| Low | | | 5.00 |
| High | | | 0.00 |
| | | | |
| | | | |
| | | | |

| Technology | Evaluator | Evaluator's $/kW | Average Weight |
|---|---|---|---|
| Nat gas G/T combined cycle plant | Eastern U.S. Utilit | $571 | 5.00 |
| Natural gas G/T repowering | Eastern U.S. Utilit | $1,378 | 3.97 |
| Coal integrated gasification combined cycle plant | Eastern U.S. Utilit | $1,676 | 3.59 |
| Coal FBC steam plant | Eastern U.S. Utilit | $1,622 | 3.66 |
| Waste incineration plant | G/C | $4,500 | 0.00 |



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# Exhibit 4-3 (Cont'd)

## Technology Ranking Results

### Variable Operating Costs

eVOLVE™ Technology Ranking Procedures

| Evaluation Criterion | | | | | | | Weight |
|---|---|---|---|---|---|---|---|
| Low | | | | | | | 5.00 |
| High | | | | | | | 0.00 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Technology | Evaluator | Variable O&M $/kWh | Heat Rate Btu/kWh | Cost of Fuel $/MBtu | Fuel Costs $/kWh | Total Costs $/kWh | Average Weight |
|---|---|---|---|---|---|---|---|
| Nat gas G/T combined cycle plant | Eastern U.S. Utilit | $0.0045 | 7,360 | $2.26 | $0.0166 | $0.0211 | 0.82 |
| Natural gas G/T repowering | Eastern U.S. Utilit | $0.0062 | 9,647 | $1.77 | $0.0171 | $0.0233 | 0.00 |
| Coal integrated gasification combined cycle plant | Eastern U.S. Utilit | $0.0048 | 8,950 | $1.77 | $0.0158 | $0.0206 | 1.01 |
| Coal FBC steam plant | Eastern U.S. Utilit | $0.0076 | 8,714 | $1.77 | $0.0154 | $0.0230 | 0.10 |
| Waste incineration plant | G/C | $0.0024 | 15,666 | $0.50 | $0.0078 | $0.0102 | 5.00 |



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**Exhibit 4-11**

**Sofia TPHS**

**List of Major Equipment**

# Exhibit 4-11

## Sofia TPHS
## List of Major Equipment

| Steam Generators | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| N | Data | Boiler No. 1 | Boiler No. 2 | Boiler No. 3 | Boiler No. 4 | Boiler No. 5 | Boiler No. 6 | Boiler No. 7 | Boiler No. 8 | Boiler No. 9 |
| 1 | Model/Maker | B&W | B&W | B&W | TP-170 1M | TP-170 1M | TP-170 1M | TGM-151 B | TGM-151 M | 1st Brno Zavod |
| | | UK | UK | UK | Russia | Russia | Russia | Russia | Russia | Czechia |
| 2 | Year of Manufacturing | 44 | 44 | 44 | 54 | 54 | 54 | 62 | 62 | 78 |
| 3 | Year of Putting into Operation | 49 | 49 | 49 | 56 | 57 | 57 | 63 | 63 | 85 |
| 4 | Design Capacity, t/h | 75.00 | 75.00 | 75.00 | 170.00 | 170.00 | 170.00 | 220.00 | 220.00 | 220.00 |
| | lb/h | 165,375.00 | 165,375.00 | 165,375.00 | 374,850.00 | 374,850.00 | 374,850.00 | 485,100.00 | 485,100.00 | 485,100.00 |
| 5 | Design Steam Parameters | | | | | | | | | |
| | Temperature, C | 410.00 | 410.00 | 410.00 | 510.00 | 510.00 | 510.00 | 540.00 | 540.00 | 540.00 |
| | F | 770.00 | 770.00 | 770.00 | 950.00 | 950.00 | 950.00 | 1,004.00 | 1,004.00 | 1,004.00 |
| | Pressure, MPa | 3.15 | 2.15 | 23.15 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| | psia | 457.18 | 457.18 | 457.18 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.38 |
| 6 | Design Efficiency, % | 92.6 | 92.6 | 92.6 | 86 - 92 | 86 - 92 | 86 - 92 | 92.0 - 95.5 | 92.0 - 95.5 | 93 - 96 |
| 7 | Design Fuel | Coal | Coal | Coal | Coal | Coal | Coal | Mazut | Mazut | Mazut/N. Gas |
| 8 | Hours Worked to the End of '92 | 23856 | 235000 | 236917 | 223796 | 216742 | 207301 | 171287 | 162261 | 46719 |
| 9 | Steam Parameters as to the End of '92 | | | | | | | | | |
| | Minimum Steam Production, t/h | 20.00 | 20.00 | 20.00 | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 | 65.00 |
| | lb/h | 44,100.00 | 44,100.00 | 44,100.00 | 242,550.00 | 242,550.00 | 242,550.00 | 242,550.00 | 242,550.00 | 143,325.00 |
| | Maximum Steam Production, t/h | 60.00 | 60.00 | 60.00 | 220.00 | 220.00 | 220.00 | 220.00 | 220.00 | 220.00 |
| | lb/h | 132,300.00 | 132,300.00 | 132,300.00 | 485,100.00 | 485,100.00 | 485,100.00 | 485,200.00 | 485,100.00 | 485,100.00 |
| | Temperature, C | 410.00 | 410.00 | 410.00 | 510.00 | 510.00 | 510.00 | 540.00 | 540.00 | 540.00 |
| | F | 770.00 | 770.00 | 770.00 | 950.00 | 950.00 | 950.00 | 1,004.00 | 1,004.00 | 1,004.00 |
| | Minimum Steam Pressure, MPa | 2.00 | 2.00 | 2.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| | psia | 290.28 | 290.28 | 290.29 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.38 |
| | Maximum Steam Pressure, MPa | 2.50 | 2.50 | 2.50 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| | psia | 362.84 | 362.84 | 262.84 | 1,451.38 | 1,451.38 | 1,451.38 | 1,451.39 | 1,451.38 | 1,451.38 |
| | Minimum Efficiency, % | 92.00 | 91.20 | 91.40 | 91.50 | 91.00 | 92.00 | 91.80 | 91.80 | 95.20 |
| | Maximum Efficiency, % | 93.00 | 93.70 | 94.20 | 93.50 | 94.60 | 94.30 | 95.10 | 93.50 | 95.20 |
| 10 | Number of Cycles Operated | 531 | 597 | 564 | 613 | 679 | 592 | 994 | 772 | 135 |
| 11 | Number of Scheduled Major Repairs | 12 | 13 | 16 | 17 | 17 | 16 | 16 | 15 | - |
| 12 | Short Description of Reconstructions Performed | Transferred to mazut firing; air heater replaced. Transferred to N. Gas and Mazut firing; burners replaced. | Transferred to mazut firing; air heater replaced. Transferred to N. Gas and Mazut firing; burners replaced. | Transferred to mazut firing; air heater replaced. Transferred to N. Gas and Mazut firing; burners replaced. | Transferred to mazut firing; replacement of the heating surface and superheater's schematics. Transferred to N. Gas and Mazut firing; burners replaced, changed air heater schematics, increased economizer surface. | Transferred to mazut firing; replacement of the heating surface and superheater's schematics. Transferred to N. Gas and Mazut firing; burners replaced, changed air heater schematics, increased economizer surface. | Transferred to mazut firing; replacement of the heating surface and superheater's schematics. Transferred to N. Gas and Mazut firing; burners replaced, changed air heater schematics, increased economizer surface. | Transferred to N. Gas and Mazut firing; burners replaced, air heater replaced. | Transferred to N. Gas and Mazut firing; burners replaced, air heater replaced. | None |



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# Exhibit 4-11 (Cont'd)

## Sofia TPHS
## List of Major Equipment

| Hot Water Boilers | | | | | | | |
|---|---|---|---|---|---|---|---|
| N | Data | HWB No. 1 | HWB No. 2 | HWB No. 3 | HWB No. 4 | HWB No. 5 | HWB No. 6 |
| 1 | Model | PTVM-100 | PTVM-100 | PTVM-100 | PTVM-100 | PTVM-100 | PTVM-100 |
| 2 | Year of Manufacturing | 1962 | 1963 | 1970 | 1971 | 1979 | 1977 |
| 3 | Year of Putting into Operation | 1967 | 1967 | 1973 | 1973 | 1983 | 1981 |
| 4 | Design Capacity, Gcal/h | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | MBtu/h | 396.90 | 396.90 | 396.90 | 396.90 | 396.90 | 396.09 |
| 5 | Parameters | | | | | | |
| | Maximum Water Flow, t/h | 2,140.00 | 2,140.00 | 2,140.00 | 2,140.00 | 2,140.00 | 2,140.00 |
| | lb/h | 4,718,700.00 | 4,718,700.00 | 4,718,700.00 | 4,718,700.00 | 4,718,700.00 | 4,718,700.00 |
| | Minimum Water Flow, t/h | 1,500.00 | 1,500.00 | 1,500.00 | 1,500.00 | 1,500.00 | 1,500.00 |
| | lb/h | 3,307,500.00 | 3,307,500.00 | 3,307,500.00 | 3,307,500.00 | 3,307,500.00 | 3,307,500.00 |
| | Minimum Water Temperature at the Boiler's Inlet, when Firing N. Gas, C | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| | F | 158.00 | 158.00 | 158.00 | 158.00 | 158.00 | 158.00 |
| | Minimum Water Temperature at the Boiler's Inlet, when Firing Mazut, C | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 |
| | F | 230.00 | 230.00 | 230.00 | 230.00 | 230.00 | 230.00 |
| | Water Pressure at Boiler's Outlet, MPa | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 |
| | psia | 232.22 | 232.22 | 232.22 | 232.22 | 232.22 | 232.22 |
| | Water Pressure at Boiler's Outlet, MPa | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | Maximum Water Temp. at Boiler's Outlet, C | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 |
| | F | 302.00 | 302.00 | 302.00 | 302.00 | 302.00 | 302.00 |
| | Efficiency, when Operating on N. Gas, % | 88.60 | 88.60 | 88.60 | 88.60 | 88.60 | 88.60 |
| | Efficiency, when Operating on Mazut, % | 86.80 | 86.80 | 86.80 | 86.80 | 86.80 | 86.80 |
| 6 | Fuel | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut | N. GSA/Mazut | N. Gas/Mazut | N. Gas/Mazut |
| 7 | Hours Worked to the End of '92 | 32688 | 34068 | 34461 | 44802 | 32251 | 26038 |
| 8 | Number of Scheduled Major Repairs | 5 | 5 | 5 | 2 | - | - |



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# Exhibit 4-11 (Cont'd)

## Sofia TPHS
## List of Major Equipment

| Steam Turbines | | | | | |
|---|---|---|---|---|---|
| N | Data | Turbine No. 4 | Turbine No. 5 | Turbine No. 6 | Turbine No. 8 |
| 1 | Model/Maker | VT-25-4 | VT-25-4 | VPT-50-2 | R-25-90/10 |
| | | Russia | Russia | Russia | Czechia |
| 2 | Year of Manufacturing | 1954 | 1954 | 1961 | 1979 |
| 3 | Year of Putting into Operation | 1956 | 1957 | 1962 | 1985 |
| 4 | Design Power, MW | 25.00 | 25.00 | 50.00 | 25.00 |
| 5 | Inlet Steam Parameters | | | | |
| | Temperature, C | 500.00 | 500.00 | 535.00 | 535.00 |
| | F | 932.00 | 932.00 | 995.00 | 995.00 |
| | Pressure, MPa | 8.82 | 8.82 | 8.82 | 8.82 |
| | psia | 1,280.12 | 1,280.12 | 1,280.12 | 1,280.12 |
| | Design Steam Flow, t/h | 125.00 | 125.00 | 200.00 | 220.00 |
| | lb/h | 275,625.00 | 275,625.00 | 441,000.00 | 485,100.00 |
| | Maximum Steam Flow, t/h | 156.00 | 156.00 | 380.00 | 220.00 |
| | lb/h | 343,980.00 | 343,980.00 | 837,900.00 | 485,100.00 |
| 5a | Condensing Pressure, in HG | 1.38 | 1.38 | 1.38 | - |
| 6 | Hours Worked up to the End of '92 | 215456 | 213138 | 211420 | 74955 |
| 7 | Operational Data as to the End of '92 | | | | |
| | Electric Power, MW | 18.00 | 18.00 | 50.00 | 25.00 |
| | Inlet Steam Temperature, C | 500.00 | 500.00 | 535.00 | 535.00 |
| | F | 932.00 | 932.00 | 995.00 | 995.00 |
| | Inlet Steam Pressure, MPa | 8.82 | 8.82 | 8.82 | 8.82 |
| | psia | 1,280.12 | 1,280.12 | 1,280.12 | 1,280.12 |
| 8 | Cycles Worked | 239 | 282 | 187 | 87 |
| 9 | Number of Schedules Major Repairs | 15 | 13 | 9 | 1 |
| 10 | Maximum Industrial Extraction Pressure, ata | N/A | N/A | 16.00 | 13.00 |
| | psia | N/A | N/A | 227.60 | 184.92 |
| | Minimum Industrial Extraction Pressure, ata | N/A | N/A | 10.00 | 8.00 |
| | psia | N/A | N/A | 142.25 | 113.80 |
| | Maximum Industrial Extraction Flow, t/h | N/A | N/A | 230.00 | 220.00 |
| | lb/h | N/A | N/A | 507,150.00 | 485,100.00 |
| | Minimum Industrial Extraction Flow, t/h | N/A | N/A | - | 180.00 |
| | lb/h | N/A | N/A | - | 396,900.00 |
| 11 | Maximum Heating Extraction Pressure, ata | 2.50 | 2.50 | 2.50 | N/A |
| | psia | 35.56 | 35.56 | 35.56 | N/A |
| | Minimum Heating Extraction Pressure, ata | 1.20 | 1.20 | 1.20 | N/A |
| | psia | 17.07 | 17.07 | 17.07 | N/A |
| | Maximum Heating Extraction Flow, t/h | 100.00 | 100.00 | 160.00 | N/A |
| | lb/h | 220,500.00 | 220,500.00 | 352,800.00 | N/A |
| | Maximum Heat/Power Ration | 2.01 | 2.01 | 1.54 | 1.41 |
| Summary | | | | | |
| | Total Production of Steam | t/h | lb/h | | |
| 1 | 2.5 MPa, 410C (Boilers 1, 2, 3) | 180.00 | 396,900.00 | | |
| 2 | 10 MPa, 510C (Boilers 4, 5, 6) | 360.00 | 793,800.00 | | |
| 3 | 10 MPa, 540C (Boilers 7, 8, 9) | 360.00 | 793,800.00 | | |
| Total Maximum Production of Electricity, MW | | 111.00 | | | |
| | | t/h | lb/h | | |
| 1 | Total Maximum Industrial Steam Extraction | 450.00 | 992,250.00 | | |
| 2 | Total Maximum Heating Steam Extraction | 360.00 | 793,800.00 | | |
| 3 | Total Maximum Industrial Steam Production | 630.00 | 1,389,150.00 | | |
| | (Boilers 1, 2, 3 + Industr. Extr. + BPT Exh.) | | | | |
| 4 | Total Maximum Heating Steam Production | 440.00 | 970,200.00 | | |
| | (Heat. Extractions + Extr. from BPT Exhaust) | | | | |



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**Exhibit 4-28**

**Trajco Kostov TPHS**

**List of Major Equipment**

# Exhibit 4-28

## Trajco Kostov TPHS
## List of Major Equipment

| Steam Generators | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| N | Data | Boiler No. 1 | Boiler No. 2 | Boiler No. 3 | Boiler No. 4 | Boiler No. 5 | Boiler No. 6 | Boiler No. 7 |
| 1 | Model/Maker | Brno | Brno | Brno | Brno | Brno | Brno | Brno |
| | | Czechia | Czechia | Czechia | Czechia | Czechia | Czechia | Czechia |
| 2 | Year of Manufacturing | 63 | 64 | 66 | 66 | 79 | 80 | 79 |
| 3 | Year of Putting into Operation | 64 | 64 | 67 | 68 | 88 | 88 | 89 |
| 4 | Design Capacity, t/h | 220.00 | 220.00 | 220.00 | 220.00 | 220.00 | 220.00 | 220.00 |
| | lb/h | 485,100.00 | 485,100.00 | 485,100.00 | 485,100.00 | 485,100.00 | 485,100.00 | 485,100.00 |
| 5 | Design Steam Parameters | | | | | | | |
| | Temperature, C | 540.00 | 540.00 | 540.00 | 540.00 | 535.00 | 535.00 | 535.00 |
| | F | 1,004.00 | 1,004.00 | 1,004.00 | 1,004.00 | 995.00 | 995.00 | 995.00 |
| | Pressure, MPa | 9.60 | 9.60 | 9.60 | 9.60 | 13.63 | 13.63 | 13.63 |
| | psia | 1,393.32 | 1,393.32 | 1,393.32 | 1,393.32 | 1,978.23 | 1,978.23 | 1,978,23 |
| 6 | Design Efficiency, % | 91.00 | 91.00 | 91.00 | 91.00 | 92.00 | 92.00 | 92.00 |
| 7 | Design Fuel | Mazut | Mazut | Mazut | Mazut | Gas, Oil | Gas, Oil | Gas, Oil |
| 8 | Hours Worked to the End of '92 | 156032 | 147724 | 153661 | 144035 | 21939 | 21169 | 18933 |
| 9 | Steam Parameters as to the End of '92 | | | | | | | |
| | Minimum Steam Production, t/h | 100.00 | 100.00 | 100.00 | 100.00 | 120.00 | 120.00 | 120.00 |
| | lb/h | 220,500.00 | 220,500.00 | 220,500.00 | 220,500.00 | 264,600.00 | 264,600.00 | 264,600.00 |
| | Maximum Steam Production, t/h | 185.00 | 185.00 | 185.00 | 185.00 | 190.00 | 190.00 | 190.00 |
| | lb/h | 407,925.00 | 407,925.00 | 407,925.00 | 407,925.00 | 418,950.00 | 418,950.0 | 418,950.00 |
| | Temperature, C | 540.00 | 540.00 | 540.00 | 540.00 | 535.00 | 535.00 | 535.00 |
| | F | 1,004.00 | 1,004.00 | 1,004.00 | 1,004.00 | 995.00 | 995.00 | 995.00 |
| | Efficiency, % | N/A | N/A | N/A | 88.50 | N/A | N/A | 91.50 |
| 10 | Number of Cycles Operated | 458 | 456 | 426 | 360 | 117 | 136 | 78 |
| 11 | Number of Scheduled Major Repairs | 6 | 6 | 5 | 5 | - | - | - |
| 12 | Short Description of Reconstructions Performed | Transferred to mazut and gas firing, Babcock. Steam air heater, spray nozzles and superheater added. | Transferred to mazut and gas firing, Babcock. Steam air heater, spray nozzles and superheater added. | Transferred to mazut and gas firing, Babcock. Steam air heater, spray nozzles and superheater added. | Transferred to mazut and gas firing, Babcock. Steam air heater, spray nozzles and superheater added. | The firing system control and automation changed. | | |



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# Exhibit 4-28 (Cont'd)

## Trajco Kostov TPHS
## List of Major Equipment

| Hot Water Boilers | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N | Data | HWB No. 1 | HWB No. 2 | HWB No. 3 | HWB No. 4 | HWB No. 5 | HWB No. 6 | HWB No. 7 | HWB No. 8 |
| 1 | Model | VK-100 | VK-100 | VK-100 | VK-100 | VK-100 | VK-100 | VK-100 | VK-100 |
| 2 | Year of Manufacturing | 71 | 71 | 75 | 75 | 77 | 78 | 78 | 78 |
| 3 | Year of Putting into Operation | 74 | 74 | 75 | 75 | 77 | 81 | 82 | 82 |
| 4 | Design Capacity, Gcal/h | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | MBtu/h | 396.90 | 396.90 | 396.90 | 396.90 | 396.90 | 396.90 | 396.90 | 396.90 |
| 5 | Parameters | | | | | | | | |
| | Maximum Water Flow, t/h | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 |
| | lb/h | 5,512,500.00 | 5,512,500.00 | 5,512,500.00 | 5,512,500.00 | 5,512,500.00 | 5,512,500.00 | 5,512,500.00 | 5,512,500.00 |
| | Minimum Water Flow, t/h | 1,300.00 | 1,300.00 | 1,300.00 | 1,300.00 | 1,300.00 | 1,300.00 | 1,300.00 | 1,300.00 |
| | lb/h | 2,866,500.00 | 2,866,500.00 | 2,866,500.00 | 2,866,500.00 | 2,866,500.00 | 2,866,500.00 | 2,866,500.00 | 2,866,500.00 |
| | Minimum Water Temperature at the Boiler's Inlet, When Firing N. Gas, C | 70.00 | 70.00 | 7.00 | 70.00 | 70.00 | 70.00 | 70.00 | 70.00 |
| | F | 158.00 | 158.00 | 158.00 | 158.00 | 158.00 | 158.00 | 158.00 | 158.00 |
| | Minimum Water Temperature at the Boiler's Inlet, When Firing Mazut, C | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 |
| | f | 230.00 | 230.00 | 230.00 | 230.00 | 230.00 | 230.00 | 230.00 | 230.00 |
| | Water Pressure at Boiler's Inlet, MPa | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 | 1.80 |
| | psia | 261.25 | 261.25 | 261.25 | 261.25 | 261.25 | 261.25 | 261.25 | 261.25 |
| | Water Pressure at Boiler's Outlet, MPa | 1.25 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |
| | Maximum Water Temp. at Boiler's Outlet, C | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 | 150.00 |
| | F | 302.00 | 302.00 | 302.00 | 302.00 | 302.00 | 302.00 | 302.00 | 302.00 |
| | Efficiency, % | 86.40 | 86.40 | 86.40 | 86.40 | 86.40 | 86.40 | 86.40 | 86.40 |
| 6 | Fuel | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut | N. Gas/Mazut |
| 7 | Hours Worked to the End of '92 | 46118 | 39123 | 30906 | 33544 | 38348 | 31177 | 37588 | 30110 |
| 8 | Number of Scheduled Major Repairs | 2 | 2 | 4 | 3 | 1 | - | 1 | 1 |

| Hot Water Heaters* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N | Heater | Number of Heaters | | | . | | | | |
| 1 | Low Pressure Heaters | 4 | | | | | | | |
| 2 | High Pressure Heaters | 2 | | | | | | | |
| | | | | | | | | | |
| * Details N/A | | | | | | | | | |



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# Exhibit 4-28 (Cont'd)

## Trajco Kostov TPHS
## List of Major Equipment

| Steam Turbines of Tr. Kostov Cogen. Plant | | | | | | |
|---|---|---|---|---|---|---|
| N | Data | Turbine No. 1 | Turbine No. 2 | Turbine No. 3 | Turbine No. 4 | Turbine No. 5 |
| 1 | Model/Maker | VPT-30 | VPT-30 | VPT-30 | VPT-30 | PR 68/66 |
| | | -90/11/1.2 | -90/11/1.2 | -90/11/1.2 | -90/11/1.2 | -130/10/0.8 |
| | | Czechia | Czechia | Czechia | Czechia - | Czechia |
| 2 | Year of Manufacturing | 63 | 63 | 63 | 63 | 80 |
| 3 | Year of Putting into Operation | 64 | 64 | 64 | 64 | 88 |
| 4 | Design Power, MW | 30.00 | 30.00 | 30.00 | 30.00 | 66.00 |
| 5 | Inlet Steam Parameters | | | | | |
| | Temperature, C (F) | 535.00 (995.00) | 535.00 (995.00) | 535.00 (995.00) | 535.00 (995.00) | 530.00 (986.00) |
| | Pressure, MPa (psia) | 8.83 (1,281.57) | (8.83) (1,281.57) | (8.83) (1,281.57) | (8.83) (1,281.57) | (12.75) (1,850.51) |
| | Design Steam Flow, t/h (lb/h) | 118.00 (260,190.00) | 118.00 (260,190.00) | 118.00 (260,190.00) | 118.00 (260,190.00) | (496,125.00) |
| | Maximum Steam Flow, t/h (lb/h) | 200.00 (441,00.00) | 200.00 (441,00.00) | 200.00 (441,00.00) | 200.00 (441,000.00) | 420.00 (926,100.00) |
| 5a | Condenser Pressure, ata (psia) | 0.06 (0.78) | 0.06 (0.78) | 0.06 (0.78) | 0.06 (0.78) | 0.80 (11.38) |
| 6 | Hours worked up to the End of '92 | 163876 | 163876 | 163876 | 163876 | 163876 |
| 7 | Operational Data as to the End of '92 | | | | | |
| | Electric Power, MW | N/A | N/A | 30.00 | 30.00 | 66.00 |
| | Inlet Steam Temperature, C (F) | N/A | N/A | 535.00 (995.00) | 535.00 (995.00) | 535.00 (995.00) |
| | Inlet Steam Pressure, MPa (psia) | N/A | N/A | 8.83 (1,281.57) | 8.83 (1,281.57) | 12.75 (1,850.51) |
| 8 | Cycles Worked | 558 | 455 | 663 | 617 | 558 |
| 9 | Number of Scheduled Major Repairs | 10 | 8 | 6 | 7 | 10 |
| 10 | Maximum Industrial Extraction Pressure, ata (psia) | 13.00 (184.92) | 13.00 (184.92) | 13.00 (184.92) | 13.00 (184.92) | 13.00 (184.92) |
| | Minimum Industrial Extraction Pressure, ata (psia) | 8.00 (113.80) | 8.00 (113.80) | 8.00 (113.80) | 8.00 (113.80) | 8.00 (113.80) |
| Steam Turbines of Tr. Kostov Cogen. Plant | | | | | | |
| N | Data | Turbine No. 1 | Turbine No. 2 | Turbine No. 3 | Turbine No. 4 | Turbine No. 5 |
| | Maximum Industrial Extraction Flow, t/h | 90.00 | 90.00 | 90.00 | 90.00 | 250.00 |
| | lb/h | 198,450.00 | 198,450.00 | 198,450.00 | 198,450.00 | 551,250.00 |
| 11 | Maximum Heating Extraction Pressure*, ata (psia) | 2.50 (35.56) | 2.50 (35.56) | 2.50 (35.56) | 2.250 (35.56) | 2.50 (35.56) |
| | Minimum Heating Extraction Pressure*, ata (psia) | 1.20 (17.07) | 1.20 (17.07) | 1.20 (17.07) | 1.20 (17.07) | 0.10 (1.42) |
| | Maximum Heating Extraction Flow*, t/h | 70.00 | 70.00 | 70.00 | 70.00 | 230.00 |
| | lb/h | 154,350.00 | 154,350.00 | 154,350.00 | 154,350.00 | 507,150.00 |
| 12 | Maximum Heat/Power Ration | 1.74 | 1.74 | 1.74 | 1.74 | - |
| | | | | | | |
| *Turbine #5 has a boiler-condensers; heating extraction parameters are parameters of the backpressure.* | | | | | | |
| ** - Maximum and minimum allowable pressures for the boiler-condenser of turbine #5.* | | | | | | |
| | | | | | | |
| Summary | | | | | | |
| | | | | | | |
| | Total Production of Steam | t/h | lb/h | | | |
| 1 | 9.6 MPa, 540C *Boilers 1, 2, 3, 4) | 740.00 | 1,631,700.00 | | | |
| 2 | 13.63 MPa, 535 C (Boilers 5, 6, 7) | 570.00 | 1,256,850.000 | | | |
| | | | | | | |
| Total Maximum Production of Electricity, MW | | | 186 | | | |
| | | | | | | |
| | | | t/h | lb/h | | |
| 1 | Total Maximum industrial Steam Extraction | | 610.00 | 1 ,345,050.00 | | |
| 2 | Total Maximum Heating Steam Extraction | | 510.00 | 1,124,550.00 | | |



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**Exhibit 4-41**

**Republika TPHS**

**List of Major Equipment**

# Exhibit 4-41

## Republika TPHS
## List of Major Equipment

| Republika Thermal Power and Heat Station | | | | | | | |
|---|---|---|---|---|---|---|---|
| Steam Generators | | | | | | | |
| N | Data | Boiler No. 1 | Boiler No. 2 | Reserve | Boiler No. 3 | Boiler No. 4 | Boiler No. 5 |
| 1 | Manufacturer | CKD Dukla | CKD Dukla | CKD Dukla | CKD Dukla | CKD Dukla | 1st Brno |
| 2 | Year of Manufacturing | 1951 | 1951 | 1956 | 1956 | 1956 | |
| 3 | Year of Putting into Operation | 1951 | 1951 | 1958 | 1959 | 1958 | 1967 |
| 4 | Steam Output, t/h | 110.00 | 110.00 | 125.00 | 125.00 | 125.00 | 220.00 |
| | lb/h | 242,550.00 | 242,550.00 | 275,625.00 | 275,625.00 | 275,625.00 | 485,100.00 |
| | After Reconstruction, t/h | 130.00 | 130.00 | | | | |
| | lb/h | 286,650.00 | 286,650.00 | | | | |
| 5 | Design Steam Conditions | | | | | | |
| | Pressure, kg/cm^2 | 80.00 | 80.00 | 78.00 | 78.00 | 78.00 | 96.00 |
| | psia | 1,137.98 | 1,137.98 | 1,109.53 | 1,109.53 | 1,109.53 | 1,366.58 |
| | Temperature, C | 500.00 | 500.00 | 500.00 | 500.00 | 500.00 | 540.00 |
| | F | 932.00 | 932.00 | 932.00 | 932.00 | 932.00 | 1,004.00 |
| | Efficiency, % | 85.00 | 85.00 | 83.00 | 83.00 | 83.00 | 86.00 |
| 6 | Design Fuel | | | | | | |
| | Particles Size | 0-30 | 0-30 | 0-30 | 0-30 | 0-30 | 0-30 |
| | Heat Value, kcal/kg | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 | 2,500.00 |
| | BTU/lb | 4,500.00 | 4,500.00 | 4,500.00 | 4,500.00 | 4,500.00 | 4,500.00 |
| | Humidity, % | 17.0 | 17.0 | 17.0 | 17.0 | 17.0 | 17.0 |
| | Ash in Fuel Burnt, % | 45.00 | 45.00 | 45.00 | 45.00 | 45.00 | 45.00 |
| 7 | Hours in Operation up to December 1992 | 228,512 | 197,596 | 188,988 | 189,472 | 193,722 | 138,819 |
| 8 | Startup/Shutdown Cycles | 1,066 | 1,149 | 843 | 826 | 853 | 674 |
| 9 | Year of the Last General Overhaul | 1,988 | 1,990 | 1,991 | 1,990 | 1,992 | 1,988 |
| 10 | Number of General Overhauls up to 1992 | 15 | 10 | 12 | 15 | 16 | 12 |
| 11 | Hours of Operation in 1990-1992 | 12,134 | 7,727 | 3,523 | 12,862 | 6,558 | 14,074 |
| 12 | Parameters of Operation by 1992 | | | | | | |
| | Steam Output, t/h | 76.50 | 90.50 | 95.16 | 103.90 | 101.51 | 205.62 |
| | lb/h | 168,682.50 | 199,552.50 | 209,827.80 | 229,099.50 | 223,829.55 | 453,392.10 |
| | Pressure, kg/cm^2 | 67.00 | 71.00 | 69.90 | 70.10 | 72.00 | 90.10 |
| | psia | 953.06 | 1,009.96 | 994.31 | 997.16 | 1,024.18 | 1,281.65 |
| | Temperature, C | 482.00 | 496.00 | 500.00 | 493.70 | 495.30 | 526.40 |
| | F | 899.60 | 924.80 | 932.00 | 920.66 | 923.54 | 979.52 |
| | Efficiency, % | 84.50 | 81.80 | 84.11 | 82.89 | 82.04 | 82.00 |
| | Feed Water Temperature, C | | | | | | 216.00 |
| | F | | | | | | 420.80 |
| | | | | | | | |
| | | | | | | | |
| | | lb/h | t/h | | | | |
| 1 | Total Production of 950-1000 psia | | | | | | |
| | 900-930 F Steam | 1,030,991.85 | 467.57 | | | | |
| 2 | Total Production of 1280 psia | | | | | | |
| | 980 F Steam | 453,392.10 | 205.62 | | | | |



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# Exhibit 4-41 (Cont'd)

## Republika TPHS
## List of Major Equipment

| Steam Turbines | | | | |
|---|---|---|---|---|
| N | Data | Turbine #4 | Turbine #5 | Turbine #6 |
| 1 | Manufacturer | 1st Brno | Skoda | Skoda |
| | | Works | | |
| 2 | Rated Capacity, MW | 25.00 | 55.00 | 25.00 |
| 3 | Inlet Steam Parameters | | | |
| | Pressure, MPa (psia) | 7.16 (1,037.68) | 8.82 (1,278.26) | 9.00 (1,304.35) |
| | Temperature, C (F) | 490.00 (914.00) | 535.00 (995.00) | 535.00 (995.00) |
| | Maximum Throttle Flow, t/h (lb/h) | 160.00 (352,800.00) | 220.00 (485,100.00) | 208.00 (458.640.00) |
| 4 | Years of Operation | 34.00 | 19.00 | |
| 5 | Hours of Operation until December 1992 | 254,690.00 | 146,881.00 | |
| 6 | Parameters at the end of 1992 | | | |
| | Electric Output, MW | 16.15 | 35.25 | |
| | Inlet Steam Pressure, MPa | 6.78 | 7.46 | 7.50 |
| | psia | 982.61 | 1,080.43 | 1,086.96 |
| | Inlet Steam Temperature, C (F) | 479.20 (894.56) | 514.30 (957.74) | 480.00 (896.00) |
| | Maximum Throttle Flow, t/h (lb/h) | | | 160.00 (352,800.00) |
| 7 | Industrial Extraction | | | |
| | Minimum Pressure, MPa (psia) | 0.78 (113.62) | | 0.78 (113.04) |
| | Maximum Pressure, MPa (psia) | 1.27 (184.64) | | 1.38 (199.28) |
| | Maximum Steam Flow, t/h (lb/h) | 80.00 (176,400.00) | | 50.00 (110,250.00) |
| 8 | Heating Extraction | | | |
| | Minimum Pressure, MPa (psia) | 0.12 (17.04) | 0.12 (17.04) | 0.12 (17.04) |
| | Maximum Pressure, MPa (psia) | 0.25 (35.51) | 0.25 (35.51) | 0.25 (35.51) |
| | Maximum Steam Flow, t/h (lb/h) | 70.00 (154,350.00) | 150.00 (330,750.00) | 110.20 (242,991.00) |
| 9 | Minimum Steam Flow to LPT, t/h (lb/h) | 15.00 (33,075.00) | 8.00 (17,640.00) | 18.40 (40,572.00) |
| 10 | Back Pressure, MPa (psia) | | | 0.12 (17.39) |
| 11 | Cooling Water Flow, t/h | 3,000.00 | 8,000.00 | |
| | lb/h | 6,615,000.00 | 17,640,000.00 | |
| 12 | Design Cooling Water Temperature, C | 30.00 | 24.00 | |
| | F | 86.00 | 75.20 | |
| 13 | Startup/Shutdown Cycles | 641 | 446 | |
| 14 | Year of the Last General Overhaul | 1992 | | |
| 13 | Hours of Operation in 1990-1992 | 20181 | 10496 | |
| | | | | |
| *Parameters of Heating Extraction for the Turbine #6 are Given for its Exhaust | | | | |
| | | | | |
| Summary | | | | |
| | | Actual | Design | |
| | Total electric output, MW | 51.40 | 105.00 | |
| | | lb/h | t/h | |
| | Total Industrial Steam Extraction | 286,650.00 | 130.00 | |
| | Total Heating Steam Extraction | 728,091.00 | 330.20 | |
| | | | | |
| | | | | |
| | | MMBTU/h | Gcal/h | MWt |
| | Total Heat Available for District Heating | 706.25 | 177.94 | 206.95 |



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# 4A.1 DISCUSSION ON THE SURVEYED TECHNOLOGIES

## 1.1 FUEL CELLS

Fuel cells use pure hydrogen or make hydrogen from natural gas or another fuel in a catalytic process. The hydrogen then reacts with oxygen through an electrolyte to generate an electrical current. The reaction ends up recombining some of the hydrogen and oxygen, which produces hot water while the hydrogen reforming process produces carbon dioxide. By converting natural gas to electricity through a chemical process instead of combustion, the fuel cell emits barely a trace of pollution. It is also very quiet since there are no moving parts in the cell itself, though compressors and pumps in the system generate a small amount of noise. However, fuel cells are still in an early development stage and are costly: about $3000 per kilowatt at approximately 40% efficiency. While it is a feasible technology for district heating, it is too capital intensive for further consideration in this project.

## 1.2 INTEGRATED GASIFICATION COMBINED CYCLE

As the name implies, this plant integrates a coal gasifier with a gas turbine combined cycle system. Gasified coal is used to fuel the gas turbine. Gasifiers can be classified into three generic types: moving-bed, fluidized-bed, and entrained flow. The gasifier could be air-blown or oxygen-blown. It may include slurry or dry coal feed systems or different heat recovery systems for the large amount of sensible heat in the coal gas. IGCC has the capability to meet stringent environmental requirements. Technologically, many improvements still need to be made. Examples are the fouling and plugging of the syngas coolers; materials problems for the syngas cooler tubes for high sulfur coal; and refractory life and modifications to the advanced gas turbines that have been primarily designed for natural gas. Licensing of a gasification plant could be challenging, since regulatory agencies may not be too familiar with gasification emissions.



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The capital cost for an IGCC plant is quite high. Variable operating and maintenance costs are less than those for a conventional PC unit, however, fixed O&M costs are higher. Performance wise, an IGCC has an efficiency near 40% compared to a 35% efficiency of a conventional PC coal unit. An IGCC plant may burn low cost and high sulfur coal, providing advantages in both cost and emissions.

IGCC is a viable option that was selected to be investigated further.

## 1.3 ATMOSPHERIC FLUIDIZED BED COMBUSTION

Atmospheric Fluidized Bed Combustion (AFBC) technology is characterized by the use of a solid material contained in a vessel in which air and fuel are introduced and combustion takes place. The solid material may be limestone, allowing a high level of $SO_2$ removal to take place during the combustion process. Therefore, no post-combustion technology is needed to remove $SO_2$. Combustion temperatures are generally designed between 780 and 870°C and provide inherently low $NO_x$ emissions. Initial designs were "bubbling" types, characterized by air velocities of 1.2 to 3 m/s. Current designs called "circulating" fluidized beds (CFBs) have much higher velocities, and continuously recirculate entrained solids using cyclones.

The progress of AFBC development has been monitored in several conferences, highlighted by the International Conference on Fluidized Bed Combustion which has been held bi-annually for approximately 25 years. FBC technology is available with "commercial" guarantees by many international vendors.

CFB boilers can be designed for a wide variety of fuels, and for lower quality solid fuels. CFB has become the "technology of choice." They are very suitable for the types of coals found in eastern Europe, and can also co-fire biomass and waste materials.

CFB installations can be retrofit, utilizing existing steam turbine equipment, and sometimes even existing boiler foundations and other equipment. In these cases, the existing boilers would be removed.

A few installations have utilized a boiler retrofit concept which involves removal of the bottom portion of an existing top-supported boiler and substituting a bottom-supported bubbling-type FBC unit beneath the existing boiler. Consideration of this type of retrofit requires a more detailed design study to determine feasibility. Vendors of FBC boilers are generally less willing to bid on this type of retrofit due to problems which have occurred with previous installations. Since FBC boilers are shown to be one of the favored options in this study, a follow-on study could include the investigation of an FBC boiler retrofit. Since some cost savings may result, this option may be favorable from a financial viewpoint.

The FBC technology chosen for further screening is a circulating-type FBC (CFB) boiler which is offered by several international vendors. The U.S. vendor who supplied design information and costs for a CFB boiler is the Foster Wheeler Energy Corporation (FWEC). FWEC has initiated discussions with a Czechoslovak boiler manufacturer, where most of the fabrication of a boiler would take place. Foster Wheeler would provide most of the boiler design and the



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manufacture of a few of the components. Competitive bidding for the FBC boiler would result in the least-cost design which conforms to the specification.

## 1.4 PRESSURIZED FLUIDIZED BED COMBUSTION

Pressurized Fluidized Bed Combustion (PFBC) is a promising technology to burn low grade, low cost indigenous fuels in district heating systems. PFBC results in a much higher electric/heat ratio compared to its AFBC counterpart, and is actually more comparable to a gas-fired gas turbine combined cycle. PFBC is also lower in $NO_X$ emissions.

There is currently a project in the Ostrava, Czechoslovak area to construct a PFBC plant for district heating. This plant will be similar to four others which have recently been built and operated.

While this technology is promising, it is not ready for commercial application in the time required for this project. Therefore, it will not be considered for this project at this time. However, the selection of a CFB boiler would allow re-consideration of PFBC technology when additional demonstration time has been accrued.

## 1.5 GAS TURBINE COMBINED CYCLE

Gas turbines are available in discrete sizes from less than one MWe to over 150 MWe in electrical output. Waste heat boilers are available for almost any gas turbine. Gas turbines and waste heat boilers are used in combination with steam turbines in the gas turbine combined cycle (GTCC). The efficiency of the gas turbine has risen through the years, and the popularity of GTCC technology has risen significantly throughout the world. Two primary advantages of this technology are the relatively low capital cost and the short construction time. In the United States, gas turbines are generally used to meet peak loads, but the GTCC has also recently been used to meet some intermediate electrical loads. The short lead times have been useful because there has been a long delay in construction of larger coal-fired baseload plants, and the recent low natural gas prices have encouraged its use.

A disadvantage of the use of large gas turbines in the Bulgaria project is the requirement to import the most expensive portion of the equipment, making this technology less cost competitive than in the West. Maintenance for this equipment is also considered to be higher due to the import of spare parts. In the near future, it may be possible to lower the cost since there have been discussions about the manufacture of large gas turbines in East Europe by BrNo. Since most of the manufacturing work would be done within East Europe, the cost would be considerably reduced; however, the situation would not be as competitive as in the western world, so that the cost advantage may be somewhat diminished. Also, special financing and other arrangements proposed by the manufacturer in a competitive bid may soon enhance the competitiveness of this technology. Natural gas prices will also control the application of GTCC in Bulgaria. While the world capital cost of the gas turbine is relatively low, compared to coal burning technologies, fuel prices remain higher. In the United States, natural gas prices are very low and many competitive situations have been created for GTCC. However, in Bulgaria, we expect that the competitiveness of imported natural gas prices is expected to be less, and certainly, the security concern associated with heavy dependence on this fuel are also greater.



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For the purposes of this study, the gas turbine portion of the GTCC is assumed to be imported and to carry a world market price.

## 1.6 GAS TURBINE OR ENGINE REPOWERING

A gas turbine or reciprocating engine can also be used to "repower" an existing boiler to allow production of electricity from an existing low pressure steam or hot water boiler, or to obtain a higher electric to heat ratio for an existing cogeneration system.

In this configuration, the exhaust from a gas turbine or engine firing natural gas or oil is used as a heat source input for an existing boiler. Supplementary firing is used in the boiler to obtain full steam or hot water output. Thermodynamically, there are many advantages to such a system. The cost effectiveness of any installation is dependent on the price of premium gas/oil fuels and the sales price of electricity that can be negotiated with the electric utility.

There have recently been many opportunities for small boiler repowering and cogeneration systems in the United States. While overall efficiency cannot compete with larger units, a potential advantage is often tied to "peak shaving," where the equipment and operating costs are justified by the savings of peak demand charges assessed by a utility. These situations are very site specific and require a site specific assessment to determine economic attractiveness. Where electricity is generated only for internal use by a customer, there may also be savings. Where a single unit is proposed, a utility would be required to provide standby power to the user, in the Case of a unit outage. It is possible that if a large number of units were proposed, less standby power would be required, because the combined reliability of many units would be higher than a single unit.

While not selected as an option for further screening, repowering is recommended for future consideration, as this choice requires significant site-specific engineering to establish or eliminate feasibility.

## 1.7 CHENG CYCLE

The Cheng cycle is fundamentally a steam injection scheme, with the steam sent to a gas turbine combustor shell. Steam is added for power augmentation to within the limits of compressor surge margin. The increased mass flow, higher specific heat in the turbine results in increased pressure ratio. The combination of added turbine mass flow and increased cycle pressure ratio results in a greater gas turbine output and improved heat rate. As with any turbine water or steam injection scheme, the $NO_X$ emissions may reduce slightly due to increased moisture content, but the CO emissions will increase.

The problem with the Cheng cycle is not with its potential benefit, but rather the lack of an established "track record" in a size suited for use in the Bulgaria plants. The largest size demonstrated so far by the International Power Technology Company is approximately 2 MW to 6 MW, too small for the Bulgaria plants. While General Electric Company has applied a similar cycle to their aeroderivative engines of 27 MW size such as LM 2500, their success report from introducing such a scheme to large industrial gas turbines of 150 MW class, namely Model 7FA, is not yet forthcoming. It is ill advised to experiment on apparent benefit for these plants in large size; instead, proven technology must be chosen.

For this reason, the Cheng cycle was rejected. It ranked low in commercial development status and in technical considerations largely due to the limited test experience for this type of cycle in an appropriate size for application to the Bulgarian plants.

## 1.8 WASTE INCINERATION PLANT

Incinerating waste to generate power is not a new idea. One of the major reasons for its not being in widespread use is that these plants are too expensive to build. They are refuse disposal plants, not power plants. They burn the worst fuel possible and the refuse can be stored for no more than four days. The quantity and quality of available fuel is uncertain.

Energy released in the waste burning process is recovered in the boiler by generating steam. This steam is used to produce power via a steam turbine. Steam could also be extracted from the steam turbine to provide heat for district heating, generating revenue and reducing the cost of waste disposal. The capital cost of building these plants is about $4500 per kilowatt. Due to vast interest in this type of plant, it will be passed on to participate in the screening process in the next section.

# 4A.2 TURBINE MODELING

## 2.1 INTRODUCTION

The purpose of calculating turbine performance is to match a turbine's thermal output to that required by the heat load duration curves for hot water and industrial steam.

The program calculates the required amount of extraction flows, as if they were produced by separate back pressure turbines with the back pressures equal to the extraction pressures. To do this, one cogeneration turbine with two controlled extractions is divided into three turbines: A, B, and C where:

- A is the turbine with the back pressure equal to the pressure of industrial steam extraction
- B is the turbine with the back pressure equal to the pressure of hot water heating extraction
- C is a condensing turbine.

All three turbines are connected to one steam header and have parallel feedwater heating lines with the same pressure levels in corresponding feedwater heaters. (A typical model of Sofia TPHS, Turbine No. 6 is shown in Exhibit 2-1).

The program calculates performance of back pressure turbines, corresponding to the required heat load, by interpolating between the points in the turbine performance tables, that contain turbine performance at 100, 75, 50 and 25% of the required exhaust flow. The steam produced by the boiler and not used in the back pressure turbines goes to the condensing turbine, the gross power output of which is calculated by multiplying available heat by the power-to-heat ratio.

Available data for input includes:

- Turbine expansion lines
- Turbine performance charts



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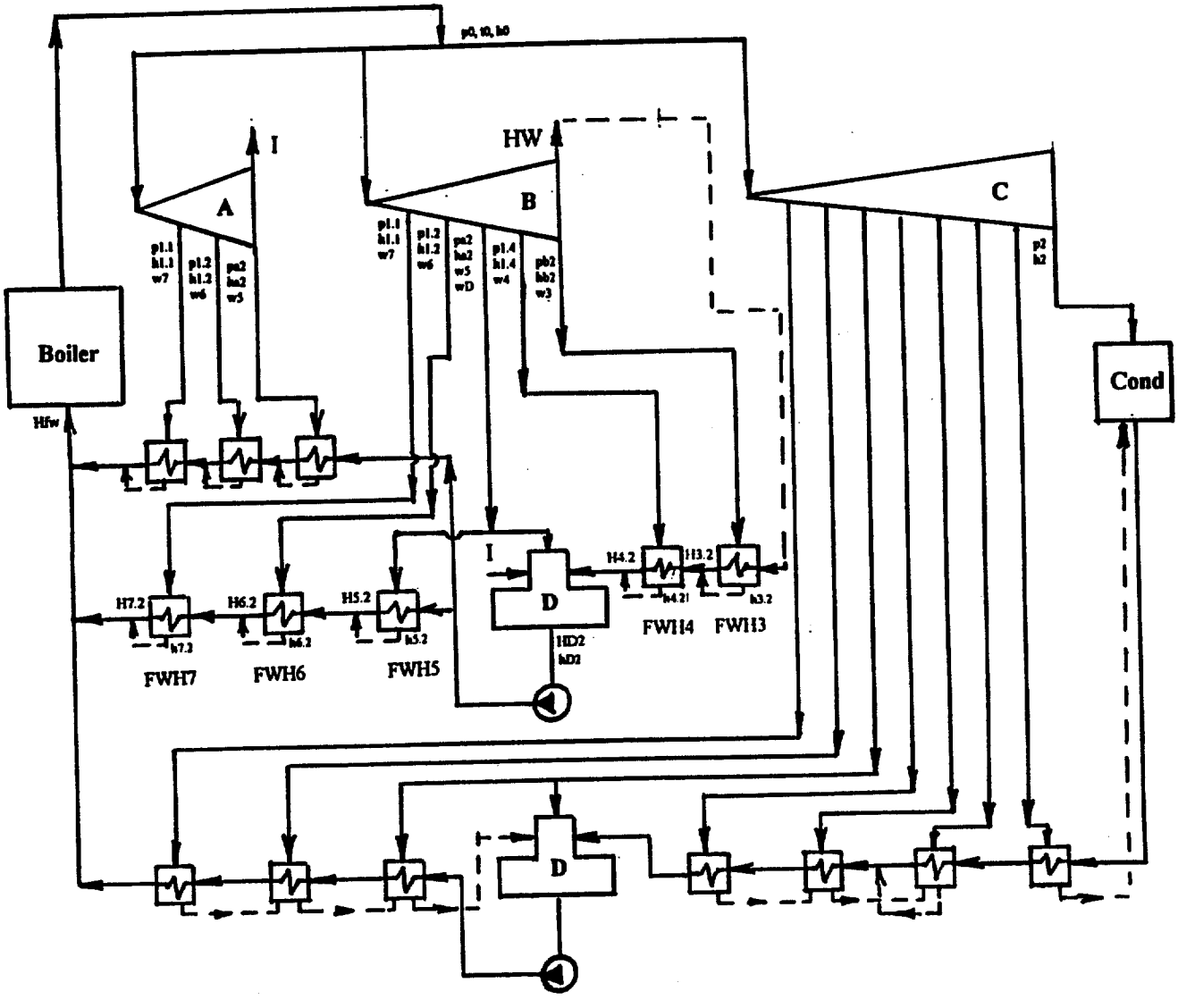
## Exhibit 4A.2-1
## Typical Model of Sofia TPS Turbine No. 6



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- Turbine correction curves
- Turbine thermal test results
- Results of new turbines' performance

However, none of the turbines has a complete set of available data.

## 2.2 ASSUMPTIONS:

All old turbines are derated by 5% due to aging.

Back pressure turbine efficiency is independent from the heat load (since the actual flow through the turbine is unknown at the beginning of the program run).

Unless test data is available, a 10% pressure drop from extraction point to the heater is assumed; likewise, the TTD for the surface heater is assumed to be 5#F.

## 2.3 BACK PRESSURE TURBINE PERFORMANCE:

Performance is calculated as follows:

1. The inlet water enthalpy is equal to the enthalpy at the feedwater pump exit.

2. Calculate extraction enthalpies multiplying turbine Section enthalpy drop by the derating factor of 0.95.

3. Calculate pressure in the feed water heaters, using the pressure drop of 10%, and the corresponding saturation temperatures.

4. Calculate the feed water temperature at the heater outlet, using the TTD of $5^{o}F$.

5. Solve the heat balance equation for the extraction flow:

$$Wan = In \frac{ian2 - ian1}{han1 - han2}$$

where Wan is the extraction flow, ian1 and ian2 are water enthalpies at heater inlet and outlet, han1 and han2 are steam enthalpies at heater inlet and outlet, In is the water flow through the heater, and in is the number of the heater.

6. Find the water flow to the next heater by adding the water flow and extraction flow.



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7. Calculate turbine net output at 100% load as:

$$MWa = \frac{I * (h0 - ha2) + RWan * (h0 - han1)}{3413} * ge$$

where I is the maximum industrial steam extraction, ge is the generator efficiency, h0 is the throttle steam enthalpy, ha2 is the industrial extraction enthalpy.

8. Calculate turbine net output for 75, 50 and 25%.

If thermal test results are available, then feedwater heating extraction is calculated directly from the extraction curves.

The same procedure is used for turbine B; the TTD is equal to 0 for the deaerator.

## 2.4 CONDENSING TURBINE PERFORMANCE:

Ratio is defined as turbine C gross power divided by the available heat, which in Case of a condensing turbine is equal to the boiler duty, Qduty, where

$$Qduty = Qhw + Qstm + (MWa + MWb + MWc) / ge + Qrej$$

The turbine C power is given by

$$MWc = \frac{Wc * (h0 - hc2) + RWcn * (h0 - han1)}{3413} * ge$$

and the boiler duty is

$$Qb = W \times (h0 - hfw),$$

where hfw is the feed water enthalpy.

If the turbine doesn't have regeneration, then

$$R = \frac{(h0 - hc2)}{(h0 - hfw)}$$



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If performance data is available, then first calculate the turbine power as if there is no regeneration, then correct it by the regeneration correction factor

$$q = \frac{MWc * (hc0-hc2)}{3413 * MW^{cch}}$$

where MWcch is the power at the corresponding throttle flow from the performance chart or other turbine performance data.

# 4A.3 HEAT UTILIZATION FACTOR EQUATIONS

The equations defining the Heat Utilization Factor (HUF) and parameters that model the factor are presented in Exhibit 4A.3-1.

## Exhibit 4A.3-1
## Heat Utilization Factors

| Major Criterion | Criterion Weighting | Status/ Characteristic | Relative Ranking | Max. Possible Points |
|---|---|---|---|---|
| Commercial and Developmental Status | 6 | utility integration<br>engineering demonstration<br>development<br>pilot<br>hypothetical | 5<br>4<br>3<br>2<br>1 | 30 |
| Technical Considerations | 5 | technically mature<br>technically demonstrated<br>technically viable<br>technically developed<br>technically inadequate | 5<br>4<br>3<br>2<br>0 | 25 |
| Licensing and Lead Time Risks | 3 | low<br>moderate<br>high<br>unknown | 5<br>4<br>3<br>0 | 15 |
| Environmental | 3 | evaluate all Exhibit 6.2.1-3 Lowest emissions is ranked 5, highest ranks 0. Rest ranked by percentage difference relative to these two. | 5 | 15 |
| Cost Uncertainty | 1 | low<br>moderate<br>uncertain<br>high<br>unknown | 5<br>4<br>3<br>2<br>0 | 5 |
| Capital Costs | 1 | evaluate all per EPRI TAG. Lowest is ranked 5, highest ranks 0. Rest ranked by percentage difference relative to these two. | 5 | 5 |
| Variable Operating Costs | 1 | evaluate variable operating cost and maintenance per EPRI TAG. Lowest is ranked 5, highest ranks 0. Rest ranked by percentage difference relative to these two. | 5 | 5 |
| **Maximum Possible Total:** | | | | **100** |



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**SECTION 6**

**Engineering Analysis - Instrumentation and Controls**

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0297

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| | | 10.3.20 Project and Work Activity Planning | 10-11 |
| | | 10.3.21 Cost Management | 10-11 |
| | | 10.3.22 Project Administration | 10-11 |
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# LIST OF EXHIBITS
# SECTION 6

# LIST OF EXHIBITS


| Exhibit | Title |
|---|---|
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| 6-2 | Substation - Building Heating and Domestic Hot Water - Sketch SK-111993 |
| 6-3A to 6-3D | Annubar - Dieterich Standing Drawings - C-9100, C-9101, C-4950, C-5250 |
| 6-4 | Differential Pressure Transmitter - Rosemount 1151 Series - Product Data Sheet PD 4360 |
| 6-5A to 6-5F | AB SVENSK VARMFMATNING SVM Water Meter SVMV-1 Isolation Relay, Energy Metal and Energy Integrator SVM93 |
| 6-6 | Controller, Tour and Andersson Ltd., Data Sheets TA9104 and C-11-35 |
| 6-7 | Controller, Tour and Andersson Ltd., Data Sheets TA9106/C-11-37 and D-11-15 |
| 6-8 | RTD, 100 OHM Platinum, PYCO Data Sheet 502 |
| 6-9 | Thermowells, PYCO Data Sheet 450-II |
| 6-10 | Control Valves, Honeywell (7 Pages in German) |
| 6-11 | Control Valve, Tour and Andersson Ltd., Data Sheet F-20-11 |
| 6-12 | Westinghouse WDPF SCADA Systems |
| 6-13 | Thermostatic Radiator Valve, TA RUT Tour Andersson Ltd., Data Sheet AB-0321-15215 |
| 6-14 | Radiator Allocator, ISTA (8 Pages in German) |




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# 6.0 ENGINEERING ANALYSIS - INSTRUMENTATION AND CONTROLS

## 6.1 DESIGN CRITERIA

Each District Heating Company function is to sell steam to their industrial users and hot water to their commercial/domestic users. The commercial/domestic users shall be defined as small business, apartment buildings, private dwellings, etc. The steam and hot water shall be purchased from the central power plant located within the district.

To determine the amount of steam and hot water required for purchase, a computer monitoring system is recommended to be installed such that (1) the quantity of steam being used by each industrial user is recorded, and (2) the quantity of hot water used by each type of domestic/commercial building for heating and domestic hot water is recorded. The quantity of each required will be dependent on the season of the year. The information gathered at each user location shall provide the demand requirement from the District to the central power utility for steam and hot water, and provide the District with the ability to charge each user for the actual amount of steam or hot water used on a monthly basis.

Since there are various substation configurations that may exist, we have assumed two basic types. One is for building heating and the other is for building heating and domestic hot water. (Exhibits 6-1 and 6-2)

### 6.1.1 FLOW MEASUREMENT (STEAM AND HOT WATER)

Even though steam flow elements exist, additional flow elements should be added to the lines. These elements, an annubar with dual flow (differential pressure) transmitters, would provide the flow data required within an accuracy of ±1% to the District Heating Computer System for monitoring and totalizing. (Exhibits 6-3A, B, C, D and 6-4)



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Each annubar would be supplied with dual transmitters, having a 5 valve test manifold valve, and a redundant 24VDC power supply. Transmitters, manifold valves and power supply will be located in a NEMA 4 temperature controlled enclosure mounted near the pipe. 316 stainless steel tubing shall connect the annubar to the transmitters/manifold valves located in the enclosure.

Substation hot water flow usage shall be monitored by a hot water flow meter/integrater (Exhibits 6-5A thru 6F) located in the substation ground floor and mounted in the discharge line. The output of the meter/integrator shall go to a remote telemetry unit (RTU) located in the area. The hot water entering the substation should pass through a filter to remove any dirt, etc. and the water quality should be maintained between a ph-value of 8.5 and 10.0. The meter internal materials shall be constructed accordingly to accept this ph-value.

In addition, the same configuration of annubar/transmitters would be added to each pumping station hot water pump discharge line to measure flow. This flow data would be brought back via an RTU to the central control system so that the discharge flow could be compared to the return flow. This comparison could then be used to advise the District Heating Company of possible leaks or illegal tapping of water from the line.

### 6.1.2 SUBSTATION CONTROL

Exhibits 6-1 and 6-2, depict the various control elements, i.e.: controller, control valves, Rtds, and RTU, that are the essential instruments in monitoring and controlling the hot water in the substation. The controllers (Exhibits 6-6 and 6-7) shown will vary from one Exhibit to the other due to its function. We will assume that Exhibit 6-2 is the most common type. The controller characteristics are, as follows with values displayed together including explanatory text on the front of the display panel.

a) Automatic adjustment of reset curve, as well as magnitude and duration of night setback

b) Continuous and automatic monitoring and adjustment for factors such as seasonal variations

c) Domestic hot water control with separate night and day setpoints

d) Time channels for HW recirculation pump control

Temperature elements (Exhibits 6-8 and 6-9) are duplex 100 ohm platinum spring loaded type per DIN 43760 standards. The well is 316 stainless steel with 1/2" NPT connections for pipe mounting.

The flow meter/integrator was discussed in Section 6.1.1.

The control valves (Exhibits 6-10 and 6-11) shall be sized to accommodate the various flows and differential pressures. Valve bodies will be flanged and rated as PN25. Body material will be nodular iron or cast steel. Valve internal trim will be of stainless steel material. Actuator will be electronic to accept the signal from the

controller. In pipe lines larger than 108mm, it is recommended that a high and low range control valve be used to improve controllability and manageability due to seasonal flow demands.

The instrument control valve wetted process materials are designed based on the criteria that all dirt, etc. has been filtered out of the hot water inlet substation line, and that the ph value is in the range of 8.5-10.0. This same criteria would also apply to the heat exchangers, pumps, etc. being used within the substation.

### 6.1.3 PUMPING STATIONS

Each pumping station will have a remote telemetry unit (RTU) located within its area. As stated in Section 6.1.1 each pump discharge line will have an annubar/transmitter added to measure flow. The output of the transmitters will go to an RTU. In addition, pump control, besides being local, can also be done through the RTU. Any pump bearing and motor temperature elements may be wired to the RTU. The RTU output will interface with the fiber-optic data highway for the SCADA System. The addition of this data will provide valuable information for the District Heating maintenance personnel.

## 6.2 SCADA SYSTEM

To monitor, maintain and generate billing for the four (4) District Heating Companies in Sophia and the District Heating Company in Pernik, a fiber-optic based SCADA System (Exhibit 6-12) is proposed. The system would include a communication network, central control facility and remote telemetry units (RTU's).

Each central control facility system shall be located in the District Heating Company's main facility. The system would include two (2) engineers/operators consoles, one (1) redundant data-link server, one (1) redundant historian, and one (1) calculator station. In addition the system will have video wall displays (complete district layout of the heating distribution system) along with the appropriate appurtenances.

The software programs included in the central control facility system will provide the district with the capability of billing each substation each month for the amount of hot water consumed, and its industrial users for the amount of steam consumed. In addition the quantity of steam and hot water is recorded. Therefore trending programs can be developed to provide information as to consumption based on monthly or seasonal temperature variations. This data could be provided to the central power utility for load projections. Also maintenance records could now be kept on the pumping station pumps, etc. Information on piping leakage could be monitored and indicated on the CRT screen and graphically displayed via the video wall.

Each substation and pumping station will include a remote telelemetry unit (RTU) located within. All field points to be monitored will be wired to a RTU. The output of the RTU is a fiber-optic link that connects to a fiber optic data highway. Each fiber-optic data highway is connected to the central control facility.



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The RTU listed in the SCADA System is one type. The number of analog and digital inputs from each substation or pumping station will determine the actual RTU design.

It is assumed that 1000 km of fiber-optic cable will be required for Sophia, and 400 km of fiber-optic cable for Pernik.

## 6.3 MISCELLANEOUS

Internal apartment heat control can be improved by adding at each radiator a thermostatic radiator valve. (Exhibit 6-13) In addition a radiator allocator may also be added (Exhibit 6-14).



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## Exhibit 6-1

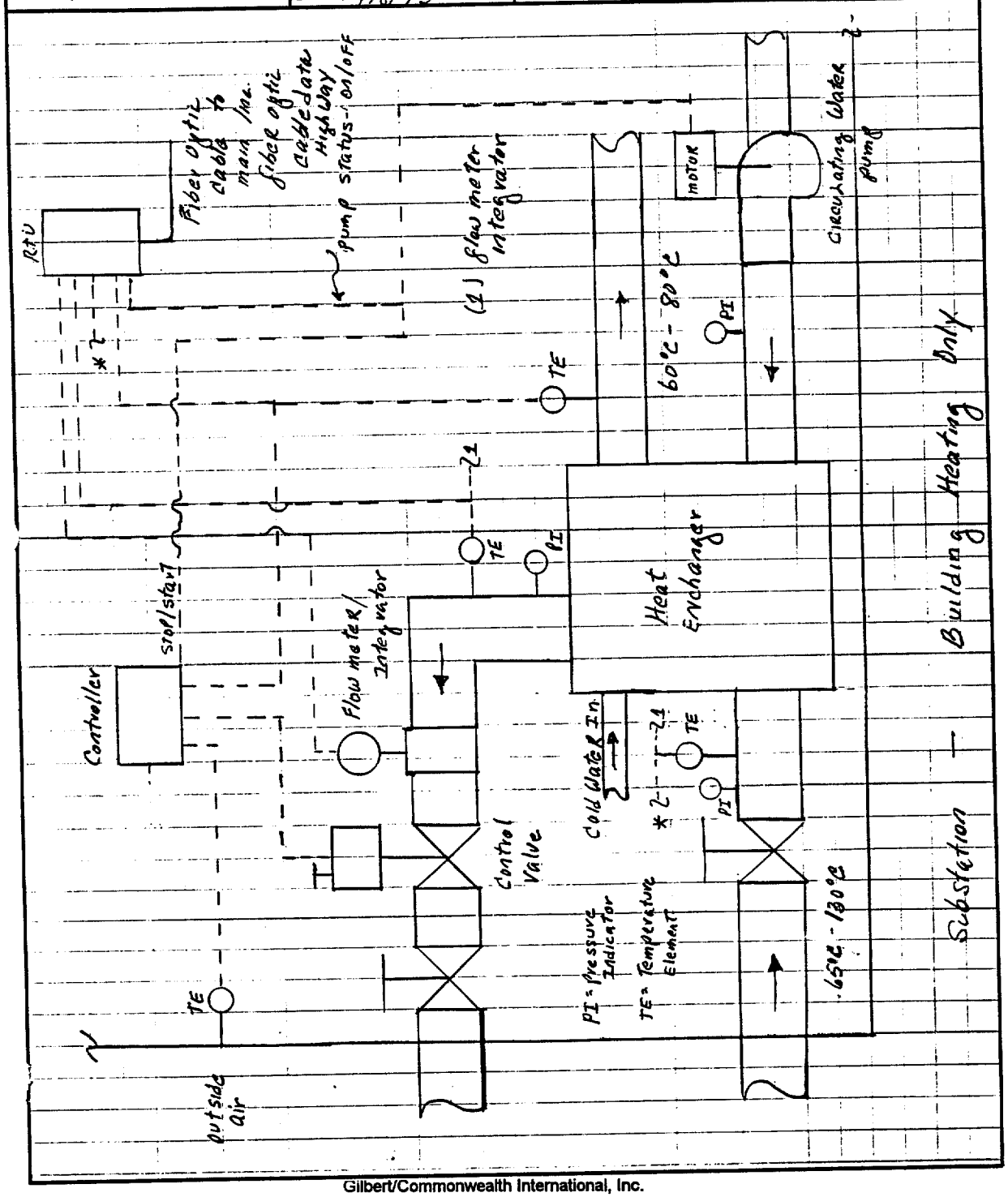
### Substation - Building Heating Only -

### Sketch SK-WCW-111893

Gilbert/Commonwealth
ENGINEERS/CONSULTANTS
CALCULATION

| SUBJECT | IDENTIFIER | PAGE |
|---|---|---|
| Bulgaria District Heating | 44-0280-103 | Sketch |

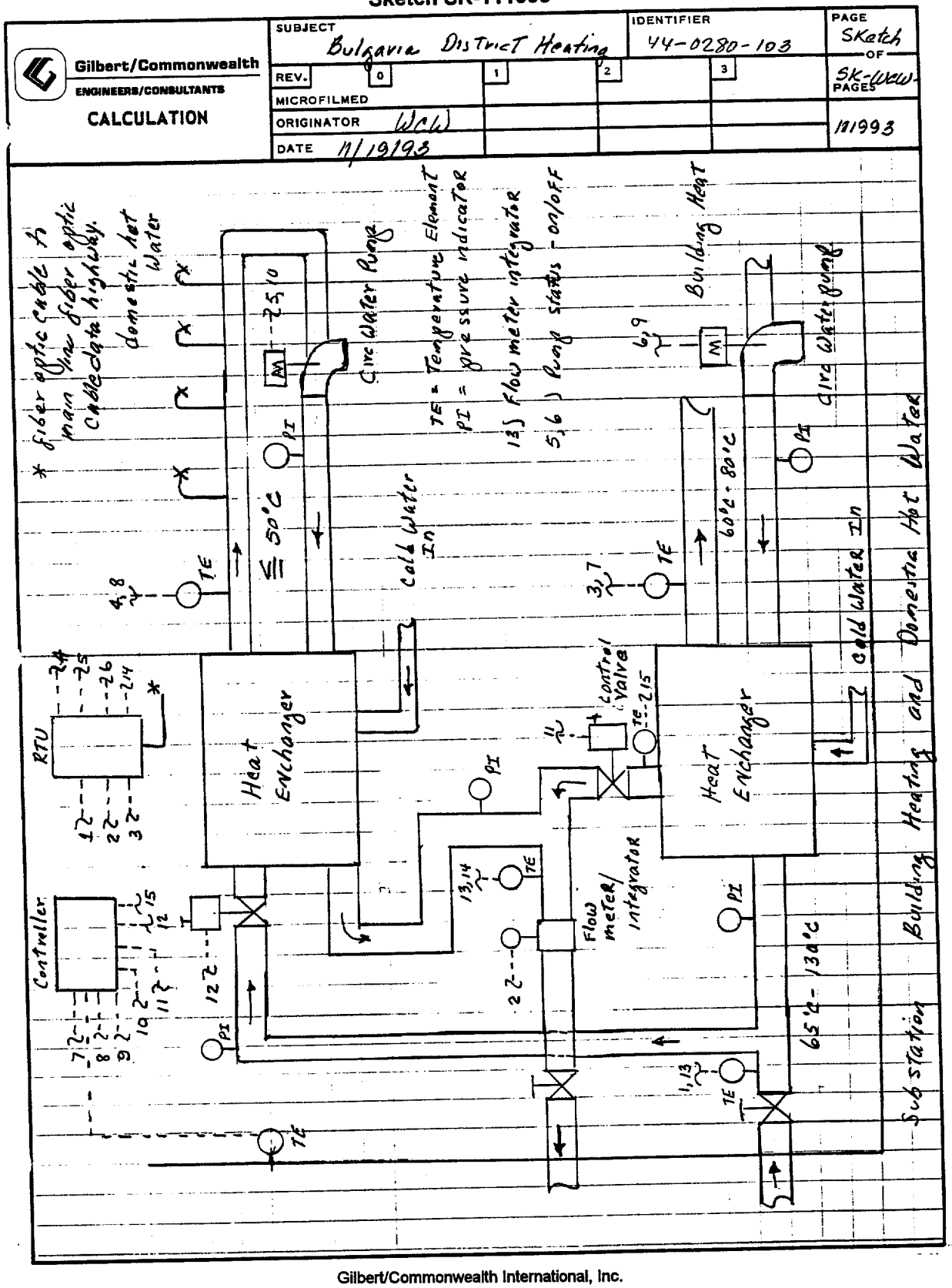
| REV. | 0 | 1 | 2 | 3 | OF SK-WCW- PAGES |
|---|---|---|---|---|---|
| MICROFILMED | | | | | 111893 |
| ORIGINATOR | WW | | | | |
| DATE | 11/18/93 | | | | |



## Exhibit 6-2

### Substation - Building Heating and Domestic Hot Water -

### Sketch SK-111993

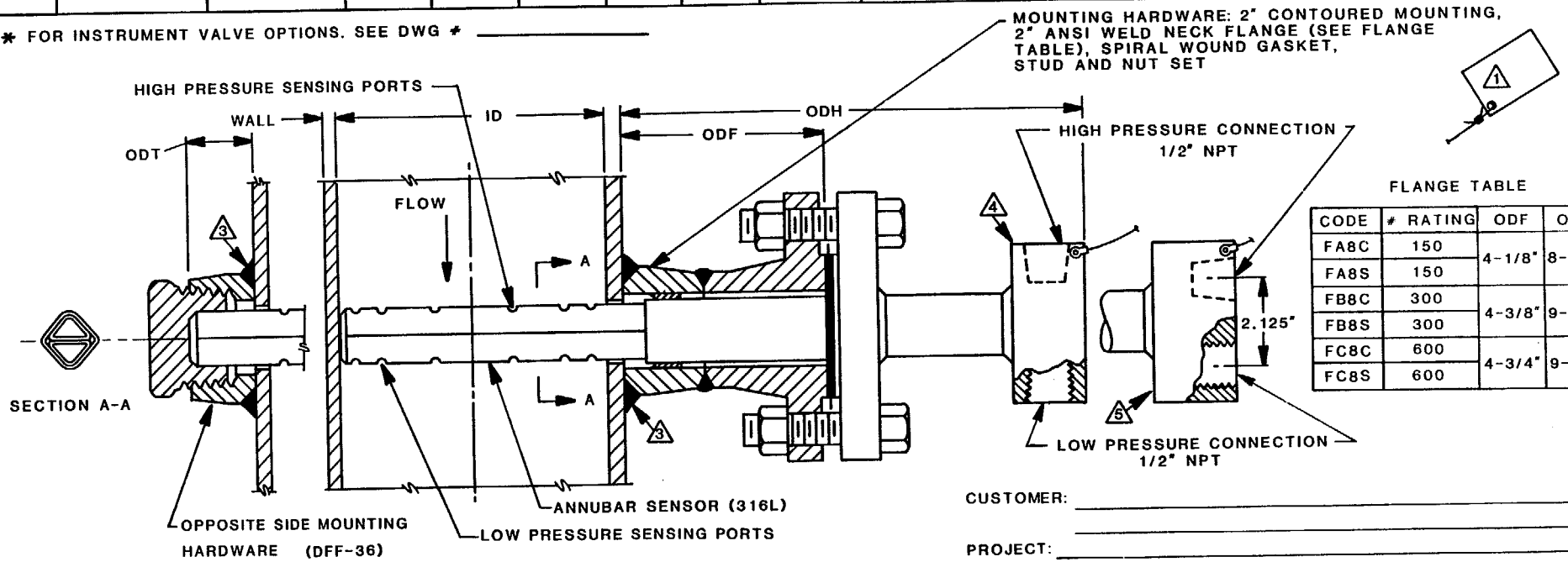


**ANNUBAR - DIETERICH STANDARD DRAWINGS**
**C-9100, C-9101, C-4950 and C-5250**

**Exhibit 6-3A to 6-3D**

| ITEM | SERIAL NO. | TAG NO. | MODEL | SENSOR | ID | WALL | HEAD | VALVES * | MOUNTING HEAD SIDE | MOUNTING OPP SIDE | ODF | OTHER OPTIONS | NOTES: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DFF | 35/36 | | | HA2 | | FA8C | MS8 | 4-1/8" | | STANDARD CALLOUT SHOWN |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* FOR INSTRUMENT VALVE OPTIONS. SEE DWG # _____




FLANGE TABLE

| CODE | # RATING | ODF | ODH |
|---|---|---|---|
| FA8C | 150 | 4-1/8" | 8-3/4" |
| FA8S | 150 | | |
| FB8C | 300 | 4-3/8" | 9-1/8" |
| FB8S | 300 | | |
| FC8C | 600 | 4-3/4" | 9-7/8" |
| FC8S | 600 | | |

CUSTOMER: _____

PROJECT: _____

P.O. NO: _____

DSC FILE NO: _____

**Exhibit 4.2-1D**

NOTES:

1. PERMANENT RUSTPROOF METAL TAG SHOWING MODEL NUMBER, PIPE SIZE, SERIAL NUMBER, STRUCTURAL LIMITS AND INFORMATION AS SUPPLIED BY CUSTOMER.
2. ANNUBAR ORIENTATION SHOWN FOR DETAIL ONLY. FOR ACTUAL RECOMMENDED LOCATION AND ORIENTATION SEE INSTALLATION INSTRUCTIONS.
3. FIELD WELD. SEE INSTALLATION INSTRUCTIONS FOR PROPER HOLE AND WELD REQUIREMENTS.
4. STANDAND INSTRUMENT HEAD, HA2. OPTIONAL HV2 REQUIRED FOR VERTICAL PIPES.
5. OPTIONAL INSTRUMENT HEAD HP2.
6. PRESSURE IS PER ANSI FLANGE RATING, MAXIMUM TEMPERATURE IS 850°F FOR THE SENSOR.
7. ADDITIONAL NOTES: _____

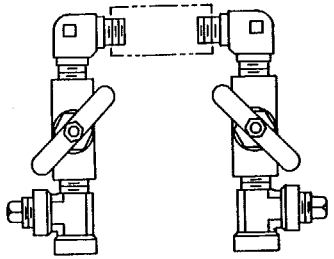
PAGE OF

## DFF-35 AND DFF-36

| APPROVAL | | LATEST REVISION | | |
|---|---|---|---|---|
| By RCW | Date 3/25/86 | Letter | Date | |
| Drawn by R. L. Underwood | Checked by J. Barnett | Date drawn 2-26-86 | Scale N.A. | C-5250 |

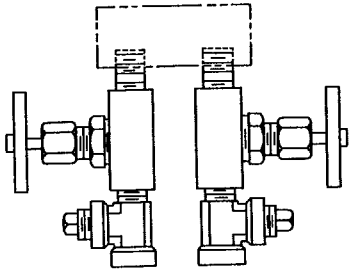
**Dieterich Standard**
A Dover Industries Company
Box 9000 Boulder, Colorado 80301 USA

## SA1 - 1/4" NPT  SA2 - 1/2" NPT



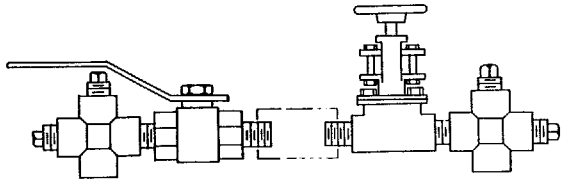
VALVE : NEEDLE TYPE
MAXIMUM PRESSURE : 4600 PSIG (SA1), 3600 PSIG (SA2)
MAXIMUM TEMPERATURE : 500°F (SA1), 600°F (SA2)

## SP1 - 1/4" NPT  SP2 - 1/2" NPT



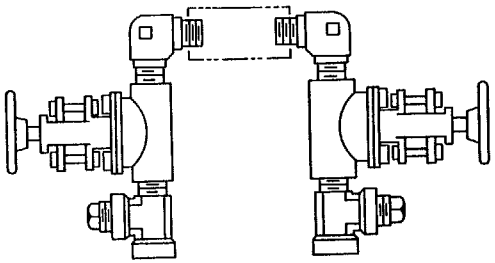
VALVE : NEEDLE TYPE
MAXIMUM PRESSURE : 3960 PSIG (SP1), 3080 PSIG (SP2)
MAXIMUM TEMPERATURE : 550°F (SP1), 600°F (SP2)

## SV1 - 1/4" NPT  SV2 - 1/2" NPT



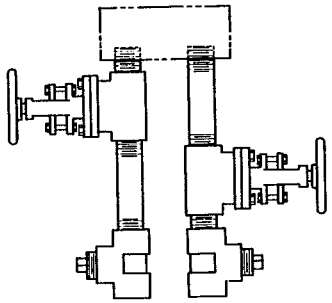
VALVE : (2) BALL (SV1), (2) OS&Y GATE (SV2)
MAXIMUM PRESSURE : 850 PSIG (SV1), 1200 PSIG (SV2)
MAXIMUM TEMPERATURE : 550°F (SV1), 775°F (SV2)

## SB1 - 1/4" NPT  SB2 - 1/2" NPT



VALVE : HIGH TEMPERATURE OS&Y GATE
MAXIMUM PRESSURE : 1200 PSIG
MAXIMUM TEMPERATURE : 775°F

## SC1 - 1/4" NPT  SC2 - 1/2" NPT



VALVE : HIGH TEMPERATURE OS&Y GATE
MAXIMUM PRESSURE : 1200 PSIG
MAXIMUM TEMPERATURE : 775°F

| INSTRUMENT CONNECTIONS | HEAD REQUIRED | SENSOR SIZE |
|---|---|---|
| SA1<br>SA2 | HA1<br>HA2 | 15/16<br>25/26, 35/36 |
| SB1<br>SB2 | HA1<br>HA2 | 15/16<br>25/26, 35/36 |
| SC1<br>SC2 | NIPPLE ONLY<br>HP2, HPF | 10<br>25/26,35/36,45/46 |
| SP1<br>SP2 | NIPPLE ONLY<br>HP2 | 10<br>25/26,35/36,45/46 |
| SV1<br>SV2 | HV1<br>HV2 | 15/16<br>25/26, 35/36 |

FOR STAINLESS STEEL OPTION ADD S TO INSTRUMENT CODE. EXAMPLE SA2S SEE CATALOG DS-1001 FOR STAINLESS STEEL PRESSURES AND TEMPERATURES.

NOTES :

1. USE WITH DRAWING NUMBER _____
2. APPLICABLE OPTIONS : _____
3. ADDITIONAL NOTES : _____

Exhibit 4.2-1A

PAGE of

# STEAM INSTRUMENT CONNECTION HARDWARE OPTIONS

| APPROVAL | | LATEST REVISION | | |
|---|---|---|---|---|
| By RCH | Date 3/26/86 | Letter | Date | |
| Drawn by Paul Moa | Checked by J. Barnett | Date drawn 3-3-86 | Scale NA | C-9100 |

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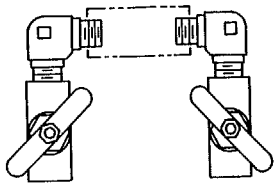
Box 9000 Boulder, Colorado 80301 USA

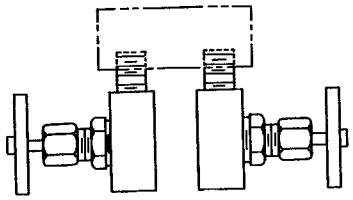
S2

**CA1** - 1/4" NPT **CA2** - 1/2" NPT



VALVE : NEEDLE TYPE
MAXIMUM PRESSURE :4630 PSIG (CA1), 3600 PSIG (CA2)
MAXIMUM TEMPERATURE : 550°F (CA1), 600°F (CA2)

**CP1** - 1/4" NPT **CP2** - 1/2" NPT

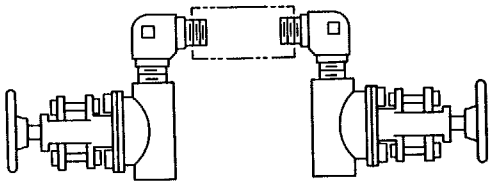


VALVE : NEEDLE TYPE
MAXIMUM PRESSURE :4630 PSIG (CP1), 3600 PSIG (CP2)
MAXIMUM TEMPERATURE : 550°F (CP1), 600°F (CP2)

| INSTRUMENT CONNECTIONS | HEAD REQUIRED | SENSOR SIZE |
|---|---|---|
| CA1<br>CA2 | HA1, HV1<br>HA2, HV2 | 15/16<br>25/26, 35/36 |
| CB1<br>CB2 | HA1, HV1<br>HA2, HV2 | 15/16<br>25/26, 35/36 |
| CC1<br>CC2 | NIPPLE ONLY<br>HP2, HPF | 10<br>25/26,35/36,45/46 |
| CP1<br>CP2 | NIPPLE ONLY<br>HP2, HPF | 10<br>25/26,35/36,45/46 |

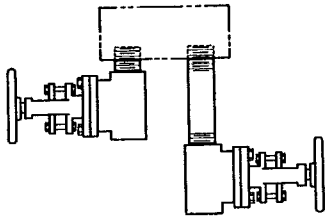
FOR STAINLESS STEEL OPTION ADD S TO INSTRUMENT CODE. EXAMPLE: CA2S

**CB1** - 1/4" NPT **CB2** - 1/2" NPT



VALVE : HIGH TEMPERATURE OS&Y GATE
MAXIMUM PRESSURE :1200 PSIG (CB1), 1200 PSIG (CB2)
MAXIMUM TEMPERATURE : 775°F (CB1), 775°F (CB2)

**CC1** - 1/4" NPT **CC2** - 1/2" NPT



VALVE : HIGH TEMPERATURE OS&Y GATE
MAXIMUM PRESSURE :1200 PSIG (CC1), 1200 PSIG (CC2)
MAXIMUM TEMPERATURE : 775°F (CC1), 775°F (CC2)

NOTES :

1. USE WITH DRAWING NUMBER _____

2. APPLICABLE OPTIONS : _____

3. ADDITIONAL NOTES : _____

PAGE of

Exhibit 4.2-1B

## GAS AND LIQUID INSTRUMENT CONNECTION HARDWARE OPTIONS

| APPROVAL | | LATEST REVISION | | |
|---|---|---|---|---|
| By RCH | Date 3/26/86 | Letter | Date | |
| Drawn by | Checked by J. Garnett | Date drawn 3-7-86 | Scale NA | C-9101 |

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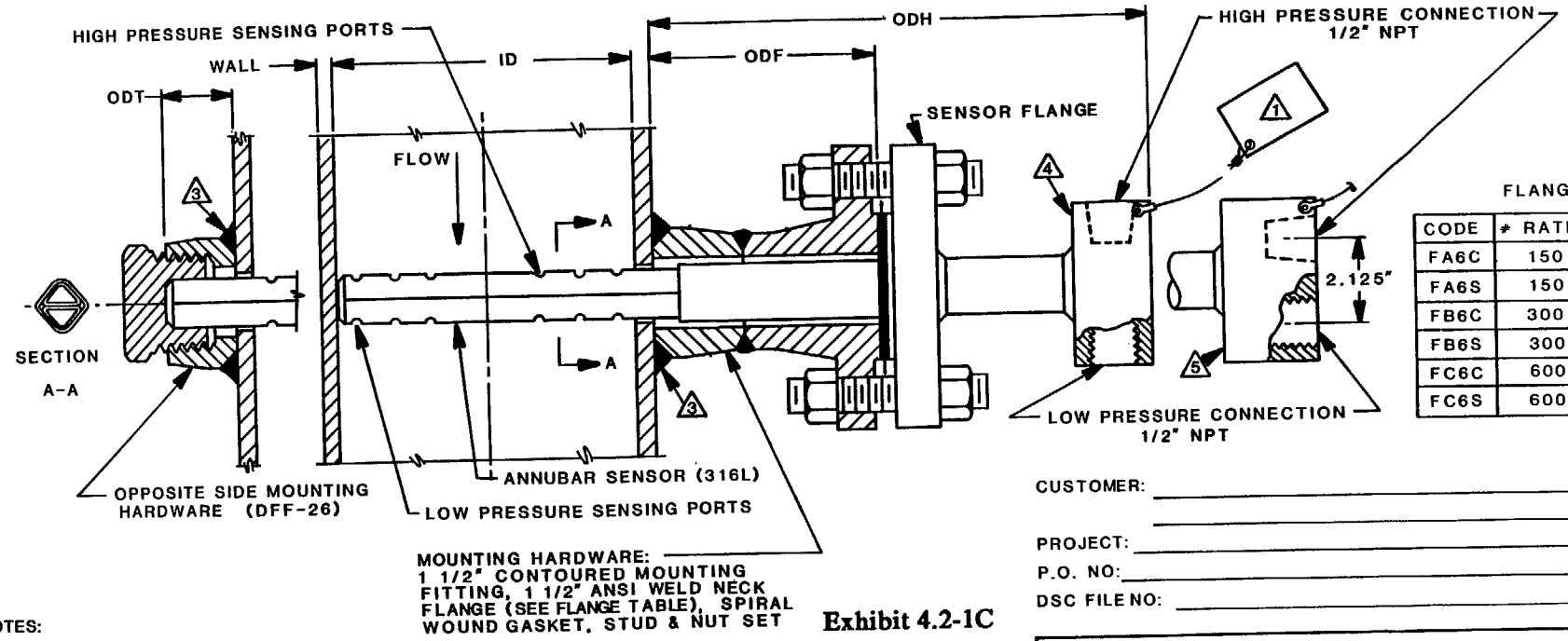
Box 9000 Boulder, Colorado 80301 USA

SB

| ITEM | SERIAL NO. | TAG NO. | MODEL | SENSOR | ID | WALL | HEAD | VALVES * | MOUNTING HEAD SIDE | MOUNTING OPP SIDE | ODF | OTHER OPTIONS | NOTES: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DFF | 25/26 | | | HA2 | | FA6C | MS6 | 3-7/8" | | STANDARD CALLOUT SHOWN |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

* FOR INSTRUMENT VALVE OPTIONS, SEE DWG # _____




FLANGE TABLE

| CODE | * RATING | ODF | ODH |
|---|---|---|---|
| FA6C | 150 | 3-7/8" | 8-3/16" |
| FA6S | 150 | | |
| FB6C | 300 | 4-1/8" | 8-9/16" |
| FB6S | 300 | | |
| FC6C | 600 | 4-7/16" | 9-3/16" |
| FC6S | 600 | | |

CUSTOMER: _____

PROJECT: _____

P.O. NO: _____

DSC FILE NO: _____

Exhibit 4.2-1C

NOTES:

1. PERMANENT RUSTPROOF METAL TAG SHOWING MODEL NUMBER, PIPE SIZE, SERIAL NUMBER, STRUCTURAL LIMITS AND INFORMATION AS SUPPLED BY CUSTOMER.
2. ANNUBAR ORIENTATION SHOWN FOR DETAIL ONLY. FOR ACTUAL RECOMMENDED LOCATION AND ORIENTATION SEE INSTALLATION INSTRUCTIONS.
3. FIELD WELD. (IMPORTANT: DRILL HOLE 7/8in. IN PIPE FOR ANNUBAR INSERTION
4. STANDARD INSTRUMENT HEAD, HA2. OPTIONAL HV2 REQUIRED FOR VERTICAL PIPES.
5. OPTIONAL INSTRUMENT HEAD HP2
6. PRESSURE IS PER ANSI FLANGE RATING, MAXIMUM TEMPERATURE IS 850°F FOR THE SENSOR.
7. ADDITIONAL NOTES: _____

PAGE OF

## DFF-25 AND DFF 26

| APPROVAL By | APPROVAL Date | LATEST REVISION Letter | LATEST REVISION Date | |
|---|---|---|---|---|
| RCH | 3/25/86 | A | 4/15/87 | |
| Drawn by R.R. Underwood | Checked by J. Barnett | Date drawn 2-27-86 | Scale N.A. | C-4950 |

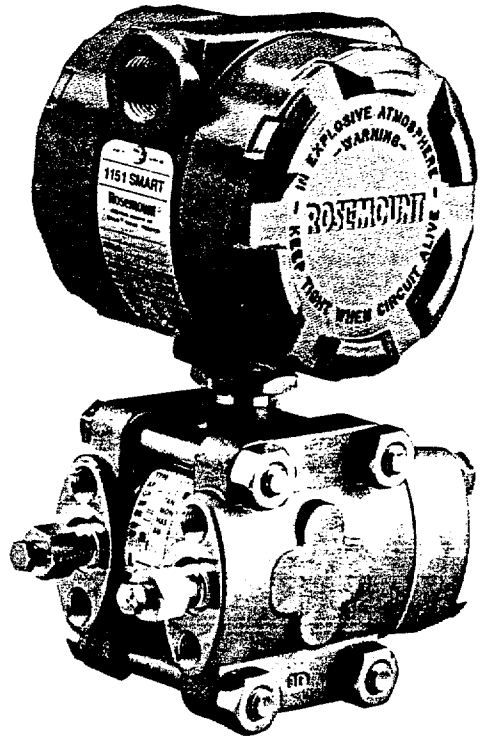
**Dieterich Standard**
A Dover Industries Company
Box 9000 Boulder, Colorado 80301 USA

154

# DIFFERENTIAL PRESSURE TRANSMITTER
## Rosemount 1151 Series
## Product Data Sheet PDS 4360
**Exhibit 6-4**

# ALPHALINE® PRESSURE TRANSMITTERS

- *A complete family of transmitters*
- *Ranges from 0–0.5 inH$_2$0 to 6,000 psig*
- *Solid-state, plug-in circuit boards*
- *Compact, rugged construction impervious to vibration*
- *Local span and zero adjustments*
- *Modular construction*
- *Adjustable damping*
- *Numerous options to permit greater application flexibility*
- *Smart, analog, or low-power electronics*




## INTRODUCTION

This product data sheet highlights Rosemount® Model 1151 differential, absolute, gage, and high-line pressure differential transmitter features and options available for them. For information about the draft range, liquid level transmitters, transmitters with remote seals, and additional information on smart transmitters, refer to their respective data sheets referenced on the back page of this data sheet.

## INDUSTRY-LEADING PERFORMANCE AND FEATURES

The Model 1151 Alphaline® series of pressure transmitters brings true precision to the measurement of flow, level, gage and absolute pressures, vacuum, and specific gravity. Direct electronic sensing with the completely sealed δ-cell™ capacitance sensing element allows significant improvement and stability in pressure measurements. Welded stress isolation clamping in the sensor housing prevents introduction of errors caused by stresses and torques on the process flanges and minimizes effects of line pressure and overpressure.

Installation, calibration, and commissioning are simplified by compact design, integral junction box, and local span and zero adjustments.

The housing features an explosion-proof, weather-proof construction with separate compartments for the electronics and wiring connections. For most models, 316L SST, Hastelloy C®, Monel®, gold-plated Monel, or tantalum materials are available for corrosive service. Modular construction and plug-in printed circuit boards aid in trouble-shooting and reduce parts stocking.

## APPLICATIONS

Model 1151 Pressure Transmitters are available in a variety of configurations for differential, flow, gage, absolute, vacuum, liquid level, and specific gravity measurement applications. The transmitter model number, determined from the ordering information tables, specifies available features such as pressure ranges, outputs, and materials of construction that are basic to each transmitter. Additional options, such as accessories, certifications, and special manufacturing procedures are also available.

© Rosemount Inc., 1992.
*May be protected by one or more of the following U.S. Patent Nos. 3,854,039; 3,975,719; 4,339,750; Re. 30,603. May Depend on Model. Other U.S. and Foreign Patents Issued and Pending.*

## OPERATION

During operation, the isolating diaphragms and fill fluid on the high and low sides transmit the process pressure to the oil fill fluid. The fluid in turn transmits the process pressure to a sensing diaphragm in the center of the δ-cell sensor. The sensing diaphragm functions as a stretched spring element that deflects in response to differential pressure across it (in GP transmitters, atmospheric pressure is transmitted in a like manner to the low side of the sensing diaphragm). In AP transmitters, a reference pressure is maintained on the low side. The displacement of the sensing diaphragm, a maximum movement of 0.004 in. (0.10 mm), is proportional to the pressure. Capacitor plates on both sides detect the position of the sensing diaphragm. The differential capacitance between the sensing diaphragm and the capacitor plates is converted electronically to an appropriate current, voltage, or digital HART® (Highway Addressable Remote Transducer) output signal.

## SPECIFICATIONS

### Functional Specifications

#### Service

Liquid, gas, and vapor applications.

#### Ranges

See Table 2 for ranges. Minimum span equals the upper range limit (URL) divided by rangedown. Rangedown varies with the output code. See Table 1.

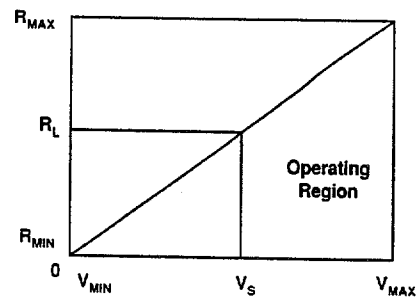
#### Outputs

| | |
|---|---|
| **Code S, Smart** | 4–20 mA dc, user selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to the HART protocol. |
| **Code E, Analog** | 4–20 mA dc, linear with process pressure. |
| **Code G, Analog** | 10–50 mA dc, linear with process pressure. |
| **Code J, Analog** | 4–20 mA dc, square root of differential input pressure between 4 and 100% of input. Linear with differential input pressure between 0 and 4% of input. |
| **Code L, Low Power** | 0.8 to 3.2 V dc, linear with process pressure. |
| **Code M, Low Power** | 1 to 5 V dc, linear with process pressure. |

#### Power Supply

External power supply required. Transmitter operates on:
12 to 45 V dc with no load for Output Codes S, E, and J.
30 to 85 V dc with no load for Output Code G.
5 to 12 V dc for Output Code L.
8 to 14 V dc for Output Code M.

Where:




| Code | $V_{min}$ | $V_{max}$ | $R_{min}$ | $R_{max}$ | $R_L$ at Supply Voltage ($V_S$) |
|---|---|---|---|---|---|
| S① | 12 | 45 | 0 | 1650 | $R_L = 50(V_S-12)$ |
| E,J | 12 | 45 | 0 | 1650 | $R_L = 50(V_S-12)$ |
| G | 30 | 85 | 0 | 1100 | $R_L = 20(V_S-30)$ |

①A minimum of 250 ohms is required for communication. Low power minimum load impedance: 100 kΩ.

#### Current Consumption (Low Power Only) Under Normal Operating Conditions

**Output Code L:**
1.5 mA dc.

**Output Code M:**
2.0 mA dc.

#### Span and Zero

**Output Code S:**
Span and zero may be accessed with local adjustments or remotely via the Model 268 SMART FAMILY® Interface.

**Output Codes E, G, J, L, and M:**
Span and zero are continuously adjustable.

#### Zero Elevation and Suppression

**Output Codes S, E, and G:**
Zero elevation and suppression must be such that the lower range value is greater than or equal to the (–URL) and the upper range value is less than or equal to the (+URL). The calibrated span must be greater than or equal to the minimum span.

**Output Code J:**
Zero is adjustable up to 10% of the calibrated flow span.

**Output Code L:**
Zero is adjustable ±10% of URL and span is adjustable from 90 to 100% of URL.

**Output Code M:**
Zero is adjustable ±50% of URL and span is adjustable from 50 to 100% of URL.



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TABLE 1. Rangeability.

| Output Code | Min. Span | Max. Span |
|---|---|---|
| S (DP and GP, SST, Range 3–8) | URL/10 | 2 × URL |
| S (All others) | URL/6 | 2 × URL |
| E, G, J | URL/6 | URL |
| L | URL/1.1 | URL |
| M | URL/2 | URL |

Table 2. Model 1151 Transmitter Range Availability by Model (URL = Upper Range Limit).

| Range Code | Model 1151 Ranges (URL) | DP | HP | GP | DP/GP/Seals | AP | LT | DR① |
|---|---|---|---|---|---|---|---|---|
| 2 | 6 $inH_20$ (1.49 kPa) | NA | NA | NA | NA | NA | NA | • |
| 3 | 30 $inH_20$ (7.46 kPa) | • | NA | • | NA | NA | NA | NA |
| 4 | 150 $inH_20$ (31.08 kPa) | • | • | • | • | • | • | NA |
| 5 | 750 $inH_20$ (186.4 kPa) | • | • | • | • | • | • | NA |
| 6 | 100 psi (689.5 kPa) | • | • | • | • | • | • | NA |
| 7 | 300 psi (2,068 kPa) | • | • | • | • | • | NA | NA |
| 8 | 1,000 psi (6,895 kPa) | • | NA | • | NA | • | NA | NA |
| 9 | 3,000 psi (20,684 kPa) | NA | NA | • | NA | NA | NA | NA |
| 0 | 6,000 psi (41,369 kPa) | NA | NA | • | NA | NA | NA | NA |

① See PDS 4294 for complete information.

Table 3. Model 1151 Output Code Availability.

| Code | Model 1151 Output Options/Damping | DP | HP | GP | DP/GP/Seals | AP | LT | DR① |
|---|---|---|---|---|---|---|---|---|
| S | 4–20 mA, digital, Smart/variable | • | • | • | • | • | • | NA |
| E | 4–20 mA, linear, analog/variable | • | • | • | • | • | • | NA |
| F① | 4–20 mA, linear, analog/variable | NA | NA | NA | NA | NA | NA | • |
| G | 10–50 mA, linear, analog/variable | • | • | • | • | • | • | NA |
| J② | 4–20 mA, square root, analog/variable | • | • | NA | NA | NA | NA | NA |
| L | 0.8 to 3.2 V, linear, low power/fixed | • | • | • | • | • | NA | NA |
| M | 1 to 5 V, linear, low power/fixed | • | • | • | • | • | NA | NA |

① See PDS 4294 for complete information.
② Available with Ranges 3–5.

**Temperature Limits**

**Electronics operating:**

Code S: –40 to 185 °F (–40 to 85 °C).
Codes E, G, L, M: –20 to 200 °F (–29 to 93 °C).
Code J: –20 to 150 °F (–29 to 66 °C).

**Sensing element operating:**

Silicone fill: –40 to 220 °F (–40 to 104 °C).
Inert fill: 0 to 160 °F (–18 to 71 °C).

**Storage:**

Code S: –60 to 185 °F (–51 to 85 °C).
Codes E, G, L, M: –60 to 250 °F (–51 to 121 °C).
Code J: –60 to 180 °F (–51 to 82 °C).



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### Static Pressure Limits

Transmitters operate within specifications between the following limits:

**Model 1151DP:** 0.5 psia (3.45 kPa) to 2,000 psig (13,790 kPa).

**Model 1151HP:** 0.5 psia (3.45 kPa) to 4,500 psig (31,027 kPa).

**Model 1151AP:** 0 psia to the URL.

**Model 1151GP:** 0.5 psia (3.45 kPa) to the URL.

### Overpressure Limits

Transmitters withstand the following limits without damage:

**Model 1151DP:** 0 psia to 2,000 psig (0 to 13,790 kPa).

**Model 1151HP:** 0 psia to 4,500 psig (0 to 31,027 kPa).

**Model 1151AP:** 0 psia to 2,000 psig (0 to 13,790 kPa).

**Model 1151GP:**

**Ranges 3–8:** 0 psia to 2,000 psig (0 to 13,790 kPa).

**Range 9:** 0 psia to 4,500 psig (31,027 kPa).

**Range 0:** 0 psia to 7,500 psig (51,710 kPa).

### Proof Pressure Limit

All models: 10,000 psig (68.95 MPa) proof pressure on the flanges.

### Humidity Limits

0 to 100% relative humidity.

### Volumetric Displacement

Less than 0.01 $in^3$ (0.16 $cm^3$).

### Damping

Numbers given are for silicone fill fluid at room temperature. The minimum time constant is 0.2 seconds (0.4 seconds for Range 3). Inert-filled sensor values would be slightly higher.

**Output Code S:**

Time constant is adjustable in 0.1 second increments from minimum to 16.0 seconds.

**Output Codes E and G:**

ime constant continuously adjustable between minimum and 1.67 seconds.

**Output Code J:**

Time constant continuously adjustable between minimum and 1.0 second.

**Output Codes L, M:**

Damping is fixed at minimum time constant.

### Turn-on Time

Maximum of 2.0 seconds with minimum damping. Low power output is within 0.2% of steady state value within 200 ms after application of power.

## Performance Specifications

(Zero-based calibrated ranges, reference conditions, silicone oil fill, 316 SST isolating diaphragms)

### Accuracy

**Output Code S:**

**Ranges 3 through 8, DP and GP transmitters:**
±0.1 of calibrated span for spans from 1:1 to 6:1 of URL. Between 6:1 and 10:1 of URL,

$$\text{accuracy} = [\pm 0.025 + 0.0125 \times \left(\frac{\text{URL}}{\text{span}}\right)]\% \text{ of span.}$$

**All other ranges and transmitters:**
±0.25% of calibrated span.

**Output Code S, square root mode:**

$$\pm[0.2 + 0.05 \times \left(\frac{\text{URL}}{\text{span}}\right)]\% \text{ of calibrated flow span.}$$

**Output Codes E, G, L, and M:**

±0.2% of calibrated span for Model 1151DP Ranges 3 through 5.
All other ranges and transmitters, ±0.25% of calibrated span.

**Output Code J:**

±0.25% of calibrated span.

### Stability

**Output Code S:**

±0.1% of URL for six months for DP and GP Ranges 3 through 8. (±0.25% for all other ranges and transmitters.)

**Output Codes E and G:**

±0.2% of URL for six months for Ranges 3 through 5. (±0.25 for all other ranges.)

**Output Codes J, L, and M:**

±0.25% of URL for six months.

### Temperature Effect

**Output Code S [–20 to 185 °F (–29 to 85 °C)]:**

**For DP and GP transmitter Range 4 through 8:**
Zero Error = ±0.25% URL per 100 °F (56 °C)
Total Error = ±(0.25% URL + 0.25% of calibrated span) per 100 °F; double the effect for other ranges and transmitters.

**Output Code E, G, L, and M:**

**For Ranges 4 through 0:**
Zero Error = ±0.5% URL per 100 °F.
Total Error = ±(0.5% URL + 0.5% of calibrated span) per 100 °F; double the effect for Range 3.

**Output Code J:**

The total output effect, whether at zero or full scale, including zero and span errors is ±1.5% of URL per 100 °F (56 °C). ±2.5% of URL per 100 °F (56 °C) for Range 3.



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### Static Pressure Effect

**DP transmitters:**

**Zero Error:** ±0.25% of URL for 2,000 psi (13,790 kPa) or ±0.5% for Range 3, correctable through rezeroing at line pressure.

**Span Error:** Correctable to ±0.25% of input reading per 1,000 psi (6,895 kPa), or to ±0.5% for Range 3. For Output Code J, the span error is correctable to ±0.125% of output reading per 1,000 psi, or to ±0.25% for Range 3.

**HP transmitters:**

**Zero Error:** ±2.0% of URL for 4,500 psi (31,027 kPa), correctable through rezeroing at line pressure.

**Span Error:** Correctable to ±0.25% of input reading per 1,000 psi (6,895 kPa), or to ±0.5% for Range 3. For Output Code J, the span error is correctable to ±0.125% of output reading per 1,000 psi, or to ±0.25% for Range 3.

### Vibration Effect

0.05% of URL per g to 200 Hz in any axis.

### Power Supply Effect

**Output Codes S, E, G, and J:**

Less than 0.005% of output span per volt.

**Output Codes L, M:**

Output shift of less than 0.05% of URL for a 1 V power supply shift.

### Load Effect

**Output Codes S, E, G, and J:**

No load effect other than the change in power supplied to the transmitter.

**Output Codes L, M:**

Less than 0.05% of URL effect for a change in load from 100 kΩ to infinite ohms.

### Short Circuit Condition (Low Power Only)

No damage to the transmitter will result when the output is shorted to common or to power supply positive (limit 12 V).

### EMI/RFI Effect

Output shift of less than 0.1% of span when tested to SAMA PMC 33.1 from 20 to 1000 MHz and for field strengths up to 30 V/m. (Code J is 0.1% of flow span.)

### Mounting Position Effect

Zero shift of up to 1 in$H_2O$ (0.24 kPa) that can be calibrated out. Range 3 transmitters with Output Code J should be installed with the diaphragm in the vertical plane.

## Physical Specifications, Standard Configuration

### Wetted Materials

**Isolating Diaphragms**

316L SST, Hastelloy C-276, Monel, gold-plated Monel, or tantalum. See ordering table for availability per model type.

**Drain/Vent Valves**

316 SST, Hastelloy C, or Monel. See ordering table for availability per model type.

**Process Flanges and Adaptors**

Plated carbon steel, 316 SST, Hastelloy C, or Monel. See ordering table for availability per model type.

**Wetted O-rings**

Viton® (other materials also available). With gold-plated Monel diaphragms (diaphragm Code _6), special fluorocarbon O-rings are supplied.

### Non-wetted Materials

**Fill Fluid**

Silicone oil or inert fill.

**Bolts**

Plated carbon steel.

**Electronics Housing**

Low-copper aluminium. NEMA 4X.

**Cover O-rings**

Buna-N.

**Paint**

Epoxy-polyester.

### Process Connections

1/4–18 NPT on 2.125-in. (54-mm) centers on flanges for Ranges 3, 4, and 5.

1/4–18 NPT on 2.188-in. (56-mm) centers on flanges for Ranges 6 and 7.

1/4–18 NPT on 2.250-in. (57-mm) centers on flanges for Range 8.

1/2–14 NPT on adaptors.

For Ranges 3, 4, and 5, flange adaptors can be rotated to give centers of 2.0 in. (51 mm), 2.125 in. (54 mm), or 2.250 in. (57 mm).

### Electrical Connections

1/2–14 NPT conduit with screw terminals and integral test jacks compatible with miniature banana plugs (Pomona 2944, 3690, or equivalent). The Model 268 SMART FAMILY Interface connections are fixed to the terminal block on smart transmitters.

### Weight

12 lb (5.4 kg) for AP, DP, GP, and HP transmitters, excluding options.



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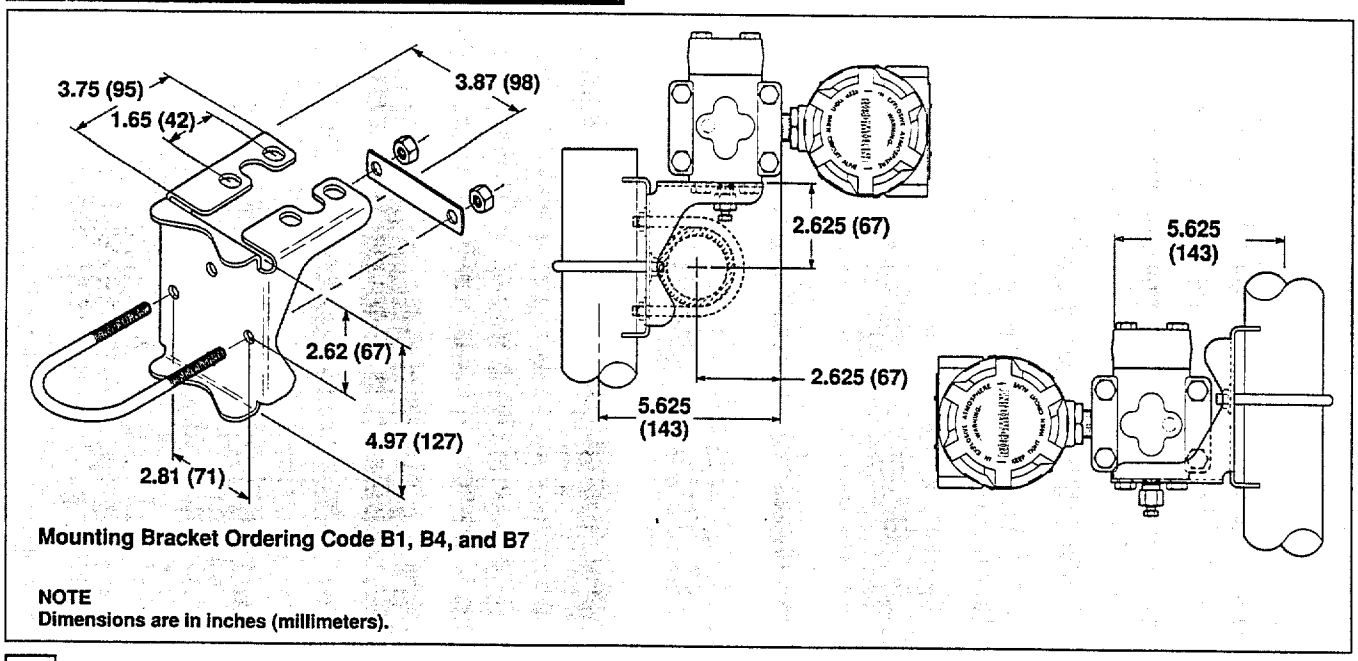
## OPTIONAL SELECTIONS

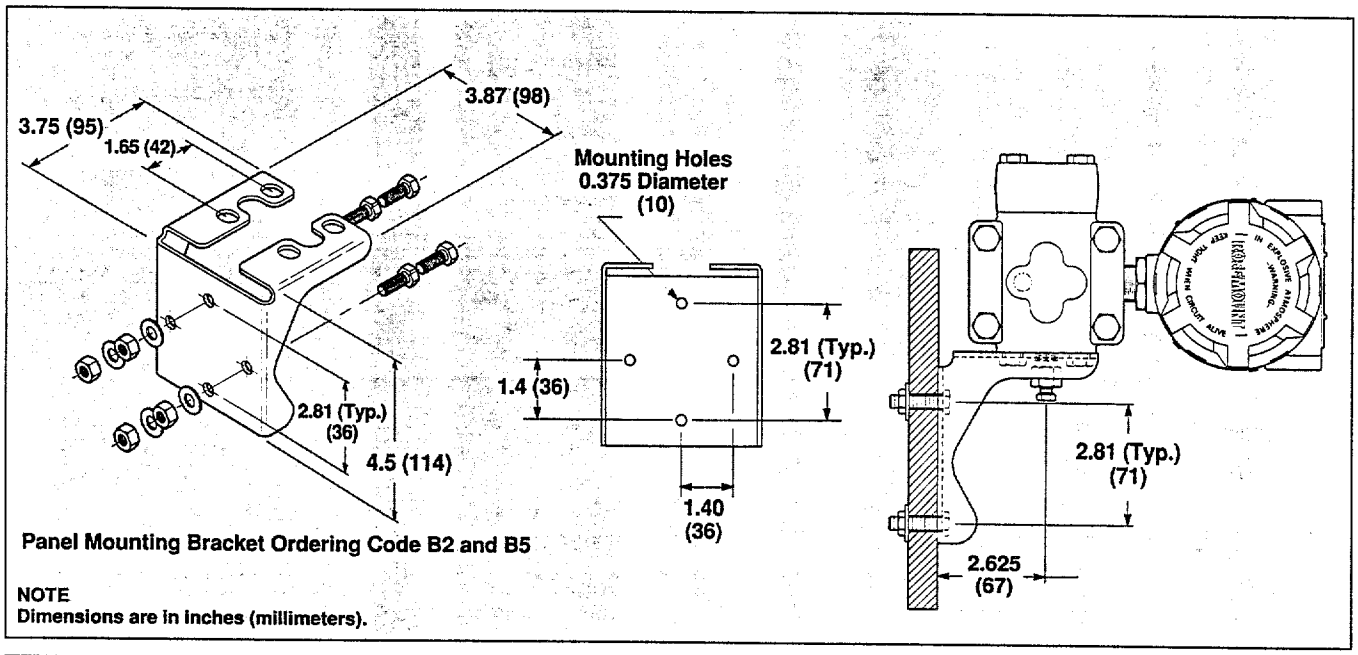
The following sections describe a variety of available options for the Model 1151 Transmitter. These options will permit greater application flexibility.

## Mounting Brackets




**B1 Bracket for 2-in. Pipe Mounting**

- Bracket for mounting transmitter on 2-in. pipe.
- Constructed of carbon steel with carbon steel U-bolt.
- Coated with epoxy-polyester paint.




**B2 Bracket for Panel Mounting**

- Bracket for mounting transmitter on panel or wall.
- Constructed of carbon steel with carbon steel bolts.
- Coated with epoxy-polyester paint.



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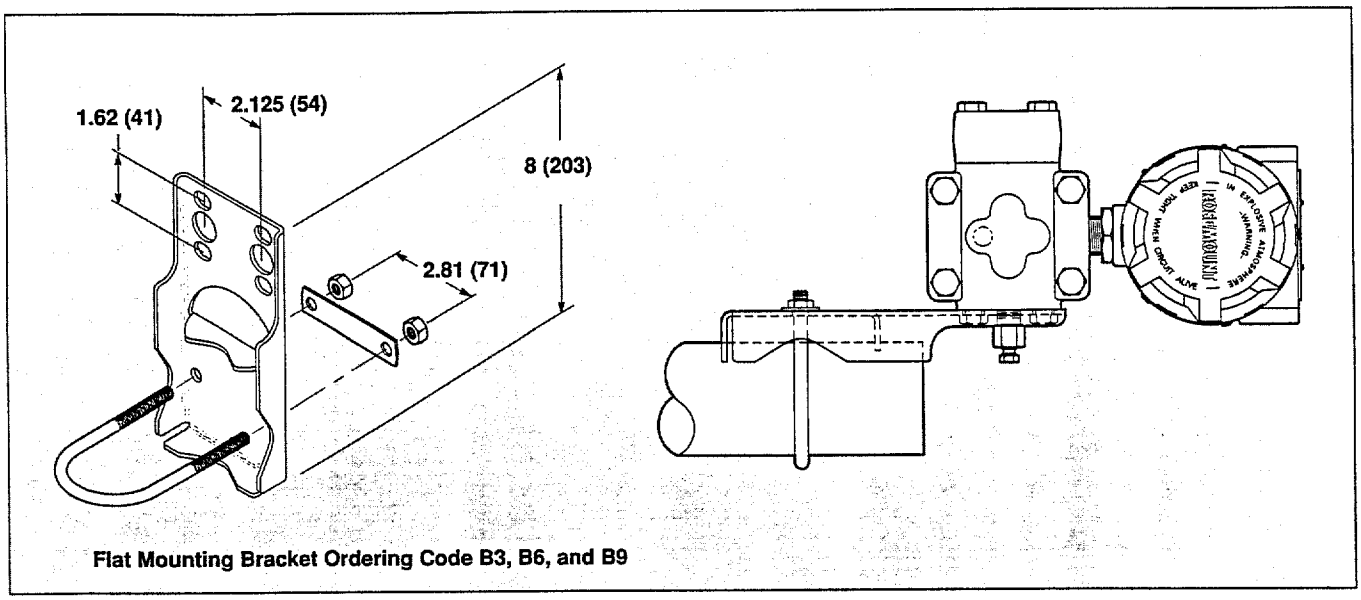


Flat Mounting Bracket Ordering Code B3, B6, and B9

**B3 Flat Bracket for 2-in. Pipe Mounting**
- Bracket for vertical mounting of transmitter on 2-in. pipe.
- Constructed of carbon steel with carbon steel U-bolt.
- Coated with epoxy-polyester paint.

**B4 Bracket for 2-in. Pipe with 316 SST Bolts**
- Same bracket as Option B1 with 316 SST bolts.

**B5 Bracket for Panel with 316 SST Bolts**
- Same bracket as Option B2 with 316 SST bolts.

**B6 Flat Bracket for 2-in. Pipe with 316 SST Bolts**
- Same bracket as Option B3 with 316 SST bolts.

**B7 304 SST Bracket and 316 SST Bolts for 2-in. Pipe Mounting**
- Same bracket as Option B1 with all SST materials.

**B9 304 SST Flat Bracket and 316 SST Bolts for 2-in. Pipe Mounting**
- Same bracket as Option B3 with all SST materals.

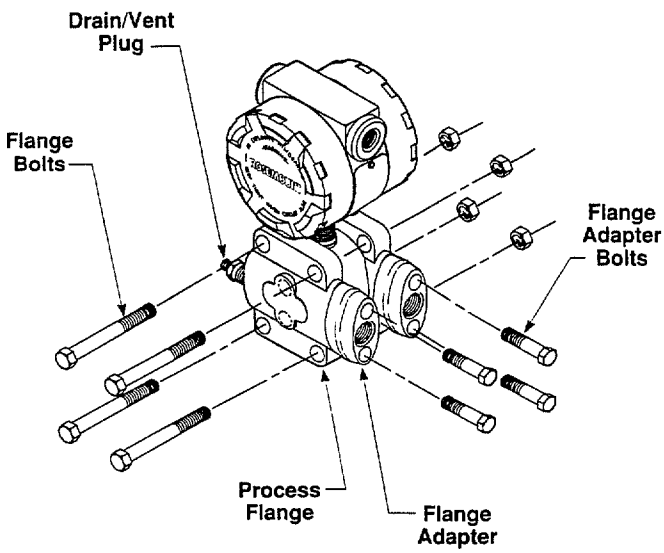
## Bolts and Nuts for Flanges and Adapters

- Options permit bolts and nuts for flanges and adapters in the specified material.

**L3 ANSI/ASTM A - 193-B7**

**L4 Austenitic 316 SST**

**L5 ANSI/ASTM A193-BFM**



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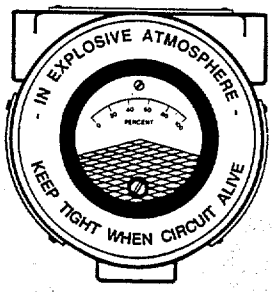
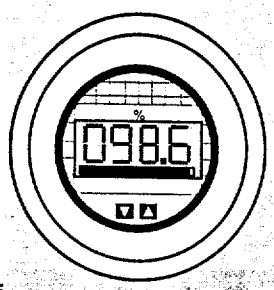
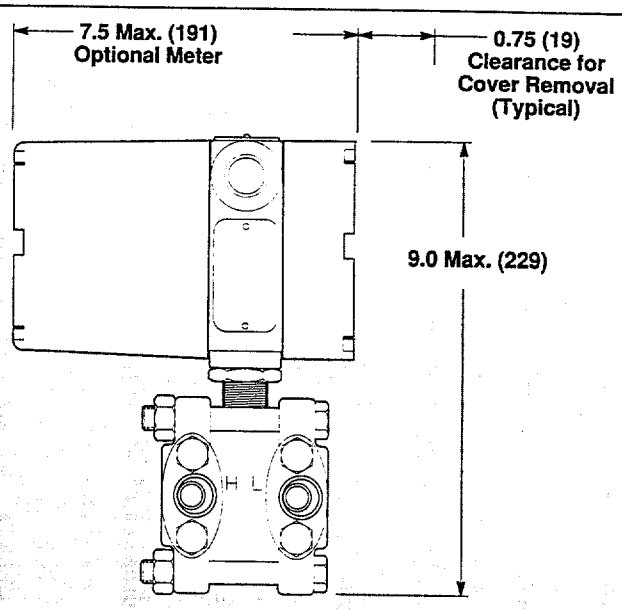
# Meters




Option Code M1
Linear Scale




Option Code M4
Linear Scale




NOTE
Dimensions are in inches (millimeters).

## ANALOG

- Meters have 2-in. (50.8 mm) scale.
- Plug-in mounting configuration.
- Indication accuracy ±2%.
- Operating temperature limit: –40 to 150 °F (–40 to 65 °C)
- Meters are enclosed in a housing certified by Factory Mutual as explosion proof for Class I, Division 1, Groups B, C, and D; Class II, Division 1, Groups E, F, and G and Class III, Division 1.
- For Optional CSA explosion-proof approval, see certification Option Code E6.

**M1 Linear Analog Meter, 0–100% Scale**

**M2 Square Root Analog Meter, 0–100% Flow Scale**

**M3 Special Scaling Analog Meter(Specify Range)**

**M6 Square Root Analog Meter, 0–10√ Scale**

NOTES

Meter Options are not available with Output Codes L or M, or Option Codes V2 or V3.

Meter Options M2, M6, M8, and M9 are not available with Output Code J.

Meter Options M4, M7, M8, and M9 are not available with Output Code G.

## LCD

- 4-digit display.
- Indication accuracy ±0.25% of calibrated span ±1 digit.
- Display resolution at ±0.5% of calibrated span ±1 digit.
- Operating temperature limit: –4 to 158 °F (–20 to 70 °C).
- Plug-in mounting configuration.
- Meters are enclosed in a housing certified by Factory Mutual as explosion proof for Class I, Division 1, Groups B, C, and D; Class II, Division 1, Groups E, F, and G and Class III, Division 1.
- For Optional CSA explosion-proof approval, see certification Option Code E6.

**M4 Linear LCD Meter, 0 to 100%**

**M7 Special Scale LCD Meter (Specify Range, Mode, and Engineering Units)**

**M8 Square Root LCD Meter, 0 to 100%**

**M9 Square Root LCD Meter, 0 to 10**



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# Certifications

TABLE 4. FM Entity Approvals.

| 1151 PARAMETERS | EQUIPMENT ASSOCIATED PARAMETERS | FM APPROVED FOR CLASS I, II, III, DIVISION 1 AND 2 GROUPS | | |
|---|---|---|---|---|
| | | A | B | C–G |
| $V_{MAX}$ = 40 V<br>$I_{MAX}$ = 165 mA<br>$C_I$ = 0 (Standard Model 1151)<br>$C_1$ = 0.024 µF (Smart))<br>$L_I$ =0 | $V_{OC} \leq 40$ V<br>$I_{SC} \leq 165$ mA<br>$C_A > 0$ (Standard)<br>$C_A > 0.024$ µF (Smart)<br>$L_A > 0$ | • | • | • |
| $V_{MAX}$ = 40 V<br>$I_{MAX}$ = 225 mA<br>$C_I$ = 0<br>$C_1$ = 0.024 µF (Smart)<br>$L_I$ = 0 | $V_{OC} \leq 40$ V<br>$I_{SC} \leq 225$ mA<br>$C_A > 0$<br>$C_A > 0.024$ µF (Smart)<br>$L_A > 0$ | NA | NA | • |

TABLE 5. CSA Barrier Selection.

| BARRIER MANUFACTURER/MODEL | CSA APPROVED FOR CLASS I, DIVISION 1 AND 2 GROUPS | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Any CSA Approved Barrier ≤ 30 V, ≥330 Ω or ≤ 28 V, ≥ 300 Ω or ≤ 22 V, ≥ 180 Ω | • | • | • | • |
| Foxboro Converters 2AS-I3I-CGB, 2AI-I3V-CGB, 2AI-I2V-CGB 2AS-I2I-CGB, 3A2-I2D CS-E/CGB-A, 3F4-I2DA1 CS-E/CGB-A, 3AD-I3IA CS-E/CGB-A, 3A2-I3D CS-E/CGB-A, AND 3A4-I2DA CS-E/CGB-A | NA | • | • | • |
| Any CSA Approved Barrier ≤ 30 V, ≥ 120 Ω | NA | NA | • | • |

## Hazardous Locations Certifications

Stainless steel certification tag is provided.

### Factory Mutual (FM) Approvals

FM Explosion Proof tag is standard. Appropriate tag will be substituted if optional certification is selected.

Explosion Proof: Class I, Division 1, Groups B, C, and D. Dust-Igniton Proof: Class II, Division 1, Groups E, F, and G. Suitable for use in: Class III, Division 1. Indoor and outdoor use. NEMA 4X.

**I5** Intrinsic Safety and Non-incendive Approvals: FM certifications optional for specific Classes, Divisions, and Groups when connected in accordance with the FM entity approvals table, Table 4.

### Canadian Standards Association (CSA) Approvals

**E6** Explosion proof for Class I, Division 1, Groups C and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 Hazardous Locations. Certified for Class I, Division 2, Groups A, B, C, and D; CSA enclosure 4, factory sealed.

**I6** Intrinsic Safety Approvals CSA certifications optional for specific Classes, Divisions, and Groups when connected in accordance with the CSA barrier selection table, Table 5. Not available with Output Code G.

**C6** Combination of I6 and E6, CSA Explosion Proof and Intrinsic Safety Approval.

### Standards Association of Australia (SAA) Flameproof Certification

**E7** Ex d IIB T6; DIP T6; IP 65.
Class I, Zone 1.

### Standards Association of Australia (SAA) Intrinsic Safety Certification

**I7** Analog:
Ex ia IIC T6; Class I, Zone 0.

Smart:
Ex ia IIC T6; Class I, Zone 0.

Low Power:
Ex ia IIC T4; Class I, Zone 0.

### CESI/CENELEC Flameproof Certification

**E8** 90.C.016: EEx d IIC T6 (without meter).
90.C.017: EEx d IIB + H2 T6 (with meter).
IP 65.

### CESI/CENELEC Intrinsic Safety Certification

**I8** EEx ia IIC T6 ($P_{max}$ = 0.35 W).
EEx ia IIC T5 ($P_{max}$ = 1.00 W).
IP 65.



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**BASEEFA/CENELEC Intrinsic Safety Certification**

I1 Smart:
EEx ia IIC T5 ($T_{amb}$ = 40 °C).
EEx ia IIC T4 ($T_{amb}$ = 80 °C).

Analog:
EEx ia IIC T5.

**BASEEFA Type N (Non-incendive) Certification**

N1 Output Code S:
Ex N II T5 ($T_{amb}$ = 50 °C); Un = 45 V.
Ex N II T4 ($T_{amb}$ = 80 °C); Un = 45 V.

Output Code E:
Ex N II T6; Un = 28 V.

Output Code F:
Ex N II T5; Un = 45 V.

Output Code J:
Ex N II T5; Un = 30 V; In = 30 mA.

**Schweizerischer Elektrotechnischer Verein (SEV) Intrinsic Safety Certification**

IC Smart:
EEx ia IIC T5 ($T_{amb}$ = 40 °C).
EEx ia IIC T4 ($T_{amb}$ = 80 °C).

Analog:
EEx ia IIC T6 ($P_{max}$ = 0.35 W).
EEx ia IIC T5 ($P_{max}$ = 0.65 W).
EEx ia IIC T4 ($P_{max}$ = 0.95 W).

## Process Connections

**D1 Side Drain/Vent-Top**

- Drain/vent valve mounted in side of flange.
- Top position used to vent gas buildup in liquid process applications with transmitter mounted vertically.
- Plug of same material as requested flange inserted in end of flange opposite adapter.

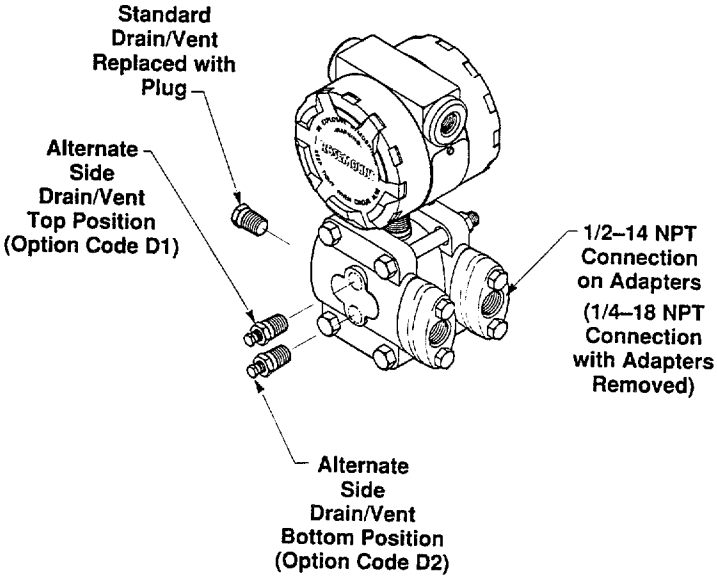
**D2 Side Drain/Vent-Bottom**

- Drain/vent valve mounted in side of flange.
- Bottom position used to drain liquid buildup in gas process applications with transmitter mounted vertically.
- Plug of same material as requested flange inserted in end of flange opposite adapter.

**D3 1/4–18 NPT Process Connection**

- Option provides 1/4–18 NPT process connection on flanges rather than standard 1/2–14 NPT.
- Flange adapters are deleted to provide desired connection.

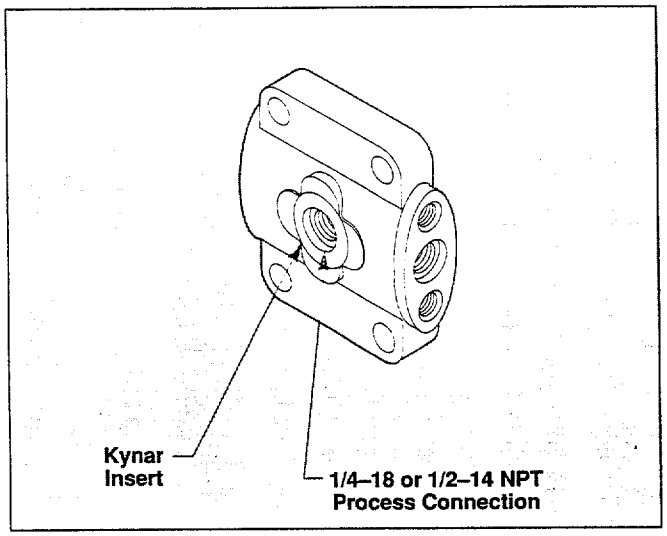
**D6 316 SST Low Side Flange (Models 1151GP and 1151AP Only)**



**K1** **1/4–18 NPT Kynar™ Process Flange Insert**

**K2** **1/2–14 NPT Kynar Process Flange Insert**

- Options provide Kynar plastic process flange insert that prevents process from coming in contact with the metal of the flange. One process insert for Models 1151AP, GP and LT; two inserts for Model 1151DP.
- Process connections are from the side.
- Available with carbon steel and stainless steel process flanges only.
- Pressure Maximum: 200 psi at 200 °F with Kynar impulse piping; 300 psi at 200 °F with metal impulse piping.




**S1** **Assembled with One Remote Diaphragm Seal**

**S2** **Assembled with Two Remote Diaphragm Seals**

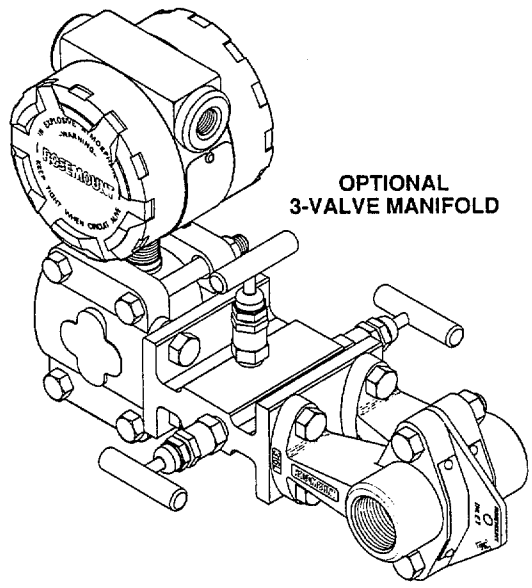
- Options provide for the assembly of one or two remote diaphragm seals.
- For Models 1151AP and 1151LT applications consult factory.
- For seal choices, consult remote seal product data sheet PDS 4394.

**S4** **Assembled with Model 1195 Integral Orifice**

- Designed for highly accurate, small-bore flow measurement of any clean gas, liquid, or vapor. See product data sheet PDS 4686.
- Reduce the costs associated with traditional orifice plate installations.
- Several configurations are available factory assembled to Rosemount differential pressure transmitters.①
- Wide orifice bore/flow range capability.
- Wide choice of process connections, including threaded, socket weld, and ANSI flanges.
- Static pressure maximum limit is 3,000 psig.
- Wetted materials are available that comply with NACE MR 01-75(90).
- Available only with Ranges 2, 3, 4, and 5.
- For integral orifice selection, see product data sheet PDS 4686.

①Applicable only to orifice assemblies without piping.

MODEL 1151 TRANSMITTER




MODEL 1195
INTEGRAL ORIFICE
ASSEMBLY



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## Wetted O-rings

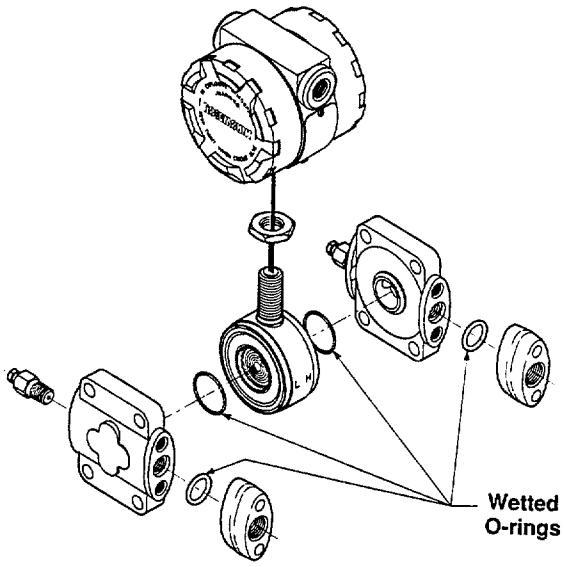
**W2** Buna N

**W3** Ethylene-Propylene

**W4** Aflas®

**W6** Spring-Loaded Teflon®

- Contains a Hastelloy spring that is in contact with the process fluid. Consult factory if Hastelloy is unacceptable.




## Procedures

### Standard Configuration

- Unless otherwise specified, transmitter will be shipped as follows:

| | |
|---|---|
| Engineering Units: | $inH_2O$ |
| 4 mA: | 0 |
| 20 mA: | Upper Range Limit |
| Output: | Linear |
| Software Tag: | Blank |

Customer may specify the above items at no charge. Software tag (8 characters) is left blank unless specified.

**C9** Custom Configuration (C9 Option)

- If option code C9 is ordered, the customer may specify the following data in addition to the standard configuration parameters. Refer to Configuration Data Sheet CDS 4593.

| | |
|---|---|
| Descriptor: | 16 characters |
| Message: | 32 characters |
| Date: | Day, Month, Year |
| Damping: | Seconds |
| Burst Mode: | Select Output Choice |
| Flange Material: | Model Code Information |
| O-Ring Material: | Model Code Information |
| Isolator Material: | Model Code Information |
| Sensor Fluid: | Model Code Information |
| Drain/Vent: | Model Code Information |
| Integral Meter: | Installed or None |
| Remote Seal: | Specified Information |
| Failure Mode: | High or Low |
| Transmitter Security: | Off or On |

**P1** Hydrostatic Testing

- Each transmitter is hydrostatic tested according to Table 6.
- Test medium is water.
- This option provided for transmitters with remote diaphragm seal on application only.
- Rosemount Procedure 1746 outlines the testing procedure.

TABLE 6. Hydrostatic Test Pressure

| MODEL | TEST PRESSURE |
|---|---|
| 1151DP | 3,000 psi |
| 1151HP | 6,750 psi |
| 1151AP | 2,000 psi |
| 1151GP | |
| Ranges 3–8 | 2,000 psi |
| Range 9 | 4,500 psi |
| Range 0 | 7,500 psi |
| 1151LT | |
| Class 150 Flange | 450 psi |
| Class 300 Flange | 1,100 psi |
| 1151DR | 1,500 psi |

**P2** Cleaning for Special Service

- This option minimizes contaminants to the process system by cleaning wetted surfaces with a suitable detergent.
- Rosemount Procedure 97412 outlines the cleaning procedure.

**P4** Calibration at Line Pressure

- This option allows transmitters to be calibrated at an elevated line pressure rather than atmospheric pressure.
- Customer must specify line pressure at which transmitter is to be calibrated.
- Customer is provided with calibration data at line pressure and equivalent data at atmospheric pressure.



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- Available with Models 1151DP and 1151HP only. (Not available with Remote Seals.)
- Elevated line pressure and differential span desired for calibration must not exceed the rated pressure for that model of transmitter.
- Minimum differential span that can be calibrated at elevated line pressure is 30 in$H_2O$; maximum is 300 psi.
- Rosemount Procedure 3787 outlines the calibration procedure.

### P5 Calibration at Temperature

- This option allows transmitters to be calibrated at temperatures other than room temperature in the range of 0 to 200 °F (–18 to 93 °C).
- Customer must specify temperature at which transmitter is to be calibrated and calibration range.
- Calibration temperature will be printed on instrument tag specified by customer, or on a tag wired to the transmitter if no tag is specified.
- Rosemount Procedure 27823B outlines the calibration procedure.

### P7 Enhanced Temperature Performance for Analog Electronics

- Transmitter is specifically compensated as a complete assembly and will exhibit 1/2 of the standard temperature coefficient over the ambient temperature range of 20 to 140 °F (–7 to 60 °C). Outside this range, the unit will meet the standard temperature effect specification published for that model.
- Not available on Range 10, limited to 1,500 psi on Range 9.
- The transmitter is compensated as an assembly; therefore, units in which the sensor module or electronics are changed after the P7 procedure has been performed will meet the standard published temperature specification for that particular model.
- Available on DP, GP, and HP models, Ranges 3–8, with SST diaphragms and Output Codes E, G, L, and M.

### P8 0.1% Accuracy for Analog Electronics

- Available on Model 1151DP (Ranges 3–8), GP (Ranges 3–8), HP, and LT transmitters with 316 SST diaphragms and Output Codes E, G, L, and M.

## Outputs

### V1 Reverse Output

- This option permits reversing of pressure input so that electrical output will increase as pressure input decreases.
- This option applies only to Models 1151GP and 1151LT. When this option is selected, the process flange, adapter, drain/vent valve, appropriate O-rings, and bolting are installed on low side of transmitter. Not available for Ranges 9 and 0.
- Not available with Model 1151AP. Reverse output on Models 1151DP, 1151HP, and 1151DR can be obtained by connecting high-pressure input to low side of transmitter and vice versa.
- This option should not be ordered with smart transmitters (Output Code S). The Model 1151 Smart transmitter can be configured for reverse output through the Model 268 SMART FAMILY® Interface.

### V2 1 Ω Test Resistor

- A 1 Ω precision resistor is mounted across the test terminals to provide 4–20 mV output or a 10–50 mV output if 10–50 mA output is used.
- This option cannot be used with any meter options or I5 or I6.

### V3 5 Ω Test Resistor

- A 5 Ω precision resistor is mounted across test terminals to provide 20–100 mV output or a 50–250 mV output if 10–50 mA output is used.
- This option cannot be used with any meter options or I5 or I6.

### Z1 4-Wire, 0–20 mA Output

### Z2 4-Wire, 0–16 mA Output

### Z3 4-Wire, 0–10 mA Output

- These options provide a zero-based current output.
- These options cannot be used with any meter or certification options, Vx options, or Output Codes G, L, M, or S.



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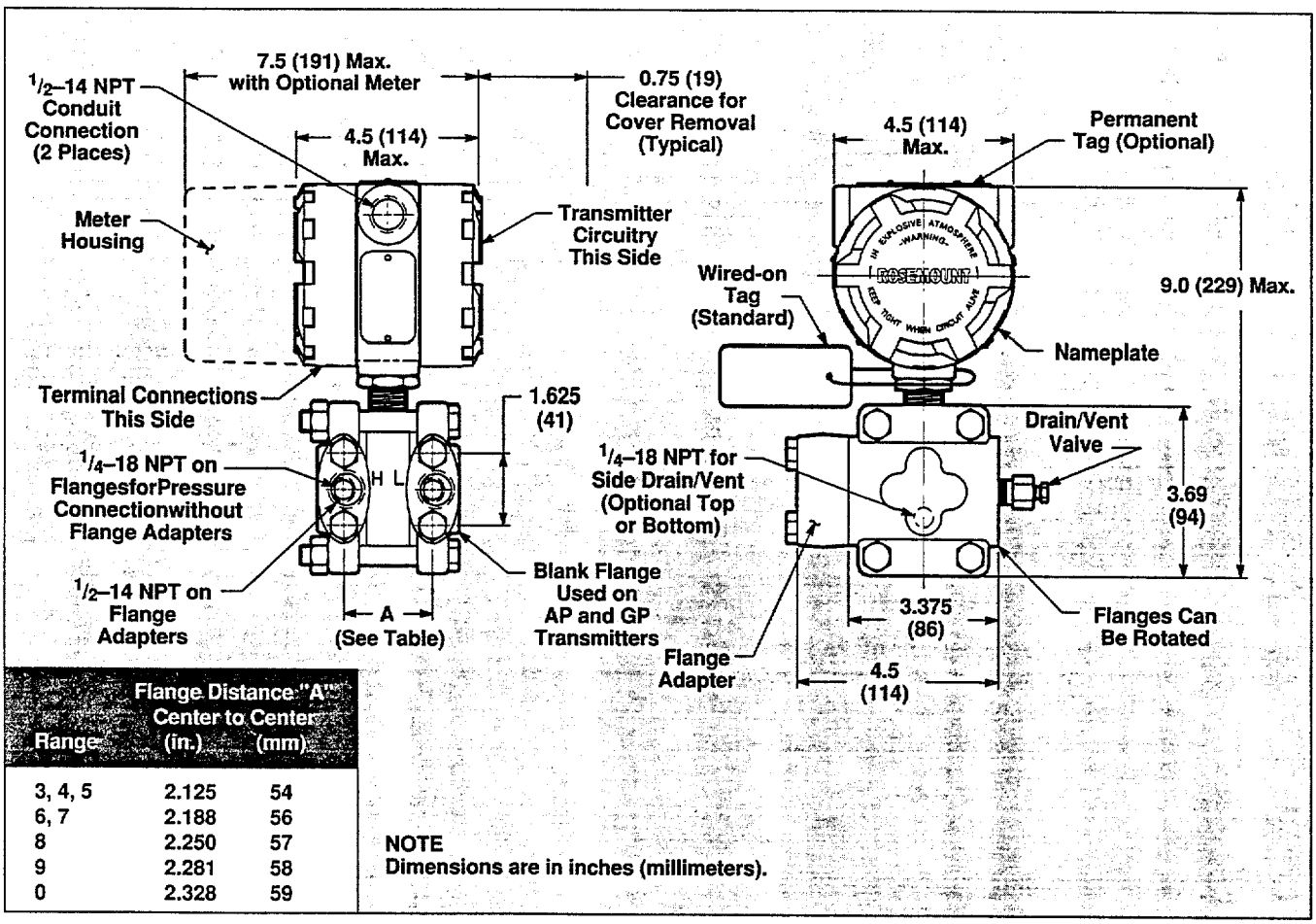


| Range | Flange Distance "A" Center to Center (in.) | (mm) |
|---|---|---|
| 3, 4, 5 | 2.125 | 54 |
| 6, 7 | 2.188 | 56 |
| 8 | 2.250 | 57 |
| 9 | 2.281 | 58 |
| 0 | 2.328 | 59 |

**NOTE**
Dimensions are in inches (millimeters).

FIGURE 1. Model 1151 Transmitter Dimensional Drawing.

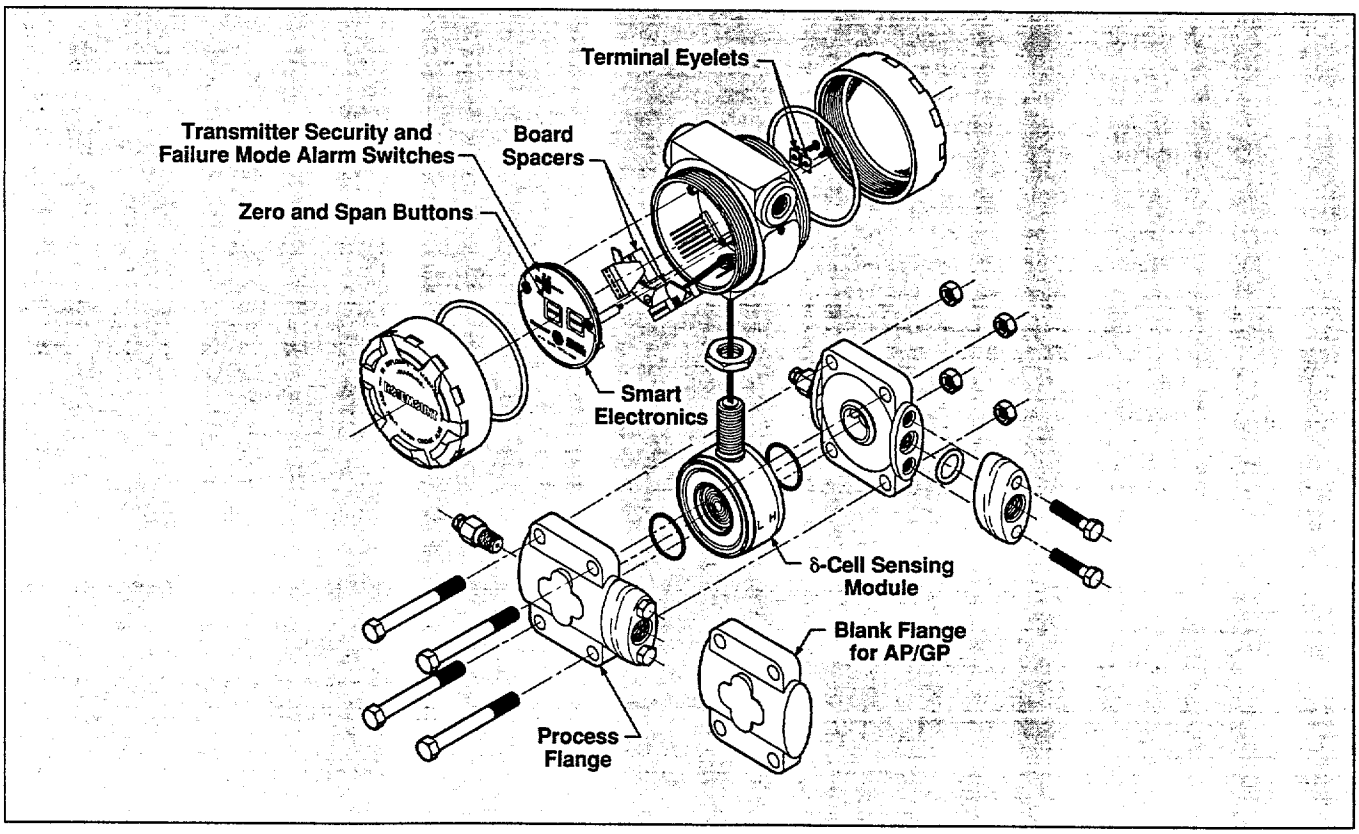


FIGURE 2. Typical Transmitter Exploded View, Shown with Smart Electronics.



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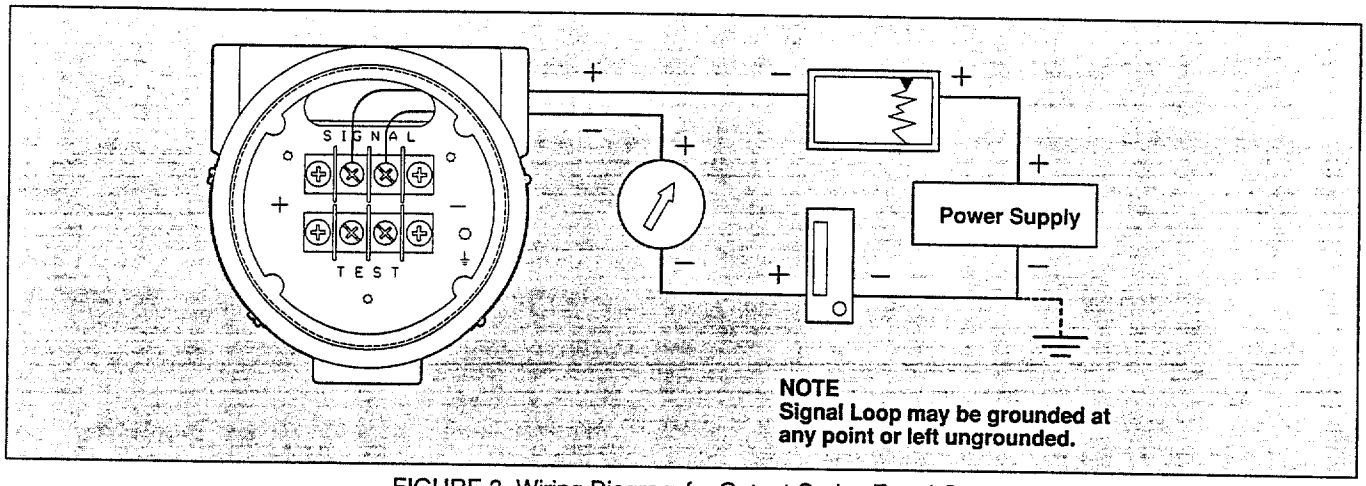


FIGURE 3. Wiring Diagram for Output Codes E and G.

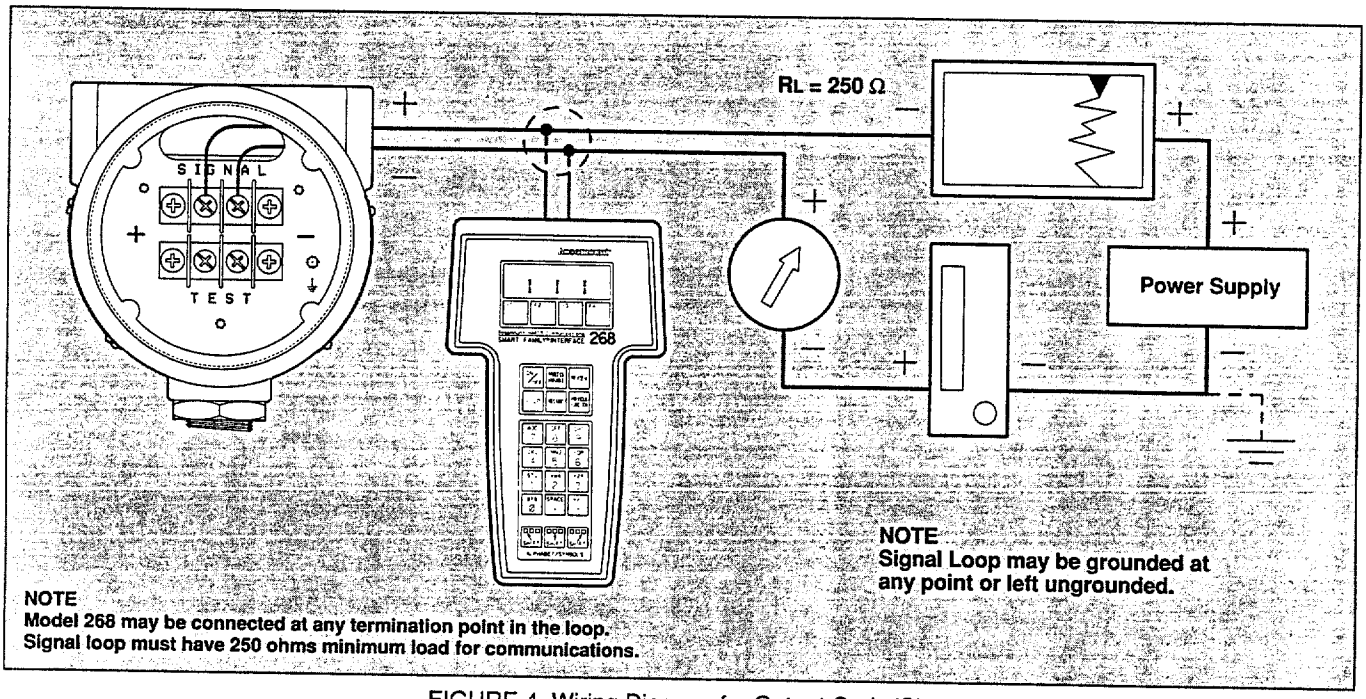


FIGURE 4. Wiring Diagram for Output Code 'S'.

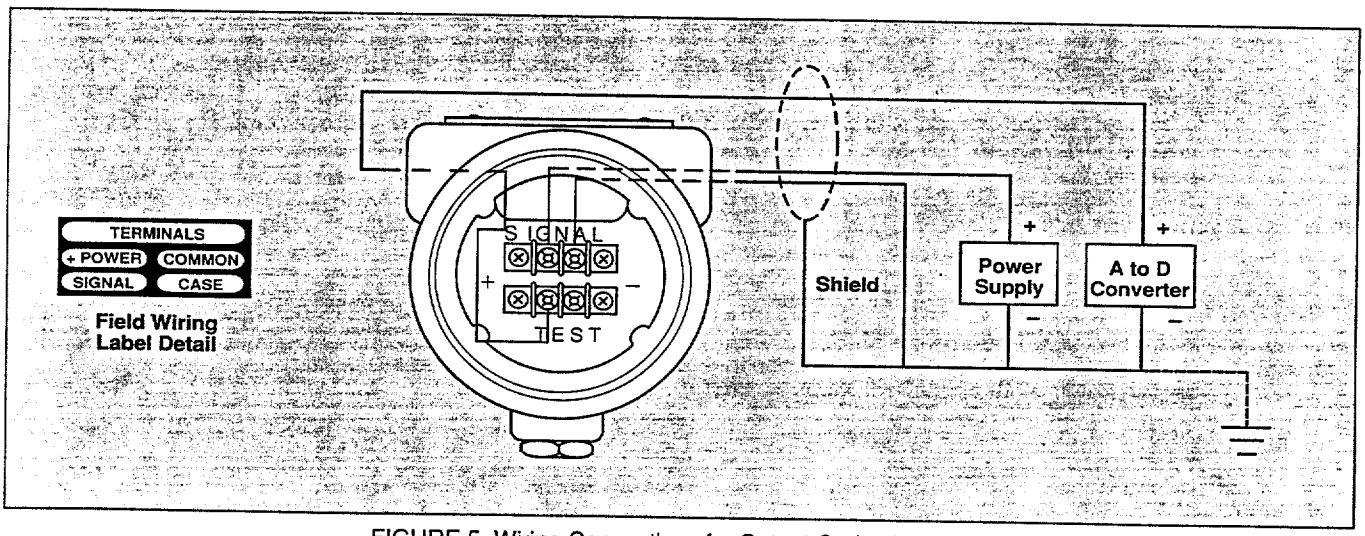


FIGURE 5. Wiring Connections for Output Codes L and M.



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## TRANSMITTER OPTION INFORMATION

The following table lists possible transmitter options as either standard or optional selections.
The ☞ symbol indicates selections that make up the typical model number "1151DP 4 S 52 B3 M1."
Use this table to identify or order a Model 1151 Pressure Transmitter.

NA = Not Applicable

### Standard Selections

| | MODEL | TRANSMITTER TYPE (select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|---|
| ☞ | 1151DP | Differential Pressure Transmitter | • | | | |
| | 1151HP | Differential Pressure Transmitter for High Line Pressures | | • | | |
| | 1151GP | Gage Pressure Transmitter | | | • | |
| | 1151AP | Absolute Pressure Transmitter | | | | • |

| | CODE | PRESSURE RANGES (URL) (select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|---|
| | 3 | 30 $inH_2O$ (7.46 kPa) | • | • | • | NA |
| ☞ | 4 | 150 $inH_2O$ (37.3 kPa) | • | • | • | • |
| | 5 | 750 $inH_2O$ (186.4 kPa) | • | • | • | • |
| | 6 | 100 psi (689.5 kPa) | • | • | • | • |
| | 7 | 300 psi (2,068 kPa) | • | • | • | • |
| | 8 | 1,000 psi (6,895 kPa) | • | NA | • | • |
| | 9 | 3,000 psi (20,684 kPa) | NA | NA | • | NA |
| | 0 | 6,000 psi (41,369 kPa) | NA | NA | • | NA |

**Rangeability**

| Output Code | Min. Span |
|---|---|
| S (DP and GP, SST, Range 3–8) | URL/10 |
| S (all others) | URL/6 |
| E, G, J | URL/6 |
| L | URL/1.1 |
| M | URL/2 |

| | CODE | TRANSMITTER OUTPUT (select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|---|
| ☞ | S | 4–20 mA/digital, Smart/variable damping | • | • | • | • |
| | E | 4–20 mA, linear, analog/variable damping | • | • | • | • |
| | G | 10–50 mA, linear, analog/variable damping | • | • | • | • |
| | J | 4–20 mA, square root, analog/variable damping | • | • | NA | NA |
| | L | 0.8 to 3.2 V, linear, low power/fixed damping | • | • | • | • |
| | M | 1 to 5 V, linear, low power/fixed damping | • | • | • | • |

MATERIALS OF CONSTRUCTION (select one) ①

| | CODE | FLANGES/ADAPTORS | DRAIN/VENTS | DIAPHRAGMS | FILL FLUID | DP | HP | GP② | AP② |
|---|---|---|---|---|---|---|---|---|---|
| ☞ | 52 | Nickel-plated carbon steel | 316 SST | 316L SST | Silicon | • | • | • | • |
| | 53 | Nickel-plated carbon steel | 316 SST | *Hastelloy C* | Silicon | • | • | • | • |
| | 54 | Nickel-plated carbon steel | 316 SST | *Monel* | Silicon | • | • | • | • |
| | 55 | Nickel-plated carbon steel | 316 SST | Tantalum | Silicon | • | NA | • | NA |
| | 56 | Nickel-plated carbon steel | 316 SST | Gold-plated *Monel* | Silicon | • | NA | • | NA |
| | 12 | Cadmium-plated carbon steel | 316 SST | 316L SST | Silicon | • | • | • | • |
| | 22 | 316 SST | 316 SST | 316L SST | Silicon | • | • | • | • |
| | 23 | 316 SST | 316 SST | *Hastelloy C* | Silicon | • | • | • | • |
| | 24 | 316 SST | 316 SST | *Monel* | Silicon | • | • | • | • |
| | 25 | 316 SST | 316 SST | Tantalum | Silicon | • | NA | • | NA |
| | 26 | 316 SST | 316 SST | Gold-plated *Monel* | Silicon | • | NA | • | NA |
| | 33 | *Hastelloy C* | *Hastelloy C* | *Hastelloy C* | Silicon | • | • | • | • |
| | 34 | *Hastelloy C* | *Hastelloy C* | *Monel* | Silicon | • | NA | • | NA |
| | 35 | *Hastelloy C* | *Hastelloy C* | Tantalum | Silicon | • | NA | • | NA |

**continued on next page**

**NOTES**

① Bolts and conduit plugs are plated carbon steel.
② On GP and AP transmitters, the low-side flange is plated carbon steel. For a stainless-steel low-side flange, order process connections Option Code D6.



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| CODE | MATERIALS OF CONSTRUCTION (1) – continued from previous page<br>FLANGES/ADAPTORS | DRAIN/VENTS | DIAPHRAGMS | FILL FLUID | DP | HP | GP (2) | AP (2) |
|---|---|---|---|---|---|---|---|---|
| 36 | *Hastelloy C* | *Hastelloy C* | Gold-plated *Monel* | Silicon | • | NA | • | NA |
| 43 | *Monel* | *Monel* | *Hastelloy C* | Silicon | • | • | • | • |
| 44 | *Monel* | *Monel* | *Monel* | Silicon | • | • | • | • |
| 45 | *Monel* | *Monel* | Tantalum | Silicon | • | NA | • | NA |
| 46 | *Monel* | *Monel* | Gold-plated *Monel* | Silicon | • | NA | • | NA |
| 73 (3) | 316 SST | *Hastelloy C* | *Hastelloy C* | Silicon | • | • | • | • |
| 83 (3) | Nickel-plated carbon steel | *Hastelloy C* | *Hastelloy C* | Silicon | • | • | • | • |
| 5A | Nickel-plated carbon steel | 316 SST | 316L SST | Inert | • | NA | • | NA |
| 5B | Nickel-plated carbon steel | 316 SST | *Hastelloy C* | Inert | • | NA | • | NA |
| 5C | Nickel-plated carbon steel | 316 SST | *Monel* | Inert | • | NA | • | NA |
| 5D | Nickel-plated carbon steel | 316 SST | Tantalum | Inert | • | NA | • | NA |
| 1A | Cadmium-plated carbon steel | 316 SST | 316L SST | Inert | • | NA | • | NA |
| 2A | 316 SST | 316 SST | 316L SST | Inert | • | NA | • | NA |
| 2B | 316 SST | 316 SST | *Hastelloy C* | Inert | • | NA | • | NA |
| 2D | 316 SST | 316 SST | Tantalum | Inert | • | NA | • | NA |
| 3B | *Hastelloy C* | *Hastelloy C* | *Hastelloy C* | Inert | • | NA | • | NA |
| 3D | *Hastelloy C* | *Hastelloy C* | Tantalum | Inert | • | NA | • | NA |
| 4B | *Monel* | *Monel* | *Hastelloy C* | Inert | • | NA | • | NA |
| 4C | *Monel* | *Monel* | *Monel* | Inert | • | NA | • | NA |
| 4D | *Monel* | *Monel* | Tantalum | Inert | • | NA | • | NA |
| 7B (3) | 316 SST | *Hastelloy C* | *Hastelloy C* | Inert | • | NA | • | NA |
| 8B (3) | Nickel-plated carbon steel | *Hastelloy C* | *Hastelloy C* | Inert | • | NA | • | NA |

## Optional Selections

| CODE | MOUNTING BRACKETS (optional – select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|
| B1 | Bracket, 2-in. pipe mount | • | • | • | • |
| B2 | Bracket, panel mount | • | • | • | • |
| ☞ B3 | Bracket, flat, 2-in. pipe mount | • | • | • | • |
| B4 | B1 bracket w/series 316 SST bolts | • | • | • | • |
| B5 | B2 bracket w/series 316 SST bolts | • | • | • | • |
| B6 | B3 bracket w/series 316 SST bolts | • | • | • | • |
| B7 | 304 SST B1 bracket with 316 SST bolts | • | • | • | • |
| B9 | 304 SST B3 bracket with 316 SST bolts | • | • | • | • |

| CODE | METERS (optional – select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|
| ☞ M1 (4) | Analog scale, linear meter, 0–100% | • | • | • | • |
| M2 (5) | Analog scale, square root meter, 0–100% Flow | • | • | NA | NA |
| M3 (4) | Analog scale, linear meter, special scale | • | • | • | • |
| M4 (4) | LCD display, linear meter, 0–100%, user scalable | • | • | • | • |
| M6 (5) | Analog scale, square root meter, 1–10 √ | • | • | NA | NA |
| M7 (6) | LCD display, linear meter, special configuration | • | • | • | • |
| M8 (5,6) | LCD display, square root meter, 0–100% flow | • | • | NA | NA |
| M9 (5,6) | LCD display, square root meter, 0–10√ | • | • | NA | NA |

**NOTES**

(1) Bolts and conduit plugs are plated carbon steel.
(2) On GP and AP transmitters, the low-side flange is plated carbon steel. For a stainless-steel low-side flange, order process connections Option Code D6.
(3) These selections meet NACE material recommendations per MR01-75.
(4) Not available with Output Code L or M, or options Zx, V2, or V3.
(5) Not available with Output Codes J, L, or M, or options Zx, V2 or V3.
(6) Not available with Output Codes G, L, or M, or options Zx, V2, or V3.

| CODE | CERTIFICATIONS (optional - select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|
| E6 | Canadian Standards Association (CSA) Explosion-proof Approval | • | • | • | • |
| I5 (7) | Factory Mutual (FM) Non-incendive and Intrinsic Safety Approval | • | • | • | • |
| I6 (7) | Canadian Standards Association (CSA) Intrinsic Safety Approval | • | • | • | • |
| C6 (7) | Combination of I6 and E6; CSA Explosion-Proof and Intrinsic Safety Approval (Requires 42.4 V dc max. power supply) | • | • | • | • |
| E7 | Standards Association of Australia (SAA) Flameproof Certification | • | • | • | • |
| E8 | CESI/CENELEC Flameproof Certification | • | • | • | • |
| I1 (8) | BASEEFA Intrinsic Safety Certification | • | • | • | • |
| I7 (8) | Standards Association of Australia (SAA) Intrinsic Safety Certification | • | • | • | • |
| I8 (14) | CESI/CENELEC Intrinsic Safety Certification | • | • | • | • |
| N1 (15) | BASEEFA Type N Certification | • | • | • | • |
| IC (8) | Schweizerischer Elektrotechnischer Verein (SEV) Intrinsic Safety Certification | • | • | • | • |

**NOTE**
FM explosion-proof approval is standard.

| CODE | BOLTS FOR FLANGES AND ADAPTORS (optional - select one) | DP | HP | GP | AP |
|---|---|---|---|---|---|
| L3 | ASTM A193-B7 flange and adaptor bolts | • | • | • | • |
| L4 | 316SST flange and adaptor bolts | • | • | • | • |
| L5 | ASTM A193-B7M flange and adaptor bolts | • | • | • | • |

| CODE | PROCESS CONNECTIONS (optional (9)) | | DP | HP | GP | AP |
|---|---|---|---|---|---|---|
| D1 | Side drain/vent, top | 316SST | • | • | • | • |
| | | *Hastelloy* | • | • | • | • |
| | | *Monel* | • | • | • | • |
| D2 | Side drain/vent, bottom | 316SST | • | • | • | • |
| | | *Hastelloy* | • | • | • | • |
| | | *Monel* | • | • | • | • |
| D3 | Process adaptors deleted | 316SST | • | • | • | • |
| | | *Hastelloy* | • | • | • | • |
| | | *Monel* | • | • | • | • |
| D6 | 316SST low side blank flange | | NA | NA | • | • |
| K1 (10) | *Kynar* insert, 1/4–18 NPT | | • | NA | • | • |
| K2 (10) | *Kynar* insert, 1/2–14 NPT | | • | NA | • | • |
| S1 (11) | Attachment of one remote seal - See PDS 4394 for ordering information | | • | NA | • | NA |
| S2 (11) | Attachment of two remote seals - See PDS 4394 for ordering information | | • | NA | NA | NA |
| S4 (12) | Attachment of Integral Orifice Assembly - See PDS 4686 for ordering information | | • | • | NA | NA |

| CODE | WETTED O-RING MATERIAL | DP | HP | GP | AP |
|---|---|---|---|---|---|
| W2 | *Buna-N* | • | • | • | • |
| W3 | Ethylene-Propylene | • | • | • | • |
| W4 | *Aflas* | • | • | • | • |
| W6 (13) | Spring-loaded *Teflon* | • | NA | • | • |

**NOTES**

(7) Not available with Output Code G or option Zx.
(8) Not available with Output Codes G, J, L, M, or option Zx.
(9) Allowable combinations are: D1, D3, D6; D2, D3, D6; and D6, S1.
(10) The maximum working pressure on this option is 300 psig.
(11) This option may only be used on ranges 4 through 8.
(12) This option has a maximum static pressure rating of 3,000 psi, and is available for factory assembly only without associated piping and is available only for ranges 2, 3, 4, and 5.
(13) Contains a Hastelloy spring that is wetted by the process; consult factory for *Teflon* O-ring without a spring.
(14) Not available with Output Codes G, J, L, M, S, or option Zx.
(15) Not available with Output Codes G, L, M, or option Zx.



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| CODE | PROCEDURES | DP | HP | GP | AP |
|---|---|---|---|---|---|
| C9 (16) | Software configuration | • | • | • | • |
| P1 | Hydrostatic testing, 150% maximum working pressure | • | • | • | • |
| P2 | Cleaning for special service | • | • | • | • |
| P4 | Calibrate at line pressure | • | • | NA | NA |
| P5 | Calibrate at specific temperature | • | • | • | • |
| P7 (17) | Improved temperature coefficient | • | • | • | • |
| P8 (18) | Calibrate to 0.1% accuracy | • | • | • | NA |
| **CODE** | **OUTPUTS** | **DP** | **HP** | **GP** | **AP** |
| V1 (19) | Reverse output | NA | NA | • | NA |
| V2 (20) | 4–20 mV test signal | • | • | • | • |
| V3 (20) | 20–100 mV test signal | • | • | • | • |
| Z1 (21) | 4-wire, 0–20 mA output | • | • | • | • |
| Z2 (21) | 4-wire, 0–16 mA output | • | • | • | • |
| Z3 (21) | 4-wire, 0–10 mA output | • | • | • | • |

**Typical Model Number: 1151DP 4 S 52 B3 M1**

**NOTES**

(16) Available with Output Code S only.

(17) Not available on range 10; limited to 1,500 psi on range 9; not applicable with Output Code S.

(18) Available only with stainless steel isolators and for span of 10 in$H_2O$ and greater; not applicable with Output Code S; available only with Output Codes E, G, L, or M; not available on AP or DR transmitters.

(19) Reverse output option is not needed with smart electronics; configurable via Model 268 SMART FAMILY Interface.

(20) Not available with Output Code L or M.

(21) Not available with options Mx, Vx, Ix, or Ex, or output codes G, L, M, or S.

## Standard Accessories

All models are shipped with flange adapters, drain/vent valves and one instruction manual per shipment.

## Tagging

Alphaline Pressure Transmitters will be tagged in accordance with customer requirements. Customer tag is 0.020 in. (0.051 cm) thick with 0.125 in. (0.318 cm) high letters. All tags are stainless steel.

## Calibration

Transmitters are factory calibrated to customer's specified range. If calibration is not specified, transmitters are calibrated at maximum range. Calibration is at ambient temperature and pressure.

## Optional Three-Valve Manifolds (Ranges 3–5)

**Part No. 1151-150-1:** 3-Valve Manifold, Carbon Steel (Anderson, Greenwood & Co., M4AVIC

**Part No. 1151-150-2:** 3-Valve Manifold, 316 SST with carbon steel bolts. (Anderson, Greenwood & Co., M4AVIS

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*Hastelloy is a registered trademark of Cabot Corporation.*
*Monel is a registered trademark of International Nickel Co.*
*Viton and Teflon are registered trademarks of E. I. du Pont de Nemours & Co.*
*Atlas is a registered trademark of Asahi Glass Co., Ltd.*
*Kynar is a trademark of Pennwalt Inc.*



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## OTHER MODEL 1151 LITERATURE

- Model 1151 Liquid Level (PDS 4526)
  Flange Mounted Liquid Level Transmitter
  Ranges from 25 to 2,770 in$H_2O$

- Model 1151DR (PDS 4294)
  Draft Range Differential Pressure Transmitter
  Ranges from $^1/_2$ to 6 in$H_2O$

- Model 1151DP/1151GP (PDS 4394)
  Differential or Gage Pressure Transmitters with Remote Seals
  Ranges from 25 in$H_2O$ to 1,000 psi

- Model 1151 Smart (PDS 4593)
  Microprocessor-based Transmitter
  Ranges from 5 in$H_2O$ to 6,000 psi

- Model 1151 Smart Retrofit Kit (PDS 4594)

**Rosemount Inc.**
**Measurement Division**
12001 Technology Drive
Eden Prairie, MN 55344 USA
Tel (612) 941-5560
Telex 4310012
Fax (612) 828-3088

**WATER METER SVMV-1**
**AB SVENSK VARMFMATNING SVM**
**Isolation Relay, Energy Meter and**
**Energy Integrator SVM93**
**Exhibit 6-5A to 6-5F**

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# Water Meter SVMV-1 (winged wheel)

SVM

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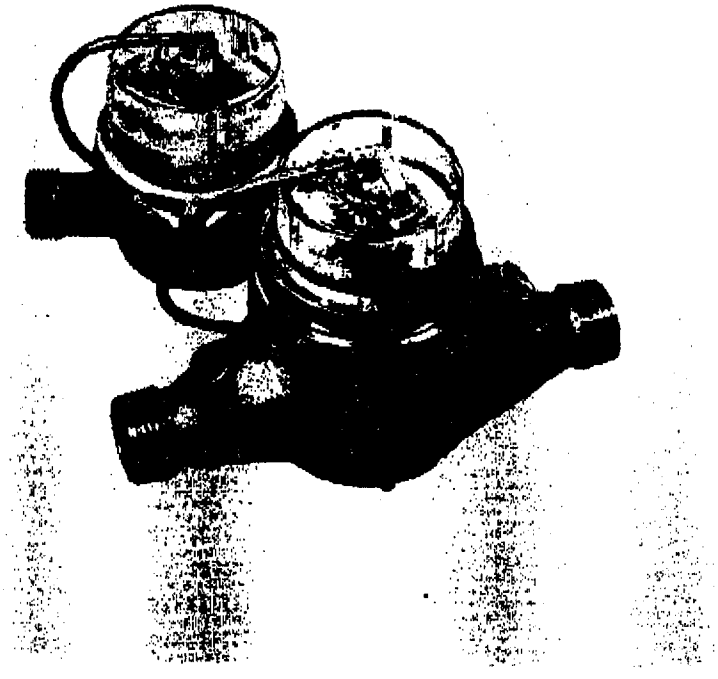
The SVMV-1 is used as flow meter for electronic energy meters in heating or cooling applications. It is compatible with Integration Units SVME.

The SVMV-1 is of dry dial type and winged wheel design, with a powerful magnetic clutch between the dry and wet sections. The magnets are corrosion resistant and they are well protected against contamination by magnetic deposits.

The meter is equipped with a digital clock and a built-in contact device. Pulse values of 2.5 l or 25 l are common standard.

120 °C

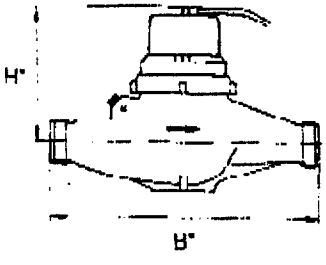


**Technical Data**

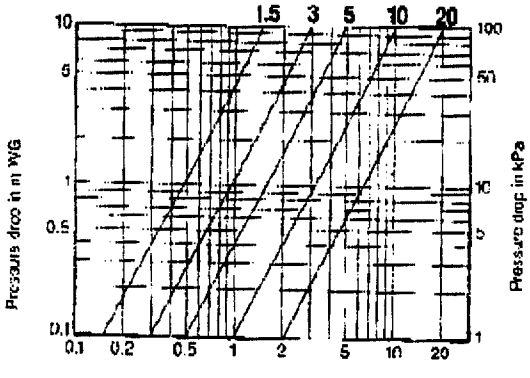
Max. temperature 120 °C
Operating pressure 16 bar
Design with threaded ends and for horizontal mounting.
Pulse rating max. 24 V/2 VA 0.2 A

PULSE VALUE TO BE CHOSEN CONSIDERING 1 Hz AS HIGHEST FREQUENCY

| Type Designation | | | 615 | 220 | 220 | 225 | 240 |
|---|---|---|---|---|---|---|---|
| Nominal size | | m³/h | 1.5 | 3 | 5 | 10 | 20 |
| Connection = bore | | DN | 15 | 20 | 20 | 25 | 40 |
| Max. peak load | $q_{max}$ | m³/h | 1.2 | 3 | 5 | 12 | 20 |
| Continuous load | $q_n$ | m³/h | 0.6 | 1.5 | 2.5 | 6 | 10 |
| Accuracy of water meter | | | | | | | |
| ±5% from | $q_{min}$ | m³/h | 0.012 | 0.030 | 0.050 | 0.090 | 0.200 |
| +2% from | $q_t$ | m³/h | 0.046 | 0.150 | 0.250 | 0.600 | 1.600 |
| Length B* | | mm | 110 | 190 | 190 | 260 | 300 |
| Height H* | | mm | 100 | 135 | 135 | 140 | 155 |
| Thread on meter | | BSP | 3/4 | 1 | 1 | 1 1/4 | 2 |
| Thread on coupling | | DGP | 1/2 | 3/4 | 3/4 | 1 | 1 1/2 |
| Weight | | kg | 0.8 | 1.9 | 1.9 | 2.9 | 5.1 |

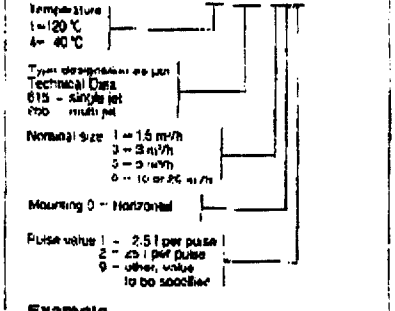



**Pressure losses**




**Ordering Key**

**Water Meter SVMV-a-bbb-ccde-f**




**Example**

Water Meter SVMV-1-220-301-5

AB SVENSK VÄRMEMÄTNING SVM Box 60, S-163 91 SPÅNGA, SWEDEN · Phone (INT + 46) 8 761 70 70 · Telex 13685 SVM S

# Water Meter SVMV-1 (Woltman type)

SVM

12/13

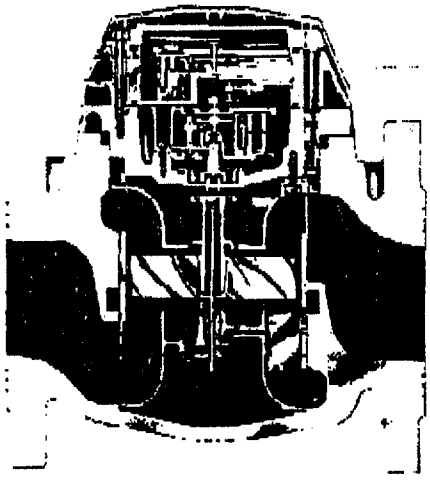
The SVMV-1 is used as a flow meter for electronic energy meters and it is compatible with all integrators of SVM type.

The meter is of Woltman type and designed so that the impeller is the only moving part in the wet section of the meter.

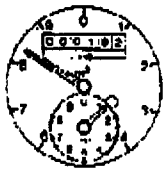
The pulse device is of "plug-in" type with a 2 way setting offering pulse outputs corresponding to 4 or 40 pulses per centre pointer revolution.

Optical check of the impeller rotation is easily made from the top of the meter housing.

130 °C



DN 50—100



DN 150

**Technical Data**

Max. temperature 130 °C
Operating pressure 16 bar
Horizontal mounting
Pulse rating max. 24 V/2 VA/0.1 A

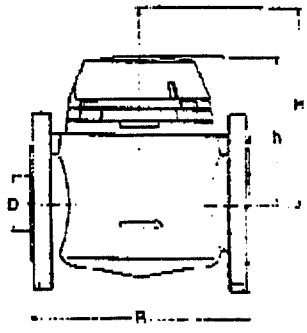
Required length of straight piping upstreams

| | |
|---|---|
| after single bend or T-junction | 2 x D |
| after non-return or trottle valve | 2 x D |
| after double bend | 3 x D |

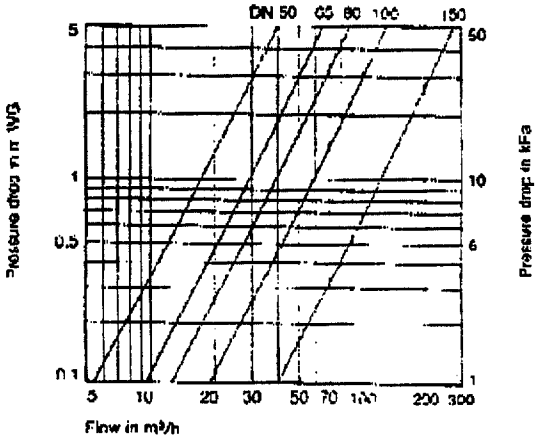
PULSE VALUE TO BE CHOSEN CONSIDERING 1 Hz AS HIGHEST FREQUENCE

| Type designation | | | 050 | 065 | 080 | 100 | 150 |
|---|---|---|---|---|---|---|---|
| Connection = bore | | DN | 50 | 65 | 80 | 100 | 150 |
| Max. peak load | $q_{max}$ | m³/h | 30 | 60 | 85 | 125 | 300 |
| Continuous load | $q_n$ | m³/h | 15 | 25 | 40 | 60 | 150 |
| Water meter accuracy | | | | | | | |
| ±5 % from | $q_{min}$ | m³/h | 0.3 | 0.5 | 0.5 | 0.6 | 1.0 |
| +2 % from | $q_t$ | m³/h | 1.5 | 3 | 3 | 4 | 12 |
| Capacity at 1 m WG | | m³/h | 18 | 30 | 40 | 60 | 125 |
| Normal pulse value | | l/pulse | 25 | 25 | 25 | 25 | 250 |
| Alternative pulse value | | l/pulse | 250 | 250 | 250 | 250 | 2500 |
| Length | B | mm | 270 | 300 | 300 | 360 | 500 |
| Height* | H | mm | 240 | 250 | 250 | 280 | 390 |
| Height | h | mm | 140 | 150 | 150 | 180 | 290 |
| Weight | | kg | 16 | 20 | 23 | 46 | 101 |

*Height H required for visual reading of digital clock




**Pressure losses**




**Ordering Key**

**Water Meter SVMV-a-bbb-1-4-e-2**

Temperature
1 = 130 °C
4 = 40 °C

Type designation as per Technical Data Table

Pulse value 2 = 25 l/pulse
3 = 250 l/pulse
4 = 2500 l/pulse

**Example**
1 Water Meter SVMV-1-050-145-2


SVM

AB SVENSK VÄRMEMÄTNING SVM
Box 60, 164 94 KISTA
tel. 08-632 96 00
fax. 08-750 97 20

MALMÖ tel. 040-29 44 65
fax. 040-29 44 07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# Isolation relay for potential-free output

SVM

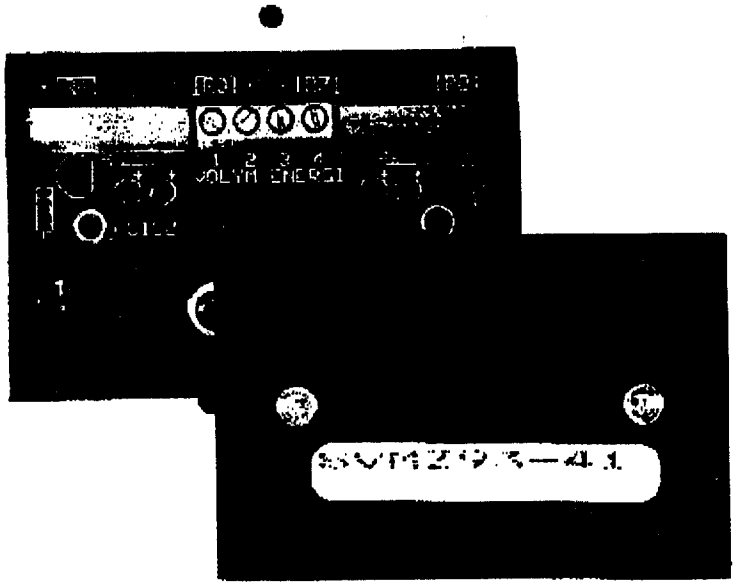
13/13

## Application

The isolation relay SVMZ93-4x is used when connecting the pulse outputs from a heat meter to a computer or any other external equipment.

The SVMZ93-4x can be used in conjunction with the following types of integration units:

- SVME62
- SVME68
- SVME9o family



## Design

The SVMZ93-4x is housed in a separate casing mounted on the outside of the meter. It is connected to the meter by a fixed cable and has a terminal strip for output signals. The casing is conveniently mounted under the SVM90 and is fastened with its backplate to the meter's sealing screw. It can also be mounted immediately adjacent to the meter.

## Measuring technique

The unit contains two signal relays, one of which is closed when the energy counter advances. The other relay is closed when the volume counter advances.
The relays are complemented with components to extend the pulses (delayed switch-off).

For circuit monitoring of the "Namur type," there is a version (SVMZ93-42) which has resistance built into the relay contacts. On the standard version (SVMZ93-41), the relay contacts are connected directly to the output terminal.

The unit consumes current every time a relay is activated. A 20-percent shorter battery lifetime can therefore be expected with battery-powered meters.

## Technical data

| | |
|---|---|
| Pulse length: | approx 200 ms |
| (contact closure) | min. 150 ms |
| Contact load: | |
| Voltage: | max. 200 V |
| Current: | max. 0.5 A |
| Power: | max. 10 W |
| Namur resistors: | |
| Series: | 2 kΩ |
| Parallel: | 14 kΩ |
| Isolation: | |
| Resistance: | min. 1,000 MΩ |
| Voltage: | max. 100 V |
| Protection class: | SEN 52 (IP 63) |
| Dimensions: | 76X53X36 mm |
| with backplate: | 76X65X36 mm |
| Cable length: | 500 mm |

## Connection

Outputs (terminal strip)
1–2 Relay contact volume pulse
3–4 Relay contact energy pulse

Inputs (fixed cable)

| Terminal number on the | | | SVME-62 | -68 | -90 |
|---|---|---|---|---|---|
| V | Volume pulse | (yellow) | 3 | 15 | 12 |
| O | Signal ground | (green) | 6 | 8 | 10 |
| + | + feed | (white) | 1 | 16 | 15 |
| E | Energy pulse | (brown) | 4 | 17 | 10 |

### Ordering Key

Isolation relay — SVMZ93-4c

1=without Namur resistors
2=with Namur resistors

AB SVENSK VÄRMEMÄTNING SVM ROX 60, S-163 91 SPÅNGA, SWEDEN
Phone INT 1 46 0 761 70 70 Telefax +46 8 760 21 08 Telex 13585 SVM S

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SVM

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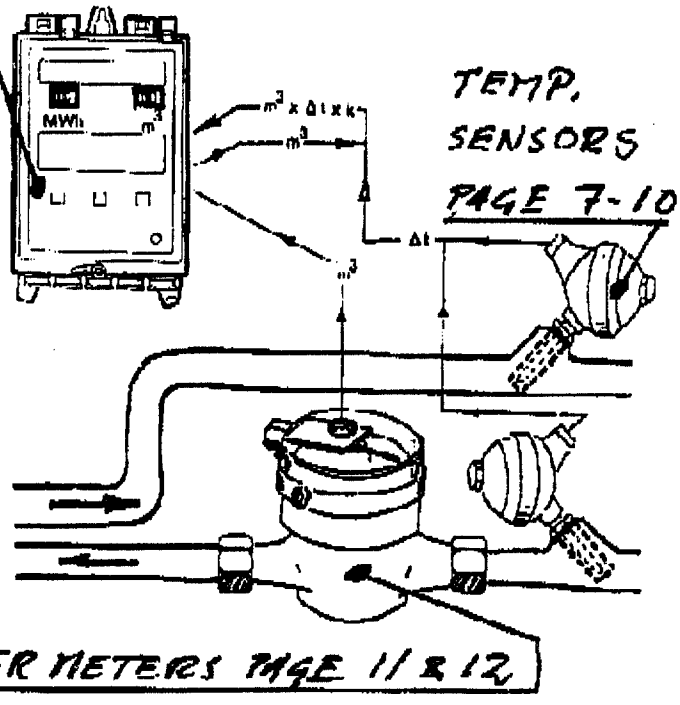
# Energy meter

INTEGRATORS PAGE 3-6

## Application

A energy meter is used to measure the heat energy distributed in a district heating system or any other system utilizing the circulation of water (or other heat media). It is usually referred to as a "kWh meter" like its counterpart among electrical meters.
The registered readings are normally used as a basis for billing for heat distribution.
The energy meter can also be used as a monitoring device for the following types of equipment:

- central heating boilers
- heat recovery equipment
- solar collectors
- heat pumps




## Design

A energy meter consists of three basic components:

- a pair of temperature sensors (resistance thermometers)
- a flow sensor (water meter)
- an integration unit

Plus optional functions such as:

- power calculation
- printer
- connection for a computer

ISOLATION RELAY PAGE 13

## Operation

Using a pair of temperature sensors (with an electronic measurement circuit built in to the integration unit), the temperature difference (utilized heat content) is measured.

In the integration unit the temperature difference is multiplied by the flow volume, which is measured by a separate flow sensor.

The signal is then processed in the integration unit. The amount of energy is not exactly proportional to the measured temperature difference and must be corrected in relation to the temperatures.
The correcting factor, generally called the heat coefficient (k-factor), is normally expressed as kWh/(m³ · °C) i.e. the number of kWh per cubic meter and centigrade temperature difference.

The integration unit normally has an electromechanical counter which calculates the total number of kWh (and m³).

## Flow sensors

As flow sensors, either traditional mechanical water meters or the magnetic inductive type are normally used.

In mechanical meters, a winged wheel or impeller is set in motion by the water. The speed of rotation is directly proportional to the speed of the water current and is transferred via a magnetic clutch to a mechanical counter. This displays, in cubic meters, the total volume of water that has passed through.
The meter has a built-in pulse sensor, often in the form of a rotating magnet and reed relay with a signal value of 25 l/pulse.

In addition to the mechanical measuring principle, an inductive measuring principle is used. This is based — like the dynamo on a bicycle — on "Faraday's Law": an electric conductor moving within a magnetic field generates an electric current proportional to the velocity of the conductor. In this case the water functions as the mobile electric conductor.

## Temperature sensors

In today's energy meters, mainly sensors of the Pt100 type are used. The temperature-dependent resistor bulb is made of platinum with a resistance of 100 ohm at 0°C. The resistance value as a function of the temperature follows a standard scale as defined in DIN 43760.

To attain required heat-metering accuracy, the sensors are chosen in pairs, with tolerances within the pairs many times closer than those specified by the DIN standard.

For special functions (meters for glycol mixtures, for example), Ni100-type sensors with a nickel resistor bulb are sometimes used.

AB SVENSK VÄRMEMÄTNING SVM BOX 60, S-163 91 SPÅNGA, SWEDEN
Phone INT +46 8 761 70 70 Telefax +46 8 760 21 08 Telex 13695 SVM S

580

SVM

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# Energy Integrator SVM 93

## Application

The SVM93 is a universal energy integrator for both heating and cooling. Together with a flow meter (SVMV-..) and a pair of temperture sensors (SVMT2..) it forms a complete energy meter.

## Mechanical Design

The integrator is built into a removable lid which is mounted onto a back plate containing the power supply and terminal connections.

There are separate terminals for testing purposes.

The integrator is factory preadjusted and sealed by a stamp at the front cover.

## Flow sensor

SVM93 can accept inputs from water meters having pulse values of 2.5 25 250 and 2500 litres or 1 10 100 and 1000 litres. The decade steps of volume pulse are set on the integrator by moving a small lever which adjusts the decimal setting of the energy and volume counters.

## Measurement

SVM93 measures the temperature difference once per volume pulse.

SVM93 has floating compensation for the heat co-efficient (k-factor) following the true theoretical value calculated upon the density and enthalpy of the energy carrier. The standard version is compensated for water as the energy carrier with the volume being measured in the lower temperature line.

The electronic measuring circuit has automatic zeroing and uses a quartz crystal as a reference. This together with the high resolution makes it very stable over the whole measuring range and ensures a high level of accuracy even at small temperature differences.

## Registration

SVM93 has 6 digit electromechanical counters for energy and volume. The pulsing of an LED confirms receipt of volume pulses. This signal also contains information about volume and temperature difference.

SVM93 has pulse outputs (with separate drivers) for energy as well as for volume. This makes it possible to transfer the measuring result to remote counters, data loggers or computers.

## Options

The lower part of the integrator is reserved for optional functions such as

- Power calculations
- Display
- Analogue output

Mains power 5 VA will be required for options.

Information on available options is published on separate data sheets.

**PTB** **SP**

The SVM 93 Energy Integrator is approved by PTB (Physikalisch-technische Bundesanstalt) in Berlin, W Germany

as well as

SP (Statens Provningsanstalt) in Borås, Sweden

## Ordering Key

**Energy Integrator SVME 93-hcd-efg**

| | | |
|---|---|---|
| Operating mode | 1 = Flow sensor in low temp | |
| | 2 = Flow sensor in high temp | |
| Power supply | 0 = External 6 V | |
| | 1 = Battery, standard | |
| | 2 = Battery, long life | |
| | 3 = Battery, -"-, built in | |
| | 4 = 220 V mains 5 VA | |
| | 5 = 220 V mains 1.5 VA | |
| | 6 = 115 V mains | |
| Options | 0 = None | |
| | 1–9 see separate info | |
| Energy unit | 1 = MWh | |
| | 2 = Gcal | |
| | 3 = GJ | |
| Flow pulse values | 1 = 2.5 lt/pulse | |
| | 2 = 25 | |
| | 3 = 250 | Y = 1 4 |
| | 4 = 2500 | |
| | 5 = 1 | |
| | 6 = 10 | X = 5–8 |
| | 7 = 100 | |
| | 8 = 1000 | |
| Language version | 3 = English | |

**Example:**

Energy integrator SMVE 93-140-123

AB SVENSK VÄRMEMÄTNING SVM BOX 60, S-163 91 SPÅNGA, SWEDEN
PHONE (INT +46) 8 761 70 70 TELEX 13665 SVM S TELEFAX (INT +46) 8 760 21 08

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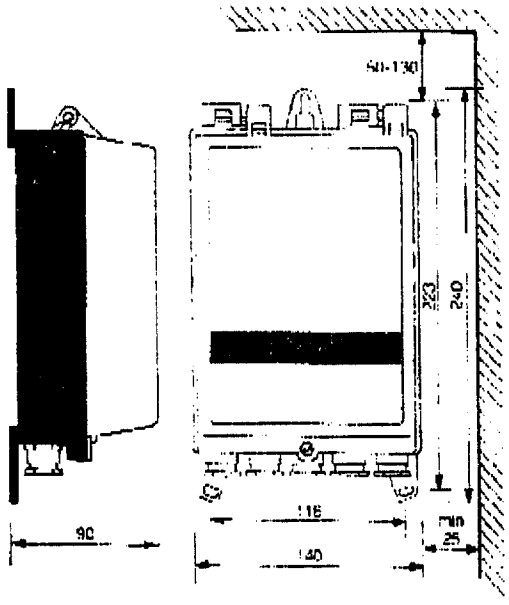
# Technical Data SVME 93

## Dimensions

| | |
|---|---|
| Power supply | battery or mains |
| 6 volt | SVM battery pack<br>built in long life batt<br>approved external source |
| 220/115 volt | (+10, −15%); 50/60 Hz |
| Power consumption | max 3W |
| Power for options/external units | |
| voltage | 6/12 v DC |
| current | 50 mA max |
| Temperature sensors | one pair SVMT 2 . . (Pt100) |
| Flow sensor | |
| Water Meter with reed contact: | |
| current | 0.1 mA max |
| frequency | 10 Hz max |
| pulse length | 0.04 s min (closed) |
| pulse interval | 0.05 s min (open) |
| Water Meter with voltage output. | |
| frequency | 10 Hz max |
| voltage | 0—1.8 V low level<br>4.4—7 V high level |
| load | 100 kohm min |
| Measuring range | 0—150 °C<br>120 °C max T-diff |
| Resolution at temp measurement | 0,01 °C |
| Pulse output | Energy & Volume<br>One pulse/counter step |
| Voltage | 5—6 V |
| Load | 200 ohm min |
| Length | 40 ms min |
| Line resistance to | |
| — temp. sensor | 10 ohm max total |
| — flow sensor | 200 ohm max |
| Ambient temp | 50 °C max |
| Protection class | IP 67 |

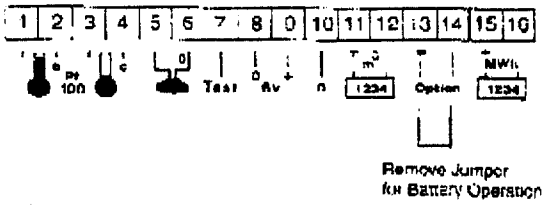



## Connections

| | |
|---|---|
| 1—2 | High temp (supply) sensor |
| 2—3 or 3—4 | Low temp (return) sensor |
| 5—6 | Flow sensor (Water meter) |
| 7—8 | Test signal |
| 8—9 | 6 volt |
| 11—12 | Slave counter — Volume |
| 13—14 | Option |
| 15—16 | Slave counter — Energy |

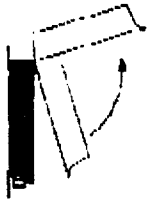
| | |
|---|---|
| 6, 8, 10 | Signal ground |
| 9, 11, 13, 15 | 6 volt |

A jumper 13 14 activates Mains LED



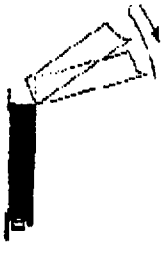

### Open

Undo the sealing screw
Lift lid until it fastens
(press slightly to the left)



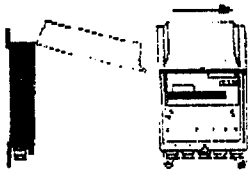
### Close

Lift lid fully up
Pull slowly down



### Remove

Lift lid
Disconnect multi-pin connector
Push lid to the right



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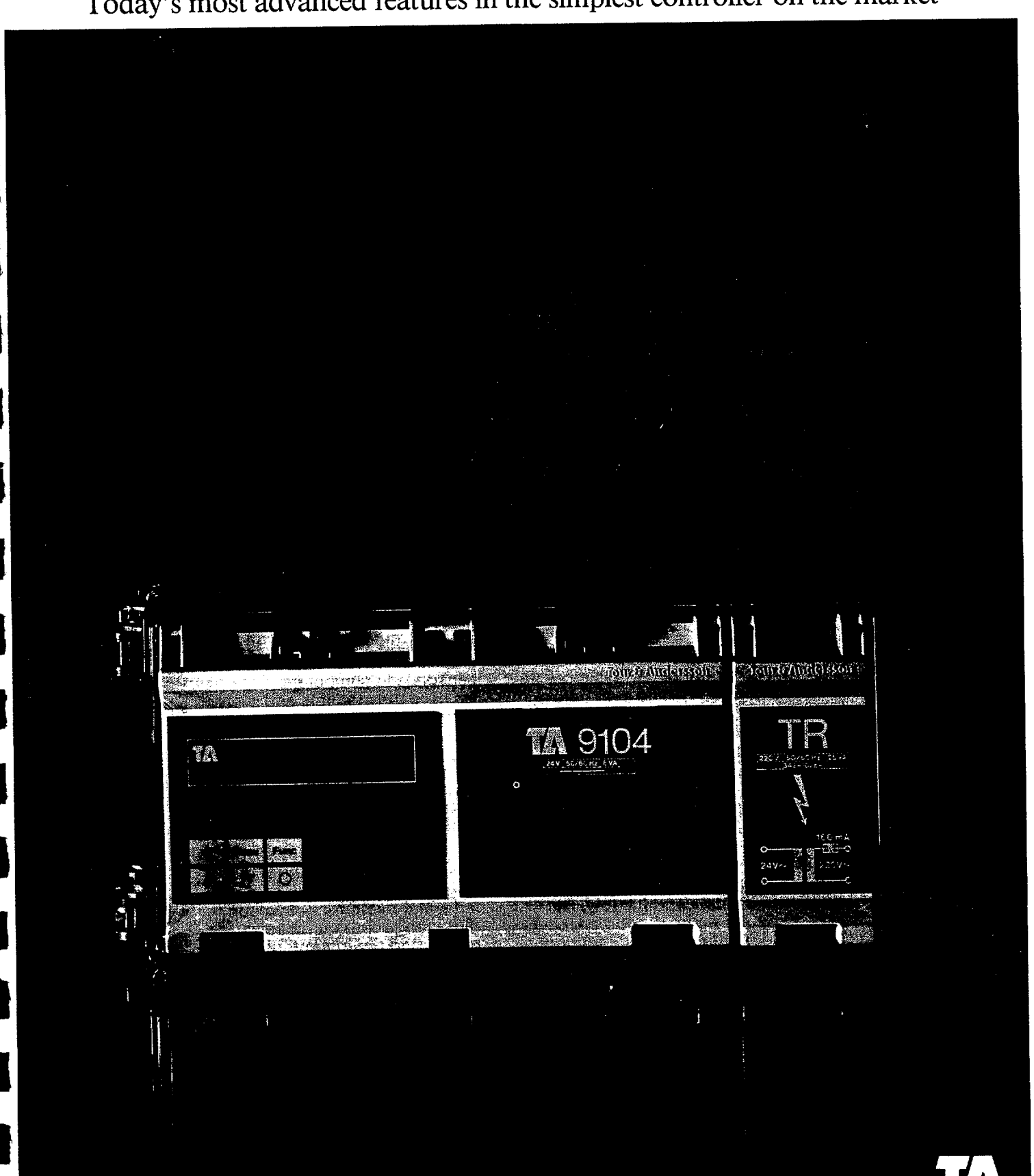
**CONTROLLER**
**TOUR AND ANDERSSON LTD.**
**Data Sheets TA9104 and C-11-35**

**Exhibit 6-6**

# TA 9104

Today's most advanced features in the simplest controller on the market




TA

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### Assists with energy statistics

To assist with energy statistics, the controller calculates and records the number of degree-days. You can then use the figures to compare the energy consumption month by month.

### No unauthorized access

Anyone can read temperatures and other values, even without the access code.

But nobody can make any changes whatever without keying in the appropriate access code.

### Prepared for communication

You can connect the controller tc the TA SYSTEM 7 monitoring system. This can be done either immediately on installation or at a later date, when several other buildings may also be monitored. The entire complex can then be monitored from a central location, thus avoiding the need for doing the rounds of the various installations.

The TA 9104 keeps the central monitoring system informed of alarms, times and temperature levels. It also provides information for your energy statistics. You can alter the times and temperature levels from a central location.

The TA 9104 supplies information on any faults that may occur, which eliminates unnecessary visits to the plant. But when a service visit is necessary, the serviceman can be furnished with the appropriate spare parts before he sets off.

### One of the biggest

There are no more than four or perhaps five companies in the world that produce more control equipment than Tour & Andersson. But none of them has come as far in applying the newest and most advanced control technology for indoor climate control.

The indoor climate is more important today than ever before. This is not only because of the continuing effort to save energy in order to combat escalating fuel and electricity costs. There is also growing awareness that the indoor climate is of decisive importance to the well-being and productivity of people.

With 2000 employees, TA is still small enough to be able to work quickly and flexibly. But because we have specialized in indoor climate control technology, we are big enough to be able to maintain a commanding lead in the field. Our position is based of many years of experience. We began manufacturing valves in 1865 and control equipment in 1925.

Today, our activities are concentrated on two fields: The Valve Sector develops, manufactures and markets valves, couplings and measuring equipment, and the Controls Sector is responsible in the same way for electronic controllers, actuators, sensors and computers. Together, we have the products and system expertise needed for everything involving the control of the indoor climate.

This means that we can supply you with the new control technology for all types of heating and air conditioning systems. We also offer today's most advanced equipment for the control and balancing of hot water and chilled water systems — in a complete range that includes valves, measuring equipment, procedures and computer programs.

We have the technology, the products, the expertise and the delivery capacity. See for yourself what we can deliver for your next project.

TA

TOUR & ANDERSSON LTD
1535 Meyerside Dr. Unit 10, Mississauga, Ont L5T 1M9, CANADA
Telephone (416)676-9015

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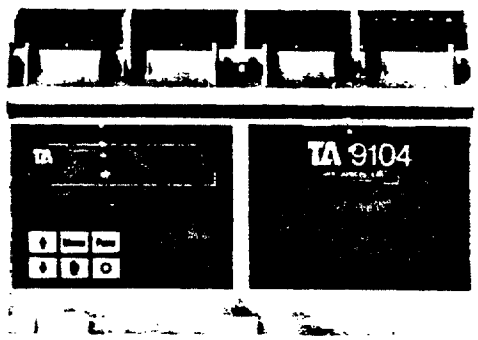
# TA 9104

**Heating controller**

C-11-35

1991-06

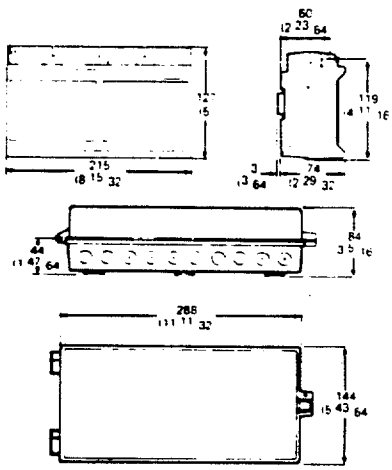
TA 9104 is designed for the control of hot water heating systems in apartment blocks, offices, schools and similar large buildings.




- Simple to operate; minimum number of controls for taking readings and varying settings. All values are displayed together with an explanatory text in the display window on the front panel.
- Automatic adjustment of reset curve, as well as magnitude and duration of night setback. Continuous and automatic monitoring and adjustment for factors such as seasonal variations.
- Preset curve with minimum and maximum limiting functions. The curve features four variable design points to permit exact matching with the heating system.
- Connected to SYSTEM 7 the unit can be used for heating control and to control the energy consumption in the building.
- Automatic changeover to and from daylight saving time, with correction for leap years.
- Extra time channel for control of optional function such as lighting or outer door locks.
- Four individually adjustable time settings for changeover from daytime to nighttime temperature, with or without optimization.
- Twelve programmable temperature reductions of optional duration for long weekends, school holidays or annual vacations. The controller may be programmed up to a year in advance.
- Two separate inputs for alarm sensors with adjustable high and low alarm settings.
- Three alarm inputs for equipment such as circulating pumps and expansion tanks, together with an output for a summated alarm.
- Degree-day recording for computing energy statistics.
- Limiting of max. power consumption in district heating systems.
- Output for control of exhaust air fan.
- Access check prevents unauthorized individuals from changing settings.

## TECHNICAL DATA

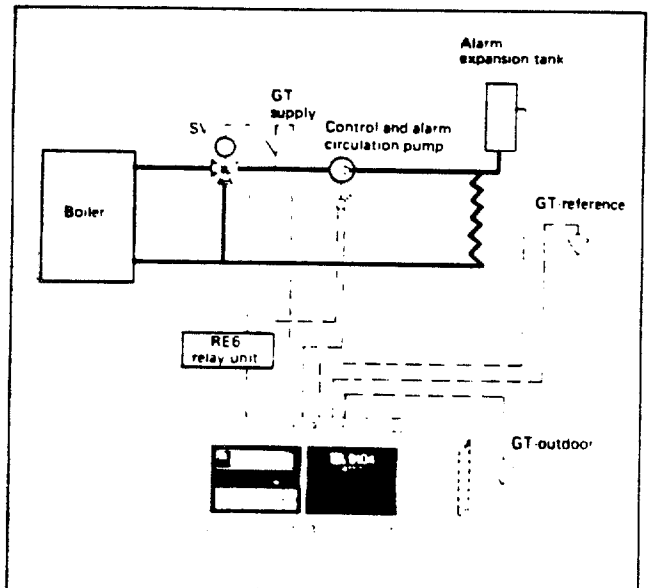
Part number . . . . . 290-9104-000
Operating voltage . . . . 24V AC/DC, −10/+20%, 50-60 Hz
Power consumption . . . . . 5 VA
Inputs:
Sensor inputs B1–B7 . . . . . Thermistor, 1800 ohm/25°C (77°F)
Calibration range. . . . . −40 to 120°C (−40 to 248°F)
Alarm inputs Z1–Z3 . . . . . Closing or opening contact to earth
Pulse inputs, X1, X2 . . . . . Closing contact to earth, min. pulse length approx. 60 ms
Outputs:
Analog outputs Y1, Y2. . . . . 0–10V DC short circuit-proof. Drives up to 10 SPC inputs (impedance 100 kohm)
Voltage output G1. . . . . 16V DC, 30 mA
Battery . . 3V lithium, 190 mA. Total life approx. 10 years. Drives clock and RAM memory for approx. 2 years.
Ambient temperature:
Operating. . . . . 0 to 50°C (32 to 122°F)
Storage . . . . . −20 to 50°C (−4 to 122°F)
Ambient humidity. . . . . max. 90% RH
Size . . . . . 4 modules



Measures within brackets in inches.

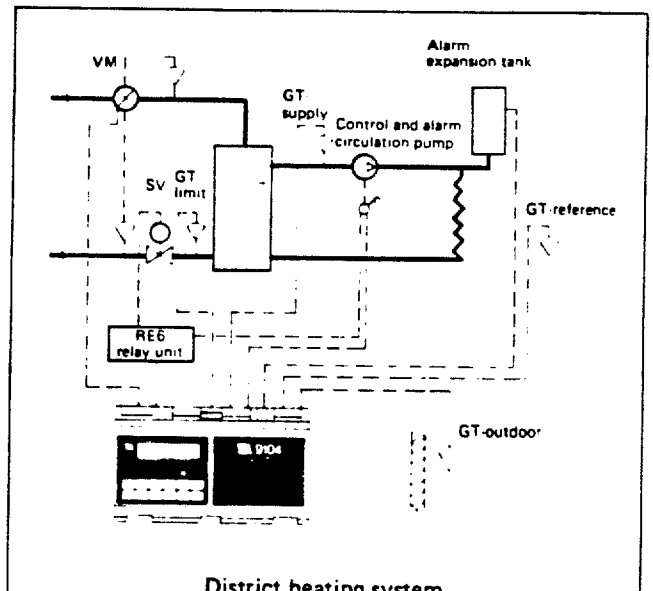
Also see leaflet C-01-5 for detailed information regarding the design of TA's modular system.

TAI 2045.91.08.2.000 GRAFORAMA




Boiler system

Fig. 1




District heating system

Fig. 2

## RESET CURVE

The outdoor reset curve for the supply temperature is based on four design points, defined at four different outdoor temperatures, see fig. 3.
The design points are individually adjustable with regard to the outdoor temperature which enables the curve to be tailored, with great accuracy, to the particular heating system.
Both the minimum and maximum values on the curve may be limited.

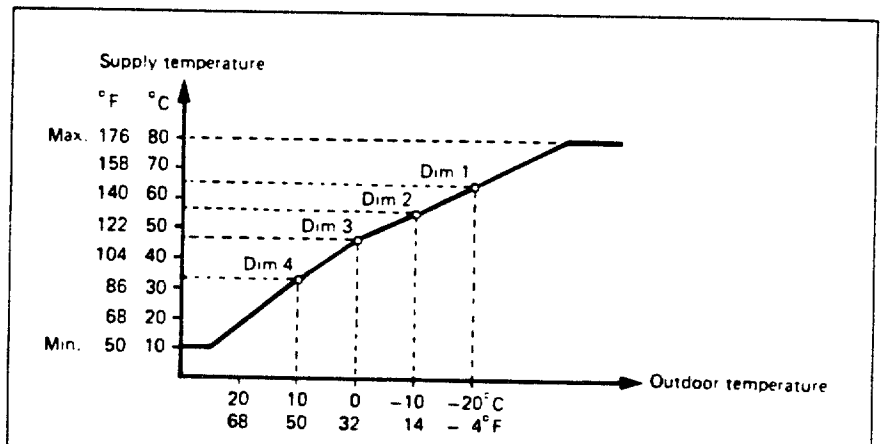



Fig. 3

**Automatic adjustment of reset curve**
The reference sensor permits automatic adjustment of the reset curve.
Since the curve is corrected continuously, it eventually becomes specific to the particular building.
If the system is not equipped with a reference sensor, or if the automatic curve adjustment function is inoperable for any reason, a "tailormade" reset curve may also be developed by varying the design points manually.

**Damped outdoor temperature**
The purpose of controlling the supply temperature is to maintain the room temperature at the correct value regardless of variations in outdoor temperature.
The mass and thermal inertia of the building means that a rapid change in outdoor temperature affects the indoor temperature only after a certain time. TA 9104 uses a damped outdoor temperature for control purposes in order to make efficient use of the heat stored in the structure of the building, see fig. 4.
As the curves indicate, rapid changes in outdoor temperature exert only a minor influence on the damped value, producing a variation equivalent to the change in temperature in the structure.
The degree of damping is variable to suit all types of buildings.
This function prevents poor comfort due to inadequate heating when building structure is cold and outside temperature rises suddenly. It also prevents unnecessary heat supply when building structure is warm and outside temperature drops suddenly.

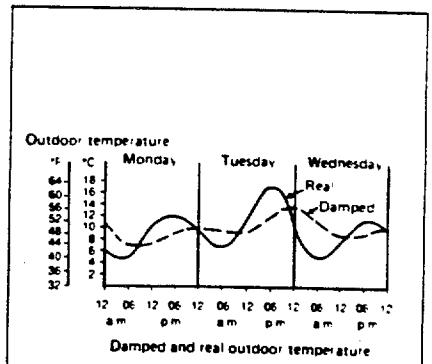



Fig. 4

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**CONTROLLER**
**TOUR AND ANDERSSON LTD.**
**Data Sheets TA9106/C-11-37**
**and D-11-15**
**Exhibit 6-7**

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# TA 9106

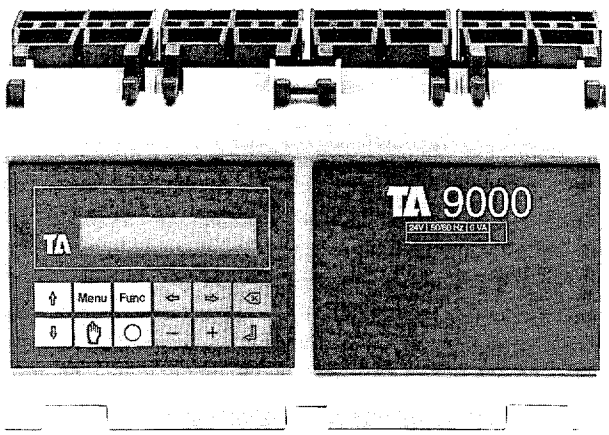
C-11-37

**Heating and hot water controller**

**1993.05**

Micro-processor based control unit for heating systems and hot water.

TA 9106 is designed for the control of hot water heating systems in apartment blocks, offices, schools and similar large buildings.




- Simple to operate. Minimum number of controls for taking readings and changing settings.
  All values are displayed together with explanatory text in the display on the front panel.
- Automatic adjustment of reset curve, as well as magnitude and duration of night setback. Continuous and automatic monitoring and adjustment for factors such as seasonal variations.
- The curve features four variable design points to permit exact matching with the heating system.
- Domestic hot water control with separate night and day setpoints.
- Connected to TA SYSTEM 7 the unit can be used for heating control and to control the energy consumption in the building.
- Automatic changeover to and from daylight saving time, with correction for leap years.
- Extra time channels for fan control and HWC pump control.
- Four individually adjustable time settings for changeover from day-time to night-time temperature, with or without optimization.
- Twelve programmable temperature reductions of optional duration for long weekends, school holidays or annual vacations. The controller may be programmed up to a year in advance.
- One separate input for alarm sensor with adjustable high and low alarm settings.
- Three alarm inputs for equipment such as circulating pumps and expansion tanks, together with an output for summated alarm.
- Degree-day recording for computing energy statistics.
- Output for control of exhaust air fan.

## TECHNICAL DATA

Part numbers TA 9106:
- Control unit ..... 290-9106-220
- Controller ..... 290-9106-260

Supply voltage ..... 24V AC -10% to +20%, 50-60 Hz
Power consumption ..... 6 VA
Inputs:
- Sensor inputs B1-B7 ..... Thermistor, 1800 ohms at 25°C
  Measuring range -40 to 120°C
- Alarm input Z1 - Z3 ..... N.O. or N.C. to M. ground
- Pulse input X1, X2 ..... N.O. to M. ground
  min pulse duration 50 ms

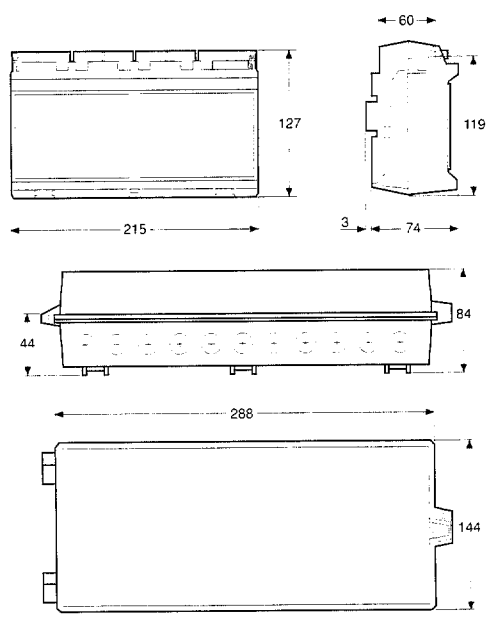
Outputs:
- Voltage output G1 ..... 16V DC, 30 mA
- Analogue outputs Y1, Y2 .... 0-10V DC, short-circuit proof
  max 10 SPC (imp. 100 ohms)

Battery ..... 3V lithium, 190 mAh

Enclosure rating ..... IP 31
Ambient temperature:
- Operation ..... 0 to 50°C
- Storage ..... -20 to 50°C

Ambient humidity ..... max 90% RH
Weight ..... 0.9 kg
Size ..... 4 modules

Also see leaflet C-01-5 for detailed information regarding the Control 80 system.




Relay outputs RE6:
- Voltage ..... Max. 250V AC
- Current ..... Max. 1 A, cos ϕ 0.5
- Fuses ..... 2, 50 x 20 mm, 2A

Size ..... 2 modules

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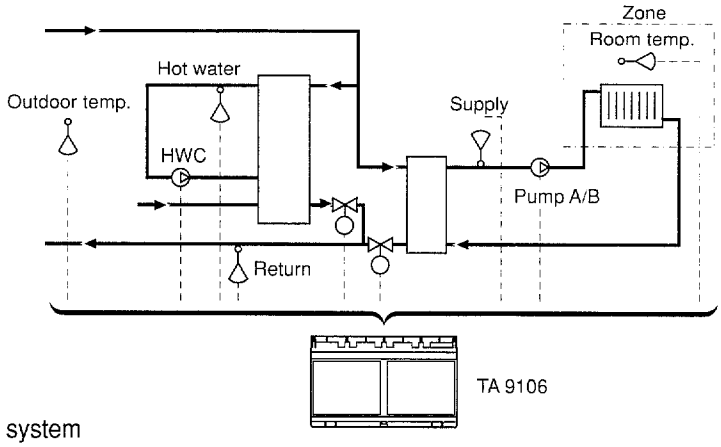


Fig. 1 District heating system

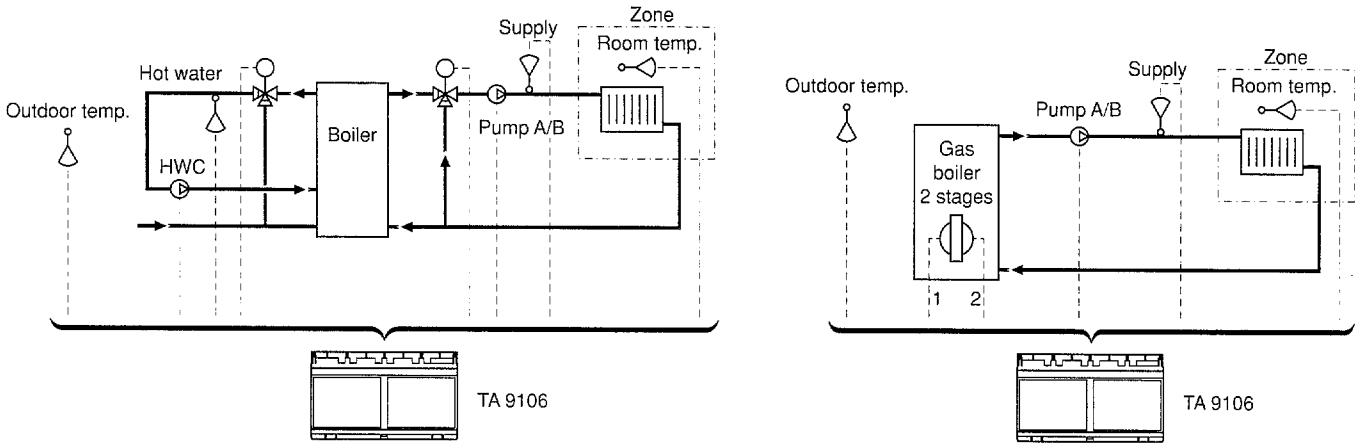


Fig. 2 Boiler systems

## RESET CURVE

The outdoor reset curve for the supply temperature is based on four design points at different outdoor temperatures, see fig. 3.

The design points are individually adjustable with regard to the outdoor temperature which enables the curve to be tailored to the particular heating system. Both the minimum and maximum values on the curve may be limited.

**Automatic adjustment of curve**

The reference sensor permits automatic adjustment of the reset curve. Since the curve is corrected continuously, it eventually becomes specific to the particular building.

In a system without a reference sensor, or if the automatic curve adjustment function is inoperable, a tailor-made reset curve may also be developed by varying the design points manually.

**Damped outdoor temperature**

The purpose of controlling the supply temperature is to maintain the room temperature at the correct value regardless of outdoor temperature.

The mass and thermal inertia of the building means that a rapid change in outdoor temperature affects the indoor temperature only after a certain time. TA 9106 uses a damped outdoor temperature for control purposes in order to use the heat stored in the structure of the building.

Rapid changes in the outdoor temperature give only a minor influence on the damped value, producing a variation equivalent to the change in temperature in the structure.

The degree of damping is variable to suit all types of buildings.

This function prevents poor comfort when outdoor temperature rises suddenly and unnecessary heat supply during the normally cold evening hours before a night setback occurs.

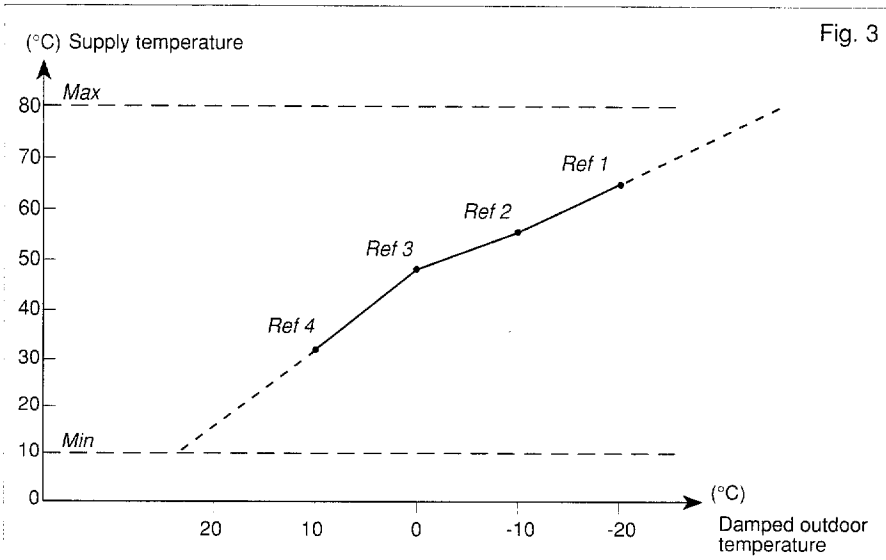


Fig. 3

TA 9106 has three 7-day programs and a yearly program (holiday), and three separate time channels.

**7-day programs**
The zone program is used for reducing the room temperature, the hot water program controls the setpoint for hot water, and the external time program sets an output (optional output 4 or 5). All of the 7-day programs have four on/off switching times per day. The times are individual for each weekday.

**Morning heat**
The time for changeover to daytime operation is optimized. TA 9106 varies the supply during the preceding period so that the room temperature is always correct at that time, see fig. 4.

The controller computes the appropriate optimizing period.

This is based on the magnitude and duration of the night setback, the outdoor temperature and a self-correcting factor representing the capacity of the heating system.

Without a reference sensor, the optimizing period varies with the damped outdoor temperature in response to a separate curve based on outdoor temperatures of -5°C and +15°C, see fig. 4.

**Morning boost**
During the optimizing period, the controller boosts the supply temperature. The increase varies with the damped outdoor temperature.

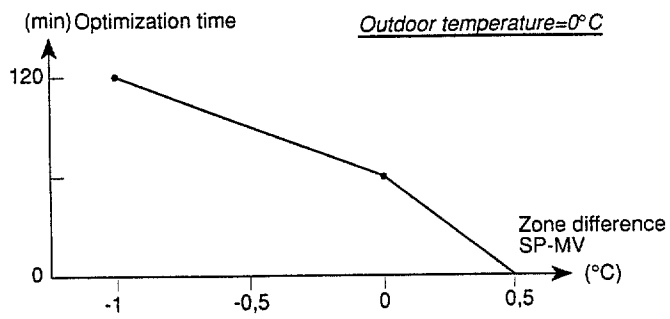

Fig. 6

Night setback is zero at the minimum setting, increasing successively as the outdoor temperature rises.

If both temperatures are set to zero, the preset setback will always be implemented, regardless of the actual outdoor temperature.

**Monday effect**
After weekends when night setback has been activated for a longer period of time, TA 9106 can commence heating at an earlier point of time than the normal morning heat function. This is achieved through increasing the heating time by a certain percentage in the optimization curve.

**Optimized stop**
The normal daytime operation can be reduced according to a curve which is calculated from the outdoor temperature and the zone control difference.

**Holiday program**
The holiday program is used to reduce the room temperature for extended periods, such as during long weekends, school holidays and annual vacations. A total of twelve reductions may be programmed up to a year in advance. The year clock is used to program the period by setting the start and stop dates. Changeover from the normal 7-day program to the holiday program takes place at midnight without optimization.

**Time channel for fan control**
TA 9106 can control both the heating system and an exhaust air fan. An analogue output enables the fan speed to be varied continuously in relation to the outdoor temperature. Although the speed is reduced as the temperature falls, the fan may be forced to operate at the maximum permissible speed for a given period during the day, by means of a separate time channel. The output may be used to operate a damper actuator or to control a fan speed controller.

A starting and a stopping time for forcing may be entered for an optional number of days, the times being the same for each day.

**Time channel for HWC-pump**
A starting and a stopping time for HWC-pump may be entered for an optional number of days, the times being the same for each day.

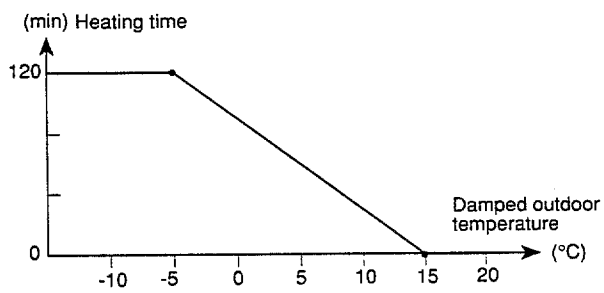

Fig. 4

The morning boost reaches a maximum at an outdoor temperature of 10°C, and is reduced successively to reach zero at 20°C and at a variable minimum outdoor temperature.

**Variable night setback**
The night setback function is variable to ensure that the heating system will restore the room temperature after setback at a low outdoor temperature.

The magnitude of the setback is determined by the damped outdoor temperature in accordance with a curve based on two variable outdoor temperatures, see

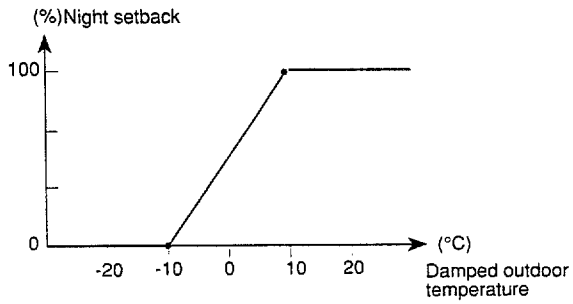

Fig. 5

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## BOILER CONTROL

TA 9106 can control boilers with two or three stages. The number of stages is selectable from the operator's menus.

The following example is used to describe the control principle of a two-stage boiler, see fig. 7 (see also installation):

If the supply temperature falls below the low dead zone boiler stage 1 is started. At the same time, an integration of control difference is initiated. When the integral value exceeds an adjustable value (15°Cmin) boiler stage 2 is started.

Boiler stage 2 is stopped when the supply temperature exceeds the high dead zone.

If the temperature still exceeds the high dead zone when the integral value has fallen below the adjustable value, boiler stage 1 is stopped.

If three boiler stages are selected, stage 3 is handled in the same way.

*Example: Boiler control with two boiler stages*

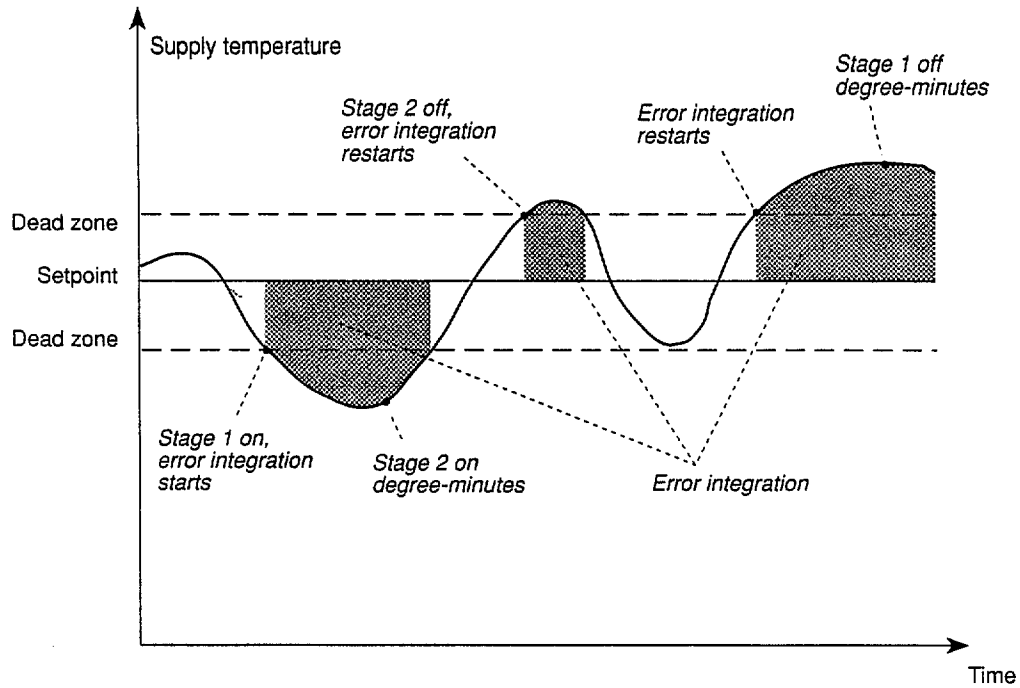


Fig. 7

## DOMESTIC HOT WATER

TA 9106 can control one or several EM actuators. The output signal is 2-10V control voltage. The domestic hot water may have separate day and night setpoints.

For optimum function the controller should operate together with the rapid temperature sensor EGWS.

The hot water controller has PI-function with adjustable P-band (50°C) and I-time (30 s). A limitation of output signal prevents escalation of integration. To ensure a good stabilty at low demand, the hot water controller uses a variable dead zone. This means that a high dead zone is used during low demand (HWC-flow) and a low one during tapping.

## PUMP CONTROL

The purpose of the pump control logic is to utilise the heat stored in the building in the most efficient manner possible. Thus, the pump is operated only when an actual heating requirement exists. The following conditions apply:

- The pump is stopped and the control valve closed when the lowest value of the calculated supply setpoint and the undamped outdoor temperature curve, falls below a preset value (21°C).
- The pump starts and the valve opens only when **both** of the above calculated values exceed the setpoint (21°C).
- The pump is stopped and the control valve closed when the damped outdoor temperature exceeds a preset "cut-off" temperature limit (18°C) with a hysteresis of 1.5°C.

When the conditions for stopping the pump have been satisfied, the pump is stopped with a fixed time delay of 5 minutes.

A restart after the pump is stopped can take place only after a preset delay (2 hours).

TA 9106 can control a single pump or twin pumps.

If twin pump function is activated and an error occurs on a pump in operation, the other pump is started. Pump switching is normally invoked every Monday at 12.00, but can be changed via a menu to occur at defined months instead.

The HWC-pump is controlled either by the time group which controls the domestic hot water setpoint (night/day) or by a separate time channel.

### Anti-freezing protection

The pump will start and the valve will begin to control to prevent freezing when the outdoor temperature falls below a preset limit (2°C).

### Exercising of pump

The pump is started at 1200 hours each day and run for one minute to prevent seizure during the summer shutdown months.

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## LIMITATION OF RETURN WATER TEMPERATURE

In a mixing valve control system, the limitation becomes effective as soon as the return temperature exceeds the preset limit at which point the controller reduces the supply temperature.

The limiting function is floating, in other words, it is controlled by the outdoor temperature in accordance with a separate reset curve based on design points of 0°C and -20°C as illustrated in fig. 8.

An alarm is initiated if the reduction exceeds 20°C (adjustable).

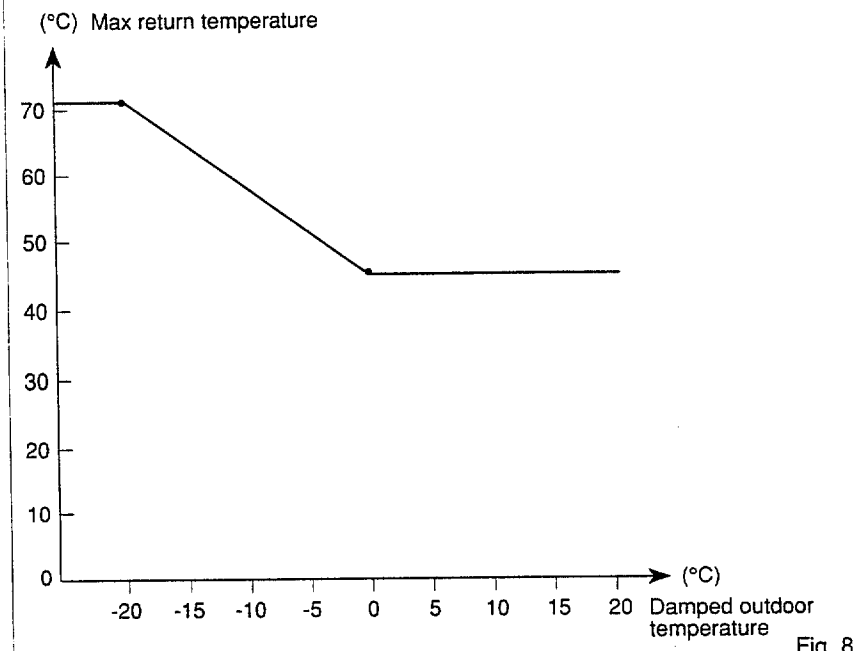


Fig. 8

## POWER LIMITING

The power consumption may be limited to a preset high limit.

As an example, this may apply to a district heating system in which the available power output must be distributed over periods of high load. If the power consumption exceeds the preset high limit, TA 9106 will gradually lower the setpoint for the supply temperature until the power output is below the set power limit.

An alarm will be initiated if the limiting function remains in force for an extended period.

## ENERGY MEASUREMENT

By using the pulse inputs X1 and X2 it is possible to measure the energy consumption of the heating system. Measurements from the last day and for the last hour can be read off from the display.

The scale factor (kWh per pulse) can be set, and the pulse input X2 also gives the possibility to measure an optional quantity, e.g. flow (m3 per pulse).

When connected to TA SYSTEM 7, the values can automatically be transferred to the central system for storage and presentation.

## DEGREE-DAYS

TA 9106 computes and records degree-days for the purpose of compiling energy statistics. The number of degree-days in a 24-hour period are calculated as the difference between a variable reference temperature (17°C) and the daily mean temperature.

If the mean temperature exceeds a variable firing temperature setting (12°C), no degree-days are recorded.

The mean value of the outdoor temperature is computed on the basis of hourly readings.

## ALARMS

TA 9106 has built-in alarm central with three digital alarms and temperature alarms for all sensors except the outdoor and limiting sensors. In addition there is an output for sum alarm. The digital alarm inputs can be used for such as circulation pumps and expansion vessels.

Alarms are indicated on the TA 9106 by a flashing LED on the front panel accompanied by an explanatory text in the display.

## OPERATION

Reading and changing values require only a minimum of key operations by means of advanced menu techniques.

All values are arranged in logical order under three main menus, each of which is divided into function menus.

On the display all values are presented together with explanatory texts, which also helps in making operation easy.

```
SUPPLY TEMP.      50.6°C
OUTDOOR           11.5°C
```

## AUTHORIZATION CHECK

TA 9106 incorporates an authorization check designed to prevent unauthorized individuals from altering the settings.

An access code is entered by the system manager, ensuring that alterations to the program can be made only by an individual who enters the correct code. However, readings are freely available.

## BATTERY BACKUP

During a power failure all outputs will be reset. Because of the backup the controller will start up with user settings and work normally after the power failure.

## ACCESSORIES

The TA 9106 is delivered either in a special locking case with a transparent lid or as a terminal block unit with a mounting kit.

The locking case enables wall or flush panel mounting.

Mounting kit for flush panel mounting of case:

Part number: 912-1120-000

Mounting kit for mounting of terminal block unit on a 35 mm DIN rail or equivalent:

Part number: 912-1140-000

## COMMUNICATION

TA 9106 is designed to operate either as an independent controller or under a master computerized control and monitoring system. Either direct trunk line or the telecommunications system (via modems) may be used for communication.

When connected to a TA SYSTEM 7 central system, the operating conditions of the boilers, pumps, fans etc. can be monitored. Temperatures, energy consumption and alarms may all be read, while setpoints, time settings may be altered as required, as well as starting and stopping of pumps etc.

## RELAY OUTPUT RE6

The RE6 is connected to the TA 9106 via a shielded cable to terminal C2. The signal is converted in RE6 into four single-polarity closing relay outputs. An address switch in the RE6 is used to select output from the TA 9106.

A total of three RE6 units can be connected to the TA 9106. Communication with the TA 9106 is indicated by a LED.

## INSTALLATION

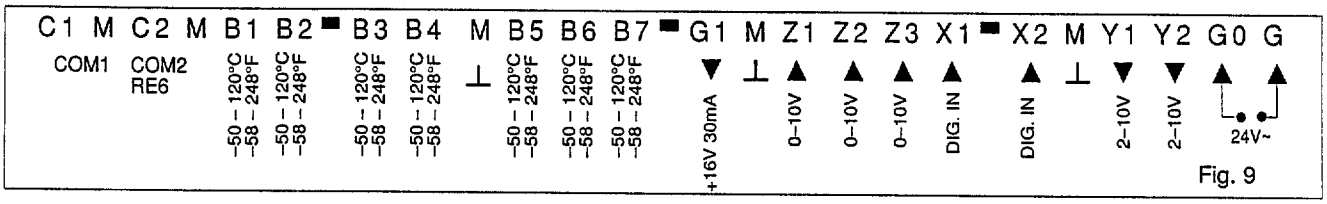


Fig. 9

### Connections on the terminal board

**C1, M** Communication with TA SYSTEM 7 (Refer to **KE1/KE2 Handbook**)
**C2, M** Communication with RE6
**B1** Sensor input, supply water temp.
**B2** Sensor input, outdoor temp.
**B3** Sensor input, room temp.
**B4** Sensor input, return water temp.
**M** Measurement neutral
**B5** Input, extended day/forced night.
**B6** Sensor input, hot water.
**B7** Input, extra temperature input.
**G1** +16V DC output
**M** Measurement neutral
**Z1** Input, external alarm 1
**Z2** Input, external alarm 2/pump A
**Z3** Input, external alarm 3/pump B
**X1** Digital input for energy measurement and power limiting 1
**X2** Digital inp., energy measurement 2
**M** Measurement neutral
**Y1** Analog output, hot water control
**Y2** Analog output, fan control
**G0** System neutral
**G** 24V AC/DC supply, input

### RE6-A

**KC1** Common connection for relays K1 and K2.
**K1** Incr. supply to zone/boiler stage (see table below)
**K2** Decr. supply to zone/boiler stage (see table below)
**KC2** Common connection for relays K3 and K4.
**K3** Control pump A
**K4** Output sum alarm/time channel

### RE6-B

**KC3** Common connection for relays K5 and K6.
**K5** Output time channel/sum alarm
**K6** Control pump B
**KC4** Common connection for relays K7 and K8.
**K7** Sum alarm pumps
**K8** Control HWC pump

### RE6-C

**KC5** Common connection for relays K9 and K10.
**K9** Output optimisation/morning heat
**K10** Output normal day operation.

### Cable lengths

Max. 4 m of shielded cable to C1 and C2.

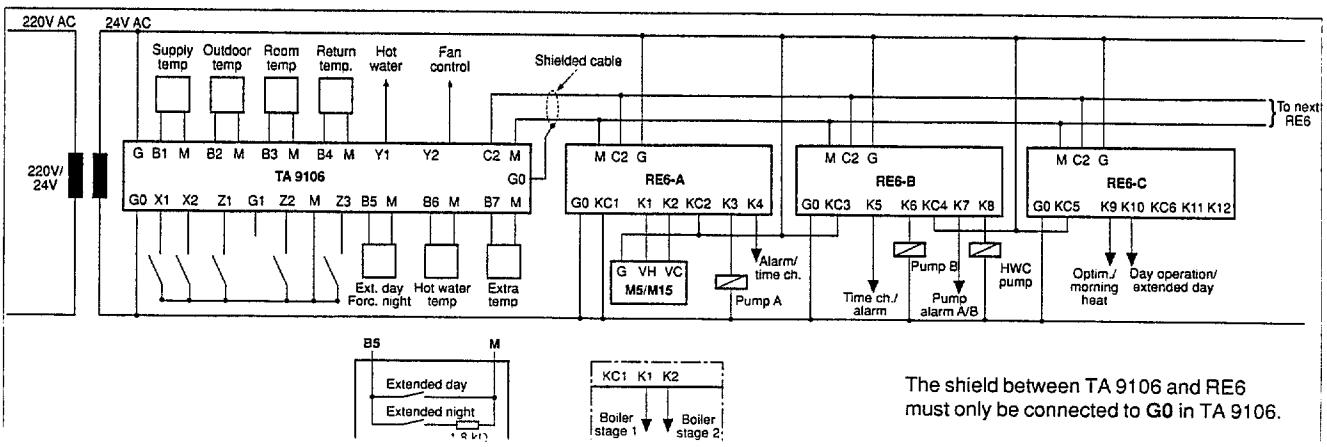
Max. 100 m of 1.5 sq.mm cable to G, G0 and G1 and K.

Max. 200 m of 0.25 sq.mm cable to digital inputs.

Max. 200 m of 0.5 sq.mm cable to other terminals.

| Boiler stage | K1 | K2 |
|---|---|---|
| 1 | 1 | 0 |
| 1 + 2 | 0 | 1 |
| 1 + 2 + 3 | 1 | 1 |

**Note!** Only K2 is set when boiler stages 1+2 are active. Therefore you must make sure externally that boiler stage 1 is activated both by K1 and K2.




The shield between TA 9106 and RE6 must only be connected to **G0** in TA 9106.

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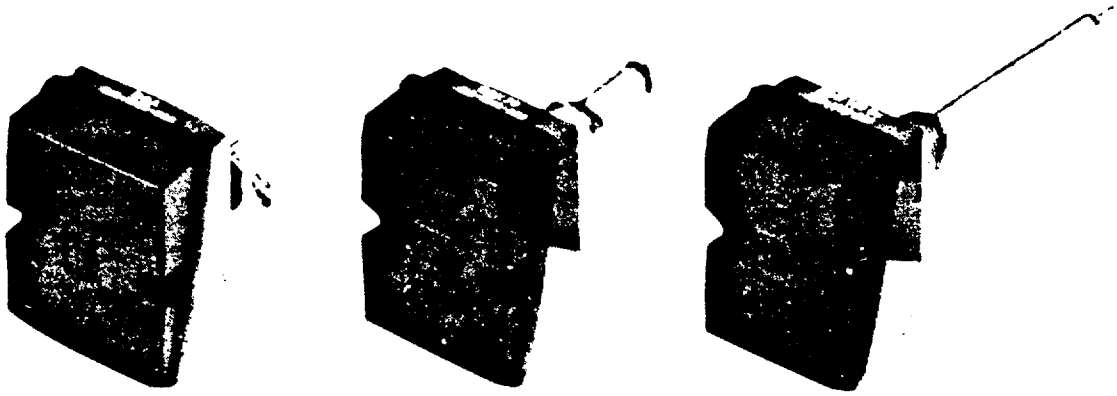
# EGA, EGK, EGW

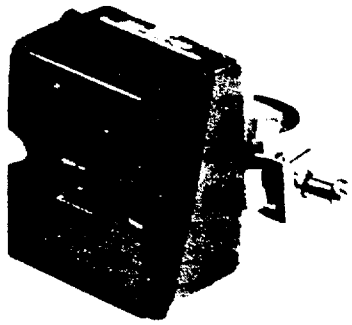
**D-11-15**

**Thermistor type sensors**

**February 1989**



## WATER TEMPERATURE SENSOR, STRAP-ON SURFACE, TYPE EGA

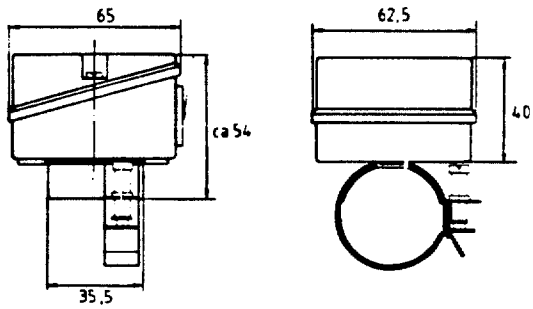


The EGA is designed for surface pipe mounting.
To ensure good thermal transmission to the copper plate and the thermistor the EGA must be mounted on an unisolated pipe section.

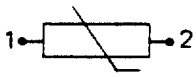
Electrical installation: Ø 19 hole for conduit entry Pr 18.6.

### TECHNICAL DATA

| | |
|---|---|
| Part number | 513-1100-000 |
| Ambient temperature, operation | min. −40°C |
| | max. 120°C |
| Time constant | approx. 60 seconds |
| Enclosure | IP 54 |
| Material: | |
| Case | carbonate plastic, red |
| Cover | carbonate plastic, black |
| Weight | 100 g |



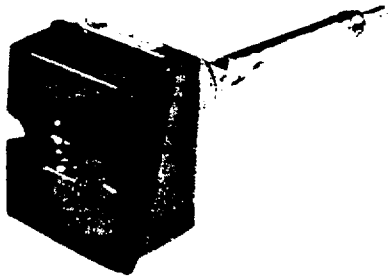

### WIRING DIAGRAM



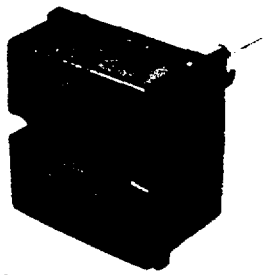



595

# WATER TEMPERATURE SENSOR, TYPE EGW, EGWW and EGWS



EGW



EGWS

The EGW, EGWW and EGWS are designed for mounting in pipe systems without separate pocket. The insert pipe is of copper or acid-resistant steel.

The EGWW comprises two temperature sensors, one for control and one for limit purposes.
The sensor has pipe thread o.d. R 1/2" (DN 15).

Electrical connection: Ø 19 mm hole for conduit entry Pr 18.6.

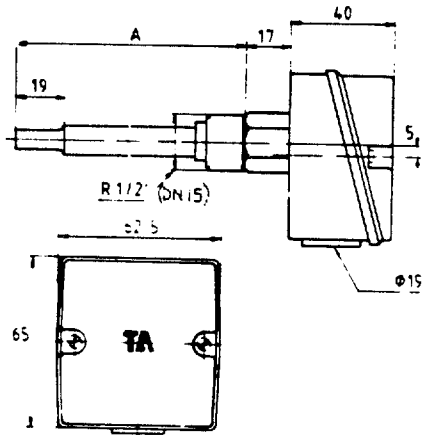
## TECHNICAL DATA

| Type: | Insert length: | Weight: | Part number: |
|---|---|---|---|
| EGW 120 Cu | 120 mm | 190 g | 512-1720-000 |
| EGW 220 Cu | 220 mm | 220 g | 512-1730-000 |
| EGW 120 St | 120 mm | 190 g | 512-1720-010 |
| EGW 220 St | 220 mm | 220 g | 512-1730-010 |
| EGWW 120 Cu | 120 mm | 190 g | 512-2720-000 |
| EGWW 220 Cu | 220 mm | 220 g | 512-2730-000 |
| EGWW 120 St | 120 mm | 190 g | 512-2720-010 |
| EGWW 220 St | 220 mm | 220 g | 512-2730-010 |
| EGWS | 120 mm | 150 g | 512-2770-010 |

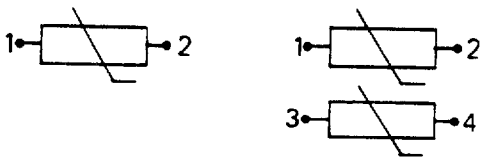
Ambient temperature, operation . . . . . .min. –40°C
max. 120°C

Time constant:
EGW,EGWW
Copper . . . . . .approx. 40 seconds
Acid-resistant steel. . . . . .approx. 60 seconds
EGWS
Acid-resistant steel . . . . . .approx.1.5 seconds

Pressure rating:
Copper . . . . . PN 10
Acid-resistant steel. . . . . PN 16
Enclosure. . . . . IP 54
Material:
Case . . . . . carbonate plastic, red
Cover . . . . . .carbonate plastic, black




## WIRING DIAGRAM




EGW
EGWS

EGWW

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**RTD, 100 OHM PLATIMUM**

**PYCO Data Sheet 502**

**Exhibit 6-8**

# UNDERSTANDING RTD TERMINOLOGY

## CALIBRATION

All RTD's are positive temperature coefficient resistors; i.e., the resistance increases as the temperature increases. Most standard RTD's define the resistance at 0°C; e.g., 100 ohm platinum, 120 ohm nickel. One notable exception is the 10 ohm copper RTD: this sensor is 10 ohms at 25°C.

There is no standardized abbreviation for the various RTD calibrations. The calibration tables in this product sheet define the resistance at 0°C (except for 10 ohm copper) and the ratio of the resistance at 100°C to the resistance at 0°C.

**100 PT 1.385** defines the platinum **(PT)** RTD calibration as **100 ohms at 0°C** and **138.5 ohms at 100°C: $^{R}100°C/^{R}0°C=1.385$.**

**100 PT 1.392** defines the platinum **(PT)** RTD calibration as **100 ohms at 0°C** and **139.2 ohms at 100°C: $^{R}100°C/^{R}0°C=1.392$.**

**120 NI 1.672** defines the nickel **(NI)** RTD calibration as **120 ohms at 0°C** and **200.64 ohms at 100°C: $^{R}100°C/^{R}0°C=1.672$.**

**10 CU 1.427** defines the copper **(CU)** RTD calibration as **10 ohms at 25°C.** The resistance at **0°C is 9.035 ohms** and **12.893 ohms at 100°C. $^{R}100°C/^{R}0°C=1.427$.**

## BASIC DESIGN FEATURES FOR ALL SPRING-LOADED FASTIP RTD'S

Standard **FASTIP** RTD's have an accuracy of ±0.5%. This percentage relates to the resistance tolerance at 0°C. For example, **100 PT 1.385** sensors would have a resistance between 100.5 and 99.5 ohms at 0°C. The corresponding temperature equivalent is ±1.5°C.

**PRODUCT SHEET'500** defines PYCO's calibration terminology as well as the other basic terms used in selecting RTD elements and assemblies. Standard **FASTIP** RTD's can be used continuously up to 500°F (260°C). This limitation is due to the Teflon insulated leads and not to the sensor itself.

## 22-4000 SERIES SPRING-LOADED FASTIP ASSEMBLIES

## 22-6000 SERIES SPRING-LOADED FASTIP ELEMENTS

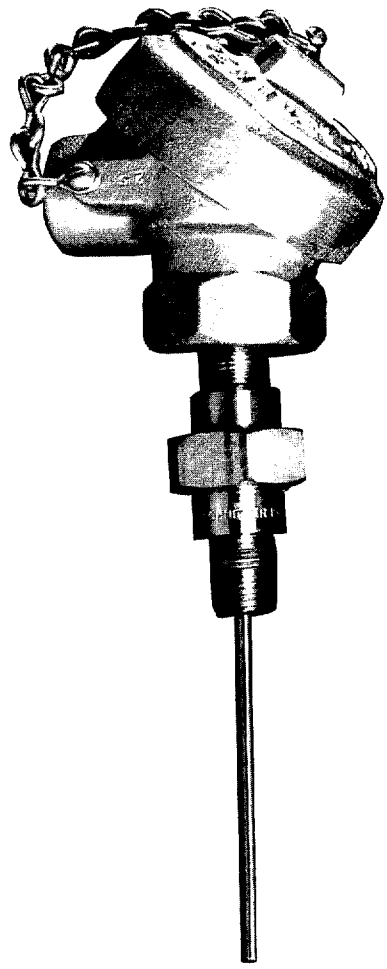
**TABLE 1** itemizes all standard **FASTIP** assemblies and elements, defining **CALIBRATION, TYPE** and **FORM.**

**TABLE 1**

| Item | Calibration | Type | Form |
|---|---|---|---|
| 01 | 120 NI 1.672 | 2-Wire | Single |
| 02 | 120 NI 1.672 | 2-Wire | Duplex |
| 03 | 120 NI 1.672 | 3-Wire | Single |
| 04 | 120 NI 1.672 | 3-Wire | Duplex |
| 05 | 10 CU 1.427 | 2-Wire | Single |
| 06 | 10 CU 1.427 | 2-Wire | Duplex |
| 07 | 10 CU 1.427 | 3-Wire | Single |
| 08 | 10 CU 1.427 | 3-Wire | Duplex |
| 09 | 100 PT 1.385 | 2-Wire | Single |
| 10 | 100 PT 1.385 | 2-Wire | Duplex |
| 11 | 100 PT 1.385 | 3-Wire | Single |
| 12 | 100 PT 1.385 | 3-Wire | Duplex |
| 13 | 100 PT 1.392 | 2-Wire | Single |
| 14 | 100 PT 1.392 | 2-Wire | Duplex |
| 15 | 100 PT 1.392 | 3-Wire | Single |
| 16 | 100 PT 1.392 | 3-Wire | Duplex |

A COMPLETE LINE OF
THERMOCOUPLES
RESISTANCE THERMOMETERS
AND ACCESSORIES

# SPRING-LOADED RESISTANCE THERMOMETERS



March, 1988 by PYCO Inc., Penndel, PA

600 E. LINCOLN HWY.
PENNDEL, PA 19047
215/757-3704
TELEX: 83-4703
FAX: 215/757-3780

PYCO

502

598

**TABLE 2** lists the standard 0.250" spring-loaded **FASTIP** assemblies and elements according to the hardware (nipple **"N"** or nipple-union-nipple **"NUN"**) and head options (screw-cover head **"SCH"** or miniature twist-lock head **"MTH"**).

**TABLE 2**

| Head | Hardware | Assembly P/N | Element P/N |
|---|---|---|---|
| SCH | N | 22-4018-Item-"N"-"A" | 22-6028-Item-"L" |
| SCH | N-U-N | 22-4015-Item-"N"-"A" | 22-6028-Item-"L" |
| MTH | N | 22-4026-Item-"N"-"A" | 22-6021-Item-"L" |
| MTH | N-U-N | 22-4027-Item-"N"-"A" | 22-6021-Item-"L" |

## UNDERSTANDING THE DIMENSIONS

**PHOTO A** and **SKETCH B** show the relationship between the element length and the thermowell-hardware dimensions for **ALL** PYCO spring-loaded RTD's.

**"N"** = Nipple length minus the thread engagement
**"A"** = Cavity depth: Length of bore in the well.
**"L"** = **"N"** + **"A"** plus **AN ADDITIONAL LENGTH (See TABLE 3)** that will assure at least 0.3" spring-loading. **TABLE 3** shows the additional length for assemblies using the screw-cover head **(SCH)** or miniature twist-lock head **(MTH).**

**TABLE 3**

| Type of Head | Element Length |
|---|---|
| Screw-Cover SCH | "L" ="N" + "A" + 2.2" |
| Min. Twist-Lock MTH | "L" ="N" + "A" + 1.4" |

**PHOTO C** shows an assembly with a nipple **"N"** and miniature twist-lock head **(MTH). PHOTO D** and **SKETCH D** illustrates the assembly with an "O"-ring seal. This assembly seals against a pressure of 500 psi up to a temperature of 500°F (260°C). **TABLE 4** shows the element length for all of the spring-loaded assemblies with the "O"-ring seal. **NOTE** that this assembly is also available with the General Purpose Head **(GPH).**

**TABLE 4**

| Head | Element Length |
|---|---|
| Screw-Cover SCH | "L" = "A" + 3.5" |
| General Purpose GPH | "L" = "A" + 2.9" |
| Min. Twist-Lock MTH | "L" = "A" + 2.7" |

**TABLE 5** lists all of the standard "O"-ring seal assemblies along with the part number of the respective replacement elements. These assemblies are shown in **PHOTOS E, F and G.**

**TABLE 5**

| OD | Head | Assembly P/N | Element P/N |
|---|---|---|---|
| 0.215 | SCH | 22-3051-Item-"A" | 22-6027-Item-"L" |
| 0.215 | GPH | 22-4039-Item-"A" | 22-6027-Item-"L" |
| 0.215 | MTH | 22-4031-Item-"A" | 22-6029-Item-"L" |
| 0.250 | SCH | 22-3046-Item-"A" | 22-6028-Item-"L" |
| 0.250 | GPH | 22-4038-Item-"A" | 22-6028-Item-"L" |
| 0.250 | MTH | 22-4021-Item-"A" | 22-6021-Item-"L" |

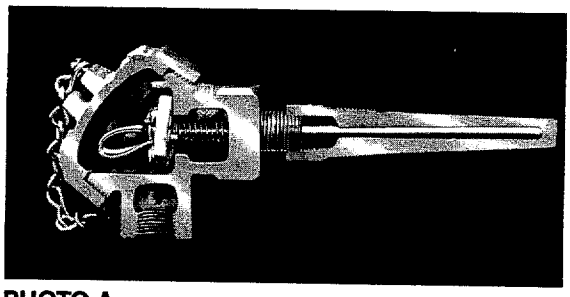
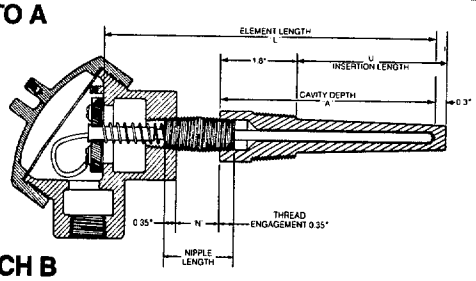


**PHOTO A**




**SKETCH B**

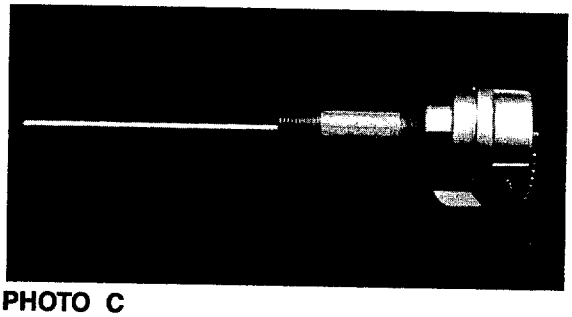


**PHOTO C**

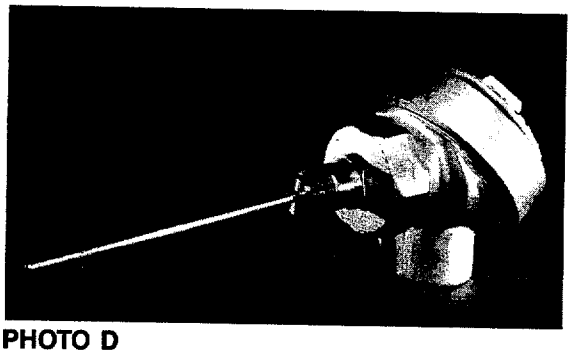
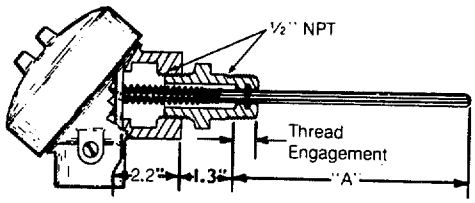
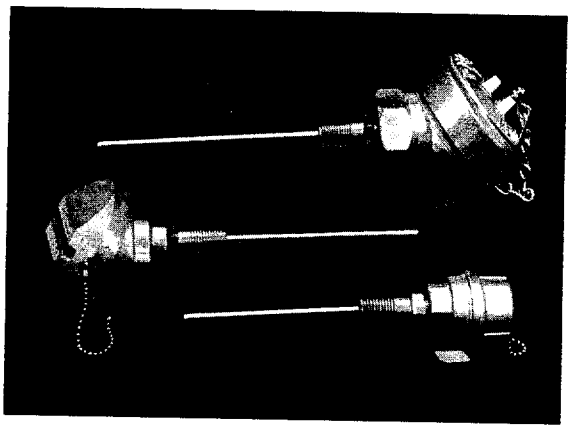


**PHOTO D**




**SKETCH D**



**PHOTOS E, F and G.**

FASTIP ASSEMBLY WITH HEAD (SCH, GPH, MTH) AND THE "O"-RING SEAL FITTING

**From TABLE 5** select the six-digit **(22-XXXX)** assembly part number which identifies the element sheath diameter **(0.215" or 0.250")** and the type of head **(SCH, GPH, MTH).**

**From TABLE 1** select the two-digit item number which identifies the CALIBRATION, TYPE and FORM.

REPLACEMENT ELEMENT FOR ABOVE ASSEMBLIES

**From TABLE 5** select the six-digit **(22-XXXX)** element part number corresponding to the assembly with which it is used. For element length **"L"** use the formula in **TABLE 4.**

**SEE THE EXAMPLES BELOW**

## HOW TO ORDER SUMMARY

FASTIP ASSEMBLY WITH HEAD (SCH or MTH) and HARDWARE ("N" or "N-U-N")

**From TABLE 2** select the six-digit **(22-XXXX)** assembly part number which identifies the assembly in terms of head and hardware.

**From TABLE 1** select the two-digit item number which identifies the CALIBRATION, TYPE and FORM.

Specify the **"N"** dimension. (The shortest **"N"** dimension for a nipple is 0.4". Shortest **"N"** dimension for the nipple-union-nipple is 2.7". (See Table 8).

Specify the **"A"** dimension to the nearest 0.1".

REPLACEMENT ELEMENT FOR ABOVE ASSEMBLIES

**From TABLE 2** select the element part number corresponding to the assembly with which it is used. For element length "L", use the formula in **TABLE 3.**

## HOW TO ORDER FASTIP RTD'S

Specify a FASTIP RTD assembly with a screw-cover head and a 3" nipple. (Refer to TABLE 2). The element is to spring-load into a well with a bore depth of 6.3". The calibration is 120 ohm nickel (120NI1.627), 3-wire single (refer to TABLE 1).

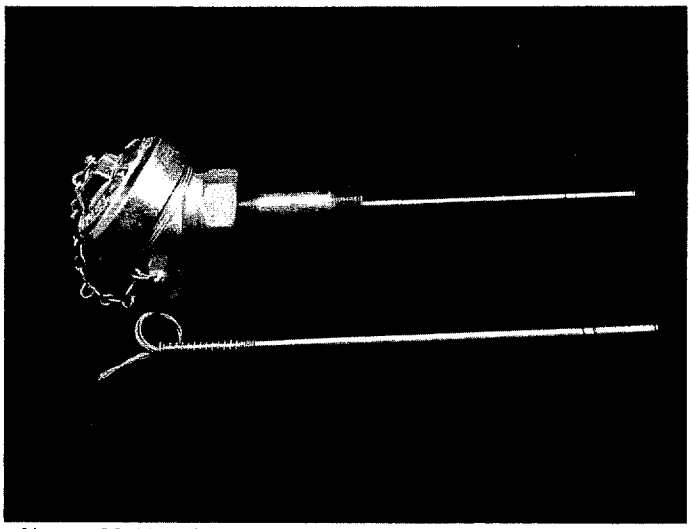
**22-4018-03-2.3-6.3**

**22-4018** = Assembly with a screw-cover head and nipple
**03** = 120NI1.627
TYPE = 3-wire
FORM = Single
**2.3** = **"N"** dimension for a 3 inch long nipple (See PHOTO A and SKETCH B).
**6.3** = **"A"** dimension equal to the cavity depth of the well of 6.3".

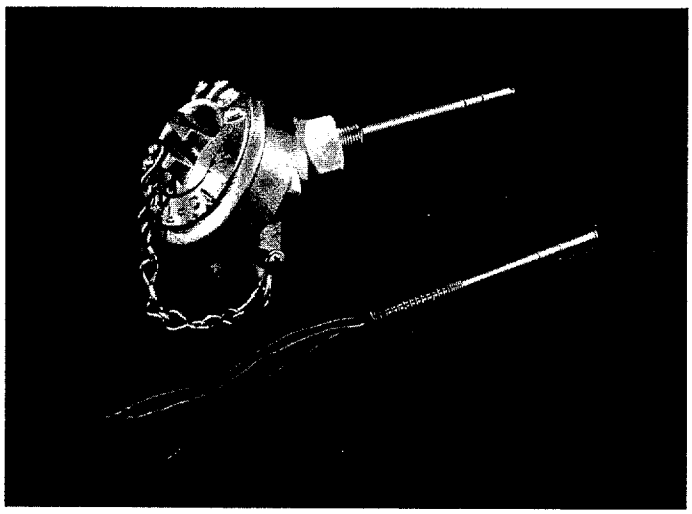
**22-6028-03-10.8** specifies the replacement element for the above assembly. **NOTE:** The element length **"L"** = 10.8". From TABLE 3, **"L" ="N" + "A" + 2.2**
**10.8 = 2.3 + 6.3 + 2.2.**

**22-3046-03-7.5** identifies an assembly with the "O"-ring seal. Calibration, type and form are the same as above. The **"A"** dimension is 7.5".

ALL ASSEMBLIES WITH THE SCREW-COVER HEAD ARE AVAILABLE WITH THE 23-7513 (Two-wire) or 23-7514 (Three-wire) TRANSMITTER



*Above: 22-4018 Assembly*
*Below: 22-6028 Replacement Element*



*Above: 22-3046 Assembly*
*Below: 22-6028 Replacement Element*

22-4019 and 22-4030 SPRING-LOADED HIGH RELIABILITY ASSEMBLIES

22-6030 SPRING-LOADED HIGH RELIABILITY ELEMENT

This series offers 100 ohm PLATINUM elements **(100PT1.385)** in both single and duplex **FORM.** Also available in single FORM only are the **200PT1.385** and **500PT1.385** calibrations. **ALL** have a ±0.1% accuracy, equivalent to about ±0.3°C at 0°C. **ALL 22-6030** elements have a 0.250" sheath diameter with an integrally mounted terminal block.

**ALL** of the **22-6030** elements conform to **DIN 43760;** i.e. $^{R}0°C/^{R}100°C=1.385$. Resistance sensors built to this DIN standard offer characteristics better suited to rugged industrial applications that involve temperature cycling and vibration.

NUCLEAR HIGHLITE

The **22-4019** and **22-4030** assemblies using the **22-6030** element were tested and qualify for use in nuclear power generating stations. Qualification testing includes elevated temperature, background and accident level radiation, vibration endurance, seismic and LOCA simulation tests in accordance with IEEE 323-1974, 344-1975, 382-1972, 383-1974, and MIL-STD 167-1. Thermowell assemblies comply with ASME BP&V Code Section III and, upon request, are analyzed in accordance with PTC 19.3.

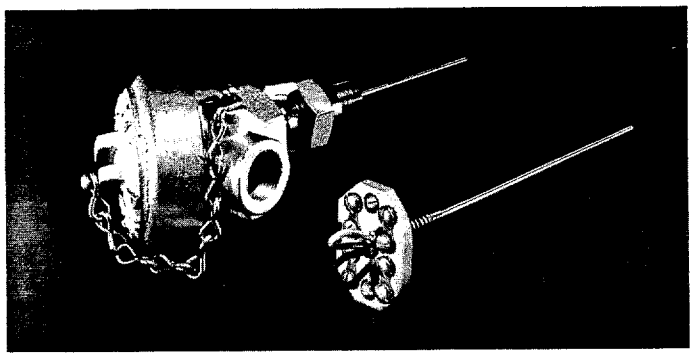
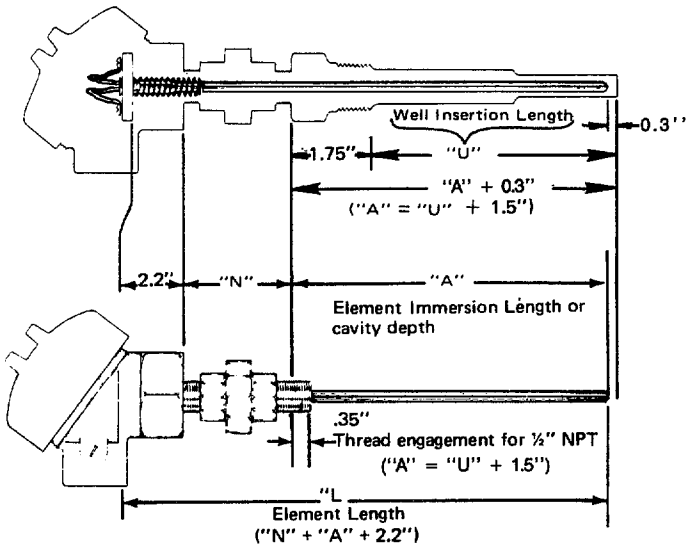


**PHOTO H** shows the **22-4030** assembly, and to its right, the **22-6030** replacement element.




**SKETCH OF 22-4030**

The Silhouette above of the **22-4030 "NUN"** assembly relates the **22-6030** element length to a typical threaded thermowell's "U" dimension. While not nuclear qualified, the assemblies using the miniature twist-lock head (**MTH**) use an element with the same design features as the **22-6030** element except that the block used with the **MTH** is not an integral part of the element.

**TABLE 6** lists the part numbers for **SCH** and **MTH** assemblies with **"N"** and **"NUN"** hardware. The replacement element part numbers are listed. See Table 3 for the formula for calculating the element length **"L"**.

**TABLE 6**

| Head | Hardware | Assembly P/N | Element P/N |
|---|---|---|---|
| SCH | N | 22-4019-Item-"N"-"A" | 22-6030-Item-"L" |
| SCH | N-U-N | 22-4030-Item-"N"-"A" | 22-6030-Item-"L" |
| MTH | N | 22-4028-Item-"N"-"A" | 22-6022-Item-"L" |
| MTH | N-U-N | 22-4029-Item-"N"-"A" | 22-6022-Item-"L" |

**TABLE 7** itemizes **ALL HIGH RELIABILITY** assemblies and elements for **CALIBRATION, TYPE** and **FORM.**

**TABLE 7**

| Item | Calibration | Type | Form |
|---|---|---|---|
| 01 | 100 PT 1.385 | 2-Wire | Single |
| 02 | 100 PT 1.385 | 3-Wire | Single |
| 03 | 100 PT 1.385 | 2-Wire | Duplex |
| 04 | 100 PT 1.385 | 3-Wire | Duplex |
| 05 | 500 PT 1.385 | 2-Wire | Single |
| 06 | 500 PT 1.385 | 3-Wire | Single |
| 07 | 200 PT 1.385 | 2-Wire | Single |
| 08 | 200 PT 1.385 | 3-Wire | Single |

# HOW TO ORDER HIGH RELIABILITY RTD'S

### HOW TO ORDER SUMMARY

**HIGH RELIABILITY ASSEMBLY WITH HEAD (SCH OR MTH) AND HARDWARE ("N" OR "N-U-N")**

**From TABLE 6** select the six-digit (**22-4XXX**) assembly part number which identifies the assembly in terms of head and hardware.

**From TABLE 7** select one of the eight two-digit item numbers which identifies the CALIBRATION, TYPE and FORM.

Specify the **"N"** dimension. (The shortest **"N"** dimension for a nipple is 0.4". Shortest **"N"** dimension for the nipple-union-nipple is 2.7".)

Specify the **"A"** dimension to the nearest 0.1".

**TABLE 8**

Using a 1/2" IPS Nipple:
"N" = 0.4", 1.3", 1.8", 2.3", 2.8", 3.3"

With a 1/2" N-U-N:
"N" = 2.7", 3.6", 4.1", 4.5", 4.6", 5.0", 5.1", 5.5", 5.6", 6.0", 6.5", 7.0", 7.5", 8.0", 8.5"

**REPLACEMENT ELEMENT FOR ABOVE ASSEMBLIES**

**From TABLE 6** select the element part number corresponding to the assembly with which it is used. For element length **"L"**, use the formula in **TABLE 3.**

**SEE EXAMPLES BELOW**

**22-4030-04-2.7-7.5** identifies a high reliability assembly with screw-cover head and nipple-union-nipple hardware.

**04** = **CALIBRATION** = 100PT1.385
**TYPE** = 3-Wire
**FORM** =Duplex
**"N"** = 2.7"
**"A"** = 7.5"

**22-6030-04-12.4** specifies the replacement element.

ALL ASSEMBLIES WITH THE SCREW-COVER HEAD ARE AVAILABLE WITH THE 23-7513 (Two-wire) OR 23-7514 (Three-wire) RTD TRANSMITTER.

# THERMOWELLS

## PYCO Data Sheet 450-II

**Exhibit 6-9**

**Thermowells** are precision machined metallic structures designed to protect temperature sensing devices. They generally suit applications where pressures exceed 75 psi and can be used with any type of temperature sensing element.

Engineering tables and application data (below and page No. 4) will assist in matching a standard PYCO thermowell to your installation parameters. The standard thermowell designs (pages 2 and 3) offer two advantages: (1) since they are produced on a large quantity basis, they bring about reduced cost. (2) the use of "standard" wells enables you to interchange sensing elements, reduces the number of spare wells needed for safe coverage and thus minimizes down time.

Nevertheless, should you run into a thermowell requirement beyond the scope of PYCO's "standards" please feel free to contact our representatives or sales engineers.

The tables below present safe values for both tapered and straight stem thermowells under the application velocity/flows of air, gas, steam or materials of similar density, and (bracketed figures) water flow.

Maximum flow/velocity in feet per second for .385" bore (14 gage) STRAIGHT STEM Thermowells

| INSERTION LENGTH – "U" | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2½ | 4½ | 7½ | 10½ | 13½ | 16½ | 19½ | 22½ | MATERIAL |
| 290 (145) | 150 (80) | 54.1 (48) | 27.6 | 16.7 | 11.1 | 8.0 | 6.0 | Brass |
| 326 (260) | 192 (144) | 69.5 | 35.4 | 20.5 | 14.3 | 10.3 | 7.7 | Carbon Steel |
| 349 (360) | 199 | 71.9 | 36.6 | 21.2 | 14.8 | 10.7 | 8.0 | A.I.S.I. 304 and 316 s/s |
| 316 | 189 | 68.1 | 34.8 | 20.8 | 14.0 | 10.0 | 7.5 | Monel |

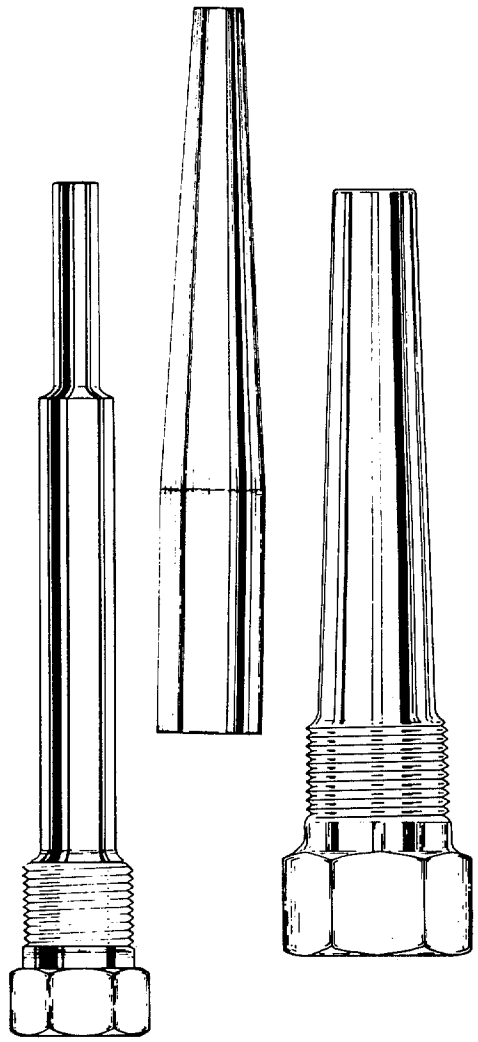
Maximum flow (ft./sec.) for .385" bore (14 gage) TAPERED Thermowell

| INSERTION LENGTH – "U" | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Material | 2½ | 4½ | 7½ | 10½ | 13½ | 16½ | 19½ | 22½ |
| Brass | 321 (150) | 129 (83.5) | 46.8 | 23.6 | 14.5 | 9.6 | 6.9 | 5.1 |
| Carbon Steel | 410 (270) | 249 (150) | 90.3 | 45.6 | 27.8 | 18.5 | 13.2 | 9.8 |
| A.I.S.I. 304 & 316 | 483 (350) | 272 (208) | 97.3 | 49.7 | 30.4 | 20.3 | 14.5 | 10.7 |
| Monel | 396 (300) | 214 (167) | 77.5 | 39.2 | 23.8 | 16.0 | 10.3 | 7.7 |

Maximum flow (ft./sec.) for .260" bore (20 gage) TAPERED Thermowell

| INSERTION LENGTH – "U" | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Material | 2½ | 4½ | 7½ | 10½ | 13½ | 16½ | 19½ | 22½ |
| Brass | 305 (97.5) | 93.8 (54.1) | 33.9 | 17.1 | 10.5 | 7.0 | 5.0 | 3.7 |
| Carbon Steel | 386 (175) | 180 (97.2) | 65.3 (58.3) | 33.0 | 20.1 | 13.4 | 9.6 | 7.1 |
| A.I.S.I. 304 & 316 | 440 (243) | 197 (134) | 71.2 | 36.0 | 22.0 | 14.7 | 10.5 | 7.8 |
| Monel | 354 (195) | 155 (108) | 56.1 | 28.4 | 17.3 | 11.6 | 7.5 | 5.6 |

A COMPLETE LINE OF
THERMOCOUPLES
RESISTANCE THERMOMETERS
AND ACCESSORIES



# THERMOWELLS
# 450-II

Printed on Recycled Paper

1977 by PYCO, Penndel, Pa.

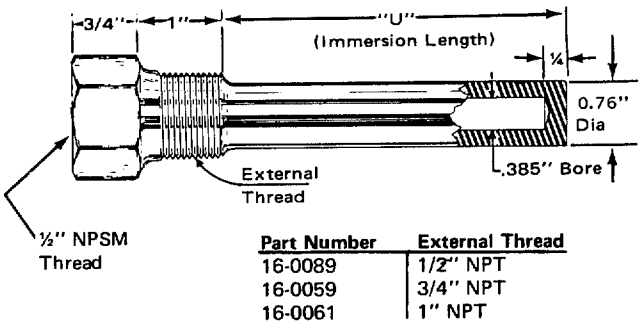
PYCO

PACESETTER IN TEMPERATURE MEASUREMENT QUALITY & SERVICE

600 E. LINCOLN HWY.
PENNDEL, PA. 19047
215/757-3704
TELEX: 83-4703

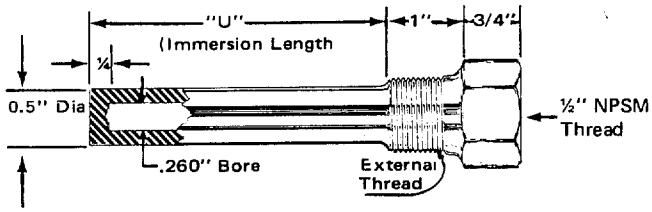
603

## STRAIGHT HEX-HEAD THERMOWELLS:

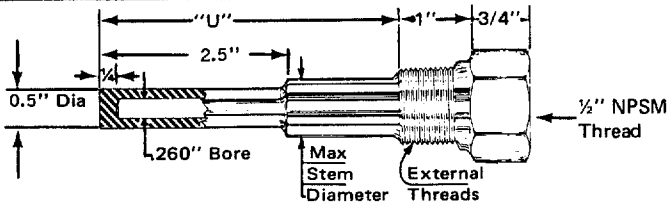



| Part Number | External Thread |
|---|---|
| 16-0089 | 1/2" NPT |
| 16-0059 | 3/4" NPT |
| 16-0061 | 1" NPT |

| Part Number | External Thread |
|---|---|
| 16-0043 | 1/2" NPT |
| 16-0047 | 3/4" NPT |



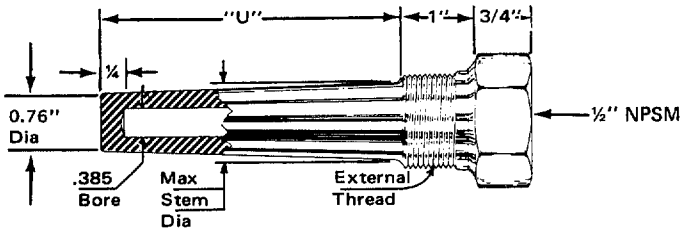

## REDUCED TIP THERMOWELLS:

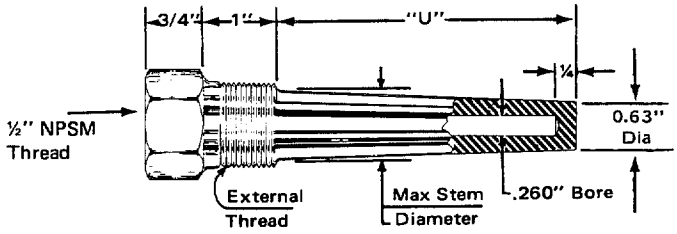



| Part Number | External Thread | Maximum Stem Diameter |
|---|---|---|
| 16-0083 | 1/2" NPT | 0.63" |
| 16-0048 | 3/4" NPT | 0.75" |
| 16-0054 | 1" NPT | 0.88" |

## TAPERED THERMOWELLS:

| Part Number | External Thread | Maximum Stem Diameter |
|---|---|---|
| 16-0063 | 1" NPT | 1.062" |




| Part Number | External Thread | Maximum Stem Diameter |
|---|---|---|
| 16-0049 | 3/4" NPT | 0.88" |
| 16-0056 | 1" NPT | 1.062" |

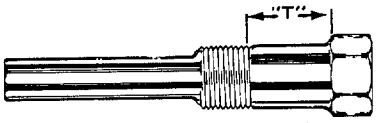
### MATERIAL AVAILABLE :

304 Stainless Steel
316 Stainless Steel
347 Stainless Steel
410 Stainless Steel
Inconel
Monel
Carbon Steel
Hastelloy "B"
Hastelloy "C"
Brass
Carpenter 20
Nickel

### HOW TO ORDER:

Part Number – "U" (in inches) – Material

Part Number – "U" (in inches) – Material – "T" (in inches)




("T" dimension must be specified when ordering Thermowell w/LAGGING EXTENSION).

EXAMPLES: 16-0083-8" - 304$^{S}$/s - T=3

indicates a 304$^{S}$/s reduced-tip well w/3" lag. Stem length is 8".

NOTES:

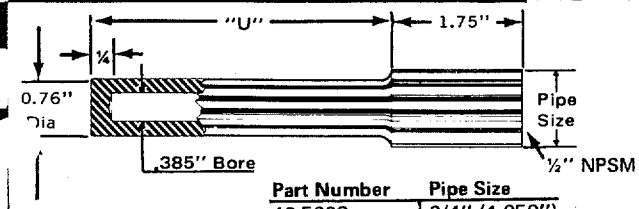
1). All threaded wells are available with brass plug and chain.

2). Van Stone or flanged thermowells' part numbers should include the following:

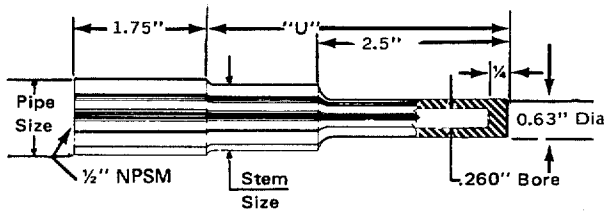
(a) – Flange size
(b) – pressure rating
(c) – facing
(d) – material

EXAMPLE: 16-3010-4" - Monel w/1"-150 lbs. RF Carbon Steel Flange
(a) (b) (c) (d)

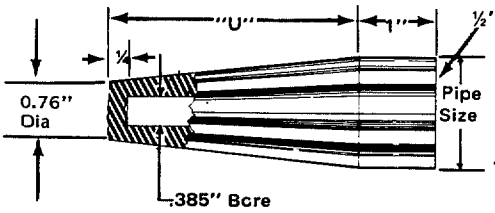
## WELD-IN TYPE THERMOWELLS:




| Part Number | Pipe Size |
|---|---|
| 16-5032 | 3/4" (1.050") |
| 16-5033 | 1" (1.315") |

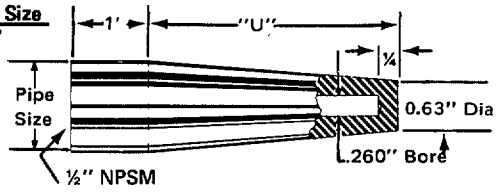


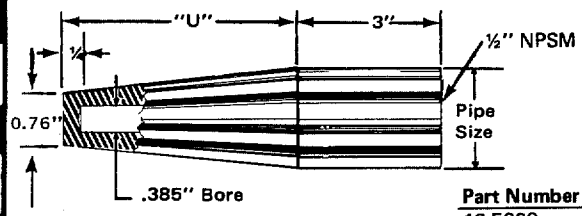

| Part Number | Pipe Size | Stem Size |
|---|---|---|
| 16-5031 | 3/4" (1.050") | 0.75" |
| 16-5018 | 1" (1.315") | 0.88" |




| Part Number | Pipe Size |
|---|---|
| 16-5036 | 1" (1.315") |

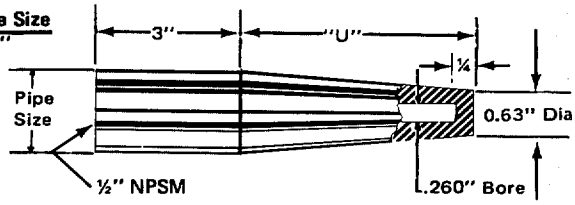
| Part Number | Pipe Size |
|---|---|
| 16-5034 | 3/4" |
| 16-5035 | 1" |



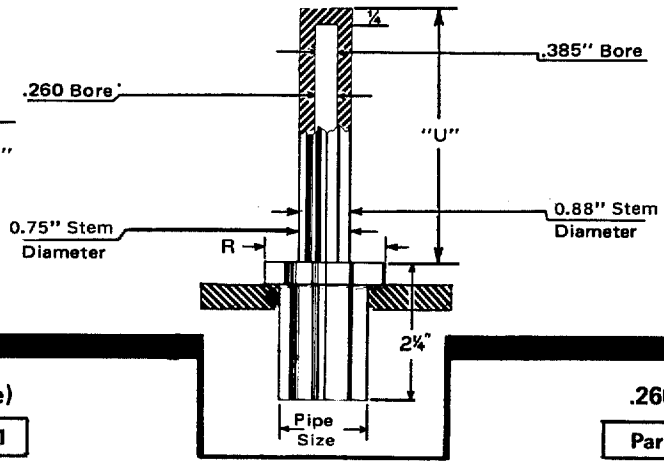

| Part Number | Pipe Size |
|---|---|
| 16-5039 | 1" (1.315") |

| Part Number | Pipe Size |
|---|---|
| 16-5037 | 3/4" |
| 16-5038 | 1" |




## VAN STONE THERMOWELLS:

| Part Number | Pipe Size | R |
|---|---|---|
| 16-3008 | 1" | 2" |
| 16-3009 | 1-1/2" | 2.88" |




| Part Number | Pipe Size | R |
|---|---|---|
| 16-3010 | 1" | 2" |
| 16-3011 | 1-1/2" | 2.88" |

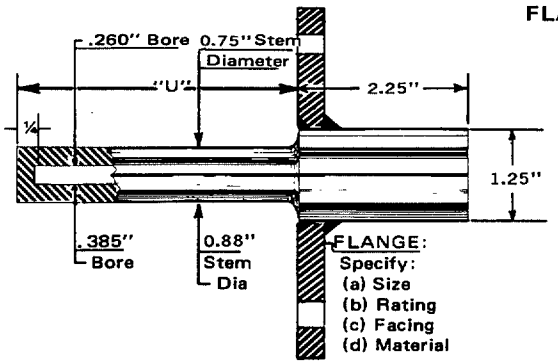
**Straight:** .260" BORE (20 Gage)

**Part Number: 16-2021**

**Tapered:** .260" BORE (20 Gage)

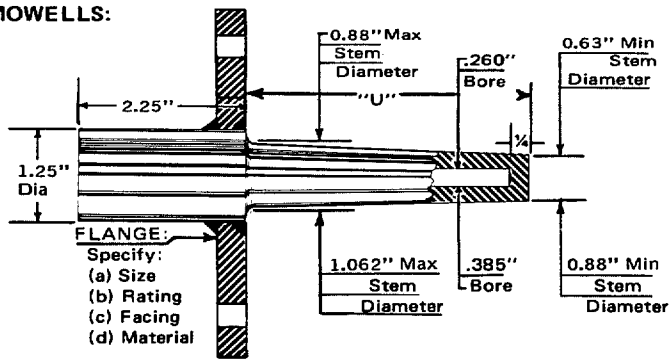
**Part Number: 16-2044**

## FLANGED THERMOWELLS:




.385" BORE (14 Gage)

**Part Number: 16-2022**




.385" BORE (14 Gage)

**Part Number: 16-2045**

605

One chooses the material of a thermowell primarily when considering the durability a material will have when exposed to the process environment. The following corrosive guide to materials selects certain atmospheres and recommends the least expensive material best suited to the application.

| CORRODENT | TEMP. F | CONC. % | RECOM. MAT. |
|---|---|---|---|
| Acetic Acid | 212 | All | Monel |
| Acetone | 212 | All | 304 SS |
| Acetylene | 400 | | 304 SS |
| Alcohols (Ethanol and Butyl) | 212 | All | 304 SS |
| Ammonia, Dry | 212 | All | 304, 316 SS |
| Ammonium Hydroxide | 212 | All | 304, 316 SS |
| Ammonium Chloride | 300 | 50% | Monel |
| Ammonium Nitrate | 300 | All | 304 SS |
| Ammonium Sulfate | 212 | All | 316 SS |
| Asphalt | 250 | | 304 SS |
| Atmosphere, (Industrial and Marine) | | | 304 SS |
| Bleaching Powder | 70 | 50% | Monel |
| Borax | 212 | All | Brass |
| Boric Acid | 400 | All | 316 SS |
| Bromine | 125 | Dry | Monel |
| Calcium Bisulphite | 75 | All | Hast. C |
| Calcium Chloride | 212 | All | Hast. C |
| Calcium Hydroxide | 300 | 20% | Hast. C |
| Carbon Dioxide, Dry | 800 | All | Brass |
| Carbonated Water and Beverages | 212 | All | 304 SS |
| Carbon Tetrachloride | 125 | All | Monel |
| Chlorine, Dry and Moist | 100 | | Monel |
| Chloroform, Dry | 212 | | Monel |
| Chromic Acid | 300 | All | Hast. C |
| Citric Acid | 212 | All | Hast. C |
| Copper (10) Chloride | 212 | All | Hast. C |
| Copper (10) Nitrate and Sulfate | 300 | All | 316 SS |
| Copper Plating Solution (Cyanide) | 180 | | 304 SS |
| Copper Plating Solution (Acid) | 75 | | 304 SS |
| Creosote | 200 | All | 304 SS |
| Crude Oil | 300 | | Monel |
| Ethyl Chloride, Dry | 500 | | Steel |
| Ethylene Glycol (uninhibited) | 212 | All | 304 SS |
| Ethylene Oxide | 75 | | Steel |
| Fatty Acids | 500 | All | 316 SS |
| Ferric Chloride | 75 | All | Hast. C |
| Ferric Sulfate | 300 | All | 304 SS |
| Formaldehyde | 212 | 40% | 316 SS |
| Freon | 300 | | Steel |
| Fluorine, Anhydrous | 100 | | 304 SS |
| Gasoline | 300 | Steel | |
| Glucose and Glue ph 6.8 | 300 | | 304 SS |
| Glycerine | 212 | All | Brass |
| Hydrobromic Acid | 212 | All | Hast. C |
| Hydrochloric Acid (37.38%) | 225 | All | Hast. B |
| Hydrogen Chloride, Dry | 500 | | 304 SS |
| Hydrofluoric Acid | 212 | 60% | Monel |
| Hydrofluogilicic Acid | 212 | 40% | Monel |
| Hydrogen Peroxide | 125 | 10-100% | 304 SS |

| CORRODENT | TEMP. F | CONC. % | RECOM. MAT. |
|---|---|---|---|
| Kerosene | 300 | All | Steel |
| Lacquers and Thinners | 300 | All | 304 SS |
| Lactic Acid | 300 | All | 316 SS |
| Lime | 212 | All | 316 SS |
| Magnesium Chloride | 212 | 50% | Nickel |
| Magnesium Hydroxide | 75 | All | 304 SS |
| Magnesium Sulfate | 212 | 40% | 304 SS |
| Mercuric Chloride | 75 | 10% | Hast. C |
| Mercury | 700 | 100% | Steel |
| Milk, fresh or sour | 180 | | 304 SS |
| Natural Gas | 70 | | 304 SS |
| Nitric Acid | 75 | All | 304 SS |
| Nitric Acid | 300 | All | 316 SS |
| Oxygen | 75 | All | Steel |
| Photographic Bleaching | 100 | All | 304 SS |
| Phosphoric Acid | 212 | All | 316 SS |
| Phenol | 212 | All | 316 SS |
| Potassium Compounds | SEE SODIUM COMPOUNDS | | |
| Propane | 300 | | Steel |
| Resin | 700 | 100% | 316 SS |
| Sea Water | 75 | | Monel |
| Soap and Detergent: | 212 | All | 304 SS |
| Sodium Bicarbonate | 212 | 20% | 316 SS |
| Sodium Bisulphite | 212 | 20% | 304 SS |
| Sodium Carbinate | 212 | 40% | 316 SS |
| Sodium Chloride | 300 | 30% | Monel |
| Sodium Chromate | 212 | All | 316 SS |
| Sodium Cyanide | 212 | All | 304 SS |
| Sodium Hydroxide | 212 | 30% | 316 SS |
| Sodium Hypochlorite | 75 | 10% | Hast. C |
| Sodium Nitrate | 212 | 40% | 304 SS |
| Sodium Nitrite | 75 | 20% | 316 SS |
| Sodium Sulfate | 212 | 30% | 316 SS |
| Sodium Sulfide | 212 | 10% | 316 SS |
| Sodium Sulfite | 212 | 30% | 304 SS |
| Sodium Thiosulfate | 212 | All | 304 SS |
| Steam | | | 304 SS |
| Sulfur | 500 | | 304 SS |
| Sulfur Chloride | 75 | Dry | 316 SS |
| Sulfur Dioxide and Trioxide | 500 | Dry | 316 SS |
| Sulfuric Acid | 212 | 10% | 316 SS |
| Sulfuric Acid | 212 | 10-90% | Hast. B |
| Sulfuric Acid | 212 | 90-100% | 316 SS |
| Sulfuric Acid, Fuming | 175 | | Hast. C |
| Sulfurous Acid | 75 | 20% | 316 SS |
| Tannic Acid | 75 | 40% | Hast. B |
| Turpentine | 75 | | 316 SS |
| Zinc Chloride | 212 | All | Hast. B |
| Zinc Sulfate | 212 | All | 316 SS |

Three temperature-dependent factors influence ordering thermowells: (a) the corrosiveness of the environment (table, page No. 4), (b) the stress on material due to process flow/velocity (page No. 1), and (c) the process pressure (below).

PRESSURE/TEMPERATURE RATINGS
(in lbs. per square inch) for straight or tapered (.385" bore) thermowells.*

.385" Bore (14 Gage)

| MATERIAL | TEMPERATURE —°F. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 70° | 200° | 400° | 600° | 800° | 1000° | 1200° |
| Brass | 5000 | 4200 | 1000 | – | – | – | – |
| Carbon Steel | 5200 | 5000 | 4800 | 4600 | 3500 | 1500 | – |
| A.I.S.I. 304 | 7000 | 6200 | 5600 | 5400 | 5200 | 4500 | 1650 |
| A.I.S.I. 316 | 7000 | 7000 | 6400 | 6200 | 6100 | 5100 | 2500 |
| Monel | 6500 | 6000 | 5400 | 5300 | 5200 | 1500 | – |

PRESSURE/TEMPERATURE RATINGS
(in lbs. per square inch) for .260" bore tapered thermowells.*

.260" Bore (20 Gage)

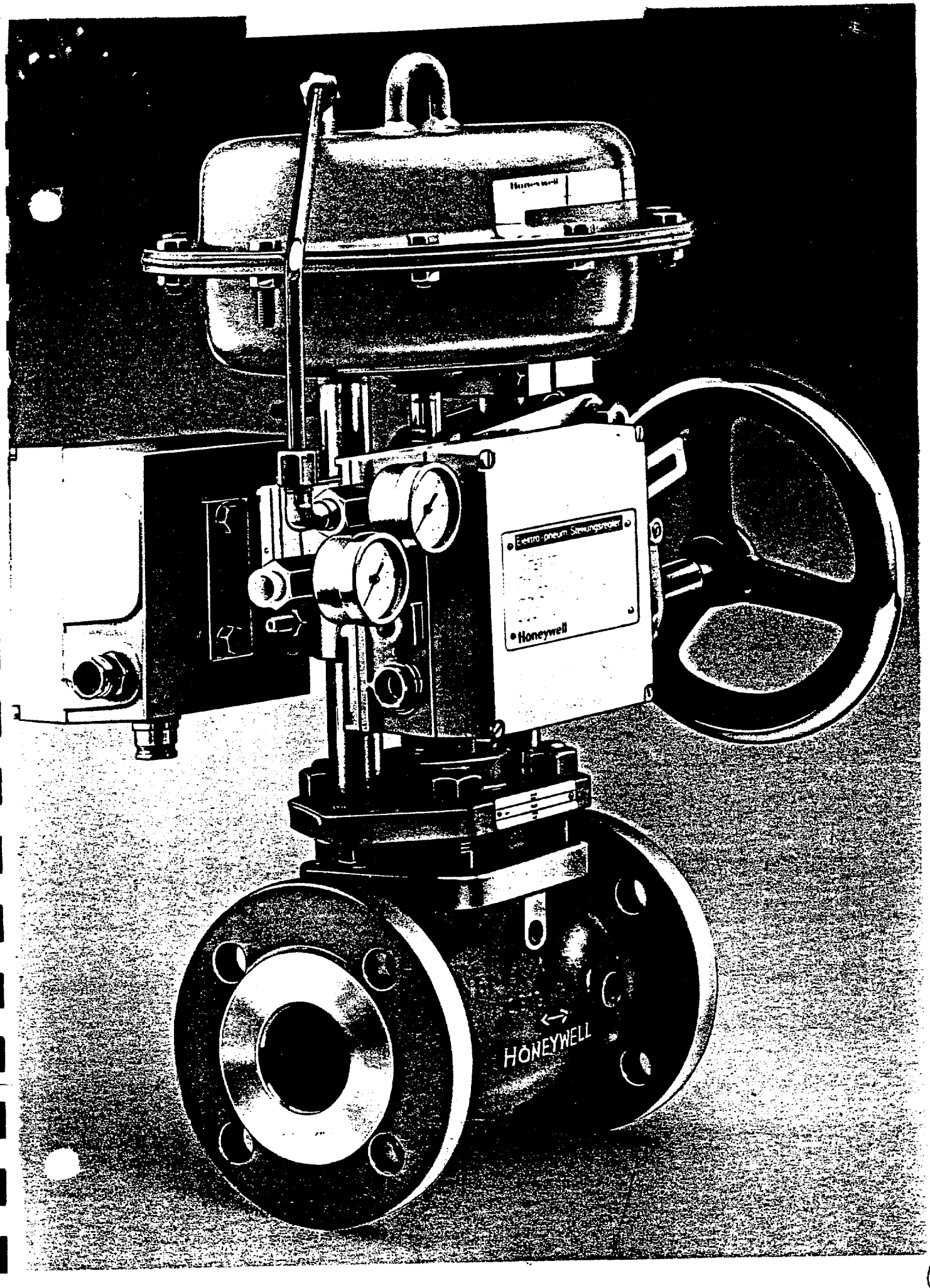
| MATERIAL | TEMPERATURE —°F. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 70° | 200° | 400° | 600° | 800° | 1000° | 1200° |
| Brass | 5300 | 4750 | 1100 | – | – | – | – |
| Carbon Steel | 5950 | 5750 | 5450 | 5250 | 4000 | 1750 | – |
| A.I.S.I. 304 | 7800 | 7050 | 6400 | 6150 | 6000 | 5190 | 1875 |
| A.I.S.I. 316 | 7800 | 7800 | 7250 | 7100 | 6950 | 5800 | 2720 |
| Monel | 7450 | 6850 | 6150 | 6100 | 5940 | 1750 | – |

*Pressures shown are for a safe non-collapsing pressure per appropriate listed material temperatures.

**CONTROL VALVES, HONEYWELL**

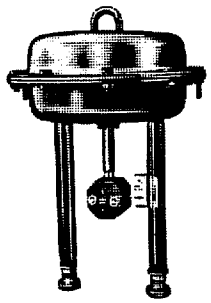
**(6 Pages in German)**

**Exhibit 6-10**


Elektro-pneum. Stellungsregler
Honeywell
HONEYWELL

# Honeywell Stellantriebe und Hilfsgeräte für Stellgeräte...

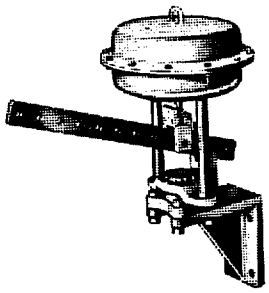
**Serie 2000 Pneumatische Membranantriebe**



| Spezifikation | |
|---|---|
| Typ: | Membranantrieb mit Federrückstellung |
| Antriebsgrößen: | 300 bis 2600 $cm^2$ wirksame Fläche |
| Wirkungsweise: | Direkt und umgekehrt |
| Temperaturbereich: | -60 bis 130° C |
| Nennhübe: | 10 bis 100 mm |
| Max. zulässiger Druck: | 6.0 bar |
| Geräte-Information: | DA-12 |

| Hauptmerkmale | Nutzen für den Anwender |
|---|---|
| Kompakte Stahlkonstruktion, vibrations- und stoßfest. | Universelle Anwendung für alle Industriezweige und Stellgeräte-Baureihen, reduzierte Lagerhaltung von Antrieben und Ersatzteilen. |
| Geeignet für rauhen Alltagsbetrieb und extreme Umgebungsbedingungen, hohe Lebensdauer. | Einsetzbar in allen Klimazonen von -60° bis 130°C, wartungsfrei, extrem langlebig (>$10^6$ Zyklen), geringer Ersatzteilbedarf. |
| Einfache Reversierbarkeit vor Ort. Multifederantrieb mit justierbarem Signalbereich. | Einfache Anpassung an gegebene Prozeßbedingungen Kosteneinsparung bei Inbetriebnahme und Service. |
| Erweiterte Funktionalität durch umfangreiches Zubehör. | Passende Stellungsregler, Signalformer, Schalter, Handräder etc., ermöglichen nachträgliche Erweiterung. |

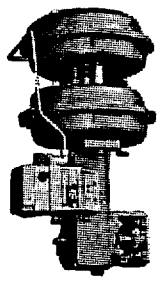
**Serie 2000 Pneumatische Membranantriebe mit Hebel**



| Spezifikation | |
|---|---|
| Typ: | Membranantrieb mit Federrückstellung |
| Antriebsgrößen: | 300 bis 600 $cm^2$ wirksame Fläche |
| Wirkungsweise: | Direkt und umgekehrt |
| Temperaturbereich: | -60 bis 130° C |
| Nennhübe am Hebel: | 42 bis 263 mm |
| Max. zulässiger Druck: | 6.0 bar |
| Geräte-Information: | DA-19 |

| Hauptmerkmale | Nutzen für den Anwender |
|---|---|
| Kompakte Stahlkonstruktion, vibrations- und stoßfest. | Universelle Anwendung für alle Industriezweige und Stellgeräte-Baureihen, reduzierte Lagerhaltung von Antrieben und Ersatzteilen. |
| Geeignet für rauhen Alltagsbetrieb und extreme Umgebungsbedingungen, hohe Lebensdauer. | Einsetzbar in allen Klimazonen von -60° bis 130°C, wartungsfrei, extrem langlebig (>$10^6$ Zyklen), geringer Ersatzteilbedarf. |
| Einfache Reversierbarkeit vor Ort. Multifederantrieb mit justierbarem Signalbereich. | Einfache Anpassung an gegebene Prozeßbedingungen Kosteneinsparung bei Inbetriebnahme und Service. |
| Erweiterte Funktionalität durch umfangreiches Zubehör. | Passende Stellungsregler, Signalformer, Schalter, Handräder etc., ermöglichen nachträgliche Erweiterung. |

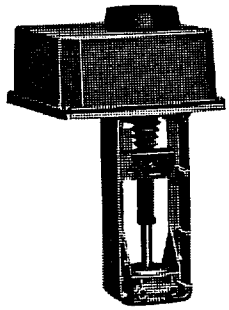
**Serie 2000 Pneumatische Schwenkantriebe**



| Spezifikation | |
|---|---|
| Typ: | Membranantrieb mit Federrückstellung und gekapseltem Umlenkgetriebe |
| Antriebsgrößen: | 300 bis 2600 $cm^2$ wirksame Fläche |
| Wirkungsweise: | Direkt und umgekehrt |
| Temperaturbereich: | -60 bis 130° C |
| Drehwinkel am Ausgang: | 60° - 90° |
| Max. zulässiger Druck: | 6.0 bar |
| Geräte-Information: | |

| Hauptmerkmale | Nutzen für den Anwender |
|---|---|
| Kompakte, völlig gekapselte Konstruktion, stoß- und vibrationsfest. | Universelle Anwendung für alle Drehstellgeräte gemäß ISO 5210/11, reduzierte Lagerhaltung von Antrieben und Ersatzteilen. |
| Geeignet für rauhen Alltagsbetrieb und extreme Umgebungsbedingungen, hohe Lebensdauer. | Einsetzbar in allen Klimazonen von -60° bis 130°C, wartungsfrei, extrem langlebig, geringer Ersatzteilbedarf. |
| Einfache Reversierbarkeit vor Ort, Multifederantrieb mit justierbarem Signalbereich. | Einfache Anpassung an gegebene Prozeßbedingungen, Kosteneinsparung bei Inbetriebnahme und Service. |
| Erweiterte Funktionalität durch umfangreiches Zubehör. | Passende Stellungsregler, Signalformer, Schalter, Handräder etc., ermöglichen nachträgliche Erweiterung. |

**Serie M 6421/25 Elektrische Stellgeräte-Antriebe ohne Stellungsregler**
**Serie M 7421/25 Elektrische Stellgeräte-Antriebe mit Stellungsregler**

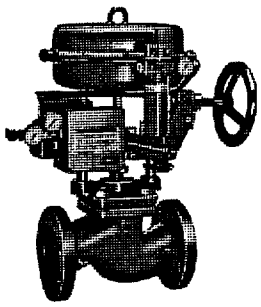


| Spezifikation | |
|---|---|
| Typ: | Elektrischer Schubantrieb |
| Funktion: | Ohne oder mit integriertem Regler |
| Eingangssignal: | 4-20 mA |
| Temperaturbereich: | -20 bis 60° C |
| Nennhub: | 20 und 38 mm |
| Hilfsenergie: | 24 V und 220 V |
| Geräte-Information: | DA-20.1 |

| Hauptmerkmale | Nutzen für den Anwender |
|---|---|
| Kompakt, niedrige Bauhöhe, Montage in jeder Position, kraftabhängige Endabschaltung. | Exzellentes Kosten-/Leistungsverhältnis bei kleinen Antriebskräften, einfache Installation und Inbetriebnahme, wartungsfrei. |
| Geeignet für Regelung oder Auf-ZU Betrieb bis DN 80. | Anwendbar bei Serien 2000, 2003, 2013, V 5066, gemeinsame Ersatzteilhaltung. |
| Bis zu 4 sindstellbare Endschalter, Rückführpotentiometer, Stellungsregler. | Einfache Anpassung an vorhandenen Regelkreis, vielseitige Anwendungen, präzise Regelung. |

# Eine breite Palette erprobter Stellgeräte-Baureihen...

**Serie 2060 Regelventil (2-Wege) für den Mitteldruckbereich bis PN 100**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 15 bis DN 150 |
| **Nenndrücke:** | PN 63, PN 100 |
| **Temperaturbereich:** | -200 bis 540° C |
| **Stellverhältnis:** | 50:1 |
| **Geräte-Information:** | - - - |

**Hauptmerkmale**

Kompakt, obengeführt, universelle Anwendung.

Verfügbar in den häufigsten Ausführungsformen.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell

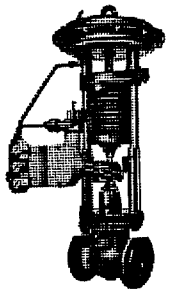
**Nutzen für den Anwender**

Gleiche Baugruppen wie Serie 2000, reduzierter Ersatzteilbedarf.

Weiter Anwendungsbereich, praxiserprobt.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**Serie 600 Regelventil (2-Wege) mit Druckausgleich**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 15 bis DN 150 |
| **Nenndrücke:** | PN 16, PN 25, PN 40 und ANSI 300 |
| **Temperaturbereich:** | -200 bis 540° C |
| **Stellverhältnis:** | 50:1 |
| **Geräte-Information:** | DA-18 |

**Hauptmerkmale**

Schwere, kegelschaftgeführte Baureihe mit Druckausgleich.

Verfügbar in den häufigsten Ausführungsformen.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell.

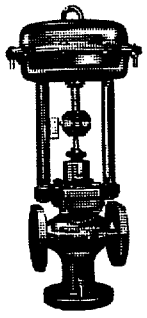
**Nutzen für den Anwender**

Hohe Stabilität bei großen Drücken und Differenzdrücken.

Weiter Anwendungsbereich, praxiserprobt.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**Serie 2003 Regelventil (3-Wege) für Mischbetrieb**
**Serie 2013 Regelventil (3-Wege) für Verteilerbetrieb**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 15 bis DN 300 |
| **Nenndrücke:** | PN 16, PN 25, PN 40 und ANSI 300 |
| **Temperaturbereich:** | -200 bis 540° C |
| **Stellverhältnis:** | 50:1 |
| **Geräte-Information:** | DA-18 |

**Hauptmerkmale**

Sitzringgeführte Baureihe, einfach anzupassen an Misch- oder Verteilerbetrieb.

Verfügbar in den häufigsten Ausführungsformen.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell.

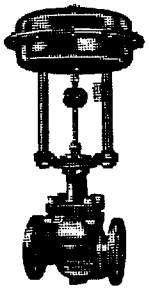
**Nutzen für den Anwender**

Keine zusätzlichen Teile, geringe Kosten für gemeinsame Ersatzteile und Lagerhaltung.

Weiter Anwendungsbereich, praxiserprobt.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, (Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**Serie 9000 Käfigventil (2-Wege) für hohe Betriebsdrücke bis PN 160**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 25 bis DN 300 |
| **Nenndrücke:** | PN 40, PN 63, PN 100 PN 160 und ANSI 300, ANSI 600, ANSI 900 |
| **Temperaturbereich:** | -200 bis 540° C |
| **Stellverhältnis:** | 50:1 |
| **Geräte-Information:** | DA-24 |

**Hauptmerkmale**

Käfiggeführte Baureihe, wahlweise mit oder ohne Druckausgleich.

Verfügbar in den häufigsten Ausführungsformen, weiter Anwendungsbereich.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell.

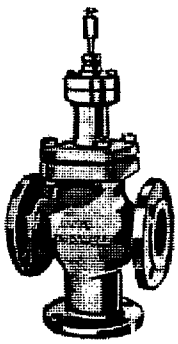
**Nutzen für den Anwender**

Extrem stabile Konstruktion für hohe Differzdrücke, einfache Wartung und Instandhaltung.

Sehr gute dynamische Stabilität, lange Lebensdauer, Geräuscharmut, praxiserprobte Baureihe für schwierige Applikationen.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**Serie V 5066 Regelventil (3-Wege) für Warmeträgeröle**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 25 bis DN 80 |
| **Nenndruck:** | PN 16 |
| **Temperaturbereich:** | -60 bis 350° C |
| **Stellverhältnis:** | 30:1 |
| **Geräte-Information:** | DA-21 |

**Hauptmerkmale**

Spezialbaureihe für Wärmsträgeröl-Anwendungen mit doppelwandigem Edelstahl-Faltenbalg.

Geeignet für Misch- und Verteilerbetrieb ohne zusätzliche Bauteile.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell

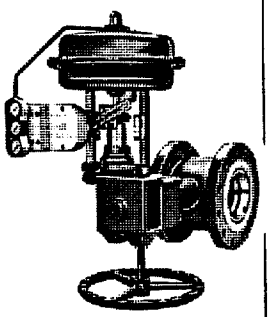
**Nutzen für den Anwender**

Wartungsfrei, keine Packungsleckage, sehr günstiges Kosten-/Leistungsverhältnis.

Hohe Flexibilität und Zuverlässigkeit durch einheitliche Ausführung.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**Serie 2100 Regelventil (2-Wege) für zähe oder verschmutzte Medien**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 25 bis DN 300 |
| **Nenndrücke:** | PN 25, PN 40, PN 63, PN 100 und ANSI 150, ANSI 300, ANSI 600 |
| **Temperaturbereich:** | -60 bis 350° C |
| **Stellverhältnis:** | 100:1 |
| **Geräte-Information:** | DA-11 |

**Hauptmerkmale**

Patentierte Drehkegel-Ausführung, sehr große Kv-Werte.

Gerader Durchfluß, keine Umlenkungen oder Toträume.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell.

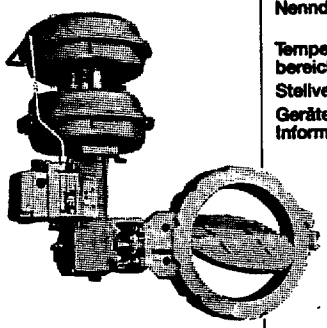
**Nutzen für den Anwender**

Gute dynamische Stabilität, kleine Restleckmengen, Kosteneinsparung durch Wahl einer kleineren Nennweite möglich.

Keine Verstopfung oder Ansammlung von Feststoffen, hohe Betriebssicherheit bei zähen, schmutzigen Medien, erhöhte Lebensdauer bei Suspensionen.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, (Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**erie 2950 Drosselklappe für hohen Durchfluß bei kleinen Differenzdrücken**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 80 bis DN 800 |
| **Nenndrücke:** | PN 10, PN 16, PN 25 und ANSI 125, ANSI 150, |
| **Temperaturbereich:** | -10 bis 350° C |
| **Stellverhältnis:** | 30:1 |
| **Geräte-Information:** | |

**Hauptmerkmale**

Robuste, bewährte Drosselklappenausführung.

Flanschlose und geflanschte Ausführungsformen lieferbar.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell.

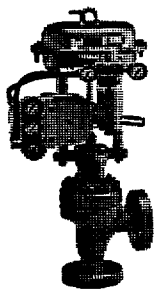
**Nutzen für den Anwender**

Exzellentes Kosten-/Leistungsverhältnis, sehr gute Regelbarkeit.

Große Flexibilität bei Anpassung an Gegenflansche, einfache Montage.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, (Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

**Serie 800-30 Regelventil (Eckbauweise) für Hochdruck-Anwendungen**



**Spezifikation**

| | |
|---|---|
| **Nennweiten:** | DN 25 bis DN 150 |
| **Nenndrücke:** | PN 160, PN 250, PN 320 und ANSI 900, ANSI 1500, AINSI 2500 |
| **Temperaturbereich:** | -60 bis 450° C |
| **Stellverhältnis:** | 50:1 |
| **Geräte-Information:** | |

**Hauptmerkmale**

Kegelschaftgeführte Hochdruck-Baureihe, mit und ohne Druckausgleich.

Spezielle Formgebung des Ventilgehäuses.

Anti-Kavitationsgarnituren.

Gleiche Antriebe und Hilfsgeräte wie für die übrigen Ventilbaureihen von Honeywell.

**Nutzen für den Anwender**

Sehr robuste Konstruktion, gute dynamische Stabilität bei hohen Differenzdrücken.

Minimaler Verschleiß und erhöhte Lebensdauer, geeignet für abrasive Medien.

Hohe Lebensdauer, Geräuscharmut.

Standardisiertes Antriebs- und Zubehörprogramm (Stellungsregler, Schalter, Signalumformer etc), minimale Kosten für Ersatzteile und Lagerhaltung.

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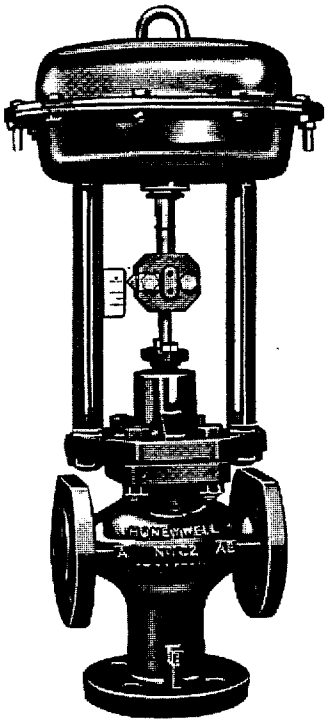
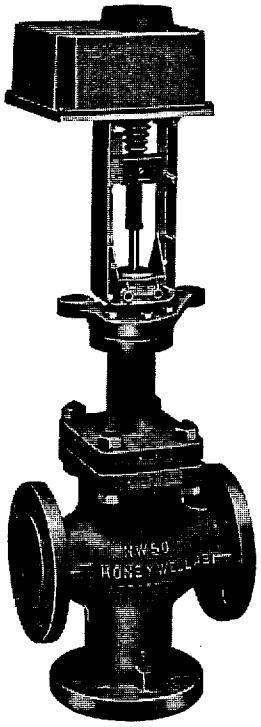
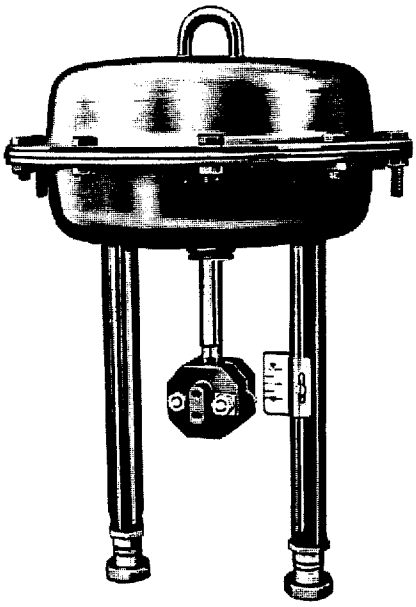


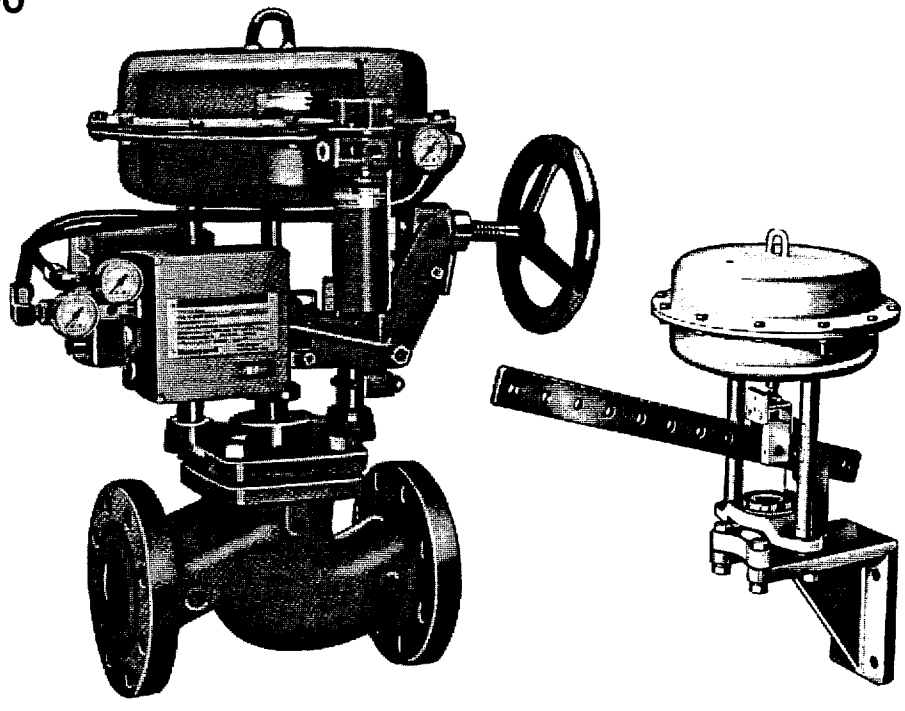




# Pneumatischer Antrieb Serie 2000

| Nutzen für den Anwender | Merkmale | Nutzen für den Anwender |
|---|---|---|
| Geringer Platzbedarf, einfache Installation und Instandhaltung. | Kompakte Stahlkonstruktion, vibrations- und stoßfest. | Universelle Anwendung für alle Industriezweige und Honeywell Stellgeräte-Baureihen. |
| Dichter Abschluß, kostengünstig, kein spezielles Absperrventil notwendig. | Geeignet für rauhen Alltagsbetrieb und extreme Umgebungs-bedingungen. | Einsetzbar in allen Klimazonen von -60°C bis 130°C, wartungsfrei, unempfindlich gegen Stoß und Vibrationen, Seeklima, Industrie-atmosphäre. |
| Leichte Austauschbarkeit und Instandhaltung, perfekte Zentrierung, geringe Schließkräfte. | Hohe Stellkräfte trotz geringer Abmessungen, Tandem- Ausführung unter Verwendung gleicher Bauteile. | Kein Druckregler (bis max. 6.0 bar) erforderlich, Montage in jeder Position und nachträgliche Erweiterung als Tandem-Version möglich. |
| Geringe Kosten für Lagerhaltung und Ersatzteile. | Justierbare Signalbereiche und Umkehrung der Wirkungsweise ohne zusätzliche Teile. | Einfache Anpassung an gegebene Prozeßbedingungen, wezige Nenn-signalbereiche, reduzierter Ersatz-teilbedarf. |
| "The Right Fit", d.h. optimale Anpassung an die jeweiligen Betriebsbedingungen. | Multifeder-Antrieb mit spezieller Stangenabdichtung. | Geringes Gewicht, extrem hohe Lebensdauer (< 1 Million Hubzyklen). |
| Große Flexibilität, leichte Anpassung an besondere Betriebsbedingungen, verlängerte Lebensdauer, Geräusch-armut. | | |
| Leichte Wartung, niedrige Kosten für Instandhaltung, keine Spezial-werkzeuge. | | |

# Serie 2000



## Regelventil Serie 2000

| Merkmale | Nutzen für den Anwender | Merkmale |
|---|---|---|
| **K**ompakte Universal-Baureihe von DN 15 bis DN 300 gemäß DIN und ANSI Normen.<br>Nenndrücke : PN 16, PN 25, PN 40<br>ANSI 150, ANSI 300<br>Temperaturbereich: -200-540°C<br>Regelbarkeit : 50:1<br>Geräte-Information: DA-13 | **S**ehr weiter Anwendungsbereich, keine verschiedenen Baureihen innerhalb einer Anlage, wirtschaftliche Lagerhaltung, reduzierter Ersatzteilbedarf, lieferbar in allen gängigen Ausführungsformen, Werkstoffen, Druckstufen usw. | **N**iedrige Bauhöhe, oben geführter Drosselkörper.<br>**E**insitzausführung bis DN 100.<br>**O**ptimierte Regelgarnituren. |
| **E**insetzbar bei den meisten (90%) industriellen Anwendungen, zahlreiche Ausführungsformen und Prüfbescheide sind verfügbar: | **P**raxiserprobte Zuverlässigkeit, limitiertes Risiko, exzellentes Preis-/Leistungsverhältnis ("The Right Fit"). | **G**emeinsame Hilfsgeräte für alle Stellgeräte-Baureihen. |
| ☐ 6 verschiedene Werkstoffe<br>☐ 4 verschiedene Oberteile<br>☐ 5 verschiedene Drosselorgane<br>☐ 3 Standard-Kennlinien<br>☐ pneumatische und elektrische Antriebe<br>☐ Zertifikate : VdTUV, DVGW, PTB, Germanischer Lloyd, DSRK, etc. | **U**nterstützung durch erfahrene Anwendungsspezialisten von Honeywell.<br>Mit Hilfe von VALCAL wird durch auch dem Laien eine vernünftige Berechnung und Auswahl ermöglicht. | **G**roße Auswahl an verschiedenen Kv-Werten und Kennlinien.<br>**V**erschiedene, auswechselbare Garnituren. |
| **O**ptimierter Strömungsverlauf, geringer Widerstand. | **H**ohe Durchflußkapazität, geringe Turbulenzen, geräuscharm, hohe Lebensdauer. | **K**ostengünstige, einfache Ersatzteile |

# Honeywell Stellgeräte: "The Right Fit"

**Honeywell Stellgeräte zeichnen sich aus durch:**

- **Innovative Technik**
- **Präzision und Zuverlässigkeit**
- **Hohes Qualitätsniveau**
- **Computerunterstützte Berechnung, Herstellung und Auswahl**
- **Rasche Verfügbarkeit (JIT)**
- **Einfache Installation und Instandhaltung**

Honeywell Industrie-Stellgeräte sind "die ideale Lösung", um Ihren Regelkreis zu schließen. Sie sind in fast allen Industriezweigen anwendbar und stehen in zahlreichen Druckstufen, Nennweiten und Werkstoffen zur Ve: ung. Sie werden ergänzt durch ein breites Sortiment von Hilfsgeräten, um den Anforderungen des Marktes gerecht zu werden. Zu nennen sind : Pneumatische und elektropneumatische Stellungsregler, Signalumformer, Grenzwertgeber, Magnetventile usw.

Honeywell-Stellgeräte werden seit mehr als 30 Jahren in Europa produziert. In diesem Zeitraum bewies das Unternehmen seine Leistungsfähigkeit als weltweiter Hersteller von zuverlässigen, qualitativ hochwertigen Regelventilen. Die Anwendungen reichen von relativ einfachen Regelungen in der Gebäudeautomation bis hin zu extrem schwierigen Aufgaben in Kernkraftwerken.

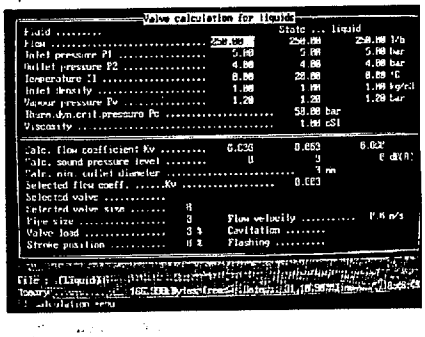
Bei der Auswahl eines geeigneten Stellgerätes müssen Sie stets aus einer Fülle möglicher Lösungen die optimale herausfinden, d.h. eine Entscheidung treffen, die in technischer und ökonomischer Hinsicht optimal ist. Dies 'ordert nicht nur gründliche Faci ntnisse, sondern darüber hinaus einen beträchtlichen Zeitaufwand für Berechnung, Produktspezifikation und Auswahl. Um wertvolle Zeit zu sparen und sicherzustellen, daß Sie von Beginn an die richtige Entscheiding treffen, hat Honeywell VALCAL entwickelt, ein Computer-Programm für die Berechnung, Spezifikation und Auswahl des bestgeeigneten Stellgerätes. VALCAL ermöglicht eine rasche und optimale Auswahl aus einer breiten Palette möglicher Lösungen und gewährleistet, daß Sie das Stellgerät identifizieren, das exakt Ihren spezifischen Anforderungen entspricht. Eine Kopie der Basisversion VALCAL 3.3 stellen wir unseren Kunden auf Anforderung kostenlos zur Verfügung.

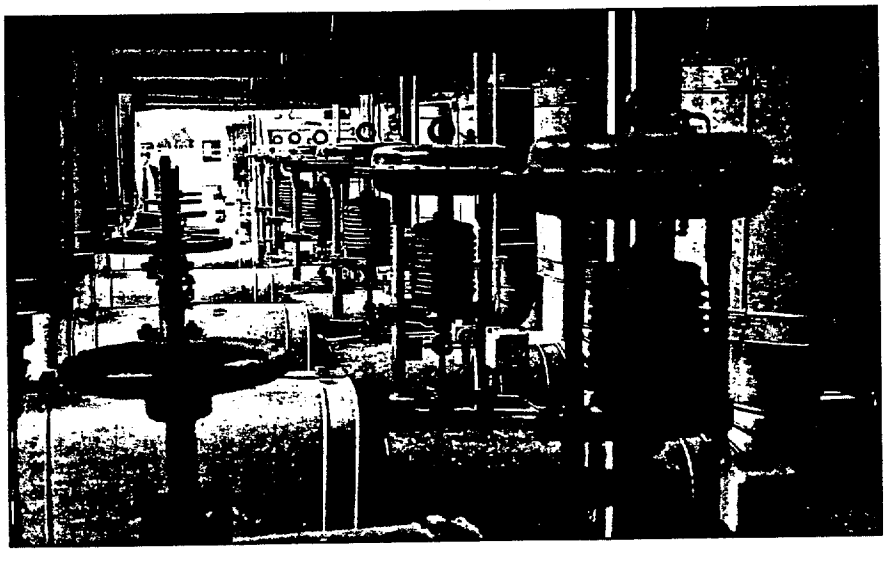
Die folgenden Seiten zeigen das Standard-Stellgeräte- und Zubehörprogramm von Honeywell. Bei der Ausarbeitung spezieller, anwendungsspezifischer Lösungen sind wir Ihnen gerne behilflich. Falls Sie weitere Informationen wünschen, oder an unserem Programm VALCAL 3.3 interessiert sind, so wenden Sie sich bitte an die nächste Honeywell-Niederlassung.

## Baureihe 2000

**...variabel, ökomisch, weltweit erprobt...**

Honeywell-Stellgeräte der Baureihe 2000 sind in allen bedeutenden Industriezweigen für die unterschiedlichsten Anwendungen einsetzbar. Ihre hohe Zuverlässigkeit - auch unter extremen Prozeß- oder Umweltbedingungen-, die einfache Wartung und Instandhaltung und - nicht zuletzt - die künftig zu betrachtende Integrationsfähigkeit in moderne Prozeßleitsysteme, werden Honeywell - Stellgeräte der Baureihe 2000 auch in der Zukunft attraktiv erscheinen lassen.



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**CONTROL VALVES**
**TOUR AND ANDERSSON LTD.**
**Data Sheet F-20-11**

**Exhibit 6-11**

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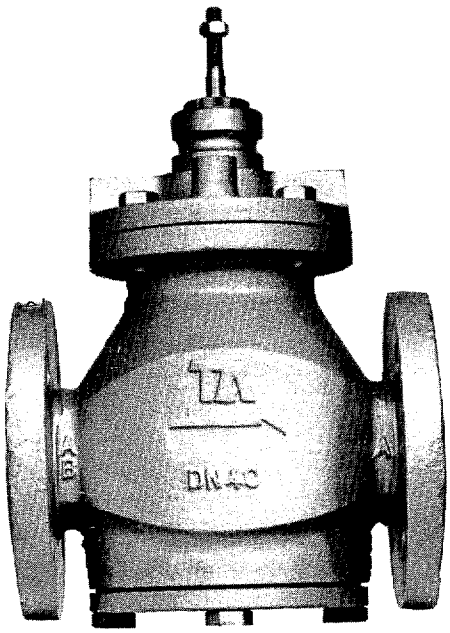
# V 295

**2-way control valve**



December 1983




The V295 is a flanged piston valve of nodular iron, size DN 40–100, pressure rating PN 25.

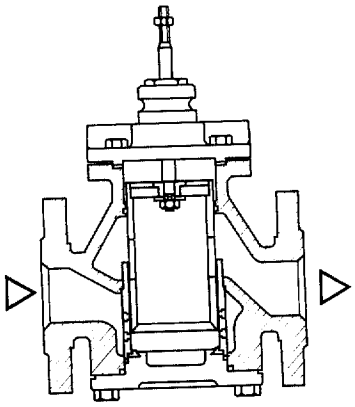
The V295 is ideal for district heating.

The type of actuator fitted is determined by the control system: required torque, travel time, etc.

As standard, the valve and actuator are supplied separately as an assambly but can be supplied for site assembly.

## TECHNICAL DATA

| | |
|---|---|
| Type | V295 |
| Part number | See table 1 |
| Size | DN 40–100 |
| Construction | Flanged piston valve |
| Characteristic | Logarithmic |
| $K_{VS}$ value | 16–125 |
| Pressure rating | PN 25 |
| Max. temperature water | 180°C |
| Max. Δ Pm, valve open | 800 kPa |
| Rangeability | 30:1 |
| Max. leakage, closed valve | 0.1% of $K_{VS}$ |
| Material: | |
| Body | Nodular iron SIS 0717-02 |
| Plug and seat | Stainless steel SIS 2333 |
| Packing | Spring loaded V-ring of PTFE |
| Connection | Flanged ISO/R 2084, BS 4504 |
| Valve lift | 31.5–50.3 mm |
| Weight | 15–57.0 kg |



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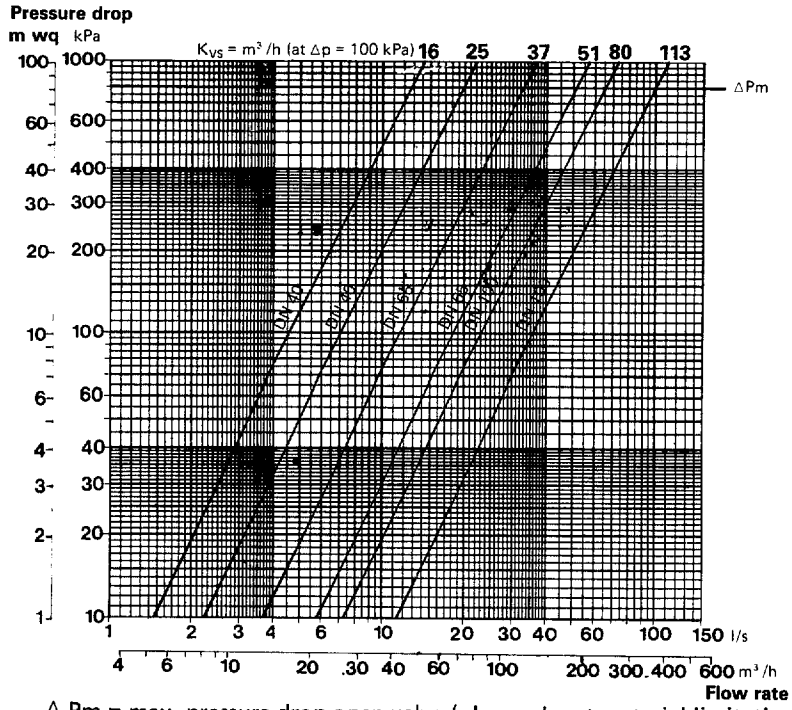
## PRESSURE DROP DIAGRAM




Δ Pm = max. pressure drop open valve (plug and seat material limitation).

## PART NUMBERS

| Size DN/$K_{VS}$ | Part number |
|---|---|
| 40/16 | 721-9574-000 |
| 40/25 | 721-9546-000 |
| 65/40 | 721-9550-000 |
| 65/63 | 721-9554-000 |
| 100/80 | 721-9558-000 |
| 100/125 | 721-9562-000 |

## ACTUATORS

| Actuator | M5C EM5C | M15C |
|---|---|---|
| Valve | Max. differential pressure with valve closed, Δ Pc in kPa (Q leakage < 0.1%) | |
| DN 40 | 1600 | 1600 |
| DN 65 | 600 | 700 |
| DN 100 | – | 450 |

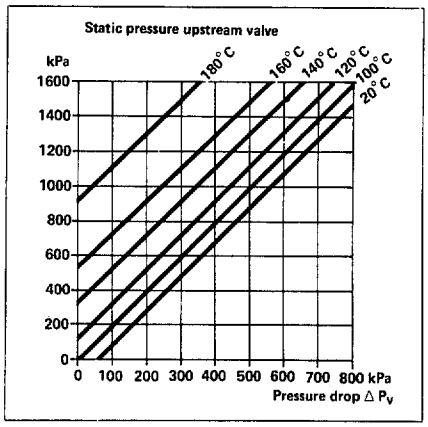
## INSTALLATION

The valve should be mounted in the return, where possible, to avoid unnecessarily high actuator temperature.

The actuator should not be located under the valve.

A filter should be installed upstream of the valve if the medium contains suspended solids.

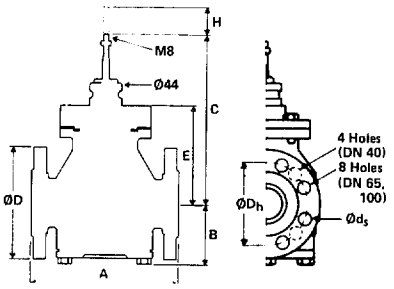
The cavitation diagram shows permitted pressure drop Δ $P_V$ across the valve to prevent cavitation occurring.




## ORDERING EXAMPLES

a) Valve . . . . . V295/DN 40/$K_{VS}$ 25. . . . . Part number: 721-9546-000
b) Motorised valve assambled. . . . . EM5C/24V/180°/V295/DN 40/$K_{VS}$ 25
Type of actuator . . . . . EM5C/24V/180°
Type of valve . . . . . V295/DN 40/$K_{VS}$ 25

## DIMENSIONS




| Size DN | Dimensions (mm) A | B | C | E | ØD | $D_h$ | $d_s$ | H |
|---|---|---|---|---|---|---|---|---|
| 40 | 200 | 82 | 212 | 132 | 150 | 110 | 18 | 31.5 |
| 65 | 290 | 106 | 228 | 148 | 185 | 145 | 18 | 40.9 |
| 100 | 350 | 124 | 258 | 178 | 235 | 190 | 22 | 50.3 |

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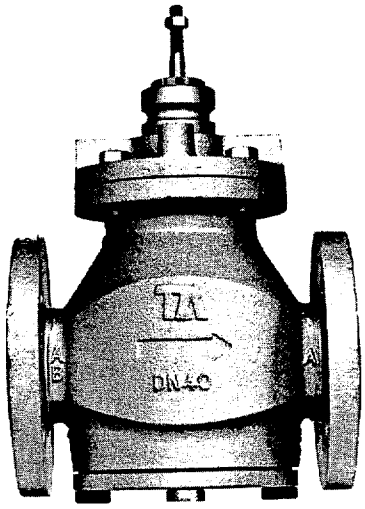
TA
INCENTIVE GROUP

# V295

**Compensated two-way piston valve**
**Ductile iron, PN 25**

1993.10




- V295 is a two-way piston valve with flanged ends
- The valve is balanced (pressure-compensated), thereby requiring a low actuating force.

## APPLICATION

The valve is primarily intended to be used in heating, air conditioning and distric heating installations with large pressure drops.

For other types of applications, please contact your nearest TA sales office.

The V295 valve can be used with the following types of fluids:

- hot water, or deaerated cooling water.
- water with additives such as phosphate or hydrazine.
- deaerated water with glycol-type antifreeze agent (max. 50%), and brines (special packing box required, see "SPARE PARTS").
- with cooling medias at temperatures below 0 °C a stem heater must be fitted, to protect from stem seizure due to freezing. See "ACCESSORIES".

## TECHNICAL DATA

Valve type ..... 2-way compensated piston valve
Pressure class ..... PN 25 (bars)
Flow characteristic ..... Eq% (logarithmic)
Rangeability ..... 25
Leakage ..... max. 0,1% of $K_v$
$\Delta p_m$ ..... max. 800 kPa, water
Medium temperature:
Max. ..... 180 °C
Min. ..... –20 °C
Flange connection ..... hole pattern acc. to SS335 and ISO2084
Suitable weld flange with collar ..... SS 2034
Materials:
Body ..... ductile iron SS 0727-02
Piston and sleeve ..... stainless steel SS 2346-02
Stem ..... stainless steel SS 2346-02
Packing box, standard ..... type T
Special packing box for max. 50% glycol ..... type Q

| Size DN | $K_v$ m³/h | h mm | Part number | $K_{v\,min}$ m³/h |
|---|---|---|---|---|
| 40 | 16 | 31,5 | 721-9574-000 | 0,7 |
| | 25 | 31,5 | 721-9546-000 | 1,0 |
| 65 | 37 | 40,9 | 721-9550-000 | 1,5 |
| | 51 | 40,9 | 721-9554-000 | 2,0 |
| 100 | 80 | 50,3 | 721-9558-000 | 3,2 |
| | 113 | 50,3 | 721-9562-000 | 4,5 |

**Remarks**

The rangeability is the ratio of $K_v$ to $K_{Vmin}$.

$K_v$ is the valve flow at the max. lift and a pressure drop of 100 kPa across the valve.

$K_{Vmin}$ is the minimum controllable flow at a pressure drop of 100 kPa, within the flow range where the characteristic meets the requirements on characteristic slope according to IEC534-1.

h is the lift of the valve in mm.

$\Delta p_m$ is max. pressure drop across a fully open valve.



We reserve the right to make minor changes.

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The valve has a cylindrical piston which moves inside a cylindical seat, equipped with a number of holes.

When the piston moves upwards the holes are gradually exposed, resulting in increasing flow.

The piston is open at both ends and the valve is therefore compensated. This means that the pressure drop across the valve will not be affected by the movement of the piston. The valve can therefore handle large flows without a corresponding increase in the required actuating force.

The flow characteristic is equal percentage (Eq%, also called logarithmic), giving an equal-percentage change in flow. The latter is necessary to give good control in systems with large load variations.

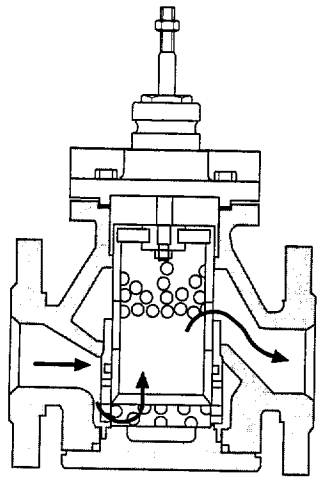

Figure 1

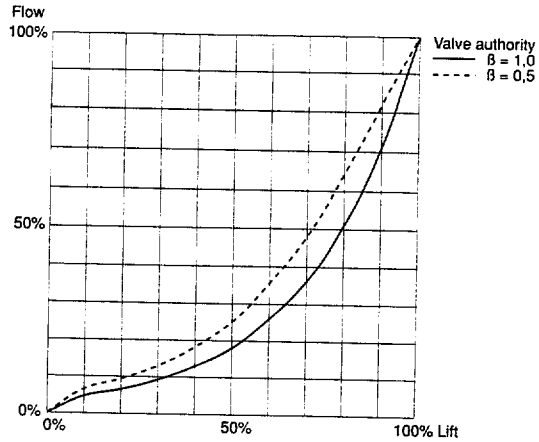


Figure 2

## ACTUATOR AND LINKAGE SELECTION

**Electric actuators**

The M5C and M15C actuators are controlled by increase/decrease signals.

The EM5C actuator is controlled by a modulating 2–10 V DC signal.

The linkage need be ordered separately only if the valve and the actuator are delivered as separate items.

| Size DN | M5C, EM5C part number | $\Delta P_c$ (kPa) | M15C part number | $\Delta P_c$ (kPa) |
|---|---|---|---|---|
| 40 | 911-1070-375 | 1600 | 911-1070-375 | 1600 |
| 65 | 911-1070-475 | 600 | 911-1070-475 | 700 |
| 100 | 911-1070-575 | – | 911-1070-575 | 450 |

$\Delta P_c$ = Max. close-off pressure drop across the valve.

## INSTALLATION

The valve is to be installed in the line so that the direction of flow coincides with the arrow on the valve body.

Whenever possible, the valve should be installed in the return line, to avoid exposing the valve to unnecessarily high temperatures. The valve must not be mounted with the actuator under the valve.

To prevent dirt from getting caught between plug and seat, it is recommended to install a strainer upstream of the valve. Also flush and rinse the piping system before installation of the valve.

**A.** Typical installation without local circulating pump.

To provide good function the pressure drop across the valve should be no less than half of the available pressure (Δp). This corresponds to a valve authority of 50%.

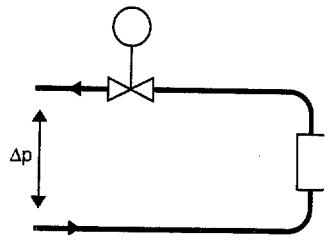


Figure 3

**B.** Typical installation with local circulating pump.

The $K_v$ value of the valve to be selected so that the entire available pressure drop (Δp) falls across the control valve.

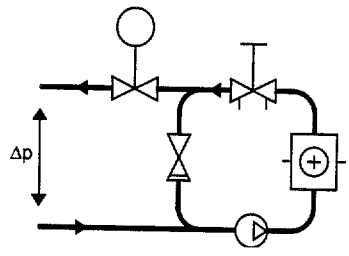


Figure 4

## PRESSURE DROP DIAGRAM

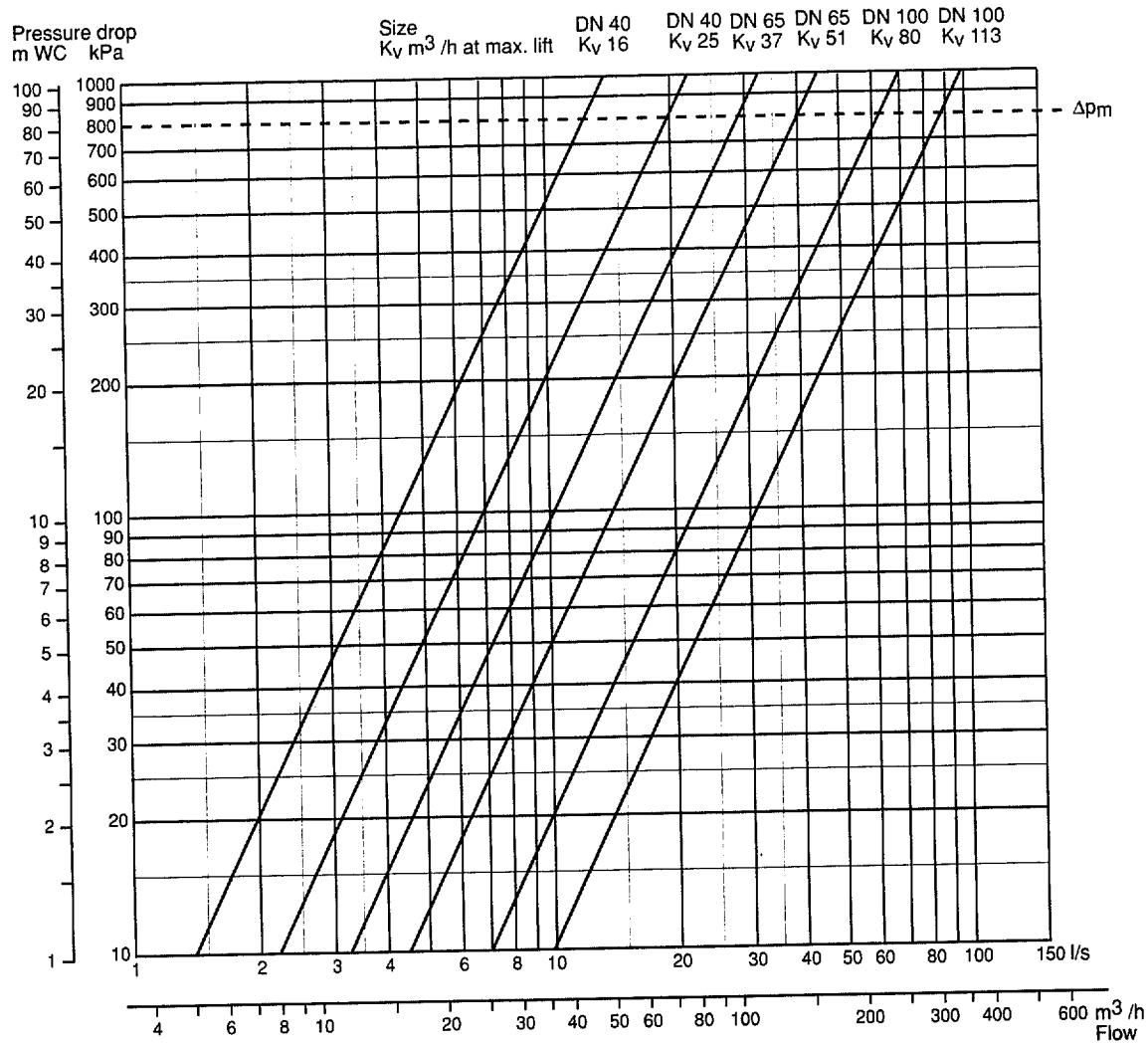


Figure 5

## CAVITATION

Cavitation takes place in a valve when the velocity of the flow between the plug and seat increases to the extent that gas bubbles are created in the water. When, after the plug and seat, the velocity decreases, the gas bubbles collapse (implode), generating considerable noise and causing considerable wear on the valve.

By means of the cavitation diagram shown in figure 6 it can be checked if risk of cavitation exists with the working conditions in the pertinent installation. Proceed as follows:

Using the static pressure before the valve (e.g. 1 000 kPa), plot a horizontal line to the line for the temperature of the liquid (e.g. 120 °C). From the intersection point, plot a vertical line downwards and read off the max. permissible pressure drop across the valve. If the computed pressure drop exceeds the value read from the diagram there is risk of cavitation.

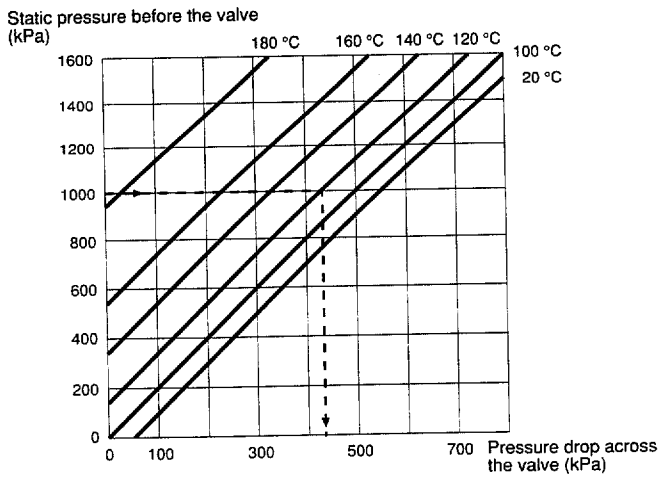


Figure 6

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## ORDERING EXAMPLE

The valve can be ordered in the following ways.

1. Valve only

V295 / DN 40 / Kv 16

Valve type — Size — Kv value

2. Complete control valve with fitted actuator, adjusted and ready for use.

M5C / 24 V / 180° / V295 / DN 40 / Kv 16

Actuator designation — Valve type — Size — Kv value

3. Valve and actuator delivered as separate items

Actuator designation M5C/24 V/180°
Valve designation V295/DN 40/Kv 16
Linkage, part number 911-1970-375

Note that the linkage for the electric actuator must also be ordered as a separate item.

## MEASUREMENTS AND WEIGHTS

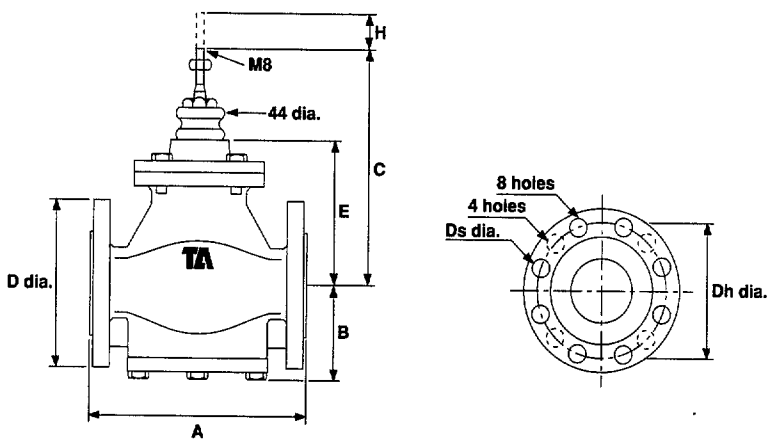


Figure 7

| Size DN | Measurements in mm A | B | C | E | dia. D | dia. Dh | dia. ds | No. of holes | H | Weight kg |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 200 | 82 | 212 | 132 | 150 | 110 | 18 | 4 | 31,5 | 15 |
| 65 | 290 | 106 | 228 | 148 | 185 | 145 | 18 | 8 | 40,9 | 32 |
| 100 | 350 | 124 | 258 | 178 | 235 | 190 | 22 | 8 | 50,3 | 54 |

## SPARE PARTS

**Standard packing box**
Type T: max. 180 °C
Part number: 080-2064-005.

**Special packing box for max. 50% glycol**
Type Q: –20 to 30 °C
Part number: 080-4724-005.

## ACCESSORIES

**Stem Heater**
Heating element for the valve stem.

Designed for actuators M5C, EM5C and M15C.
Part number: 911-2062-000.

Printed in Sweden by Novum Grafiska AB, Gbg 1994. 14383

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# SCADA SYSTEMS

## WESTINGHOUSE WDPF

**Exhibit 6-12**

## SCADA System for the City of Sophia, Bulgaria

### OVERVIEW

* Central Monitoring
* GIS
* Relational Database
* Billing
* Expandable

### CENTRAL CONTROL STATION

* WEStation Consoles
* WEStation Historian
* WEStation Calculator Builder
* WEStation Data Link Server

### COMMUNICATIONS SYSTEM

* Fiber Optic Backbone
* use SONET

### REMOTE TELEMETRY UNITS

* small, portable
* downloadable
* expandable

### INSTALLATION

*SCADA System for the City of Sophia, Bulgaria*

## *OVERVIEW*

*Westinghouse proposes a fiber-optic backbone based SCADA system to monitor, maintain, and generate billing for the heating distribution system for the City of Sophia, Bulgaria.*

*This system would include a Central Control Facility, Communication System and Remote Telemetry Units.*

*The Central Control Facility, would include "sate-of-the-shelf" hardware and software packages that would allow operators to monitor the entire heating distribution system from a central location, using a back projection Video Display Wall driven by powerful workstations.*

*The Communication System is a fiber-optic based Metropolitan Area Network (MAN) using standards established by the Exchange Carriers Standards Association (ECSA) for the American National Standards Institute (ANSI). The communication protocol will be DQDB - Distributed Queued Dual Bus IEEE 802.6 which is a Switched Multimegabit Data Service (SMDS).*

*The Remote Telemetry Units will be "intelligent" devices that can "stand-alone". These remote units will consists of three types that will provide a handful of I/O such as standard 4-20ma analog input signals as well as pulse accumulators that will take contact closures.*

## *CENTRAL CONTROL FACILITY*

*Monitoring the entire Heating Distribution System will be conducted at the Central Control Facility using powerful 32 bit workstations. Westinghouse is proposing three workstations with two monitors each that will interface to the back projection Video Wall. A redundant HISTORIAN will contain the Global Relational Database. A Calculator workstation will make all the necessary performance and heat usage calculations. A LOGGER workstation will perform all the reporting and billing print-outs. A Redundant Data-Link Server will collect and poll all the Remote Telemetry Units and pass the information to the Operator's Consoles, Historian, Calculator and the Logger.*

## VIDEO WALL

The Video Wall will consist of two foot by two foot squares covering an eight foot by eight foot area. This Video Wall will provide a complete overview of the Distribution Area that can be easily seen by anyone in the room. The graphics displayed on this system will be resident in the workstations. At any time an operator sitting at one of the workstations, can take command of the entire Video Wall and display a graphic resident in their machine. The Graphics will be arranged in a hierarchial method starting first with a broad geographic overview "zooming" down into more specific distribution areas. The workstations will be mounted in an Evan's Console that will meet the ergonomic and operational demands of the City's operators.

## HISTORIAN

A fully redundant Central Control Facility Historian will maintain a global database of all the I/O in the SCADA system. This Historian will use "shadow disk" technology that will periodically back-up data on a second hard disk which will minimize the impact of a hard disk "crash". The Historian will use an ORACLE Relational Database to store and manipulate the data. Through the use of SQL calls, application software packages can access the data in the relational database. The Historian will maintain historical data collected from the SCADA system as well as a customer database, and maintenance information such as calibration and service data.

## GIS

The Historian will integrate with the Heating Distribution Systems Geographic Information System (GIS) which will provide a graphical front end to the global database. The GIS will graphically correlate the Heating Distribution parameters and display them in a logical format. For example, if an operator wants to locate sections of pipe that may need repair, the GIS system would access the Relational Database and compare acceptable heat loss for a certain section of pipe. In the cases where the historical data collected from the SCADA system compiled in the relational database calculates a heat loss that exceeds the acceptable rate, the GIS will highlight on a map the sections of pipe that exhibit a high loss rate, indicating "leaks" or other anomalies to the operator. The GIS will also be beneficial in the billing of customers where geographic locations can be isolated into billing areas to track usage and growth for specific regions, this would be helpful in providing cost analysis for booster pump stations and new generating facilities.

*LOGGER*

*Billing will be facilitated through a device connected to the Historian that will generate the necessary billing forms. This device, LOGGER, will access the Global Relational Database making calculations and formatting invoices. These invoices can then be distributed to all of the Heating Distribution System's Customers. The LOGGER will also print-out preventative maintenance schedules, monthly operation and maintenance reports and daily reports.*

## OPERATOR CONSOLES

The Operator Consoles will utilize commercially available RISC (Reduced Instruction Set Computer) workstation technology and the UNIX operating system. The workstation will use a windows environment and very high resolution graphics utilizing X-window technology for compatibility with other hardware platforms. These stations will perform monitoring operations, tuning and maintenance functions all from the same console.

## FEATURES:

* 1.3 Gigabyte mass storage capacity
* Approximately 1K x 1K (16K x 16K virtual) display resolution
* Independent Ethernet communications network
* X-Windows Display

* Configurable zoom/pan plus display
* Single or Dual 19-inch CRT(s)
* RISC based UNIX workstation
* Alphanumeric keyboard and three button mouse
* 300 CPS alarm printer

The Operator Console will exhibit the following features:

* Menu system
  - Diagram display
  - Program execution
  - Submenu hierarchy

* General Message Display

* Alarm Display
  - Unacknowledged List
  - Alarm List
  - Alarm History
  - Acknowledge Function
  - Normal/Priority Mode Selection
  - Alarm Message Review

* Drag/Drop point names

* "soft" keyboard functions

* Point Information

* *Point Search*

* *Operator Event Logging*

* *System Diagnostics*

* *Security system*
    - *Up to 50 passwords, each mapped to one of ten levels of security*

* *Control Tune*

*Point Search*

*The point search function allows the user to examine the data base for specific point values or point status. Point search results can either be displayed on the screen or sent to a local printer. The following criteria are available to define the point search*

* *Entered value/limits*
* *Sensor alarms*
* *Points in alarm*
* *Scan remove*
* *Limit/Alarm check removed*
* *Tagged-out points*
* *Timed-out points*
* *Point Quality*

*Point Information*

*The Point Information function allows the operator to view and change data for any selected process point. Every dynamic data point on a display is automatically given a point information poke field. The information displayed varies based on point type, and only certain fields of the data base may be changed. The poke field display contains the following:*

* *Process Information*
* *Point name, description, value and quality*
* *Broadcast frequency*
* *Scan status (on/off)*
* *Alarm information*
    - *Alarm status (alarm check on/off, limit check on/off)*
    - *Alarm limits (low, high, incremental, deadband)*
* *System information (e.g., origination node, system identifier)*
* *Hardware information (e.g., I/O address, signal type)*

*The following data acquisition functions are available from a pull-down menu:*

* *Change scan status*
* *Change alarm status*
* *Change value*
* *Change limits*

*Operator Event Logging*

*Certain operator actions cause the OpCon to send an event message to a dedicated event logging node. The node then generates a time-tagged ASCII message which is sent to the Historian. Operator event messages can then be retrieved from the historical device for display on the screen or printout at a local printer.*

*Alarming*

*The Operator interface to the alarm system consists of three displays accessible through the alarm icon. Displays include Alarm History, Alarm List, and Unacknowledged List. Normal and Priority Mode filtering, and Alarm Acknowledgement functions are also available. Each alarm event can be printed as it occurs .*

*Unacknowledged List - displays the oldest unacknowledged alarms and returns.*

*Alarm List - displays the current alarms and, if selected returns.*

*Alarm History - displays a list of all alarm events including alarms, returns, increments, digital state changes, etc.*

*Acknowledge Function - allows the operator to acknowledge alarms and returns on a point-by-point or page-by-page basis.*

*Normal/Priority Mode Selection - allows the operator to change the current display/prints based on the information defined by the filtering setup.*

*Alarm Message Review*

*The alarm message review function retrieves the alarm messages stored by the Historian. Based on a user-specified time period, options for review of alarm data history include:*

* *Alarm and return messages*
* *"Node status" alarm and return messages*
* *Process point alarm and return messages*
* *Digital change-of-state messages*

* *Analog process point alarm and return messages*
* *Digital process point alarm and return messages*

*Control Tune*

*To speed debugging, controller loop and ladder functions appear in configuration displays in the precise form in which they were engineered - active and live.*

## *HISTORIAN*

*The Historian will be a RISC based workstation that provides mass storage and retrieval services for live data samples, sequence-of-events structures, and log and application files. The primary function of the Historian is to archive data and display trends of active variables on the control system network. The Historian will include the use of an Optical "juke-box" Storage Device. Standard features of the Historian include:*

* *Local or Remote Display of Trends*
* *Independent Ethernet communications network*
* *Approximately 1K x 1K (16K x 16K virtual) display resolution*
* *X-Windows display*
* *Configurable zoom/pan plus display*
* *Tape, disk media or Optical Disk options*

*The Historian is used to collect and store data collected from the SCADA system. Point values, alarm messages, sequence-of-events messages and data files are stored on the Historian hard disk and archived periodically. Collected data may be stored in either the Main History subsystem for short-term periods, or the Long-Term History subsystem for storage periods of up to several years.*

*The information on the Historian may be retrieved for use in CRT trends, review displays or printed reports. The Operator Console may be used to retrieve data that the Historian has archived to an optical Disk.*

*Salient functional characteristics of the Historian include:*

* *All points stored at a 1 second interval based upon change in value*
* *Limited point count stored 10 times per second*
* *Lab data entry function accepts files with time-tagged values*
* *Alarm and operator event message storage*
* *Sequence of events storage*
* *Log and application file storage*
* *Displays of up to 8 points per window (horizontal, vertical or X-Y format)*
* *Zoom/pan search of trends*
* *Point and message review*

## LOGGER

The Logger is a RISC-based workstation that provides printed reports of on-line activity in the control system network. The Logger may be supplied either as an independent drop or as a package implemented on the Operator Console or Engineers Console. Standard Logger features include:

* Local or remote display of trends
* Independent Ethernet communications network
* Up to four color log printers (300 CPS)
* Up to three color alarm printers (300 CPS)
* Color Video copier

Plant operations typically require some form of hardcopy assessment of plant activity. The Logger has the following attributes:

* Manages printouts and video copies from all drops
* Collects and prints point alarms and stores data at Historian
* Produces user-defined, free-format report layouts
* Accommodates multiple data types
    - Current data
    - Historical data
    - Text data
    - Files
* Initiates logs from multiple report triggers
    - Periodic
    - Event driven
    - On-demand
* Logs alarms as well as data
* Multiple redundancy capability
    - Backup printer
    - Redundant log servers
* Dedicated or multipurpose printers

Report content is defined using the report file definition function. Report information can include:

* Point detail information
* current values of process points which are accessed directly from the SCADA System
* Process point data which has been stored in the Historian

*The following additional functions allow users to get the information they need, in a format they want:*

* *Addition*
* *Subtraction*
* *Multiplication*
* *Division*
* *Exponentiation*
* *Form Text*
* *Single or multiple page*

## COMMUNICATION SYSTEM

As SCADA Systems have evolved, so has the need to carry greater amounts of data across a single transmission media. Westinghouse is proposing the use of a Metropolitan Area Network (MAN) that would provide the communications backbone for the Heating Distribution System.

Metropolitan Area Network (MAN) technology originally evolved from LAN designs. It uses digital backbones, specifically fiber optics, to carry traffic, link WANs and support applications such as high-speed file transfer, video conferencing, and integrated data, voice and text.

The demand for high speed connectivity is driving all kinds of new technologies. The explosion of LANs ( Local Area Networks) and WANs (Wide Area Networks) is an excellent illustration and that is where the growth has been in data communications. LANs and WANs are usually private networks. The development of MAN (Metropolitan Area Networks) technology is being driven by local public telephone companies to meet the demand for local and metropolitan connectivity.

A MAN consists of dedicated high-speed packet switches. MAN traffic initially will not carry voice but will share the communication paths in a local exchange carrier's SONET (Synchronous Optical Network) - based fiber optic transport plan. SONET is a standard interface designed to bring increased uniformity and new capabilities to fiber optic transmission. Based on light wave technology, speeds range from 50 Mbps to nearly 2,500 Mbps. The benefits include faster access to new services, extra network capacity on demand, and instant recovery from network failures.

The SONET signal is capable of carrying large amounts of information in a variety of formats from a variety of sources to a variety of destinations. Its optical carriers are very flexible in that way. SONET starts with twenty-four asynchronous digital signals or DS0s (64kb/s) are multiplexed onto a DS1 (1.544 Mb/s) signal. In the synchronous world of SONET, the equivalent of a DS1 is known as a virtual tributary 1.5 or VT1.5. The VT2 is equal to the European primary rate of 2.048 Mb/s.

The SONET frame begins as a Synchronous Transfer Signal (STS) which contains 28 VT1.5s (or 21 VT2s) plus a robust assortment of overhead blocks that provide OAM&P capabilities. The STS-1 is 51.84 Mb/s.

The STS-1 does not have to be constructed of virtual tributaries. In the asynchronous world, the DS3 at 45 Mb/s is approximately the same as 28 VT1.5s. So an STS-1 could also contain a single DS3 plus its required overhead blocks. While still in the electrical domain, STS-1 signals are then interleaved to form higher rates (STS-N) for transport over the SONET network. The electrical signals are then converted to standard optical carrier signals.

*In the international SDH environment, the synchronous frames are also contructed of both payload and overhead components. The SDH frame is called the Synchronous Transport Module (STM) and its consistuent elements are Virtual Containers. The standards and structure of the SDH frame are such that they easily permit interworking and connectivity across international boundaries. One STM carries three STS-1 or OC-1 signals.*

## *REMOTE TELEMETRY UNITS*

*The Remote Telemetry Units will be intelligent stand alone devices. The devices will operate on downloadable configuration parameters.*

*The RTU will monitor all the I/O connected to that particular unit and determine what points have changed over a specified period of time. The new values of the points that have changed will be organized and stored in a buffer. Once polled, the RTU will transmit all stored data to the Central Control Facility. Then the RTU will receive any pertinent information from the Central Control Facility. After this exchange is made the Central Control Facility will poll the next RTU in sequence.*

*The RTU can be programmed for either digital logic or analog control functions. This gives the RTU the capability for performing rudimentrary calculation ability. An LCD programmer will be provided for the local programming of the RTU.*

*The RTUs will support two analog inputs 4-20ma and two pulse accumulators and will include power supplies and environmental enclosures.*

*The RTUs will be fiber-optic cable compatible. The protocol used to communicate to the individual RTUs will be an industry standard: Field Bus, CE Bus, MMS (this still needs some investigation).*

*To increase data throughput of the system, a hierarchial approach of using multiple master RTUs and sub master RTUs may be used (this still needs some investigation and depends on the protocol used to communicate to the RTUs from above).*

# WEStation Product Overview

## Description

The WEStation family of products represents the integration of powerful, commercially available RISC (Reduced Instruction Set Computer) workstation technology and UNIX™ operating system with Westnet II™, the industry's fastest and most reliable real-time control and monitoring network. WEStation's advanced control, graphical interface, and information processing capabilities are designed to perform a broad range of process control and information applications in manufacturing, water/wastewater treatment, chemical processing, metals processing and power production industries worldwide.

### Features

- Open hardware and software platform
- Commercially available RISC workstation technology
- Real-time UNIX™ operating system
- X-Window technology
- Redundant Westnet II™ data highways
- Ethernet® information highways

***WDPFII WEStation***

WEStation utilizes a common base hardware and operating system for each of the different applications which it performs. Specific WEStation functionality is defined by the implementation of Westinghouse and/or third-party software packages that best suit the desired application.

Westinghouse-developed software products perform a wide range of operator, engineering and information processing functions on WEStation. A brief description of each WEStation software package is noted below. For detailed information on any one functional drop, please see the applicable descriptive bulletin.

**WEStation Operator** – Provides graphical interface for control, diagnostics, trending, alarming and plant monitoring functions.

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**WEStation Engineer** – Performs all engineering functions required to configure, edit and implement a WDPF drop on the Westnet II data highway.

**WEStation Historian** – Performs historical data collection/storage and information processing functions.

**WEStation Log Server** – Enables creation and printing of free-format process reports, and printing of alarm and graphic displays.

**WEStation Data Link Server** – Provides an interface to non-WDPF networks.

**WEStation Information Manager** – Provides a relational data base of all WDPF information.

**WEStation Computation Server** – Provides a platform for advanced calculations.

To optimize overall system performance, WEStation utilizes multiple communications networks. Through a direct connection to the redundant, deterministic Westnet II data highway, WEStation accesses real-time process data. WEStation also communicates with an integral Ethernet® information highway to support file and non-time-critical data transfers between WEStations, and between WDPF and other plant information networks.

With its open hardware and software architecture, WEStation integrates the WDPF// distributed control system and plant information networks, providing numerous advantages to users:

- Operators, technicians, engineers, management and administrative personnel have simultaneous access to vital real-time information – information which can be used to make decisions and effectively operate, engineer, maintain and enhance plant performance.
- Up-to-the-second data can be accessed graphically from any local or remote station.
- Direct connection to an independent Local or Wide Area Network (LAN or WAN) provides the capability to create a totally integrated plant information network.
- Third-party software and hardware can be easily integrated to meet the specific information needs of all levels of personnel.

Only WEStation provides the high-speed processing, powerful mathematical computation capability, and advanced graphics features demanded in today's process control and information applications.

## Function/Operation

WEStation hardware packaging supports a variety of configurations, each housing a workstation processor, communications hardware and required peripherals. A VME backplane contains the workstation processor board as well as the Westnet II data highway controller card and the Ethernet adapter card. Peripherals such as hard disk memory, optical disk drives and magnetic tape drives may be housed within the console as necessary to suit the specified application.

The Westnet II data highway controller card accesses and updates the real-time process information that is broadcast on the data highway. A dynamically updated image of the entire 32,000-point WDPF// data base is maintained on this card, providing immediate access to all of the attributes of each variable defined within WDPF. For advanced control and performance functions, dynamic reference to real-time data is easily accomplished by accessing the controller card's memory via utility programs.

Compatible with open architecture standards, all Westinghouse software packages operating on WEStation utilize UNIX and X-Window technology. The use of UNIX provides the capability to easily integrate third-party software and user-developed custom functions onto WEStation. Third-party and custom packages can be interfaced directly to the real-time Westnet II highway via the data highway controller card. Compliance with X-Window standards enables users to graphically access real-time or historical data using other X-compliant third-party software packages.

**Communications**
WEStation is configured to communicate with a redundant Westnet II data highway as well as an Ethernet information highway. Standard packaging for the Ethernet highway consists of a single connection through the primary RISC processor. An optional redundant Ethernet



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connection can be supported through a VME-based board. Both the data and information highways are directly connected to the WEStation console. For an additional level of security, WEStation can be connected to the Westnet II data highway via remote interface.

WEStation enhances overall system performance by maximizing the benefits of both the probabilistic, Ethernet information highway and the deterministic, Westnet II data highway. For up-to-the-second plant process data, WEStation communicates via the data highway. To retrieve and broadcast non-time-critical data such as configuration files or historical information, WEStation communicates via the information highway using TCP/IP protocol.

As an option, the Ethernet information highway can be extended through a secure bridge to local or wide-area networks. This extension allows all variables (real-time and non-real-time) as well as process graphic displays to be passed from the WDPF// distributed control system to the LAN or WAN. For controlled access, multiple layers of security may be administered through a WEStation. Linking the plant's control and administrative data bases allows users to combine pertinent real-time control data with resource, production and geographic information.

For applications requiring multiple, isolated data highways serving unique plant or process areas, WEStation provides a a bridge between the networks. Within the VME chassis of each WEStation are expansion slots for up to three individual, redundant Westnet II data highway controller cards (see Figure 1).

## Requirements

The base hardware provided with each WEStation is listed below. Optional WEStation hardware is listed in Table 1.

- RISC workstation
  - Two RS-232 serial ports
  - 64 megabytes RAM
  - One SCSI port (Small Computer Serial Interface)
  - One Ethernet interface
- One Westnet II Data highway controller card
- 500 megabyte hard disk drive
- VME backplane

To ensure independent start-up and primary operation, each WEStation has at least one hard disk drive with a minimum of 500 megabytes of memory. Ordinarily, the operating system, plant functional software, and appropriate graphic and system load files are resident on this local

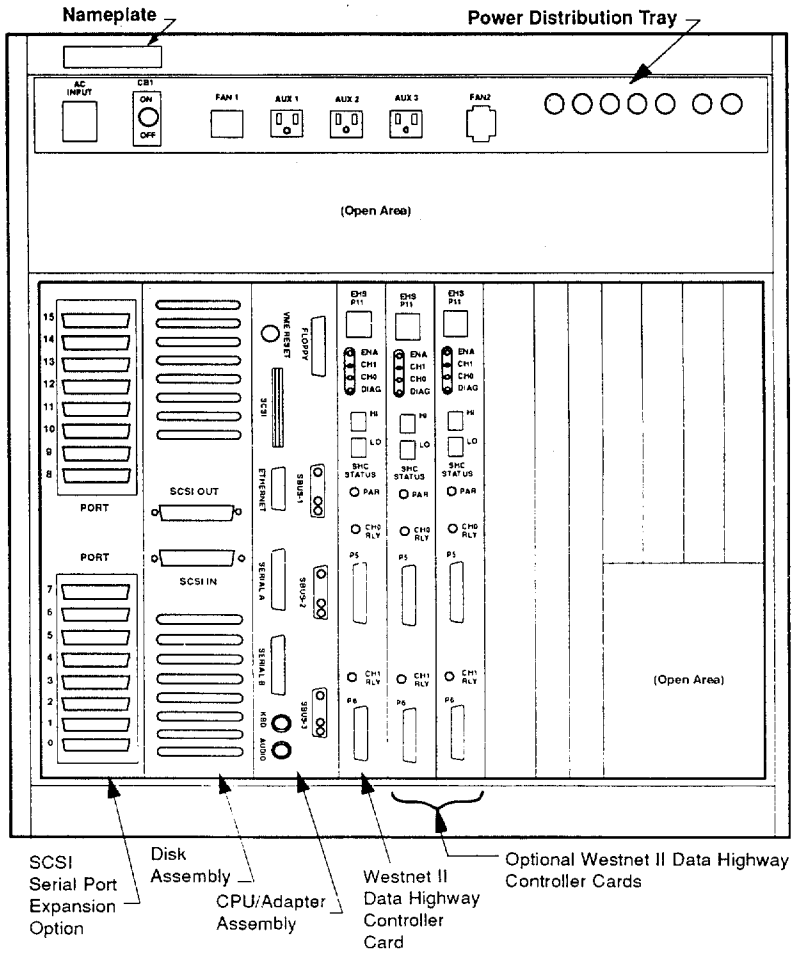


*Figure 1. Typical Base WEStation Enclosure*



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hard drive. The hard drive is accessed through the SCSI port provided on the RISC workstation.

Specific CRT models are selected based on the application to be performed by the WEStation. As many as two CRTs may be utilized with a single set of WEStation electronics. In addition, touchscreen monitors are available for use with the WEStation Operator product.

Two RS-232 ports are provided with each WEStation. Although most frequently used for connection to a local printer, these ports may also be used to support membrane control keyboards, touchscreen monitors, or third-party devices. Additional RS-232 ports may be added to the WEStation as needed.

Standard input devices used with WEStation include a QWERTY keyboard and mouse, with which all which all operation, configuration and system maintenance functions can be performed. For operator functions, a membrane keyboard, touchscreen and trackball are available.

***Table 1. Optional WEStation Hardware***

| HARDWARE | OPTIONS AVAILABLE |
|---|---|
| Additional or Upgraded Hard Disks | 1.3 Gigabytes |
| Additional Westnet II Data Highway Controller Cards | 2 Additional, for Interface to a Maximum of 3 Data Highways |
| Additional RS-232 Serial Ports | 8 Port Expansion<br>16 Port Expansion |
| Optical Disk Drives | 1 Gigabyte<br>6.5 Gigabyte |
| Magnetic Tape Drives | 150 Megabyte (1/4" tape)<br>2.3 Gigabyte (8 millimeter) |
| Floppy Disk Drives | 1.44 Megabyte (3.5") |
| Monitors | 17" Monochrome<br>17" Color<br>19" Color* (1152 x 900 pixel resolution)<br>27" Color (1152 x 900 pixel resolution) |
| Pointing Devices | Mouse*<br>Trackball<br>Touchscreen Monitor (19" only) |
| Keyboards | QWERTY*<br>Membrane Control (Westinghouse design) |
| Local Printers | Genicom Dot Matrix<br>HP LaserJet<br>Tektronix Color Screen Copier |

* Denotes standard option.

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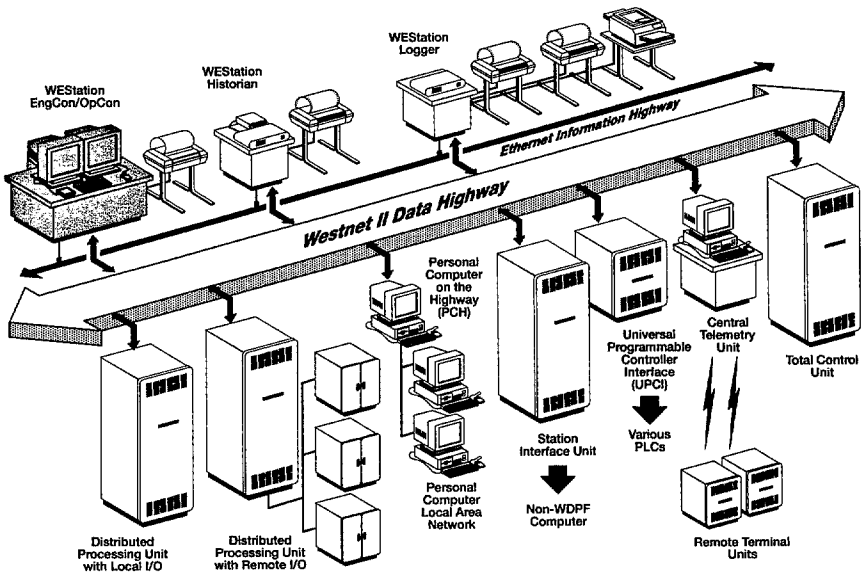
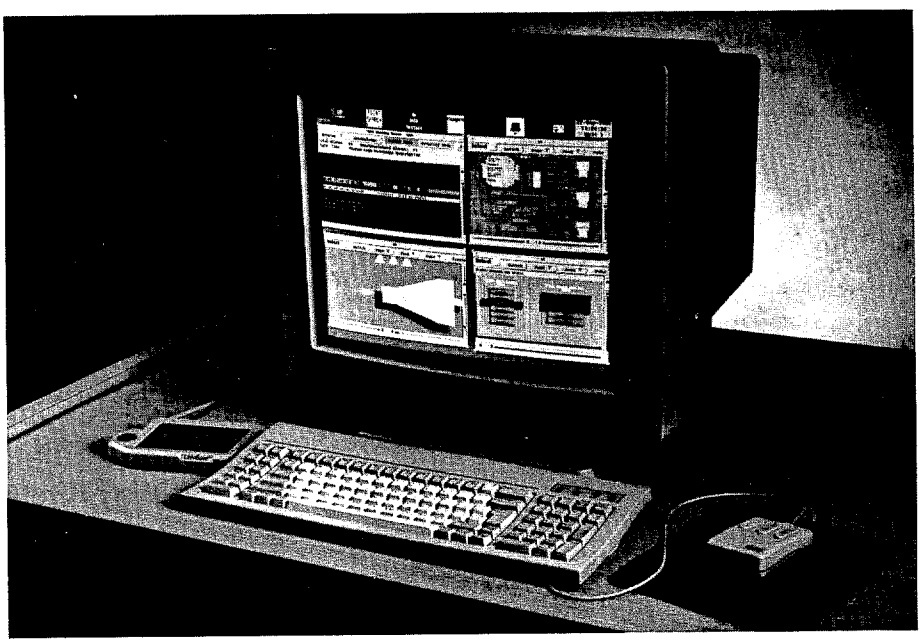
# WDPF II® WEStation OpCon




**WDPF *II* WEStation Architecture**



**WEStation OpCon**

The WDPF WEStation OpCon is a RISC-based (Reduced Instruction Set Computer) workstation that uses a windows environment and very high resolution graphics to perform operations, tuning and maintenance functions. Although its primary function is to control and monitor a WDPF control system process, by incorporating functions from other WEStation drops the WEStation OpCon also has the capability to produce free-format printouts and perform historical functions and optimization calculations. For more information on these functions, see Descriptive Bulletins 21-196 and 21-197.

## Features

To provide an open architecture base, several RISC processors with vendor-based UNIX™ operating systems are offered as the WEStation OpCon. Vendor-supplied hardware options such as main memory size, hard/floppy disk media, printers and operator interface tools may be selected based upon the user's specific application. Standard features of the WEStation OpCon include:

- 654 Megabyte or greater mass storage capacity
- Compatibility with WDPF Westnet II™ Data Highway with access to all 32,000 data points
- Approximately 1K x 1K (16K x 16K virtual) display resolution
- Independent Ethernet communications network
- Large color palette
- "Windows" display
- Configurable zoom/pan plus display paging
- Single or dual 19-inch CRT(s)

Westinghouse incorporates the Westnet II Data Highway Interface into the workstation hardware. Once connected to the Data Highway, this interface provides a window to the process such that data acquisition, control, historical and other operational functions can take place. An open environment, compatible to the inclusion of various third-party components, is maintained throughout.

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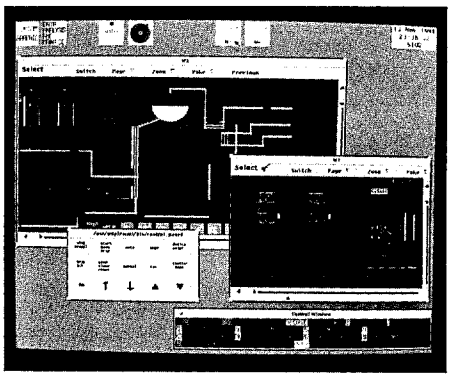
Typical hardware for a WEStation OpCon would include:

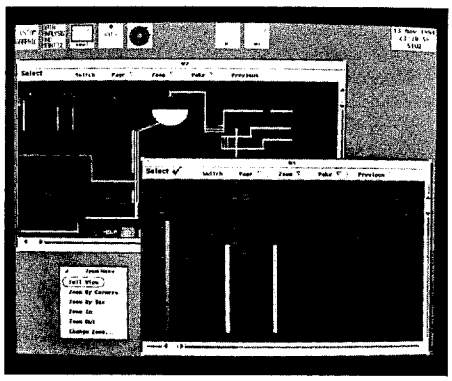
- RISC-based UNIX workstation
- 19-inch color monitor
- Alphanumeric keyboard and three-button mouse
- 200 CPS alarm printer

## Functions

The control and monitoring functions of the WEStation OpCon are enhanced by high-resolution graphics and advanced display features such as zooming, panning and windowing. The computation power of the RISC workstation permits the development of advanced displays and maximizes the availability of graphics and user functions throughout the system.



**Process Graphic with Live Configuration**



**Zoom Function for Enhanced Detail**

The operator accesses the desired function by selecting one of several icons that appear at the top of the CRT display. Using these icons, functions such as standard alarming, configuration display, loop tuning, ladder configuration and custom process views may be activated into a window. Each window may then be sized and moved to present multiple displays in the desired format. Up to seven displays including alarming, configuration, tuning and four plant process displays can be in active windows simultaneously. Standard function displays can also be recalled for reference, review and environment adjustments.

Custom diagrams that are developed with the CAD-style Graphics Builder on the WEStation EngCon are stored on disk on the target WEStation OpCon. Diagrams may either be shared among all OpCons or designated to a specific drop(s). For more information on the WEStation EngCon graphics building capabilities, see Descriptive Bulletin 21-194.

To speed debugging, controller loop and ladder functions appear in configuration displays in the precise form in which they were engineered — active and live.

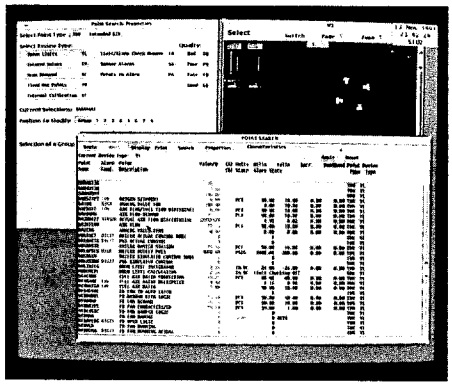
In addition to standard loop and custom displays, the WEStation OpCon provides the following:

- Menu system
  - — Diagram display
  - — Program execution
  - — Submenu hierarchy
- General message display
- Alarm display
- Drag/drop point names
- "Soft" keyboard functions
- Point information
- System diagnostics
- Security system
  - — Up to 50 passwords, each mapped to one of ten levels of security

### Point Search

The Point Search function allows the user to examine the data base for specific point values or point status. Point search results can either be displayed on the screen or sent to a local printer. The following criteria are available to define the point search:

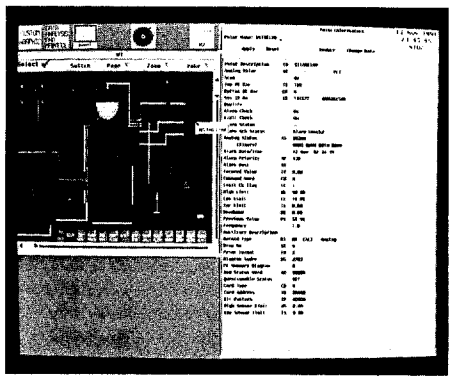
- Entered value/limits
- Sensor alarms
- Points in alarm
- Scan remove
- Limit/alarm check removed
- Tagged-out points
- Timed-out points
- Point quality



**Point Search Display**

### Point Information

The Point Information function allows the operator to view and change data for any selected process point. Every dynamic data point on a display is automatically given a point information poke field. The information displayed varies based on point type, and only certain fields of the data base may be changed.



**Point Information Display**

The poke field display contains the following:

- Process information
- Point name, description, value and quality
- Broadcast frequency
- Scan status (on/off)
- Alarm information
  - — Alarm status (alarm check on/off, limit check on/off)
  - — Alarm limits (low, high, incremental, deadband)
- System information (e.g., origination drop, system identifier)
- Hardware information (e.g., I/O address, signal type)

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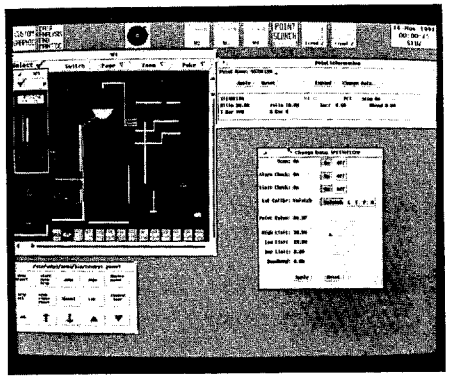
The following data acquisition functions are available from a pull-down menu:

- Change scan status
- Change alarm status
- Change value
- Change limits



**Point Attribute Change Display**

**Operator Event Logging**
Certain operator actions cause the WEStation OpCon to send an event message to a dedicated event logging drop. The drop then generates a time-tagged ASCII message which is sent over the Westnet II Data Highway to a historical device. Operator event messages can then be retrieved from the historical device for display on the screen or printout at a local printer.

Every operator event message contains the following information:

- Event subtype
- Date/time (to the nearest second)
- Event description

Depending upon the type of event, each message also contains some of the following data:

- Point, device or drop name
- Point description
- Old value/mode and new value/mode
- Loop number, algorithm name and algorithm type

The types of event messages that are initiated by the WEStation OpCon include:

- Data Acquisition System (DAS) functions and failures as determined by scan status, alarm/limit check status, entered value or changed alarm limits
- Algorithm tuning and failures
- Update time
- Forced values
- Fault clear/acknowledge

The Distributed Processing Unit (DPU) initiates the following types of event messages:

- Discrete control messages
- Modulating control messages
- Miscellaneous messages (e.g., enter/exit edit mode)
- Failures determined by the DPU software logic (e.g., mode changes, device actions)

**Alarming**
The operator interface to the alarm system consists of three displays accessible through the alarm icon. Displays include Alarm History, Alarm List, and Unacknowledged List. Normal and Priority Mode filtering, and Alarm Acknowledgement functions are also available. Each alarm event can be printed as it occurs if the WEStation OpCon is configured with an alarm printer.

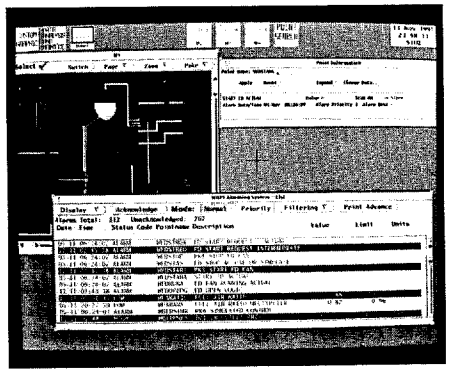
***Unacknowledged List*** — displays the oldest unacknowledged alarms and returns

***Alarm List*** — displays the current alarms and, if selected, returns

***Alarm History*** — displays a list of all alarm events including alarms, returns, increments, digital state changes, etc.

***Acknowledge Function*** — allows the operator to acknowledge alarms and returns on a point-by-point or page-by-page basis

***Normal/Priority Mode Selection*** — allows the operator to change the current display/prints based on the information defined by the filtering setup



**Alarm List Display**

**Alarm Message Review**
The Alarm Message Review function retrieves the alarm messages stored by the WEStation Historian (Descriptive Bulletin 21-196). Based on a user-specified time period, options for review of alarm data history include:

- Alarm and return messages
- "Drop status" alarm and return messages
- "Drop status" alarm and return messages originating from a single drop
- Process point alarm and return messages from a single drop
- Process point alarm and return messages
- Process point alarm and return messages for a single point
- Digital change-of-state messages
- Analog process point alarm and return messages
- Digital process point alarm and return messages

## Benefits

The WEStation OpCon is a process man-machine interface that provides centralized access to a variety of data that is pertinent to plant operations. Using window displays, individual informational activities appear simultaneously in an operator-friendly manner. Conventional graphics, data base and spreadsheet functions combine to offer the following benefits:

- Operator may select any display in any window
- Operator may view up to four functions simultaneously
- Icons remind operators of functions that need attention
- Enhanced resolution provides greater detail
- Control displays and alarm lists are active simultaneously
- Zoom and pan functions provide natural access to plant process
- Option for additional icon programs

With the WEStation OpCon, Westinghouse combines powerful WDPF highway communications and application software with commercially available RISC hardware platforms. All from a single supplier, this seamless integration of a high-performance workstation, powerful 32-bit process controller and 32,000 point Data Highway offers users a level of reliability and versatility unmatched by any other control system technology.

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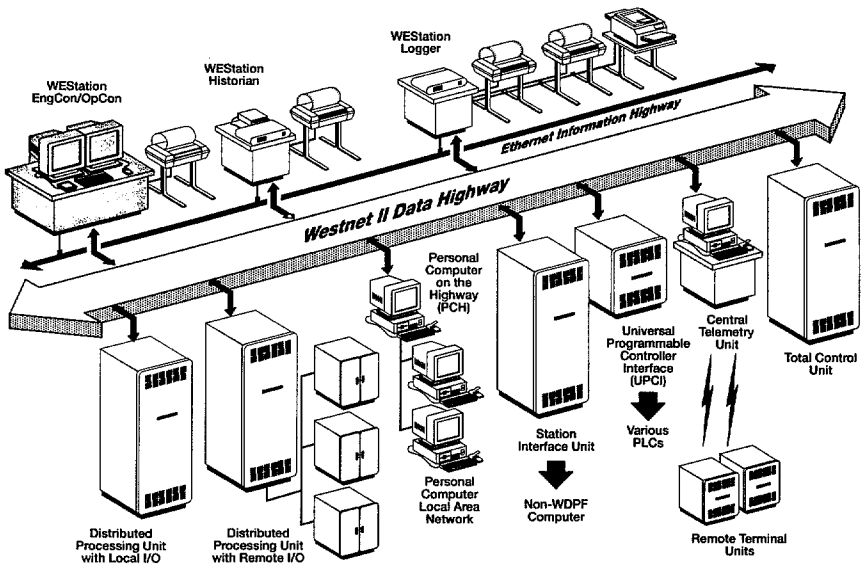
# WDPF II® WEStation EngCon




**WDPF *II* WEStation Architecture**

The WDPF WEStation EngCon is a RISC-based (Reduced Instruction Set Computer) workstation that uses a windows environment and very high resolution graphics to perform engineering, operations and maintenance functions. Although its primary function is to configure drops on a WDPF control system network, by incorporating functions from other WEStation drops the EngCon also has the capability to produce free-format printouts and perform historical functions and optimization calculations. For more information on these functions, see Descriptive Bulletins 21-196 and 21-197.

## Features

To provide an open architecture base, several RISC processors with vendor-based UNIX™ operating systems are offered as the WEStation EngCon. Vendor-supplied hardware options such as main memory size, hard/floppy disk media, printers and operator interface tools may be selected based upon the user's specific application. Standard features of the WEStation EngCon include:

- 654 Megabyte or greater mass storage capacity
- Compatibility with WDPF Westnet II™ Data Highway with access to all 32,000 data points
- Dual performance as operator station when not performing configuration
- Independent Ethernet communications network
- Approximately 1K x 1K (16K x 16K virtual) display resolution
- Large color palette
- "Windows" display
- Configurable zoom/pan plus display paging
- Laser and line printer
- Tape, disk media or optical disk options
- Single or dual 19-inch CRT(s)

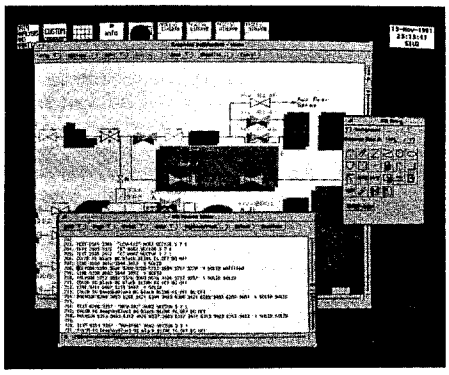
Westinghouse incorporates the Westnet II Data Highway Interface into the workstation hardware. Once connected to the Data Highway, this interface provides a window to the process such that data acquisition, control, display design and other configuration functions can take place. An open environment, compatible to the inclusion of various third-party components, is maintained throughout.

## Functions

The WEStation EngCon performs system administration functions and is the repository for all system software. System object code and application source code are housed within the station.

The WEStation EngCon functions as either an operator station or an engineering station. In the engineering mode, applications software for all drops may be developed, loaded and maintained. New configurations are transferred over the Westnet II Data Highway to the destination drop. Specific engineering functions of the WEStation EngCon include:

- Data base and control configuration
- Plant display graphics and faceplate configuration
- Report and historical point configuration
- Configuration of data links to other networks
- Loading of configurations to all other stations and drops
- Documentation of all designs



**Graphic Generation with Documentation**

### Controller Configuration Editing

Data bases, continuous loops, ladder sequences and batch languages are configured directly from the WEStation EngCon. Using conventional hierarchical configuration languages, the engineer can design control strategies from configuration windows and download them to the destination controller. Already familiar to current WDPF users, the language approach is easy for

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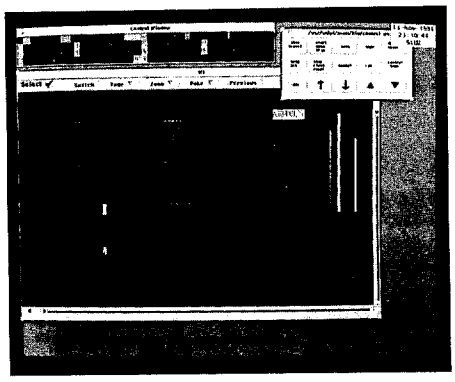
**WEStation EngCon**

first-time users to learn. Configurations that have already been developed on other WDPF products are compatible with the WEStation EngCon.

The WEStation EngCon permits several configuration windows to be active simultaneously, each directed at different target drops. This allows the user to quickly switch between several configuration sessions, thereby minimizing the time required to enter and exit each session.



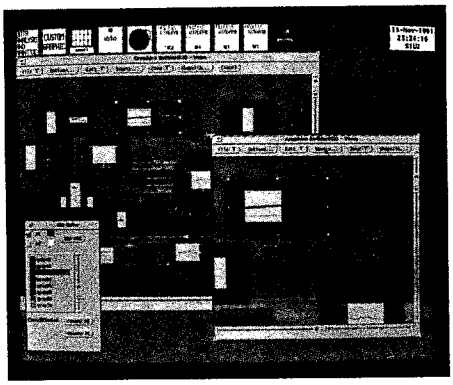
**On-line Controller Configuration**

**Graphics Building and Editing**
The Graphics Builder package is a CAD-type tool used to create and edit both the static and dynamic portions of diagrams displayed on the WEStation OpCon (Descriptive Bulletin 21-195).

Features of the Graphics Builder package include:

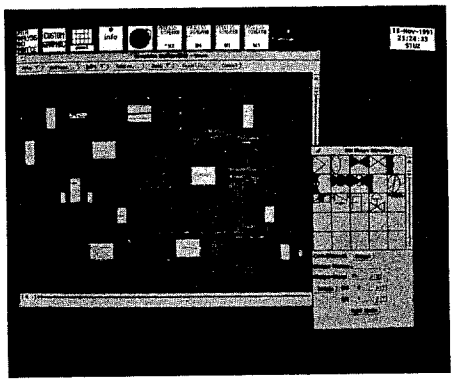
- 8 standard colors and 256 configurable colors
- 15 configurable line widths
- Non-scalable text with 8 configurable character sizes and scalable text with no fixed configurable character sizes
- 8 standard fill patterns and 256 configurable fill patterns
- Built-in fill pattern builder/editor
- 8 standard line patterns and 256 configurable line patterns
- Built-in line pattern builder/editor
- Built-in shape/symbol editor to define up to 256 shapes
- Macro support
- "Click-and-drag" point names
- Error detection
- Auto-save
- Grid/snap support
- Cursor position display
- Pan/zoom
- Maintenance of aspect ratio on a resize operation
- Clockwise and counterclockwise rotation
- Inversion of items top-to-bottom and/or left-to-right
- Up to 10 copies of an item or group of items
- Grouping or ungrouping of items on the screen
- Undo or redo of last edit performed in an edit session
- Save comments in a graphic

The Graphics Builder package provides a CAD-style user interface for editing and building graphics. A base window contains the drawing canvas and the control panel. Control panel buttons are then used to access the support windows and menus that are used to build and edit graphics.



**Graphics Builder Color Change in Zoom**

Users can create, edit and delete shapes. Shapes and symbols can be comprised of lines, rectangles, circles, dots, arcs, polygons and ellipses. Shapes are created by positioning the shape elements on the drawing canvas, and then selecting the "make shape" function. This standard "click-and-drag" methodology is also used to draw, move and resize shapes. A scrolling pictorial list of all the currently defined shapes is provided. In order that they may be shared between diagrams, all shapes are stored in an external file which is read at program start-up.



**Graphics Builder Featuring Shape Library**

Drawing attributes such as color, line width, fill pattern and text size are selected from menus or scrolling lists and remain current until new attributes are selected.

Using the color library, the user can display a grid of lines or dots. The user may also specify the grid cell dimensions, and whether the grid cell should automatically

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scale on a zoom operation. A snapping function, when activated, aligns all display items on grid points.

Macros are mini-graphics that are designed to function as graphic templates. When added to a graphic, the macro is passed to a list of parameters which will be referenced in specified display items. A macro may contain up to 99 substitutable process point name parameters; up to 50 substitutable text parameters in the background section; and up to 50 substitutable text parameters in the foreground section.

The maximum virtual coordinate range for a graphic is 16K x 16K. When a graphic is initially loaded or created, the entire graphic is scaled to fit into the Graphics Builder drawing canvas. A "zoom" function allows the user to view a finer resolution. The Graphics Builder package also maintains an internal list of the previous 50 views (zoom levels), and supports a "zoom previous" function to return to an earlier view.

A "zoom extents" function allows the user to define a rectangular portion of the entire 16K x 16K virtual canvas to be interpreted as a full-screen diagram when displayed on the WEStation OpCon.

## Benefits

The WEStation EngCon uses command conventions that are easy to learn and already familiar to existing WDPF users. These configuration approaches are based on industry standards and operate on existing controllers. Benefits to users include:

- Graphical display of configuration
- Documentation in the same graphic language
- Multiple windows to permit configuration of several drops simultaneously
- Automatic compilation of graphic displays during design
- Standard templates for graphics and control
- Simultaneous configuration and on-line operation

With the WEStation EngCon, Westinghouse combines powerful WDPF highway communications and application software with commercially available RISC hardware platforms. All from a single supplier, this seamless integration of a high-performance workstation, powerful 32-bit process controller and 32,000-point Data Highway offers users a level of reliability and versatility unmatched by any other control system technology.

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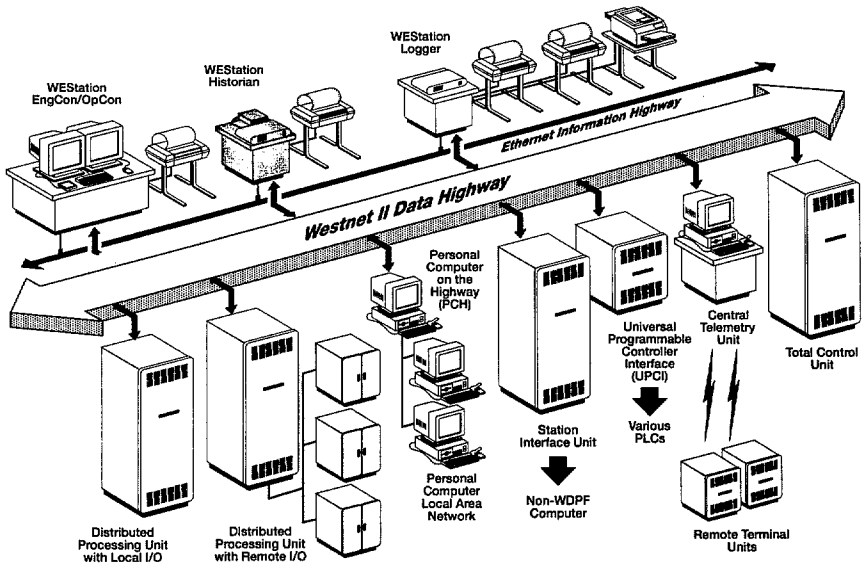
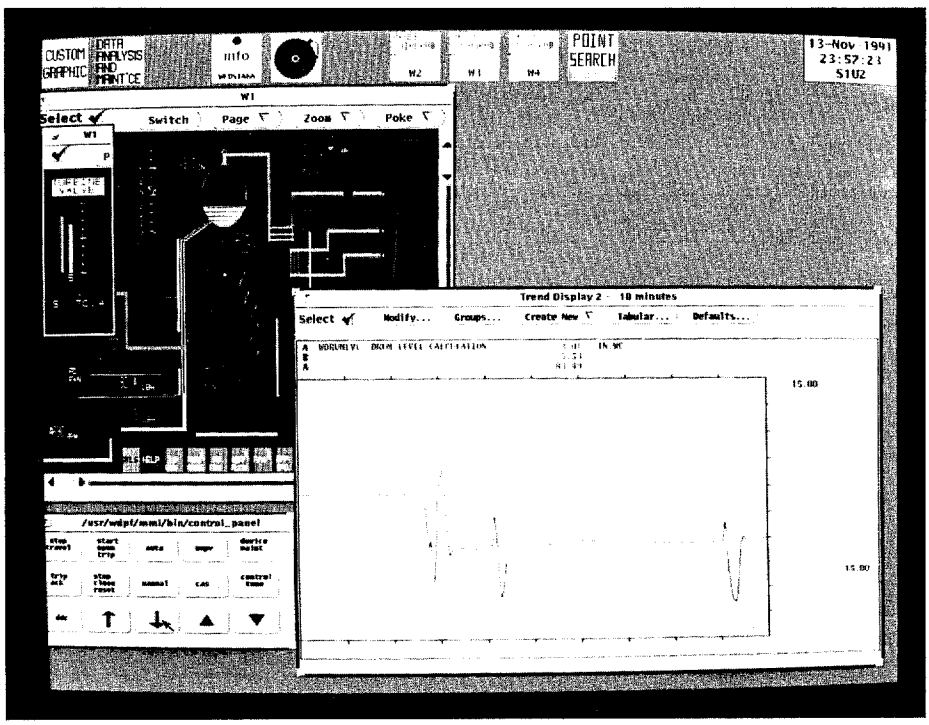
# WDPF II® WEStation Historian




**WDPF *II* WEStation Architecture**




**Graphic and Trend Display**

The WDPF WEStation Historian is a RISC-based (Reduced Instruction Set Computer) workstation that provides mass storage and retrieval services for live data samples, sequence-of-events structures, and log and application files. The primary function of the WEStation Historian is to archive data and display trends of active variables on the WDPF control system network. The WEStation Historian may be supplied either as an independent drop or as a package implemented on the WEStation EngCon or WEStation OpCon. For more information on these two drops, see Descriptive Bulletins 21-194 and 21-195.

## Features

To provide an open architecture base, several RISC processors with vendor-based UNIX™ operating systems are offered as the WEStation Historian. Vendor-supplied hardware options such as main memory size, hard/floppy disk media, printers and operator interface tools may be selected based upon the user's specific application. Standard features of the WEStation Historian include:

- Compatibility with WDPF Westnet II™ Data Highway with access to all 32,000 data points
- Local or remote (WEStation OpCon) display of trends
- Independent Ethernet communications network
- Approximately 1K x 1K (16K x 16K virtual) display resolution
- "Windows" display
- Configurable zoom/pan plus display paging
- Tape, disk media or optical disk options

Westinghouse incorporates the Westnet II Data Highway Interface into the workstation hardware. Once connected to the Data Highway, this interface provides a window to the process such that historical and other operational functions can take place. An open environment, compatible to the inclusion of various third-party components, is maintained throughout.

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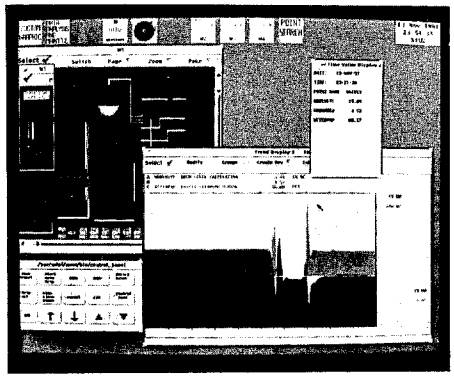
## Functions

The WEStation Historian is used to collect and store data from the Westnet II Data Highway. Point values, alarm messages, sequence-of-events messages and data files are stored on the Historian hard disk and archived periodically. Collected data may be stored in either the Main History subsystem for short-term periods, or the Long-Term History subsystem for storage periods of up to several years.

The information on the WEStation Historian may be retrieved for use in CRT trends, review displays or printed reports. The WEStation EngCon may be used to retrieve data that the WEStation Historian has archived to an optical disk.

Salient functional characteristics of the WEStation Historian include:

- All points stored at 1 second intervals based upon change in value
- Limited point count stored 10 times per second
- Lab data entry function accepts files with time-tagged values
- Alarm and operator event message storage
- Sequence-of-events storage
- Log and application file storage
- Displays of up to 8 points per window (horizontal, vertical or X-Y orientation)
- Zoom/pan search of trends
- Point and message review



**Trended Variables with Bias Fill**

### Main History Points Collection

The Main History subsystem of the WEStation Historian collects, stores and retrieves the value and status of process points on the Westnet II Data Highway. The Main History subsystem scans up to 16,357 process points per second. A time-tagged history sample is taken for status or value changes greater than the specified deadband.

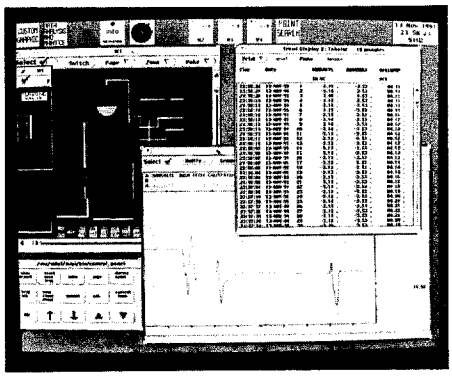
To conserve storage space, time-tagged history samples are stored in a compressed format on the Main History file hard disk. Because the operator is able to manipulate a closed file more than an open one, the Main History file is periodically closed and a new history file is opened as the current active file.

To minimize data retrieval time, files remain on the hard disk until 80 percent of the area allocated for Main History files has been exceeded. Once the 80-percent level is reached, the oldest files will be deleted until 50 percent of the allocated area becomes available. Depending on the level of process activity and collection deadband values, the WEStation Historian is able to maintain several months worth of Main History data.

### Long-Term History Points Collection

A separate set of process point values and calculated values may be collected for storage into Long-Term History files. This subsystem uses the same methods for collecting, storing and retrieving information as the Main History subsystem. As with the Main History subsystem, points are scanned once per second and a time-tagged history sample is taken for status/value changes greater than the specified deadband.

Up to 600 process points may be designated for long-term storage. Depending on the level of process activity and collection deadband values, the WEStation Historian is able to maintain several years worth of Long-Term History data files on the hard disk.



**Trended Variables with Tabular Data**

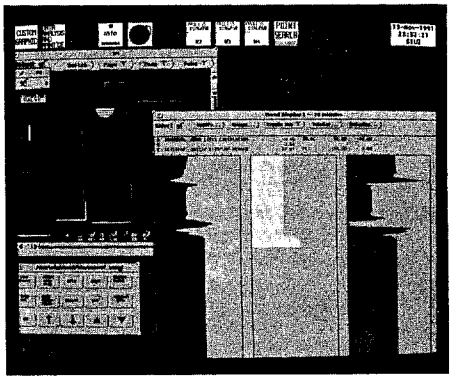
### On-Line Trending

An On-Line Trending package is available on the WEStation OpCon, EngCon or Historian to allow the operator to display up to eight process points on either a single graph or in tabular format. A background process collects 600 samples of data for up to 1,000 points at a predetermined collection rate ranging from one second to approximately 80 hours.

On-line trending features include:

- Ten user-selectable intervals from 10 minutes to 33.3 days
- Horizontal, vertical-combined, vertical side-by-side, and X-Y plot presentation options
- Linear and logarithmic scaling
- Tabular (numerical) display of data
- Trend group display (display 1 of 600 predefined trend groups)

Because it can run on any WEStation OpCon, EngCon or Historian with display capability, the trending package features all aspects of "windows" display. Using windows, the operator can simultaneously view trends, alarms, plant graphics and loop displays on the CRT screen.



**Vertical Trend with Bias Fill**

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## Benefits

The capability to provide a file-structured storage repository for data of all types, including on-line variables and process-oriented application files, makes the WEStation Historian a valuable addition to any WDPF system. The live and historical trend display functions of the WEStation Historian are fully integrated with the WDPF graphics display package featured on the WEStation OpCon or EngCon. Benefits to users include:

- High-speed and mass-storage capacity for virtually unlimited point sample storage
- Storage of multiple data types
- Query and sort functions for quick access to stored data
- Simultaneous view of historical trends and other graphics on a WEStation OpCon or EngCon
- Calculation/forecasting applications

With the WEStation Historian, Westinghouse combines powerful WDPF highway communications and application software with commercially available RISC hardware platforms. All from a single supplier, this seamless integration of a high-performance workstation, powerful 32-bit process controller and 32,000-point Data Highway offers users a level of reliability and versatility unmatched by any other control system technology.

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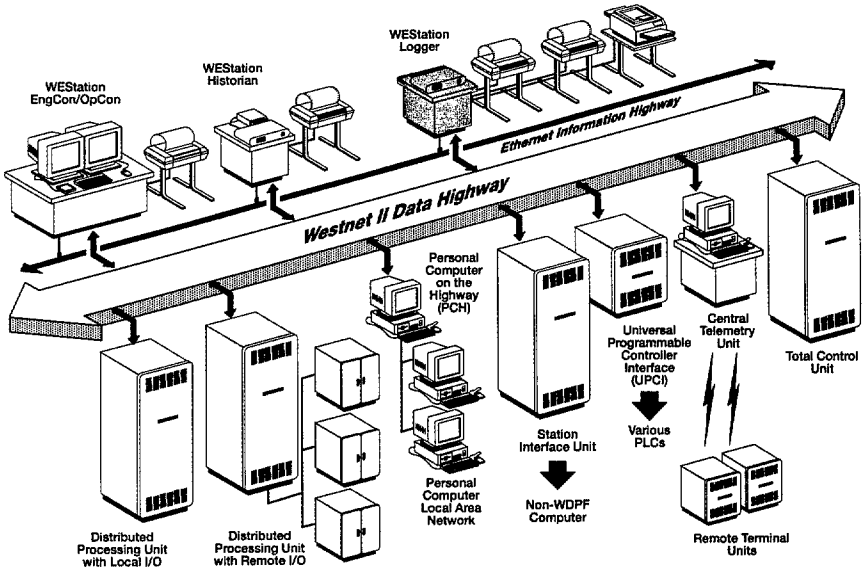
# WDPF II WEStation Logger




**WDPF *II* WEStation Architecture**

The WDPF WEStation Logger is a RISC-based (Reduced Instruction Set Computer) workstation that provides printed reports of on-line activity in the WDPF control system network. The WEStation Logger may be supplied either as an independent drop or as a package implemented on the WEStation EngCon or WEStation OpCon. For more information on these two drops, see Descriptive Bulletins 21-194 and 21-195.

## Features

To provide an open architecture base, several RISC processors with vendor-based UNIX™ operating systems are offered as the WEStation Logger. Vendor-supplied hardware options such as main memory size, hard/floppy disk media, printers and operator interface tools may be selected based upon the user's specific application. Standard features of the WEStation Logger include:

- Compatibility with WDPF Westnet II™ Data Highway with access to all 32,000 data points
- Local or remote (WEStation OpCon) display of trends
- Independent Ethernet communications network
- Up to 4 color log printers (200 CPS)
- Up to 3 color alarm printers (200 CPS)
- Color video copier

Westinghouse incorporates the Westnet II Data Highway Interface into the workstation hardware. Once connected to the Data Highway, this interface provides a window to the process such that sampling, logging and free-format report functions can take place. An open environment, compatible to the inclusion of third-party components, is maintained throughout.

## Functions

Plant operations typically require some form of hardcopy assessment of plant activity. In cases where only a nominal amount of reporting is required, the WEStation Logger software can be applied to a WEStation EngCon or OpCon and the necessary reports can be generated while the station performs its primary duties. An independent WEStation Logger drop is advantageous when a greater amount of data is to be stored and reproduced in report format.

As an independent drop, the WEStation Logger has the following attributes:

- Manages printouts and video copies from all drops
- Collects and prints point alarms and stores data at WEStation Historian (Descriptive Bulletin 21-196)
- Produces user-defined, free-format report layouts
- Accommodates multiple data types
  — Current data
  — Historical data
  — Text data
  — Files
- Initiates logs from multiple report triggers
  — Periodic
  — Event-driven
  — On-demand
- Logs alarms as well as data
- Multiple redundancy capability
  — Backup printer
  — Redundant log servers
- Dedicated or multipurpose printers

**Report Configuration**
The Report Builder, a utility program which resides on the WEStation EngCon, is used to develop free-format reports. A multilevel menu system allows the user to specify the content, format and source of data to be included in the report. Industry-standard spreadsheet configurations are used to define the presentation of the report sheet itself. Reports may be generated at user-defined intervals, on-demand, or on an event-triggered basis.

Report content is defined using the report file definition function. Report information can include:

- Point detail information
- Current values of process points which are accessed directly from the Westnet II Data Highway
- Process point data which has been stored in the WEStation Historian

The following additional functions allow users to get the information they need, in a format they want:

- Addition
- Subtraction
- Multiplication
- Division
- Exponentiation
- Form Text
- Single or multiple page

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## Benefits

For those that require daily or fewer hard-copy reports, appropriate modules of the WEStation Logger software can be applied as a package on the WEStation OpCon or EngCon. Alternatively, when a number of multipurpose reports are required, an independent WEStation Logger drop provides numerous options for report style and frequency. In either case, the WEStation Logger offers the following benefits:

- Free-format printout capability for management reports
- Redundancy for accurate report data
- Multiple printers to reduce confusion
- Alarm history review to trace events
- User-selectable printout time or frequency
- Report file storage capability for later review

With the WEStation Logger, Westinghouse combines powerful WDPF highway communications and application software with commercially available RISC hardware platforms. All from a single supplier, this seamless integration of a high-performance workstation, powerful 32-bit process controller and 32,000-point Data Highway offers users a level of reliability and versatility unmatched by any other control system technology.

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DESCRIPTIVE BULLETIN

WDPF//®

DB21-201

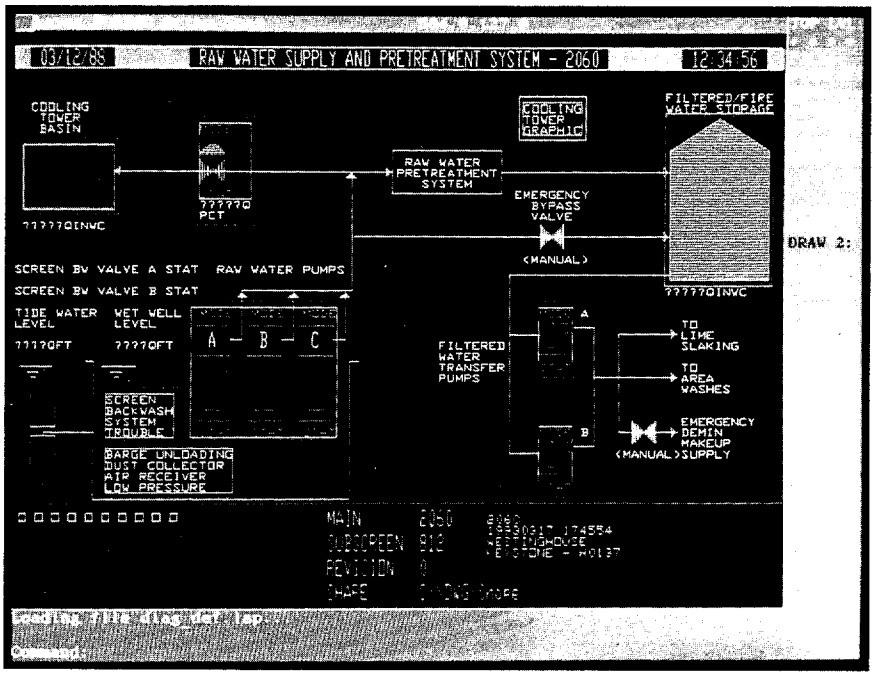
# AutoGRAPH™ Graphics Builder

## Description

Part of the WDPF// family of distributed control and information products, AutoGRAPH is an AutoCAD®-based software package used to build, edit and compile high-resolution WDPF process diagrams for display on either a WDPF Standard Operator Station or a PCH (Personal Computer on the Highway) Station.

### Features

- Open operating environment and drawing features of AutoCAD
- Menu-driven drawing environment for the creation of process diagrams
- Translators for conversion between AutoCAD (.dxf) file format and Westinghouse (.gcc) graphic file format
- Shape builder and configurable shape library
- Standard and configurable color library
- Standard and configurable line and fill patterns
- Pop-up dialogue boxes to display and edit graphic element attributes




**Process Diagram Creation**

Designed as an add-on package to AutoCAD release 11 or 12, AutoGRAPH combines WDPF// process diagram features with the industry standard drawing features of AutoCAD. By incorporating the intuitive, easy-to-use features of AutoCAD, AutoGRAPH greatly reduces the overall time required to develop WDPF process diagrams. Process graphics created within AutoGRAPH are stored in AutoCAD (.dxf) file format and then translated to Westinghouse (.gcc) file format. These files are then compiled and downloaded to a WDPF Standard Operator Station or PCH.

A full-function, PC-based Engineer Station is created when AutoGRAPH is used in conjunction with the PCH Engineer software module. For more information on PCH hardware and software, see Descriptive Bulletins 21-190 and 21-193.

## Function/Operation

During AutoCAD start-up, the user is given the option to initiate either a straight AutoCAD session or an AutoGRAPH session. If AutoGRAPH is selected, the user is presented with a Westinghouse

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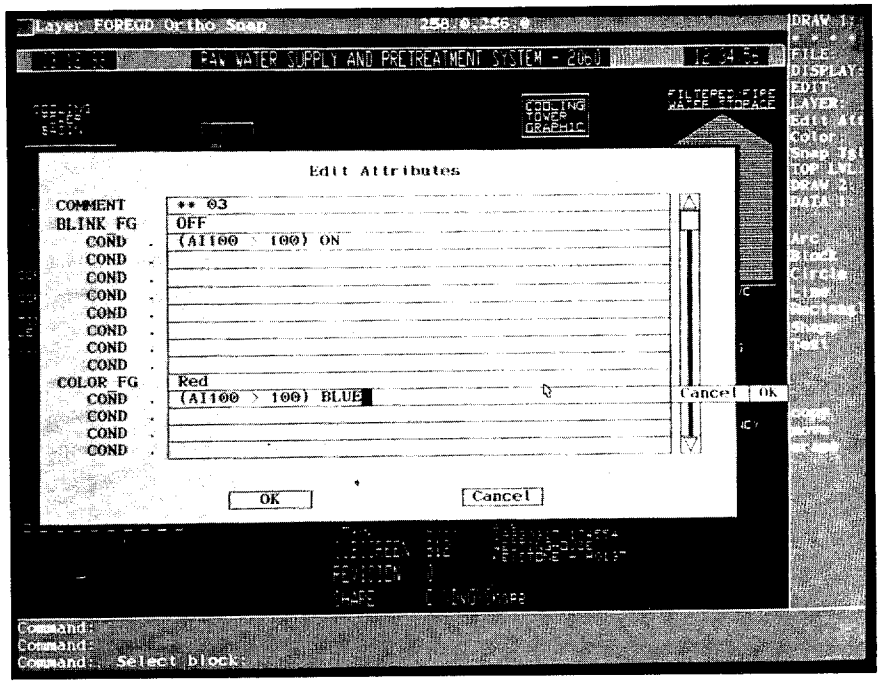
designed menu of WDPF// graphic options. A specific graphic element such as a shape, trend, or bar chart may then be selected from the menu via a mouse. Prompts presented at the bottom of the screen query the user for all of the information necessary to implement the desired graphic. The user can enter requested information via keyboard, mouse selection of screen options, or acceptance of default entries.

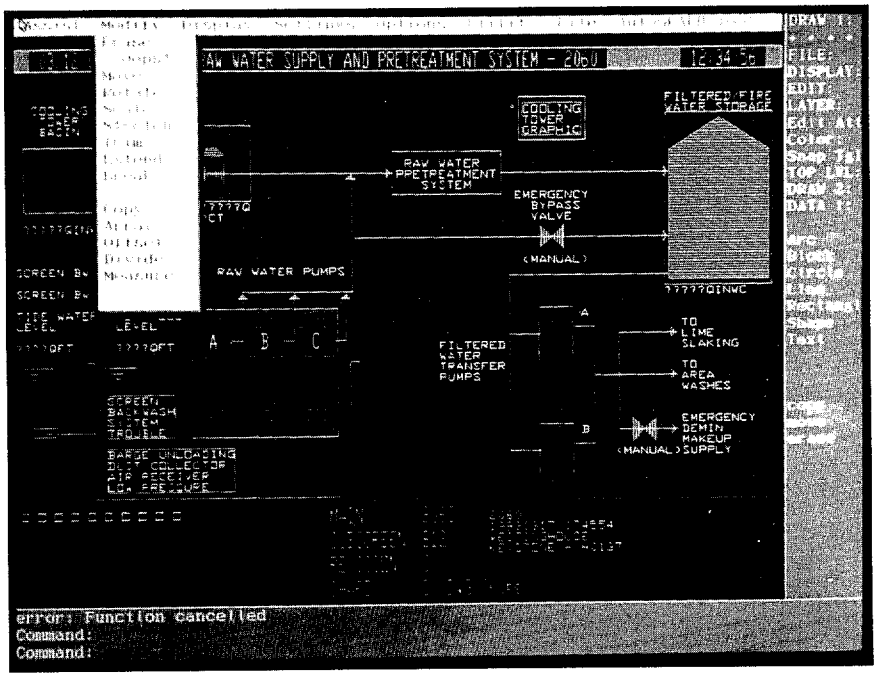
Each graphic element used in the overall process diagram has an associated pop-up dialogue box which displays its specific attributes including color, location, size, and associated conditional logic. To edit a particular graphic element, the dialogue box may be recalled and attributes changed through the entry fields.

Although the code generated within AutoGRAPH is specific to WDPF// process diagrams, AutoGRAPH drawing conventions and techniques are provided by AutoCAD. These user-friendly drawing features dramatically reduce the overall time required to develop WDPF process diagrams. Drawing features include:

- *Click* and *Drag* to position graphic elements within a process diagram
- *Snap* to align graphic elements to specific character or vector coordinates
- *Copy*, *Move*, *Rotate*, and *Zoom*
- Configurable grid display




**Pop-up Dialogue Boxes**




**AutoCAD Drawing Features**



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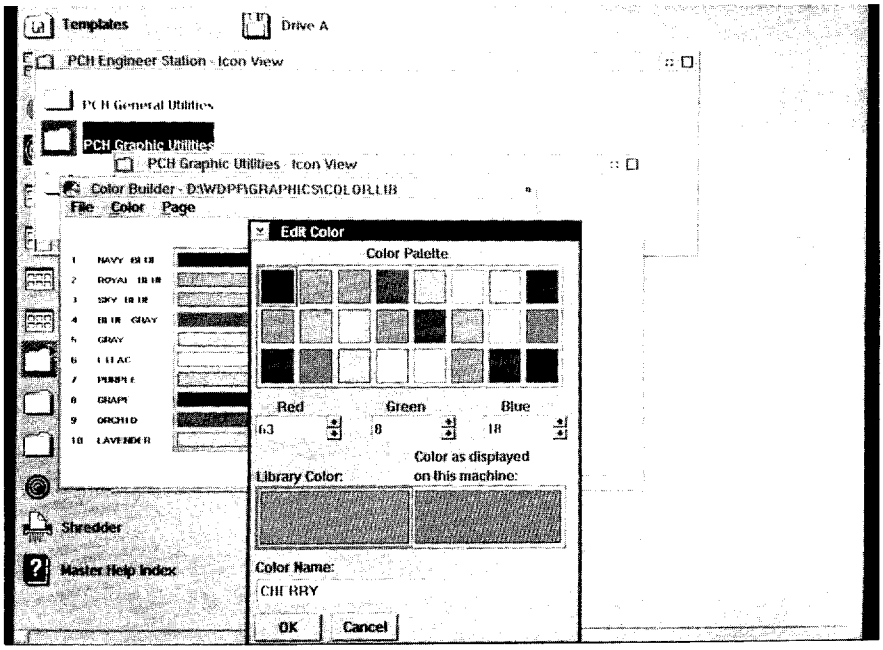
- Cursor position display to indicate character or vector coordinates

AutoGRAPH also provides full access to a series of configurable libraries including:

- Shape library that accommodates up to 256 different shapes for use within a single process graphic
- Color library featuring 8 standard colors or 256 configurable colors for use within a single process graphic
- Line pattern library featuring 8 standard line patterns, 8 configurable line patterns, and line pattern builder/editor
- Fill pattern library featuring 8 standard fill patterns, 8 configurable fill patterns, and fill pattern builder/editor

These libraries are created through standard utilities provided with AutoGRAPH. Easy access to all libraries eliminates the need to redesign commonly used shapes, colors, lines and fill patterns.

Once a process diagram is complete, it is saved in AutoCAD (.dxf) file format. Westinghouse translators are provided to convert the AutoCAD file to Westinghouse (.gcc) graphic source code format. These translators also provide the capability to convert a Westinghouse file to an AutoCAD file. Once a file is in Westinghouse (.gcc) graphic source code format, it can be compiled into object code for display at either a WDPF Standard Operator Station or a PCH.




**Custom Color Library Editor**

## Requirements

To operate AutoGRAPH, the following base hardware and software are required:

- 386-based, IBM-compatible personal computer
- Math co-processor
- 4 megabytes RAM memory
- 10 megabytes of available hard disk if using AutoCAD release 11, or 25 megabytes of available hard disk if using AutoCAD release 12
- VGA or higher-resolution color monitor
- Mouse
- AutoCAD release 11 or 12*

* Operating system requirements are dictated by the AutoCAD version selected. AutoDESK offers DOS®, Windows® and Solaris® versions of AutoCAD, all of which are compatible with AutoGRAPH.



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# Overview of Software Packages

**Background:** WEStation software packages perform a wide variety of operator, engineering, and information processing functions. Each package utilizes UNIX and X-Window technology, and is, therefore, compatible with open architecture standards. The use of UNIX allows users to easily integrate third-party and custom software onto WEStation, and interface directly to the Westnet II real-time data highway. X-window displays allow users to graphically access real-time or historical data from WEStation as well as other X-compliant third-party software. Westinghouse-designed software packages include:

### WEStation Operator

Real-time graphical interface for control, diagnostics, trending, alarming, and monitoring plant conditions. Operators and other plant personnel have immediate access to one-second updates of process variables, enabling rapid response to dynamic process parameters. To simplify the review and analysis of historical and live process data, access to information is provided through real-time data displays that feature high-speed, high-resolution process graphics; alarm screens; and a suite of graphical user interface (GUI) tools.

### WEStation Engineer

Software tools to design, develop, implement, and maintain a controlled process. GUI-based (graphical user interface) functions are used to build and edit control logic, process graphics, and the system data base. Fill-in-the-blank graphical editors guide the user through the definition of control logic and the system data base, while a CAD-like graphics builder reduces the cycle time required to develop process graphics. Multiple levels of security and the structure of software directories at the WEStation enable control and ensure the integrity of system software.

### WEStation Historian

Mass storage and retrieval of process data, alarms, sequence-of-events (SOE) data, and other control system information. Data is collected at intervals of 1 or 0.1 seconds and stored on-line for later retrieval and review. Format options include trends and tabular, report-style displays. For long-term storage, data can be archived to optical disk.

### WEStation Log Server

Creation, storage, and printing of free-format reports as well as optional printing of alarms and graphic displays. Current, historical, text, or file data can be included in reports. Reports can be generated at scheduled intervals; on demand; or on an event-driven basis.

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### WEStation Computation Server

Dispatching service for the execution of plant application programs such as process optimization and energy management routines. Application programs are initiated at the onset of specific system events, at scheduled intervals, or on demand. Additional features include initialization routines, system event and periodic checking functions, user interface functions, and a set of library routines to support application programs.

### WEStation Information Manager

A central, relational data base (RDB) that reflects all WDPF system configuration and plant process information residing on individual controllers. With a valid logon, changes made to process data on the RDB are automatically downloaded to WDPF drops and controllers. Likewise, changes made to point values and attributes at individual drops are automatically updated in the RDB. The RDB can also accommodate other pertinent data such as termination, wiring, field device, and maintenance information. Connection to the fully open Ethernet information highway allows multiple local and remote users to access data base information with Westinghouse and third-party software.

### WEStation Data Link Server

Additional means to link WEStation to a variety of external devices including other computers and computer networks. These external devices may be connected to WEStation via user-installed networks such as ethernet or token ring. Also included are remote devices connected via serial links. The data link package supports industry standard communication protocols, allowing non-Westinghouse devices to communicate with the real-time Westnet II data highway. This software may be configured to run a variety of link protocols simultaneously. Note that TCP/IP-compliant devices can also be connected directly to the WDPF Ethernet information highway without using WEStation Data Link Server software.

- Users with multiple sites can install master units in their own engineering offices.

**Relational Database Management System Option**

A System Maintenance Subsystem (SMS) can be used to maintain the current WDPF point information and DPU configuration in a local Relational Database Management System (RDBMS). As an additional enhancement to the overall system, Westinghouse is offering this RDBMS. Access functions provide access to WDPF database point records using SHC library function calls. These functions are responsible for retrieval and storage of point attributes, point value, and point status. This information is accessed using standard ANSI SQL. The SMS file definition is configured with entries representing all database (no control) points originated by each drop on the system. The significance of the SMS is that:

- It can generate itself automatically on any WDPF system interfaced to a WEStation,
- Once in place, Structured Query Language (SQL) calls can be used to view, list or correlate multiple databases,
- Changes to the SMS values or attributes are broadcast to update point data in other drops,
- Changes to values or attributes that occur in the other drops either due to program changes or MMI actions are automatically updated in the SMS, and
- Users may manipulate or view the database using third party software packages in addition to using Westinghouse programs.

**Training**

If Kennecott desires, all training can be conducted at the Kennecott site. This situation would allow Kennecott personnel to remain in close proximity to their designated job functions. In addition, Westinghouse will allow Kennecott to video tape all training courses in-order-to keep a library for future training needs.

## 5.2 Company Differentiations:

**U.S. Owned Company**

The value of a United States owned company differs greatly from one that has manufacturing in the United States. With Westinghouse, you can be sure that all research, development, and engineering will remain in the United States, with profits used to spur continued growth in our improving economy. Although it is difficult to place a dollar value on United States ownership, it has real worth.

**Field Service, Project Management**

We have established the structure of our project team up-front for this proposal. Our team will ensure an implementation that exceeds your expectations. Our projects are managed in-house to maintain your schedules, provide no hidden surprises, and finish within your budget.

Once shipped we will offer expedient service to meet your start-up schedules. We are proud of our track record, but we are never complacent or satisfied. Our experience will save approximately 10% of your time required for start-up. This will save on the direct cost of a Westinghouse engineer, but also with Kennecott engineers, constructors, and plant personnel. Westinghouse will enable you to get your unit on-line faster.

**Experience, Long-Term Support**

Westinghouse has considerable experience applying WDPF II to the ever changing needs of Industrial Markets, the stringent requirements of the Nuclear Industry, and the



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Application Name: WDPF II Information Manager

WDPF II is a distributed control system that provides integrated modulating control, sequential control and data acquisition for a wide variety of system applications in utility, chemical, and process manufacturing segments.

The WDPF Information Manager provides an Oracle interface to real time process data and associated configuration information. Traditionally, process information is distributed in flat file databases as close to the originating controller as feasible for timetagging and real time control response. The Information Manager provides a centralized link between the distributed real time information and both local and remote users of the information. The Information Manager is initially populated from distributed control system configuration data, or it creates a reflection of the on-line database by monitoring process control system data, then polls controllers for additional configuration details. With this representation in place, two-way updates of point values and attributes take place, keeping both the Information Manager and the distributed databases synchronized.

Once in place, SQL calls can be used to view, correlate, or modify multiple process databases. Changes originating in the process databases due to plant changes or operator actions are automatically updated in the Information Manager database. Changes originated in the SQL interface are downloaded to real time processors. Limitations are placed on the SQL interface to prevent inappropriate modification of critical data.

Key Features:

- Automatically create relational database from real time process databases
- Use SQL calls to view, list, or corrolate multiple process databases
- Change process database locally or remotely through SQL calls
- Manage SQL entry to protect real time data

Application Name: WDPF II Calculation Builder

WDPF II is a distributed control system that provides integrated modulating control, sequential control and data acquisition for a wide variety of system applications in utility, chemical, and process manufacturing segments.

The WDPF II Calculation Builder offers a method for users to easily define and execute miscellaneous calculations in a process control system environment. Calculations are entered in PL*SQL syntax using the WEStation Operator Station graphical user interface (GUI), and are stored in an Oracle relational database. The calculations can perform functions on any process point real-time or historical value. Calculations may include matrix manipulations or other complex functions not typically found in a control processor. Calculations may also call predefined subroutines such as those which calculate steam or gas properties.

The Calculation Builder is designed to address the need for flexible calculation requirements. Calculations can be created and modified on line through a set of window based menus and can be executed without compiling and linking code. Each user can maintain a private collection of calculation sets and also have read access to those sets which are public. A set of calculations can run on demand or can execute on a predefined periodic schedule. Results are stored in the relational database where they can be further manipulated or transferred to the real time data highway.

Calculation sets stored in the relational database may be sorted and printed in many different forms as needed for documentation.

Key Features:

- Create and modify calculations on-line
- Execute calculations directly without compiling or linking
- Store inputs, outputs, and formulas in a relational database for later retrieval, modification, and documentation
- Call external routines written in a compiled 3GL language such as Fortran or C

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Application Name: WDPF II Operator Log Book

WDPF II is a distributed control system that provides integrated modulating control, sequential control and data acquisition for a wide variety of system applications in utility, chemical, and process manufacturing segments.

In a typical industrial plant control room, a hard copy notebook provides a location for operational and supervisory personnel to record operating circumstances, events, and continuing activities during a work shift. This notebook is maintained at all times and is referred to by supervisors and maintenance engineers as needed.

The Operator Log Book is designed to replace the hard copy operator notebook with a CRT-based, free format entry field "note pad" that allows a plant operator or engineer to write, read, and send directed messages. Entry fields are provided for operator name, time and a free form detailed message.

A message pending indication appears at the operator's message icon whenever a message is queued. Messages can be retrieved and sorted by name or time, printed using SQL report forms, and retained for long periods of time.

In order to make the Operator Log Book useful to operating personnel, it must have an easy to use entry system for storing messages and for searching previous entries. It also must provide a high speed user interface, be secure, and provide high integrity of retained information. A relational database was chosen for this function because of these requirements.

Key Features:

Replace hard copy notebook with computerized message storage system

Easy to use operator entry via free format entry field

Retrieve messages by name or time

Print messages using SQL report forms

Archive messages for later retieval

Application Name: WDPF II Maintenance Log

WDPF II is a distributed control system that provides integrated modulating control, sequential control and data acquisition for a wide variety of system applications in utility, chemical, and process manufacturing segments.

The WDPF II Maintenance Log provides information to the operator on designated process plant equipment. Displays and reports provide continuous monitoring of equipment attributes such as run time, number of starts, vibration, and instantaneous electrical current usage. This information can be used for:

- determining the status of plant equipment and when equipment must be shut down for maintenance
- scheduling preventative maintenance
- analyzing trends for predictive maintenance
- collecting statistical information on equipment performance and reliability

The Maintenance Log provides three user interfaces: the definition and description of plant equipment to be included in the maintenance log; the viewing of collected maintenance data; and the reset of cumulative information (total running time and number of equipment starts since last maintenance period). The maintenance log uses the WDPF Historian to collect real time information. Periodically, the maintenance log queries and consolidates data from the historian and moves it into the relational database files. CRT displays and reports are produced from the data stored in the relational database. Reports include such information as equipment name and description, total runtime this period (e.g., this month), accumulated runtime since last maintenance, total number of starts this period, accumulated starts since last maintenance, peak vibration for period, peak current for period, and the date of last user reset of the runtime and starts accumulations.

Key Features:

Automatic collection of equipment run time statistics

Operator display of key information

Periodic maintenance reports for major equipment groups

Reset of cumulative information since last maintenance

5. WDPF II WEStag

WEStag is a plant tagout system running on a WDPF II distributed control system. It is an automated system designed to improve the process by which plant personnel establish and maintain equipment isolations in compliance with company and OSHA regulations.

WEStag uses fill-in-the-blank screens to develop equipment tagouts, sometimes referred to as clearances or red tag procedures. A library of preplanned clearances can be developed following plant approved procedures. Sets of procedures can easily recalled for immediate implementation . Legible tag labels, check lists, and other legal documents can be printed that show, for instance, the location and sequence of tag placement.

Numerous reports, such as tagout status, can be displayed or printed to provide timely management of current or planned outage activities. Bar coded tags can further improve tag accountability and productivity.

Controllable equipment within the WDPF distributed control system can automatically be locked out from operator action based on "tag hung" status in the WEStag system. Process graphics display the current lock out status of equipment.

# NASA (National Aeronautics and Space Administration)

## Ames Research Center, Transonic Wind Tunnel

**Background:** Designs and prototypes of space vehicles and of civilian and military aircraft are analyzed and tested rigorously at Ames, a leading research, development and testing facility in Moffett Field, California. Tests in a 12' diameter wind tunnel subject scale models or flight surface structures to aerodynamic conditions that actual aircraft might encounter in flight.

Test procedures begin by mounting the structures to be tested on support stands that can be manipulated in six axes of motion to simulate pitch, roll, yaw, and other attitudes and angles of attack. High-speed winds are developed in the tunnel using a large, variable-speed motor that drives a fan. The velocity and pressure of winds are controlled precisely and continuously by variable aperture inlet guide vanes.

**System architecture:** The WDPF*II* WEStation system includes:

- Three dual-CRT and one single-CRT WEStation operator consoles.
- One dual-CRT WEStation engineer console.
- One WEStation historian.
- Three WDPF*II* distributed processing units (DPUs).
- Two WDPF*II* total control units (TCUs).
- One redundant Westnet II data highway.

**Application:** The WDPF*II* WEStation system controls the entire environment in the tunnel: wind speed, temperature, and pressure; positions of inlet guide vanes and the model support stand; and other equipment such as valves, switches, motors, and controls for automatic start-up and safety shutdown. Each controller is dedicated to specific process functions, with DPUs and TCUs handling continuous control and sequential operations.

The TCUs maintain the critical balance between wind velocity and test stand position. A correction function in the TCU that employs ultra-high speed, angular mathematics is used to make the minute adjustments in the test stand needed for accurate measurements.

WDPF*II*'s ability to handle broadcast variables at 10Hz and process loops at 20Hz make it uniquely qualified to meet the high-speed control requirements of NASA's applications.

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# **DESTEC Engineering,** A Subsidiary of Dow Chemical Company
## Oyster Creek Power Station, A Cogeneration Plant

**Background:** The Oyster Creek Power Station provides electricity and process steam to Dow Chemical's plant in Freeport, Texas. DESTEC, a subsidiary of Dow, specified a WDPF*II* WEStation system to control three 80 MW gas turbines; one 185 MW steam turbine; three heat recovery steam generators; and balance of plant equipment.

**System architecture:** The plant's seven separate equipment areas are connected by a redundant Westnet II data highway and an Ethernet information highway. Buildings are connected by fiber optic cable, drops within buildings by coax cable. The WDPF*II* WEStation control system includes:

- Five WEStation operator consoles.
- Five WEStation engineer consoles.
- One redundant WEStation historian/logger.
- Twenty-one redundant WDPF*II* distributed processing units (DPUs), one with two remote I/O units.
- One WEStation data link server.
- Three Sun Microsystems workstations connected to the Ethernet information highway for remote log-in to WEStations.
- A training system with a WEStation engineer console; a WEStation historian/logger; a redundant DPU; a Sun Microsystems workstation connected to the Ethernet information highway; and fiber optic repeaters. Connected to the primary control system by Ethernet, the training consoles can be used to control the plant in an emergency situation.

**Application:** DESTEC is performing system configuration on DPUs and WEStations for plant control, optimization, and reporting. Operator consoles dedicated to specific plant locations enhance system security, and graphics are specific to that location. All graphics, created easily using a WEStation Graphics Builder, are high-resolution and use pop-up windows for control.

Communication to the plant LAN (local area network) is via the WEStation data link server. The network allows remote workstations to access process data for administrative and engineering functions. Each WEStation operator console in the control room can support three remote users who can, with a valid logon, access process diagrams, alarm information, trending, and historical data. For remote users, these functions are operative in monitor mode only; they provide fast, on-line displays of plant status and other information in an X-windows environment, while maintaining overall system security.

*"We selected WEStation for a number of reasons, including its compatibility with our existing DECnet highway and VAX mini computers. It reduced our initial cost and gave us enterprise-wide access to data from the WEStation historian for management reporting, engineering analysis, and performance calculations. Another important reason for selecting WEStation was the convenience of data that's available instantaneously in our people's offices. They no longer need to visit the control room to obtain critical information."*

**Gene Atteberry**
**Distributed Control Systems Supervisor, DESTEC Engineering**

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# Los Angeles Department of Water and Power

## Harbor Generating Station, A Combined-Cycle Plant

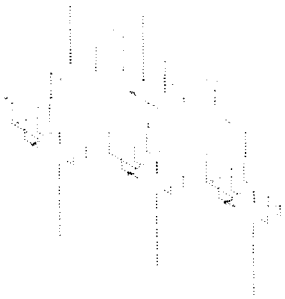
**Background:** The Harbor Generating Station, completed in 1949, is being repowered at a cost of $220 million. Included in the repowering project are an advanced WDPF*II* WEStation distributed control and information system, heat recovery steam generators, emissions control and monitoring systems, and two new combustion turbines. When the repowering is complete, the station will generate 240 MW, and $NO_x$ emissions from the plant will be reduced 20 percent.

**System Architecture:** The WEStation system features sophisticated, plant-wide data acquisition and control, information management, and remote networking. A WEStation console is located 11 miles away at the department's general office. The console can access process graphics via X11 calls over a T1 phone link, and is the server for a network of UNIX-based workstations at the general office.

The plant-wide data acquisition and control system includes a redundant Westnet II data highway that supports...

- Six single-screen WEStation operator consoles, each able to support up to three remote users.
- One single-screen WEStation engineer console.
- One redundant WEStation historian/logger.
- Twenty-seven redundant WDPF*II* distributed processing units (DPUs) interfaced to conventional input/output (I/O) and a total of 323 field-positioned smart transmitters. Using QST cards in the DPUs, all values and operational parameters supported by the smart transmitters can be viewed and manipulated by operators at WEStation consoles.

**Application:** The WEStation system includes controls for the two new 80 MW gas turbines. Each feeds one of two heat recovery steam generators, which in turn supply steam to drive an 80 MW steam turbine-generator. DPUs perform level one control and data acquisition for all production and balance of plant equipment.



High-resolution, three-dimensional system graphics are produced with an Intergraph Microstation CAD package; it utilizes OpenLook standard features for interactive elements such as scroll bars, push buttons, and entry fields.

A fully integrated, on-line relational data base management system (RDBMS) centralizes all data bases into one cross-referenced entity, allowing operations made in one application to be available to others. Data is modified when the RDBMS detects general-purpose messages that alter the on-line data base. The RDBMS serves on-site users and remote users at the general office with simplified sequential query language (SQL) support for on-line and historical data variables.

*"The largest benefit of having an open architecture in a distributed control system is information accessibility. The plant itself is basically a generator of information...there are lots of entities within our company—operations and maintenance people, our engineers—who have very practical use for that data."*

**Nathan Look**
**Electrical Design Engineer,**
**Los Angeles Department of Water and Power**

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**Advanced Features:** Because of its flexibility, the WEStation system can accommodate a number of advanced control, calculation, and management features and functions. The Harbor Station system includes the following:

| Feature | Function |
|---|---|
| Performance calculation | Optimize operations of generating equipment |
| Expert system (Nexpert Object) | Predictive diagnostics |
| Alarms | Alarms, with icon windows of plant groupings and conventional text messages. |
| Automated plant tagging | Track status of plant equipment and generate reports |
| Operator log book | Retain operator notes during daily operations |
| Maintenance log | Monitor and alarm operational characteristics of points |
| Free-form calculations | 'Forms' and text entry of formulae for on-line calculations |

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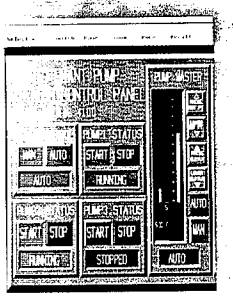
WDPF II

WEStation

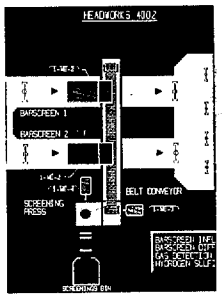
# Value...Integrating Process Control and Business Information

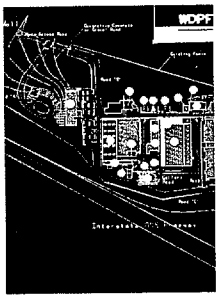
# [illegible] Enterprise Wide Information for Improved Performance



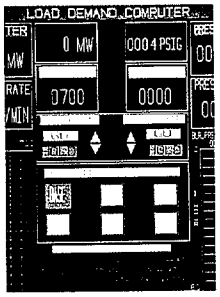

Reliable information originated by process [illegible] distributed control systems, real time process data that was once confined to control systems in plants and facilities, can now be available throughout your enterprise. Combining the critical data with existing business information creates a comprehensive view of operations. A view that is available simultaneously to literally any person, any place, who needs to regardless of location.

[illegible] to mine of process information can help [illegible] and accelerate informed [illegible] decisions and [illegible] the costs of [illegible] and other [illegible] the performance of individual [illegible] enterprises can be improved.



[illegible] information available from [illegible] control system can now be [illegible] plant managers, quality [illegible] and [illegible] supply chain [illegible] design and planning engineers [illegible] emphasis [illegible] financial managers and [illegible] any person or function [illegible] enterprise.

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**Only WEStation**—the next level of performance in distributed control and information systems—adds to the value of both process and management information by combining them and making them accessible throughout the enterprise. This unique feature—plus myriad others—leads to unique benefits for users...

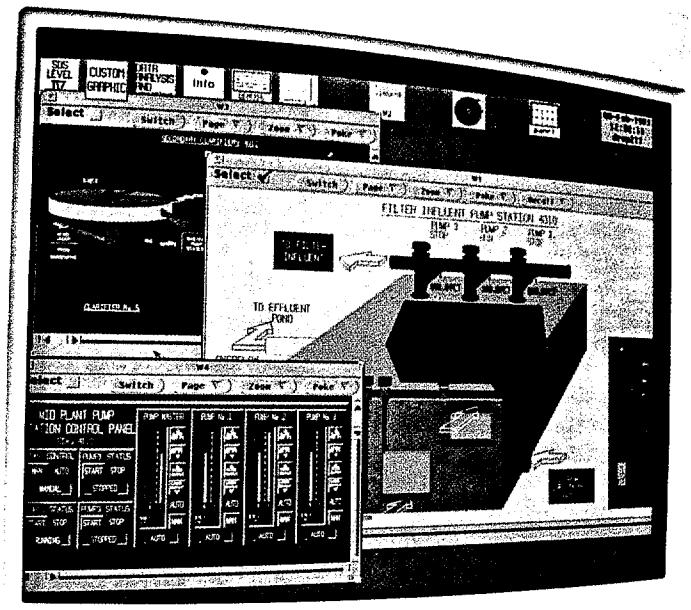
**Reliability**, built on WDPF experience and its platform of proven hardware and software. WEStation is an important extension of the WDPF control system that was introduced by Westinghouse in 1982, and which now is operating in thousands of process plants and power generating stations worldwide. Like WDPF, WEStation hardware and software are proven in service to be the industry's outstanding performers. Features include the Westnet II data highway, the most powerful and reliable in the industry; the UNIX operating system; RISC-based workstation technology; an open Ethernet information highway to link process and business data; and an integrated relational data base.

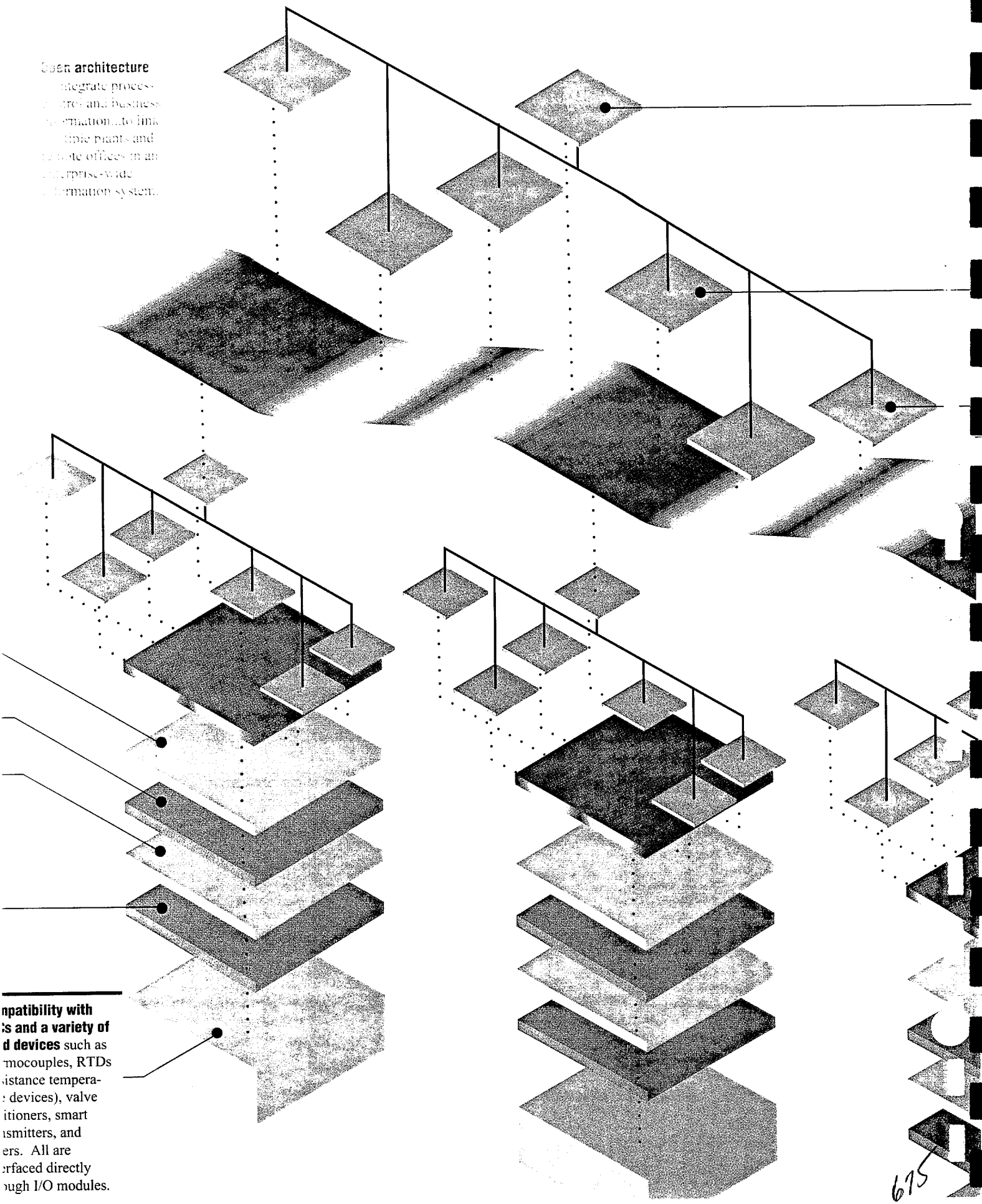
**Flexibility/expandability** to avoid obsolescence, widen choices of operating modes, and minimize operating costs. Open architecture standards, national and international communications protocols, X-compliant windowing environment, and ANSI-standard C code provide the power to expand and accommodate new technologies. And outstanding processing power and openness allow easy access to conventional field devices, and integration of third-party hardware and off-the-shelf software.

WEStation can be connected to any number of local area and wide area networks (LANs and WANs) to create a plant-wide or enterprise-wide information system. And WEStation is extremely modular and scalable: start with a system of modest scope and expand it later; select certain hardware and software packages and add to them later as needs for information change and technology evolves.

**Minimum costs** through compatibility with existing information systems, and flexibility/expandability. WEStation can communicate and share information with existing field devices and other equipment such as PLCs, PCs, mini-computers, mainframes, workstations and analytical equipment—without in any way compromising the security, speed and responsiveness of the control system. And WEStation's flexibility/expandability reduce costs by protecting initial investments against obsolescence.

**Expanded capabilities**, to far beyond traditional highway communication. Only WEStation can offer a fully integrated, on-line relational data base management system to centralize all information in one cross-referenced data base. It combines process and management information for optimum benefits throughout the organization.

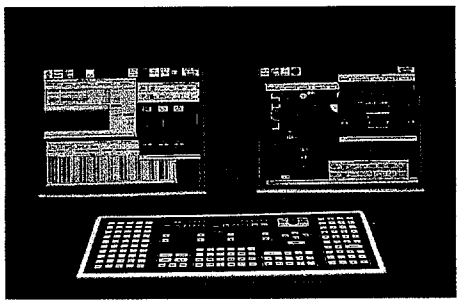




**Open architecture**
integrate process control and business information to link multiple plants and remote offices in an enterprise-wide information system.

**Compatibility with PLCs and a variety of field devices** such as thermocouples, RTDs (resistance temperature devices), valve positioners, smart transmitters, and others. All are interfaced directly through I/O modules.

# WDPF WEStation: An Elegant and Powerful Combination of Features



**Common hardware platform and operating system to support multiple functions** such as engineering, operations, data storage and retrieval, communication to third-party devices, and advanced computation.

**Engineering software** with capabilities to build process graphics, the control data base, and control programs; load configurations to all other stations; and electronically document all designs on-line.

**Historian/logger packages** for mass storage, retrieval, and reporting of real-time process data; SOE (sequence-of-events) data; and other events.

**Compatibility with third-party software** enhances the value of WEStation by enabling the addition of functions such as on-line document view, multi-media and/or video, geographical information systems, expert systems, spreadsheets, and many others. In addition, plant application software packages developed by Westinghouse are available to control and monitor specific processes.

**Operator package,** the graphical interface for plant control, diagnostics, trending, alarming, and plant monitoring. Operators respond quickly to high-resolution, high-speed graphics, and advanced display features. Process diagrams, comprehensive control functions, and many other plant parameters are instantly available. In addition, operator and maintenance log books can be created and viewed, and plant tag-outs can be managed automatically on-line.

**The Ethernet information highway** links the WDPF*II* process control system with business and information systems without burdening the real-time Westnet II data highway. Non-real-time information such as configuration and historical files is distributed by the Ethernet highway using open industry protocols.

**Westnet II data highway,** the industry's most powerful and reliable, assures that the control system's process values are broadcast onto the highway every second, regardless of plant conditions. All critical WDPF process functions are integrated onto Westnet II, which interfaces directly with Westinghouse and industry-standard platforms such as IBM PCs, DEC VAX and Alpha computers, and a variety of workstations.

**Control processors and I/O,** including WDPF*II* DPUs (distributed processing units) with local and remote I/O, central and remote telemetry units, batch control units, and others.

# 3/ VESTRON Users Recognize Its Value

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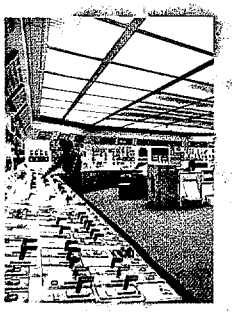
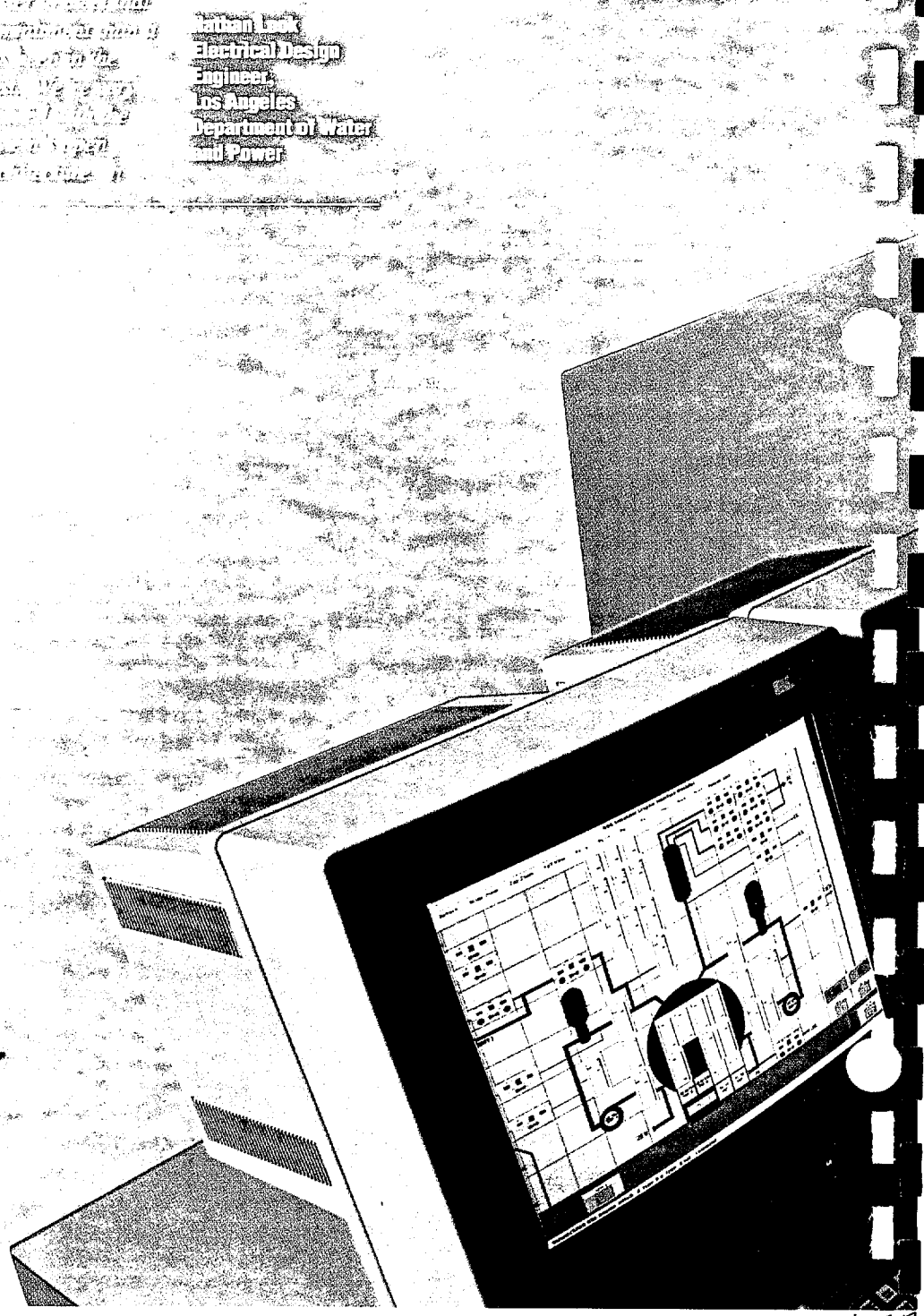


**Electrical Design Engineer, Los Angeles Department of Water and Power**



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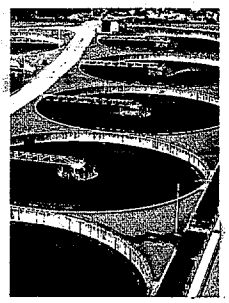
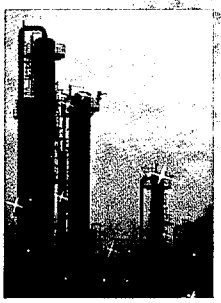




| | | WEStation |
|---|---|---|
| **Design Features** | • Real-time UNIX operating system with multiple gigabytes of on-line mass storage capability | ✓ |
| | • Ergonomically designed RISC hardware platform | ✓ |
| | • X-compliant windowing environment | ✓ |
| | • High-resolution, high-speed, full-color graphics | ✓ |
| | • Comprehensive control functions for rapid response to dynamic process conditions | ✓ |
| | • Open architecture to accommodate third-party hardware and software | ✓ |
| | • Integrated relational data base capability | ✓ |
| **Proven Reliability** | • Based on WDPF*II* technology, with thousands of installations worldwide | ✓ |
| | • Deterministic Westnet II real-time data highway | ✓ |
| | • Fully open Ethernet information highway that utilizes TCP/IP standard protocol | ✓ |
| **Flexibility/ Expandability** | • Easily accommodates third-party hardware and software | ✓ |
| | • Integrates with all LANs, WANs, and existing information systems | ✓ |
| **Minimum Costs** | • Supports multiple functions and data highways | ✓ |
| | • Compatible with existing PLCs, PCs, workstations and other hardware | ✓ |
| | • Compatible with third-party software | ✓ |
| **Expanded Capabilities** | • The only information and control system capable of integrating business and process information and communicating to every location and function in the enterprise | ✓ |
| **Customer Satisfaction** | • Complete, single-source responsibility | ✓ |
| | • Commitment to customer satisfaction through total quality | ✓ |

## ...o Benefit the Entire Organization

**Financial managers and cost accountants,** by combining process and business information, are able to determine costs at specified points in the process and continuously track the total costs of each plant's output.

**Environmental engineers and compliance officers** control and monitor plant emissions to assure compliance with regulations, including those for continuous emissions monitoring, using the real-time and historical information available from WEStation. Demonstrating compliance, and the results of steps taken to assure compliance, is simpler and more supportable.

**Operations managers** are, because of WEStation, able to benchmark and compare the historical and current performances of all plants within the company, then adopt best practices.

**Wide area networks (WANs)** distribute information among any number of plants and other facilities, regardless of location.

**Plant managers** benefit from WDPF*II* WEStation with a comprehensive view of operations that is far more timely and useful than the piecemeal views that have traditionally been available.

**Design and planning engineers** rely on information from WEStation to configure and test control strategies on-line, and integrate operations data from all the company's plants into designs for new plants and upgrades of existing plants.

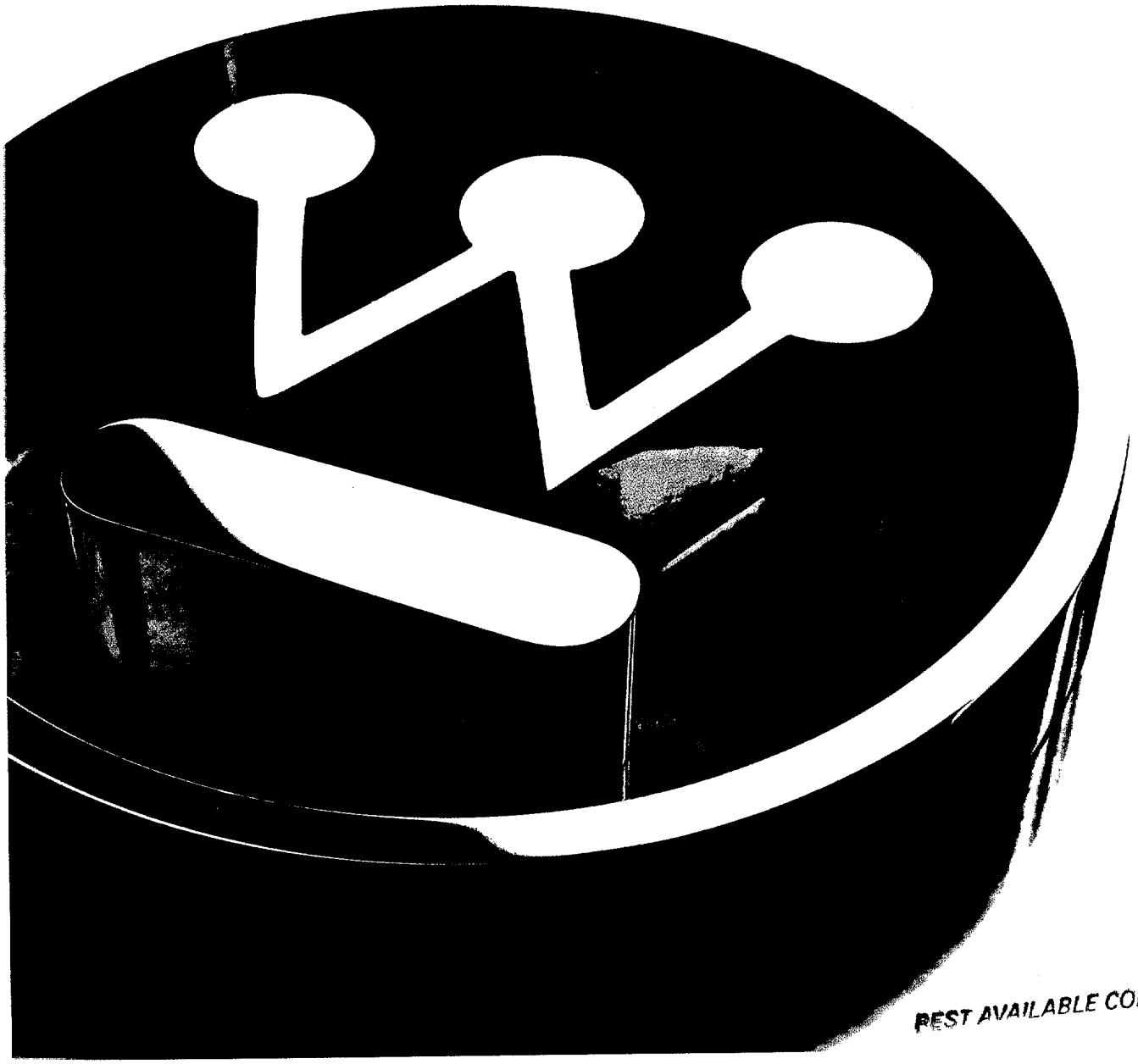
**Local area networks (LANs)** connect users throughout a plant with the Ethernet information highway and/or the Westnet II data highway.

**Plant operators, quality control engineers, and maintenance supervisors** use information available from WDPF*II* WEStation to monitor plant conditions and operate plant processes, schedule maintenance, diagnose and resolve upsets, and in general raise plant productivity and efficiency...the conventional uses of data from process control systems.

**Westinghouse pioneered,** more than a quarter-century ago, the application of digital control to power generation and industrial processes. Now, with WEStation, Westinghouse has pioneered the integration of process control and business information. The expertise developed over those years is applied to projects from initial evaluation of needs through engineering support throughout the service life of the system.

Services include conceptual design and definitive cost estimates...design engineering...manufacture and assembly of components...systems engineering, test, and simulation...installation... commissioning and start-up...training of operators and maintenance people... spare and replacement parts...service and long-term support, including development of enhancements to upgrade even the earliest digital systems to WDPF*II* and WEStation...and the Westinghouse assurance of reliable performance.

In independent surveys, Westinghouse process control systems receive consistently high marks from users for overall performance and customer satisfaction. One reason is the Westinghouse commitment to total quality; it focuses on doing the right things right the first time. With WDPF*II* WEStation, Westinghouse has again demonstrated its capabilities to assure the highest standards of quality in all products and services.



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**THERMOSTATIC RADIATOR VALVE**
**TA RUT, TOUR AND ANDERSSON LTD**
**Data Sheet AB-0321-15215**

**Exhibit 6-13**

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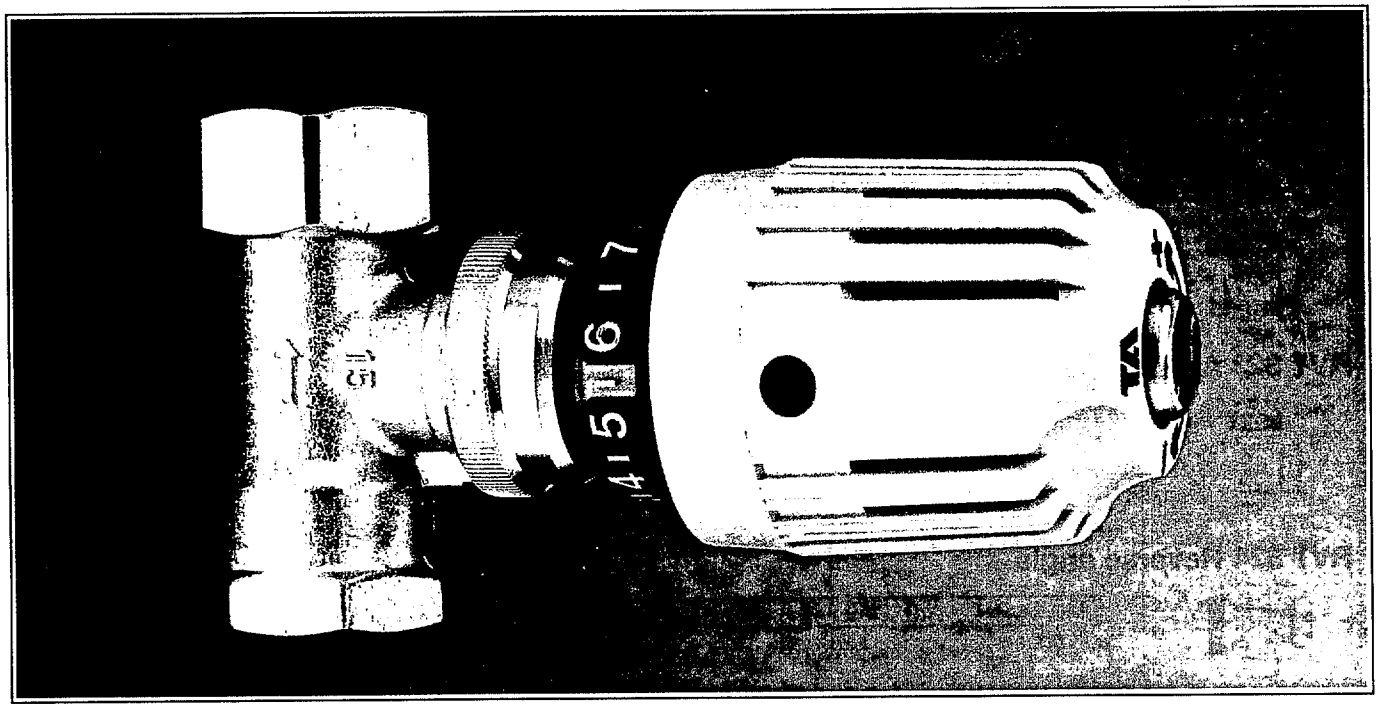
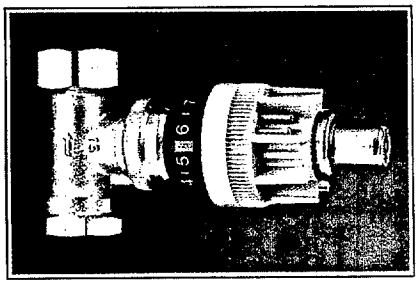
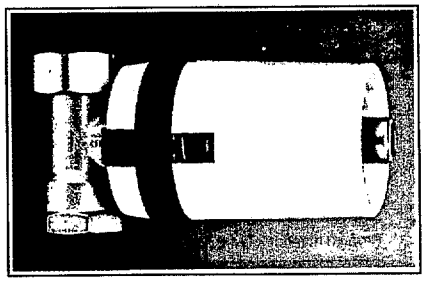
# THE TA RVT

## RVT Thermostatic Radiator Valve
## The new RVT cuts energy costs and improves comfort





You limit or lock the temperature range with concealed pins in the handwheel.



The accuracy of the actuator is not influenced by the tamper proof guard.

- RVT is a self-contained thermostatic valve for temperature control of individual rooms. It can be used with hot water systems and steam heating systems alike, offering great improvements in heating economy and comfort.
- You can count on a long service life for the valve. The valve body is made from a special copper alloy, Ametal®, resistant to dezincification, and then nickel plated.
- You can get the valve in sizes from ½" to 1¼" NPT. The molded disc and plug give excellent flow characteristics. The valve is normally open with angle, straight or reverse angle body. The inlet is female NPT, the outlet either male NPT or sweat union.
- The thermostatic actuator is calibrated to a high accuracy. You can choose from three different Control Unit models: Attached, remote bulb, or remote adjustment.

TA

TOUR & ANDERSSON INC • 1001 Briggs Road, Suite 205, Mt. Laurel, NJ 08054, Phone: (609)-778 13 00

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**Applications:**
Hot water and steam heating systems.

**Nominal temperature range:**
43–79°F.

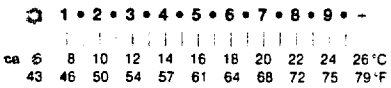
**Max body pressure:**
200 psi (water), 15 psi (steam).

**Max static pressure:** 250 psi.

| **Max pressure drop:** | (water) |
|---|---|
| ½" | 25 psi |
| ¾" | 20 psi |
| 1" | 15 psi |
| 1¼" | 15 psi |

**Max working temperature:**
+ 250°F. The thermostatic head may not be exposed to a higher temperature than + 122°F or lower than – 4°F.

**The approx temperature for thermostatic head RVT**



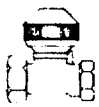

**Surface treatment:**
Nickel plated.

**Length of capillary tube:**
6 Ft standard, 15 Ft or 25 Ft.

**Material:**
Body ½"–1": AMETAL®
Body 1¼": Brass
Stem: Brass
Disc: EPDM Rubber

## VALVE BODIES

### RVT 321 Straight

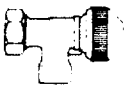


| Product number | C$_v$ | Size |
|---|---|---|
| 75 321–915 | 1.5 | 1/2" |
| –920 | 2.0 | 3/4" |
| – 925 | 3.0 | 1" |

### RVT 323 Angle

| Product number | C$_v$ | Size |
|---|---|---|
| 75 323–915 | 1.9 | 1/2" |
| –920 | 2.3 | 3/4" |
| – 925 | 3.0 | 1" |
| –942 U | 3.0 | 1¼" |

### RVT 324 Reverse angle



| Product number | C$_v$ | Size |
|---|---|---|
| 75 324–915 | 1.8 | 1/2" |
| –920 | 2.1 | 3/4" |

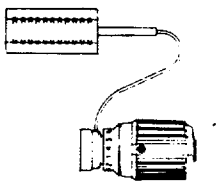
Product numbers refer to valve body including union nut.

## THERMOSTAT

### RVT 341 Attached sensor

| Product number | Temp. range | Color |
|---|---|---|
| 50 341–201 | 43–79°F | Beige |
| 50 341–202 | 43–79°F | White |

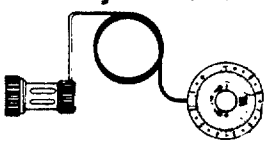
### RVT 342 Remote sensor adjustment on the valve



| Product number | Temp. range | Length of capillary tube | Color |
|---|---|---|---|
| 50 342–201 | 43–79°F | 6 Ft | Beige |
| –251 | 43–79°F | 15 Ft | Beige |
| –281 | 43–79°F | 25 Ft | Beige |
| –401 | 43–79°F | 6 Ft* | Beige |
| –451 | 43–79°F | 15 Ft | Beige |
| 50 342–202 | 43–79°F | 6 Ft | White |
| –252 | 43–79°F | 15 Ft | White |

*Armor Cable

### RVT 346 Remote sensing and adjustment



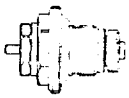
| Product number | Temp. range | Length of capillary tube | Color |
|---|---|---|---|
| 50 346–201 | 43–79°F | 6 Ft | Beige |
| –251 | 43–79°F | 15 Ft | Beige |
| –281 | 43–79°F | 25 Ft | Beige |
| –301 | 50–86°F | 6 Ft[1)] | Beige |
| –401 | 43–79°F | 6 Ft* | Beige |
| –451 | 43–79°F | 15 Ft | Beige |
| 50 346–202 | 43–79°F | 6 Ft | White |

*Armor Cable 1) Cooling Only

### 24 V AC 2-POSITION Thermo-electric actuator

| Product number |
|---|
| E22 C24 |

### RVT 343
**Trim cartridge**



| Product number | Size |
|---|---|
| 50 343–001 | 1/2"–3/4" |
| –003 | 1–1¼" |

### RVT 701
**Union tail piece, NPT**

| Product number | Size |
|---|---|
| 50 701–915 | 1/2" |
| –920 | 3/4" |
| –925 | 1" |
| 75 701–942 U | 1¼" |

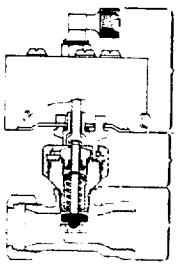
**Note:** Product number refers to tailpiece only

### RVT 703
**Union tail piece, Sweat**

| Product number | Size |
|---|---|
| 50703–815 | 1/2" |
| –820 | 3/4" |
| –825 | 1" |

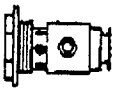
**Note:** Product number refers to tailpiece only

### Pneumatic actuators and adapters




| Product number |
|---|
| **Pneumatic actuator** |
| PA 7 L (3–7 ) PSI |
| PA 7 H (8–11 ) PSI |
| PA 7 C (8–11 ) PSI |
| **Bonnet adapter** |
| LV 228 001 |

### RVT 101 1¼" Insert



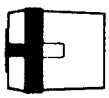
| Product number | C$_v$ | Type |
|---|---|---|
| 75 101–740 U | 3.0 | 1-pipe |
| 75 101–791 U | 3.0 | 2-pipe |

**1-pipe shown**

### Accessories

| Product number | Type | Temp. |
|---|---|---|
| 50–345–002 | Locking pins | |
| 50–349–008 | Spacer | 7°F increase |
| 50–399–001 | Manual Handwheel | |

### RVT 349 Tamperproof guard for RVT 341 and 342



| Product number | Type |
|---|---|
| 50–349–003 | 1/2"–3/4" |
| 75–349–008 | Reset tool |
| 50–349–009 | Disassembly tool |

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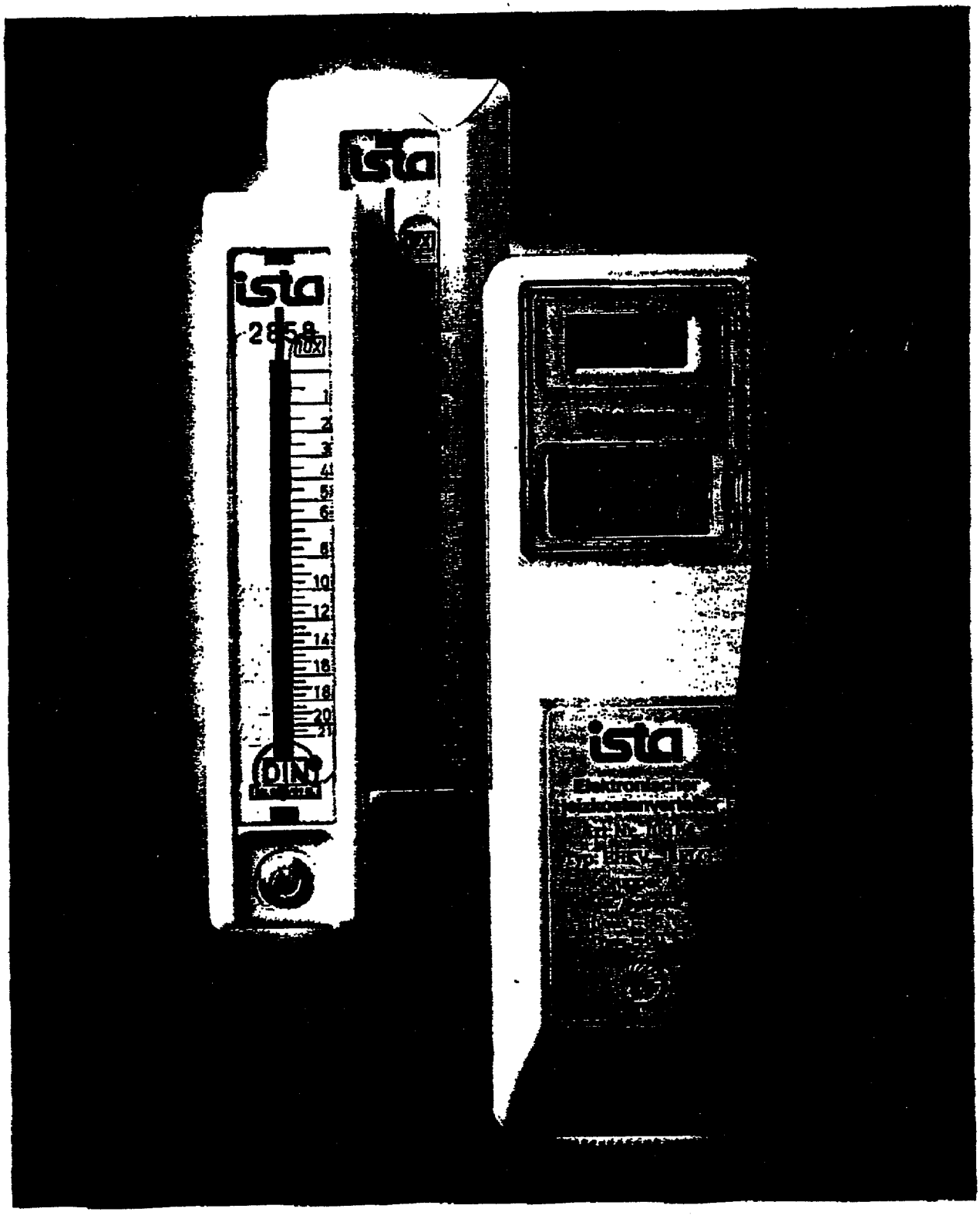
**RADIATOR ALLOCATOR, ISTA**

**(8 Pages in German)**

**Exhibit 6-14**

# Heizkostenverteiler

Verdunstungsprinzip, elektronisch




**In Service und Beratung vorn**

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## Bewertungsfaktoren richtig ermitteln und richtig anwenden

Die mittlere Heizkörpertemperatur muß auf die Meßflüssigkeit bzw. den Fühler der Heizkostenverteiler möglichst intensiv einwirken.

Maßgebend dafür sind u. a.

- die Güte des Wärmekontaktes zwischen dem Rückenteil des HKV und der Heizkörperoberfläche im Montagepunkt (wesentlich abhängig auch vom Montageteil),
- die Wärmeabstrahlung des HKV-Vorderteils, die zudem noch von der Umgebungstemperatur bestimmt wird.

Es gibt aber noch andere Gründe, warum Temperaturunterschiede auftreten. Den bedeutendsten Einfluß haben die Heizkörperarten, wie z. B.

- Gliederheizkörper
- plattenartige Heizkörper
- Konvektoren
- Mischformen.

Trotz gleicher Wärmeabgabe verschiedener Heizkörper entstehen deshalb unterschiedliche Temperaturen am montierten HKV. Diese Unterschiede müssen mit Hilfe von sogenannten $K_c$-Werten korrigiert werden. Jede Kombination Heizkörperart/Heizkostenverteiler hat ihren spezifischen $K_c$-Wert.

Für eine Vielzahl von Heizkörperarten werden für ista auf einem von der Eichbehörde anerkannten Prüfstand für Heizkostenverteiler erforderliche $K_c$-Werte gemessen. Eine staatlich anerkannte Prüfstelle nach Heizkostenverordnung überwacht diese Arbeiten.

Ein hoher Aufwand – zu Ihrer Sicherheit!

## Heizkostenverteiler richtig montieren

Gleichgültig, ob HKVV oder HKVE verwendet werden, die richtige Gerätemontage entscheidet wesentlich, ob die Heizkostenermittlung korrekt wird.

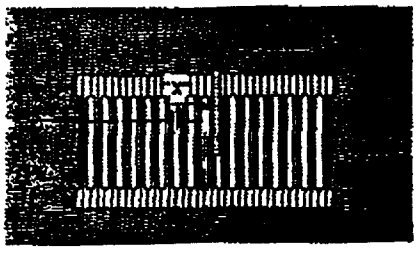
Bei einem HKVV ist das Meßergebnis die Menge der Meßflüssigkeit, die über die Zeitdauer der Temperatureinwirkung aus der Meßampulle verdunstet. Bei einem HKVE werden vom Fühler elektrische Signale in Abhängigkeit seiner Temperatur als Zählimpuls an das Rechenwerk gegeben.

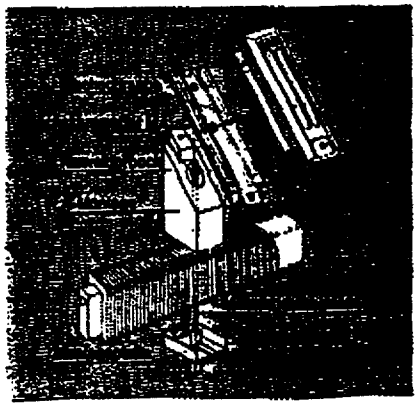
Die von der Meßflüssigkeit/dem Fühler aufgenommene Temperatur muß deshalb repräsentativ (mittlere Heizkörpertemperatur) für die Wärmeabgabe des Heizkörpers sein. Bei den meisten Heizkörpern liegt diese mittlere Heizkörpertemperatur bei 75 % seiner Bauhöhe und ½ der Baulänge.

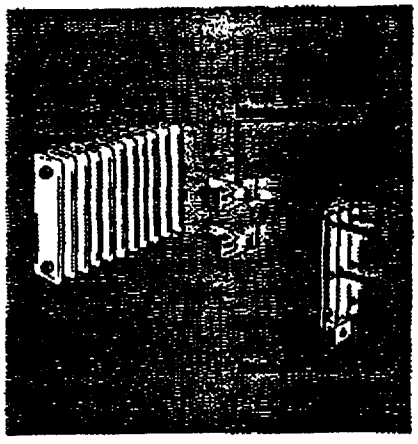
Die unterschiedlichsten Heizkörperbauarten aber verlangen unterschiedliche Montageteile und Befestigungsarten für die Heizkostenverteiler. Jede Befestigungsart bedarf besonderer Montageteile. Daraus wiederum ergeben sich unterschiedlichste $K_c$-Bewertungsfaktoren. Der ista Monteur weiß genau, wie zu montieren ist. Sein Montagehandbuch sagt ihm, was zu tun ist, an welchen Punkt er montieren muß, mit welchen Montageteilen. Speziell entwickelte Montagemethoden für ista Heizkostenverteiler für fast alle vorkommenden Heizkörperarten ermöglichen eine DIN-gerechte Montage.

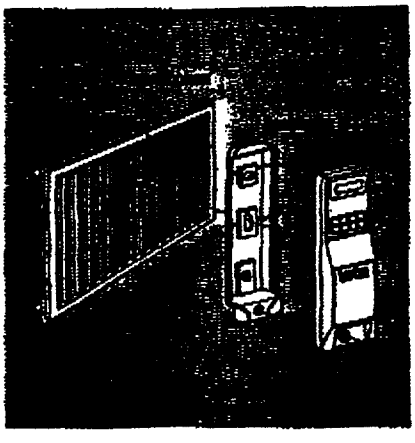
Nur wenn richtig montiert wird, kann richtig gemessen und gerecht abgerechnet werden.

Anwendungssicherheit entscheidet!









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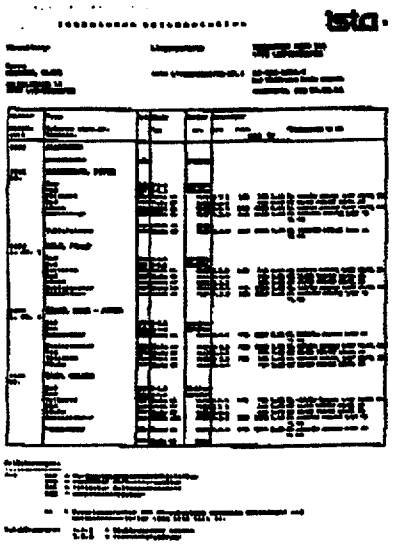
## ASS, das ista-Abrechnungs-Sicherheits-System

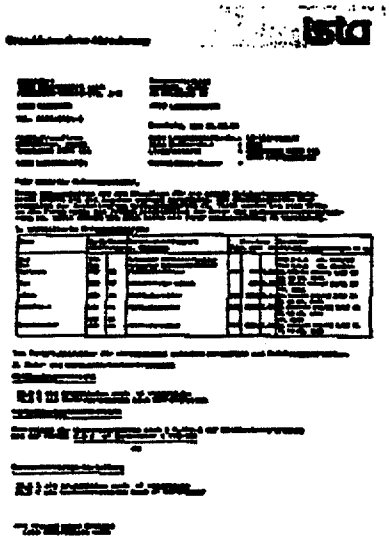


Beratungssicherheit hin, Anwendungssicherheit her – Sie als Vermieter und Eigentümer des Objektes und wir als Ihr Dienstleistungsunternehmen können uns noch so sehr bemühen alles korrekt zu machen – wenn Ihre Mieter die zur Abrechnung führenden Daten nicht prüfen können, bleiben sie mißtrauisch. Und Sie selbst wollen ja sicher auch gern ganz genau wissen, welche einzelnen Daten später zur Heizkostenabrechnung führen.

Offenlegung und Prüfbarkeit aller relevanten Daten schaffen Vertrauen und Akzeptanz.

Sobald wir nach der Montage der HKV die vielen von uns erhobenen Daten Ihrer Liegenschaft erfaßt haben, legen wir Ihnen diese zur Bestätigung vor. Sollten einmal Fehler vorhanden sein – unsere Monteure sind auch nur Menschen – können wir diese mit Ihnen gemeinsam korrigieren, bevor die erste Heizkostenabrechnung erstellt wird, damit sie auch richtig und rechtssicher wird!

Und Ihre Mieter? Für sie erstellen wir die „Nutzerdokumentation". Auch hierin weisen wir alle Meßstellen, die

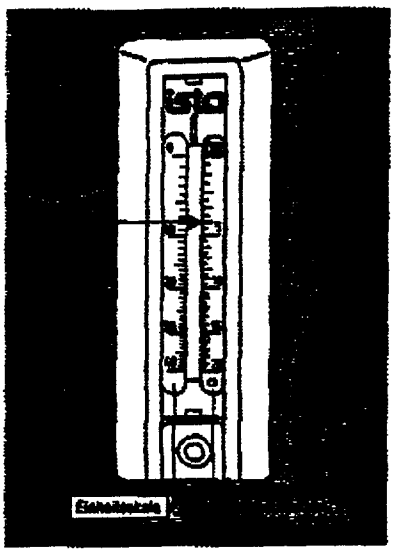


Maße der Heizkörper, die Nummern der HKV, die Abrechnungsart der Kosten etc. aus. Wir wollen nichts unklar lassen, sondern mit Ihnen gemeinsam höchste Sicherheit erreichen. Und das bereits vor der ersten Heizkostenabrechnung.

Natürlich benötigt dieses partnerschaftliche Verfahren ein wenig Zeit:

- Aufmaß der Heizkörper
- Erfassen aller Daten
- Bestätigung der technischen Dokumentation durch Sie
- Bestätigung der Nutzerdokumentation durch Ihre Mieter
- Berechnung der Bewertungsfaktoren bei uns anhand der bestätigten Grunddaten.

Und weil wir das alles für Sie leisten wollen, liefern wir alle ista HKV immer mit Einheitsskale. Jedes Gerät hat unabhängig von der Größe des Heizkörpers und dem anzuwendenden $K_c$-Wert die gleiche Skale oder Anzeigegeschwindigkeit. Die Montage der HKV kann ohne Verzögerung durchgeführt werden, Sie können ihre gesetzliche Meßpflicht unverzüglich erfüllen.




Erst wenn alle Daten geprüft sind, werden die DIN-gerechten Bewertungsfaktoren bestimmt. In den Ablese- und Abrechnungsformularen sind dann alle Daten klar dargestellt und die Berechnung der Verbrauchswerte ist übersichtlich und nachvollziehbar.

Wenn Sie es wünschen, rüsten wir bei der ersten Ablesung die HKV mit den bewerteten Skalen, den sogenannten Produktenskalen, aus. Bei HKVE geschieht das elektronisch durch Umprogrammierung der Anzeigegeschwindigkeit.

Erst prüfen – dann richtig bewerten = ista-Abrechnungs-Sicherheits-System.

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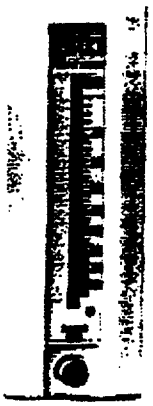
## Heizkostenverteiler nach dem Verdunstungsprinzip



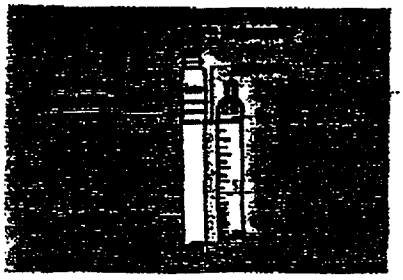
HKVV für Radiatoren **Art.-Nr. 10350**

Der Heizkostenverteiler nach Verdunstungsprinzip ist der „Senior" aller Heizkostenverteiler. Vielfältige „moderne" Wünsche kümmern ihn nicht. Er beschränkt sich auf das Wesentliche. Seine Meßflüssigkeit „fühlt" die Heizkörpertemperatur. Und dann verdunstet sie; je heißer sie wird und je länger das andauert, umso mehr.

Der schnellste ist der HKVV nicht und er läßt sich auch nicht täglich „in die Karten gucken". Es dauert eine Weile, bis er zeigt, was er geschafft hat. Kurzfristige Ergebnisse sind nicht seine Stärke.

Dafür aber tut er überall dort verläßlich seinen Dienst, wo ihm das richtige „Klima" geboten wird. Er legt Wert auf gleichbleibende Betriebsbedingungen, liebt Heizkörpertemperaturen um 55 °C im Jahresmittel. Dann passen seine „Charakteraigenschaften" bestens zu den Erfordernissen.

Er ist und bleibt ein „Spezialist" für traditionelle Warmwasser-Heizungsanlagen in ihrer ursprünglichen Bauform und Betriebsweise mit min. 55 °C, max. 90 °C. Vorlauftemperatur bei –12 °C Außentemperatur.

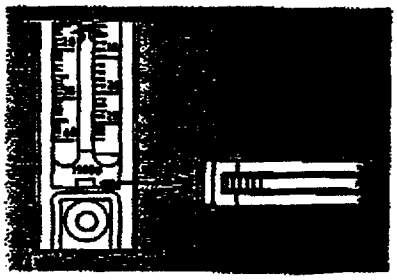


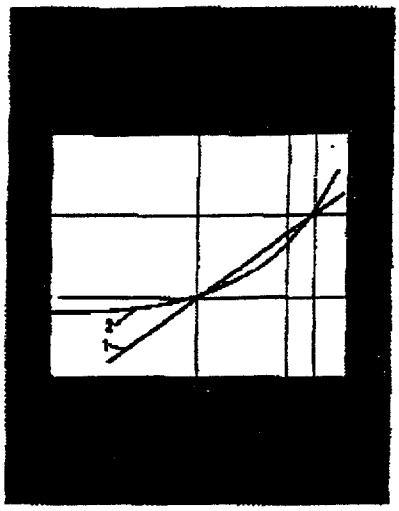
HKVV für Platten **Art.-Nr. 10450**

### Gerätebeschreibung

In das metallische Gehäuse mit hoher Wärmeleitfähigkeit ist ein symmetrischer Kanal zur Aufnahme der Präzisionsmeßampulle eingegossen. Diese ist aus Glas und hat eine obere Einschnürung mit kalibrierter Öffnung. Das Gehäuseoberteil besteht aus wärmebeständigem Kunststoff mit eingeprägter Einheitsskale und Einspreizmöglichkeit für eine Produktenskale. Die nach DIN 4713 Teil 2 geforderte Überfüllhöhe der Meßflüssigkeit in der Präzisionsmeßampulle läßt sich von außen kontrollieren. Eine verdunstungsunabhängige Vorjahresanzeige in Form eines roten Markierungspfeiles ist einstellbar. Gehäuseunterteil und -oberteil werden durch eine patentierte Verplombung gegeneinander gesichert.

Das Gehäuseoberteil hat im unteren Bereich einen Durchbruch. Durch Aufsetzen einer Lichtquelle (Taschenlampe) auf den Durchbruch wird die Meßflüssigkeitsstandhöhe in der Meßampulle deutlich leuchtend angezeigt. So ist auch in geschlossenem Gerätezustand, z. B. bei Zwischenablesungen, eine einwandfreie Ablesung durch jedermann möglich.

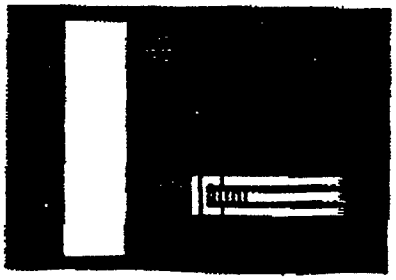




1 = Heizkörper-Wärmeleistung
2 = Verdunstungskurve der HKVV-Meßflüssigkeit

### Funktionsweise

Das Gehäuseunterteil übernimmt die Temperatur der Heizkörperfläche am Montagepunkt des HKVV. Dadurch wird die Meßflüssigkeit in der Präzisionsmeßampulle erwärmt. In Abhängigkeit der Temperatur und der Zeitdauer ihrer Einwirkung verdunstet die Meßflüssigkeit. Wie alle Flüssigkeiten verdunstet sie auch in gewissem Maße, ohne daß der Heizkörper in Betrieb ist. Diese „Kaltverdunstung" ist in allen HKVV gleich. Durch eine festgelegte Überfüllung von Meßflüssigkeit nach DIN 4713 Teil 2 wird diese Kaltverdunstung ausgeglichen und schlägt bei den Verbrauchswerten in der Heizkostenabrechnung nicht zu Buche. Die verdunstete Menge Meßflüssigkeit wird an den Skalen des HKVV abgelesen. Für die Heizkostenabrechnung werden die Anzeigewerte mit DIN-gerechten Bewertungsfaktoren entsprechend der Eigenschaften des jeweiligen Heizkörpers und des verwendeten HKVV bewertet. Diese Eigenschaften ergeben sich aus Größe, Bauart und Heizleistung des Heizkörpers, der Bauart des HKVV und seiner Montageart am Heizkörper.





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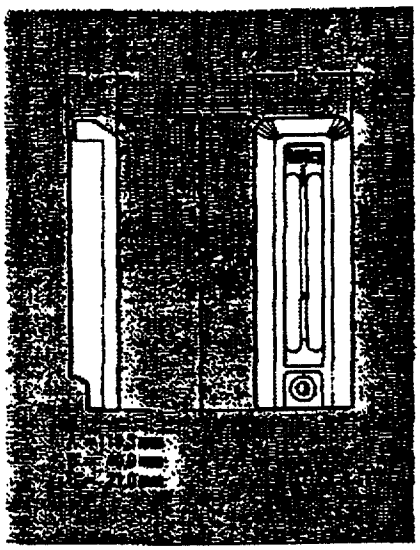

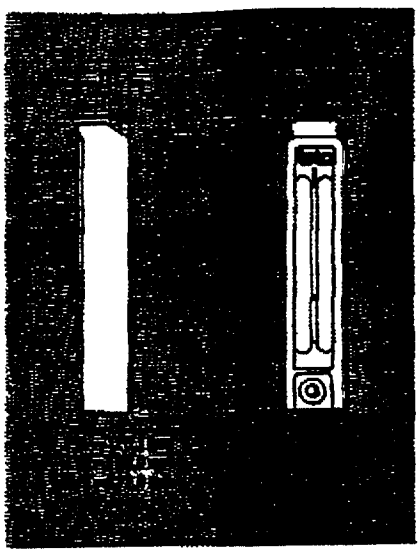

## Technische Daten

Zugelassen nach HeizkostenV, geprüft nach DIN 4713 Teil 2, Ausgabe März 1990.

| | |
|---|---|
| Abmessungen: | siehe Maßzeichnungen |
| Werkstoffe: | |
| Unterteil | Alu-Druckguß 226D |
| Oberteil | POM |
| Meßampulle: | |
| Außenmaße | 90 × 7,25 mm |
| Wandstärke | 0,7 mm |
| Innendurchmesser | 5,85 mm zylindrisch |
| Material | Glas, weiß |
| Flüssigkeit: | |
| Bezeichnung | Methylbenzoat |
| Reinheitsgrad | 99,2 % |
| Siedepunkt | 199 °C |
| Erstarrungspunkt | −12 °C |
| Skalensystem: | Einheitsskale 0–40 auf Wunsch Produktskalen Leistungsbereich 116,5 W bis 9304 W mittels 82 Skalengrößen |
| Skalenlänge | 58,5 mm |
| Verbrauchsanzeige | analog |
| Ablesekontrolle | Markierung für Vorjahresstand |

Techn. Änderungen vorbehalten.

## Einsatzbereiche

An allen handelsüblichen Heizkörpern, sofern das Gerät im Temperaturmittelpunkt des Heizkörpers montiert werden kann.

| | |
|---|---|
| Min. Auslegungs-Vorlauftemperatur | 65 °C |
| Max. Auslegungs-Vorlauftemperatur | 90 °C |

(höhere Temperaturen auf Anfrage; Entwurf DIN 4713 Teil 2 ist zu beachten).

## Technische/physikalische Grenzen

Die Meßflüssigkeit bestimmt wesentlich die Einsatzgrenzen des HKVV. Die Verdunstungsgeschwindigkeit der Meßflüssigkeit in der Präzisionsmeßampulle nimmt mit fallender Temperatur bis zur Kaltverdunstungsrate überproportional stark ab. Die Folge sind dann sehr geringe Anzeigewerte (siehe Diagramm S. 4). Deshalb muß die Meßflüssigkeit im HKVV im Mittel über die Heizperiode etwa 55 °C ausgesetzt werden. Bei hohen Temperaturen steigt die Flüssigkeitsabnahme überproportional stark; bei sehr hohen Temperaturen besteht die Gefahr, daß die Meßflüssigkeit völlig verdunstet (Leerverdunstung). Deshalb ist gemäß DIN 4713 Teil 2 der Einsatz auf Heizsysteme mit Auslegungstemperaturen von mindestens 65 °C und maximal 90 °C begrenzt.

Bei System-Temperatur über 90 °C bis 130 °C sind gem. DIN 4713 Teil 2 besondere anlagentechnische Bedingungen Voraussetzung für den Einsatz von HKVV.

Nicht verwendungsfähig bei

- Fußbodenheizungen
- Deckenstrahlungsheizungen
- klappengesteuerten Heizkörpern
- Badewannenkonvektoren
- Warmlufterzeugern
- Heizsystemen, die mit niedrigeren Auslegungsvorlauftemperaturen als 65 °C arbeiten
- *Heizsystemen, bei denen die Heizkörper mit Dampf betrieben werden*
- Einrohrheizungen (eingeschränkt)
- Heizkörpern mit bei DIN-Wärmeleistung nicht berücksichtigten Verkleidungen

## Anlagentechnische Grenzen

Nicht verwendungsfähig bei

- Anlagen mit mehreren Regelkreisen, sofern kein zentrales Meßgerät (Wärmezähler) je Regelkreis vorhanden ist
- Anlagen mit 1 Regelkreis, jedoch unterschiedlichen Gebäudeteilen mit spezifisch unterschiedlichem Wärmebedarf
- wärmedämmtechnisch bzw. regelungstechnisch modernisierten Gebäuden mit „prakt. Auslegungs-Vorlauftemperatur" unter 68 °C
- Gebäudekombinationen mit nach alter und nach neuer Wärmeschutzverordnung berechneter Gebäudeteile
- erheblich überdimensionierten Anlagen

Ein klassisches Indiz für nicht mehr ausreichende Einsatzbedingungen von HKVV sind Kosten von mehr als DM 15,– je Verbrauchswert (sogen. Strichpreis). Das trifft in vielen „Altanlagen" zu. Aus Gründen der Rechtssicherheit der Heizkostenabrechnung ist in solchen Fällen dringend zu empfehlen, die Anlage und das Meßsystem überprüfen zu lassen. Der Einsatz empfindlicherer und für die Betriebsbedingungen der Anlage geeigneterer Meßverfahren ist in aller Regel wesentlich günstiger als eine Änderung der Anlagentechnik.

In Anlagen mit häufigem Mieterwechsel zeigt der HKVV eine physikalisch bedingte Schwäche: infolge der Kaltverdunstungsvorgabe ist der Wärmeverbrauch des ausziehenden Mieters in aller Regel nicht feststellbar; Rechtsstreitigkeiten sind „programmiert".

Elektronische Heizkostenverteiler, 1-Fühler-Geräte, bieten in beiden Fällen Abhilfe.



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## Elektronische HKV

Elektronische HKV sind nach zwei wesentlich unterschiedlich arbeitenden Gerätearten zu unterscheiden:

- 1-Fühler-System
- 2-Fühler-System

1-Fühler-System:

Wie bei HKVV erfaßt nur ein Fühler die Heizkörpertemperatur am Montagepunkt des HKV. Allerdings wesentlich präziser, schneller und stärker reagierend, da es ein elektronischer Sensor ist. Jedoch wird auch hier nicht die Raumlufttemperatur erfaßt.

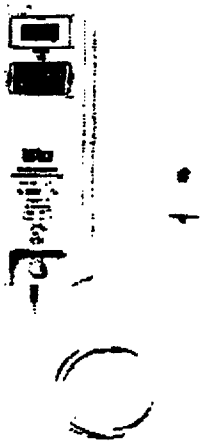
In Wohngebäuden herrschen üblicherweise Raumtemperaturen von 18 – 22 °C. Deshalb werden die Wärmeleistungswerte der Heizkörper gemäß Forderungen aus DIN 4713 auf 20 °C Raumlufttemperatur bezogen. In der Elektronik der Geräte wird daher ein Festwert für 20 °C Raumlufttemperatur simuliert. So bildet dann das Rechenwerk die Differenz aus Heizkörpertemperatur abzüglich 20 °C Raumlufttemperatur. Der hieraus sich ergebende Wert, die sogenannte Übertemperatur, treibt die Anzeige des Gerätes.

2-Fühler-System

Hier wird zusätzlich zur Heizkörpertemperatur auch die tatsächliche Raumlufttemperatur durch einen zweiten Fühler erfaßt. Nahezu exakt kann so die tatsächliche Wärmeleistung des Heizkörpers ermittelt werden. 2-Fühlergeräte müssen insbesondere im Niedertemperatur-Bereich eingesetzt werden.

## Elektronischer Heizkostenverteiler 1FLC

HKVE-1FLC Kompaktgerät
**Art.-Nr. 10660**



HKVE-1FLC mit Fernfühler
**Art.-Nr. 10664**

Die Verbindung traditionell bewährter Methoden mit neuer Technologie ist das Prinzip des elektronischen HKVE-1FLC. Wie der „Verdunster" arbeitet er mit nur einem Fühler. Doch das ist ein elektronisches Bauelement und äußerst sensibel. Empfindlich wie er ist, kann er auch mit recht niedrigen Temperaturen sicher umgehen. Sein elektronisches „Gehirn", ein CMOS-Chip modernster Bauart, ist aufnahmefähig und äußerst konsequent. Strikt tut es das, was ihm von seinem Konstrukteur gesagt wurde, exakt nach DIN-Vorschriften. Nicht mehr und nicht weniger. Die Raumlufttemperatur nimmt es als festen Wert von 20 °C an. Und damit rechnet es, und das blitzschnell, in kleinsten Einheiten. Dies zeigt der 1FLC dann sofort und dauernd an, in Zahlen, für jedermann deutlich lesbar. Täglich, stündlich, ja sogar in noch kürzeren Zeiteinheiten weist er den neuesten Stand seiner Berechnungen aus. Und das alles 5 Jahre lang mit nur einer einzigen Batterie als Energieversorgung.

So stört ihn während der Ablesung niemand bei seiner Arbeit. Er ist sicher, irritieren oder gar manipulieren läßt er sich nicht.

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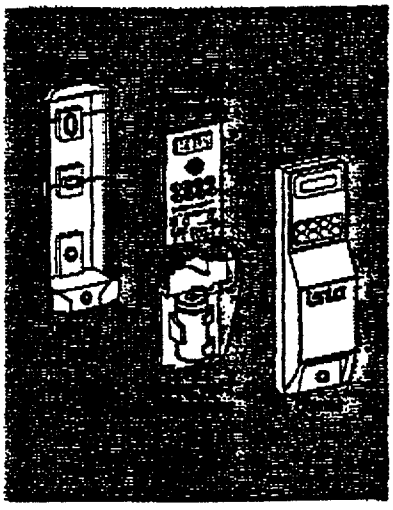


## Gerätebeschreibung

Das Geräteunterteil besteht aus hochwärmeleitfähigem Material zur Montage am Heizkörper, das Geräteoberteil aus wärmebeständigem Kunststoff. In ihm sind die Platine mit allen elektronischen Bauteilen, eine LCD-Anzeige, die Langzeitbatterie und der Heizkörperfühler plaziert. Der Heizkörperfühler ist so montiert, daß er sehr exakt die Temperatur des Gehäuseunterteiles erfaßt. Im Geräteoberteil ist ein Plexiglasfenster angebracht, duch das die LCD sicher abgelesen werden kann.

Außerdem sind dahinter die Programmierkontakte für die Bewertungsfaktoren zugänglich. Das „Fenster" selbst ist für Unbefugte eingriffssicher verschlossen.

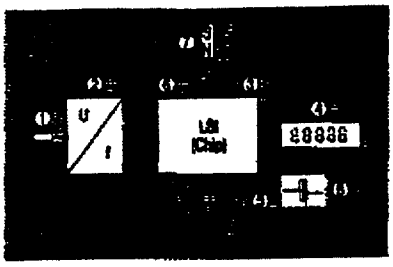
Geräteoberteil und -unterteil haben eine zylindrische Bohrung, durch die beide Teile gegeneinander verplombt werden.

Bei der Geräteausführung mit Fernfühler ist der Heizkörperfühler über ein 3m-Kabel aus dem Gehäuseoberteil herausgeführt. Nur der Fernfühler wird mit seiner metallischen Grundplatte auf dem Heizkörper montiert; das Kunststoffgehäuse sowie das Kabel sind temperaturbeständig bis 110°C. Das Geräteoberteil wird auf ein Wandgehäuse neben den Heizkörper gesetzt.

## Funktionsweise

Das Gehäuseunterteil übernimmt die Temperatur der Heizkörperoberfläche am Montagepunkt und leitet sie an den hochwertigen Temperaturfühler im HKVE. Aus der Fühlertemperatur und dem im HKVE festeingestellten Wert von 20°C für die Raumlufttemperatur berechnet die Elektronik die sogenannte Übertemperatur. Entsprechend der Zeitdauer und der Höhe der anstehenden Übertemperatur zählt das Gerät Anzeigewerte, die auf einer 5stelligen hochtemperaturfesten multifunktionalen LCD-Anzeige abgelesen werden können. Für die Heizkostenabrechnung werden diese Anzeigewerte nach DIN 4713 Teil 3 bezüglich der jeweiligen Eigenschaften der Heizkörper bewertet. Die Eigenschaften ergeben sich aus Größe, Bauart und Heizleistung des Heizkörpers, der Bauart des HKVE und seiner Montage Art am Heizkörper.

Die Starttemperatur für Zählimpulse ist 28,5°C. Fühlertemperaturen, die kleiner sind, veranlassen keine Zählimpulse. Eine Kaltverdunstung wie beim HKVV kann dadurch nicht auftreten. Geringfügige sogenannte „Sommerzählimpulse" sind u. U. möglich, wenn durch Fremdwärmequellen Fühlertemperaturen über 28,5°C entstehen.




① = Thermistor (NTC)
② = Spannungs-Frequenzwandler
③ = Rechenelektronik (LSI)
④ = LCD (hochtemperaturfest)
⑤ = P-Skalenprogrammierung mit Leitgummi-Stopfen
⑥ = Funktionskontroll-Taste (Reed)
⑦ = Magnet-Betätiger (von außen, ohne Öffnen)
⑧ = Langzeit-Lithium-Batterie

Technische Änderungen vorbehalten.

Der HKVE wird durch eine hochwertige Langzeit-Lithiumbatterie für eine Betriebsdauer von 5 + 1 Jahr mit Strom versorgt. Beim Ablesen der Geräte ist daher keine Öffnung des Gehäuses notwendig. Selbst die Funktionsprüfung des HKVE einschließlich der Prüfung der einwandfreien Funktion der LCD kann von außen erfolgen.

## Technische Daten

| | |
|---|---|
| Gerätetyp | HKVE-1FLC |
| Zulassung nach HeizkostenV gem. DIN-Entwurf, Stand Febr. 86 | A2.01/1986 |
| Temperaturmeßbereich: | 28,5°C ... 83,5°C |
| Max. Auslegungs-Vorlauftemperatur (Heizkörper) | 95°C für Kompaktgerät<br>110°C für Fernfühler-Ausführung |
| Min. Auslegungs-Vorlauftemperatur (Heizkörper) | 60°C |
| Abmessungen: | (H×B×T) in mm = 140 × 43 × 30 |
| Werkstoffe: | Unterteil Alu-Druckguß 226 D<br>Oberteil Novodur ABS |
| Anzeige: | multifunktionale 5stellige LCD, hochtemp.-fest (Ziffern H×B, 4,7×2,8 mm) |
| Anzeigecharakteristik: | gemäß DIN |
| Anzeigegeschwindigkeit: | DIN Gruppe A |
| Starttemperatur $t_s$: | 28,5 °C |
| Basis-Raumlufttemperatur: | 20 °C |
| Technologie: | CMOS-Kundenchip |
| Stromversorgung: | 5-Jahres-Lithium-Batt. + 1 Jahr Res. |
| Klimatische Anwendungsklasse: | DIN 40040, Klasse KOG |
| Skalierung: | elektron. Programmierung (in RAM) |
| Skalensystem: | Einheitsskale serienmäßig<br>auf Wunsch Produktenskala<br>Leistungsbereich 116,3 W bis 9304 W mittels 82 Skalen |
| Funktionstest: | ohne Öffnung des Gerätes |

Technische Änderungen vorbehalten.

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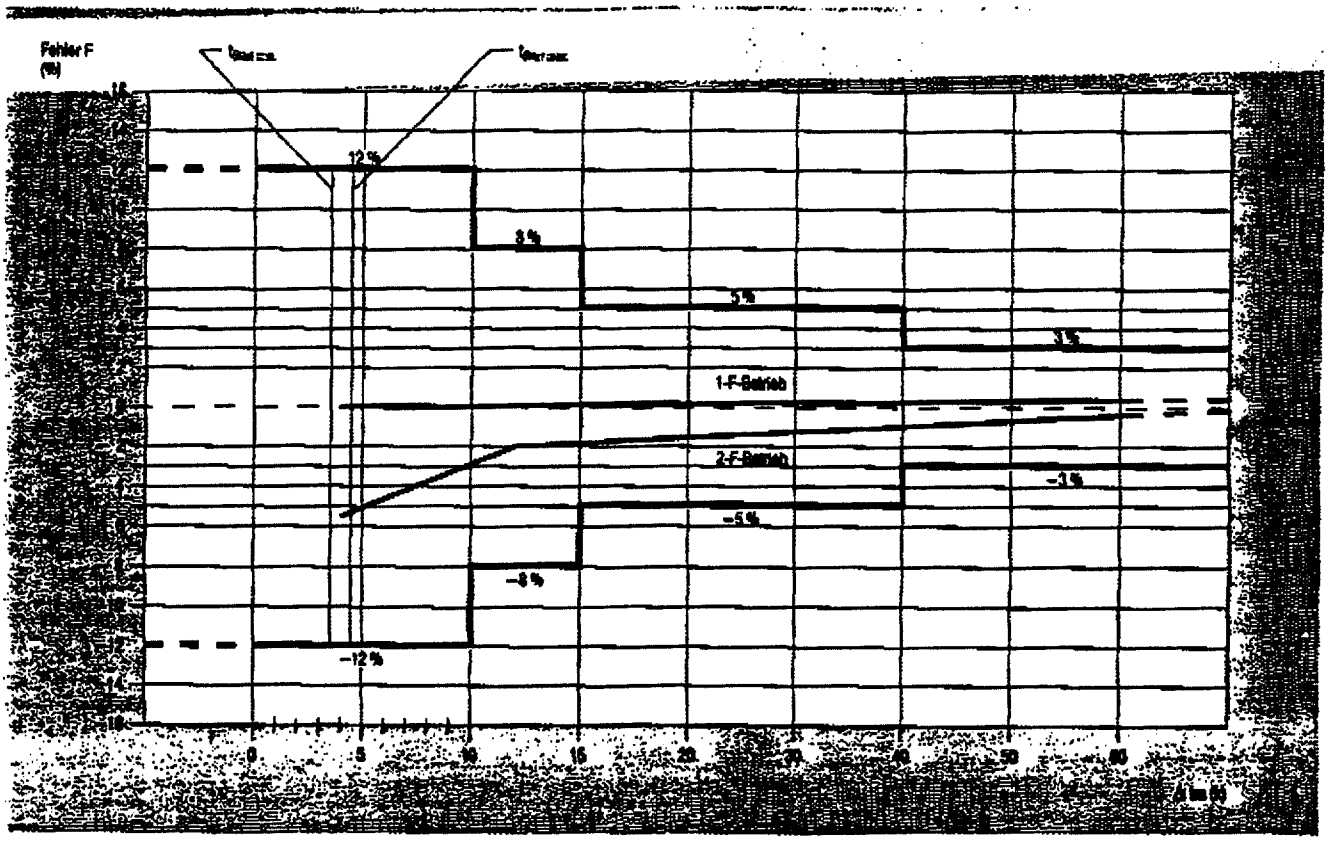


HKVE-2FLC, DIN-Fehlergrenzen Kompakt- und Fernfühlergerät

## Erfassungstoleranzen gemäß DIN 4713/14

±8% für 10 K ≤ $\Delta t_m$ < 15 K
±5% für 15 K ≤ $\Delta t_m$ < 40 K
±3% für 40 K ≤ $\Delta t_m$

mit $\Delta t_m = t_m - t_r$

(Vergleiche amtlich geeichte Wärmezähler)

In der Produktion werden in den Abgleichpunkten sehr viel kleinere Toleranzen eingehalten (Exemplarstreuung gering).

## Einsatzbereiche

| | |
|---|---|
| Max. Auslegungs-Vorlauftemperatur | 110°C (130°C)* |
| Min. Auslegungs-Vorlauftemperatur | 40°C (40°C)* |

An fast allen handelsüblichen Heizkörpern, sofern das Gerät im Temperaturmittelpunkt des Heizkörpers montiert werden kann.

Klassisches Anwendungsgebiet für HKVE-2FLC sind Niedertemperatur-Anlagen und solche, deren praktische Vorlauftemperatur bei z.B. −12°C unter 60°C bleibt (überdimensionierte Altanlagen).

* Klammerwerte gelten für Ausführung mit Fernfühler.

## Technische/physikalische Einsatzgrenzen

Nicht verwendungsfähig bei:

- Fußbodenheizungen
- Deckenstrahlungsheizungen
- klappengesteuerten Heizkörpern
- Warmlufterzeugern
- Heizsystemen, die mit niedrigeren Auslegungs-Vorlauftemperaturen als 40°C arbeiten.
- Heizsystemen, bei denen die Heizkörper mit Dampf betrieben werden.

Ansonsten ist der Einsatzbereich nur durch die Auslegungs-Vorlauftemperatur der Heizanlage begrenzt.

## Anwendungstechnische Grenzen

Der nach DIN 4713 Teil 3 geforderte und im HKVE-2FLC realisierte Manipulationsschutz bewirkt bei Wärmestau eine Umschaltung der Betriebsart in den 1-Fühler-Betrieb. Dieser kann ungewollt, z.B. durch Handtücher über, oder Gardinen vor dem Heizkörper, oder auch nur durch unglückliche Möblierung hervorgerufen werden. Je höher die Heizkörpertemperatur ist, um so leichter/schneller tritt ein solcher Wärmestau auf.

Im praktischen Einsatz, insbesondere in Wohnanlagen mit raumweise ohnehin höheren Temperaturen als 20 °C, wird daher ein Teil der Geräte fast ausschließlich im 1-Fühler-Betrieb arbeiten. Die meßtechnischen Vorteile eines 2-Fühler-Gerätes kommen dann nicht zur Geltung. Nicht zuletzt aufgrund der Meßrentabilität sollten in solchen Anlagen besser 1-Fühler-Geräte wie der ista HKVE-1FLC verwendet werden.

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SECTION 7

Capital Cost Estimate

Vol. 8

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# Bulgarian District Heating System Feasibility Study

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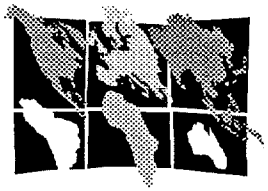

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# LIST OF EXHIBITS
# SECTION 7

# LIST OF EXHIBITS


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# 7.0 CAPITAL COST ESTIMATE

## 7.1 INTRODUCTION

This section describes the estimating approach and provides an order of magnitude cost estimate for 11 cases developed in Section 4.0 of this report. The cost estimate for all cases is developed in three different categories. These categories are: (1) cost for the rehabilitation of the existing equipment or the cost of the new one; (2) cost for the transmission and distribution systems; and (3) cost for I&C equipment. Exhibit 7-1 on page 7-10 provides comparison table for all analyzed cases according to the three estimating categories.

The equipment and material cost data are based on the vendor quotes that represent their budgetary (list) prices for the equipment. Accordingly, the provided cost data and estimates should be treated as an indication and should be used only as a project(s) budgetary data. The order of magnitude estimates are based on the conceptual project data and are usually +/-30% of the final project cost estimate.

GC II experience indicates, and was confirmed by the contacted vendors, the final equipment prices could be substantially lower than the budgetary prices. This particularly applies if the contracts are based on a volume purchase. Therefore, for the contract negotiation phase, the investor (owner) should have the project in a relatively advanced design stage, or even detailed equipment specifications and help from an experienced architect-engineer/consultant in contract negotiations.

### 7.1.1 GOALS AND OBJECTIVES

The goal for this section was to develop an order of magnitude estimate, based on conceptual design data. When available, project preliminary design data were also used. The developed cost data was used for: (1) input into the economic analysis; (2) project budgetary purposes; and (3) preparation of the final bankable document.

The cost data in the economic analysis will serve as a basis for the options least - cost analysis and selection of the best option for an owner review and approval.



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The preparation of the final bankable document should be the first step for the owner loan application effort that should immediately follow completion of this study.

### 7.1.2 Scope of Work and Limitations

The scope of the work included preparation of an order of magnitude cost estimate and corresponding cash-flow for: (1) district heating plants; and (2) distribution and transmission piping and substations of Sofia, Trajco Kostov, Liulin, and Republika plants district heating systems as identified below:

| | | |
|---|---|---|
| Sofia THPS | S1 | Rehabilitation of the existing system in accordance with B&W recommendations for equipment rehabilitation provided in Section 2.5 and proposed new equipment configuration presented in Section 4.6.1.1 of the report. |
| | S2 | Gas turbine/HRSG repowering option for retired steam boiler No. 4 per proposed new equipment configuration presented in Section 4.6.1.2 and B&W recommendation for equipment rehabilitation provided in Section 2.5 of the report. |
| | S3 | Gas turbine/HRSG/steam turbine combined cycle option for retired hot water boilers No. 3, per proposed new equipment configuration presented in Section 4.6.1.3 and B&W recommendation for the equipment rehabilitation provided in Section 2.5 and of the report. |
| Trajco Kostov THPS | K1 | Rehabilitation of the existing system in accordance with the B&W recommendations provided in Section 2.5 and proposed new equipment configuration presented in Section 4.6.2.1 of the report. |
| | K2 | Gas turbine/HRSG/steam turbine combined cycle option for retired hot water boilers No. 8 per proposed new equipment configuration presented in Section 4.6.2.2 and B&W recommendation for equipment rehabilitation provided in Section 2.5 and of the report. |
| Liulin TPS | L1 | Rehabilitation of the existing system in accordance with the B&W recommendations for equipment rehabilitation provided in Section 2.5 and proposed new equipment configuration presented in Section 4.6.4.1 of the report. |



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| | | |
|---|---|---|
| | L2 | Gas turbine/HRSG/steam turbine combined cycle option for retired hot water boilers No. 1 per proposed new equipment configuration presented in Section 4.6.4.2 and B&W recommendation for equipment rehabilitation provided in Section 2.5 and of the report. |
| Republika THPS | P1 | Rehabilitation of the existing system in accordance with the B&W recommendations provided in Section 2.5 and proposed new equipment configuration provided in Section 4.6.3.1 of the report. |
| | P3 | Fluidized bed boiler option, for retired steam boilers No. 1, and No. 2 and retired steam turbines No. 1 No. 2 and No. 3, per proposed new equipment configuration provided in Section 4.6.3.2 and B&W recommendation for equipment rehabilitation provided in Section 2.5 and of the report. |

Due to the similarity of Liulin and Zemliane systems, the Liulin cost data will be used for the Zemliane system.

The order of magnitude cost estimate includes direct cost component, indirect cost component, contingencies, and proposed cash flow. The order of magnitude cost estimate will include all cost elements, starting with the project design, equipment procurement, and project construction.

The cash-flow for plant rehabilitation is based on B&W recommendations for equipment rehabilitation. Repowering/combined cycle options cash-flows are developed assuming as soon as possible replacement cases. The transmission and distribution component cash-flow was developed in accordance with the piping replacement schedule jointly developed by Bulgarian and GC II experts.

### 7.1.3 ORGANIZATION OF THE SECTION

In the following subsections, a more detailed discussion of the methodology used in this study for cost development and results of order of magnitude cost estimate will be provided.

This section is divided into three (3) subsections including this introduction.

Subsection 7.2 describes methodology used by GC II team to gather required data, and prepare the order of magnitude estimate.

Subsection 7.3 presents the cost estimating results and briefly discuss the developed cost data.

## 7.2 ESTIMATE APPROACH

The cost evaluation effort was directed at developing a conceptual cost estimate for each case at each site. The general approach consisted of evaluating each



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case separately in order to define the modification scope at each of the district heating plants, and to quantify significant commodities and work activities. The bases for the order of magnitude estimate were

### 7.2.1 Direct Costs

A variety of approaches were utilized to develop the direct cost depending on the engineered system design at each District Heating System plant site.

Thermal/hot water boilers, turbine generator modifications, FBC, simple cycle and combined cycle plants were priced according to vendor budget prices. Budget prices exclude quantity discounts. Heating substation material and labor costs were inputs by the client. The major equipment and cost source (Vendor) are shown below:

| Item | Vendor |
|---|---|
| Thermal/Hot Water Boiler Modifications | Babcock & Wilcox |
| Fluidized Bed Boiler (FBC) | Foster Wheeler Energy International, Inc. |
| Combustion Turbines | |
| LM 6000 DLG | Steward & Stevenson Services, Inc. |
| GE 6FA | GE Industrial & Power System Sales |
| Steam Turbine Generator Modifications | Elliot Company |
| Steam Turbine Generator (New) | ABB Power Generation, Inc. |
| Condenser | Ecolaire |
| Heat Recovery Steam Generator | Deltak Corporation |
| SCADA System Costs | Westinghouse Corporation's Energy Systems |
| I&C equipment | Turn Andersen Co.<br>Honeywell, Inc. |
| Preinsullated Piping | Logstor Ror<br>ABB I.C. Moler |
| Substations | Alfa Laval |

Balance of Plant (B.O.P.) costs were derived from historical in-house data using as a basis, similar GC II projects. Demolition of existing turbine generators, boilers, switchgear setup costs were derived from historical in-house data and anticipated local labor productivity.

SCADA Systems costs for Sofia and Pernik Plants were budgetary quotes from Westinghouse Electric Corporation's Energy Systems. Kostov and Liulin Plants were factored from Sofia based on total length of pipe and quantity of substations per respective District Heating System plant.



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Heating distribution piping was based on replacement rates of heating supply pipelines for all plants. Sofia, Kostov, Liulin, and Pernik. Heating distribution piping costs were based on total length of pipe/DHS developed from piping lists showing length of pipe. All pipe/substation quantities were provided by Bulgarian heating districts and Bulgarian experts.

All conceptual capital cost estimates are in 4th quarter 1993 U.S. dollars and Bulgarian Leva and are included in Appendix.

### 7.2.2 INDIRECT COSTS

The following are indirect cost elements that were included in the development of the order of magnitude cost estimate:

- **Construction hours split:** The construction labor hours were distributed as 20% foreign and 80% Bulgarian labor productivity.
- **Hourly Rates:** Elliot Company stated that for the turbine rehabilitation work a Bulgarian mechanic receives $3.50/hour which includes food and transportation. GC II multiplied this hourly rate by 1.5 to include additional overhead costs which yielded a revised Bulgarian wage rate of $5.25/hour (U.S. $ equivalent).

  Foreign construction labor is based on the U.S. rate of $50/hour and local Bulgarian rate of $5.25/hour.
- **Plant Design Engineering:** An allowance of 7.5% of Total Direct Cost was added to cover normal engineering, drafting, scheduling, cost engineering, and expenses.
- **Owner's Cost:** An allowance of 3% of total direct cost was added to cover normal owner's interface engineering.
- **Freight:** Major equipment including freight (FAS to U.S. east coast port). An allowance of 15% for ocean freight, and 2% for inland freight was included.

### 7.2.3 CONTINGENCY

A contingency was applied to direct and indirect costs in proportion to the level of information available. An allowance of 15% was applied to provide the unforeseen elements of cost within the current defined project scope. This contingency provides for trivial changes, normal claims, omissions, profit levels, weather, and so forth. It is expected that by the end of the project the entire contingency will be spent on either direct or indirect accounts.

### 7.2.4 CASH FLOW

The cash flow is shown on each District Heating System plant summary level tables. This cash flow is a compilation of individual cash flows and is an estimate of expenditures on an annual basis.

## 7.3 PRESENTATION AND DISCUSSION OF RESULTS

The cost estimating results for Sofia and Pernik District Heating Systems are presented in a series of tables attached as an Appendix to this section. The District Heating System capital costs for all cases/sites follow the designation developed in Section 4.3 of the report and are summarized below.

| | |
|---|---|
| S1 | Sofia THPS |
| S2 | Sofia THPS |
| S3 | Sofia THPS |
| K1 | Trajco Kostov THPS |
| K2 | Trajco Kostov THPS |
| L1 | Liulin HPS |
| L2 | Liulin HPS |
| P1 | Republika THPS |
| P3 | Republika THPS |

Each case/site includes capital costs (in U.S. $ and Bulgarian Leva), indirect costs, and annual cash flow. All costs are presented in current U.S. dollars with the exchange rates US$/Bulgarian Leva @ 32 Leva/U.S.$.

Derived cost estimate results are presented in a group of tables, with each group containing higher level of details. The following are three group of tables: (1) comparison table: (2) summary level tables; and (3) detailed estimate tables.

### 7.3.1 COMPARISON TABLE

Comparison table is presented in Exhibit 7-1. This table presents a top level estimate data for three categories of improvements: (1) Plant Modifications; (2) Transmission and Distribution/Substation System upgrade; and (3) I&C System upgrade. Categories were developed to minimize interfaces among them and allow easier economic sensitivity analysis, i.e., where the future investment will result in an early return and have the largest impact.

The table is intended to provide quick insight on an anticipated level of investment for each site and each category. The information however does not contain any intelligence and the only purpose is to be used as a quick comparison between different options and different categories.

From the Exhibit 7-1, it is obvious that the least capital intensive cases are those involving only necessary improvements, followed by repowering cases. The most capital intensive are cases that include T/G/combined cycle option(s). Exhibit 7-1 also shows that there is no difference between different cases in the same District Heating Area for "Transmission and Distribution/Substation Systems upgrade" or "I&C System upgrade" cost categories.

### 7.3.2 SUMMARY LEVEL TABLES

Summary level tables, Appendix 7-1 provide more project cost insights then the comparison table. The purpose of these tables is to allow closer cost comparison between different options and equipment configurations. It also enhance control of obtained results and provide more data for analysis.



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Each summary level table is divided into 11 categories. These categories are general definitions for all sites. The following is the brief description of categories used in this estimate:

| | | |
|---|---|---|
| 1. | SITE IMPROVEMENTS | Where applicable grading, excavation, backfill, roads, site drainage, and fencing are included. |
| 1b. | DEMOLITION | Demolish existing boilers, turbine generators, pumps, and structures where applicable. |
| 2. | FOUNDATIONS | Furnish new foundations for boilers, turbine generators, pumps, and structures were applicable. |
| 3. | STRUCTURES/BUILDINGS | Furnish new buildings for boilers, turbine generators, controls, machine shop, and administration services where applicable. |
| 4a. | GAS TURBINE GENERATOR | Furnish total plant scope including site improvements, foundations, structures, combustion turbine, heat recovery steam generator, balance of plant miscellaneous mechanical equipment, piping, electrical equipment, and electrical bulk materials. |
| 4b. | STEAM TURBINE GENERATOR | Performance modifications to existing turbine generators, including where necessary new turbine generators with foundation, condenser, piping, electrical, and instrumentation & controls. |
| 5a. | STANDARD BOILER | Performance and safety modifications to existing thermal and hot water boilers. |
| 5b. | FLUIDIZED BED BOILERS | Install new Fluidized Bed Combustion plant with FBC boilers, civil/structural, mechanical, piping, electrical, and instrumentation & controls accounts. Also included erection of existing boiler (currently in storage) for Republika (Pernik 6). |
| 5c. | HEAT RECOVERY STEAM GENERATOR | Furnish and install Heat Recovery Steam Generator (HRSG) for each Combined Cycle Plant. |
| 6. | ENVIRONMENTAL CONTROLS | Included with FBC unit. |
| 7a. | MATERIAL HANDLING AND FUEL SUPPLY | Included with FBC unit. |
| 7b. | FEEDWATER, CONDENSATE, ETC. | Included with respective plant. |



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| | | |
|---|---|---|
| 7c. | OTHER MECHANICAL EQUIPMENT | Includes all Balance of Plant (B.O.P.) such as pumps, tanks, and heat exchangers. |
| 8. | ELECTRICAL AND I&C | Includes all electrical equipment, cable, conduit, and other miscellaneous bulk materials. |
| 9. | POWER DISTRIBUTION EQUIPMENT | Includes motors, variable speed drives, transformers, and wire and conduit. |
| 10b. | HEATING DISTRIBUTION PIPING | Includes heating distribution piping laid down in duct, overhead, collector with insulation. |
| 10c. | HEATING DISTRIBUTION I&C | Includes Supervisory Control and Data Acquisition (SCADA) equipment and fiber optic leasing costs. |
| 11. | HEATING SUBSTATIONS I&C | Includes controller, resistive temperature detection, substation wiring, control valves, and Btu meters. |

All listed categories include foreign and local equipment and labor costs.

In Subsection 7.3.1 it was concluded that only differences between various cases in the same District Heating Area comes from the equipment related costs. Below is the brief summary of the cost per installed kW of existing and new equipment for different sites and different cases:

| CASE | 1,000 U.S. $ | NEW MW | NEW $/kW | TOTAL MW | TOTAL $/kW |
|---|---|---|---|---|---|
| S1 | 46,035.50 | - | - | 111.00 | 414.73 |
| S2 | 97,068.40 | 74.40 | 1,304.68 | 185.40 | 523.56 |
| S3 | 109,547.70 | 107.55 | 1,018.57 | 218.40 | 501.59 |
| SA | 91,920.20 | 74.40 | 1,235.49 | 185.40 | 495.79 |
| K1 | 57,574.34 | - | - | 188.00 | 306.25 |
| K2 | 122,966.90 | 107.55 | 1,143.35 | 299.55 | 410.51 |
| L1 | 17,876.00 | - | - | - | - |
| L2 | 82,658.90 | 107.55 | 768.56 | 107.55 | 768.56 |
| P1 | 211,106.90 | - | - | 105.00 | 2,010.54 |
| P3 | 212,760.40 | - | - | 115.00 | 1,850.09 |

The presented costs per kW represent installed capacities and include 7.5% engineering cost, 3% owner's cost and 15% contingencies.

Costs represented as a $/kW of installed capacity are quick estimate values based on a similar installation. This method can yield significant differences depending on total plant scope, plant location (US versus foreign locations), labor source, labor cost, and productivity. Since these plants are located in Bulgaria where; (1) no construction track record exists; and (2) rapid change of labor cost is experienced in last few years, the provided information should be used as an indication of possible project cost or as a guideline with a substantial margin.



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It should be noted also that simple $/kW ratio could be misleading if this project is compared with other green field projects. The principal reason for that is because one of the major goals in this study was to optimize system overall efficiency and come with the least - cost option rather than develop least - capital intensive configuration.

### 7.3.3 DETAILED ESTIMATE TABLES

Detailed estimate tables provide detailed information on the GC II developed order of magnitude cost estimate. The tables account for each major piece of equipment, labor requirements related to the construction activities, and B.O.P. equipment, and transportation and custom issues. The information are intended for cost Bulgarian estimators and Financial Institutions that will scrutinize and review the cost estimating data.

Appendix 7-2 contains Detailed Estimate Tables for all sites and all engineering cases developed in Section 4 of the report.

# Exhibit 7-1

## Summary Comparisons for all Sites
## Bulgaria District Heating Plants

| SITE | PLANT DESCRIPTION | Total Local Expenditures Leva (x1000) | Total Foreign Expenditures US $ (x1000) | Total Expenditures US $ (x1000) |
|---|---|---|---|---|
| S1 | Rehabilitation of Existing Sofia Systems | | | |
| | Plant Modifications | 56,604.8 | 44,266.6 | 46,035.5 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | Heat Replacement Equip. (Elec. Heater) | – | – | – |
| | TOTAL | 723,241.6 | 136,462.5 | 159,063.8 |
| S2 | Combustion Turbine / HRSG Addition at Sofia | | | |
| | Plant Modifications | 122,785.2 | 93,231.4 | 97,068.4 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | TOTAL | 789,421.9 | 185,427.3 | 210,096.8 |
| S3 | Combustion Turbine Combined Cycle Addition at Sofia | | | |
| | Plant Modifications | 146,174.0 | 104,979.8 | 109,547.7 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | TOTAL | 812,810.8 | 197,175.7 | 222,576.1 |
| SA | Combustion Turbine Combined Cycle Addition at Sofia | | | |
| | Plant Modifications | 122,436.0 | 88,094.1 | 91,920.2 |
| | Heating Distribution Equip. & Piping | 472,483.6 | 50,943.2 | 65,708.3 |
| | Heating Distribution & Substation I & C | 194,153.2 | 41,252.8 | 47,320.0 |
| | TOTAL | 789,072.7 | 180,290.0 | 204,948.6 |
| K1 | Rehabilitation of Existing Kostov Systems | | | |
| | Plant Modifications | 47,145.6 | 56,101.0 | 57,574.3 |
| | Heating Distribution Equip. & Piping | 750,024.7 | 79,012.2 | 102,450.5 |
| | Heating Distribution & Substation I & C | 256,282.4 | 54,453.6 | 62,462.5 |
| | TOTAL | 1,053,452.7 | 189,566.9 | 222,487.3 |
| K2 | Combustion Turbine Combined Cycle Addition at Kostov | | | |
| | Plant Modifications | 136,737.2 | 118,693.9 | 122,966.9 |
| | Heating Distribution Equip. & Piping | 750,024.7 | 79,012.2 | 102,450.5 |
| | Heating Distribution & Substation I & C | 256,282.4 | 54,453.6 | 62,462.5 |
| | TOTAL | 1,143,044.3 | 252,159.7 | 287,879.9 |
| L1 | Rehabilitation of Existing Lulin Systems | | | |
| | Plant Modifications | 18,366.7 | 17,364.5 | 17,876.0 |
| | Heating Distribution Equip. & Piping | 233,240.0 | 25,282.2 | 32,571.0 |
| | Heating Distribution & Substation I & C | 139,790.5 | 29,702.0 | 34,070.4 |
| | TOTAL | 389,397.1 | 72,348.8 | 84,517.4 |
| L2 | Combustion Turbine Combined Cycle Addition at Lulin | | | |
| | Plant Modifications | 105,275.1 | 79,369.1 | 82,658.9 |
| | Heating Distribution Equip. & Piping | 233,240.0 | 25,282.2 | 32,571.0 |
| | Heating Distribution & Substation I & C | 139,790.5 | 29,702.0 | 34,070.4 |
| | TOTAL | 478,305.5 | 134,353.3 | 149,300.3 |
| P1 | Rehabilitation of Existing Pernik (Republika) Systems | | | |
| | Plant Modifications | 218,890.8 | 204,266.5 | 211,106.9 |
| | Heating Distribution Equip. & Piping | 149,770.6 | 16,997.2 | 21,677.5 |
| | Heating Distribution & Substation I & C | 58,848.7 | 14,471.1 | 16,310.1 |
| | TOTAL | 427,510.1 | 235,734.9 | 249,094.5 |
| P3 | Fluidized Bed Boiler Addition at Pernik | | | |
| | Plant Modifications | 281,764.2 | 203,955.3 | 212,760.4 |
| | Heating Distribution Equip. & Piping | 149,770.6 | 16,997.2 | 21,677.5 |
| | Heating Distribution & Substation I & C | 58,848.7 | 14,471.1 | 16,310.1 |
| | TOTAL | 490,383.5 | 235,423.6 | 250,748.1 |

| SITE | | Total Local Expenditures Leva (x1000) | Total Foreign Expenditures US $ (x1000) | Total Expenditures US $ (x1000) |
|---|---|---|---|---|
| S0 | | | | |
| | | 21,518.1 | 16,767.2 | 17,439.6 |
| | | 4,724.8 | 509.4 | 657.1 |
| | | 3,883.1 | 825.1 | 946.4 |
| | | 286,759.9 | 0.0 | 8,961.2 |
| | | 316,885.9 | 18,101.7 | 28,004.4 |



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**SUMMARY LEVEL TABLES**

**SOFIA CASE S1, S2, S3, SA, SO**

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | S1 SUMMARY All Units |
| Technology: | Rehabilitation of Existing Sofia Systems |
| Demand: | |

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | 5,174.7 | 2,838.6 | | 8,013.3 | 3,931.2 | 192.0 | | 4,123.2 |
| 5a | Standard Boilers | | 36,440.6 | | 36,440.6 | 28,176.1 | 2,464.9 | | 30,641.0 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 370,968.3 | | 370,968.3 | 38,617.6 | | | 38,617.6 |
| 10c | Heating Distribution I&C | | 23,115.8 | | 23,115.8 | 6,390.0 | 282.3 | | 6,672.4 |
| 11 | Heating Substation I&C | | 129,360.0 | | 129,360.0 | 25,725.0 | | | 25,725.0 |
| | TOTAL DIRECT COST | 5,174.7 | 562,814.2 | | 567,988.9 | $104,229.9 | $2,939.3 | | $107,169.2 |

| | | | |
|---|---|---|---|
| | Plant Design Engineering | 42,599.2 | Plant Design Engineering | 8,037.7 |
| | Construction Supervision | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| Exchange Lev/US$ | Owner's Costs | 18,317.6 | Owner's Costs | 3,456.2 |
| | Taxes and Permits | | Taxes and Permits | |
| | Other _____ | | Other _____ | |
| | SUBTOTAL | 628,905.7 | SUBTOTAL | 118,663.1 |
| | ESCALATION | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 94,335.9 | CONTINGENCY | 17,799.5 |
| | TOTAL COST (Bulgaria part) | 723,241.6 | TOTAL COST (Foreign Exch. part) | 136,462.5 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 35,891.3 | 1,121.6 | 16,125.7 |
| 1995 | 87,955.9 | 2,748.6 | 12,932.6 |
| 1996 | 108,211.9 | 3,381.6 | 15,807.4 |
| 1997 | 110,196.3 | 3,443.6 | 16,026.5 |
| 1998 | 136,192.0 | 4,256.0 | 33,524.9 |
| 1999 | 77,169.7 | 2,411.6 | 12,465.5 |
| 2000 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2001 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2002 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2003 | 54,937.2 | 1,716.8 | 17,430.0 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 723,241.6 | $22,601.3 | $136,462.5 |

| TOTAL IN US$ (US$,x1000) |
|---|
| $159,063.8 |

**Notes:**

1.



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| **Variant / Plant:** | S2 SUMMARY All Plants |
| **Technology:** | Combustion Turbine / HRSG Addition at Sofia |
| **Demand:** | |

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 3,520.0 | | 3,520.0 | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | 27,320.8 | 27,417.7 | | 54,738.5 | 41,835.0 | 1,854.6 | | 43,689.6 |
| 4b | Steam Turbine Generator | 5,174.7 | 2,838.6 | | 8,013.3 | 3,931.2 | 192.0 | | 4,123.2 |
| 5a | Standard Boilers | | 30,156.0 | | 30,156.0 | 23,365.5 | 2,039.8 | | 25,405.3 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 370,968.3 | | 370,968.3 | 38,617.6 | | | 38,617.6 |
| 10c | Heating Distribution I&C | | 23,115.8 | | 23,115.8 | 6,390.0 | 282.3 | | 6,672.4 |
| 11 | Heating Substation I&C | | 129,360.0 | | 129,360.0 | 25,725.0 | | | 25,725.0 |
| | TOTAL DIRECT COST | 32,495.6 | 587,467.3 | | 619,962.8 | $141,254.3 | $4,368.8 | | $145,623.1 |

| | | | |
|---|---|---|---|
| | Plant Design Engineering | 46,497.2 | Plant Design Engineering | 10,921.7 |
| | Construction Supervision | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| Exchange Lev/US$ | Owner's Costs | 19,993.8 | Owner's Costs | 4,696.3 |
| | Taxes and Permits | | Taxes and Permits | |
| | Other | | Other | |
| | SUBTOTAL | 686,453.8 | SUBTOTAL | 161,241.2 |
| | ESCALATION | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 102,968.1 | CONTINGENCY | 24,186.2 |
| | TOTAL COST (Bulgaria part) | 789,421.9 | TOTAL COST (Foreign Exch. part) | 185,427.3 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 33,840.0 | 1,057.5 | 19,402.9 |
| 1995 | 117,629.0 | 3,675.9 | 46,311.5 |
| 1996 | 152,721.5 | 4,772.5 | 32,496.9 |
| 1997 | 110,196.3 | 3,443.6 | 16,026.5 |
| 1998 | 131,378.6 | 4,105.6 | 29,980.6 |
| 1999 | 77,169.7 | 2,411.6 | 12,465.5 |
| 2000 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2001 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2002 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2003 | 53,799.5 | 1,681.2 | 16,593.4 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 789,421.9 | $24,669.4 | $185,427.3 |

| TOTAL IN US$ (US$,x1000) |
|---|
| $210,096.8 |

**Notes:**

1.



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

**Variant / Plant:** S3 SUMMARY All Plants
**Technology:** Combustion Turbine Combined Cycle Addition at Sofia
**Demand:**

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 373.1 | | 373.1 | | | | |
| 2 | Foundations | 41,971.2 | 6,917.3 | | 48,888.5 | 1,311.6 | 467.9 | | 1,779.5 |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | 7,199.6 | | 7,199.6 | 23,740.8 | 487.0 | | 24,227.8 |
| 4b | Steam Turbine Generator | 5,174.7 | 5,753.9 | | 10,928.7 | 10,717.2 | 389.2 | | 11,106.4 |
| 5a | Standard Boilers | | 35,007.8 | | 35,007.8 | 27,205.6 | 2,367.9 | | 29,573.5 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | 2,675.9 | | 2,675.9 | 5,294.3 | 181.0 | | 5,475.3 |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | 5,719.2 | | 5,719.2 | 4,690.3 | 386.9 | | 5,077.2 |
| 8 | Electrical and I&C | | 4,003.3 | | 4,003.3 | 4,934.2 | 270.8 | | 5,205.0 |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 370,968.3 | | 370,968.3 | 38,617.6 | | | 38,617.6 |
| 10c | Heating Distribution I&C | | 23,115.8 | | 23,115.8 | 6,390.0 | 282.3 | | 6,672.4 |
| 11 | Heating Substation I&C | | 129,360.0 | | 129,360.0 | 25,725.0 | | | 25,725.0 |
| | TOTAL DIRECT COST | 47,145.9 | 591,185.0 | | 638,331.0 | $150,016.6 | $4,833.0 | | $154,849.6 |

| | | | | | |
|---|---|---|---|---|---|
| | | Plant Design Engineering | 47,874.8 | Plant Design Engineering | 11,613.7 |
| | | Construction Supervision | | Construction Supervision | |
| 32 | = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| | Exchange Lev/US$ | Owner's Costs | 20,586.2 | Owner's Costs | 4,993.9 |
| | | Taxes and Permits | | Taxes and Permits | |
| | | Other | | Other | |
| | | SUBTOTAL | 706,792.0 | SUBTOTAL | 171,457.2 |
| | | ESCALATION | w/economics | ESCALATION | w/economics |
| | | CONTINGENCY | 106,018.8 | CONTINGENCY | 25,718.6 |
| | | **TOTAL COST (Bulgaria part)** | 812,810.8 | **TOTAL COST (Foreign Exch. part)** | 197,175.7 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 35,893.8 | 1,121.7 | 16,121.2 | |
| 1995 | 87,955.9 | 2,748.6 | 19,139.8 | |
| 1996 | 121,920.9 | 3,810.0 | 28,221.9 | |
| 1997 | 142,184.0 | 4,443.3 | 43,959.1 | |
| 1998 | 181,787.8 | 5,680.9 | 48,961.0 | |
| 1999 | 77,169.7 | 2,411.6 | 12,465.5 | |
| 2000 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2001 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2002 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2003 | 53,211.2 | 1,662.9 | 16,157.2 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ |
| TOTAL COST | 812,810.8 | $25,400.3 | $197,175.7 | (US$,x1000) |
| | | | | $222,576.1 |

**Notes:**

1.



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

**Variant / Plant:** SA SUMMARY All Plants
**Technology:** Combustion Turbine Combined Cycle Addition at Sofia
**Demand:**

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 373.1 | | 373.1 | | | | |
| 2 | Foundations | 41,971.2 | 6,917.3 | | 48,888.5 | 1,311.6 | 467.9 | | 1,779.5 |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | 7,199.6 | | 7,199.6 | 23,740.8 | 487.0 | | 24,227.8 |
| 4b | Steam Turbine Generator | 2,822.8 | 4,334.6 | | 7,157.5 | 9,734.4 | 293.2 | | 10,027.6 |
| 5a | Standard Boilers | | 20,136.7 | | 20,136.7 | 16,029.3 | 1,362.0 | | 17,391.3 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | 2,675.9 | | 2,675.9 | 5,294.3 | 181.0 | | 5,475.3 |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | 5,719.2 | | 5,719.2 | 4,690.3 | 386.9 | | 5,077.2 |
| 8 | Electrical and I&C | | 4,003.3 | | 4,003.3 | 4,934.2 | 270.8 | | 5,205.0 |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 370,968.3 | | 370,968.3 | 38,617.6 | | | 38,617.6 |
| 10c | Heating Distribution I&C | | 23,115.8 | | 23,115.8 | 6,390.0 | 282.3 | | 6,672.4 |
| 11 | Heating Substation I&C | | 129,360.0 | | 129,360.0 | 25,725.0 | | | 25,725.0 |
| | TOTAL DIRECT COST | 44,794.0 | 574,894.6 | | 619,688.6 | $137,857.5 | $3,731.1 | | $141,588.6 |

| | | | | |
|---|---|---|---|---|
| | Plant Design Engineering | 46,476.6 | Plant Design Engineering | 10,619.1 |
| | Construction Supervision | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| Exchange Lev/US$ | Owner's Costs | 19,985.0 | Owner's Costs | 4,566.2 |
| | Taxes and Permits | | Taxes and Permits | |
| | Other | | Other | |
| | SUBTOTAL | 686,150.2 | SUBTOTAL | 156,773.9 |
| | ESCALATION | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 102,922.5 | CONTINGENCY | 23,516.1 |
| | **TOTAL COST (Bulgaria part)** | 789,072.7 | **TOTAL COST (Foreign Exch. part)** | 180,290.0 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | TOTAL IN US$ (US$,x1000) |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 27,999.4 | 875.0 | 9,454.7 | |
| 1995 | 87,955.9 | 2,748.6 | 19,139.8 | |
| 1996 | 121,920.9 | 3,810.0 | 28,221.9 | |
| 1997 | 142,184.0 | 4,443.3 | 43,959.1 | |
| 1998 | 172,181.3 | 5,380.7 | 42,611.2 | |
| 1999 | 77,169.7 | 2,411.6 | 12,465.5 | |
| 2000 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2001 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2002 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2003 | 46,974.2 | 1,467.9 | 12,287.8 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | |
| TOTAL COST | 789,072.7 | $24,658.5 | $180,290.0 | $204,948.6 |

**Notes:**

1.

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

**Variant / Plant:** S0 SUMMARY All Plants
**Technology:** Rehabilitation of Existing Sofia Systems
**Demand:**

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | 5,174.7 | 2,838.6 | | 8,013.3 | 3,931.2 | 192.0 | | 4,123.2 |
| 5a | Standard Boilers | | 8,885.7 | | 8,885.7 | 8,443.7 | 601.0 | | 9,044.7 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | 166,154.6 | 59,048.8 | | 225,203.3 | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 0.9 | | 0.9 | 13.9 | | | 13.9 |
| 10b | Heating Distribution Piping | | 3,709.7 | | 3,709.7 | 386.2 | | | 386.2 |
| 10c | Heating Distribution I&C | | 462.3 | | 462.3 | 127.8 | 5.6 | | 133.4 |
| 11 | Heating Substation I&C | | 2,587.2 | | 2,587.2 | 514.5 | | | 514.5 |
| | TOTAL DIRECT COST | 171,329.3 | 77,533.1 | | 248,862.4 | $13,417.3 | $798.7 | | $14,215.9 |

| | | | | | |
|---|---|---|---|---|---|
| | | Plant Design Engineering | 18,664.7 | Plant Design Engineering | 1,066.2 |
| | | Construction Supervision | | Construction Supervision | |
| 32 | = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| | Exchange Lev/US$ | Owner's Costs | 8,025.8 | Owner's Costs | 458.5 |
| | | Taxes and Permits | | Taxes and Permits | |
| | | Other | | Other | |
| | | SUBTOTAL | 275,552.9 | SUBTOTAL | 15,740.6 |
| | | ESCALATION | w/economics | ESCALATION | w/economics |
| | | CONTINGENCY | 41,332.9 | CONTINGENCY | 2,361.1 |
| | | **TOTAL COST (Bulgaria part)** | 316,885.9 | **TOTAL COST (Foreign Exch. part)** | 18,101.7 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 305,909.2 | 9,559.7 | 14,689.0 | |
| 1995 | | | | |
| 1996 | | | | |
| 1997 | | | | |
| 1998 | 3,397.8 | 106.2 | 1,706.3 | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | 7,578.9 | 236.8 | 1,706.3 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 316,885.9 | $9,902.7 | $18,101.7 | $28,004.4 |

**Notes:**

1.



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**SUMMARY LEVEL TABLES**

**KOSTOV CASE K1, K2**

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

**Variant / Plant:** K1 SUMMARY All Units
**Technology:** Rehabilitation of Existing Kostov Systems
**Demand:**

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 7,096.8 | | 7,096.8 | 9,937.1 | 627.0 | | 10,564.1 |
| 5a | Standard Boilers | | 29,928.4 | | 29,928.4 | 31,469.8 | 2,024.3 | | 33,494.1 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 145.6 | | 145.6 | 2,223.9 | | | 2,223.9 |
| 10b | Heating Distribution Piping | | 588,877.1 | | 588,877.1 | 59,827.3 | | | 59,827.3 |
| 10c | Heating Distribution I&C | | 30,513.0 | | 30,513.0 | 8,434.8 | 372.7 | | 8,807.5 |
| 11 | Heating Substation I&C | | 170,755.2 | | 170,755.2 | 33,957.0 | | | 33,957.0 |
| | TOTAL DIRECT COST | | 827,316.1 | | 827,316.1 | $145,850.0 | $3,024.0 | | $148,874.0 |

| | | | | | |
|---|---|---|---|---|---|
| | | Plant Design Engineering | 62,048.7 | Plant Design Engineering | 11,165.6 |
| | | Construction Supervision | | Construction Supervision | |
| 32 | = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| | Exchange Lev/US$ | Owner's Costs | 26,680.9 | Owner's Costs | 4,801.2 |
| | | Taxes and Permits | | Taxes and Permits | |
| | | Other | | Other | |
| | | SUBTOTAL | 916,045.8 | SUBTOTAL | 164,840.8 |
| | | ESCALATION | w/economics | ESCALATION | w/economics |
| | | CONTINGENCY | 137,406.9 | CONTINGENCY | 24,726.1 |
| | | TOTAL COST (Bulgaria part) | 1,053,452.7 | TOTAL COST (Foreign Exch. part) | 189,566.9 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 42,290.2 | 1,321.6 | 13,152.5 | |
| 1995 | 152,171.6 | 4,755.4 | 20,587.5 | |
| 1996 | 187,961.1 | 5,873.8 | 25,267.5 | |
| 1997 | 190,061.1 | 5,939.4 | 25,488.8 | |
| 1998 | 217,906.4 | 6,809.6 | 57,662.2 | |
| 1999 | 91,582.9 | 2,862.0 | 15,351.5 | |
| 2000 | 39,301.3 | 1,228.2 | 4,243.0 | |
| 2001 | 39,301.3 | 1,228.2 | 4,243.0 | |
| 2002 | 39,301.3 | 1,228.2 | 4,243.0 | |
| 2003 | 51,316.3 | 1,603.6 | 15,965.2 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | 2,259.1 | 70.6 | 3,362.9 | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 1,053,452.7 | $32,920.4 | $189,566.9 | $222,487.3 |

**Notes:**

1.



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| **Variant / Plant:** | **K2 SUMMARY All Plants** |
| **Technology:** | **Combustion Turbine Combined Cycle Addition at Kostov** |
| **Demand:** | |

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 373.1 | | 373.1 | | | | |
| 2 | Foundations | 41,971.2 | 6,917.3 | | 48,888.5 | 1,311.6 | 467.9 | | 1,779.5 |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | 7,199.6 | | 7,199.6 | 23,740.8 | 487.0 | | 24,227.8 |
| 4b | Steam Turbine Generator | | 10,012.1 | | 10,012.1 | 16,723.1 | 824.2 | | 17,547.3 |
| 5a | Standard Boilers | | 28,013.1 | | 28,013.1 | 29,954.6 | 1,894.8 | | 31,849.4 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | 2,675.9 | | 2,675.9 | 5,294.3 | 181.0 | | 5,475.3 |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | 5,719.2 | | 5,719.2 | 4,690.3 | 386.9 | | 5,077.2 |
| 8 | Electrical and I&C | | 4,003.3 | | 4,003.3 | 4,934.2 | 270.8 | | 5,205.0 |
| 9 | Power Distribution & Transmissio | | 500.2 | | 500.2 | 2,053.4 | | | 2,053.4 |
| 10a | Heating Distribution Equipment | | 145.6 | | 145.6 | 2,223.9 | | | 2,223.9 |
| 10b | Heating Distribution Piping | | 588,877.1 | | 588,877.1 | 59,827.3 | | | 59,827.3 |
| 10c | Heating Distribution I&C | | 30,513.0 | | 30,513.0 | 8,434.8 | 372.7 | | 8,807.5 |
| 11 | Heating Substation I&C | | 170,755.2 | | 170,755.2 | 33,957.0 | | | 33,957.0 |
| | TOTAL DIRECT COST | 41,971.2 | 855,704.6 | | 897,675.8 | $193,145.3 | $4,885.2 | | $198,030.5 |
| | | Plant Design Engineering | | | 67,325.7 | Plant Design Engineering | | | 14,852.3 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | included | Freight/Shipping | | | included |
| | Exchange Lev/US$ | Owner's Costs | | | 28,950.0 | Owner's Costs | | | 6,386.5 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 993,951.6 | SUBTOTAL | | | 219,269.3 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | | 149,092.7 | CONTINGENCY | | | 32,890.4 |
| | | TOTAL COST (Bulgaria part) | | | 1,143,044.3 | TOTAL COST (Foreign Exch. part) | | | 252,159.7 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 42,342.9 | 1,323.2 | 13,281.6 | |
| 1995 | 152,171.6 | 4,755.4 | 27,056.2 | |
| 1996 | 201,765.6 | 6,305.2 | 38,205.0 | |
| 1997 | 222,271.8 | 6,946.0 | 54,598.0 | |
| 1998 | 263,873.6 | 8,246.1 | 73,683.8 | |
| 1999 | 91,582.9 | 2,862.0 | 15,351.5 | |
| 2000 | 39,301.3 | 1,228.2 | 4,243.0 | |
| 2001 | 39,301.3 | 1,228.2 | 4,243.0 | |
| 2002 | 39,301.3 | 1,228.2 | 4,243.0 | |
| 2003 | 48,872.8 | 1,527.3 | 13,891.9 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | 2,259.1 | 70.6 | 3,362.9 | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 1,143,044.3 | $35,720.1 | $252,159.7 | $287,879.9 |

**Notes:**

1.



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# SUMMARY LEVEL TABLES
# LUILIN CASE L1, L2

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| **Variant / Plant:** | L1 SUMMARY All Units |
| **Technology:** | Rehabilitation of Existing Lulin Systems |
| **Demand:** | |

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 12,853.4 | | 12,853.4 | 12,767.6 | 869.4 | | 13,637.0 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 61.8 | | 61.8 | 945.2 | | | 945.2 |
| 10b | Heating Distribution Piping | | 183,110.4 | | 183,110.4 | 18,909.9 | | | 18,909.9 |
| 10c | Heating Distribution I&C | | 16,643.5 | | 16,643.5 | 4,600.8 | 203.3 | | 4,804.1 |
| 11 | Heating Substation I&C | | 93,139.2 | | 93,139.2 | 18,522.0 | | | 18,522.0 |
| | TOTAL DIRECT COST | | 305,808.2 | | 305,808.2 | $55,745.5 | $1,072.7 | | $56,818.2 |

| | | | | | |
|---|---|---|---|---|---|
| | | Plant Design Engineering | 22,935.6 | Plant Design Engineering | 4,261.4 |
| | | Construction Supervision | | Construction Supervision | |
| 32 | = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| | Exchange Lev/US$ | Owner's Costs | 9,862.3 | Owner's Costs | 1,832.4 |
| | | Taxes and Permits | | Taxes and Permits | |
| | | Other | | Other | |
| | | SUBTOTAL | 338,606.2 | SUBTOTAL | 62,912.0 |
| | | ESCALATION | w/economics | ESCALATION | w/economics |
| | | CONTINGENCY | 50,790.9 | CONTINGENCY | 9,436.8 |
| | | TOTAL COST (Bulgaria part) | 389,397.1 | TOTAL COST (Foreign Exch. part) | 72,348.8 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 10,796.9 | 337.4 | 1,369.0 | |
| 1995 | 47,858.1 | 1,495.6 | 7,640.8 | |
| 1996 | 58,581.9 | 1,830.7 | 9,292.8 | |
| 1997 | 59,724.8 | 1,866.4 | 9,416.7 | |
| 1998 | 67,548.5 | 2,110.9 | 18,859.6 | |
| 1999 | 49,928.7 | 1,560.3 | 8,400.3 | |
| 2000 | 21,411.4 | 669.1 | 2,341.1 | |
| 2001 | 21,411.4 | 669.1 | 2,341.1 | |
| 2002 | 21,411.4 | 669.1 | 2,341.1 | |
| 2003 | 30,724.1 | 960.1 | 10,346.2 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ |
| TOTAL COST | 389,397.1 | $12,168.7 | $72,348.8 | (US$,x1000) |
| | | | | $84,517.4 |

**Notes:**

1.



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| **Variant / Plant:** | L2 SUMMARY All Plants |
| **Technology:** | Combustion Turbine Combined Cycle Addition at Lulin |
| **Demand:** | |

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 373.1 | | 373.1 | | | | |
| 2 | Foundations | 41,971.2 | 6,917.3 | | 48,888.5 | 1,311.6 | 467.9 | | 1,779.5 |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | 7,199.6 | | 7,199.6 | 23,740.8 | 487.0 | | 24,227.8 |
| 4b | Steam Turbine Generator | | 2,915.4 | | 2,915.4 | 6,786.0 | 197.2 | | 6,983.2 |
| 5a | Standard Boilers | | 10,401.5 | | 10,401.5 | 10,826.7 | 703.6 | | 11,530.3 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | 2,675.9 | | 2,675.9 | 5,294.3 | 181.0 | | 5,475.3 |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | 5,719.2 | | 5,719.2 | 4,690.3 | 386.9 | | 5,077.2 |
| 8 | Electrical and I&C | | 4,003.3 | | 4,003.3 | 4,934.2 | 270.8 | | 5,205.0 |
| 9 | Power Distribution & Transmissio | | 500.2 | | 500.2 | 2,053.4 | | | 2,053.4 |
| 10a | Heating Distribution Equipment | | 61.8 | | 61.8 | 945.2 | | | 945.2 |
| 10b | Heating Distribution Piping | | 183,110.4 | | 183,110.4 | 18,909.9 | | | 18,909.9 |
| 10c | Heating Distribution I&C | | 16,643.5 | | 16,643.5 | 4,600.8 | 203.3 | | 4,804.1 |
| 11 | Heating Substation I&C | | 93,139.2 | | 93,139.2 | 18,522.0 | | | 18,522.0 |
| | TOTAL DIRECT COST | 41,971.2 | 333,660.2 | | 375,631.4 | $102,615.1 | $2,897.6 | | $105,512.7 |

| | | | | | |
|---|---|---|---|---|---|
| | | Plant Design Engineering | 28,172.4 | Plant Design Engineering | 7,913.5 |
| | | Construction Supervision | | Construction Supervision | |
| 32 | = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| | Exchange Lev/US$ | Owner's Costs | 12,114.1 | Owner's Costs | 3,402.8 |
| | | Taxes and Permits | | Taxes and Permits | |
| | | Other | | Other | |
| | | SUBTOTAL | 415,917.9 | SUBTOTAL | 116,828.9 |
| | | ESCALATION | w/economics | ESCALATION | w/economics |
| | | CONTINGENCY | 62,387.7 | CONTINGENCY | 17,524.3 |
| | | TOTAL COST (Bulgaria part) | 478,305.5 | TOTAL COST (Foreign Exch. part) | 134,353.3 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 10,796.9 | 337.4 | 1,369.0 | |
| 1995 | 47,858.1 | 1,495.6 | 14,109.5 | |
| 1996 | 72,386.5 | 2,262.1 | 22,230.2 | |
| 1997 | 91,935.4 | 2,873.0 | 38,525.9 | |
| 1998 | 112,310.8 | 3,509.7 | 33,952.5 | |
| 1999 | 49,928.7 | 1,560.3 | 8,400.3 | |
| 2000 | 21,411.4 | 669.1 | 2,341.1 | |
| 2001 | 21,411.4 | 669.1 | 2,341.1 | |
| 2002 | 21,411.4 | 669.1 | 2,341.1 | |
| 2003 | 28,854.9 | 901.7 | 8,742.4 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 478,305.5 | $14,947.0 | $134,353.3 | $149,300.3 |

**Notes:**

1.



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**SUMMARY LEVEL TABLES**

**PERNIK CASE P1, P3**

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

**Variant / Plant:** P1 SUMMARY All Units
**Technology:** Rehabilitation of Existing Pernik (Republika) Systems
**Demand:**

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 6,022.8 | | 6,022.8 | 10,314.5 | 480.9 | | 10,795.4 |
| 5a | Standard Boilers | | 165,880.5 | | 165,880.5 | 138,402.8 | 11,220.0 | | 149,622.8 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 117,529.6 | | 117,529.6 | 11,958.6 | | | 11,958.6 |
| 10c | Heating Distribution I&C | | 24,040.1 | | 24,040.1 | 6,661.1 | 293.6 | | 6,954.7 |
| 11 | Heating Substation I&C | | 22,176.0 | | 22,176.0 | 4,410.0 | | | 4,410.0 |
| | TOTAL DIRECT COST | | 335,739.8 | | 335,739.8 | $173,137.0 | $11,994.5 | | $185,131.5 |

| | | | | |
|---|---|---|---|---|
| | Plant Design Engineering | 25,180.5 | Plant Design Engineering | 13,884.9 |
| | Construction Supervision | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| Exchange Lev/US$ | Owner's Costs | 10,827.6 | Owner's Costs | 5,970.5 |
| | Taxes and Permits | | Taxes and Permits | |
| | Other | | Other | |
| | SUBTOTAL | 371,747.9 | SUBTOTAL | 204,986.8 |
| | ESCALATION | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 55,762.2 | CONTINGENCY | 30,748.0 |
| | TOTAL COST (Bulgaria part) | 427,510.1 | TOTAL COST (Foreign Exch. part) | 235,734.9 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 193,058.7 | 6,033.1 | 175,392.6 |
| 1995 | 26,733.7 | 835.4 | 4,323.0 |
| 1996 | 32,898.1 | 1,028.1 | 5,277.3 |
| 1997 | 33,557.1 | 1,048.7 | 5,355.5 |
| 1998 | 64,693.7 | 2,021.7 | 32,338.3 |
| 1999 | 24,555.9 | 767.4 | 4,410.5 |
| 2000 | 12,550.8 | 392.2 | 1,458.4 |
| 2001 | 12,550.8 | 392.2 | 1,458.4 |
| 2002 | 12,550.8 | 392.2 | 1,458.4 |
| 2003 | 13,455.7 | 420.5 | 2,860.5 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | 904.9 | 28.3 | 1,402.1 |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 427,510.1 | $13,359.7 | $235,734.9 |

TOTAL IN US$ (US$,x1000): $249,094.5

**Notes:**

1. INCLUDES ENVIRONMENTAL



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| **Variant / Plant:** | **P3 SUMMARY All Plants** |
| **Technology:** | **Fluidized Bed Boiler Addition at Pernik** |
| **Demand:** | |

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | 23,932.8 | 21,244.6 | | 45,177.4 | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 6,847.4 | | 6,847.4 | 11,909.4 | 529.3 | | 12,438.7 |
| 5a | Standard Boilers | | 71,323.2 | | 71,323.2 | 59,294.9 | 4,824.2 | | 64,119.1 |
| 5b | Fluid Bed Boilers | | 97,932.0 | | 97,932.0 | 76,508.6 | 7,107.3 | | 83,615.9 |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 117,529.6 | | 117,529.6 | 11,958.6 | | | 11,958.6 |
| 10c | Heating Distribution I&C | | 24,040.1 | | 24,040.1 | 6,661.1 | 293.6 | | 6,954.7 |
| 11 | Heating Substation I&C | | 22,176.0 | | 22,176.0 | 4,410.0 | | | 4,410.0 |
| | TOTAL DIRECT COST | 23,932.8 | 361,183.8 | | 385,116.6 | $172,132.6 | $12,754.5 | | $184,887.0 |

| | | | | | |
|---|---|---|---|---|---|
| | | Plant Design Engineering | 28,883.7 | Plant Design Engineering | 13,866.5 |
| | | Construction Supervision | | Construction Supervision | |
| 32 | = Assumed 1993 | Freight/Shipping | included | Freight/Shipping | included |
| | Exchange Lev/US$ | Owner's Costs | 12,420.0 | Owner's Costs | 5,962.6 |
| | | Taxes and Permits | | Taxes and Permits | |
| | | Other | | Other | |
| | | SUBTOTAL | 426,420.4 | SUBTOTAL | 204,716.2 |
| | | ESCALATION | w/economics | ESCALATION | w/economics |
| | | CONTINGENCY | 63,963.1 | CONTINGENCY | 30,707.4 |
| | | TOTAL COST (Bulgaria part) | 490,383.5 | TOTAL COST (Foreign Exch. part) | 235,423.6 |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 146,573.5 | 4,580.4 | 75,855.1 | |
| 1995 | 26,733.7 | 835.4 | 4,323.0 | |
| 1996 | 32,898.1 | 1,028.1 | 5,277.3 | |
| 1997 | 51,763.4 | 1,617.6 | 20,900.3 | |
| 1998 | 73,302.5 | 2,290.7 | 39,670.0 | |
| 1999 | 39,644.7 | 1,238.9 | 17,293.5 | |
| 2000 | 31,255.9 | 976.7 | 17,429.1 | |
| 2001 | 40,608.4 | 1,269.0 | 25,414.4 | |
| 2002 | 31,198.7 | 975.0 | 20,912.7 | |
| 2003 | 15,497.8 | 484.3 | 6,954.4 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | 906.8 | 28.3 | 1,393.8 | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 490,383.5 | $15,324.5 | $235,423.6 | $250,748.1 |

**Notes:**

1. INCLUDES ENVIRONMENTAL



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**DETAILED ESTIMATE TABLES**

**SOFIA CASE S1, S2, S3, SA, S0**

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL S1
Technology: Boiler Rehabilitation at Existing Sofia Station
Demand:

INPUT AREA

1

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 36,440.6 | | 36,440.6 | 28,176.1 | 2,464.9 | | 30,641.0 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 36,440.6 | | 36,440.6 | $28,176.1 | $2,464.9 | | $30,641.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 2,733.0 | Plant Design Engineering | 7.5% | 2,296.1 |
| | Construction Supervision | | | Construction Supervision | | |
| 32 = Assumed 1993 | Freight/Shipping | | included | Freight/Shipping | | included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 1,175.2 | Owner's Costs | 3.0% | 988.2 |
| | Taxes and Permits | | | Taxes and Permits | | |
| | Other | | | Other | | |
| | SUBTOTAL | | 40,348.9 | SUBTOTAL | | 33,927.3 |
| | ESCALATION | | w/economics | ESCALATION | | w/economics |
| | CONTINGENCY | 15.0% | 6,052.3 | CONTINGENCY | 15.0% | 5,089.1 |
| | TOTAL COST (Bulgaria part) | | 46,401.2 | TOTAL COST (Foreign Exch. part) | | 39,016.4 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 28,176.1 | 3,603.7 | | | 32% | |
| 28,176.1 | 3,603.7 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 11,159.5 | 348.7 | 11,693.2 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 21,275.0 | 664.8 | 15,649.5 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 13,966.8 | 436.5 | 11,673.7 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 46,401.2 | $1,450.0 | $39,016.4 |

TOTAL IN US$ (US$,x1000): $40,466.4

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 24.1% | 30.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 45.9% | 40.1% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 30.1% | 29.9% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL S0 S1 S2 |
| Technology: | Steam Turbine Generator Rehabilitation at Sofia Station |
| Demand: | |

1

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | 5,174.7 | 2,838.6 | | 8,013.3 | 3,931.2 | 192.0 | | 4,123.2 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 5,174.7 | 2,838.6 | | 8,013.3 | $3,931.2 | $192.0 | | $4,123.2 |
| | | Plant Design Engineering | | 7.5% | 601.0 | Plant Design Engineering | | 7.5% | 309.2 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 258.4 | Owner's Costs | | 3.0% | 133.0 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 8,872.7 | SUBTOTAL | | | 4,565.4 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 1,330.9 | CONTINGENCY | | 15.0% | 684.8 |
| | | TOTAL COST (Bulgaria part) | | | 10,203.6 | TOTAL COST (Foreign Exch. part) | | | 5,250.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 4,092.9 | 280.7 | | 4% | 32% | |
| 4,092.9 | 280.7 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 3,397.8 | 106.2 | 1,637.6 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 3,397.8 | 106.2 | 1,706.3 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 3,408.0 | 106.5 | 1,706.3 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 10,203.6 | $318.9 | $5,250.2 |

TOTAL IN US$ (US$,x1000): $5,569.1

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 33.3% | 35.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 33.3% | 32.5% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 33.4% | 32.5% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

BULGARIA DISTRICT HEATING STUDY
CAPITAL COST AND CASH FLOW

Variant / Plant: DETAIL S1 S2 S3
Technology: Distribution Piping w/L.D.Sensors in Sofia Heating District
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 370,968.3 | | 370,968.3 | 38,617.6 | | | 38,617.6 |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 371,059.2 | | 371,059.2 | $40,007.6 | | | $40,007.6 |
| | | Plant Design Engineering | | 7.5% | 27,829.4 | Plant Design Engineering | | 7.5% | 3,000.6 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 11,966.7 | Owner's Costs | | 3.0% | 1,290.2 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 410,855.3 | SUBTOTAL | | | 44,298.4 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 61,628.3 | CONTINGENCY | | 15.0% | 6,644.6 |
| | | TOTAL COST (Bulgaria part) | | | 472,483.6 | TOTAL COST (Foreign Exch. part) | | | 50,943.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 1,390.0 | 2.6 | | | 100% | |
| 38,617.6 | 11,592.8 | | | 100% | |
| 40,007.6 | 11,595.6 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 18,615.9 | 581.7 | 2,017.3 |
| 1995 | 54,949.8 | 1,717.2 | 5,919.6 |
| 1996 | 68,604.6 | 2,143.9 | 7,391.9 |
| 1997 | 70,589.0 | 2,205.9 | 7,610.9 |
| 1998 | 71,912.0 | 2,247.3 | 7,753.6 |
| 1999 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2000 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2001 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2002 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2003 | 37,562.4 | 1,173.8 | 4,050.0 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 472,483.6 | $14,765.1 | $50,943.2 |

TOTAL IN US$ (US$,x1000): $65,708.3

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 3.9% | 4.0% |
| 1995 | 11.6% | 11.6% |
| 1996 | 14.5% | 14.5% |
| 1997 | 14.9% | 14.9% |
| 1998 | 15.2% | 15.2% |
| 1999 | 8.0% | 8.0% |
| 2000 | 8.0% | 8.0% |
| 2001 | 8.0% | 8.0% |
| 2002 | 8.0% | 8.0% |
| 2003 | 8.0% | 8.0% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | | |
|---|---|---|
| Variant / Plant: | DETAIL | S1 S2 S3 SA |
| Technology: | Distribution Piping w/L.D.Sensors in Sofia Heating District | |
| Demand: | | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 370,968.3 | | 370,968.3 | 38,617.6 | | | 38,617.6 |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 371,059.2 | | 371,059.2 | $40,007.6 | | | $40,007.6 |
| | | Plant Design Engineering | | 7.5% | 27,829.4 | Plant Design Engineering | | 7.5% | 3,000.6 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 11,966.7 | Owner's Costs | | 3.0% | 1,290.2 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 410,855.3 | SUBTOTAL | | | 44,298.4 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 61,628.3 | CONTINGENCY | | 15.0% | 6,644.8 |
| | | TOTAL COST (Bulgaria part) | | | 472,483.6 | TOTAL COST (Foreign Exch. part) | | | 50,943.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 1,390.0 | 2.6 | | | 100% | |
| 38,617.6 | 11,592.8 | | | 100% | |
| 40,007.6 | 11,595.6 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 18,615.9 | 581.7 | 2,017.3 | |
| 1995 | 54,949.8 | 1,717.2 | 5,919.6 | |
| 1996 | 68,604.6 | 2,143.9 | 7,391.9 | |
| 1997 | 70,589.0 | 2,205.9 | 7,610.9 | |
| 1998 | 71,912.0 | 2,247.3 | 7,753.6 | |
| 1999 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2000 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2001 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2002 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2003 | 37,562.4 | 1,173.8 | 4,050.0 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ |
| TOTAL COST | 472,483.6 | $14,765.1 | $50,943.2 | (US$,x1000) |
| | | | | $65,708.3 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 3.9% | 4.0% |
| 1995 | 11.6% | 11.6% |
| 1996 | 14.5% | 14.5% |
| 1997 | 14.9% | 14.9% |
| 1998 | 15.2% | 15.2% |
| 1999 | 8.0% | 8.0% |
| 2000 | 8.0% | 8.0% |
| 2001 | 8.0% | 8.0% |
| 2002 | 8.0% | 8.0% |
| 2003 | 8.0% | 8.0% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL S1 S2 S3 SA
Technology: Control System Upgrade for Sofia Heating District
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | 23,115.8 | | 23,115.8 | 6,390.0 | 282.3 | | 6,672.4 |
| 11 | Heating Substation I&C | | 129,360.0 | | 129,360.0 | 25,725.0 | | | 25,725.0 |
| | TOTAL DIRECT COST | | 152,475.8 | | 152,475.8 | $32,115.0 | $282.3 | | $32,397.4 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 11,435.7 | Plant Design Engineering 7.5% | 2,429.8 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 4,917.3 | Owner's Costs 3.0% | 1,044.8 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 168,828.8 | SUBTOTAL | 35,872.0 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 25,324.3 | CONTINGENCY 15.0% | 5,380.8 |
| | TOTAL COST (Bulgaria part) | | 194,153.2 | TOTAL COST (Foreign Exch. part) | 41,252.8 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 6,390.0 | 1,004.7 | | | 72% | |
| 25,725.0 | 4,042.5 | | | 100% | |
| 32,115.0 | 5,047.2 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 2,718.1 | 84.9 | 577.5 | |
| 1995 | 33,006.0 | 1,031.4 | 7,013.0 | |
| 1996 | 39,607.2 | 1,237.7 | 8,415.6 | |
| 1997 | 39,607.2 | 1,237.7 | 8,415.6 | |
| 1998 | 39,607.2 | 1,237.7 | 8,415.6 | |
| 1999 | 39,607.2 | 1,237.7 | 8,415.6 | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | | | | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 194,153.2 | $6,087.3 | $41,252.8 | $47,320.0 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 1.4% | 1.4% |
| 1995 | 17.0% | 17.0% |
| 1996 | 20.4% | 20.4% |
| 1997 | 20.4% | 20.4% |
| 1998 | 20.4% | 20.4% |
| 1999 | 20.4% | 20.4% |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL S2
Technology: Alternate #1 Boiler Rehabilitation at Existing Sofia Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 30,156.0 | | 30,156.0 | 23,365.5 | 2,039.8 | | 25,405.3 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 30,156.0 | | 30,156.0 | $23,365.5 | $2,039.8 | | $25,405.3 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 2,261.7 | Plant Design Engineering 7.5% | 1,905.4 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 972.5 | Owner's Costs 3.0% | 819.3 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 33,390.2 | SUBTOTAL | 28,130.0 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 5,008.5 | CONTINGENCY 15.0% | 4,219.5 |
| | TOTAL COST (Bulgaria part) | | 38,398.8 | TOTAL COST (Foreign Exch. part) | 32,349.8 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 23,365.5 | 2,982.2 | | | 32% | |
| 23,365.5 | 2,982.2 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 9,108.2 | 284.6 | 9,407.2 | |
| 1995 | | | | |
| 1996 | | | | |
| 1997 | | | | |
| 1998 | 16,461.6 | 514.4 | 12,105.2 | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | 12,829.0 | 400.9 | 10,837.1 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 38,398.8 | $1,200.0 | $32,349.8 | $33,549.5 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 23.7% | 29.1% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 42.9% | 37.4% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 33.4% | 33.5% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | | |
|---|---|---|
| Variant / Plant: | DETAIL | S2 |
| Technology: | LM-6000 Combustion Turbine / HRSG Additions | |
| Demand: | | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 3,520.0 | | 3,520.0 | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | 27,320.8 | 27,417.7 | | 54,738.5 | 41,835.0 | 1,854.6 | | 43,689.6 |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 27,320.8 | 30,937.7 | | 58,258.5 | $41,835.0 | $1,854.6 | | $43,689.6 |
| | Plant Design Engineering | | | 7.5% | 4,369.4 | Plant Design Engineering | | 7.5% | 3,276.7 |
| | Construction Supervision | | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 1,878.8 | Owner's Costs | | 3.0% | 1,409.0 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 64,506.7 | SUBTOTAL | | | 48,375.3 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 9,676.0 | CONTINGENCY | | 15.0% | 7,256.3 |
| | | TOTAL COST (Bulgaria part) | | | 74,182.7 | TOTAL COST (Foreign Exch. part) | | | 55,631.6 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| | 110.0 | | | 100% | |
| 42,688.8 | 2,711.4 | | 2% | 32% | |
| 42,688.8 | 2,821.4 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | | | 5,563.2 | |
| 1995 | 29,673.1 | 927.3 | 33,379.0 | |
| 1996 | 44,509.6 | 1,390.9 | 16,689.5 | |
| 1997 | | | | |
| 1998 | | | | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | | | | |
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| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 74,182.7 | $2,318.2 | $55,631.6 | $57,949.8 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | | 10.0% |
| 1995 | 40.0% | 60.0% |
| 1996 | 60.0% | 30.0% |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
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| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL S3 SA |
| Technology: | CT–6FA Combustion Turbine Combined Cycle Additions |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 373.1 | | 373.1 | | | | |
| 2 | Foundations | 41,971.2 | 6,917.3 | | 48,888.5 | 1,311.6 | 467.9 | | 1,779.5 |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | 7,199.6 | | 7,199.6 | 23,740.8 | 487.0 | | 24,227.8 |
| 4b | Steam Turbine Generator | | 2,915.4 | | 2,915.4 | 6,786.0 | 197.2 | | 6,983.2 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | 2,675.9 | | 2,675.9 | 5,294.3 | 181.0 | | 5,475.3 |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | 5,719.2 | | 5,719.2 | 4,690.3 | 386.9 | | 5,077.2 |
| 8 | Electrical and I&C | | 4,003.3 | | 4,003.3 | 4,934.2 | 270.8 | | 5,205.0 |
| 9 | Power Distribution & Transmission | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 41,971.2 | 29,803.6 | | 71,774.8 | $46,757.2 | $1,990.7 | | $48,747.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 5,383.1 | Plant Design Engineering | 7.5% | 3,656.1 |
| | Construction Supervision | | | Construction Supervision | | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 2,314.7 | Owner's Costs | 3.0% | 1,572.1 |
| | Taxes and Permits | | | Taxes and Permits | | |
| | Other | | | Other | | |
| | SUBTOTAL | | 79,472.7 | SUBTOTAL | | 53,976.1 |
| | ESCALATION | | w/economics | ESCALATION | | w/economics |
| | CONTINGENCY | 15.0% | 11,920.9 | CONTINGENCY | 15.0% | 8,096.4 |
| | TOTAL COST (Bulgaria part) | | 91,393.6 | TOTAL COST (Foreign Exch. part) | | 62,072.5 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| | 11.7 | | | 100% | |
| 2,623.2 | 684.1 | | 50% | 32% | |
| | | | | 32% | |
| 23,740.8 | 712.0 | | | 32% | |
| 6,786.0 | 288.3 | | | 32% | |
| | | | | 32% | |
| | | | | 32% | |
| 5,294.3 | 264.6 | | | 32% | |
| | | | | 32% | |
| | | | | 32% | |
| | | | | 32% | |
| 4,690.3 | 585.8 | | | 32% | |
| 4,934.2 | 395.9 | | | 32% | |
| | | | | 32% | |
| | | | | 32% | |
| 48,068.8 | 2,922.1 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | | | | |
| 1995 | | | 6,207.3 | |
| 1996 | 13,709.0 | 428.4 | 12,414.5 | |
| 1997 | 31,987.7 | 999.6 | 27,932.6 | |
| 1998 | 45,696.8 | 1,428.0 | 15,518.1 | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | | | | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 91,393.6 | $2,856.0 | $62,072.5 | $64,928.6 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | | |
| 1995 | | 10.0% |
| 1996 | 15.0% | 20.0% |
| 1997 | 35.0% | 45.0% |
| 1998 | 50.0% | 25.0% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL S0 |
| Technology: | Alternate #2 Boiler Rehabilitation at Existing Sofia Station |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 8,885.7 | | 8,885.7 | 8,443.7 | 601.0 | | 9,044.7 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C–Elec.Htrs. | 166,154.6 | 59,048.8 | | 225,203.3 | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 0.9 | | 0.9 | 13.9 | | | 13.9 |
| 10b | Heating Distribution Piping | | 3,709.7 | | 3,709.7 | 386.2 | | | 386.2 |
| 10c | Heating Distribution I&C | | 462.3 | | 462.3 | 127.8 | 5.6 | | 133.4 |
| 11 | Heating Substation I&C | | 2,587.2 | | 2,587.2 | 514.5 | | | 514.5 |
| | TOTAL DIRECT COST | 166,154.6 | 74,694.6 | | 240,849.1 | $9,486.1 | $606.7 | | $10,092.7 |
| | | Plant Design Engineering | | 7.5% | 18,063.7 | Plant Design Engineering | | 7.5% | 757.0 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 7,767.4 | Owner's Costs | | 3.0% | 325.5 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 266,680.2 | SUBTOTAL | | | 11,175.2 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 40,002.0 | CONTINGENCY | | 15.0% | 1,676.3 |
| | | TOTAL COST (Bulgaria part) | | | 306,682.2 | TOTAL COST (Foreign Exch. part) | | | 12,851.5 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 8,443.7 | 678.7 | | | 32% | |
| 5,192.3 | 1,845.3 | | 100% | 100% | |
| 13.9 | 0.03 | | | 100% | |
| 386.2 | 115.95 | | | 100% | |
| 127.8 | 20.1 | | | 72% | |
| 514.5 | 80.9 | | | 100% | |
| 14,678.4 | 2,940.9 | | | | |

>>>>>>>>>>>>>>>

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 302,511.4 | 9,453.5 | 12,851.5 | |
| 1995 | | | | |
| 1996 | | | | |
| 1997 | | | | |
| 1998 | | | | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | 4,170.9 | 130.3 | | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 306,682.2 | $9,583.8 | $12,851.5 | $22,435.3 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 98.6% | 100.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 1.4% | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL SA
Technology: Boiler Rehabilitation at Existing Sofia Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 20,136.7 | | 20,136.7 | 16,029.3 | 1,362.0 | | 17,391.3 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 20,136.7 | | 20,136.7 | $16,029.3 | $1,362.0 | | $17,391.3 |
| | | Plant Design Engineering | | 7.5% | 1,510.2 | Plant Design Engineering | | 7.5% | 1,304.3 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 649.4 | Owner's Costs | | 3.0% | 560.9 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 22,296.3 | SUBTOTAL | | | 19,256.5 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 3,344.4 | CONTINGENCY | | 15.0% | 2,888.5 |
| | | TOTAL COST (Bulgaria part) | | | 25,640.8 | TOTAL COST (Foreign Exch. part) | | | 22,145.0 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 16,029.3 | 1,991.3 | | | 32% | |
| 16,029.3 | 1,991.3 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 4,866.6 | 152.1 | 5,503.0 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 13,166.5 | 411.5 | 9,664.1 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 7,607.6 | 237.7 | 6,977.9 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 25,640.8 | $801.3 | $22,145.0 |

TOTAL IN US$ (US$,x1000): $22,946.3

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 19.0% | 24.9% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 51.4% | 43.6% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 29.7% | 31.5% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL SA
Technology: Steam Turbine Generator Rehabilitation at Sofia Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | 2,822.8 | 1,419.3 | | 4,242.1 | 2,948.4 | 96.0 | | 3,044.4 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 2,822.8 | 1,419.3 | | 4,242.1 | $2,948.4 | $96.0 | | $3,044.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 318.2 | Plant Design Engineering | 7.5% | 228.3 |
| | Construction Supervision | | | Construction Supervision | | |
| 32 = Assumed 1993 | Freight/Shipping | | included | Freight/Shipping | | included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 136.8 | Owner's Costs | 3.0% | 98.2 |
| | Taxes and Permits | | | Taxes and Permits | | |
| | Other | | | Other | | |
| | SUBTOTAL | | 4,697.1 | SUBTOTAL | | 3,370.9 |
| | ESCALATION | | w/economics | ESCALATION | | w/economics |
| | CONTINGENCY | 15.0% | 704.6 | CONTINGENCY | 15.0% | 505.6 |
| | TOTAL COST (Bulgaria part) | | 5,401.6 | TOTAL COST (Foreign Exch. part) | | 3,876.5 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 3,036.6 | 140.4 | | 3% | 32% | |
| 3,036.6 | 140.4 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 1,798.7 | 56.2 | 1,356.6 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 1,798.7 | 56.2 | 1,259.9 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 1,804.1 | 56.4 | 1,259.9 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 5,401.6 | $168.8 | $3,876.5 |

TOTAL IN US$ (US$,x1000): $4,045.3

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 33.3% | 35.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 33.3% | 32.5% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 33.4% | 32.5% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL S3 |
| Technology: | Boiler Rehabilitation at Existing Sofia Station |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 35,007.8 | | 35,007.8 | 27,205.6 | 2,367.9 | | 29,573.5 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 35,007.8 | | 35,007.8 | $27,205.6 | $2,367.9 | | $29,573.5 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 2,625.6 | Plant Design Engineering 7.5% | 2,218.0 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 1,129.0 | Owner's Costs 3.0% | 953.7 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other _____ | | | Other _____ | |
| | SUBTOTAL | | 38,762.4 | SUBTOTAL | 32,745.3 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 5,814.4 | CONTINGENCY 15.0% | 4,911.8 |
| | TOTAL COST (Bulgaria part) | | 44,576.8 | TOTAL COST (Foreign Exch. part) | 37,657.1 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 27,205.6 | 3,461.9 | | | 32% | |
| 27,205.6 | 3,461.9 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | TOTAL IN US$ (US$,x1000) |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 11,162.0 | 348.8 | 11,688.7 | |
| 1995 | | | | |
| 1996 | | | | |
| 1997 | | | | |
| 1998 | 21,174.0 | 661.7 | 15,567.4 | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | 12,240.8 | 382.5 | 10,400.9 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | |
| TOTAL COST | 44,576.8 | $1,393.0 | $37,657.1 | $39,050.1 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 25.0% | 31.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 47.5% | 41.3% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 27.5% | 27.6% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



743

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL S3 |
| Technology: | Steam Turbine Generator Rehabilitation at Sofia Station |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | 5,174.7 | 2,838.6 | | 8,013.3 | 3,931.2 | 192.0 | | 4,123.2 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 5,174.7 | 2,838.6 | | 8,013.3 | $3,931.2 | $192.0 | | $4,123.2 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 601.0 | Plant Design Engineering 7.5% | 309.2 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 258.4 | Owner's Costs 3.0% | 133.0 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 8,872.7 | SUBTOTAL | 4,565.4 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 1,330.9 | CONTINGENCY 15.0% | 684.8 |
| | TOTAL COST (Bulgaria part) | | 10,203.6 | TOTAL COST (Foreign Exch. part) | 5,250.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 4,092.9 | 280.7 | | 4% | 32% | |
| 4,092.9 | 280.7 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 3,397.8 | 106.2 | 1,837.6 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 3,397.8 | 106.2 | 1,706.3 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 3,408.0 | 106.5 | 1,706.3 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 10,203.6 | $318.9 | $5,250.2 |

TOTAL IN US$ (US$,x1000): $5,569.1

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 33.3% | 35.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 33.3% | 32.5% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 33.4% | 32.5% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**SOFIA CASE S1, S2, S3, SA, S0**

**DETAILED ESTIMATE BACKUP INFORMATION**

FILE: SBURMS1.WK3
DATE: 31-Jan-94
TIME: 01:19 PM

OCEAN – U.S. 50 0.15
INLAND – U.S. 0.02
US/BULG 0.8 0.2
LEVA 32 0.1155
0.5 LABOR (50% OF MAT'L) 1.1
5.25 BULG RATE US $
168 BULG RATE LEVA

## THERMAL BOILER MODIFICATIONS – SOFIA PLANTS – Sa

| | ITEM | | NO. OF PLANTS | COST | ACTION | NECESSITY | % TOTAL | MTL % SUBTOTAL | C.F. YEAR | CNTR MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | U.S. LABOR U.S. $ | BULG LABOR U.S. $ | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | 1996 | C.F. TOTAL /YEAR 2003 | 1994 | BULG LABOR US $ 1996 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1,2,& 3 retire units 1 & 2 | BURNERS | | 1 | 218.30 | REPLACE NOW | NECESSITY | | 0.411 | 1994 | 308.66 | 37.11 | 255.41 | 25.54 | 11.80 | | 255.41 | | | 11.80 | | |
| | BURNER MGM'T | multiplier | | * | REPLACE NOW | NECESSITY | | | 1994 | | 52.51 | 361.39 | 8.19 | 3.78 | | 361.39 | | | 3.78 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | | | | 166.72 | | | 8.72 | |
| | FD FAN OPTION | | | 161.30 | REPLACE 5 YEARS | ENHANCEMENT | | 0.304 | 1996 | | 27.42 | 166.72 | 18.87 | 8.72 | | 66.66 | | 3.17 | | | |
| | DUCT WORK FOR BURNERS | | | 56.70 | REPLACE NOW | NECESSITY | | 0.111 | 1994 | | 9.96 | 66.66 | 6.67 | 3.17 | | | 108.11 | | | 4.99 | |
| | SOOTBLOWERS | | | 92.40 | REPLACE 5 YEARS | ENHANCEMENT | | 0.174 | 1996 | | 15.71 | 108.11 | 10.81 | 4.99 | | | | | | | |
| | | SUBTOTAL | | 530.7 | | | 0.10 | | | 308.66 | 142.73 | 862.31 | 70.26 | 32.47 | 32.47 | 695.46 | 296.63 | 0.00 | 19.76 | 13.71 | 0.00 |
| SOFIA – 4, 5 & 6 | WATERWALLS | | 3 | 3634.5 | REPLACE 5 YEARS | ENHANCEMENT | | 0.457 | 1996 | | 617.87 | 4252.37 | 425.24 | 196.48 | | | 4252.37 | | | 196.48 | |
| | BURNERS | | | 1227.9 | REPLACE NOW | NECESSITY | | 0.148 | 1994 | 1235.52 | 206.74 | 1436.64 | 143.66 | 66.37 | | 1436.64 | | | 66.37 | | |
| | BURNER MGM'T | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | |
| | SOOTBLOWERS | | | 831.3 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.100 | 2003 | | 141.32 | 972.62 | 97.26 | 44.94 | | | 972.62 | | | | 44.94 |
| | MAINSTEAM LINE | | | 1349.4 | REPLACE NOW | NECESSITY | | 0.162 | 1994 | | 229.40 | 1578.80 | 157.88 | 72.94 | | 1578.80 | | | 72.94 | | |
| | AIRHEATER RETUBE | | | 1273.6 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.153 | 2003 | | 216.55 | 1490.35 | 149.03 | 68.85 | | | 1490.35 | | | | 68.85 |
| | | SUBTOTAL | | 8316.9 | | | 0.40 | | | 1235.52 | 1623.91 | 11176.33 | 1005.84 | 464.70 | 154.90 | 4481.00 | 4252.37 | 2462.97 | 154.45 | 196.48 | 113.79 |
| SOFIA – 7 & 8 | WATERWALLS | | 2 | 3863.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.596 | 1996 | | 656.81 | 4520.41 | 452.04 | 208.84 | | | 4520.41 | | | 208.84 | |
| | BURNERS | | | 1582.6 | REPLACE NOW | NECESSITY | | 0.244 | 1994 | | 269.04 | 1851.64 | 185.18 | 85.55 | | 1851.64 | | | 85.55 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | | 1994 | 1235.52 | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | |
| | SOOTBLOWERS | | | 184.6 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.029 | 2003 | | 31.42 | 216.22 | 21.62 | 9.99 | | | 216.22 | | | | 9.99 |
| | AIRHEATER RETUBE | | | 849.2 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.131 | 2003 | | 144.36 | 993.56 | 99.36 | 45.90 | | | 993.56 | | | | 45.90 |
| | | SUBTOTAL | | 6480.2 | | | 0.40 | | | 1235.52 | 1311.67 | 9027.38 | 790.94 | 365.42 | | 3267.20 | 4520.41 | 1209.78 | 100.68 | 206.84 | 55.89 |
| SOFIA – 9 | BURNERS | | 1 | 625.4 | REPLACE 10 YEARS | NECESSITY | 0.10 | 1.000 | 2003 | 308.66 | 158.63 | 1093.11 | 8.19 | 3.78 | 3.78 | | | 1093.11 | | | 3.78 |
| | | SUBTOTAL | | 625.4 | | | | | | 308.66 | 158.63 | 1093.11 | 8.19 | 3.78 | | 0.00 | 0.00 | 1093.11 | 0.00 | 0.00 | 3.78 |
| | | *TOTAL SOFIA COSTS* | | 15953.2 | | | 1.000 | | | 3086.60 | 3237.14 | 22279.14 | 1875.25 | 866.37 | | | | | | | |
| | * TOTAL ALL UNITS AT PLANT THE COST IS INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | 0.78 | 3088.60 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | | | 0.78 | 409.50 | multiplied by 0.78% | | | | | | | | | | | | | | | | |

## HOT WATER BOILER MODIFICATIONS – SOFIA PLANTS – Sa

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1 – 6 retire units 1 – 2 | SOOTBLOWERS | | 4 | 184.60 | REPLACE 5 YEARS | ENHANCEMENT | | 0.056 | 1996 | 1722.3 | 324.21 | 2231.31 | 223.13 | 103.09 | | | 2231.31 | | | 103.09 | |
| | WATERWALLS | multiplier | 0.50 | 1978.20 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.596 | 2003 | | 336.29 | 2314.49 | 231.45 | 106.93 | | | | 2314.49 | | | 106.93 |
| | BURNERS | | | 1154.60 | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.348 | 2003 | | 196.32 | 1351.12 | 135.11 | 62.42 | | | | 1351.12 | | | 62.42 |
| | BURNER CONTROLS | | | * | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 3317.6 | | | 1.000 | 1.000 | | 1722.3 | 856.62 | 5896.92 | 589.69 | 272.44 | 68.11 | 0.00 | 2231.31 | 3665.61 | 0.00 | 103.09 | 169.35 |
| | | TOTALS | | | | | | | | | | 28176.06 | 2464.94 | 1138.80 | 259.26 | 8443.66 | 11300.91 | 8431.46 | 273.89 | 522.10 | 342.82 |
| | | | | 1722.30 | reduced by 0.50% | | | | | | TOTAL MAT'L | 28176.06 | | | | | | | | | |
| | | | | 195.00 | reduced by 0.50% | | | | | | | | | | % OF TOTAL | 29.97% | 40.11% | 29.92% | 24.05% | 45.65% | 30.10% |
| | * TOTAL ALL UNITS AT PLANT THE COST IS INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 28176.1 | 3603.7 | 0.000% | 31.601% |

BEST AVAILABLE COPY

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE: | STGMODS1.WK3 | S1 | | 16/25 | 25/50 | OCEAN - U.S. | HOTEL/DAY | 100 | | | 50.00 U.S. | | | | | | | | | | | | | | | | | | | | | | | | |
| DATE: | 18-Jan-94 | S2 | | CAP. | CAP | 0.15 | MEALS/DAY | 15 | MEN | | 8 | | 8 | LEVA | /HR | | | | | | | | | | | | | | | | | | | | |
| TIME: | 01:17 PM | S3 | | EXP. | EXP | INLAND - U.S. | CAR/DAY | 50 | WEEKS | | 6 | | 6 | 32 | 5.25 BULG IN US $ | | | | | | | | | | | | | | | | | | | | |
| | | | | 1.86 | 1.88 | 0.02 | | --- | WEEKS | | 5 | | 40 | | 166 BULG IN LEVA | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | 175 | $/$ | | 40 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | EXP. MEN | | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | DAYS | | 7 | | | | | | | | | | | | | | | | | | | | | | | | |

TURBINE GENERATOR - MODIFICATIONS - SOFIA PLANTS - 4b

| | | ITEM | | NO. OF PLANTS | COST | MTL % SUBTOTAL | C.F. YEAR | FREIGHT | TOTAL MTL. U.S. $ | TOTAL MTL. /PLANT U.S. $ | U.S $ EXPENSES LEVA | INSTALLATION U.S. $ | INSTALLATION LEVA | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1996 | MTL. $ U.S. 2003 | LABOR LEVA 1994 | LABOR LEVA 1996 | LABOR LEVA 2003 | MTL. LEVA 1994 | MTL. LEVA 1996 | MTL. LEVA 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA - 4 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 382.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | SUBTOTAL | | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 382.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 382.00 | 382.00 | 382.00 |
| SOFIA - 5 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 382.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | SUBTOTAL | | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 382.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 382.00 | 382.00 | 382.00 |
| SOFIA - 6 | MW 50 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 - TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 1 | 80.00 | 80.00 | 80.00 | | 13.80 | 93.80 | | | | | | | | | | | | | | |
| | | | | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | SUBTOTAL | | | 460.00 | 460.00 | | 78.20 | 538.20 | 538.20 | 470.40 | 80.00 | 268.80 | 268.80 | 538.20 | 444.80 | 444.80 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| SOFIA - 8 | MW 25 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 - TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 77 | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | SUBTOTAL | | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 470.40 | 80.00 | 268.80 | 268.80 | 444.60 | 444.60 | 444.60 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | | TOTALS | | | | | | | LEVA = | | 1724.80 | USE = | 1075.20 | 1075.20 | | | | 1075.20 | 1075.20 | 1075.20 | 1724.80 | 1724.80 | 1724.80 |
| | | | | | | | | | | | | | | | | | LEVA = | 1075.20 | 1075.20 | 1075.20 | | | |
| | | | | | | | | | US $ = | 1310.40 | 53.80 | 329.00 | 64.00 | | 1310.40 | 1216.80 | 1216.80 | US $ = | 64.00 | 64.00 | 64.00 | | | |
| | | | | | | | | | | | | 373.80 | | | | | | | | | | | |
| | | | | | | | | | | | | LEVA = | 948.18 LABOR INC 10% PROD | | | | | | | | | | |
| | | | | | | | | | | MTL. | included w | 960 | LBR | | | | | | | | | | |
| | | | | | | | | | TOTAL US $ *3 = | 4092.9 | 4092.9 | | 280.70 LABOR IN US $ FOR 3 PLANTS | | | | | | | | | | |

| | EQUIP/ MATL | LABOR | PERCENT LOCAL MATL | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 4092.9 | 280.704 | 3.951% | 31.801% |

BEST AVAILABLE COPY

FILE. S1EQUIP.WK3
DATE: 1-Dec-93

DATE: 31-Jan-94
TIME: 09:48 AM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 EA | 80 | 1 | 12 | 2 | 281 | 48.00 | 144 | 0 | 50 | 0 | 156 | 168 | 27 |
| VSD | | | 3 EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | SUBTOTAL | | | | | | | $1,390 | | | | US | $0 | | LEVA | 91 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 1,390 MATERIAL (US $) | 0 | 1389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 1,389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *91 LABOR(LEVA)* | *0* | *90.92* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **1389.96** | **2.84** | **0.00%** | **100.00%** |

BEST AVAILABLE COPY

FILE: S1PIP10B.WK3
DATE: 22-Nov-93

DATE: 23-Mar-94
TIME: 03:30 PM

## SOFIA PLANTS ( 10 b 1 )

# HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

### *LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB. COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 2,142 | 37 | 6 | 1 | 43 | | 414 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 39,066 | 720 | 106 | 14 | 842 | | 6,085 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 69,776 | 1,552 | 233 | 31 | 1,816 | | 17,432 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 120,988 | 3,017 | 452 | 60 | 3,529 | | 33,863 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 36,756 | 1,223 | 183 | 24 | 1,431 | | 13,739 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 24,542 | 910 | 136 | 18 | 1,064 | | 10,216 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 51,700 | 2,290 | 344 | 46 | 2,679 | | 25,723 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 17,086 | 1,110 | 167 | 22 | 1,299 | | 12,472 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 3,942 | 368 | 55 | 7 | 430 | | 4,128 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 6,076 | 693 | 104 | 14 | 811 | | 7,784 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 60 | 8 | 1 | 0 | 9 | | 89 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 7,260 | 1,056 | 158 | 21 | 1,235 | | 11,856 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 1,610 | 248 | 37 | 5 | 291 | | 2,790 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 7,024 | 1,284 | 193 | 26 | 1,503 | | 14,428 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 186.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | – | 232.00 | 14,418 | 3,345 | 502 | 67 | 3,914 | | 37,571 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | – | 409.17 | 7,960 | 3,257 | 488 | 65 | 3,811 | | 36,582 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | 1,690 | 837 | 126 | 17 | 979 | | 9,399 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | 1,638 | 1,276 | 191 | 26 | 1,493 | | 14,336 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 413,976 | | | US | $27,160 | LEVA | 260,928 |

### *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 23,960 | 597 | 90 | 12 | 699 | | 6,710 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 7,196 | 239 | 36 | 5 | 280 | | 2,690 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 7,736 | 287 | 43 | 6 | 336 | | 3,221 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 7,772 | 344 | 52 | 7 | 403 | | 3,867 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 9,064 | 590 | 89 | 12 | 691 | | 6,631 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 5,286 | 493 | 74 | 10 | 577 | | 5,537 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 5,240 | 598 | 90 | 12 | 699 | | 6,713 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 1,044 | 138 | 21 | 3 | 161 | | 1,546 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 13,690 | 1,985 | 298 | 40 | 2,323 | | 22,296 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 180 | 28 | 4 | 1 | 32 | | 312 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 4,616 | 844 | 127 | 17 | 988 | | 9,484 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 186.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | – | 232.00 | 3,454 | 801 | 120 | 16 | 938 | | 9,001 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | – | 409.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 69,264 | | | US | $5,126 | LEVA | 78,010 |

(1) LABOR PERCENT PROVIDED BY CLIENT

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749

## OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.67 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 146 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.66 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 158 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 36.06 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.68 | 0.842 | 3,327 | 168.00 | 559 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 341 | 104 | 37.08 | 1,430 | 53 | 6 | 1 | 62 | 1.55 | 0.776 | 4,164 | 168.00 | 703 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 1,470 | 65 | 10 | 1 | 76 | 1.90 | 0.949 | 245 | 168.00 | 41 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 128 | 52.50 | 80 | 4 | 1 | 0 | 5 | 2.04 | 1.020 | 5,515 | 168.00 | 926 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 1,360 | 101 | 15 | 2 | 118 | 2.70 | 1.352 | 3,216 | 168.00 | 541 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 720 | 57 | 8 | 1 | 67 | 2.98 | 1.490 | 22,997 | 168.00 | 3,864 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 86.33 | 4,420 | 382 | 57 | 8 | 446 | 3.47 | 1.734 | 759 | 168.00 | 128 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 140 | 12 | 2 | 0 | 14 | 3.62 | 1.808 | 25,449 | 168.00 | 4,275 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 4,528 | 456 | 68 | 9 | 534 | 3.75 | 1.873 | 0 | 168.00 | 0 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | – | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 37,297 | 168.00 | 6,266 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 5,382 | 579 | 87 | 12 | 677 | 4.62 | 2.310 | 0 | 168.00 | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 16,642 | 168.00 | 2,796 |
| DN | 700 -711/900 | 28" | 10 | 8.60 | 0.35 | 1,524 | – | 127.00 | 2,050 | 260 | 39 | 5 | 305 | 5.41 | 2.706 | 0 | 168.00 | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.60 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 22,298 | 168.00 | 3,746 |
| DN | 800 -813/1000 | 32" | – | 8.60 | 0.35 | 1,909 | – | 159.08 | 1702 | 271 | 41 | 5 | 317 | 6.73 | 4.367 | 0 | 168.00 | 0 |
| DN | 850 -864/1100 | 34" | – | 8.60 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 48,727 | 168.00 | 8,188 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 2,980 | 591 | 89 | 12 | 692 | 10.90 | 5.451 | 0 | 168.00 | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | – | 0 | 0 | 0 | 0 | 13.07 | 6.534 | | | |
| | | | | | | | | | 26,282 | | | US | $3,312 | | | | LEVA | 32,031 |

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## SOFIA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

**CASH FLOW (000)** *LAID DOWN IN (EXISTING) DUCT*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27160 | MATERIAL (US $) | 951.30 | 2201.58 | 2745.18 | 2908.26 | 3018.96 | 3071.34 | 3071.34 | 3071.34 | 3071.34 | 3071.34 |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 260928 | *LABOR(LEVA)* | *9132.47* | *21135.14* | *26353.69* | *27919.26* | *28962.97* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 260928 | *TOTAL (LEVA)* | *9132.47* | *21135.14* | *26353.69* | *27919.26* | *28962.97* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 27,179.96 | 8,153.99 | 0.00% | 100.00% |



52

**CASH FLOW (000)** *LAID DOWN – INSULATION FOAM CONCRETE*

| | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| 8125 | MATERIAL (US $) | 406.30 | 1625.21 | 2031.51 | 2031.51 | 2031.51 |
| | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 78010 | *LABOR(LEVA)* | *3900.51* | *15602.03* | *19502.54* | *19502.54* | *19502.54* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 78010 | *TOTAL (LEVA)* | *3900.51* | *15602.03* | *19502.54* | *19502.54* | *19502.54* |
| | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 8,126.06 | 2,437.82 | 0.00% | 100.00% |

**CASH FLOW (000)** *OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*

| | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| 3312 | MATERIAL (US $) | 165.58 | 662.32 | 827.91 | 827.91 | 827.91 |
| | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 32031 | *LABOR(LEVA)* | *1601.53* | *6406.10* | *8007.63* | *8007.63* | *8007.63* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 32031 | *TOTAL (LEVA)* | *1601.53* | *6406.10* | *8007.63* | *8007.63* | *8007.63* |
| | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 3,311.62 | 1,000.95 | 0.00% | 100.00% |

**CASH FLOW (000)** *TOTAL DISTRIBUTION PIPING*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38618 | MATERIAL (US $) | 1523.16 | 4489.11 | 5604.60 | 5767.68 | 5878.40 | 3071.34 | 3071.34 | 3071.34 | 3071.34 | 3071.34 |
| | % | 3.94% | 11.62% | 14.51% | 14.94% | 15.22% | 7.95% | 7.95% | 7.95% | 7.95% | 7.95% |
| 370968 | *LABOR(LEVA)* | *14634.50* | *43143.27* | *53863.88* | *55429.43* | *56473.14* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 370968 | *TOTAL (LEVA)* | *14634.50* | *43143.27* | *53863.88* | *55429.43* | *56473.14* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| | % | 3.94% | 11.63% | 14.52% | 14.94% | 15.22% | 7.95% | 7.95% | 7.95% | 7.95% | 7.95% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 38,617.64 | 11,592.76 | 0.00% | 100.00% |

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151

FILE: S1_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 03:52 PM

# SOFIA (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY | MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $(000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 12 | 1950 | 260 | 546 | 12.00 | 432 | 86 | 50 | 4 | 380 | 168 | 64 |
| | SUBTOTAL | | | | | | | | $137 (.25 MULTIPLIER-25% ALLOT FOR SOFIA) | | | | US | $1 | | LEVA | $16 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 5,312,500 | 1 | 796875 | 106250 | 6216 | N/A | N/A | N/A | N/A | 281 | N/A | N/A | 23100 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *37,500* | *1* | – | – | *38* | | | | | 282 | | | 23,116 |
| | TOTAL US $ | | | | 5,350,000 | 1 | – | – | 6,390 | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 137 MATERIAL (US $) | 1.92 | 23.27 | 27.93 | 27.93 | 27.93 | 27.93 |
| 1 LABOR (US $) | 0.02 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 |
| SUBTOTAL | 1.93 | 23.45 | 28.15 | 28.15 | 28.15 | 28.15 |
| *16 LABOR(LEVA)* | *0.22* | *2.71* | *3.26* | *3.26* | *3.26* | *3.26* |
| 6,216 WEST. SCADA EQUIPMENT | 87.02 | 1056.68 | 1267.99 | 1267.99 | 1267.99 | 1267.99 |
| 38 FIBER OPTIC LEASING | 0.53 | 6.38 | 7.65 | 7.65 | 7.65 | 7.65 |
| 281 WEST. SCADA LABOR (US $) | 3.94 | 47.81 | 57.38 | 57.38 | 57.38 | 57.38 |
| SUBTOTAL | 91.48 | 1,110.84 | 1,333.01 | 1,333.01 | 1,333.01 | 1,333.01 |
| 6,672 TOTAL US $ | 93.41 | 1,134.30 | 1,361.16 | 1,361.16 | 1,361.16 | 1,361.16 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *23,100 WEST. SCADA LABOR (LEVA)* | *323.40* | *3927.00* | *4712.40* | *4712.40* | *4712.40* | *4712.40* |
| *23,116 TOTAL (LEVA)* | *323.62* | *3,929.71* | *4,715.66* | *4,715.66* | *4,715.66* | *4,715.66* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **6,390.02** | **1,004.70** | **0.000%** | **71.899%** |

BEST AVAILABLE COPY

22

FILE: S1HDSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:19 PM

# SOFIA (4) HEATING SUBSTATIONS I & C (11)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | | NOTE 1 | 1 LOT | 7000 | 3675 | INC. | INC. | 25725 | 1000 | 3,675 | 129,360 |
| CONSISTING OF: | | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | | |
| RTO | | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | | |
| | | | | | | | | --- | | --- | --- |
| | | | | | | | | $25,725 | | 0 | $129,360 |
| | | TOTAL US $ | | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 25,725 MATERIAL (US $) | 360.15 | 4373.25 | 5247.90 | 5247.90 | 5247.90 | 5247.90 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 360.15 | 4,373.25 | 5,247.90 | 5,247.90 | 5,247.90 | 5,247.90 |
| *129,360 LABOR(LEVA)* | *1811.04* | *21991.20* | *26389.44* | *26389.44* | *26389.44* | *26389.44* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **25,725.00** | **4,042.50** | **0.000%** | **100.000%** |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

BEST AVAILABLE COPY

73

FILE: SBLRMS2.WK3
DATE: 31-Jan-94
TIME: 01:27 PM

OCEAN – U.S. 50 0.15
INLAND – U.S. 0.02
US/BULG 0.8
0.2 U.S.
0.5 LABOR (50% OF MAT'L)
LEVA 32
1.1 0.1155
5.25 BULG RATE US $
166 BULG RATE LEVA

## THERMAL BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | ITEM | | NO. OF PLANTS | COST | ACTION | NECESSITY | % TOTAL | MTL % SUBTOTAL | C.F. YEAR | CNTR MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | U.S. LABOR U.S. $ | BULG LABOR U.S. $ | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | C.F. TOTAL /YEAR 1996 | 2003 | 1994 | BULG LABOR US $ 1996 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1,2,& 3 retire units 1 & 2 | BURNERS | | 1 | 218.30 | REPLACE NOW | NECESSITY | | 0.758 | 1994 | | 37.11 | 255.41 | 25.54 | 11.80 | | 255.41 | | | 11.80 | | |
| | BURNER MGM'T | multiplier | | * | REPLACE NOW | NECESSITY | | | 1994 | 306.66 | 52.51 | 361.38 | 8.19 | 3.78 | | 361.38 | | | 3.78 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | | | | 0.00 | | | 0.00 | |
| | FD FAN OPTION | 161.30 | | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | 65.68 | | | 3.17 | | |
| | DUCT WORK FOR BURNERS | | | 58.70 | REPLACE NOW | NECESSITY | | 0.212 | 1994 | | 8.98 | 68.68 | 6.67 | 3.17 | | | 0.00 | | | 0.00 | |
| | SOOTBLOWERS | 92.40 | | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1998 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | |
| | | SUBTOTAL | | 277 | | | 0.10 | | | 306.66 | 99.60 | 685.48 | 40.80 | 18.76 | 18.76 | 685.48 | 0.00 | 0.00 | 18.76 | 0.00 | 0.00 |
| SOFIA – 4, 5 & 6 | WATERWALLS | | 3 | 3634.5 | REPLACE 5 YEARS | ENHANCEMENT | | 0.437 | 1996 | | 617.87 | 4252.37 | 425.24 | 196.46 | | | 4252.37 | | | 196.46 | |
| | BURNERS | | | 1227.9 | REPLACE NOW | NECESSITY | | 0.148 | 1994 | | 208.74 | 1436.64 | 143.66 | 66.37 | | 1436.64 | | | 66.37 | | |
| | BURNER MGM'T | | | ** | REPLACE NOW | NECESSITY | | | 1994 | 617.76 | 105.02 | 722.78 | 16.38 | 7.57 | | 722.78 | | | 7.57 | | |
| | COMB. CONTROLS | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | 44.94 |
| | SOOTBLOWERS | | | 631.3 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.100 | 2003 | | 141.32 | 972.62 | 97.26 | 44.94 | | | 972.62 | | | | |
| | MAINSTEAM LINE | | | 1349.4 | REPLACE NOW | NECESSITY | | 0.182 | 1994 | | 229.40 | 1578.80 | 157.88 | 72.94 | | 1578.80 | | | 72.94 | | |
| | AIRHEATER RETUBE | | | 1273.8 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.153 | 2003 | | 216.55 | 1490.35 | 149.03 | 68.85 | | | 1490.35 | | | | 68.85 |
| | | SUBTOTAL | | 8316.9 | | | 0.20 | | | 617.76 | 1518.89 | 10453.56 | 968.46 | 457.13 | 152.38 | 3738.22 | 4252.37 | 2462.97 | 146.88 | 196.46 | 113.79 |
| SOFIA – 7 retire unit 7 | WATERWALLS | 0 | 0 | 0 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | BURNERS | | | 0 | REPLACE NOW | NECESSITY | | 0.000 | 1994 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | | | 0.00 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | | 1994 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | | | | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | 0.00 |
| | SOOTBLOWERS | 0 | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | | 0.00 |
| | AIRHEATER RETUBE | 0 | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | | 0.00 |
| | | SUBTOTAL | | 0 | | | 0.20 | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SOFIA – 8 | WATERWALLS | | 1 | 1931.8 | REPLACE 5 YEARS | ENHANCEMENT | | 0.596 | 1996 | | 326.41 | 2260.21 | 226.02 | 104.42 | | | 2260.21 | | | 104.42 | |
| | BURNERS | | | 791.3 | REPLACE NOW | NECESSITY | | 0.244 | 1994 | | 134.52 | 925.82 | 92.58 | 42.77 | | 925.82 | | | 42.77 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | 0.000 | 1994 | 1235.52 | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | 0.000 | 1994 | | | | | 0.00 | | | | | | | 4.99 |
| | SOOTBLOWERS | | | 92.4 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.029 | 2003 | | 15.71 | 108.11 | 10.81 | 4.99 | | | 108.11 | | | | 22.95 |
| | AIRHEATER RETUBE | | | 424.6 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.131 | 2003 | | 72.16 | 496.78 | 49.68 | 22.95 | | | 496.78 | | | | |
| | | SUBTOTAL | | 3240.1 | | | 0.40 | | | 1235.52 | 760.66 | 5236.48 | 411.85 | 190.28 | | 2371.38 | 2260.21 | 604.89 | 57.91 | 104.42 | 27.95 |
| SOFIA – 9 | BURNERS | | 1 | 625.4 | REPLACE 10 YEARS | NECESSITY | 0.10 | 1.000 | 2003 | 306.66 | 158.83 | 1093.11 | 8.19 | 3.78 | 3.78 | | | 1093.11 | | | 3.78 |
| | | SUBTOTAL | | 625.4 | | | | | | 306.66 | 158.83 | 1093.11 | 8.19 | 3.78 | | 0.00 | 0.00 | 1093.11 | 0.00 | 0.00 | 3.78 |
| | | *TOTAL SOFIA COSTS* | | 12458.4 | | | 1.000 | | | 2471.04 | 2538.17 | 17468.81 | 1450.10 | 669.95 | | | | | | | |
| | | | 0.78 | 3068.80 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | | | 0.78 | 408.50 | multiplied by 0.78% | | | | | | | | | | | | | | | | |

* TOTAL ALL UNITS AT PLANT THE COST IS INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

## HOT WATER BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1 – 6 retire units 1 – 2 | SOOTBLOWERS | | 4 | 184.60 | REPLACE 5 YEARS | ENHANCEMENT | | 0.058 | 1996 | 1722.3 | 324.21 | 2231.31 | 223.13 | 103.08 | | | 2231.31 | | | 103.08 | |
| | WATERWALLS | multiplier | 0.50 | 1976.20 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.598 | 2003 | | 336.29 | 2314.49 | 231.45 | 106.93 | | | | 2314.49 | | | 106.93 |
| | BURNERS | | | 1154.60 | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.348 | 2003 | | 196.32 | 1351.12 | 135.11 | 62.42 | | | | 1351.12 | | | 62.42 |
| | BURNER CONTROLS | | | * | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 3317.6 | | | 1.000 | 1.000 | | 1722.3 | 856.82 | 5896.92 | 589.69 | 272.44 | | 68.11 | 0.00 | 2231.31 | 0.00 | 103.08 | 169.35 |
| | | TOTALS | | | | | | | | | | 23365.53 | 2038.79 | 842.39 | | 243.03 | 6795.08 | 6743.86 | 223.55 | 403.87 | 314.67 |
| | | | | 1722.30 | reduced by 0.50% | | | | | | TOTAL MAT'L | 23365.53 | | | | | | | | | |
| | | | | 195.00 | reduced by 0.50% | | | | | | | | | | % OF TOTAL | 29.08% | 37.42% | 33.50% | 23.72% | 42.87% | 33.41% |

* TOTAL ALL UNITS AT PLANT THE COST IS INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 23365.5 | 2982.2 | 0.000% | 31.601% |

BEST AVAILABLE COPY

754

LM6000DLN S-2 SOFIA PLANT 4 a
CG41-0MWR3 MID - RANGE

## *S2 Combustion Turbine Generator / HRSG Additions 4 a*

FILE: CTHRSGS2.WK3
DATE: 09-Feb-94
TIME: 11:47 AM

MATERIAL

| | | UNIT 1 | | UNIT 2 |
|---|---|---|---|---|
| | CT MATERIAL | 14,200,000 | | 14,200,000 |
| | CT FREIGHT | 2,414,000 | | 2,414,000 |
| | TOTAL MATERIAL US$ | 16,614,000 | | 16,614,000 |
| ITEM 4a | TOTAL MATERIAL/FREIGHT CT,s FOR 2 UNITS | 33,228,000 | | |
| | HRSG MATERIAL | 1,960,000 | | 1,960,000 |
| | HRSG FREIGHT | 333,200 | | 333,200 |
| | TOTAL MATERIAL US$ | 2,293,200 | | 2,293,200 |
| ITEM 5c | TOTAL MATERIAL/FREIGHT HRSG,s FOR 2 UNITS | 4,586,400 | | |
| | B.O.P. MATERIAL | 2,207,200 | | 1,959,000 |
| | B.O.P. FREIGHT | 375,200 | | 333,000 |
| | TOTAL MATERIAL US$ | 2,582,400 | | 2,292,000 |
| ITEM 3 | TOTAL MATERIAL/FREIGHT B.O.P.,s FOR 2 UNITS | 4,874,400 | | |
| | MATERIAL CHECK | 36,486,200 | | |
| | TOTAL MAT'L 2 UNITS | 36,486,200 | | |
| | FREIGHT CHECK | 6,202,600 | 3,122,400 | |
| | TOTAL FGT 2 UNITS | 6,202,600 | | |
| | TPC 2 UNITS | 51,961,680 | | |

THEREFORE:

| ITEM No. | | |
|---|---|---|
| 3 = | B.O.P. MTL + FGT + LBR | 9,919,480 |
| 4a = | CT MTL + FGT + LBR | 36,397,400 |
| 5c = | HRSG MTL + FGT + LBR | 5,644,800 |

DEMOLITION - REMOVE EXIST. T/G 1 & 2, 12 & 6 MW EA.

| | | | |
|---|---|---|---|
| AHF ( U.S. ) | 100,000 | 100000.000 | = BASE |
| LEVA ( U.S.$ ) | 100,000 | 1.100 | 110,000 |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 42,688.8 | 2,711.4 | 2.000% | 31.601% |

BEST AVAILABLE COPY

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE: | STGMOD92.WK3 | S1 | 19/25 | 26/50 | OCEAN – U.S. | HOTEL/DAY | 100 | | 50.00 U.S. | | | | | | | | |
| DATE: | 18-Jan-94 | S2 | CAP. | CAP. | 0.16 | MEALS/DAY | 15 | MEN | 6 | 6 | LEVA | /HR | | | | | |
| TIME: | 01:16 PM | S3 | EXP. | EXP. | INLAND – U.S. | CAR/DAY | 60 | WEEKS | 6 | 6 | 32 | 5.25 BULG IN US $ | | | | | |
| | | | 1.98 | 1.98 | 0.02 | | --- | WEEKS | 5 | | | 168 BULG IN LEVA | | | | | |
| | | | | | | | 175 | 5 / 6 | 40 | 40 | | | | | | | |
| | | | | | | | | EXP. MEN | 2 | | | | | | | | |
| | | | | | | | | DAYS | 7 | | | | | | | | |

| TURBINE GENERATOR – MODIFICATIONS – SOFIA PLANTS – 4b | | ITEM | | NO. OF PLANTS | COST | MTL % SUBTOTAL | C.F. YEAR | FREIGHT | TOTAL MTL. U.S. $ | TOTAL MTL. /PLANT U.S. $ | U.S $ EXPENSES LEVA | INSTALLATION U.S. $ | INSTALLATION LEVA | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1996 | MTL. $ U.S. 2003 | LABOR LEVA 1994 | LABOR LEVA 1996 | LABOR LEVA 2003 | MTL. LEVA 1994 | MTL. LEVA 1996 | MTL. LEVA 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 4 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 382.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | SUBTOTAL | | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 382.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 382.00 | 382.00 | 382.00 |
| SOFIA – 5 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 382.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | SUBTOTAL | | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 382.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 382.00 | 382.00 | 382.00 |
| SOFIA – 6 | MW 50 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 1 | 80.00 | 80.00 | 80.00 | | 13.80 | 93.80 | | | | | | | | | | | | | | |
| | | SUBTOTAL | | | 460.00 | 460.00 | | 78.20 | 538.20 | 538.20 | 470.40 | 80.00 | 268.80 | 268.80 | 538.20 | 444.80 | 444.80 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| SOFIA – 9 | MW 25 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 77 | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | SUBTOTAL | | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 470.40 | 80.00 | 268.80 | 268.80 | 444.60 | 444.60 | 444.60 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | | TOTALS | | | | | | | LEVA = | | 1724.80 | USE= | 1075.20 | 1075.20 | | | | 1075.20 | 1075.20 | 1075.20 | 1724.80 | 1724.80 | 1724.80 |
| | | | | | | | | | | | | | | | | | LEVA = | 1075.20 | 1075.20 | 1075.20 | | | |
| | | | | | | | | | US $ = | 1310.40 | 53.80 | 320.00 | 64.00 | | 1310.40 | 1216.80 | 1216.80 | US $ = | 64.00 | 64.00 | 64.00 | | | |
| | | | | | | | | | | | | 373.90 | | | | | | | | | | | |
| | | | | | | | | | | | | LEVA = | 948.19 LABOR INC 10% PROD LBR | | | | | | | | | | |
| | | | | | | | | TOTAL US $ *3 = | | MTL. 4092.8 | Included w 4092.8 | 960 | 299.79 LABOR IN US $ FOR 5 PLANTS | | | | | | | | | | |

| MODEL COST SUMMARY (US $) | EQUIP/ MATL | LABOR | PERCENT LOCAL MATL | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| | 4092.8 | 280.704 | 3.951% | 31.601% |

FILE: S2EQUIP WK3
DATE: 1-Dec-93

DATE: 01-Feb-94
TIME: 11:13 AM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | SUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 80 | 1 | 12 | 2 | 281 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | SUBTOTAL | | | | | | | | $1,390 | | | | US | $0 | | LEVA | 91 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 1,390 MATERIAL (US $) | 0 | 1389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 1,389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *91 LABOR(LEVA)* | *0* | *90.92* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **1389.96** | **2.84** | **0.00%** | **100.00%** |

FILE: S2PIP10B.WK3
DATE: 22-Nov-93

DATE: 23-Mar-94
TIME: 03:34 PM

## SOFIA PLANTS ( 10 b 1 )

# HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

### *LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB.COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 2.142 | 37 | 6 | 1 | 43 | | 414 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 39,066 | 720 | 108 | 14 | 842 | | 8,065 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 69,778 | 1,552 | 233 | 31 | 1,816 | | 17,432 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 120,988 | 3,017 | 452 | 60 | 3,529 | | 33,663 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 36,756 | 1,223 | 183 | 24 | 1,431 | | 13,739 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 24,542 | 910 | 136 | 18 | 1,064 | | 10,218 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 388 | 144 | 44.30 | 51,700 | 2,290 | 344 | 46 | 2,679 | | 25,723 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 17,088 | 1,110 | 167 | 22 | 1,299 | | 12,472 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 3,942 | 368 | 55 | 7 | 430 | | 4,128 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 6,076 | 693 | 104 | 14 | 811 | | 7,784 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 60 | 8 | 1 | 0 | 9 | | 89 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 7,280 | 1,056 | 158 | 21 | 1,235 | | 11,856 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 1,610 | 248 | 37 | 5 | 291 | | 2,790 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 7,024 | 1,284 | 193 | 26 | 1,503 | | 14,426 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 188.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,764 | – | 232.00 | 14,418 | 3,345 | 502 | 67 | 3,914 | | 37,571 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | – | 409.17 | 7,960 | 3,257 | 489 | 65 | 3,811 | | 36,582 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | 1,690 | 837 | 126 | 17 | 979 | | 9,399 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | 1,836 | 1,276 | 191 | 26 | 1,493 | | 14,336 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 413,976 | | | US | $27,160 | LEVA | 260,928 |

### *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 23,960 | 597 | 90 | 12 | 699 | | 6,710 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 7,196 | 239 | 36 | 5 | 280 | | 2,690 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 7,738 | 287 | 43 | 6 | 336 | | 3,221 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 388 | 144 | 44.30 | 7,772 | 344 | 52 | 7 | 403 | | 3,867 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 9,084 | 590 | 89 | 12 | 691 | | 6,631 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 5,288 | 493 | 74 | 10 | 577 | | 5,537 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 5,240 | 598 | 90 | 12 | 699 | | 6,713 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 1,044 | 138 | 21 | 3 | 161 | | 1,548 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 13,690 | 1,985 | 298 | 40 | 2,323 | | 22,296 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 180 | 28 | 4 | 1 | 32 | | 312 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 4,618 | 844 | 127 | 17 | 988 | | 9,484 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 188.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,764 | – | 232.00 | 3,454 | 801 | 120 | 16 | 938 | | 9,001 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | – | 409.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 69,264 | | | US | $8,126 | LEVA | 78,010 |

(1) LABOR PERCENT PROVIDED BY CLIENT

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## OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET
(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL US $ / 12 M | FTGS INSUL ALLOW $ /12M | PIPE/FTGS INSUL US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA–000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -46/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.67 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 146 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.68 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 158 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 36.08 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.68 | 0.842 | 3,327 | 168.00 | 559 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 341 | 104 | 37.08 | 1,430 | 53 | 8 | 1 | 62 | 1.55 | 0.776 | 4,164 | 168.00 | 703 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 1,470 | 65 | 10 | 1 | 76 | 1.90 | 0.949 | 245 | 168.00 | 41 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 128 | 52.50 | 80 | 4 | 1 | 0 | 5 | 2.04 | 1.020 | 5,515 | 168.00 | 926 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 1,360 | 101 | 15 | 2 | 118 | 2.70 | 1.352 | 3,218 | 168.00 | 541 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 720 | 57 | 9 | 1 | 67 | 2.98 | 1.490 | 22,997 | 168.00 | 3,864 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 86.33 | 4,420 | 382 | 57 | 8 | 446 | 3.47 | 1.734 | 759 | 168.00 | 128 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 140 | 12 | 2 | 0 | 14 | 3.62 | 1.808 | 25,449 | 168.00 | 4,275 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 4,528 | 456 | 68 | 9 | 534 | 3.75 | 1.873 | 0 | 168.00 | 0 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | – | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 37,297 | 168.00 | 6,266 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 5,362 | 579 | 87 | 12 | 677 | 4.62 | 2.310 | 0 | 168.00 | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 16,642 | 168.00 | 2,796 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | – | 127.00 | 2,050 | 260 | 39 | 5 | 305 | 5.41 | 2.706 | 0 | 168.00 | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 22,298 | 168.00 | 3,746 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 1,909 | – | 159.08 | 1702 | 271 | 41 | 5 | 317 | 6.73 | 4.367 | 0 | 168.00 | 0 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 48,727 | 168.00 | 8,186 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 2,980 | 591 | 89 | 12 | 692 | 10.90 | 5.451 | 0 | 168.00 | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | – | 0 | 0 | 0 | 0 | 13.07 | 6.534 | | | |
| | | | | | | | | | 26,262 | | | US | $3,312 | | | | LEVA | 32,031 |

## SOFIA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27160 | MATERIAL (US $) | | 951.30 | 2201.58 | 2745.18 | 2908.26 | 3016.98 | 3071.34 | 3071.34 | 3071.34 | 3071.34 | 3071.34 |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 260928 | *LABOR(LEVA)* | | *9132.47* | *21135.14* | *26353.69* | *27919.26* | *28962.97* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 260928 | *TOTAL (LEVA)* | | *9132.47* | *21135.14* | *26353.69* | *27919.26* | *28962.97* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 27,179.96 | 8,153.99 | 0.00% | 100.00% |

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**CASH FLOW (000)** *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 6126 | MATERIAL (US $) | | 408.30 | 1625.21 | 2031.51 | 2031.51 | 2031.51 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 78010 | *LABOR(LEVA)* | | *3900.51* | *15602.03* | *19502.54* | *19502.54* | *19502.54* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 78010 | *TOTAL (LEVA)* | | *3900.51* | *15602.03* | *19502.54* | *19502.54* | *19502.54* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 8,126.06 | 2,437.82 | 0.00% | 100.00% |

**CASH FLOW (000)** *OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 3312 | MATERIAL (US $) | | 165.58 | 662.32 | 827.91 | 827.91 | 827.91 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 32031 | *LABOR(LEVA)* | | *1601.53* | *6406.10* | *8007.63* | *8007.63* | *8007.63* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 32031 | *TOTAL (LEVA)* | | *1601.53* | *6406.10* | *8007.63* | *8007.63* | *8007.63* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 3,311.62 | 1,000.95 | 0.00% | 100.00% |

**CASH FLOW (000)** *TOTAL DISTRIBUTION PIPING*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38618 | MATERIAL (US $) | | 1523.18 | 4469.11 | 5804.60 | 5767.68 | 5876.40 | 3071.34 | 3071.34 | 3071.34 | 3071.34 | 3071.34 |
| | | % | 3.94% | 11.62% | 14.51% | 14.94% | 15.22% | 7.95% | 7.95% | 7.95% | 7.95% | 7.95% |
| 370968 | *LABOR(LEVA)* | | *14634.50* | *43143.27* | *53863.88* | *55429.43* | *56473.14* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 370968 | *TOTAL (LEVA)* | | *14634.50* | *43143.27* | *53863.88* | *55429.43* | *56473.14* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| | | % | 3.94% | 11.63% | 14.52% | 14.94% | 15.22% | 7.95% | 7.95% | 7.95% | 7.95% | 7.95% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 38,617.64 | 11,592.76 | 0.00% | 100.00% |

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FILE: S2_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 03:55 PM

# SOFIA (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $(000) | SUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 12 | 1950 | 260 | 546 | 12.00 | 432 | 66 | 50 | 4 | 380 | 168 | 64 |
| | SUBTOTAL | | | | | | | | $137 (.25 MULTIPLIER-25% ALLOT FOR SOFIA) | | | | US | $1 | | LEVA | $16 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 5,312,500 | 1 | 796875 | 106250 | 6216 | N/A | N/A | N/A | N/A | 261 | N/A | N/A | 23100 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *37,500* | *1* | – | – | *38* | | | | | | | | |
| | TOTAL US $ | | | | 5,350,000 | 1 | – | – | 6,390 | | | | | 262 | | | 23,116 |

**CASH FLOW (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 137 MATERIAL (US $) | 1.92 | 23.27 | 27.93 | 27.93 | 27.93 | 27.93 |
| 1 LABOR (US $) | 0.02 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 |
| SUBTOTAL | 1.93 | 23.45 | 28.15 | 28.15 | 28.15 | 28.15 |
| *16 LABOR(LEVA)* | *0.22* | *2.71* | *3.26* | *3.26* | *3.26* | *3.26* |
| 6,218 WEST. SCADA EQUIPMENT | 87.02 | 1056.66 | 1267.99 | 1267.99 | 1267.99 | 1267.99 |
| 38 FIBER OPTIC LEASING | 0.53 | 6.38 | 7.65 | 7.65 | 7.65 | 7.65 |
| 281 WEST. SCADA LABOR (US $) | 3.94 | 47.81 | 57.38 | 57.38 | 57.38 | 57.38 |
| SUBTOTAL | 91.48 | 1,110.84 | 1,333.01 | 1,333.01 | 1,333.01 | 1,333.01 |
| 6,672 TOTAL US $ | 93.41 | 1,134.30 | 1,361.16 | 1,361.16 | 1,361.16 | 1,361.16 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *23,100 WEST. SCADA LABOR (LEVA)* | *323.40* | *3927.00* | *4712.40* | *4712.40* | *4712.40* | *4712.40* |
| *23,116 TOTAL (LEVA)* | *323.62* | *3,929.71* | *4,715.66* | *4,715.66* | *4,715.66* | *4,715.66* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **6,390.02** | **1,004.70** | **0.000%** | **71.899%** |

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FILE: S2HDSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:23 PM

# SOFIA (4) HEATING SUBSTATIONS I & C (11)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | | NOTE 1 | 1 LOT | 7000 | 3675 | INC. | INC. | 25725 | 1000 | 3,675 | 129,360 |
| CONSISTING OF: | | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | | |
| RTD | | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | | |
| | | | | | | | | --- | | --- | --- |
| | | TOTAL US $ | | | | | | $25,725 | | 0 | $129,360 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 25,725 MATERIAL (US $) | 360.15 | 4373.25 | 5247.90 | 5247.90 | 5247.90 | 5247.90 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 360.15 | 4,373.25 | 5,247.90 | 5,247.90 | 5,247.90 | 5,247.90 |
| *129,360 LABOR(LEVA)* | *1811.04* | *21991.20* | *26389.44* | *26389.44* | *26389.44* | *26389.44* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **25,725.00** | **4,042.50** | **0.000%** | **100.000%** |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

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762

CTCCA_S3.WK3
DATE: 1/4/94

CG75.MW6FA BIG – RANGE
PG6918FA HI–TEMP

S – 3 COMBINED CYCLE PLANT

CT = 75000kw, TG = 38000kw

| $ FGT | | MTL | LABOR | TOTAL |
|---|---|---|---|---|
| 146,425 | SITE IMPROVEMENTS | 861,322 | 804,678 | 1,666,000 |
| 141,984 | FOUNDATIONS | 835,083 | 1,247,416 | 2,082,500 |
| 92,755 | STRUCTURES | 545,615 | 287,385 | 833,000 |
| 3,449,521 | COMBUSTION TURBINE | 20,291,300 | 2,434,956 | 22,726,256 |
| 769,250 | HEAT RECOVERY STEAM GENERATOR | 4,525,000 | 905,000 | 5,430,000 |
| 886,000 | TURBINE GENERATOR | 5,800,000 | 986,000 | 6,786,000 |
| 455,059 | B.O.P. MISC. MECHANICAL EQUIPMENT | 2,676,820 | 591,580 | 3,268,400 |
| 228,440 | PIPING – OUTSIDE | 1,332,001 | 1,342,699 | 2,674,700 |
| 0 | PIPING – INSIDE | W/ABV. | W/ABV. | W/ABV. |
| 512,136 | ELECTRICAL EQUIPMENT | 3,012,564 | 426,436 | 3,439,000 |
| 204,798 | ELECTRICAL/I&C BULK MATERIALS | 1,204,693 | 927,507 | 2,132,200 |
| | TOTAL DIRECT COST | 41,094,397 | 9,953,659 | 51,038,056 |
| 6,994,347 | FREIGHT – OCEAN & INLAND | 6,994,347 | | 6,994,347 |
| | TOTAL | 48,088,744 | 9,953,659 | 58,022,403 |

| | U.S. | $/MH | $/kw |
|---|---|---|---|
| MANHOURS (S 3) | 226,220 | 44 | DP&L (REFERENCE) |
| CHECK | | | 58,022,403 |

| ITEM No. | DESCRIPTION | MAT'L/FGT U.S. $ (000) | LABOR U.S. $ (000) | TOTALS U.S. $ (000) | PERCENT LOCAL LABOR |
|---|---|---|---|---|---|
| 3 | SITEWORK, FDNS & STRUCTURES | 2,623.16 | 684.06 | 3,307.23 | 31.601% |
| 4a | COMBUSTION TURBINE | 23,740.62 | 711.98 | 24,452.60 | 31.601% |
| 4b | TURBINE GENERATOR | 6,786.00 | 288.31 | 7,074.31 | 31.601% |
| 5c | HRSG | 5,294.25 | 284.62 | 5,578.87 | 31.601% |
| 7c | B.O.P. | 4,690.32 | 565.58 | 5,255.90 | 31.601% |
| 8 | ELECTRICAL / I&C | 4,934.19 | 395.89 | 5,330.08 | 31.601% |
| 1b | DEMOLITION – 50 % of S 2 | | 11.66 | 11.66 | 100.000% |
| | TOTAL U.S. $ | 48,068.74 | 2,922.11 | 50,990.85 | |

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763

FILE: S3EQUIP.WK3
DATE: 1-Dec-93

DATE: 01-Feb-94
TIME: 11:13 AM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 80 | 1 | 12 | 2 | 261 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | 80 | 1 | 8 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | SUBTOTAL | | | | | | | | $1,390 | | | | US | $0 | | LEVA | 91 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 1,390 MATERIAL (US $) | 0 | 1389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 1,389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *91 LABOR(LEVA)* | *0* | *90.82* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | 1389.96 | 2.84 | 0.00% | 100.00% |

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| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE: | STGMOD93.WK3 | 18/25 | 25/50 | OCEAN – U.S. | HOTEL/DAY | 100 | | 50.00 U.S. | | | | | | | |
| DATE: | 12–Jul–94 | CAP. | CAP. | 0.15 | MEALS/DAY | 15 | MEN | 8 | 6 | LEVA | /HR | | | | |
| TIME: | 07:51 AM | EXP. | EXP. | INLAND – U.S. | CAR/DAY | 60 | WEEKS | 8 | 6 | 32 | 5.25 BULG IN US $ | | | | |
| | | 1.88 | 1.88 | 0.02 | | ---- | WEEKS | 5 | | | 168 BULG IN LEVA | | | | |
| | | | | | | 175 | 5 / 6 | 40 | 40 | | | | | | |
| | | | | | | | EXP. MEN | 2 | | | | | | | |
| | | | | | | | DAYS | 7 | | | | | | | |

TURBINE GENERATOR – MODIFICATIONS – SOFIA PLANTS – 4b

| | | ITEM | | NO. OF PLANTS | COST | MTL % SUBTOTAL | C.F. YEAR | FREIGHT | TOTAL MTL. U.S. $ | TOTAL MTL. /PLANT U.S. $ | U.S $ EXPENSES LEVA | INSTALLATION U.S. $ | INSTALLATION LEVA | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1998 | MTL. $ U.S. 2003 | LABOR LEVA 1994 | LABOR LEVA 1998 | LABOR LEVA 2003 | MTL. LEVA 1994 | MTL. LEVA 1998 | MTL. LEVA 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 4 | | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 392.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | MW | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | 18 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 392.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | | 268.80 | 268.80 | 268.80 | 392.00 | 392.00 | 392.00 |
| SOFIA – 5 | | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 392.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | MW | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | 18 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 392.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | | 268.80 | 268.80 | 268.80 | 392.00 | 392.00 | 392.00 |
| SOFIA – 6 | | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | MW | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | 50 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1–TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 1 | 80.00 | 80.00 | 80.00 | | 13.60 | 93.60 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 460.00 | 460.00 | | 78.20 | 538.20 | 538.20 | 470.40 | 80.00 | 268.80 | 268.80 | 538.20 | 444.60 | 444.60 | | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| SOFIA – 8 | | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | MW | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | 25 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1–TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | ?? | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 470.40 | 80.00 | 268.80 | 268.80 | 444.60 | 444.60 | 444.60 | | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | | | TOTALS | | | | | | LEVA = | | 1724.80 | USE= | 1075.20 | 1075.20 | | | | | 1075.20 | 1075.20 | 1075.20 | 1724.80 | 1724.80 | 1724.80 |
| | | | | | | | | | | | | | | | | | LEVA = | | 1075.20 | 1075.20 | 1075.20 | | | |
| | | | | | | | | | US $ = | 1310.40 | 53.90 | 320.00 | 64.00 | | 1310.40 | 1216.80 | 1216.80 | US $ = | 64.00 | 64.00 | 64.00 | | | |
| | | | | | | | | | | | | 373.90 | | | | | | | | | | | | |
| | | | | | | | | | | | | LEVA = | 946.18 LABOR INC 10% PROD | | | | | | | | | | | |
| | | | | | | | | TOTAL US $ *3 = | MTL. 4092.9 | included w 4092.9 | | 950 | LBR 280.70 LABOR IN US $ FOR 3 PLANTS | | | | | | | | | | | |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| | 4092.9 | 280.704 | 3.951% | 31.601% |

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76

FILE: SBLRMS3.WK3
DATE: 12-Jul-94
TIME: 07:45 AM

OCEAN – U.S. 50 0.15 | INLAND – U.S. 0.02 | 0.5 LABOR (50% OF MAT'L) US/BULG 0.2 | LEVA 32 0.1155 | 1.1 | 5.25 BULG RATE US $ 168 BULG RATE LEVA

## THERMAL BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | ITEM | | NO. OF PLANTS | COST | ACTION | NECESSITY | % TOTAL | MTL % SUBTOTAL | C.F. YEAR | CNTR MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | U.S. LABOR U.S. $ | BULG LABOR U.S. $ | TOTAL LBR. /PLANT LEVA | 1994 MTL. $ U.S. | 1996 | C.F. TOTAL /YEAR 2003 | 1994 | BULG LABOR US $ 1996 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1,2,& 3 | BURNERS | | 1 | 216.30 | REPLACE NOW | NECESSITY | | 0.411 | 1994 | | 37.11 | 255.41 | 25.54 | 11.60 | | 255.41 | | | 11.60 | | |
| retire units 1 & 2 | BURNER MGM'T | multiplier | | * | REPLACE NOW | NECESSITY | | | 1994 | 306.66 | 52.51 | 361.39 | 8.19 | 3.76 | | 361.39 | | | 3.76 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | | | | | | | | |
| | FD FAN OPTION | | | 161.30 | REPLACE 5 YEARS | ENHANCEMENT | | 0.304 | 1996 | | 27.42 | 188.72 | 18.87 | 8.72 | | | 188.72 | | | 8.72 | |
| | DUCT WORK FOR BURNERS | | | 58.70 | REPLACE NOW | NECESSITY | | 0.111 | 1994 | | 9.98 | 68.68 | 6.87 | 3.17 | | 68.68 | | | 3.17 | | |
| | SOOTBLOWERS | | | 92.40 | REPLACE 5 YEARS | ENHANCEMENT | | 0.174 | 1996 | | 15.71 | 108.11 | 10.81 | 4.99 | | | 108.11 | | | 4.99 | |
| | | SUBTOTAL | | 530.7 | | | 0.10 | | | 306.66 | 142.73 | 962.31 | 70.28 | 32.47 | 32.47 | 685.48 | 296.83 | 0.00 | 18.76 | 13.71 | 0.00 |
| SOFIA – 4, 5 & 6 | WATERWALLS | | 3 | 3634.5 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 617.67 | 4252.37 | 425.24 | 196.48 | | | 4252.37 | | | 196.48 | |
| | BURNERS | | | 1227.9 | REPLACE NOW | NECESSITY | | 0.000 | 1994 | | 208.74 | 1436.64 | 143.66 | 66.37 | | 1436.64 | | | 66.37 | | |
| | BURNER MGM'T | | | ** | REPLACE NOW | NECESSITY | | | 1994 | 1235.52 | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | |
| | SOOTBLOWERS | | | 531.3 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 141.32 | 972.62 | 97.26 | 44.94 | | | | 972.62 | | | 44.94 |
| | MAINSTEAM LINE | | | 1349.4 | REPLACE NOW | NECESSITY | | 0.000 | 1994 | | 229.40 | 1578.60 | 157.86 | 72.94 | | 1578.60 | | | 72.94 | | |
| | AIRHEATER RETUBE | | | 1273.6 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 216.55 | 1490.35 | 149.03 | 68.85 | | | | 1490.35 | | | 68.85 |
| | | SUBTOTAL | | 8316.9 | | | 0.40 | | | 1235.52 | 1623.91 | 11178.33 | 1005.84 | 464.70 | | 4461.00 | 4252.37 | 2462.97 | 154.45 | 196.48 | 113.79 |
| SOFIA – 7 & 8 | WATERWALLS | | 2 | 3863.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.596 | 1996 | | 656.81 | 4520.41 | 452.04 | 208.84 | | | 4520.41 | | | 208.84 | |
| | BURNERS | | | 1582.6 | REPLACE NOW | NECESSITY | | 0.244 | 1994 | | 269.04 | 1851.64 | 185.16 | 85.55 | | 1851.64 | | | 85.55 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | | 1994 | 1235.52 | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | |
| | SOOTBLOWERS | | | 154.6 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.029 | 2003 | | 31.42 | 216.22 | 21.62 | 9.99 | | | | 216.22 | | | 9.99 |
| | AIRHEATER RETUBE | | | 849.2 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.131 | 2003 | | 144.38 | 993.56 | 99.36 | 45.90 | | | | 993.56 | | | 45.90 |
| | | SUBTOTAL | | 6450.2 | | | 0.40 | | | 1235.52 | 1311.67 | 9027.39 | 790.94 | 385.42 | | 3297.20 | 4520.41 | 1209.78 | 100.68 | 208.84 | 55.89 |
| SOFIA – 9 | BURNERS | | 1 | 625.4 | REPLACE 10 YEARS | NECESSITY | 0.10 | 1.000 | 2003 | 306.66 | 158.83 | 1093.11 | 8.19 | 3.76 | 3.76 | | | 1093.11 | | | 3.76 |
| | | SUBTOTAL | | 625.4 | | | | | | 306.66 | 158.83 | 1093.11 | 8.19 | 3.76 | | 0.00 | 0.00 | 1093.11 | 0.00 | 0.00 | 3.76 |
| | | *TOTAL SOFIA COSTS* | | 15953.2 | | | 1.000 | | | 3066.60 | 3237.14 | 22279.14 | 1875.25 | 866.37 | | | | | | | |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | 0.78 | 3066.60 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | 0.78 | 409.50 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

## HOT WATER BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1 – 6 | SOOTBLOWERS | | 3 | 138.60 | REPLACE 5 YEARS | ENHANCEMENT | | 0.056 | 1996 | 1722.3 | 316.35 | 2177.25 | 217.73 | 100.58 | | | 2177.25 | | | 100.58 | |
| retire units 1 – 3 | WATERWALLS | multiplier | 0.50 | 1483.65 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.596 | 2003 | | 252.22 | 1735.87 | 173.59 | 80.20 | | | | 1735.87 | | | 80.20 |
| | BURNERS | | | 868.10 | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.348 | 2003 | | 147.24 | 1013.34 | 101.33 | 46.82 | | | | 1013.34 | | | 46.82 |
| | BURNER CONTROLS | | | * | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 2488.35 | | | 1.000 | 1.000 | | 1722.3 | 715.81 | 4926.46 | 492.65 | 227.60 | 75.87 | 0.00 | 2177.25 | 2749.21 | 0.00 | 100.59 | 127.01 |
| | | TOTALS | | | | | | | | | | 27205.60 | 2367.90 | 1093.97 | 112.12 | 8443.66 | 11246.86 | 7515.06 | 273.69 | 519.60 | 300.48 |
| | | | | | | | | | | | TOTAL MAT'L | 27205.60 | | | | | | | | | |
| | | | | | | | | | | | | | | | % OF TOTAL | 31.04% | 41.34% | 27.62% | 25.04% | 47.50% | 27.47% |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | | 1722.30 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | | 195.00 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 27205.6 | 3461.9 | 0.000% | 31.501% |

BEST AVAILABLE COPY

FILE:S3PIP108.WK3
DATE: 22-Nov-93

DATE: 23-Mar-94
TIME: 03:39 PM

## SOFIA PLANTS ( 10 b 1 )

# HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

### *LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB.COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 2,142 | 37 | 6 | 1 | 43 | | 414 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 39,066 | 720 | 108 | 14 | 842 | | 8,065 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 69,778 | 1,552 | 233 | 31 | 1,816 | | 17,432 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 120,986 | 3,017 | 452 | 60 | 3,529 | | 33,683 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 258 | 143 | 33.28 | 38,758 | 1,223 | 183 | 24 | 1,431 | | 13,739 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 24,542 | 910 | 136 | 18 | 1,064 | | 10,216 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 388 | 144 | 44.30 | 51,700 | 2,290 | 344 | 46 | 2,679 | | 25,723 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 17,086 | 1,110 | 167 | 22 | 1,299 | | 12,472 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 3,942 | 368 | 55 | 7 | 430 | | 4,128 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 6,078 | 693 | 104 | 14 | 811 | | 7,784 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 60 | 6 | 1 | 0 | 9 | | 89 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 7,280 | 1,056 | 158 | 21 | 1,235 | | 11,856 |
| DN | 450 -457/580 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 1,610 | 248 | 37 | 5 | 291 | | 2,790 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 7,024 | 1,284 | 193 | 26 | 1,503 | | 14,426 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,281 | - | 188.42 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 14,418 | 3,345 | 502 | 67 | 3,914 | | 37,571 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 7,960 | 3,257 | 489 | 65 | 3,811 | | 38,582 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 1,690 | 837 | 126 | 17 | 979 | | 9,399 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 1,838 | 1,276 | 191 | 26 | 1,493 | | 14,338 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 413,978 | | | US | $27,180 | LEVA | 260,928 |

### *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 23,880 | 597 | 90 | 12 | 699 | | 6,710 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 258 | 143 | 33.28 | 7,196 | 239 | 36 | 5 | 280 | | 2,690 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 7,738 | 287 | 43 | 6 | 336 | | 3,221 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 388 | 144 | 44.30 | 7,772 | 344 | 52 | 7 | 403 | | 3,887 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 9,064 | 590 | 89 | 12 | 691 | | 6,631 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 5,288 | 493 | 74 | 10 | 577 | | 5,537 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 5,240 | 598 | 90 | 12 | 699 | | 6,713 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 1,044 | 138 | 21 | 3 | 161 | | 1,548 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 13,690 | 1,985 | 298 | 40 | 2,323 | | 22,296 |
| DN | 450 -457/580 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 180 | 28 | 4 | 1 | 32 | | 312 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 4,618 | 844 | 127 | 17 | 988 | | 9,484 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,281 | - | 188.42 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 3,454 | 801 | 120 | 16 | 938 | | 9,001 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 89,264 | | | US | $8,126 | LEVA | 78,010 |

(1) LABOR PERCENT PROVIDED BY CLIENT

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## OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL. US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.90 | 0.10 | 127 | 97 | 18.87 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 146 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.66 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 156 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 35.06 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.68 | 0.842 | 0 | 168.00 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 341 | 104 | 37.06 | 1,430 | 53 | 8 | 1 | 62 | 1.55 | 0.776 | 3,327 | 168.00 | 559 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 1,470 | 65 | 10 | 1 | 76 | 1.90 | 0.949 | 4,184 | 168.00 | 703 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 128 | 52.50 | 80 | 4 | 1 | 0 | 5 | 2.04 | 1.020 | 245 | 168.00 | 41 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.06 | 1,360 | 101 | 15 | 2 | 118 | 2.70 | 1.352 | 5,515 | 168.00 | 926 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 720 | 57 | 9 | 1 | 67 | 2.98 | 1.490 | 3,216 | 168.00 | 541 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 86.33 | 4,420 | 382 | 57 | 8 | 446 | 3.47 | 1.734 | 22,997 | 168.00 | 3,864 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 140 | 12 | 2 | 0 | 14 | 3.62 | 1.808 | 759 | 168.00 | 128 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 4,528 | 456 | 68 | 9 | 534 | 3.75 | 1.873 | 25,449 | 168.00 | 4,275 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | – | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 5,382 | 579 | 87 | 12 | 677 | 4.62 | 2.310 | 37,297 | 168.00 | 6,266 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | – | 127.00 | 2,050 | 260 | 39 | 5 | 305 | 5.41 | 2.706 | 16,642 | 168.00 | 2,796 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 1,909 | – | 159.08 | 1702 | 271 | 41 | 5 | 317 | 8.73 | 4.367 | 22,298 | 168.00 | 3,746 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 0 | 168.00 | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 2,960 | 591 | 89 | 12 | 692 | 10.90 | 5.451 | 48,727 | 168.00 | 8,186 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | – | 0 | 0 | 0 | 0 | 13.07 | 6.534 | 0 | 168.00 | 0 |
| | | | | | | | | | 26,262 | | | US | $3,312 | | | | LEVA | 32,031 |

## SOFIA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27180 | MATERIAL (US $) | | 951.30 | 2201.58 | 2745.18 | 2906.26 | 3016.96 | 3071.34 | 3071.34 | 3071.34 | 3071.34 | 3071.34 |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 260928 | *LABOR(LEVA)* | | *9132.47* | *21135.14* | *26353.69* | *27919.26* | *28962.97* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 260928 | *TOTAL (LEVA)* | | *9132.47* | *21135.14* | *26353.69* | *27919.26* | *28962.97* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 27,179.96 | 8,153.99 | 0.00% | 100.00% |

BEST AVAILABLE COPY



768

## CASH FLOW (000) *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 8126 | MATERIAL (US $) | | 406.30 | 1625.21 | 2031.51 | 2031.51 | 2031.51 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 78010 | *LABOR(LEVA)* | | *3900.51* | *15602.03* | *19502.54* | *19502.54* | *19502.54* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 78010 | *TOTAL (LEVA)* | | *3900.51* | *15602.03* | *19502.54* | *19502.54* | *19502.54* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 8,126.06 | 2,437.82 | 0.00% | 100.00% |

## CASH FLOW (000) *OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 3312 | MATERIAL (US $) | | 165.58 | 662.32 | 827.91 | 827.91 | 827.91 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 32031 | *LABOR(LEVA)* | | *1601.53* | *6406.10* | *8007.63* | *8007.63* | *8007.63* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 32031 | *TOTAL (LEVA)* | | *1601.53* | *6406.10* | *8007.63* | *8007.63* | *8007.63* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 3,311.62 | 1,000.95 | 0.00% | 100.00% |

## CASH FLOW (000) *TOTAL DISTRIBUTION PIPING*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38618 | MATERIAL (US $) | | 1523.18 | 4489.11 | 5604.60 | 5767.68 | 5878.40 | 3071.34 | 3071.34 | 3071.34 | 3071.34 | 3071.34 |
| | | % | 3.94% | 11.62% | 14.51% | 14.94% | 15.22% | 7.95% | 7.95% | 7.95% | 7.95% | 7.95% |
| 370968 | *LABOR(LEVA)* | | *14634.50* | *43143.27* | *53863.86* | *55429.43* | *58473.14* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 370968 | *TOTAL (LEVA)* | | *14634.50* | *43143.27* | *53863.86* | *55429.43* | *58473.14* | *29484.83* | *29484.83* | *29484.83* | *29484.83* | *29484.83* |
| | | % | 3.94% | 11.63% | 14.52% | 14.94% | 15.22% | 7.95% | 7.95% | 7.95% | 7.95% | 7.95% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 38,617.64 | 11,592.76 | 0.00% | 100.00% |



769

FILE: S3_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 03:55 PM

# SOFIA (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM DESCRIPTION VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $(000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | 3 | EA | 13000 | 12 | 1950 | 260 | 548 | 12.00 | 432 | 86 | 50 | 4 | 380 | 168 | 64 |
| SUBTOTAL | | | | | | | $137 (.25 MULTIPLIER-25% ALLOT FOR SOFIA) | | | | US | $1 | | LEVA | $16 |
| SCADA EQUIPMENT (WESTINGHOUSE) | 1 | LT | 5,312,500 | 1 | 796875 | 106250 | 6216 | N/A | N/A | N/A | N/A | 261 | N/A | N/A | 23100 |
| *FIBER OPTIC LEASING* | *1* | *LT* | *37,500* | *1* | – | – | *38* | | | | | 262 | | | 23,116 |
| TOTAL US $ | | | 5,350,000 | 1 | – | – | 6,390 | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 137 MATERIAL (US $) | 1.92 | 23.27 | 27.93 | 27.93 | 27.93 | 27.93 |
| 1 LABOR (US $) | 0.02 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 |
| SUBTOTAL | 1.93 | 23.45 | 28.15 | 28.15 | 28.15 | 28.15 |
| *16 LABOR(LEVA)* | *0.22* | *2.71* | *3.26* | *3.26* | *3.26* | *3.26* |
| 6,216 WEST. SCADA EQUIPMENT | 67.02 | 1056.66 | 1267.99 | 1267.99 | 1267.99 | 1267.99 |
| 38 FIBER OPTIC LEASING | 0.53 | 6.38 | 7.65 | 7.65 | 7.65 | 7.65 |
| 261 WEST. SCADA LABOR (US $) | 3.94 | 47.81 | 57.36 | 57.36 | 57.36 | 57.36 |
| SUBTOTAL | 91.46 | 1,110.84 | 1,333.01 | 1,333.01 | 1,333.01 | 1,333.01 |
| 6,672 TOTAL US $ | 93.41 | 1,134.30 | 1,361.16 | 1,361.16 | 1,361.16 | 1,361.16 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *23,100 WEST. SCADA LABOR (LEVA)* | *323.40* | *3927.00* | *4712.40* | *4712.40* | *4712.40* | *4712.40* |
| *23,116 TOTAL (LEVA)* | *323.62* | *3,929.71* | *4,715.66* | *4,715.66* | *4,715.66* | *4,715.66* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **6,390.02** | **1,004.70** | **0.000%** | **71.899%** |

FILE: S3HDSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:24 PM

# SOFIA (4) HEATING SUBSTATIONS I & C (11)

| ITEM DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | NOTE 1 | 1 LOT | 7000 | 3675 | INC. | INC. | 25725 | 1000 | 3,675 | 129,360 |
| CONSISTING OF: | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | |
| RTD | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | |
| | | | | | | | --- | | --- | --- |
| TOTAL US $ | | | | | | | $25,725 | | 0 | $129,360 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 25,725 MATERIAL (US $) | 360.15 | 4373.25 | 5247.90 | 5247.90 | 5247.90 | 5247.90 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 360.15 | 4,373.25 | 5,247.90 | 5,247.90 | 5,247.90 | 5,247.90 |
| *129,360 LABOR(LEVA)* | *1811.04* | *21991.20* | *26389.44* | *26389.44* | *26389.44* | *26389.44* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **25,725.00** | **4,042.50** | **0.000%** | **100.000%** |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

CTCCA_SA.WK3
DATE: 7/12/94

CG75.MW6FA BIG – RANGE
PG6918FA HI–TEMP

S–A COMBINED CYCLE PLANT

CT = 75000kw; TG = 36000kw

| $ FGT | | MTL. | LABOR | TOTAL |
|---|---|---|---|---|
| 146,425 | SITE IMPROVEMENTS | 861,322 | 804,678 | 1,666,000 |
| 141,964 | FOUNDATIONS | 835,083 | 1,247,418 | 2,082,500 |
| 92,755 | STRUCTURES | 545,615 | 287,385 | 833,000 |
| 3,449,521 | COMBUSTION TURBINE | 20,291,300 | 2,434,956 | 22,726,256 |
| 769,250 | HEAT RECOVERY STEAM GENERATOR | 4,525,000 | 905,000 | 5,430,000 |
| 966,000 | TURBINE GENERATOR | 5,800,000 | 986,000 | 6,786,000 |
| 455,059 | B.O.P. MISC. MECHANICAL EQUIPMENT | 2,676,820 | 591,580 | 3,268,400 |
| 226,440 | PIPING – OUTSIDE | 1,332,001 | 1,342,699 | 2,674,700 |
| 0 | PIPING – INSIDE | W/ABV. | W/ABV. | W/ABV. |
| 512,136 | ELECTRICAL EQUIPMENT | 3,012,564 | 426,436 | 3,439,000 |
| 204,796 | ELECTRICAL/I&C BULK MATERIALS | 1,204,693 | 927,507 | 2,132,200 |
| | TOTAL DIRECT COST | 41,064,397 | 9,953,659 | 51,038,056 |
| 6,984,347 | FREIGHT – OCEAN & INLAND | 6,984,347 | | 6,984,347 |
| | TOTAL | 48,068,744 | 9,953,659 | 58,022,403 |
| | | | | $/kw |
| | | U.S. | $/MH | |
| | MANHOURS (S 3) | 226,220 | 44 | DP&L (REFERENCE) |
| | CHECK | | | 58,022,403 |

| ITEM No. | DESCRIPTION | MAT'L/FGT U.S. $ (000) | LABOR U.S. $ (000) | TOTALS U.S. $ (000) | PERCENT LOCAL LABOR |
|---|---|---|---|---|---|
| 3 | SITEWORK, FDNS & STRUCTURES | 2,623.16 | 684.06 | 3,307.23 | 31.601% |
| 4a | COMBUSTION TURBINE | 23,740.82 | 711.98 | 24,452.80 | 31.601% |
| 4b | TURBINE GENERATOR | 6,786.00 | 288.31 | 7,074.31 | 31.601% |
| 5c | HRSG | 5,294.25 | 264.62 | 5,558.87 | 31.601% |
| 7c | B.O.P. | 4,690.32 | 565.58 | 5,255.90 | 31.601% |
| 8 | ELECTRICAL / I&C | 4,934.19 | 395.89 | 5,330.08 | 31.601% |
| 1b | DEMOLITION – 50 % of S 2 | | 11.66 | 11.66 | 100.000% |
| | TOTAL U.S. $ | 48,068.74 | 2,922.11 | 50,990.85 | |

BEST AVAILABLE COPY

772

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE: | STGMODSA.WK3 | 18/25 | 25/50 | OCEAN – U.S. | HOTEL/DAY | 100 | | $0.00 U.S. | | | | | | |
| DATE: | 12–Jul–94 | CAP. | CAP. | 0.15 | MEALS/DAY | 15 | MEN | 8 | 8 | LEVA | /HR | | | |
| TIME: | 07:49 AM | EXP. | EXP. | INLAND – U.S. | CAR/DAY | 60 | WEEKS | 8 | 6 | 32 | 5.25 BULG IN US $ | | | |
| | | 1.88 | 1.88 | 0.02 | | ---- | WEEKS | 5 | | | 168 BULG IN LEVA | | | |
| | | | | | | 175 | 5 / 8 | 40 | 40 | | | | | |
| | | | | | | | EXP. MEN | 2 | | | | | | |
| | | | | | | | DAYS | 7 | | | | | | |

TURBINE GENERATOR – MODIFICATIONS – SOFIA PLANTS – 4b

| | ITEM | | NO. OF PLANTS | COST | MTL % SUBTOTAL | C.F. YEAR | FREIGHT | TOTAL MTL. U.S. $ | TOTAL MTL. /PLANT U.S. $ | U.S $ EXPENSES LEVA | INSTALLATION U.S. $ | INSTALLATION LEVA | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1996 | MTL. $ U.S. 2003 | LABOR LEVA 1994 | LABOR LEVA 1996 | LABOR LEVA 2003 | MTL. LEVA 1994 | MTL. LEVA 1996 | MTL. LEVA 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 4 | AIR COOLED GENERATOR | | 1 | 0.00 | 0.00 | | 0.00 | 0.00 | | 0.00 | 0.00 | 0 | 0 | | | | | | | | | |
| RETIRE UNIT 4 MW | CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| 18 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | SUBTOTAL | | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SOFIA – 5 | AIR COOLED GENERATOR | | 1 | 0.00 | 0.00 | | 0.00 | 0.00 | | 0.00 | 0.00 | 0 | 0 | | | | | | | | | |
| RETIRE UNIT 5 MW | CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| 18 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | SUBTOTAL | | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SOFIA – 6 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 60.00 | 268.8 | 268.8 | | | | | | | | | |
| MW | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| 50 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | REPAIR/RECONDITION H.P. CYL. | 1 | 80.00 | 80.00 | 80.00 | | 13.60 | 93.60 | | | | | | | | | | | | | | |
| | SUBTOTAL | | | 460.00 | 460.00 | | 78.20 | 538.20 | 538.20 | 470.40 | 60.00 | 268.80 | 268.80 | 538.20 | 444.60 | 444.60 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| SOFIA – 8 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 60.00 | 268.8 | 268.8 | | | | | | | | | |
| MW | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| 25 | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | REPAIR/RECONDITION H.P. CYL. | ?? | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | SUBTOTAL | | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 470.40 | 60.00 | 268.80 | 268.80 | 444.60 | 444.60 | 444.60 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | TOTALS | | | | | | | LEVA = | | 940.80 | USE= | 537.60 | 537.60 | | | | 537.60 | 537.60 | 537.60 | 940.80 | 940.80 | 940.80 |
| | | | | | | | | | | | | | | | | LEVA = | 537.60 | 537.60 | 537.60 | | | |
| | | | | | | | | US $ = | 962.80 | 29.40 | 160.00 | 32.00 | | 962.80 | 889.20 | 889.20 | US $ = 32.00 | 32.00 | 32.00 | | | |
| | | | | | | | | | | | 189.40 | | | | | | | | | | | |
| | | | | | | | | | | | LEVA = | 473.08 LABOR INC 10% PROD LBR | | | | | | | | | | |
| | | | | | | | TOTAL US $ *3 = | | MTL. 3036.6 | included w 4092.9 | 480 | 140.35 LABOR IN US $ FOR 3 PLANTS | | | | | | | | | | |

| MODEL COST SUMMARY (US $) | EQUIP/ MATL | LABOR | PERCENT LOCAL MATL | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| | 3036.6 | 140.352 | 2.905% | 31.601% |

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FILE: SBLRMSA.WK3
DATE: 12-Jul-94
TIME: 07:47 AM

OCEAN – U.S. 50 0.15 | INLAND – U.S. 0.02 | 0.5 LABOR (50% OF MAT'L) US/BULG 0.2 | LEVA 32 | 1.1 0.1155 | 5.25 BULG RATE US $ 168 BULG RATE LEVA

## THERMAL BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | ITEM | | NO. OF PLANTS | COST | ACTION | NECESSITY | % TOTAL | MTL % SUBTOTAL | C.F. YEAR | CNTR MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | 0.8 U.S. LABOR U.S. $ | BULG LABOR U.S. $ | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1996 | C.F. TOTAL /YEAR 2003 | C.F. TOTAL /YEAR 1994 | BULG LABOR US $ 1996 | BULG LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1,2,& 3 | BURNERS | | 1 | 218.30 | REPLACE NOW | NECESSITY | | 0.411 | 1994 | | 37.11 | 255.41 | 25.54 | 11.80 | | 255.41 | | | 11.80 | | |
| retire units 1 & 2 | BURNER MGM'T | multiplier | | * | REPLACE NOW | NECESSITY | | | 1994 | 306.88 | 52.51 | 361.39 | 5.19 | 3.78 | | 361.39 | | | 3.78 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | | | | | | | | |
| | FD FAN OPTION | | | 161.30 | REPLACE 5 YEARS | ENHANCEMENT | | 0.304 | 1996 | | 27.42 | 188.72 | 18.87 | 8.72 | | | 188.72 | | | 8.72 | |
| | DUCT WORK FOR BURNERS | | | 58.70 | REPLACE NOW | NECESSITY | | 0.111 | 1994 | | 9.98 | 68.68 | 6.87 | 3.17 | | 68.68 | | | 3.17 | | |
| | SOOTBLOWERS | | | 92.40 | REPLACE 5 YEARS | ENHANCEMENT | | 0.174 | 1996 | | 15.71 | 108.11 | 10.81 | 4.99 | | | 108.11 | | | 4.99 | |
| | | SUBTOTAL | | 530.7 | | | 0.10 | | | 306.88 | 142.73 | 962.31 | 70.28 | 32.47 | 32.47 | 685.48 | 296.83 | 0.00 | 18.76 | 13.71 | 0.00 |
| SOFIA – 4, 5 & 6 | WATERWALLS | | 0 | 0 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| retire units 4, 5 & 6 | BURNERS | | | 0 | REPLACE NOW | NECESSITY | | 0.000 | 1994 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | | | 0.00 | | |
| | BURNER MGM'T | | | ** | REPLACE NOW | NECESSITY | | | 1994 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | | | 0.00 | | |
| | COMB. CONTROLS | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | |
| | SOOTBLOWERS | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | MAINSTEAM LINE | | | 0 | REPLACE NOW | NECESSITY | | 0.000 | 1994 | | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | | | 0.00 | | |
| | AIRHEATER RETUBE | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 0 | | | 0.40 | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SOFIA – 7 & 8 | WATERWALLS | | 2 | 3863.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.598 | 1996 | | 656.61 | 4520.41 | 452.04 | 208.64 | | | 4520.41 | | | 208.64 | |
| | BURNERS | | | 1582.6 | REPLACE NOW | NECESSITY | | 0.244 | 1994 | | 269.04 | 1851.64 | 185.16 | 85.55 | | 1851.64 | | | 85.55 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | | 1994 | 1235.52 | 210.04 | 1445.56 | 32.78 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | |
| | SOOTBLOWERS | | | 184.8 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.029 | 2003 | | 31.42 | 216.22 | 21.62 | 9.99 | | | | 216.22 | | | 9.99 |
| | AIRHEATER RETUBE | | | 849.2 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.131 | 2003 | | 144.36 | 993.56 | 99.36 | 45.90 | | | | 993.56 | | | 45.90 |
| | | SUBTOTAL | | 6480.2 | | | 0.40 | | | 1235.52 | 1311.67 | 9027.39 | 790.94 | 365.42 | | 3297.20 | 4520.41 | 1209.78 | 100.68 | 208.64 | 55.89 |
| SOFIA – 9 | BURNERS | | 1 | 625.4 | REPLACE 10 YEARS | NECESSITY | 0.10 | 1.000 | 2003 | 306.88 | 158.83 | 1093.11 | 8.19 | 3.78 | 3.78 | | | 1093.11 | | | 3.78 |
| | | SUBTOTAL | | 625.4 | | | | | | 306.88 | 158.83 | 1093.11 | 8.19 | 3.78 | | 0.00 | 0.00 | 1093.11 | 0.00 | 0.00 | 3.78 |
| | | *TOTAL SOFIA COSTS* | | 7636.3 | | | 1.000 | | | 1853.28 | 1813.23 | 11102.81 | 869.42 | 401.67 | | | | | | | |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | 0.78 | 3066.80 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | 0.78 | 409.50 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT | | | | | | | | | | | | | | | | | | | | |
| | SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

## HOT WATER BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1 – 6 | SOOTBLOWERS | | 3 | 136.60 | REPLACE 5 YEARS | ENHANCEMENT | | 0.056 | 1996 | 1722.3 | 316.35 | 2177.25 | 217.73 | 100.59 | | | 2177.25 | | | 100.59 | |
| retire units 1 – 3 | WATERWALLS | multiplier | 0.50 | 1463.65 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.598 | 2003 | | 252.22 | 1735.67 | 173.58 | 80.20 | | | | 1735.67 | | | 80.20 |
| | BURNERS | | | 588.10 | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.348 | 2003 | | 147.24 | 1013.34 | 101.33 | 46.82 | | | | 1013.34 | | | 46.82 |
| | BURNER CONTROLS | | | * | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 2488.35 | | | 1.000 | 1.000 | | 1722.3 | 715.81 | 4926.48 | 492.65 | 227.60 | 75.87 | 0.00 | 2177.25 | 2749.21 | 0.00 | 100.59 | 127.01 |
| | | TOTALS | | | | | | | | | | 16029.27 | 1362.06 | 629.27 | 112.12 | 3982.68 | 8994.49 | 5052.10 | 118.44 | 323.15 | 186.69 |
| | | | | | | | | | | | TOTAL MAT'L | 16029.27 | | | | | | | | | |
| | | | | | | | | | | | | | | | % OF TOTAL | 24.65% | 43.64% | 31.52% | 18.98% | 51.35% | 29.67% |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | | 1722.30 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | | 195.00 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT | | | | | | | | | | | | | | | | | | | | |
| | SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 16029.3 | 1991.3 | 0.000% | 31.601% |

FILE: SAEQUIP.WK3
DATE: 1-Dec-93

DATE: 12-Jul-94
TIME: 07:40 AM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 80 | 1 | 12 | 2 | 281 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | 80 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | | SUBTOTAL | | | | | | | $1,390 | | | | US | $0 | | LEVA | 91 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 1,390 MATERIAL (US $) | 0 | 1389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 1,389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *91 LABOR(LEVA)* | *0* | *90.92* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **1389.96** | **2.84** | **0.00%** | **100.00%** |

BEST AVAILABLE COPY

775

FILE: SAPIP10B.WK3
DATE: 22-Nov-93

DATE: 12-Jul-94
TIME: 07:42 AM

## SOFIA PLANTS ( 10 b 1 )

# HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

### *LAID DOWN IN DUCT, OVERHEAD, COLLECTOR, INSULATION FOAM-POLYURETHANE*

| | METRIC DIMENSION | U.S. DIA | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $/12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | UNIT MH/M PIPE | ECAV. VOL/M (CM) | ECAV. TOTAL (CM) | UNIT MH/M ECAV. | TOTAL MNHRS PIPE/EXC | *RATE / HR (LEVA)* | *LAB.COST PIPE/EXC (LEVA-000)* | *EXCAV. MAT'L (LEVA-000)* | QTY ALARMS REQ'D | UNIT ALM/WIRE W/FGT US $ | TOTAL ALM/WIRE W/FGT US $(000) | UNIT MH ALM/WIRE | TOTAL MNHRS ALM/WIRE | *LAB.COST ALM/WIRE (LEVA-000)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 1,071 | 18 | 3 | 0 | 22 | 0.67 | 2.100 | 2,249 | 0.448 | 1,201 | *168.00* | *202* | *178* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 19,563 | 360 | 54 | 7 | 422 | 0.81 | 2.167 | 42,393 | 0.462 | 24,656 | *168.00* | *4,181* | *3,358* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 34,804 | 774 | 118 | 15 | 906 | 0.93 | 2.236 | 77,822 | 0.476 | 49,033 | *168.00* | *8,238* | *6,163* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 60,564 | 1,511 | 227 | 30 | 1,767 | 1.03 | 2.305 | 139,646 | 0.491 | 92,089 | *168.00* | *15,471* | *11,080* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.26 | 16,376 | 545 | 82 | 11 | 638 | 1.34 | 2.447 | 40,077 | 0.521 | 30,481 | *168.00* | *5,121* | *3,174* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 12,271 | 455 | 68 | 9 | 532 | 1.62 | 2.593 | 31,819 | 0.552 | 26,708 | *168.00* | *4,487* | *2,520* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 28,685 | 1,161 | 177 | 24 | 1,362 | 1.87 | 2.743 | 73,142 | 0.584 | 65,561 | *168.00* | *11,014* | *5,793* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 9,278 | 603 | 90 | 12 | 705 | 2.22 | 3.058 | 28,354 | 0.651 | 26,683 | *168.00* | *4,483* | *2,246* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 2,011 | 187 | 28 | 4 | 219 | 2.66 | 3.387 | 6,811 | 0.722 | 6,795 | *168.00* | *1,142* | *539* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 3,716 | 424 | 64 | 8 | 496 | 3.14 | 3.734 | 13,883 | 0.795 | 14,642 | *168.00* | *2,460* | *1,100* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 390 | 51 | 8 | 1 | 60 | 3.31 | 4.098 | 1,598 | 0.872 | 1,631 | *168.00* | *274* | *127* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 5,850 | 848 | 127 | 17 | 992 | 3.92 | 4.479 | 26,202 | 0.954 | 28,520 | *168.00* | *4,791* | *2,075* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 875 | 135 | 20 | 3 | 158 | 4.30 | 4.877 | 4,267 | 1.038 | 4,671 | *168.00* | *785* | *338* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 5,776 | 1,056 | 158 | 21 | 1,236 | 4.98 | 5.292 | 30,567 | 1.126 | 35,251 | *168.00* | *5,922* | *2,421* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | - | 6.64 | 5.723 | 0 | 1.219 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 9,900 | 2,297 | 345 | 46 | 2,687 | 9.29 | 6.172 | 61,103 | 1.315 | 104,966 | *168.00* | *17,634* | *4,639* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | - | 10.68 | 6.638 | 0 | 1.414 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 700 -711/900 | 28" | 10 | 8.60 | 0.35 | 4,910 | - | 409.17 | 5,005 | 2,048 | 307 | 41 | 2,396 | 12.51 | 7.120 | 35,636 | 1.516 | 70,212 | *168.00* | *11,796* | *2,622* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 750 -762/900 | 30" | 10 | 8.60 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | - | 15.26 | 7.620 | 0 | 1.623 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 800 -813/1000 | 32" | - | 8.60 | 0.35 | 5,942 | - | 495.17 | 1,696 | 840 | 126 | 17 | 983 | 18.45 | 8.136 | 13,799 | 1.733 | 34,224 | *168.00* | *5,750* | *1,093* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 850 -864/1100 | 34" | - | 8.60 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | - | 21.19 | 8.670 | 0 | 1.846 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | - | 28.63 | 9.220 | 0 | 1.984 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 2,409 | 1,673 | 251 | 33 | 1,957 | 39.11 | 10.372 | 24,986 | 2.209 | 99,525 | *168.00* | *16,720* | *1,979* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | - | 50.90 | 11.591 | 0 | 2.468 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | - | 65.48 | 12.878 | 0 | 2.742 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| | | | | | | | | | 218,244 | | | US | $17,559 | | | | | | *LEVA* | *120,470* | *51,825* | | US | $0 | | *LEVA* | *0* |

### *LAID DOWN - INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | 0.67 | 2.100 | 0 | 0.448 | 0 | *168.00* | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | 0.81 | 2.167 | 0 | 0.462 | 0 | *168.00* | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | 0.93 | 2.236 | 0 | 0.476 | 0 | *168.00* | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 11,980 | 299 | 45 | 6 | 349 | 1.03 | 2.305 | 27,614 | 0.491 | 18,210 | *168.00* | *3,059* | *2,187* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.26 | 3,598 | 120 | 16 | 2 | 140 | 1.34 | 2.447 | 8,804 | 0.521 | 6,696 | *168.00* | *1,125* | *697* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 3,669 | 143 | 22 | 3 | 168 | 1.62 | 2.593 | 10,032 | 0.552 | 8,421 | *168.00* | *1,415* | *795* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 3,886 | 172 | 26 | 3 | 201 | 1.87 | 2.743 | 10,659 | 0.584 | 9,554 | *168.00* | *1,605* | *844* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 4,542 | 295 | 44 | 6 | 345 | 2.22 | 3.058 | 13,880 | 0.651 | 13,063 | *168.00* | *2,195* | *1,099* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 2,644 | 246 | 37 | 5 | 288 | 2.66 | 3.387 | 8,955 | 0.722 | 8,934 | *168.00* | *1,501* | *709* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 2,620 | 299 | 45 | 6 | 350 | 3.14 | 3.734 | 9,783 | 0.795 | 10,318 | *168.00* | *1,733* | *775* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 522 | 69 | 10 | 1 | 81 | 3.31 | 4.098 | 2,139 | 0.872 | 2,183 | *168.00* | *367* | *169* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 6,845 | 993 | 149 | 20 | 1,161 | 3.92 | 4.479 | 30,659 | 0.954 | 33,371 | *168.00* | *5,606* | *2,428* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 90 | 14 | 2 | 0 | 16 | 4.30 | 4.877 | 439 | 1.038 | 480 | *168.00* | *81* | *35* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 2,309 | 422 | 63 | 8 | 494 | 4.98 | 5.292 | 12,219 | 1.126 | 14,092 | *168.00* | *2,367* | *968* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | - | 6.64 | 5.723 | 0 | 1.219 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 1,727 | 401 | 60 | 8 | 469 | 9.29 | 6.172 | 10,659 | 1.315 | 18,311 | *168.00* | *3,078* | *844* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | - | 10.68 | 6.638 | 0 | 1.414 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 700 -711/900 | 28" | 10 | 8.60 | 0.35 | 4,910 | - | 409.17 | 0 | 0 | 0 | 0 | 0 | 12.51 | 7.120 | 0 | 1.516 | 0 | *168.00* | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 750 -762/900 | 30" | 10 | 8.60 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | - | 15.26 | 7.620 | 0 | 1.623 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 800 -813/1000 | 32" | - | 8.60 | 0.35 | 5,942 | - | 495.17 | 0 | 0 | 0 | 0 | 0 | 18.45 | 8.136 | 0 | 1.733 | 0 | *168.00* | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 850 -864/1100 | 34" | - | 8.60 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | - | 21.19 | 8.670 | 0 | 1.846 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | - | 28.63 | 9.220 | 0 | 1.984 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 0 | 0 | 0 | 0 | 0 | 39.11 | 10.372 | 0 | 2.209 | 0 | *168.00* | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | - | 50.90 | 11.591 | 0 | 2.468 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | - | 65.48 | 12.878 | 0 | 2.742 | 0 | - | *0* | *0* | 0 | 1,432 | 0 | 18.00 | 0 | *0* |
| | | | | | | | | | 44,632 | | | US | $4,063 | | | | | | *LEVA* | *24,130* | *11,551* | | US | $0 | | *LEVA* | *0* |

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776

## SOFIA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

**CASH FLOW (000)** *LAID DOWN IN DUCT, OVERHEAD, COLLECTOR, INSULATION FOAM–POLYURETHANE*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17559 | MATERIAL (US $) | 614.55 | 1422.25 | 1773.42 | 1878.77 | 1949.00 | 1984.12 | 1984.12 | 1984.12 | 1984.12 | 1984.12 |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 120470 | LABOR(LEVA) | 4216.44 | 9758.04 | 12167.43 | 12890.25 | 13372.13 | 13613.07 | 13613.07 | 13613.07 | 13613.07 | 13613.07 |
| 51825 | EXCAV.MAT'L(LEVA) | 1813.67 | 4197.81 | 5234.30 | 5545.25 | 5752.55 | 5856.20 | 5856.20 | 5856.20 | 5856.20 | 5856.20 |
| 172294 | TOTAL (LEVA) | 6030.30 | 13955.84 | 17401.73 | 18435.50 | 19124.68 | 19469.26 | 19469.26 | 19469.26 | 19469.26 | 19469.26 |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 19178.11 | 3764.68 | 8.44% | 100.00% |

**CASH FLOW (000)** *LAID DOWN – INSULATION FOAM CONCRETE*

| | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| 4063 | MATERIAL (US $) | 203.15 | 812.61 | 1015.76 | 1015.76 | 1015.76 |
| | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 24130 | LABOR(LEVA) | 1206.52 | 4826.07 | 6032.59 | 6032.59 | 6032.59 |
| 11551 | EXCAV.MAT'L(LEVA) | 577.54 | 2310.16 | 2887.70 | 2887.70 | 2887.70 |
| 35681 | TOTAL (LEVA) | 1784.06 | 7136.24 | 8920.30 | 8920.30 | 8920.30 |
| | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 4423.99 | 754.07 | 8.16% | 100.00% |

**CASH FLOW (000)** *TOTAL DISTRIBUTION PIPING*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21622 | MATERIAL (US $) | 817.70 | 2234.85 | 2788.17 | 2894.53 | 2964.76 | 1984.12 | 1984.12 | 1984.12 | 1984.12 | 1984.12 |
| | % | 3.78% | 10.34% | 12.90% | 13.39% | 13.71% | 9.18% | 9.18% | 9.18% | 9.18% | 9.18% |
| 144600 | LABOR(LEVA) | 5422.95 | 14584.11 | 18200.02 | 18922.84 | 19404.72 | 13613.07 | 13613.07 | 13613.07 | 13613.07 | 13613.07 |
| 63376 | EXCAV.MAT'L(LEVA) | 2391.41 | 6507.97 | 8122.00 | 8432.95 | 8640.25 | 5856.20 | 5856.20 | 5856.20 | 5856.20 | 5856.20 |
| 207976 | TOTAL (LEVA) | 7814.36 | 21092.08 | 26322.03 | 27355.79 | 28044.97 | 19469.26 | 19469.26 | 19469.26 | 19469.26 | 19469.26 |
| | % | 3.76% | 10.14% | 12.66% | 13.15% | 13.48% | 9.36% | 9.36% | 9.36% | 9.36% | 9.36% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 23602.10 | 4518.75 | 8.39% | 100.00% |

FILE: SA_SCADA.WK:
DATE: 1-Dec-93

DATE: 12-Jul-94
TIME: 07:43 AM

# SOFIA (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY | MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $(000) | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROLLER | | | 0 | EA | 1500 | 14700 | 225 | 30 | 0 | 6.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| RTD | | | 0 | EA | 280 | 14700 | 39 | 5 | 0 | 1.50 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| SUBSTATION WIRING | | | 0 | LT | 160 | 14700 | 24 | 3 | 0 | 30.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| CONT.VLVS. | | | | | | | | | | | | | | | | | |
| | 1 1/2" (40MM) | | 0 | EA | 1400 | 7350 | 210 | 28 | 0 | 2.80 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 1 1/2" (40MM) | | 0 | EA | 1400 | 2940 | 210 | 28 | 0 | 2.80 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 2 1/2" (65MM) | | 0 | EA | 2100 | 1470 | 315 | 42 | 0 | 4.10 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 4" (100MM) | | 0 | EA | 3500 | 2940 | 525 | 70 | 0 | 6.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| WTR. MTRS. | | | | | | | | | | | | | | | | | |
| | 1.5 CM/HR | | 0 | EA | 675 | 735 | 101 | 14 | 0 | 4.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 2.5 CM/HR | | 0 | EA | 675 | 1470 | 101 | 14 | 0 | 4.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 6 CM/HR | | 0 | EA | 720 | 3675 | 108 | 14 | 0 | 4.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 6 CM/HR | | 0 | EA | 720 | 5145 | 108 | 14 | 0 | 4.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 10 CM/HR | | 0 | EA | 890 | 2940 | 134 | 18 | 0 | 4.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | 15 CM/HR | | 0 | EA | 1200 | 735 | 180 | 24 | 0 | 4.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| THER RAD VLV | | | 0 | LT | 50 | 882000 | 8 | 1 | 0 | 1.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| FLOW ELEMENTS | | | 3 | EA | 13000 | 12 | 1950 | 260 | 548 | 12.00 | 432 | 86 | 50 | 4 | 380 | 168 | 64 |
| HEAT ALLOCATORS | | | 0 | EA | 12 | 1 | 2 | 0 | 0 | 1.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| ALARM COMPONENTS-ABB/GC | | | 0 | LT | | | | | 0 | | | | | | | | 0 |
| (SEE NOTE 1) | | | | | | | | | | | | | | | | | |
| | SUBTOTAL | | | | | | | | $137 | (.25 MULTIPLIER-25% ALLOT FOR SOFIA) | | | US | $1 | | LEVA | 16 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 5,312,500 | 1 | 796875 | 106250 | 6216 | N/A | N/A | N/A | N/A | 281 | N/A | N/A | 23100 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *37,500* | *1* | - | - | *38* | | | | | | | | |
| | TOTAL US $ | | | | 5,350,000 | 1 | - | - | 6,390 | | | | | 282 | | | 23,116 |

## CASH FLOW (000)

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | |
| 137 | MATERIAL (US $) | 1.92 | 23.27 | 27.93 | 27.93 | 27.93 | 27.93 |
| 1 | LABOR (US $) | 0.02 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 |
| | SUBTOTAL | 1.93 | 23.45 | 28.15 | 28.15 | 28.15 | 28.15 |
| *16* | *LABOR(LEVA)* | *0.22* | *2.71* | *3.26* | *3.26* | *3.26* | *3.26* |
| 6,216 | WEST. SCADA EQUIPMENT | 87.02 | 1056.68 | 1267.99 | 1267.99 | 1267.99 | 1267.99 |
| 38 | FIBER OPTIC LEASING | 0.53 | 6.38 | 7.65 | 7.65 | 7.65 | 7.65 |
| 281 | WEST. SCADA LABOR (US $) | 3.94 | 47.81 | 57.38 | 57.38 | 57.38 | 57.38 |
| | SUBTOTAL | 91.48 | 1,110.84 | 1,333.01 | 1,333.01 | 1,333.01 | 1,333.01 |
| 6,672 | TOTAL US $ | 93.41 | 1,134.30 | 1,361.16 | 1,361.16 | 1,361.16 | 1,361.16 |
| | % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *23,100* | *WEST. SCADA LABOR (LEVA)* | *323.40* | *3927.00* | *4712.40* | *4712.40* | *4712.40* | *4712.40* |
| *23,116* | *TOTAL (LEVA)* | *323.62* | *3,929.71* | *4,715.66* | *4,715.66* | *4,715.66* | *4,715.66* |
| | % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **6390.02** | **1004.70** | **0.000%** | **71.899%** |

NOTE 1: SEE SOFIA 10b1 & 10c1 FOR DETAILS OF PIPE LENGTHS & QUANITY OF ALARMS
NOTE 2: SEE SOFIA 11 FOR SUBSTATION INSTRUMENTS & CONTROLS

78

FILE: SAALARMS.WK:
DATE: 22-Nov-93

DATE: 12-Jul-94

## SOFIA PLANTS (10c1)

## HEATING DISTRIBUTION PIPING W/ ALARM COMPONENTS (10c1)

| METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | UNIT MH/M PIPE | ECAV. VOL/M (CM) | ECAV. TOTAL (CM) | UNIT MH/M ECAV. | TOTAL MNHRS PIPE/EXC | RATE / HR (LEVA) | LAB.COST PIPE/EXC (LEVA-000) | EXCAV. MAT'L (LEVA-000) | QTY ALARMS REQ'D | UNIT ALM/WIRE W/ FGT US $ | TOTAL ALM/WIRE W/ FGT US $(000) | UNIT MH ALM/WIRE | TOTAL MNHRS ALM/WIRE | LAB.COST ALM/WIRE (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN 40 -48/100 | 1 1/2" | 40 | 2.80 | 0.10 | 107 | 100 | 17.21 | 1,071 | 18 | 3 | 0 | 22 | 0.81 | 2.100 | 2,249 | 0.446 | 1,135 | 168.00 | 191 | 178 | 89 | 1,432 | 128 | 18.00 | 1,607 | 270 |
| DN 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 19,563 | 360 | 54 | 7 | 422 | 0.74 | 2.167 | 42,393 | 0.462 | 23,447 | 168.00 | 3,939 | 3,358 | 1,630 | 1,432 | 2,335 | 18.00 | 29,345 | 4,930 |
| DN 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 34,804 | 774 | 116 | 15 | 906 | 0.85 | 2.238 | 77,822 | 0.478 | 48,082 | 168.00 | 7,742 | 6,163 | 2,900 | 1,432 | 4,154 | 18.00 | 52,208 | 8,771 |
| DN 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 72,584 | 1,809 | 271 | 36 | 2,117 | 0.94 | 2.305 | 167,260 | 0.491 | 103,508 | 168.00 | 17,389 | 13,247 | 6,047 | 1,432 | 8,660 | 18.00 | 108,848 | 18,286 |
| DN 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 258 | 143 | 33.28 | 19,976 | 665 | 100 | 13 | 778 | 1.22 | 2.447 | 48,881 | 0.521 | 34,745 | 168.00 | 5,837 | 3,671 | 1,665 | 1,432 | 2,384 | 18.00 | 29,964 | 5,034 |
| DN 125 -139/225 | 5" | 40 | 3.80 | 0.14 | 311 | 134 | 37.06 | 18,140 | 598 | 90 | 12 | 700 | 1.48 | 2.593 | 41,851 | 0.552 | 32,746 | 168.00 | 5,501 | 3,315 | 1,345 | 1,432 | 1,926 | 18.00 | 24,210 | 4,067 |
| DN 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 30,551 | 1,353 | 203 | 27 | 1,583 | 1.70 | 2.743 | 83,801 | 0.584 | 69,909 | 168.00 | 11,745 | 8,637 | 2,546 | 1,432 | 3,646 | 18.00 | 45,827 | 7,699 |
| DN 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 188 | 64.99 | 13,820 | 898 | 135 | 18 | 1,051 | 2.02 | 3.056 | 42,234 | 0.651 | 36,951 | 168.00 | 6,208 | 3,345 | 1,152 | 1,432 | 1,649 | 18.00 | 20,730 | 3,483 |
| DN 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 4,655 | 434 | 65 | 9 | 508 | 2.42 | 3.387 | 15,766 | 0.722 | 14,605 | 168.00 | 2,454 | 1,249 | 388 | 1,432 | 556 | 18.00 | 6,963 | 1,173 |
| DN 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 6,338 | 723 | 108 | 14 | 846 | 2.86 | 3.734 | 23,666 | 0.795 | 23,149 | 168.00 | 3,889 | 1,874 | 528 | 1,432 | 756 | 18.00 | 9,507 | 1,597 |
| DN 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 912 | 120 | 18 | 2 | 141 | 3.01 | 4.096 | 3,737 | 0.872 | 3,540 | 168.00 | 595 | 296 | 76 | 1,432 | 109 | 18.00 | 1,368 | 230 |
| DN 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 12,695 | 1,841 | 276 | 37 | 2,154 | 3.57 | 4.479 | 56,861 | 0.954 | 57,365 | 168.00 | 9,637 | 4,503 | 1,058 | 1,432 | 1,515 | 18.00 | 19,043 | 3,199 |
| DN 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,810 | 242 | 154.29 | 965 | 149 | 22 | 3 | 174 | 3.91 | 4.877 | 4,706 | 1.038 | 4,774 | 168.00 | 802 | 373 | 80 | 1,432 | 115 | 18.00 | 1,448 | 243 |
| DN 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.65 | 6,085 | 1,478 | 222 | 30 | 1,730 | 4.52 | 5.292 | 42,786 | 1.128 | 45,685 | 168.00 | 7,675 | 3,389 | 674 | 1,432 | 965 | 18.00 | 12,128 | 2,037 |
| DN 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | - | 8.04 | 5.723 | 0 | 1.219 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| DN 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 11,627 | 2,697 | 405 | 54 | 3,156 | 8.44 | 6.172 | 71,782 | 1.315 | 113,459 | 168.00 | 19,061 | 5,684 | 969 | 1,432 | 1,388 | 18.00 | 17,441 | 2,930 |
| DN 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,664 | - | 307.00 | - | 0 | 0 | 0 | - | 9.71 | 6.638 | 0 | 1.414 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| DN 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 5,005 | 2,048 | 307 | 41 | 2,396 | 11.38 | 7.120 | 35,636 | 1.516 | 64,518 | 168.00 | 10,839 | 2,822 | 417 | 1,432 | 597 | 18.00 | 7,508 | 1,261 |
| DN 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | - | 13.87 | 7.620 | 0 | 1.623 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| DN 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 1,696 | 840 | 126 | 17 | 983 | 16.77 | 8.136 | 13,799 | 1.733 | 31,380 | 168.00 | 5,272 | 1,093 | 141 | 1,432 | 202 | 18.00 | 2,544 | 427 |
| DN 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | - | 19.27 | 8.670 | 0 | 1.846 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| DN 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | - | 26.03 | 9.220 | 0 | 1.964 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| DN 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 2,409 | 1,673 | 251 | 33 | 1,957 | 35.55 | 10.372 | 24,986 | 2.209 | 90,961 | 168.00 | 15,281 | 1,979 | 201 | 1,432 | 287 | 18.00 | 3,614 | 607 |
| DN 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | - | 46.28 | 11.591 | 0 | 2.468 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| DN 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | - | 59.53 | 12.878 | 0 | 2.742 | 0 | - | 0 | 0 | 0 | 1,432 | 0 | 18.00 | 0 | 0 |
| | | | | | | | | 262,876 | | | US | $21,622 | | | | | | LEVA | 134,057 | 83,378 | | US | $31,372 | | LEVA | 72,869 |

**CASH FLOW (SEE 10c)**

MATERIAL (US $)

*LABOR(LEVA)*

*EXCAV.MAT'L(LEVA)*

FILE: SAHDSTIC.WK3
DATE: 1-Dec-93

DATE: 12-Jul-94
TIME: 07:41 AM

# SOFIA (4) HEATING SUBSTATIONS I & C (11)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ (000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROLLER | | | 1 | EA | 1500 | 14700 | 225 | 30 | 25799 | 6.00 | 88200 | 17640 | 50 | 882 | 77616 | 168 | 13,039 |
| RTD | | | 6 | EA | 260 | 14700 | 39 | 5 | 26830 | 1.50 | 132300 | 26460 | 50 | 1,323 | 116424 | 168 | 19,559 |
| SUBSTATION WIRING | | | 1 | LT | 160 | 14700 | 24 | 3 | 2752 | 30.00 | 441000 | 88200 | 50 | 4,410 | 388080 | 168 | 65,197 |
| CONT.VLVS. | | | | | | | | | | | | | | | | | |
| | 1 1/2" (40MM) | | 2 | EA | 1400 | 7350 | 210 | 28 | 24079 | 2.80 | 41160 | 8232 | 50 | 412 | 36221 | 168 | 6,085 |
| | 1 1/2" (40MM) | | 2 | EA | 1400 | 2940 | 210 | 28 | 9631 | 2.80 | 16464 | 3293 | 50 | 165 | 14488 | 168 | 2,434 |
| | 2 1/2" (65MM) | | 2 | EA | 2100 | 1470 | 315 | 42 | 7224 | 4.10 | 12054 | 2411 | 50 | 121 | 10608 | 168 | 1,782 |
| | 4" (100MM) | | 2 | EA | 3500 | 2940 | 525 | 70 | 24079 | 6.00 | 35280 | 7056 | 50 | 353 | 31046 | 168 | 5,216 |
| WTR. MTRS. | | | | | | | | | | | | | | | | | |
| | 1.5 CM/HR | | 1 | EA | 675 | 735 | 101 | 14 | 580 | 4.00 | 2940 | 588 | 50 | 29 | 2587 | 168 | 435 |
| | 2.5 CM/HR | | 1 | EA | 675 | 1470 | 101 | 14 | 1181 | 4.00 | 5880 | 1176 | 50 | 59 | 5174 | 168 | 869 |
| | 6 CM/HR | | 1 | EA | 720 | 3675 | 108 | 14 | 3096 | 4.00 | 14700 | 2940 | 50 | 147 | 12936 | 168 | 2,173 |
| | 8 CM/HR | | 1 | EA | 720 | 5145 | 108 | 14 | 4334 | 4.00 | 20580 | 4116 | 50 | 206 | 18110 | 168 | 3,043 |
| | 10 CM/HR | | 1 | EA | 890 | 2940 | 134 | 18 | 3061 | 4.00 | 11760 | 2352 | 50 | 118 | 10349 | 168 | 1,739 |
| | 15 CM/HR | | 1 | EA | 1200 | 735 | 180 | 24 | 1032 | 4.00 | 2940 | 588 | 50 | 29 | 2587 | 168 | 435 |
| FLOW ELEMENTS | | | 0 | EA | 13000 | 12 | 1950 | 260 | 0 | 12.00 | 0 | 0 | 50 | 0 | 0 | 168 | 0 |
| | | | | | | | | | | | | | | | | | 0 |
| ALARM COMPONENTS-ABB/GC | | | 0 | LT | | | | | 0 | | | | | | | | |
| (SEE NOTE 1) | | | | | | | | | $33,414 (.25 MULTIPLIER-25% ALLOT FOR SOFIA) | | | | US | $2,063 | | LEVA | 30,502 |
| | SUBTOTAL | | | | | | | | | | | | | | | | |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 0 | LT | 0 | 0 | 0 | 0 | 0 | N/A | N/A | N/A | N/A | 0 | N/A | N/A | 0 |
| | | | | | | | | | | | | | | 2,063 | | | 30,502 |
| (SEE NOTE 2) | TOTAL US $ | | | | 0 | | | | 33,414 | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 33,414 MATERIAL (US $) | 467.60 | 5680.45 | 6816.54 | 6816.54 | 6816.54 | 6816.54 |
| 2,063 LABOR (US $) | 28.68 | 350.73 | 420.88 | 420.88 | 420.88 | 420.88 |
| SUBTOTAL | 496.69 | 6,031.19 | 7,237.43 | 7,237.43 | 7,237.43 | 7,237.43 |
| *30,502 LABOR(LEVA)* | *427.02* | *5185.26* | *6222.31* | *6222.31* | *6222.31* | *6222.31* |
| 0 WEST. SCADA EQUIPMENT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 WEST. SCADA LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35,476 TOTAL US $ | 496.69 | 6,031.19 | 7,237.43 | 7,237.43 | 7,237.43 | 7,237.43 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *0 WEST. SCADA LABOR (LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| *30,502 TOTAL (LEVA)* | *427.02* | *5,185.26* | *6,222.31* | *6,222.31* | *6,222.31* | *6,222.31* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| | 33414.43 | 3016.32 | 0.000% | 31.601% |

| OPTIONS: | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| THER RAD VLV | 220500 | EA | 50 | 1 | 8 | 1 | 12899 | 1.00 | 220500 | 44100 | 50 | 2,205 | 194040 | 168 | 32,599 |
| HEAT ALLOCATORS | 225000 | EA | 12 | 1 | 2 | 0 | 3159 | 1.00 | 225000 | 45000 | 50 | 2,250 | 198000 | 168 | 33,264 |

NOTE 1: SEE SOFIA 10b1 & 10c1 FOR DETAILS OF PIPE LENGTHS & QUANITY OF ALARMS
NOTE 2: SEE SOFIA 10c FOR FLOW ELEMENTS, ALARM COMPONENTS, & SCADA (WESTINGHOUSE) EQUIPMENT

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE: | STGMODS0 WK3 | S1 | 18/25 | 25/50 | OCEAN – U.S. | HOTEL/DAY | 100 | | 50.00 U.S. | | | | | | | | |
| DATE | 03-Feb-94 | S2 | CAP. | CAP. | 0.15 | MEALS/DAY | 15 | MEN | 6 | 6 | LEVA | /HR | | | | | |
| TIME: | 11:15 AM | S3 | EXP. | EXP. | INLAND – U.S. | CAR/DAY | 60 | WEEKS | 6 | 6 | 32 | 5.25 BULG IN US $ | | | | | |
| | | | 1.69 | 1.86 | 0.02 | | --- | WEEKS | 6 | | | 168 BULG IN LEVA | | | | | |
| | | | | | | | 175 | 5 / 8 | 40 | 40 | | | | | | | |
| | | | | | | | | EXP. MEN | 2 | | | | | | | | |
| | | | | | | | | DAYS | 7 | | | | | | | | |

TURBINE GENERATOR – MODIFICATIONS – SOFIA PLANTS – 4b

| | | ITEM | | NO. OF PLANTS | COST | MTL % SUBTOTAL | C.F. YEAR | FREIGHT | TOTAL MTL. U.S. $ | TOTAL MTL. /PLANT U.S. $ | U.S $ EXPENSES LEVA | INSTALLATION U.S. $ | INSTALLATION LEVA | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1998 | MTL. $ U.S. 2003 | LABOR LEVA 1994 | LABOR LEVA 1998 | LABOR LEVA 2003 | MTL. LEVA 1994 | MTL. LEVA 1998 | MTL. LEVA 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 4 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 392.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 392.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 392.00 | 392.00 | 392.00 |
| SOFIA – 5 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 392.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 392.00 | 80.00 | 268.80 | 268.80 | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 392.00 | 392.00 | 392.00 |
| SOFIA – 6 | MW 50 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 1 | 80.00 | 80.00 | 80.00 | | 13.60 | 93.60 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 460.00 | 460.00 | | 78.20 | 538.20 | 538.20 | 470.40 | 80.00 | 268.80 | 268.80 | 538.20 | 444.60 | 444.60 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| SOFIA – 8 | MW 25 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | ?? | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | SUBTOTAL | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 470.40 | 80.00 | 268.80 | 268.80 | 444.60 | 444.60 | 444.60 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | | | TOTALS | | | | | | LEVA = | | 1724.80 | USE= | 1075.20 | 1075.20 | | | | 1075.20 | 1075.20 | 1075.20 | 1724.80 | 1724.80 | 1724.80 |
| | | | | | | | | | | | | | | | | | LEVA = | 1075.20 | 1075.20 | 1075.20 | | | |
| | | | | | | | | | US $ = | 1310.40 | 53.80 | 320.00 | 64.00 | | 1310.40 | 1216.80 | 1216.80 | US $ = | 64.00 | 64.00 | 64.00 | | | |
| | | | | | | | | | | | | 373.90 | | | | | | | | | | | |
| | | | | | | | | | | | | LEVA = | 946.15 LABOR INC 10% PROD | | | | | | | | | | |
| | | | | | | | | | | MTL. | Included w | | LBR | | | | | | | | | | |
| | | | | | | | | | TOTAL US $ *3 = | 4092.9 | 4092.9 | 960 | 280.70 LABOR IN US $ FOR 3 PLANTS | | | | | | | | | | |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| | 4092.9 | 280.704 | 3.951% | 31.601% |

BEST AVAILABLE COPY

FILE: SBLRMS0.WK3
DATE: 03-Feb-94
TIME: 11:09 AM

OCEAN – U.S. 50 0.15
INLAND – U.S. 0.02
US/BULG 0.8
0.2
LEVA 32
1.1
0.1155
0.5 LABOR (50% OF MAT'L)
5.25 BULG RATE US $
168 BULG RATE LEVA

## THERMAL BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | ITEM | | NO. OF PLANTS | COST | ACTION | NECESSITY | % TOTAL | MTL % SUBTOTAL | C.F. YEAR | CNTR MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | U.S. LABOR U.S. $ | BULG LABOR U.S. $ | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | 1996 | C.F. TOTAL /YEAR 2003 | 1994 | BULG LABOR US $ 1996 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1,2,& 3 retire units 1 & 2 | BURNERS | | 1 | 218.30 | REPLACE NOW | NECESSITY | | 0.788 | 1994 | 306.66 | 37.11 | 255.41 | 25.54 | 11.80 | | 255.41 | | | 11.80 | | |
| | BURNER MGM'T | multiplier | | * | REPLACE NOW | NECESSITY | | | 1994 | | 52.51 | 361.39 | 8.19 | 3.78 | | 361.39 | | | 3.78 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | | | | 0.00 | | | 0.00 | |
| | FD FAN OPTION | | | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | |
| | DUCT WORK FOR BURNERS | | | 58.70 | REPLACE NOW | NECESSITY | | 0.212 | 1994 | | 9.98 | 68.68 | 6.67 | 3.17 | | 68.68 | | | 3.17 | | |
| | SOOTBLOWERS | | | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | | SUBTOTAL | | 277.0 | | | 0.10 | | | 306.66 | 99.60 | 685.48 | 40.60 | 18.78 | 18.78 | 685.48 | 0.00 | 0.00 | 18.78 | 0.00 | 0.00 |
| SOFIA – 4, 5 & 6 | WATERWALLS | | 3 | 0 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | BURNERS | | | 1227.9 | REPLACE NOW | NECESSITY | | 0.476 | 1994 | 1235.52 | 208.74 | 1436.64 | 143.66 | 68.37 | | 1436.64 | | | 68.37 | | |
| | BURNER MGM'T | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | 0.00 |
| | SOOTBLOWERS | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | MAINSTEAM LINE | | | 1349.4 | REPLACE NOW | NECESSITY | | 0.524 | 1994 | | 229.40 | 1578.80 | 157.88 | 72.94 | | 1578.80 | | | 72.94 | | |
| | AIRHEATER RETUBE | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | | SUBTOTAL | | 2577.3 | | | 0.40 | | | 1235.52 | 646.18 | 4461.00 | 334.30 | 154.45 | 51.48 | 4461.00 | 0.00 | 0.00 | 154.45 | 0.00 | 0.00 |
| SOFIA – 7 & 8 | WATERWALLS | | 2 | 0 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | BURNERS | | | 1582.6 | REPLACE NOW | NECESSITY | | 1.000 | 1994 | 1235.52 | 269.04 | 1851.64 | 185.16 | 85.55 | | 1851.64 | | | 85.55 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | | 1994 | | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | 0.00 |
| | SOOTBLOWERS | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | 0.00 |
| | AIRHEATER RETUBE | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | 0.00 |
| | | SUBTOTAL | | 1582.6 | | | 0.40 | | | 1235.52 | 479.08 | 3297.20 | 217.92 | 100.68 | | 3297.20 | 0.00 | 0.00 | 100.68 | 0.00 | 0.00 |
| SOFIA – 9 | BURNERS | | 1 | 0 | REPLACE 10 YEARS | NECESSITY | 0.10 | 0.000 | 2003 | 0.00 | 0.00 | 0.00 | 8.19 | 3.78 | 3.78 | | 0.00 | | | 0.00 | 3.78 |
| | | SUBTOTAL | | 0 | | | 1.000 | | | 0.00 | 0.00 | 0.00 | 8.19 | 3.78 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.78 |
| | | *TOTAL SOFIA COSTS* | | 4436.9 | | | | | | 2779.92 | 1226.86 | 8443.68 | 601.02 | 277.67 | | | | | | | |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | 0.78 | 3088.60 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | 0.78 | 409.50 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

## HOT WATER BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1 – 6 retire units 1 – 2 | SOOTBLOWERS | | 4 | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | WATERWALLS | multiplier | 0.50 | 0.00 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | BURNERS | | | 0.00 | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | BURNER CONTROLS | | | * | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 0 | | | 1.000 | 0.000 | | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | TOTALS | | | | | | | | | | 8443.68 | 601.02 | 277.67 | 74.02 | 8443.68 | 0.00 | 0.00 | 273.69 | 0.00 | 3.78 |
| | | | | | | | | | | | TOTAL MAT'L | 8443.68 | | | | | | | | | |
| | | | | | | | | | | | | | | | % OF TOTAL | 100.00% | 0.00% | 0.00% | 98.64% | 0.00% | 1.36% |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | | 1722.30 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | | 195.00 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 8443.7 | 878.7 | 0.000% | 31.601% |

BEST AVAILABLE COPY

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FILE: | STGMODS0.WK3 | S1 | 18/25 | 25/50 | OCEAN – U.S. | HOTEL/DAY | 100 | | 50.00 U.S. | | | | | | | | |
| DATE: | 16-Mar-94 | S2 | CAP. | CAP. | 0.15 | MEALS/DAY | 15 | MEN | 6 | 6 | LEVA | /HR | | | | | |
| TIME: | 03:09 PM | S3 | EXP. | EXP. | INLAND – U.S. | CAR/DAY | 50 | WEEKS | 6 | 6 | 32 | 5.25 SULG IN US $ | | | | | |
| | | | 1.68 | 1.98 | 0.02 | | --- | WEEKS | 5 | | | 168 SULG IN LEVA | | | | | |
| | | | | | | | 175 | 5 / 6 | 40 | 40 | | | | | | | |
| | | | | | | | | EXP. MEN | 2 | | | | | | | | |
| | | | | | | | | DAYS | 7 | | | | | | | | |

TURBINE GENERATOR – MODIFICATIONS – SOFIA PLANTS – 4b

| | | ITEM | | NO. OF PLANTS | COST | MTL % SUBTOTAL | C.F. YEAR | FREIGHT | TOTAL MTL. U.S. $ | TOTAL MTL. /PLANT U.S. $ | U.S $ EXPENSES LEVA | INSTALLATION U.S. $ | INSTALLATION LEVA | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1996 | MTL. $ U.S. 2003 | LABOR LEVA 1994 | LABOR LEVA 1996 | LABOR LEVA 2003 | MTL. LEVA 1994 | MTL. LEVA 1996 | MTL. LEVA 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 4 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 392.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | | | --- | --- | | --- | --- | | --- | --- | --- | --- | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 392.00 | 392.00 | 392.00 |
| | | SUBTOTAL | | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 392.00 | 80.00 | 268.80 | 268.80 | | | | | | | | | |
| SOFIA – 5 | MW 18 | AIR COOLED GENERATOR | | 1 | 130.00 | 130.00 | | 22.10 | 152.10 | | 392.00 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 0 | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | | | --- | --- | | --- | --- | | --- | --- | --- | --- | 163.80 | 163.80 | 163.80 | 268.80 | 268.80 | 268.80 | 392.00 | 392.00 | 392.00 |
| | | SUBTOTAL | | | 140.00 | 140.00 | | 23.80 | 163.80 | 163.80 | 392.00 | 80.00 | 268.80 | 268.80 | | | | | | | | | |
| SOFIA – 6 | MW 50 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | 1 | 80.00 | 80.00 | 80.00 | | 13.80 | 93.80 | | | | | | | | | | | | | | |
| | | | | | --- | --- | | --- | --- | | --- | --- | --- | --- | 538.20 | 444.80 | 444.80 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | | SUBTOTAL | | | 460.00 | 460.00 | | 78.20 | 538.20 | 538.20 | 470.40 | 80.00 | 268.80 | 268.80 | | | | | | | | | |
| SOFIA – 8 | MW 25 | HYDROGEN COOLED GENERATOR | | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | 470.40 | 80.00 | 268.8 | 268.8 | | | | | | | | | |
| | | CLEAN, CHECK, BALANCE ROTOR | | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | | | | | | | |
| | | AT SHOP | | | | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPLACE LABRYINTH RINGS | 20 | 7.50 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | | | | | | | |
| | | REPLACE H.P. CYLINDER 1 – TIME | | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | REPAIR/RECONDITION H.P. CYL. | ?? | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | |
| | | | | | --- | --- | | --- | --- | | --- | --- | --- | --- | 444.80 | 444.80 | 444.80 | 268.80 | 268.80 | 268.80 | 470.40 | 470.40 | 470.40 |
| | | SUBTOTAL | | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 470.40 | 80.00 | 268.80 | 268.80 | | | | | | | | | |
| | | TOTALS | | | | | | | LEVA = | | 1724.80 | USE= | 1075.20 | 1075.20 | | | | 1075.20 | 1075.20 | 1075.20 | 1724.80 | 1724.80 | 1724.80 |
| | | | | | | | | | | | | | | | | | LEVA = | 1075.20 | 1075.20 | 1075.20 | | | |
| | | | | | | | | | US $ = | 1310.40 | 53.90 | 320.00 | 64.00 | | 1310.40 | 1218.80 | 1218.80 | US $ = | 64.00 | 64.00 | 64.00 | | | |
| | | | | | | | | | | | | 373.90 | | | | | | | | | | | |
| | | | | | | | | | | | | LEVA = | 946.18 LABOR INC 10% PROD | | | | | | | | | | |
| | | | | | | | | | | MTL. | Included w | LBR | 290.70 LABOR IN US $ FOR 3 PLANTS | | | | | | | | | | |
| | | | | | | | | | TOTAL US $ *3 = | 4092.9 | 4092.9 | 960 | | | | | | | | | | | |

| | EQUIP/ MATL | LABOR | PERCENT LOCAL MATL | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 4092.9 | 280.704 | 3.951% | 31.601% |

BEST AVAILABLE COPY

FILE: SBURMS0.WK3
DATE: 16-Mar-94
TIME: 03:07 PM

OCEAN – U.S. 50 | INLAND – U.S. 0.02 | 0.15 | 0.5 LABOR (50% OF MAT'L) | US/BULG 0.6 | 0.2 | LEVA 32 | 1.1 | 0.1155 | 5.25 BULG RATE US $ | 168 BULG RATE LEVA

## THERMAL BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | ITEM | | NO. OF PLANTS | COST | ACTION | NECESSITY | % TOTAL | MTL % SUBTOTAL | C.F. YEAR | CNTR MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | LABOR U.S. $ | BULG LABOR U.S. $ | TOTAL LBR. /PLANT LEVA | MTL. $ U.S. 1994 | MTL. $ U.S. 1996 | C.F. TOTAL /YEAR 2003 | C.F. TOTAL /YEAR 1994 | BULG LABOR US $ 1996 | BULG LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1,2,& 3 retire units 1 & 2 | BURNERS | | 1 | 218.30 | REPLACE NOW | NECESSITY | | 0.788 | 1994 | | 37.11 | 255.41 | 25.54 | 11.80 | | 255.41 | | | 11.80 | | |
| | BURNER MGM'T | multiplier | | * | REPLACE NOW | NECESSITY | | | 1994 | 308.56 | 52.51 | 361.39 | 8.19 | 3.78 | | 361.39 | | | 3.78 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | | | | 0.00 | | | 0.00 | |
| | FD FAN OPTION | | | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | |
| | DUCT WORK FOR BURNERS | | | 58.70 | REPLACE NOW | NECESSITY | | 0.212 | 1994 | | 9.96 | 68.66 | 6.67 | 3.17 | | 68.66 | | | 3.17 | | |
| | SOOTBLOWERS | | | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | | SUBTOTAL | | 277.0 | | | 0.10 | | | 308.56 | 99.60 | 685.46 | 40.60 | 18.76 | 18.76 | 685.46 | 0.00 | 0.00 | 18.76 | 0.00 | 0.00 |
| SOFIA – 4, 5 & 6 | WATERWALLS | | 3 | 0 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | BURNERS | | | 1227.9 | REPLACE NOW | NECESSITY | | 0.478 | 1994 | | 206.74 | 1436.64 | 143.66 | 68.37 | | 1436.64 | | | 96.37 | | |
| | BURNER MGM'T | | | ** | REPLACE NOW | NECESSITY | | | 1994 | 1235.52 | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | ** | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | 0.00 |
| | SOOTBLOWERS | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | MAINSTEAM LINE | | | 1349.4 | REPLACE NOW | NECESSITY | | 0.524 | 1994 | | 229.40 | 1578.80 | 157.88 | 72.94 | | 1578.80 | | | 72.94 | | |
| | AIRHEATER RETUBE | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | | SUBTOTAL | | 2577.3 | | | 0.40 | | | 1235.52 | 646.15 | 4481.00 | 334.30 | 154.45 | 51.48 | 4481.00 | 0.00 | 0.00 | 154.45 | 0.00 | 0.00 |
| SOFIA – 7 & 8 | WATERWALLS | | 2 | 0 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | BURNERS | | | 1582.6 | REPLACE NOW | NECESSITY | | 1.000 | 1994 | | 269.04 | 1851.64 | 185.16 | 85.55 | | 1851.64 | | | 85.55 | | |
| | BURNER MGM'T | | | * | REPLACE NOW | NECESSITY | | | 1994 | 1235.52 | 210.04 | 1445.56 | 32.76 | 15.14 | | 1445.56 | | | 15.14 | | |
| | COMB. CONTROLS | | | * | REPLACE NOW | NECESSITY | | | 1994 | | | | | 0.00 | | | | | | | 0.00 |
| | SOOTBLOWERS | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | 0.00 |
| | AIRHEATER RETUBE | | | 0 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | 0.00 |
| | | SUBTOTAL | | 1582.6 | | | 0.40 | | | 1235.52 | 479.08 | 3297.20 | 217.92 | 100.68 | | 3297.20 | 0.00 | 0.00 | 100.68 | 0.00 | 0.00 |
| SOFIA – 9 | BURNERS | | 1 | 0 | REPLACE 10 YEARS | NECESSITY | 0.10 | 0.000 | 2003 | 0.00 | 0.00 | 0.00 | 8.19 | 3.78 | 3.78 | | 0.00 | | | 0.00 | 3.78 |
| | | SUBTOTAL | | 0 | | | | | | 0.00 | 0.00 | 0.00 | 8.19 | 3.78 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.78 |
| | | *TOTAL SOFIA COSTS* | | 4438.9 | | | 1.000 | | | 2779.92 | 1226.86 | 8443.66 | 601.02 | 277.67 | | | | | | | |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | 0.78 | 3068.80 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | 0.78 | 409.50 | multiplied by 0.78% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

## HOT WATER BOILER MODIFICATIONS – SOFIA PLANTS – 5a

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFIA – 1 – 6 retire units 1 – 2 | SOOTBLOWERS | | 4 | 0.00 | REPLACE 5 YEARS | ENHANCEMENT | | 0.000 | 1996 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | | | 0.00 | |
| | WATERWALLS | multiplier | 0.50 | 0.00 | REPLACE 5 – 10 YEARS | ENHANCEMENT | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | BURNERS | | | 0.00 | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | BURNER CONTROLS | | | * | REPLACE WITHIN 5 YEARS | NECESSITY | | 0.000 | 2003 | | 0.00 | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 |
| | | SUBTOTAL | | 0 | | | 1.000 | 0.000 | | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | TOTALS | | | | | | | | | | 8443.66 | 601.02 | 277.67 | 74.02 | 8443.66 | 0.00 | 0.00 | 273.69 | 0.00 | 3.78 |
| | | | | | | | | | | | TOTAL MAT'L | 8443.66 | | | | | | | | | |
| | | | | | | | | | | | | | | | % OF TOTAL | 100.00% | 0.00% | 0.00% | 96.84% | 0.00% | 1.36% |
| | * TOTAL ALL UNITS AT PLANT THE COST IS | | | 1722.30 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | | 195.00 | reduced by 0.50% | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 8443.7 | 878.7 | 0.000% | 31.601% |

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# DETAILED ESTIMATE TABLES

## KOSTOV TRAJCO CASE K1, K2
## LIULIN CASE L1, L2

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL K1 |
| Technology: | Boiler Rehabilitation at Existing Kostov Station |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 29,928.4 | | 29,928.4 | 31,469.8 | 2,024.3 | | 33,494.1 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmission | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 29,928.4 | | 29,928.4 | $31,469.8 | $2,024.3 | | $33,494.1 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 2,244.6 | Plant Design Engineering 7.5% | 2,512.1 |
| | Construction Supervision | | | Construction Supervision | |
| | Freight/Shipping | | Included | Freight/Shipping | Included |
| 32 = Assumed 1993 Exchange Lev/US$ | Owner's Costs | 3.0% | 965.2 | Owner's Costs 3.0% | 1,080.2 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 33,138.2 | SUBTOTAL | 37,086.4 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 4,970.7 | CONTINGENCY 15.0% | 5,563.0 |
| | TOTAL COST (Bulgaria part) | | 38,109.0 | TOTAL COST (Foreign Exch. part) | 42,649.3 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 31,469.8 | 2,959.8 | | | 32% | |
| 31,469.8 | 2,959.8 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 4,192.0 | 131.0 | 5,629.7 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 24,161.1 | 755.0 | 28,660.4 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 9,755.9 | 304.9 | 8,359.3 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 38,109.0 | $1,190.9 | $42,649.3 |

TOTAL IN US$ (US$,x1000): $43,840.2

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 11.0% | 13.2% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 63.4% | 67.2% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 25.6% | 19.6% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL K1 |
| Technology: | Steam Turbine Generator Rehabilitation at Kostov Station |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 7,096.8 | | 7,096.8 | 9,937.1 | 627.0 | | 10,564.1 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmission | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 7,096.8 | | 7,096.8 | $9,937.1 | $627.0 | | $10,564.1 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 532.3 | Plant Design Engineering 7.5% | 792.3 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 228.9 | Owner's Costs 3.0% | 340.7 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 7,857.9 | SUBTOTAL | 11,697.1 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 1,178.7 | CONTINGENCY 15.0% | 1,754.6 |
| | TOTAL COST (Bulgaria part) | | 9,036.6 | TOTAL COST (Foreign Exch. part) | 13,451.7 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 9,937.1 | 848.8 | | | 28% | |
| 9,937.1 | 848.8 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 2,259.1 | 70.6 | 3,362.9 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 2,259.1 | 70.6 | 3,362.9 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 2,259.1 | 70.6 | 3,362.9 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | 2,259.1 | 70.6 | 3,362.9 |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 9,036.6 | $282.4 | $13,451.7 |

TOTAL IN US$ (US$,x1000): $13,734.1

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 25.0% | 25.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 25.0% | 25.0% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 25.0% | 25.0% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | 25.0% | 25.0% |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL K2
Technology: Boiler Rehabilitation at Existing Kostov Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 28,013.1 | | 28,013.1 | 29,954.6 | 1,894.8 | | 31,849.4 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 28,013.1 | | 28,013.1 | $29,954.6 | $1,894.8 | | $31,849.4 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 2,101.0 | Plant Design Engineering 7.5% | 2,388.7 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 903.4 | Owner's Costs 3.0% | 1,027.1 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 31,017.6 | SUBTOTAL | 35,265.2 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 4,652.6 | CONTINGENCY 15.0% | 5,289.8 |
| | TOTAL COST (Bulgaria part) | | 35,670.2 | TOTAL COST (Foreign Exch. part) | 40,555.0 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 29,954.6 | 2,770.2 | | | 32% | |
| 29,954.6 | 2,770.2 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 4,244.8 | 132.6 | 5,758.8 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 24,113.1 | 753.5 | 28,510.2 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 7,312.4 | 228.5 | 6,286.0 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 35,670.2 | $1,114.7 | $40,555.0 |

TOTAL IN US$ (US$,x1000): $41,669.7

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 11.9% | 14.2% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 67.6% | 70.3% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 20.5% | 15.5% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL K2
Technology: Steam Turbine Generator Rehabilitation at Kostov Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 7,096.8 | | 7,096.8 | 9,937.1 | 627.0 | | 10,564.1 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 7,096.8 | | 7,096.8 | $9,937.1 | $627.0 | | $10,564.1 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 532.3 | Plant Design Engineering 7.5% | 792.3 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 228.9 | Owner's Costs 3.0% | 340.7 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 7,857.9 | SUBTOTAL | 11,697.1 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 1,178.7 | CONTINGENCY 15.0% | 1,754.6 |
| | TOTAL COST (Bulgaria part) | | 9,036.6 | TOTAL COST (Foreign Exch. part) | 13,451.7 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 9,937.1 | 848.8 | | | 26% | |
| 9,937.1 | 848.8 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 2,259.1 | 70.6 | 3,362.9 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 2,259.1 | 70.6 | 3,362.9 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 2,259.1 | 70.6 | 3,362.9 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | 2,259.1 | 70.6 | 3,362.9 |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 9,036.6 | $282.4 | $13,451.7 |

TOTAL IN US$ (US$,x1000): $13,734.1

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 25.0% | 25.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 25.0% | 25.0% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 25.0% | 25.0% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | 25.0% | 25.0% |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL K1 K2 |
| Technology: | Distribution Piping w/L.D.Sensors in Kostov Heating District |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 145.6 | | 145.6 | 2,223.9 | | | 2,223.9 |
| 10b | Heating Distribution Piping | | 588,877.1 | | 588,877.1 | 59,827.3 | | | 59,827.3 |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 589,022.7 | | 589,022.7 | $62,051.3 | | | $62,051.3 |
| | | Plant Design Engineering | | 7.5% | 44,176.7 | Plant Design Engineering | | 7.5% | 4,653.8 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| | | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| 32 | = Assumed 1993 | Owner's Costs | | 3.0% | 18,996.0 | Owner's Costs | | 3.0% | 2,001.2 |
| | Exchange Lev/US$ | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 652,195.4 | SUBTOTAL | | | 68,706.3 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 97,829.3 | CONTINGENCY | | 15.0% | 10,305.9 |
| | | TOTAL COST (Bulgaria part) | | | 750,024.7 | TOTAL COST (Foreign Exch. part) | | | 79,012.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 2,223.9 | 4.6 | | | 100% | |
| 59,827.3 | 18,402.4 | | | 100% | |
| 62,051.3 | 18,407.0 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 32,251.1 | 1,007.8 | 3,397.5 |
| 1995 | 108,603.6 | 3,393.9 | 11,330.4 |
| 1996 | 135,679.5 | 4,240.0 | 14,159.0 |
| 1997 | 137,779.5 | 4,305.6 | 14,380.2 |
| 1998 | 139,204.6 | 4,350.1 | 14,530.3 |
| 1999 | 39,301.3 | 1,228.2 | 4,243.0 |
| 2000 | 39,301.3 | 1,228.2 | 4,243.0 |
| 2001 | 39,301.3 | 1,228.2 | 4,243.0 |
| 2002 | 39,301.3 | 1,228.2 | 4,243.0 |
| 2003 | 39,301.3 | 1,228.2 | 4,243.0 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 750,024.7 | $23,438.3 | $79,012.2 |

TOTAL IN US$ (US$,x1000): $102,450.5

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 4.3% | 4.3% |
| 1995 | 14.5% | 14.3% |
| 1996 | 18.1% | 17.9% |
| 1997 | 18.4% | 18.2% |
| 1998 | 18.6% | 18.4% |
| 1999 | 5.2% | 5.4% |
| 2000 | 5.2% | 5.4% |
| 2001 | 5.2% | 5.4% |
| 2002 | 5.2% | 5.4% |
| 2003 | 5.2% | 5.4% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL K1 K2 |
| Technology: | Control System Upgrade for Kostov Heating District |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmission | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | 30,513.0 | | 30,513.0 | 8,434.8 | 372.7 | | 8,807.5 |
| 11 | Heating Substation I&C | | 170,755.2 | | 170,755.2 | 33,957.0 | | | 33,957.0 |
| | TOTAL DIRECT COST | | 201,268.2 | | 201,268.2 | $42,391.8 | $372.7 | | $42,764.5 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 15,095.1 | Plant Design Engineering 7.5% | 3,207.3 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | included | Freight/Shipping | included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 6,490.9 | Owner's Costs 3.0% | 1,379.2 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 222,854.2 | SUBTOTAL | 47,351.0 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 33,428.1 | CONTINGENCY 15.0% | 7,102.6 |
| | TOTAL COST (Bulgaria part) | | 256,282.4 | TOTAL COST (Foreign Exch. part) | 54,453.6 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 8,434.8 | 1,328.2 | | | 72% | |
| 33,957.0 | 5,336.1 | | | 100% | |
| 42,391.8 | 6,662.3 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 3,588.0 | 112.1 | 762.4 |
| 1995 | 43,568.0 | 1,361.5 | 9,257.1 |
| 1996 | 52,281.6 | 1,633.8 | 11,108.5 |
| 1997 | 52,281.6 | 1,633.8 | 11,108.5 |
| 1998 | 52,281.6 | 1,633.8 | 11,108.5 |
| 1999 | 52,281.6 | 1,633.8 | 11,108.5 |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 256,282.4 | $8,008.8 | $54,453.6 |

TOTAL IN US$ (US$,x1000) $62,462.5

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 1.4% | 1.4% |
| 1995 | 17.0% | 17.0% |
| 1996 | 20.4% | 20.4% |
| 1997 | 20.4% | 20.4% |
| 1998 | 20.4% | 20.4% |
| 1999 | 20.4% | 20.4% |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL L2 K2 |
| Technology: | CT–6FA Combustion Turbine Combined Cycle Additions |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | 373.1 | | 373.1 | | | | |
| 2 | Foundations | 41,971.2 | 6,917.3 | | 48,888.5 | 1,311.6 | 467.9 | | 1,779.5 |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | 7,199.6 | | 7,199.6 | 23,740.8 | 487.0 | | 24,227.8 |
| 4b | Steam Turbine Generator | | 2,915.4 | | 2,915.4 | 6,786.0 | 197.2 | | 6,983.2 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | 2,675.9 | | 2,675.9 | 5,294.3 | 181.0 | | 5,475.3 |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | 5,719.2 | | 5,719.2 | 4,690.3 | 386.9 | | 5,077.2 |
| 8 | Electrical and I&C | | 4,003.3 | | 4,003.3 | 4,934.2 | 270.8 | | 5,205.0 |
| 9 | Power Distribution & Transmissio | | 500.2 | | 500.2 | 2,053.4 | | | 2,053.4 |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 41,971.2 | 30,303.8 | | 72,275.0 | $48,810.5 | $1,990.7 | | $50,801.3 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 5,420.6 | Plant Design Engineering 7.5% | 3,810.1 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 2,330.9 | Owner's Costs 3.0% | 1,638.3 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 80,026.5 | SUBTOTAL | 56,249.7 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 12,004.0 | CONTINGENCY 15.0% | 8,437.5 |
| | TOTAL COST (Bulgaria part) | | 92,030.4 | TOTAL COST (Foreign Exch. part) | 64,687.1 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| | 11.7 | | | 100% | |
| 2,823.2 | 684.1 | | 50% | 32% | |
| 23,740.8 | 712.0 | | | 32% | |
| 6,786.0 | 268.3 | | | 32% | |
| 5,294.3 | 264.6 | | | 32% | |
| 4,690.3 | 585.8 | | | 32% | |
| 4,934.2 | 395.9 | | | 32% | |
| 2,053.4 | 15.6 | | | 100% | |
| 50,122.1 | 2,937.7 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | | | | |
| 1995 | | | 6,468.7 | |
| 1996 | 13,804.6 | 431.4 | 12,937.4 | |
| 1997 | 32,210.7 | 1,006.6 | 29,109.2 | |
| 1998 | 46,015.2 | 1,438.0 | 16,171.8 | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | | | | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 92,030.4 | $2,876.0 | $64,687.1 | $67,563.1 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | | |
| 1995 | | 10.0% |
| 1996 | 15.0% | 20.0% |
| 1997 | 35.0% | 45.0% |
| 1998 | 50.0% | 25.0% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL L1
Technology: Boiler Rehabilitation at Existing Lulin Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 12,853.4 | | 12,853.4 | 12,767.6 | 869.4 | | 13,637.0 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmission | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 12,853.4 | | 12,853.4 | $12,767.6 | $869.4 | | $13,637.0 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 964.0 | Plant Design Engineering 7.5% | 1,022.6 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 414.5 | Owner's Costs 3.0% | 439.6 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 14,231.9 | SUBTOTAL | 15,099.6 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 2,134.8 | CONTINGENCY 15.0% | 2,264.9 |
| | TOTAL COST (Bulgaria part) | | 16,366.7 | TOTAL COST (Foreign Exch. part) | 17,364.5 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 12,767.6 | 1,271.1 | | | 32% | |
| 12,767.6 | 1,271.1 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | | | |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 7,054.0 | 220.4 | 9,359.5 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 9,312.6 | 291.0 | 8,005.1 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 16,366.7 | $511.5 | $17,364.5 |

TOTAL IN US$ (US$,x1000): $17,876.0

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | | |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 43.1% | 53.9% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 56.9% | 46.1% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL L2
Technology: Boiler Rehabilitation at Existing Lulin Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 10,401.5 | | 10,401.5 | 10,826.7 | 703.6 | | 11,530.3 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmission | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 10,401.5 | | 10,401.5 | $10,826.7 | $703.6 | | $11,530.3 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 780.1 | Plant Design Engineering | 7.5% | 864.8 |
| | Construction Supervision | | | Construction Supervision | | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 335.4 | Owner's Costs | 3.0% | 371.9 |
| | Taxes and Permits | | | Taxes and Permits | | |
| | Other | | | Other | | |
| | SUBTOTAL | | 11,517.1 | SUBTOTAL | | 12,766.9 |
| | ESCALATION | | w/economics | ESCALATION | | w/economics |
| | CONTINGENCY | 15.0% | 1,727.6 | CONTINGENCY | 15.0% | 1,915.0 |
| | TOTAL COST (Bulgaria part) | | 13,244.7 | TOTAL COST (Foreign Exch. part) | | 14,681.9 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 10,826.7 | 1,028.6 | | | 32% | |
| 10,826.7 | 1,028.6 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | | | |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 5,801.2 | 181.3 | 8,280.6 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | 7,443.5 | 232.6 | 6,401.3 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 13,244.7 | $413.9 | $14,681.9 |

TOTAL IN US$ (US$,x1000): $15,095.8

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | | |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 43.8% | 56.4% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 56.2% | 43.6% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL L1 L2
Technology: Distribution Piping w/L.D.Sensors in Lulin Heating District
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 61.8 | | 61.8 | 945.2 | | | 945.2 |
| 10b | Heating Distribution Piping | | 183,110.4 | | 183,110.4 | 18,909.9 | | | 18,909.9 |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 183,172.2 | | 183,172.2 | $19,855.1 | | | $19,855.1 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 13,737.9 | Plant Design Engineering 7.5% | 1,489.1 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 5,907.3 | Owner's Costs 3.0% | 640.3 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 202,817.4 | SUBTOTAL | 21,984.5 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 30,422.6 | CONTINGENCY 15.0% | 3,297.7 |
| | TOTAL COST (Bulgaria part) | | 233,240.0 | TOTAL COST (Foreign Exch. part) | 25,282.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 945.2 | 1.9 | | | 100% | |
| 18,909.9 | 5,722.2 | | | 100% | |
| 19,855.1 | 5,724.1 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 6,839.8 | 276.2 | 953.1 | |
| 1995 | 24,093.7 | 752.9 | 2,591.4 | |
| 1996 | 30,064.6 | 939.5 | 3,233.6 | |
| 1997 | 31,207.5 | 975.2 | 3,357.5 | |
| 1998 | 31,977.2 | 999.3 | 3,440.9 | |
| 1999 | 21,411.4 | 669.1 | 2,341.1 | |
| 2000 | 21,411.4 | 669.1 | 2,341.1 | |
| 2001 | 21,411.4 | 669.1 | 2,341.1 | |
| 2002 | 21,411.4 | 669.1 | 2,341.1 | |
| 2003 | 21,411.4 | 669.1 | 2,341.1 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | | | | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 233,240.0 | $7,288.7 | $25,282.2 | $32,571.0 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 3.6% | 3.6% |
| 1995 | 10.3% | 10.3% |
| 1996 | 12.9% | 12.8% |
| 1997 | 13.4% | 13.3% |
| 1998 | 13.7% | 13.6% |
| 1999 | 9.2% | 9.3% |
| 2000 | 9.2% | 9.3% |
| 2001 | 9.2% | 9.3% |
| 2002 | 9.2% | 9.3% |
| 2003 | 9.2% | 9.3% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



795

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL L1 L2 |
| Technology: | Control System Upgrade for Lulin Heating District |
| Demand: | |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | 16,643.5 | | 16,643.5 | 4,600.8 | 203.3 | | 4,804.1 |
| 11 | Heating Substation I&C | | 93,139.2 | | 93,139.2 | 18,522.0 | | | 18,522.0 |
| | TOTAL DIRECT COST | | 109,782.7 | | 109,782.7 | $23,122.8 | $203.3 | | $23,326.1 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 8,233.7 | Plant Design Engineering 7.5% | 1,749.5 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 3,540.5 | Owner's Costs 3.0% | 752.3 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 121,556.9 | SUBTOTAL | 25,827.8 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 18,233.5 | CONTINGENCY 15.0% | 3,874.2 |
| | TOTAL COST (Bulgaria part) | | 139,790.5 | TOTAL COST (Foreign Exch. part) | 29,702.0 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 4,600.8 | 723.4 | | | 72% | |
| 18,522.0 | 2,910.6 | | | 100% | |
| 23,122.8 | 3,634.0 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 1,957.1 | 61.2 | 415.8 |
| 1995 | 23,764.4 | 742.6 | 5,049.3 |
| 1996 | 28,517.3 | 891.2 | 6,059.2 |
| 1997 | 28,517.3 | 891.2 | 6,059.2 |
| 1998 | 28,517.3 | 891.2 | 6,059.2 |
| 1999 | 28,517.3 | 891.2 | 6,059.2 |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 139,790.5 | $4,368.5 | $29,702.0 |

| TOTAL IN US$ (US$,x1000) |
|---|
| $34,070.4 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 1.4% | 1.4% |
| 1995 | 17.0% | 17.0% |
| 1996 | 20.4% | 20.4% |
| 1997 | 20.4% | 20.4% |
| 1998 | 20.4% | 20.4% |
| 1999 | 20.4% | 20.4% |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**KOSTOV TRAJCO CASE K1, K2, L1, L2**

**LIULIN CASE L1, L2**

**DETAILED ESTIMATE BACKUP INFORMATION**

FILE: SSLRMKI.WK3
DATE: 18-Dec-93
TIME: 01 57 PM

| CALCULATION FACTORS | Shipping/Freight | % Material |
|---|---|---|
| | OCEAN - U.S. 15% | % Local |
| | INLAND - U.S. 2% | % Foreign 100% |

50% LABOR (50% OF MAT'L)
32 LEVA/8
20% Foreign % Labor

$0.00 US LABOR RATE
5.26 BULG RATE US $
188 BULG RATE LEVA

1.1 PRODUCTIVITY
0.1185 Composite Local
Labor Factor $

## THERMAL BOILER MODIFICATIONS – KOSTOV PLANTS – 5

| ITEM | NO OF PLANTS | MATERIAL COST $x1000 | | ACTION | NECESSITY | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1996 | FOREIGN $ U.S. 2003 | LOCAL LABOR US $ 1994 | LOCAL LABOR US $ 1996 | LOCAL LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KOSTOV – 1,2,3 & 4 BURNERS | 4 | 246.8 | 982.4 | REPLACE 10 YEARS | NECESSITY | | 0.190 | 2003 | | 167.0 | $1,149.4 | 1,149.4 | | 491.2 | 98.2 | 45.38 | 1,452.4 | | | 1,247.6 | | | 45.4 |
| BURNER MGM'T | | * | | REPLACE 5 YEARS | NECESSITY | | | 1996 | 2294.40 | 390.0 | $2,684.4 | 2,684.4 | | 260.0 | 52.0 | 24.02 | 769.9 | | 2,734.4 | | | 24.0 | |
| COMB. CONTROLS | | * | | REPLACE 5 YEARS | NECESSITY | | | | | | | | | | | | | | | 1,340.8 | | | 48.6 |
| FD FAN OPTION | | 263.9 | 1,055.6 | REPLACE 10 YEARS | ENHANCEMENT | | 0.204 | 2003 | | 179.5 | $1,235.1 | 1,235.1 | | 527.8 | 105.6 | 48.77 | 1,560.5 | | | 294.2 | | | 10.9 |
| DUCT WORK FOR BURNERS | | 58.7 | 234.9 | REPLACE 10 YEARS | ENHANCEMENT | | 0.045 | 2003 | | 39.9 | $274.7 | 274.7 | | 117.4 | 23.5 | 10.85 | 347.1 | | | 1,407.7 | | | 51.2 |
| SOOTBLOWERS | | 277.1 | 1,108.4 | REPLACE 10 YEARS | ENHANCEMENT | | 0.214 | 2003 | | 188.4 | $1,298.9 | 1,298.9 | | 554.2 | 110.8 | 51.21 | 1,638.7 | | | 2,295.0 | | | 83.1 |
| MAINSTEAM LINE | | 449.8 | 1,799.2 | REPLACE 10 YEARS | ENHANCEMENT | | 0.347 | 2003 | | 305.9 | $2,105.1 | 2,105.1 | | 899.6 | 179.9 | 83.12 | 2,658.9 | | | | | | |
| SUBTOTAL | | | 5,180.4 | | | 27% | | | 2294.40 | 1,270.7 | $8,745.5 | $8,745.5 | | 2,850.2 | 570.0 | 263.36 | 8,427.5 | | 2,734.4 | 6,578.1 | | 24.0 | 239.3 |
| KOSTOV – 5,6 & 7 WATERWALLS | 3 | 613.9 | 1,841.7 | REPLACE NOW | NECESSITY | | 1.000 | 1994 | | 313.1 | $2,154.8 | 2,154.8 | | 920.9 | 184.2 | 85.09 | 2,722.9 | 2,338.0 | | | 86.1 | | |
| BURNERS | | ** | | REPLACE NOW | NECESSITY | | | 1994 | 1720.80 | 292.5 | $2,013.3 | 2,013.3 | | 196.9 | 39.4 | 18.02 | 576.6 | 2,062.3 | | | 18.0 | | |
| BURNER MGM'T | | ** | | REPLACE NOW | NECESSITY | | | | | | | | | | | | | | | | | | |
| COMB. CONTROLS | | | | | | | | | | | | | | | | | | | | | | | |
| SUBTOTAL | | | 1,841.7 | | | 20% | | | 1720.80 | 605.6 | $4,168.1 | $4,168.1 | | 1,116.9 | 223.2 | 103.10 | 3299.35 | 4381.30 | | | 103.10 | | |

## HOT WATER BOILER MODIFICATIONS – KOSTOV PLANTS – 5

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KOSTOV – 1 – 8 SOOTBLOWERS | 8 | 92.4 | 739.2 | REPLACE 5 YEARS | ENHANCEMENT | | 0.066 | 1996 | | 125.7 | $864.9 | 864.9 | | 369.6 | 73.9 | 34.15 | 1,062.9 | | 936.8 | | | 34.2 | |
| WATERWALLS | | 989.1 | 7,912.8 | REPLACE 5 YEARS | ENHANCEMENT | | 0.702 | 1996 | | 1,345.2 | $9,258.0 | 9,258.0 | | 3,954.4 | 791.3 | 365.57 | 11,369.5 | | 10,049.3 | | | 365.6 | |
| BURNERS | | 327.4 | 2,619.2 | REPLACE 5 YEARS | ENHANCEMENT | | | 1996 | | 445.3 | $3,064.5 | 3,064.5 | | 1,308.6 | 261.9 | 121.01 | 3,672.2 | | 3,326.4 | | | 121.0 | |
| BURNER CONTROLS | | * | | REPLACE 5 YEARS | ENHANCEMENT | | | 1996 | 4568.80 | 780.1 | $5,348.9 | 5,348.9 | | 520.9 | 104.0 | 48.06 | 1,537.6 | | 6,472.9 | | | 48.0 | |
| SUBTOTAL | | | 11,271.2 | | | 63% | | | 4568.80 | 2,696.2 | $16,556.2 | $16,556.2 | | 6,155.6 | 1,231.1 | 568.78 | 18,200.9 | | 19787.3 | | | 568.6 | |
| TOTAL KOSTOV COSTS | | | 18,293.3 | | | | | | 6404.00 | 4,572.6 | $31,469.8 | $31,469.8 | | 10,121.7 | 2,024.3 | 936.24 | 29,927.7 | 4,381.3 | 22,523.6 | 6,578.1 | 103.1 | 592.6 | 239.3 |

*TOTAL ALL UNITS AT PLANT THE COST $ INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

| | | |
|---|---|---|
| 15 | 8,604.0 | TOTAL I&C MATERIAL |
| | 975.0 | TOTAL I&C INSTALLATION |

| C.F. TOTAL $ | | | $33,494.2 | | | $936.2 |
|---|---|---|---|---|---|---|
| | 1994 | 1996 | 2003 | 1994 | 1996 | 2003 |
| % OF TOTAL | 0.131 | 0.672 | 0.196 | 0.110 | 0.634 | 0.256 |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| | 31,469.8 | 2,959.6 | | 31.601% |

| | | | | |
|---|---|---|---|---|
| FILE: | STGMOOK1.WK3 | S1 | 18/25 | 25/50 |
| DATE: | 13-Jan-94 | S2 | CAP. | CAP. |
| TIME: | 12:53 PM | S3 | EXP. | EXP. |
| | | | 1.68 | 1.68 |

| | |
|---|---|
| OCEAN – U.S. | 15% |
| INLAND – U.S. | 2% |

| | |
|---|---|
| HOTEL/DAY | 100 |
| MEALS/DAY | 15 |
| CAR/DAY | 80 |
| US Daily Est | 175 |

| | | |
|---|---|---|
| Outage Hours | 50.00 | U.S.Base Rate |
| Local # MEN | 8 | |
| WEEKS–Base | 6 | |
| WEEKS–Alt. | 5 | |
| 5 / 8 | 40 | |
| Foreign # Men | 2 | |
| Expense DAYS | 7 | |

| | |
|---|---|
| 1.1 | Productivity–Local |
| 0.1155 | Composite Local Labor Factor |
| 5.25 | BULG IN US $ |
| 168 | BULG IN LEVA |
| 32 | Exchange Rate Lev/$ |

## TURBINE GENERATOR – MODIFICATIONS – KOSTOV PLANTS – 4 b

| ITEM | NO. OF PLANTS | UNIT COST | SUBTOTAL MTL $ | C.F. YEAR | FREIGHT | TOTAL MTL. Per Outage $ | TOTAL MTL. /Unit/Outage U.S. $ | TOTAL # OUTAGES | TOTAL MTL. U.S. $ | LABOR & EXPENSES U.S $ EXPENSES U.S. $ | FOREIGN INSTALLATION U.S. $ | LOCAL INSTALLATION U.S. $ | LOCAL INSTALLATIO LEV | FOREIGN (U.S. $) 1994 | 1996 | 2003 | 2008 | LOCAL (U.S. $) 1994 | 1996 | 2003 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AIR COOLED GENERATOR | 0 | | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MW CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REPLACE LABRYINTH RINGS | 0 | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SUBTOTAL | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| AIR COOLED GENERATOR | 0 | | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MW CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REPLACE LABRYINTH RINGS | 0 | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SUBTOTAL | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| U/C multi. 1.23 | | | | | | | | | | 7.35 | 24.00 | 11.09 | 354.82 | 347.952 | 347.952 | 347.952 | 347.952 | 11.068 | 11.068 | 11.068 | 11.068 |
| KOSTOV – HYDROGEN COOLED GENERATOR | 1 | 270.80 | 270.80 | | 48.00 | 318.80 | | | | | | | | 14.381 | 14.381 | 14.381 | 14.381 | 0 | 0 | 0 | 0 |
| MW CLEAN, CHECK, BALANCE ROTOR | | 12.30 | 12.30 | | 2.09 | 14.39 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 215.865 | 215.865 | 215.865 | 215.865 | 0 | 0 | 0 | 0 |
| REPLACE LABRYINTH RINGS | 20 | 184.50 | 184.50 | | 31.37 | 215.87 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REPLACE H.P. CYLINDER 1–TIME | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 115.126 | 115.126 | 115.126 | 115.126 | 0 | 0 | 0 | 0 |
| REPAIR/RECONDITION H.P. 1 | 1 | 98.40 | 98.40 | | 16.73 | 115.13 | | | | | | | | | | | | | | | |
| SUBTOTAL | | 565.80 | 565.80 | | 96.19 | 661.99 | 661.99 | 4 | 2647.94 | 7.35 | 24.00 | 11.09 | 354.82 | 693.34 | 693.34 | 693.34 | 693.34 | 11.09 | 11.09 | 11.09 | 11.09 |
| U/C multi. 1.15 | | | | | | | | | | 29.40 | 96.00 | 44.35 | 1419.26 | 1180.41 | 1180.41 | 1180.41 | 1180.41 | 44.352 | 44.352 | 44.352 | 44.352 |
| KOSTOV – HYDROGEN COOLED GENERATOR | 4 | 253.00 | 1012.00 | | 43.01 | 1055.01 | | | | | | | | 47.955 | 47.955 | 47.955 | 47.955 | 0 | 0 | 0 | 0 |
| MW CLEAN, CHECK, BALANCE ROTOR | | 11.50 | 46.00 | | 1.96 | 47.96 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 719.325 | 719.325 | 719.325 | 719.325 | 0 | 0 | 0 | 0 |
| REPLACE LABRYINTH RINGS | 20 | 172.50 | 690.00 | | 29.33 | 719.33 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REPLACE H.P. CYLINDER 1–TIME | 7.50 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| REPAIR/RECONDITION H.P. #7 | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| SUBTOTAL | | 437.00 | 1748.00 | | 74.29 | 1822.29 | 455.57 | 16 | 7289.18 | 29.40 | 96.00 | 44.35 | 1419.26 | 1947.69 | 1947.69 | 1947.69 | 1947.69 | 44.35 | 44.35 | 44.35 | 44.35 |
| TOTAL/PLANT | | | $2,313.8 | | $170.5 | $2,484.3 | | | $9,937.1 | $36.8 | $120.0 | $55.4 LEVA = | 1774.08 | $2,641.0 | $2,641.0 | $2,641.0 | $2,641.0 | $55.4 | $55.4 | $55.4 | $55.4 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | C.F. TOTAL $ | | | | $10,584.1 | | | | | | | $221.8 |
| | | | | | | | | | | 1994 | 1996 | 2003 | 2008 | 1994 | 1996 | 2003 | 2008 |
| TOTAL FOREIGN LABOR & EXPENSE | $827.0 | | | | | | | | % OF TOTAL | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 |
| TOTAL LOCAL LABOR | $221.8 | | | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY U.S. $ | $9,937.1 | $848.8 | 0.00% | 26.128% |

FILE: K1EQUIP.WK3
DATE: 1-Dec-93

DATE: 31-Jan-94
TIME: 02:54 PM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 80 | 1 | 12 | 2 | 261 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | | SUBTOTAL | | | | | | | $2,224 multiplier of 1.6 of Sofia | | | | US | $0 | | LEVA | 145 multiplier of 1.6 of Sofia |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 2,224 MATERIAL (US $) | 0 | 2223.94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 2,223.94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *145 LABOR(LEVA)* | *0* | *145.47* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 2223.94 | 4.55 | 0.00% | 100.00% |

FILE: K1PIP10B.WK3
DATE: 22-Nov-93

DATE: 24-Mar-94
TIME: 10:44 AM

# KOSTOV PLANTS ( 10 b 1 )

## HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

### *LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | LAB. COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 5,048 | 87 | 13 | 2 | 102 | 978 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 31,948 | 588 | 88 | 12 | 688 | 6,809 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 48,678 | 1,083 | 162 | 22 | 1,267 | 12,161 |
| DN | 80 -89/180 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 38,232 | 953 | 143 | 19 | 1,115 | 10,707 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 258 | 143 | 33.28 | 37,426 | 1,248 | 187 | 25 | 1,457 | 13,990 |
| DN | 125 -139/225 | 5" | 40 | 3.80 | 0.14 | 311 | 134 | 37.06 | 20,532 | 761 | 114 | 15 | 890 | 8,547 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 386 | 144 | 44.30 | 29,320 | 1,299 | 195 | 26 | 1,520 | 14,588 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 27,194 | 1,767 | 265 | 35 | 2,068 | 19,851 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 13,212 | 1,232 | 185 | 25 | 1,441 | 13,835 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 13,028 | 1,486 | 223 | 30 | 1,739 | 16,691 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 708 | 93 | 14 | 2 | 109 | 1,050 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 23,146 | 3,356 | 503 | 67 | 3,927 | 37,697 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 396 | 61 | 9 | 1 | 71 | 688 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.85 | 13,004 | 2,376 | 357 | 48 | 2,782 | 26,707 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 7,124 | 2,915 | 437 | 58 | 3,410 | 32,740 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 5,334 | 2,641 | 396 | 53 | 3,090 | 29,668 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | 2442 | 1,472 | 221 | 29 | 1,723 | 16,537 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | 722 | 888 | 133 | 16 | 1,039 | 9,971 |
| | | | | | | | | | 317,494 | | | US | $28,438 | LEVA 273,008 |

### *LAID DOWN -- INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 80 -89/180 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 73,968 | 1,844 | 277 | 37 | 2,158 | 20,715 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 258 | 143 | 33.28 | 24,290 | 808 | 121 | 16 | 946 | 9,080 |
| DN | 125 -139/225 | 5" | 40 | 3.80 | 0.14 | 311 | 134 | 37.06 | 21,900 | 812 | 122 | 16 | 950 | 9,116 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 386 | 144 | 44.30 | 19,930 | 883 | 132 | 18 | 1,033 | 9,916 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 14,654 | 965 | 145 | 19 | 1,129 | 10,843 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 12,332 | 1,150 | 172 | 23 | 1,345 | 12,913 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 9,464 | 1,079 | 162 | 22 | 1,263 | 12,125 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 1,696 | 224 | 34 | 4 | 262 | 2,515 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 4,230 | 613 | 92 | 12 | 718 | 6,889 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 1972 | 304 | 46 | 6 | 356 | 3,417 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.85 | 3,290 | 602 | 90 | 12 | 704 | 6,757 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 2,236 | 519 | 78 | 10 | 607 | 5,827 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 10,940 | 4,476 | 671 | 90 | 5,237 | 50,278 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | 201,102 | | | US | $18,707 | LEVA 180,390 |

(1) LABOR PERCENT PROVIDED BY CLIENT

## OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL. US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL. US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA--000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.87 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 148 | 24.42 | 3,272 | 80 | 12 | 2 | 93 | 1.66 | 0.829 | 8,139 | 168.00 | 1,367 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 156 | 131 | 23.92 | 3,396 | 81 | 12 | 2 | 95 | 1.60 | 0.796 | 8,130 | 168.00 | 1,366 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 38.08 | 2,732 | 99 | 15 | 2 | 115 | 1.74 | 0.869 | 7,122 | 168.00 | 1,197 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 3,126 | 116 | 17 | 2 | 135 | 1.68 | 0.842 | 7,892 | 168.00 | 1,326 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 341 | 104 | 37.08 | 5,264 | 196 | 29 | 4 | 229 | 1.55 | 0.776 | 12,293 | 168.00 | 2,065 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 3,046 | 134 | 20 | 3 | 157 | 1.90 | 0.949 | 8,670 | 168.00 | 1,457 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 128 | 52.50 | 4,238 | 222 | 33 | 4 | 260 | 2.04 | 1.020 | 12,971 | 168.00 | 2,179 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 5,636 | 418 | 63 | 8 | 489 | 2.70 | 1.352 | 22,853 | 168.00 | 3,839 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 3,520 | 278 | 42 | 6 | 326 | 2.98 | 1.490 | 15,730 | 168.00 | 2,643 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 86.33 | 10,026 | 866 | 130 | 17 | 1,013 | 3.47 | 1.734 | 52,165 | 168.00 | 8,764 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 1,658 | 139 | 21 | 3 | 163 | 3.62 | 1.808 | 8,994 | 168.00 | 1,511 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 3,630 | 366 | 55 | 7 | 428 | 3.75 | 1.873 | 20,402 | 168.00 | 3,427 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | – | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 2,200 | 237 | 36 | 5 | 277 | 4.62 | 2.310 | 15,248 | 168.00 | 2,561 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.506 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | – | 127.00 | 18,332 | 2,326 | 349 | 47 | 2,724 | 5.41 | 2.706 | 148,619 | 168.00 | 25,002 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,626 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 1,909 | – | 159.08 | 1450 | 231 | 35 | 5 | 270 | 8.73 | 4.367 | 18,996 | 168.00 | 3,191 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 0 | 168.00 | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 0 | 0 | 0 | 0 | 0 | 10.90 | 5.451 | 0 | 168.00 | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,606 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,654 | – | 237.83 | 28418 | 6,759 | 1,014 | 135 | 7,908 | 13.07 | 6.534 | 557,050 | 168.00 | 93,584 |
| | | | | | | | | | 99,966 | | | US | $14,662 | | | | LEVA | 155,479 |

# KOSTOV PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 28438 | MATERIAL (US $) | 995.34 | 2303.50 | 2872.27 | 3042.90 | 3156.65 | 3213.53 | 3213.53 | 3213.53 | 3213.53 | 3213.53 |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 273008 | *LABOR(LEVA)* | *9555.26* | *22113.61* | *27573.78* | *29211.81* | *30303.84* | *30649.85* | *30649.85* | *30649.85* | *30649.85* | *30649.85* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 273008 | *TOTAL (LEVA)* | *9555.26* | *22113.61* | *27573.78* | *29211.81* | *30303.84* | *30649.85* | *30649.85* | *30649.85* | *30649.85* | *30649.85* |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 28,438.28 | 8,531.49 | 0.00% | 100.00% |

## CASH FLOW (000) *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 16707 | MATERIAL (US $) | | 835.37 | 3341.48 | 4176.83 | 4176.83 | 4176.83 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 160390 | *LABOR(LEVA)* | | *8019.51* | *32078.04* | *40097.55* | *40097.55* | *40097.55* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 160390 | *TOTAL (LEVA)* | | *8019.51* | *32078.04* | *40097.55* | *40097.55* | *40097.55* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 16,707.31 | 5,012.19 | 0.00% | 100.00% |

## CASH FLOW (000) *OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 14682 | MATERIAL (US $) | | 734.09 | 2936.35 | 3670.44 | 3670.44 | 3670.44 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 155479 | *LABOR(LEVA)* | | *7773.96* | *31095.85* | *38869.82* | *38869.82* | *38869.82* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 155479 | *TOTAL (LEVA)* | | *7773.96* | *31095.85* | *38869.82* | *38869.82* | *38869.82* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 14,681.74 | 4,858.73 | 0.00% | 100.00% |

## CASH FLOW (000) *TOTAL DISTRIBUTION PIPING*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59827 | MATERIAL (US $) | | 2564.79 | 8561.31 | 10719.53 | 10890.16 | 11003.91 | 3213.53 | 3213.53 | 3213.53 | 3213.53 | 3213.53 |
| | | % | 4.29% | 14.34% | 17.92% | 18.20% | 18.39% | 5.37% | 5.37% | 5.37% | 5.37% | 5.37% |
| 588877 | *LABOR(LEVA)* | | *25348.74* | *85287.50* | *106541.12* | *108179.17* | *109271.20* | *30649.85* | *30649.85* | *30649.85* | *30649.85* | *30649.85* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 588877 | *TOTAL (LEVA)* | | *25348.74* | *85287.50* | *106541.12* | *108179.17* | *109271.20* | *30649.85* | *30649.85* | *30649.85* | *30649.85* | *30649.85* |
| | | % | 4.30% | 14.48% | 18.09% | 18.37% | 18.56% | 5.24% | 5.24% | 5.24% | 5.24% | 5.24% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 59,827.34 | 18,402.41 | 0.00% | 100.00% |

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FILE: K1_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:04 PM

# KOSTOV (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $(000) | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 EA | 13000 | 12 | 1950 | 260 | 548 | 12.00 | 432 | 86 | 50 | 4 | 360 | 168 | 64 |
| | | | | | | | | $181 | (.33 MULTIPLIER-33% ALLOT FOR KOSTOV | | | US | $1 | | LEVA | $21 |
| | SUBTOTAL | | | | | | | | | | | | 371 | N/A | N/A | 30492 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 LT | 7,012,500 | 1 | 1051875 | 140250 | 8205 | N/A | N/A | N/A | N/A | | | | |
| *FIBER OPTIC LEASING* | | | *1 LT* | *49,500* | *1* | – | – | *50* | | | | | 373 | | | 30,513 |
| | TOTAL US $ | | | 7,062,000 | 1 | – | – | 8,435 | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 181 MATERIAL (US $) | 2.53 | 30.72 | 36.86 | 36.86 | 36.86 | 36.86 |
| 1 LABOR (US $) | 0.02 | 0.24 | 0.29 | 0.29 | 0.29 | 0.29 |
| SUBTOTAL | 2.55 | 30.96 | 37.15 | 37.15 | 37.15 | 37.15 |
| *21 LABOR(LEVA)* | *0.30* | *3.58* | *4.30* | *4.30* | *4.30* | *4.30* |
| 8,205 WEST. SCADA EQUIPMENT | 114.86 | 1394.78 | 1673.74 | 1673.74 | 1673.74 | 1673.74 |
| 50 FIBER OPTIC LEASING | 0.69 | 8.42 | 10.10 | 10.10 | 10.10 | 10.10 |
| 371 WEST. SCADA LABOR (US $) | 5.20 | 63.11 | 75.74 | 75.74 | 75.74 | 75.74 |
| SUBTOTAL | 120.76 | 1,466.31 | 1,759.58 | 1,759.58 | 1,759.58 | 1,759.58 |
| 8,607 TOTAL US $ | 123.30 | 1,497.27 | 1,796.73 | 1,796.73 | 1,796.73 | 1,796.73 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *30,492 WEST. SCADA LABOR (LEVA)* | *426.89* | *5183.64* | *6220.37* | *6220.37* | *6220.37* | *6220.37* |
| *30,513 TOTAL (LEVA)* | *427.18* | *5,187.22* | *6,224.67* | *6,224.67* | *6,224.67* | *6,224.67* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 8,434.82 | 1,326.21 | 0.000% | 71.899% |

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DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:25 PM

# KOSTOV (4) HEATING SUBSTATIONS I & C (11)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | | NOTE 1 | 1 LOT | 7000 | 4851 | INC. | INC. | 33957 | 1000 | 4,851 | 170,755 |
| CONSISTING OF: | | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | | |
| RTD | | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | | |
| | | | | | | | | ------- | | ------- | ------- |
| | | TOTAL US $ | | | | | | $33,957 | | 0 | $170,755 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 33,957 MATERIAL (US $) | 475.40 | 5772.69 | 6927.23 | 6927.23 | 6927.23 | 6927.23 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 475.40 | 5,772.69 | 6,927.23 | 6,927.23 | 6,927.23 | 6,927.23 |
| *170,755 LABOR(LEVA)* | *2390.57* | *29028.38* | *34834.06* | *34834.06* | *34834.06* | *34834.06* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 33,957.00 | 5,336.10 | 0.000% | 100.000% |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

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| | | | | |
|---|---|---|---|---|
| FILE: | STGMODK2.WK3 | S1 | 18/25 | 25/50 |
| DATE: | 17-Jan-94 | S2 | CAP. | CAP. |
| TIME: | 07:53 AM | S3 | EXP. | EXP. |
| | | | 1.66 | 1.66 |

| |
|---|
| OCEAN - U.S. |
| 15% |
| INLAND - U.S. |
| 2% |

| | |
|---|---|
| HOTEL/DAY | 100 |
| MEALS/DAY | 15 |
| CAR/DAY | 60 |
| US Daily Est | 175 |

| | | |
|---|---|---|
| Outage Hours | 50.00 | U.S.Base Rate |
| Local # MEN | 8 | |
| WEEKS-Base | 6 | |
| WEEKS-Alt. | 5 | |
| 5 / 8 | 40 | |
| Foreign # Men | 2 | |
| Expense DAYS | 7 | |

| | |
|---|---|
| 1.1 | Productivity-Local |
| 0.1155 | Composite Local Labor Factor |
| 5.25 | BULG IN US $ |
| 168 | BULG IN LEVA |
| 32 | Exchange Rate Lev/$ |

## TURBINE GENERATOR - MODIFICATIONS - KOSTOV PLANTS - 4 b

| | ITEM | NO. OF PLANTS | UNIT COST | SUBTOTAL MTL $ | C.F. YEAR | FREIGHT | TOTAL MTL. Per Outage $ | TOTAL MTL. /Unit/Outage U.S. $ | TOTAL # OUTAGES | TOTAL MTL U.S. $ | LABOR & EXPENSES: U.S $ EXPENSES U.S. $ | FOREIGN INSTALLATION U.S. $ | LOCAL INSTALLATION U.S. $ | LOCAL INSTALLATIO LEV | FOREIGN (U.S. $) 1994 | 1996 | 2003 | 2006 | LOCAL (U.S. $) 1994 | 1996 | 2003 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW 18 | AIR COOLED GENERATOR | 0 | | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 0 | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MW 18 | AIR COOLED GENERATOR | 0 | | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 0 | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| KOSTOV - MW 66 | U/C multi. 1.23 | | | | | | | | | | | | | | | | | | | | | |
| | HYDROGEN COOLED GENERATOR | 1 | 270.60 | 270.60 | | 46.00 | 316.60 | | | | 7.35 | 24.00 | 11.09 | 354.62 | 347.952 | 347.952 | 347.952 | 347.952 | 11.066 | 11.066 | 11.066 | 11.066 |
| | CLEAN, CHECK, BALANCE ROTOR | | 12.30 | 12.30 | | 2.09 | 14.39 | | | | | | | | 14.391 | 14.391 | 14.391 | 14.391 | 0 | 0 | 0 | 0 |
| | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 20 | 164.50 | 164.50 | | 31.37 | 215.87 | | | | | | | | 215.866 | 215.866 | 215.866 | 215.866 | 0 | 0 | 0 | 0 |
| | REPLACE H.P. CYLINDER 1-TIME | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPAIR/RECONDITION H.P. | 1 | 80.00 | 98.40 | | 16.73 | 115.13 | | | | | | | | 115.128 | 115.128 | 115.128 | 115.128 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | | 565.80 | | 96.19 | 661.99 | 661.99 | 4 | 2647.94 | 7.35 | 24.00 | 11.09 | 354.62 | 693.34 | 693.34 | 693.34 | 693.34 | 11.09 | 11.09 | 11.09 | 11.09 |
| KOSTOV - MW 30 | U/C multi. 1.15 | | | | | | | | | | | | | | | | | | | | | |
| | HYDROGEN COOLED GENERATOR | 4 | 253.00 | 1012.00 | | 43.01 | 1055.01 | | | | 29.40 | 96.00 | 44.35 | 1419.26 | 1180.41 | 1180.41 | 1180.41 | 1180.41 | 44.352 | 44.352 | 44.352 | 44.352 |
| | CLEAN, CHECK, BALANCE ROTOR | | 11.50 | 46.00 | | 1.99 | 47.99 | | | | | | | | 47.955 | 47.955 | 47.955 | 47.955 | 0 | 0 | 0 | 0 |
| | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 20 | 172.50 | 690.00 | | 29.33 | 719.33 | | | | | | | | 719.325 | 719.325 | 719.325 | 719.325 | 0 | 0 | 0 | 0 |
| | REPLACE H.P. CYLINDER 1-TIME | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPAIR/RECONDITION H.P. ?? | 80.00 | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | 437.00 | 1748.00 | | 74.29 | 1822.29 | 455.57 | 16 | 7289.16 | 29.40 | 96.00 | 44.35 | 1419.26 | 1947.69 | 1947.69 | 1947.69 | 1947.69 | 44.35 | 44.35 | 44.35 | 44.35 |
| | TOTAL/PLANT | | | $2,313.8 | | $170.5 | $2,484.3 | | | $9,937.1 | $36.8 | $120.0 | $55.4 LEVA = | 1774.08 | $2,641.0 | $2,641.0 | $2,641.0 | $2,641.0 | $55.4 | $55.4 | $55.4 | $55.4 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C.F. TOTAL $ | | | | | $10,584.1 | | | | | | | $221.8 |
| | 1994 | 1996 | 2003 | 2006 | | 1994 | 1996 | 2003 | 2006 | | | |
| % OF TOTAL | 0.250 | 0.250 | 0.250 | 0.250 | | 0.250 | 0.250 | 0.250 | 0.250 | | | |

| | |
|---|---|
| TOTAL FOREIGN LABOR & EXPENSE | $827.0 |
| TOTAL LOCAL LABOR | $221.8 |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY U.S. $ | $9,937.1 | $848.8 | 0.00% | 26.128% |

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FILE: SBLRMK2.WK3
DATE: 13-Jan-94
TIME: 11:53 AM

| CALCULATION FACTORS | Shipping\Freight | | % Material | |
|---|---|---|---|---|
| | OCEAN – U.S. | 15% | % Local | |
| | INLAND – U.S. | 2% | % Foreign | 100% |

50% LABOR (50% OF MAT'L)
32 LEVA/S
20% Foreign % Labor

50.00 US LABOR RATE
5.25 BULG RATE US $
166 BULG RATE LEVA

1.1 PRODUCTIVITY
0.1165 Composite Local Labor Factor $

## THERMAL BOILER MODIFICATIONS – KOSTOV PLANTS – 5

| ITEM | NO. OF PLANTS | MATERIAL COST $x1000 | | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1996 | FOREIGN $ U.S. 2003 | C.F. TOTAL /YEAR | LOCAL LABOR US $ 1994 | LOCAL LABOR US $ 1996 | LOCAL LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KOSTOV – 2,3 & 4 BURNERS | 3 | 245.6 | 736.8 | REPLACE 10 YEARS | NECESSITY | | 0.190 | 2003 | | 125.3 | $862.1 | $862.1 | | 368.4 | 73.7 | 34.04 | 1,092.5 | | | 936.7 | | | | 34.0 |
| BURNER MGM'T | | • | | REPLACE 5 YEARS | NECESSITY | | | 1996 | 1843.71 | 313.4 | $2,157.1 | 2,157.1 | | 208.9 | 41.8 | 19.31 | 617.6 | | 2,196.9 | | | | 19.3 | |
| COMB. CONTROLS | | • | | REPLACE 5 YEARS | NECESSITY | | | | | | | | | | | | | | | | | | | |
| FD FAN OPTION | | 263.9 | 791.7 | REPLACE 10 YEARS | ENHANCEMENT | | 0.204 | 2003 | | 134.6 | $926.3 | 926.3 | | 396.9 | 79.2 | 36.58 | 1,170.4 | | | 1,006.5 | | | | 36.6 |
| DUCT WORK FOR BURNERS | | 58.7 | 176.1 | REPLACE 10 YEARS | ENHANCEMENT | | 0.046 | 2003 | | 29.9 | $204.0 | 204.0 | | 88.1 | 17.6 | 8.14 | 260.3 | | | 223.0 | | | | 8.1 |
| SOOTBLOWERS | | 277.1 | 831.3 | REPLACE 10 YEARS | ENHANCEMENT | | 0.214 | 2003 | | 141.3 | $972.6 | 972.6 | | 415.7 | 83.1 | 38.41 | 1,228.0 | | | 1,055.6 | | | | 38.4 |
| MAINSTEAM LINE | | 449.6 | 1,348.4 | REPLACE 10 YEARS | ENHANCEMENT | | 0.347 | 2003 | | 229.4 | $1,578.6 | 1,578.6 | | 674.7 | 134.9 | 62.34 | 1,996.0 | | | 1,713.7 | | | | 62.3 |
| SUBTOTAL | | | 3,886.3 | | | 21% | | | 1843.71 | 973.9 | $6,702.0 | $6,702.0 | | 2,161.6 | 430.3 | 198.61 | 6,361.6 | | 2,196.9 | 4,934.3 | | | 19.3 | 179.6 |
| KOSTOV – 5,6 & 7 WATERWALLS | 3 | 513.9 | 1,541.7 | REPLACE NOW | NECESSITY | | 1.000 | 1994 | | 313.1 | $2,154.6 | 2,154.6 | | 820.9 | 164.2 | 86.09 | 2,722.6 | 2,336.0 | | | 86.1 | | | |
| BURNERS | | •• | | REPLACE NOW | NECESSITY | | | 1994 | 1843.71 | 313.4 | $2,157.1 | 2,157.1 | | 206.9 | 41.8 | 19.31 | 617.6 | 2,196.9 | | | 19.3 | | | |
| BURNER MGM'T | | •• | | REPLACE NOW | NECESSITY | | | | | | | | | | | | | | | | | | | |
| COMB. CONTROLS | | | | | | | | | | | | | | | | | | | | | 104.38 | | | |
| SUBTOTAL | | | 1,541.7 | | | 21% | | | 1843.71 | 626.5 | $4,311.9 | $4,311.9 | | 1,129.8 | 226.0 | 164.39 | 3340.63 | 4537.89 | | | | | | |

## HOT WATER BOILER MODIFICATIONS – KOSTOV PLANTS – 5 a

| ITEM | NO. OF PLANTS | MATERIAL COST $x1000 | | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1996 | FOREIGN $ U.S. 2003 | C.F. TOTAL /YEAR | LOCAL LABOR US $ 1994 | LOCAL LABOR US $ 1996 | LOCAL LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KOSTOV – 1 – 5 SOOTBLOWERS | 5 | 92.4 | 739.2 | REPLACE 5 YEARS | ENHANCEMENT | | 0.066 | 1996 | | 125.7 | $864.9 | 864.9 | | 369.8 | 73.9 | 34.15 | 1,092.5 | | 936.6 | | | | 34.2 | |
| WATERWALLS | | 989.1 | 7,912.9 | REPLACE 5 YEARS | ENHANCEMENT | | 0.702 | 1996 | | 1,345.2 | $9,258.0 | 9,258.0 | | 3,958.4 | 791.3 | 365.67 | 11,589.3 | | 10,049.3 | | | | 365.6 | |
| BURNERS | | 327.4 | 2,618.2 | REPLACE 5 YEARS | ENHANCEMENT | | | 1996 | | 445.3 | $3,064.5 | 3,064.5 | | 1,308.6 | 261.8 | 121.01 | 3,872.2 | | 3,326.4 | | | | 121.0 | |
| BURNER CONTROLS | | • | | REPLACE 5 YEARS | ENHANCEMENT | | | 1996 | 4916.57 | 836.8 | $5,752.4 | 5,752.4 | | 587.1 | 111.4 | 51.46 | 1,647.4 | | 6,843.8 | | | | 51.5 | |
| SUBTOTAL | | | 11,271.2 | | | 57% | | | 4916.57 | 2,781.9 | $18,939.7 | $18,939.7 | | 6,192.7 | 1,238.5 | 572.21 | 18,319.7 | | 20178.2 | | | | 572.2 | |
| TOTAL KOSTOV COSTS | 14 | | 16,998.2 | | | | | | 6804.00 | 4,352.4 | $29,954.6 | $29,954.6 | | 9,474.1 | 1,894.6 | 875.41 | 28,013.0 | 4,537.9 | 22,377.2 | 4,934.3 | 104.4 | 591.5 | 179.6 | |

| | | |
|---|---|---|
| 6,604.0 | TOTAL I&C MATERIAL | |
| 975.0 | TOTAL I&C INSTALLATION | |

*TOTAL ALL UNITS AT PLANT THE COST E INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW).

| | | | | |
|---|---|---|---|---|
| C.F.TOTAL $ | | | $31,949.4 | $875.4 |
| | 1994 | 1996 | 2003 | 1994 1996 2003 |
| % OF TOTAL | 0.142 | 0.703 | 0.155 | 0.119 0.876 0.205 |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| | 29,954.6 | 2,770.2 | | 31.601% |

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CTCCA_K2.WK3
DATE: 1/4/94

CG75.MW6FA BIG – RANGE
PG6016FA HI–TEMP

L-2 COMBINED CYCLE PLANT--KOSTOV PLANT

CT = 75000kw; TG = 36000kw

| $ FGT | | MTL. | LABOR | TOTAL |
|---|---|---|---|---|
| 146,425 | SITE IMPROVEMENTS | 861,322 | 804,678 | 1,666,000 |
| 141,994 | FOUNDATIONS | 835,083 | 1,247,418 | 2,082,500 |
| 82,755 | STRUCTURES | 546,615 | 287,385 | 833,000 |
| 3,449,521 | COMBUSTION TURBINE | 20,291,300 | 2,434,956 | 22,726,256 |
| 769,250 | HEAT RECOVERY STEAM GENERATOR | 4,525,000 | 905,000 | 5,430,000 |
| 986,000 | TURBINE GENERATOR | 5,800,000 | 986,000 | 6,786,000 |
| 465,059 | B.O.P. MISC. MECHANICAL EQUIPMENT | 2,676,820 | 591,580 | 3,268,400 |
| 228,440 | PIPING – OUTSIDE | 1,332,001 | 1,342,699 | 2,674,700 |
| 0 | PIPING – INSIDE | W/ABV. | W/ABV. | W/ABV. |
| 512,136 | ELECTRICAL EQUIPMENT | 3,012,564 | 426,436 | 3,439,000 |
| 204,798 | ELECTRICAL/I&C BULK MATERIALS | 1,204,893 | 927,507 | 2,132,200 |
| | TOTAL DIRECT COST | 41,084,997 | 9,953,659 | 51,038,656 |
| 6,984,347 | FREIGHT – OCEAN & INLAND | 6,984,347 | | 6,984,347 |
| | TOTAL | 48,068,744 | 9,953,659 | 58,022,403 |

$/kw

| | | U.S. | $/MH |
|---|---|---|---|
| | MANHOURS (S 3) | 228,220 | 44 DPEL (REFERENCE) |
| | CHECK | | 58,022,403 |

| ITEM No | DESCRIPTION | MAT'L/FGT U.S. $ (000) | LABOR U.S. $ (000) | TOTALS U.S. $ (000) | PERCENT LOCAL LABOR |
|---|---|---|---|---|---|
| 3 | SITEWORK, FDNS & STRUCTURES | 2,623.16 | 684.06 | 3,307.23 | 31.601% |
| 4a | COMBUSTION TURBINE | 23,740.62 | 711.98 | 24,452.60 | 31.601% |
| 4b | TURBINE GENERATOR | 6,786.00 | 288.31 | 7,074.31 | 31.601% |
| 5c | HRSG | 5,294.25 | 264.62 | 5,558.87 | 31.601% |
| 7c | B.O.P. | 4,690.32 | 565.58 | 5,255.90 | 31.601% |
| 8 | ELECTRICAL / I&C | 4,894.19 | 395.89 | 5,290.08 | 31.601% |
| 1b | DEMOLITION – 50 % of S 2 | | 11.86 | 11.86 | 100.000% |
| | TOTAL U.S. $ | 48,068.74 | 2,922.11 | 50,990.85 | |

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FILE: K2SWYARD.WK
DATE: 12-Jan-93

DATE: 18-Jan-94
TIME: 01:26 PM

# SWITCHYARD DISTRIBUTION EQUIPMENT (9)

| ITEM DESCRIPTION | VENDOR | UNIT QTY | MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWYD. BKR. 1200A, 230KV, W/PANEL | | 1 | EA | 200 | 1 | 30 | 4 | 234 | 240.00 | 240 | 0 | 50 | 0 | 264 | 186 | 44 |
| TRANSFORMER, 120 MVA | | 1 | EA | 800 | 1 | 120 | 16 | 936 | 1400.00 | 1400 | 0 | 50 | 0 | 1540 | 186 | 258 |
| GENERATOR BKR. 2000A | | 1 | EA | 100 | 1 | 15 | 2 | 117 | 200.00 | 200 | 0 | 50 | 0 | 220 | 186 | 37 |
| GENERATOR BKR. 4000A | | 1 | EA | 350 | 1 | 53 | 7 | 410 | 400.00 | 400 | 0 | 50 | 0 | 440 | 186 | 74 |
| TRANSFORMER, 5MVA | | 1 | EA | 85 | 1 | 13 | 2 | 99 | 200.00 | 200 | 0 | 50 | 0 | 220 | 186 | 37 |
| GROUND RESISTOR | | 1 | EA | 8 | 1 | 1 | 0 | 9 | 40.00 | 40 | 0 | 50 | 0 | 44 | 186 | 7 |
| SWITCHGEAR, 4.16 KV | | 1 | EA | 150 | 1 | 23 | 3 | 176 | 80.00 | 80 | 0 | 50 | 0 | 88 | 186 | 15 |
| TRANSFORMER, 1000 KVA | | 1 | EA | 20 | 1 | 3 | 0 | 23 | 80.00 | 80 | 0 | 50 | 0 | 88 | 186 | 15 |
| MOTOR CONTROL CENTER | | 1 | EA | 40 | 1 | 6 | 1 | 47 | 30.00 | 30 | 0 | 50 | 0 | 33 | 186 | 6 |
| WIRING & CONDUIT | | 1 | LT | 2 | 1 | 0 | 0 | 2 | 36.00 | 36 | 0 | 50 | 0 | 40 | 186 | 7 |
| SUBTOTAL | | | | | | | | $2,053 | | | | US | $0 | 2977 | LEVA | 500 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 2,053 MATERIAL (US $) | 513.34 | 1026.68 | 513.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 513.34 | 1,026.68 | 513.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *500 LABOR(LEVA)* | *125.02* | *250.03* | *125.02* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 2053.35 | 15.63 | 0.00% | 100.00% |

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FILE: K2EQUIP.WK3
DATE: 1-Dec-93

DATE: 01-Feb-94
TIME: 11:25 AM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY | MAT'L US $ | COST /UNIT (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 EA | 60 | 1 | 12 | 2 | 281 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | SUBTOTAL | | | | | | | $2,224 | multiplier of 1.6 of Sofia | | | US | $0 | | LEVA | 145 | multiplier of 1.6 of Sofia |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 2,224 MATERIAL (US $) | 0 | 2223.94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 2,223.94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *145 LABOR(LEVA)* | *0* | *145.47* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **2223.94** | **4.55** | **0.00%** | **100.00%** |

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FILE: K2PIP10B.WK3
DATE: 22-Nov-93

DATE: 24-Mar-94
TIME: 10:46 AM

# KOSTOV PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

*LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB. COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 5,048 | 87 | 13 | 2 | 102 | | 976 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 31,948 | 588 | 88 | 12 | 688 | | 6,609 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 48,678 | 1,083 | 162 | 22 | 1,267 | | 12,161 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 38,232 | 953 | 143 | 19 | 1,115 | | 10,707 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 37,426 | 1,248 | 187 | 25 | 1,457 | | 13,990 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 20,532 | 761 | 114 | 15 | 890 | | 8,547 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 29,320 | 1,299 | 195 | 26 | 1,520 | | 14,588 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 27,194 | 1,767 | 265 | 35 | 2,068 | | 19,851 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 13,212 | 1,232 | 185 | 25 | 1,441 | | 13,835 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 13,028 | 1,486 | 223 | 30 | 1,738 | | 16,691 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 708 | 93 | 14 | 2 | 109 | | 1,050 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 23,146 | 3,356 | 503 | 67 | 3,927 | | 37,697 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,810 | 242 | 154.29 | 396 | 61 | 9 | 1 | 71 | | 686 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 13,004 | 2,378 | 357 | 48 | 2,782 | | 26,707 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,764 | - | 232.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,664 | - | 307.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 7,124 | 2,915 | 437 | 58 | 3,410 | | 32,740 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 5,334 | 2,641 | 396 | 53 | 3,090 | | 29,686 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | 2442 | 1,472 | 221 | 29 | 1,723 | | 16,537 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | 722 | 888 | 133 | 16 | 1,039 | | 9,971 |
| | | | | | | | | | 317,494 | | | US | $28,438 | LEVA | 273,008 |

*LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 73,968 | 1,844 | 277 | 37 | 2,158 | | 20,715 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 24,290 | 808 | 121 | 16 | 946 | | 9,080 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 21,900 | 812 | 122 | 16 | 950 | | 9,116 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 19,930 | 883 | 132 | 18 | 1,033 | | 9,916 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 14,854 | 965 | 145 | 19 | 1,129 | | 10,843 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 12,332 | 1,150 | 172 | 23 | 1,345 | | 12,913 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 9,464 | 1,079 | 162 | 22 | 1,263 | | 12,125 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 1,698 | 224 | 34 | 4 | 262 | | 2,515 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 4,230 | 613 | 92 | 12 | 718 | | 6,889 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,810 | 242 | 154.29 | 1972 | 304 | 46 | 6 | 356 | | 3,417 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 3,280 | 602 | 90 | 12 | 704 | | 6,757 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,764 | - | 232.00 | 2,236 | 519 | 78 | 10 | 607 | | 5,827 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,664 | - | 307.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 10,940 | 4,476 | 671 | 90 | 5,237 | | 50,278 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 201,102 | | | US | $16,707 | LEVA | 160,390 |

(1) LABOR PERCENT PROVIDED BY CLIENT

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*OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL. US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL. US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL. | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL. | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA–000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.67 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.48 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 146 | 24.42 | 3,272 | 80 | 12 | 2 | 93 | 1.66 | 0.829 | 8,139 | 168.00 | 1,367 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 156 | 131 | 23.92 | 3,396 | 81 | 12 | 2 | 95 | 1.60 | 0.798 | 8,130 | 168.00 | 1,366 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 36.08 | 2,732 | 99 | 15 | 2 | 115 | 1.74 | 0.869 | 7,122 | 168.00 | 1,197 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 3,126 | 116 | 17 | 2 | 135 | 1.66 | 0.842 | 7,892 | 168.00 | 1,326 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 341 | 104 | 37.08 | 5,254 | 196 | 29 | 4 | 229 | 1.55 | 0.776 | 12,293 | 168.00 | 2,065 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 3,046 | 134 | 20 | 3 | 157 | 1.90 | 0.949 | 8,670 | 168.00 | 1,457 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 126 | 52.50 | 4,238 | 222 | 33 | 4 | 260 | 2.04 | 1.020 | 12,971 | 168.00 | 2,179 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 5,636 | 418 | 63 | 8 | 489 | 2.70 | 1.352 | 22,853 | 168.00 | 3,839 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 3,520 | 278 | 42 | 6 | 326 | 2.98 | 1.490 | 15,730 | 168.00 | 2,643 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 86.33 | 10,026 | 866 | 130 | 17 | 1,013 | 3.47 | 1.734 | 52,165 | 168.00 | 8,764 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 1,658 | 139 | 21 | 3 | 163 | 3.62 | 1.808 | 8,994 | 168.00 | 1,511 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 3,630 | 366 | 55 | 7 | 428 | 3.75 | 1.873 | 20,402 | 168.00 | 3,427 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | – | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 2,200 | 237 | 36 | 5 | 277 | 4.62 | 2.310 | 15,246 | 168.00 | 2,561 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | – | 127.00 | 18,332 | 2,328 | 349 | 47 | 2,724 | 5.41 | 2.706 | 148,819 | 168.00 | 25,002 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 1,909 | – | 159.08 | 1450 | 231 | 35 | 5 | 270 | 6.73 | 4.367 | 18,996 | 168.00 | 3,191 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 0 | 168.00 | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 0 | 0 | 0 | 0 | 0 | 10.90 | 5.451 | 0 | 168.00 | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | 28418 | 6,759 | 1,014 | 135 | 7,908 | 13.07 | 6.534 | 557,050 | 168.00 | 93,584 |
| | | | | | | | | | 99,968 | | | US | $14,682 | | | | LEVA | 155,479 |

## KOSTOV PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28438 | MATERIAL (US $) | | 995.34 | 2303.50 | 2872.27 | 3042.90 | 3158.65 | 3213.53 | 3213.53 | 3213.53 | 3213.53 | 3213.53 |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 273008 | *LABOR(LEVA)* | | *9555.26* | *22113.61* | *27573.78* | *29211.81* | *30303.84* | *30849.65* | *30849.65* | *30849.65* | *30849.65* | *30849.65* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 273008 | *TOTAL (LEVA)* | | *9555.26* | *22113.61* | *27573.78* | *29211.81* | *30303.84* | *30849.65* | *30849.65* | *30849.65* | *30849.65* | *30849.65* |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 28,438.26 | 5,531.49 | 0.00% | 100.00% |

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**CASH FLOW (000)** *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 16707 | MATERIAL (US $) | | 835.37 | 3341.46 | 4176.83 | 4176.83 | 4176.83 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 160390 | *LABOR(LEVA)* | | *8019.51* | *32078.04* | *40097.55* | *40097.55* | *40097.55* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 160390 | *TOTAL (LEVA)* | | *8019.51* | *32078.04* | *40097.55* | *40097.55* | *40097.55* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 16,707.31 | 5,012.19 | 0.00% | 100.00% |

**CASH FLOW (000)** *OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 14682 | MATERIAL (US $) | | 734.09 | 2936.35 | 3670.44 | 3670.44 | 3670.44 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 155479 | *LABOR(LEVA)* | | *7773.96* | *31095.85* | *38869.82* | *38869.82* | *38869.82* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 155479 | *TOTAL (LEVA)* | | *7773.96* | *31095.85* | *38869.82* | *38869.82* | *38869.82* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 14,681.74 | 4,858.73 | 0.00% | 100.00% |

**CASH FLOW (000)** *TOTAL DISTRIBUTION PIPING*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59827 | MATERIAL (US $) | | 2564.79 | 8561.31 | 10719.53 | 10890.18 | 11003.91 | 3213.53 | 3213.53 | 3213.53 | 3213.53 | 3213.53 |
| | | % | 4.29% | 14.34% | 17.92% | 18.20% | 18.39% | 5.37% | 5.37% | 5.37% | 5.37% | 5.37% |
| 588877 | *LABOR(LEVA)* | | *25348.74* | *85287.50* | *106541.12* | *108179.17* | *109271.20* | *30649.85* | *30649.85* | *30649.85* | *30649.85* | *30649.85* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 588877 | *TOTAL (LEVA)* | | *25348.74* | *85287.50* | *106541.12* | *108179.17* | *109271.20* | *30649.85* | *30649.85* | *30649.85* | *30649.85* | *30649.85* |
| | | % | 4.30% | 14.48% | 18.09% | 18.37% | 18.56% | 5.24% | 5.24% | 5.24% | 5.24% | 5.24% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 59,827.34 | 18,402.41 | 0.00% | 100.00% |

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FILE: K2_SCADA.WK2
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:06 PM

# KOSTOV (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | QTY MAT'L | UNIT | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $(000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 12 | 1950 | 260 | 548 | 12.00 | 432 | 86 | 50 | 4 | 380 | 165 | 64 |
| | SUBTOTAL | | | | | | | | $181 | *(.33 MULTIPLIER-33% ALLOT FOR KOSTOV* | | | US | $1 | | LEVA | $21 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 7,012,500 | 1 | 1051875 | 140250 | 8205 | N/A | N/A | N/A | N/A | 371 | N/A | N/A | 30492 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *49,500* | *1* | – | – | *50* | | | | | | | | |
| | TOTAL US $ | | | | 7,062,000 | 1 | – | – | 8,435 | | | | | 373 | | | 30,513 |

## CASH FLOW (000)

| VALUES | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| 181 MATERIAL (US $) | 2.53 | 30.72 | 36.86 | 36.86 | 36.86 | 36.86 |
| 1 LABOR (US $) | 0.02 | 0.24 | 0.29 | 0.29 | 0.29 | 0.29 |
| SUBTOTAL | 2.55 | 30.96 | 37.15 | 37.15 | 37.15 | 37.15 |
| *21 LABOR(LEVA)* | *0.30* | *3.58* | *4.30* | *4.30* | *4.30* | *4.30* |
| 8,205 WEST. SCADA EQUIPMENT | 114.86 | 1394.79 | 1673.74 | 1673.74 | 1673.74 | 1673.74 |
| 50 FIBER OPTIC LEASING | 0.69 | 8.42 | 10.10 | 10.10 | 10.10 | 10.10 |
| 371 WEST. SCADA LABOR (US $) | 5.20 | 63.11 | 75.74 | 75.74 | 75.74 | 75.74 |
| SUBTOTAL | 120.76 | 1,466.31 | 1,759.58 | 1,759.58 | 1,759.58 | 1,759.58 |
| 8,807 TOTAL US $ | 123.30 | 1,497.27 | 1,796.73 | 1,796.73 | 1,796.73 | 1,796.73 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *30,492 WEST. SCADA LABOR (LEVA)* | *426.89* | *5183.64* | *6220.37* | *6220.37* | *6220.37* | *6220.37* |
| *30,513 TOTAL (LEVA)* | *427.18* | *5,187.22* | *6,224.67* | *6,224.67* | *6,224.67* | *6,224.67* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **8,434.82** | **1,326.21** | **0.000%** | **71.899%** |

BEST AVAILABLE COPY

FILE: K2HDSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:27 PM

# KOSTOV (4) HEATING SUBSTATIONS I & C (11)

| ITEM DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | NOTE 1 | 1 LOT | 7000 | 4851 | INC. | INC. | 33957 | 1000 | 4,851 | 170,755 |
| CONSISTING OF: | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | |
| RTD | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | |
| | | | | | | | --- | | --- | --- |
| | TOTAL US $ | | | | | | $33,957 | | 0 | $170,755 |

**CASH FLOW (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 33,957 MATERIAL (US $) | 475.40 | 5772.69 | 6927.23 | 6927.23 | 6927.23 | 6927.23 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 475.40 | 5,772.69 | 6,927.23 | 6,927.23 | 6,927.23 | 6,927.23 |
| *170,755 LABOR(LEVA)* | *2390.57* | *29028.38* | *34834.06* | *34834.06* | *34834.06* | *34834.06* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **33,957.00** | **5,336.10** | **0.000%** | **100.000%** |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

BEST AVAILABLE COPY

FILE: SBLRML1.WK3
DATE: 13-Jan-94
TIME: 12:43 PM

| CALCULATION FACTORS | Shipping\Freight | | % Material | |
|---|---|---|---|---|
| | OCEAN - U.S. | 15% | % Local | 0% |
| | INLAND - U.S. | 2% | % Foreign | 100% |

50% LABOR (50% OF MAT'L)
32 LEVA/$
20% Foreign % Labor

50.00 US LABOR RATE
5.25 BULG RATE US $
168 BULG RATE LEVA

1.1 PRODUCTIVITY
0.1155 Composite Local Labor Factor $

## THERMAL BOILER MODIFICATIONS - LULIN PLANTS - 5 a

| | ITEM | NO. OF PLANTS | MATERIAL COST $x1000 | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1996 | C.F. TOTAL /YEAR 2003 | LOCAL LABOR US $ 1994 | LOCAL LABOR US $ 1996 | LOCAL LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BURNERS | 0 | 0.0 | REPLACE 10 YEARS | NECESSITY | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | BURNER MGM'T | | 0.0 | REPLACE 5 YEARS | NECESSITY | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | COMB. CONTROLS | | 0.0 | REPLACE 5 YEARS | NECESSITY | | | | 0.00 | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | FD FAN OPTION | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | DUCT WORK FOR BURNERS | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | SOOTBLOWERS | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | MAINSTEAM LINE | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | SUBTOTAL | | 0 | | | 0.00 | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| LULIN - 1-4 | SOOTBLOWERS | 4 | 92.4 369.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.058 | 1996 | | 62.8 | $432.4 | 432.4 | 0.0 | 184.8 | 37.0 | 17.08 | 548.4 | 0.0 | 489.4 | 0.0 | 0.0 | 17.1 | 0.0 |
| | WATERWALLS | | 989.1 3,956.4 | REPLACE 10 YEARS | ENHANCEMENT | | 0.598 | 2003 | | 672.8 | $4,629.0 | 4,629.0 | 0.0 | 1,978.2 | 395.6 | 182.78 | 5,849.1 | 0.0 | 0.0 | 5,024.6 | 0.0 | 0.0 | 182.6 |
| | BURNERS | | 577.4 2,309.6 | REPLACE 5 YEARS | NECESSITY | | | 1996 | | 392.8 | $2,702.2 | 2,702.2 | 0.0 | 1,154.8 | 231.0 | 106.70 | 3,414.5 | 0.0 | 2,633.2 | 0.0 | 0.0 | 106.7 | 0.0 |
| | BURNER CONTROLS | | * 0.0 | REPLACE 5 YEARS | NECESSITY | | | 1996 | 2294.40 | 390.0 | $2,684.4 | 2,684.4 | 0.0 | 290.0 | 52.0 | 24.02 | 768.6 | 0.0 | 2,736.4 | 0.0 | 0.0 | 24.0 | 0.0 |
| | SUBTOTAL | | 6635.6 | | | 0.60 | | | 2294.40 | 1518.10 | 10448.10 | 10448.10 | 0.00 | 3577.60 | 715.56 | 330.58 | 10578.84 | 0.00 | 6139.03 | 5024.63 | 0.00 | 147.80 | 182.70 |
| LULIN - 5 | SOOTBLOWERS | 1 | 92.4 92.4 | REPLACE 5 YEARS | ENHANCEMENT | | 0.086 | 1996 | | 15.7 | $108.1 | 108.1 | 0.0 | 46.2 | 9.2 | 4.27 | 136.6 | 0.0 | 117.3 | 0.0 | 0.0 | 4.3 | 0.0 |
| | WATERWALLS | | 989.1 989.1 | REPLACE 10 YEARS | ENHANCEMENT | | 0.702 | 2003 | | 168.1 | $1,157.2 | 1,157.2 | 0.0 | 494.6 | 98.9 | 45.70 | 1,462.3 | 0.0 | 0.0 | 1,254.2 | 0.0 | 0.0 | 45.7 |
| | BURNERS | | 327.4 327.4 | REPLACE 5 YEARS | NECESSITY | | | 1996 | | 55.7 | $383.1 | 383.1 | 0.0 | 163.7 | 32.7 | 15.13 | 484.0 | 0.0 | 415.8 | 0.0 | 0.0 | 15.1 | 0.0 |
| | BURNER CONTROLS | | * 0.0 | REPLACE 5 YEARS | NECESSITY | | | 1996 | 573.60 | 97.5 | $671.1 | 671.1 | 0.0 | 65.0 | 13.0 | 6.01 | 192.2 | 0.0 | 664.1 | 0.0 | 0.0 | 6.0 | 0.0 |
| | SUBTOTAL | | 1408.8 | | | 0.20 | | | 573.60 | 337.03 | 2319.53 | 2319.53 | 0.00 | 768.45 | 153.68 | 71.10 | 2275.11 | 0.00 | 1217.28 | 1256.18 | 0.00 | 25.40 | 45.70 |
| | *TOTAL LULIN COSTS* | | 8044.5 | | | | | | 2868.00 | 1855.13 | 12767.63 | $12,767.6 | $0.0 | 4,347.3 | 869.6 | 401.68 | 12,853.9 | 0.0 | 7,356.3 | 6,280.8 | 0.0 | 173.2 | 228.5 |
| | *TOTAL ALL UNITS AT PLANT THE COST IS | 5 | 2868.00 | TOTAL I&C MATERIAL | | 1.000 | | | | | | | | | | | | | | | | | |
| | INSTALLATION & STARTUP | | 325.00 | TOTAL I&C INSTALLATION | | | | | | | | | | | | | | | | | | | |
| | SINCE THIS PROPOSED FOR TOTAL PLANT IT | | | | | | | | | | | | | | | | C.F.TOTAL $ | | | $13,637.1 | | | $401.7 |
| | SHOULD BE DONE AT THE SAME TIME (NOW). | | | | | | | | | | | | | | | | | 1994 | 1996 | 2003 | 1994 | 1996 | 2003 |
| | | | | | | | | | | | | | | | | | % OF TOTAL | 0.000 | 0.539 | 0.461 | 0.000 | 0.431 | 0.569 |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| | 12767.6 | 1,271.1 | 0.000% | 31.601% |

BEST AVAILABLE COPY

FILE: L1EQUIP.WK3
DATE: 1-Dec-93

DATE: 31-Jan-94
TIME: 03:45 PM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 80 | 1 | 12 | 2 | 261 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 16 |
| STEP-UP TRANSFORMER | | | 3 | EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | | SUBTOTAL | | | | | | | $945 | | | | US | $0 | | LEVA | 62 |

multiplier of .68 of Sofia

multiplier of .68 of Sofia

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 945 MATERIAL (US $) | 0 | 945.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 945.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *62 LABOR(LEVA)* | *0* | *61.83* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **945.17** | **1.93** | **0.00%** | **100.00%** |

BEST AVAILABLE COPY

FILE: L1PP10B.WK3
DATE: 22-Nov-93

DATE: 24-Mar-94
TIME: 10:47 AM

## LULIN PLANTS ( 10 b 1 )

## HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

*LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB.COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 14,694 | 271 | 41 | 5 | 317 | | 3,040 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 32,720 | 726 | 109 | 15 | 851 | | 6,174 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 26,396 | 658 | 99 | 13 | 770 | | 7,392 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.26 | 21,254 | 707 | 106 | 14 | 828 | | 7,945 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 21,830 | 809 | 121 | 16 | 947 | | 9,087 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 386 | 144 | 44.30 | 18,422 | 816 | 122 | 16 | 955 | | 9,166 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 20,502 | 1,332 | 200 | 27 | 1,559 | | 14,966 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 9,198 | 858 | 129 | 17 | 1,003 | | 9,632 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 3,410 | 389 | 58 | 8 | 455 | | 4,369 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 10,178 | 1,476 | 221 | 30 | 1,727 | | 16,576 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.85 | 4,156 | 760 | 114 | 15 | 889 | | 8,535 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 188.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | – | 232.00 | 11862 | 2,752 | 413 | 55 | 3,220 | | 30,910 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | – | 409.17 | 832 | 340 | 51 | 7 | 398 | | 3,824 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | 2,728 | 1,350 | 202 | 27 | 1,579 | | 15,161 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 196,180 | | | US | $15,498 | LEVA | 148,777 |

*LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 2,454 | 61 | 9 | 1 | 72 | | 687 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.26 | 1,554 | 52 | 8 | 1 | 61 | | 581 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 1,552 | 58 | 9 | 1 | 67 | | 646 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 386 | 144 | 44.30 | 520 | 23 | 3 | 0 | 27 | | 259 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 1,568 | 102 | 15 | 2 | 119 | | 1,145 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 2,104 | 240 | 36 | 5 | 281 | | 2,698 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 1,104 | 160 | 24 | 3 | 187 | | 1,798 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.85 | 664 | 121 | 18 | 2 | 142 | | 1,364 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 188.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | – | 232.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | – | 409.17 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 11,520 | | | US | $956 | LEVA | 9,175 |

(1) LABOR PERCENT PROVIDED BY CLIENT



818

*OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL. US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL. | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL. | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA–000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.67 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 146 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.66 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 156 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 36.08 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.68 | 0.842 | 0 | 168.00 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 341 | 104 | 37.08 | 138 | 5 | 1 | 0 | 6 | 1.55 | 0.776 | 316 | 168.00 | 53 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 270 | 12 | 2 | 0 | 14 | 1.90 | 0.949 | 768 | 168.00 | 129 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 126 | 52.50 | 444 | 23 | 3 | 0 | 27 | 2.04 | 1.020 | 1,359 | 168.00 | 228 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 726 | 54 | 6 | 1 | 63 | 2.70 | 1.352 | 2,944 | 168.00 | 495 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 0 | 0 | 0 | 0 | 0 | 2.98 | 1.490 | 0 | 168.00 | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 881 | 175 | 88.33 | 698 | 60 | 9 | 1 | 71 | 3.47 | 1.734 | 3,632 | 168.00 | 610 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 0 | 0 | 0 | 0 | 0 | 3.62 | 1.808 | 0 | 168.00 | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 0 | 0 | 0 | 0 | 0 | 3.75 | 1.873 | 0 | 168.00 | 0 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | 0 | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 1,700 | 183 | 27 | 4 | 214 | 4.62 | 2.310 | 11,781 | 168.00 | 1,978 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.60 | 0.35 | 1,524 | – | 127.00 | 6,936 | 881 | 132 | 18 | 1,031 | 5.41 | 2.706 | 56,308 | 168.00 | 9,459 |
| DN | 750 -762/900 | 30" | 10 | 8.60 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | – | 8.60 | 0.35 | 1,909 | – | 159.08 | 1152 | 183 | 27 | 4 | 214 | 6.73 | 4.367 | 15,092 | 168.00 | 2,536 |
| DN | 850 -864/1100 | 34" | – | 8.60 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 0 | 168.00 | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 3,520 | 698 | 105 | 14 | 817 | 10.90 | 5.451 | 57,557 | 168.00 | 9,670 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | – | 0 | 0 | 0 | 0 | 13.07 | 6.534 | 0 | 168.00 | 0 |
| | | | | | | | | | 15,562 | | | US | $2,457 | | | | LEVA | 25,159 |

## LULIN PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15498 | MATERIAL (US $) | | 542.41 | 1255.30 | 1565.25 | 1658.24 | 1720.23 | 1751.22 | 1751.22 | 1751.22 | 1751.22 | 1751.22 |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 148777 | *LABOR (LEVA)* | | *5207.16* | *12050.90* | *15026.43* | *15919.09* | *16514.20* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| 0 | *EXCAV.MAT'L (LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 148777 | *TOTAL (LEVA)* | | *5207.16* | *12050.90* | *15026.43* | *15919.09* | *16514.20* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 15,497.56 | 4,649.27 | 0.00% | 100.00% |



819

**CASH FLOW (000)** ***LAID DOWN – INSULATION FOAM CONCRETE***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 956 | MATERIAL (US $) | | 47.79 | 191.14 | 238.93 | 238.93 | 238.93 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 9175 | *LABOR(LEVA)* | | *458.74* | *1834.95* | *2293.69* | *2293.69* | *2293.69* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 9175 | *TOTAL (LEVA)* | | *458.74* | *1834.95* | *2293.69* | *2293.69* | *2293.69* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 955.70 | 286.71 | 0.00% | 100.00% |

**CASH FLOW (000)** ***OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 2457 | MATERIAL (US $) | | 122.83 | 491.33 | 614.17 | 614.17 | 614.17 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 25159 | *LABOR(LEVA)* | | *1257.95* | *5031.82* | *6289.77* | *6289.77* | *6289.77* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 25159 | *TOTAL (LEVA)* | | *1257.95* | *5031.82* | *6289.77* | *6289.77* | *6289.77* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 2,456.66 | 786.22 | 0.00% | 100.00% |

**CASH FLOW (000)** ***TOTAL DISTRIBUTION PIPING***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18910 | MATERIAL (US $) | | 713.03 | 1937.78 | 2418.34 | 2511.33 | 2573.32 | 1751.22 | 1751.22 | 1751.22 | 1751.22 | 1751.22 |
| | | % | 3.77% | 10.25% | 12.79% | 13.28% | 13.61% | 9.26% | 9.26% | 9.26% | 9.26% | 9.26% |
| 183110 | *LABOR(LEVA)* | | *6923.87* | *18917.67* | *23609.89* | *24502.55* | *25097.68* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 183110 | *TOTAL (LEVA)* | | *6923.87* | *18917.67* | *23609.89* | *24502.55* | *25097.68* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| | | % | 3.78% | 10.33% | 12.89% | 13.38% | 13.71% | 9.18% | 9.18% | 9.18% | 9.18% | 9.18% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 18,909.92 | 5,722.20 | 0.00% | 100.00% |



420

FILE: L1_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:09 PM

# LULIN (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | QTY MAT'L | UNIT | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $(000) | SUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 12 | 1950 | 260 | 546 | 12.00 | 432 | 86 | 50 | 4 | 380 | 166 | 64 |
| | SUBTOTAL | | | | | | | | $99 (.18 MULTIPLIER-18% ALLOT FOR LULIN) | | | | US | $1 | | LEVA | $11 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 3,625,000 | 1 | 573750 | 76500 | 4475 | N/A | N/A | N/A | N/A | 203 | N/A | N/A | 16632 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *27,000* | *1* | - | - | *27* | | | | | | | | |
| | TOTAL US $ | | | | 3,652,000 | 1 | - | - | 4,601 | | | | | 203 | | | 16,643 |

**CASH FLOW (000)**

| VALUES | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| 99 MATERIAL (US $) | 1.38 | 16.76 | 20.11 | 20.11 | 20.11 | 20.11 |
| 1 LABOR (US $) | 0.01 | 0.13 | 0.16 | 0.16 | 0.16 | 0.16 |
| SUBTOTAL | 1.39 | 16.89 | 20.27 | 20.27 | 20.27 | 20.27 |
| *11 LABOR(LEVA)* | *0.16* | *1.95* | *2.35* | *2.35* | *2.35* | *2.35* |
| 4,475 WEST. SCADA EQUIPMENT | 62.65 | 760.79 | 912.95 | 912.95 | 912.95 | 912.95 |
| 27 FIBER OPTIC LEASING | 0.38 | 4.59 | 5.51 | 5.51 | 5.51 | 5.51 |
| 203 WEST. SCADA LABOR (US $) | 2.84 | 34.43 | 41.31 | 41.31 | 41.31 | 41.31 |
| SUBTOTAL | 65.87 | 799.81 | 959.77 | 959.77 | 959.77 | 959.77 |
| 4,604 TOTAL US $ | 67.26 | 816.70 | 980.03 | 980.03 | 980.03 | 980.03 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *16,632 WEST. SCADA LABOR (LEVA)* | *232.85* | *2827.44* | *3392.93* | *3392.93* | *3392.93* | *3392.93* |
| *16,643 TOTAL (LEVA)* | *233.01* | *2,829.39* | *3,395.27* | *3,395.27* | *3,395.27* | *3,395.27* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **4,600.81** | **723.39** | **0.000%** | **71.899%** |

FILE: L1HDSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:26 PM

# LULIN (4) HEATING SUBSTATIONS I & C (11)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | | NOTE 1 | 1 LOT | 7000 | 2646 | INC. | INC. | 18522 | 1000 | 2,646 | 93,139 |
| CONSISTING OF: | | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | | |
| RTD | | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | | |
| | | TOTAL US $ | | | | | | $18,522 | | 0 | $93,139 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 18,522 MATERIAL (US $) | 259.31 | 3148.74 | 3778.49 | 3778.49 | 3778.49 | 3778.49 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 259.31 | 3,148.74 | 3,778.49 | 3,778.49 | 3,778.49 | 3,778.49 |
| *93,139 LABOR(LEVA)* | *1303.95* | *15833.66* | *19000.40* | *19000.40* | *19000.40* | *19000.40* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 18,522.00 | 2,910.60 | 0.000% | 100.000% |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

822

CTCCA_L2.WK3
DATE: 1/4/94

CG75.MW6FA BIG – RANGE
PG6B1 6FA HI–TEMP

L-2 COMBINED CYCLE PLANT--LULIN PLANT

CT = 75000kw; TG = 38000kw

| $ FGT | | MTL | LABOR | TOTAL |
|---|---|---|---|---|
| 146,425 | SITE IMPROVEMENTS | 861,322 | 804,678 | 1,666,000 |
| 141,984 | FOUNDATIONS | 835,083 | 1,247,418 | 2,082,500 |
| 82,755 | STRUCTURES | 545,615 | 287,385 | 833,000 |
| 3,449,521 | COMBUSTION TURBINE | 20,291,300 | 2,434,956 | 22,726,256 |
| 788,250 | HEAT RECOVERY STEAM GENERATOR | 4,825,000 | 605,000 | 5,430,000 |
| 886,000 | TURBINE GENERATOR | 5,800,000 | 986,000 | 6,786,000 |
| 455,059 | B.O.P. MISC. MECHANICAL EQUIPMENT | 2,676,820 | 591,580 | 3,268,400 |
| 228,440 | PIPING – OUTSIDE | 1,332,001 | 1,342,699 | 2,674,700 |
| 0 | PIPING – INSIDE | W/ABV. | W/ABV. | W/ABV. |
| 512,136 | ELECTRICAL EQUIPMENT | 3,012,564 | 426,436 | 3,439,000 |
| 204,786 | ELECTRICAL/I&C BULK MATERIALS | 1,204,693 | 927,507 | 2,132,200 |
| | TOTAL DIRECT COST | 41,084,397 | 9,953,659 | 51,038,056 |
| 6,984,347 | FREIGHT – OCEAN & INLAND | 6,984,347 | | 6,984,347 |
| | TOTAL | 48,068,744 | 9,953,659 | 58,022,403 |
| | | | | $/kw |
| | MANHOURS ($ 3) | U.S. 226,220 | $/MH 44 | DP&L (REFERENCE) |
| | CHECK | | | 58,022,403 |

| ITEM No. | DESCRIPTION | MAT'L/FGT U.S. $ (000) | LABOR U.S. $ (000) | TOTALS U.S. $ (000) | PERCENT LOCAL LABOR |
|---|---|---|---|---|---|
| 3 | SITEWORK, FDNS & STRUCTURES | 2,623.16 | 684.06 | 3,307.23 | 31.601% |
| 4a | COMBUSTION TURBINE | 23,740.62 | 711.96 | 24,452.60 | 31.601% |
| 4b | TURBINE GENERATOR | 6,786.00 | 288.31 | 7,074.31 | 31.601% |
| 5c | HRSG | 5,294.25 | 264.62 | 5,558.87 | 31.601% |
| 7c | B.O.P. | 4,660.92 | 595.58 | 5,255.50 | 31.601% |
| 8 | ELECTRICAL / I&C | 4,934.19 | 395.89 | 5,330.08 | 31.601% |
| 1b | DEMOLITION – 50 % of S 2 | | 11.66 | 11.66 | 100.000% |
| | TOTAL U.S. $ | 48,068.74 | 2,922.11 | 50,990.85 | |

823

FILE: SBLRML2.WK3
DATE: 13-Jan-94
TIME: 12:44 PM

| CALCULATION FACTORS | Shipping\Freight | | % Material | |
|---|---|---|---|---|
| | OCEAN - U.S. | 15% | % Local | 0% |
| | INLAND - U.S. | 2% | % Foreign | 100% |

50% LABOR (50% OF MAT'L)
32 LEVA/$
20% Foreign % Labor

50.00 US LABOR RATE
5.25 BULG RATE US $
168 BULG RATE LEVA

1.1 PRODUCTIVITY
0.1155 Composite Local Labor Factor $

*THERMAL BOILER MODIFICATIONS - LULIN PLANTS - 5 a*

| | ITEM | NO. OF PLANTS | MATERIAL COST $x1000 | | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL U.S. $ | FOREIGN MTL US$ | LOCAL MTL U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1996 | FOREIGN $ U.S. 2003 | C.F. TOTAL /YEAR | LOCAL LABOR US $ 1994 | LOCAL LABOR US $ 1996 | LOCAL LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BURNERS | 0 | | 0.0 | REPLACE 10 YEARS | NECESSITY | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | BURNER MGM'T | | | 0.0 | REPLACE 5 YEARS | NECESSITY | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | COMB. CONTROLS | | | 0.0 | REPLACE 5 YEARS | NECESSITY | | | | 0.00 | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | FD FAN OPTION | | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | DUCT WORK FOR BURNERS | | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | SOOTBLOWERS | | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | MAINSTEAM LINE | | | 0.0 | REPLACE 10 YEARS | ENHANCEMENT | | | | | 0.0 | $0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| | SUBTOTAL | | | 0 | | | 0.00 | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 |
| LULIN - 1, 2 & 4 | SOOTBLOWERS | 3 | 92.4 | 277.2 | REPLACE 5 YEARS | ENHANCEMENT | | 0.056 | 1996 | | 47.1 | $324.3 | 324.3 | 0.0 | 138.6 | 27.7 | 12.61 | 409.9 | 0.0 | 352.0 | 0.0 | | 0.0 | 12.6 | 0.0 |
| | WATERWALLS | | 968.1 | 2,907.3 | REPLACE 10 YEARS | ENHANCEMENT | | 0.586 | 2003 | | 504.4 | $3,471.7 | 3,471.7 | 0.0 | 1,453.7 | 290.7 | 137.09 | 4,368.9 | 0.0 | 0.0 | 3,766.5 | | 0.0 | 0.0 | 137.1 |
| | BURNERS | | 577.4 | 1,732.2 | REPLACE 5 YEARS | NECESSITY | | | 1996 | | 294.5 | $2,026.7 | 2,026.7 | 0.0 | 868.1 | 173.2 | 80.03 | 2,580.9 | 0.0 | 2,199.9 | 0.0 | | 0.0 | 80.0 | 0.0 |
| | BURNER CONTROLS | | * | 0.0 | REPLACE 5 YEARS | NECESSITY | | | 1996 | 2151.00 | 365.7 | $2,516.7 | 2,516.7 | 0.0 | 243.8 | 48.8 | 22.52 | 720.7 | 0.0 | 2,565.4 | 0.0 | | 0.0 | 22.5 | 0.0 |
| | SUBTOTAL | | | 4976.7 | | | 0.75 | | | 2151.00 | 1211.71 | $8338.41 | $8338.41 | 0.00 | 2732.10 | 546.42 | 252.46 | 8078.27 | 0.00 | 5117.38 | 3766.47 | | 0.00 | 115.38 | 137.09 |
| LULIN - 5 | SOOTBLOWERS | 1 | 92.4 | 92.4 | REPLACE 5 YEARS | ENHANCEMENT | | 0.066 | 1996 | | 15.7 | $108.1 | 108.1 | 0.0 | 46.2 | 9.2 | 4.27 | 138.6 | 0.0 | 117.3 | 0.0 | | 0.0 | 4.3 | 0.0 |
| | WATERWALLS | | 968.1 | 969.1 | REPLACE 10 YEARS | ENHANCEMENT | | 0.702 | 2003 | | 168.1 | $1,157.2 | 1,157.2 | 0.0 | 484.6 | 96.9 | 45.70 | 1,462.3 | 0.0 | 0.0 | 1,256.2 | | 0.0 | 0.0 | 45.7 |
| | BURNERS | | 327.4 | 327.4 | REPLACE 5 YEARS | NECESSITY | | | 1996 | | 55.7 | $383.1 | 383.1 | 0.0 | 163.7 | 32.7 | 15.13 | 484.0 | 0.0 | 415.8 | 0.0 | | 0.0 | 15.1 | 0.0 |
| | BURNER CONTROLS | | * | 0.0 | REPLACE 5 YEARS | NECESSITY | | | 1996 | 717.00 | 121.9 | $838.9 | 838.9 | 0.0 | 81.3 | 16.3 | 7.51 | 240.2 | 0.0 | 655.1 | 0.0 | | 0.0 | 7.5 | 0.0 |
| | SUBTOTAL | | | 1408.9 | | | 0.25 | | | 717.00 | 361.40 | 2487.30 | 2487.30 | 0.00 | 785.70 | 157.14 | 72.60 | 2323.16 | 0.00 | 1388.29 | 1256.16 | | 0.00 | 26.90 | 45.70 |
| | *TOTAL LULIN COSTS* | | | 6385.6 | | | | | | 2868.00 | 1573.11 | 10826.71 | $10,826.7 | $0.0 | 3,517.8 | 703.6 | 325.04 | 10,401.4 | 0.0 | 6,505.6 | 5,024.6 | | 0.0 | 142.3 | 182.8 |
| | *TOTAL ALL UNITS AT PLANT THE COST IS INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | 4 | | 2966.00 | TOTAL I&C MATERIAL | | 1.000 | | | | | | | | | | | C.F.TOTAL $ | | | $11,530.3 | | | | $325.0 |
| | | | | 325.00 | TOTAL I&C INSTALLATION | | | | | | | | | | | | | | 1994 | 1996 | 2003 | | 1994 | 1996 | 2003 |
| | | | | | | | | | | | | | | | | | | % OF TOTAL | 0.000 | 0.564 | 0.436 | | 0.000 | 0.438 | 0.562 |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| | 10826.7 | 1,026.6 | 0.000% | 31.601% |

FILE: L2SWYARD.WK:
DATE: 12-Jan-93

DATE: 16-Jan-94
TIME: 01:25 PM

# SWITCHYARD DISTRIBUTION EQUIPMENT (9)

| ITEM DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SWYD. BKR. 1200A, 230KV, W/PANEL | | 1 | EA | 200 | 1 | 30 | 4 | 234 | 240.00 | 240 | 0 | 50 | 0 | 264 | 168 | 44 |
| TRANSFORMER, 120 MVA | | 1 | EA | 800 | 1 | 120 | 16 | 936 | 1400.00 | 1400 | 0 | 50 | 0 | 1540 | 168 | 259 |
| GENERATOR BKR. 2000A | | 1 | EA | 100 | 1 | 15 | 2 | 117 | 200.00 | 200 | 0 | 50 | 0 | 220 | 168 | 37 |
| GENERATOR BKR. 4000A | | 1 | EA | 350 | 1 | 53 | 7 | 410 | 400.00 | 400 | 0 | 50 | 0 | 440 | 168 | 74 |
| TRANSFORMER, 5MVA | | 1 | EA | 85 | 1 | 13 | 2 | 99 | 200.00 | 200 | 0 | 50 | 0 | 220 | 168 | 37 |
| GROUND RESISTOR | | 1 | EA | 8 | 1 | 1 | 0 | 9 | 40.00 | 40 | 0 | 50 | 0 | 44 | 168 | 7 |
| SWITCHGEAR, 4.16 KV | | 1 | EA | 150 | 1 | 23 | 3 | 176 | 80.00 | 80 | 0 | 50 | 0 | 88 | 168 | 15 |
| TRANSFORMER, 1000 KVA | | 1 | EA | 20 | 1 | 3 | 0 | 23 | 80.00 | 80 | 0 | 50 | 0 | 88 | 168 | 15 |
| MOTOR CONTROL CENTER | | 1 | EA | 40 | 1 | 6 | 1 | 47 | 30.00 | 30 | 0 | 50 | 0 | 33 | 168 | 6 |
| WIRING & CONDUIT | | 1 | LT | 2 | 1 | 0 | 0 | 2 | 36.00 | 36 | 0 | 50 | 0 | 40 | 168 | 7 |
| SUBTOTAL | | | | | | | | $2,053 | | | | US | $0 | 2977 | LEVA | 500 |

## CASH FLOW (000)

| VALUES | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,053 MATERIAL (US $) | 513.34 | 1026.68 | 513.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 513.34 | 1,026.68 | 513.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *500 LABOR(LEVA)* | *125.02* | *250.03* | *125.02* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 2053.35 | 15.63 | 0.00% | 100.00% |

FILE: L2EQUIP.WK3
DATE: 1-Dec-93

DATE: 01-Feb-94
TIME: 02:06 PM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 60 | 1 | 12 | 2 | 261 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | | SUBTOTAL | | | | | | | $945 | | | | US | $0 | | LEVA | 62 |

multiplier of .68 of Sofia

multiplier of .68 of Sofia

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 945 MATERIAL (US $) | 0 | 945.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 945.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *62 LABOR(LEVA)* | *0* | *61.83* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **945.17** | **1.93** | **0.00%** | **100.00%** |

928

FILE: L2PP10B.WK3
DATE: 22-Nov-93

DATE: 24-Mar-94
TIME: 10:49 AM

# LULIN PLANTS ( 10 b 1 )

# HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

*LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $/12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB. COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.80 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 14,694 | 271 | 41 | 5 | 317 | | 3,040 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 32,720 | 728 | 109 | 15 | 851 | | 8,174 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 26,396 | 658 | 99 | 13 | 770 | | 7,392 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 21,254 | 707 | 106 | 14 | 828 | | 7,945 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 21,830 | 809 | 121 | 16 | 947 | | 9,087 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 18,422 | 816 | 122 | 16 | 955 | | 9,168 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 20,502 | 1,332 | 200 | 27 | 1,559 | | 14,966 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 695 | 224 | 93.23 | 9,198 | 856 | 129 | 17 | 1,003 | | 9,632 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 3,410 | 389 | 58 | 8 | 455 | | 4,369 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 10,176 | 1,476 | 221 | 30 | 1,727 | | 16,576 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,810 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.85 | 4,156 | 760 | 114 | 15 | 889 | | 8,535 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 11862 | 2,752 | 413 | 55 | 3,220 | | 30,910 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 832 | 340 | 51 | 7 | 398 | | 3,824 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 2,726 | 1,350 | 202 | 27 | 1,578 | | 15,161 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 198,180 | | | US | $15,498 | LEVA | 148,777 |

*LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.80 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 2,454 | 61 | 9 | 1 | 72 | | 687 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 1,554 | 52 | 8 | 1 | 61 | | 581 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 1,552 | 58 | 9 | 1 | 67 | | 646 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 520 | 23 | 3 | 0 | 27 | | 259 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 1,568 | 102 | 15 | 2 | 119 | | 1,145 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 695 | 224 | 93.23 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 2,104 | 240 | 36 | 5 | 281 | | 2,696 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 1,104 | 160 | 24 | 3 | 187 | | 1,796 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,810 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.85 | 664 | 121 | 18 | 2 | 142 | | 1,364 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 11,520 | | | US | $958 | LEVA | 8,175 |

(1) LABOR PERCENT PROVIDED BY CLIENT



227

*OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL. US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL. | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA–000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.67 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 146 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.66 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 156 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 38.08 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.68 | 0.842 | 0 | 168.00 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 341 | 104 | 37.08 | 136 | 5 | 1 | 0 | 6 | 1.55 | 0.776 | 316 | 168.00 | 53 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 270 | 12 | 2 | 0 | 14 | 1.90 | 0.949 | 768 | 168.00 | 129 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 126 | 52.50 | 444 | 23 | 3 | 0 | 27 | 2.04 | 1.020 | 1,359 | 168.00 | 228 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 726 | 54 | 8 | 1 | 63 | 2.70 | 1.352 | 2,944 | 168.00 | 495 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 808 | 143 | 79.08 | 0 | 0 | 0 | 0 | 0 | 2.98 | 1.490 | 0 | 168.00 | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 881 | 175 | 86.33 | 696 | 60 | 9 | 1 | 71 | 3.47 | 1.734 | 3,632 | 168.00 | 610 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 0 | 0 | 0 | 0 | 0 | 3.62 | 1.808 | 0 | 168.00 | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 0 | 0 | 0 | 0 | 0 | 3.75 | 1.873 | 0 | 168.00 | 0 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | 0 | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 1,700 | 183 | 27 | 4 | 214 | 4.62 | 2.310 | 11,781 | 168.00 | 1,979 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | – | 127.00 | 6,936 | 881 | 132 | 18 | 1,031 | 5.41 | 2.706 | 58,306 | 168.00 | 9,459 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 1,909 | – | 159.08 | 1152 | 183 | 27 | 4 | 214 | 6.73 | 4.367 | 15,092 | 168.00 | 2,536 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | – | 0 | 0 | 0 | 0 | 9.78 | 4.890 | 0 | 168.00 | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 3,520 | 698 | 105 | 14 | 817 | 10.90 | 5.451 | 57,557 | 168.00 | 9,670 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | – | 0 | 0 | 0 | 0 | 13.07 | 6.534 | 0 | 168.00 | 0 |
| | | | | | | | | | 15,582 | | | US | $2,457 | | | | LEVA | 25,159 |

## LULIN PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15498 | MATERIAL (US $) | 542.41 | 1255.30 | 1565.25 | 1658.24 | 1720.23 | 1751.22 | 1751.22 | 1751.22 | 1751.22 | 1751.22 |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 146777 | *LABOR(LEVA)* | *5207.18* | *12050.90* | *15026.43* | *15919.09* | *16514.20* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 146777 | *TOTAL (LEVA)* | *5207.18* | *12050.90* | *15026.43* | *15919.09* | *16514.20* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 15,497.56 | 4,649.27 | 0.00% | 100.00% |



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**CASH FLOW (000)** ***LAID DOWN – INSULATION FOAM CONCRETE***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 956 | MATERIAL (US $) | | 47.78 | 191.14 | 238.93 | 238.93 | 238.93 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 9175 | *LABOR(LEVA)* | | *458.74* | *1834.95* | *2293.69* | *2293.69* | *2293.69* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 9175 | *TOTAL (LEVA)* | | *458.74* | *1834.95* | *2293.69* | *2293.69* | *2293.69* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **955.70** | **286.71** | **0.00%** | **100.00%** |

**CASH FLOW (000)** ***OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 2457 | MATERIAL (US $) | | 122.83 | 491.33 | 614.17 | 614.17 | 614.17 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 25159 | *LABOR(LEVA)* | | *1257.95* | *5031.82* | *6289.77* | *6289.77* | *6289.77* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 25159 | *TOTAL (LEVA)* | | *1257.95* | *5031.82* | *6289.77* | *6289.77* | *6289.77* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **2,456.66** | **786.22** | **0.00%** | **100.00%** |

**CASH FLOW (000)** ***TOTAL DISTRIBUTION PIPING***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18810 | MATERIAL (US $) | | 713.03 | 1837.78 | 2416.34 | 2511.33 | 2573.32 | 1751.22 | 1751.22 | 1751.22 | 1751.22 | 1751.22 |
| | | % | 3.77% | 10.25% | 12.79% | 13.26% | 13.61% | 9.26% | 9.26% | 9.26% | 9.26% | 9.26% |
| 183110 | *LABOR(LEVA)* | | *6923.87* | *18917.67* | *23609.89* | *24502.55* | *25097.66* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 183110 | *TOTAL (LEVA)* | | *6923.87* | *18917.67* | *23609.89* | *24502.55* | *25097.66* | *16811.75* | *16811.75* | *16811.75* | *16811.75* | *16811.75* |
| | | % | 3.76% | 10.33% | 12.89% | 13.36% | 13.71% | 9.18% | 9.18% | 9.18% | 9.18% | 9.18% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **18,909.92** | **5,722.20** | **0.00%** | **100.00%** |



829

FILE: L2_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:10 PM

# LULIN (4) DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | QTY MAT'L | UNIT | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $(000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $(000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 12 | 1950 | 260 | 546 | 12.00 | 432 | 66 | 50 | 4 | 360 | 165 | 64 |
| | | SUBTOTAL | | | | | | | $99 (.18 MULTIPLIER-18% ALLOT FOR LULIN) | | | | US | $1 | | LEVA | $11 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 3,825,000 | 1 | 573750 | 76500 | 4475 | N/A | N/A | N/A | N/A | 203 | N/A | N/A | 16632 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *27,000* | *1* | – | – | *27* | | | | | | | | |
| | | TOTAL US $ | | | 3,852,000 | 1 | – | – | 4,601 | | | | | 203 | | | 16,643 |

**CASH FLOW (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 99 MATERIAL (US $) | 1.38 | 16.76 | 20.11 | 20.11 | 20.11 | 20.11 |
| 1 LABOR (US $) | 0.01 | 0.13 | 0.16 | 0.16 | 0.16 | 0.16 |
| SUBTOTAL | 1.39 | 16.89 | 20.27 | 20.27 | 20.27 | 20.27 |
| *11 LABOR(LEVA)* | *0.16* | *1.95* | *2.35* | *2.35* | *2.35* | *2.35* |
| 4,475 WEST. SCADA EQUIPMENT | 62.65 | 760.79 | 912.95 | 912.95 | 912.95 | 912.95 |
| 27 FIBER OPTIC LEASING | 0.38 | 4.59 | 5.51 | 5.51 | 5.51 | 5.51 |
| 203 WEST. SCADA LABOR (US $) | 2.84 | 34.43 | 41.31 | 41.31 | 41.31 | 41.31 |
| SUBTOTAL | 65.87 | 799.81 | 959.77 | 959.77 | 959.77 | 959.77 |
| 4,804 TOTAL US $ | 67.26 | 816.70 | 980.03 | 980.03 | 980.03 | 980.03 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *16,632 WEST. SCADA LABOR (LEVA)* | *232.85* | *2827.44* | *3392.93* | *3392.93* | *3392.93* | *3392.93* |
| *16,643 TOTAL (LEVA)* | *233.01* | *2,829.39* | *3,395.27* | *3,395.27* | *3,395.27* | *3,395.27* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **4,600.81** | **723.39** | **0.000%** | **71.899%** |

430

FILE: L2HDSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:29 PM

# LULIN (4) HEATING SUBSTATIONS I & C (11)

| ITEM DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000 |
|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | NOTE 1 | 1 LOT | 7000 | 2646 | INC. | INC. | 18522 | 1000 | 2,646 | 93,139 |
| CONSISTING OF: | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | |
| RTD | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | |
| | | | | | | | --- | | --- | --- |
| | TOTAL US $ | | | | | | $18,522 | | 0 | $93,139 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 18,522 MATERIAL (US $) | 259.31 | 3148.74 | 3778.49 | 3778.49 | 3778.49 | 3778.49 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 259.31 | 3,148.74 | 3,778.49 | 3,778.49 | 3,778.49 | 3,778.49 |
| *93,139 LABOR(LEVA)* | *1303.95* | *15833.86* | *19000.40* | *19000.40* | *19000.40* | *19000.40* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 18,522.00 | 2,910.60 | 0.000% | 100.000% |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

# DETAILED ESTIMATE TABLES
# REPUBLIKA CASE P1, P3

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL P1 |
| Technology: | Boiler Rehabilitation at Existing Republika Station |
| Demand: | |

1

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 165,880.5 | | 165,880.5 | 138,402.8 | 11,220.0 | | 149,622.8 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 165,880.5 | | 165,880.5 | $138,402.8 | $11,220.0 | | $149,622.8 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 12,441.0 | Plant Design Engineering 7.5% | 11,221.7 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 5,349.6 | Owner's Costs 3.0% | 4,825.3 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 183,671.2 | SUBTOTAL | 165,869.9 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 27,550.7 | CONTINGENCY 15.0% | 24,850.5 |
| | TOTAL COST (Bulgaria part) | | 211,221.8 | TOTAL COST (Foreign Exch. part) | 190,520.4 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 138,402.8 | 16,403.8 | | | 32% | |
| 138,402.8 | 16,403.8 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 181,439.6 | 5,670.0 | 164,990.6 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 29,782.3 | 930.7 | 25,529.7 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 211,221.8 | $6,600.7 | $190,520.4 |

| TOTAL IN US$ (US$,x1000) |
|---|
| $197,121.0 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 85.9% | 86.6% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 14.1% | 13.4% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL P1
Technology: Steam Turbine Generator Rehabilitation at Republika Station
Demand:

INPUT AREA

1

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 6,022.8 | | 6,022.8 | 10,314.5 | 480.9 | | 10,795.4 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 6,022.8 | | 6,022.8 | $10,314.5 | $480.9 | | $10,795.4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 451.7 | Plant Design Engineering | 7.5% | 809.7 |
| | Construction Supervision | | | Construction Supervision | | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 194.2 | Owner's Costs | 3.0% | 348.2 |
| | Taxes and Permits | | | Taxes and Permits | | |
| | Other | | | Other | | |
| | SUBTOTAL | | 6,668.7 | SUBTOTAL | | 11,953.2 |
| | ESCALATION | | w/economics | ESCALATION | | w/economics |
| | CONTINGENCY | 15.0% | 1,000.3 | CONTINGENCY | 15.0% | 1,793.0 |
| | TOTAL COST (Bulgaria part) | | 7,669.0 | TOTAL COST (Foreign Exch. part) | | 13,746.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 10,314.5 | 669.1 | | | 28% | |
| 10,314.5 | 669.1 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) | |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | 4,954.2 | 154.8 | 9,539.8 | |
| 1995 | | | | |
| 1996 | | | | |
| 1997 | | | | |
| 1998 | 904.9 | 28.3 | 1,402.1 | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |
| 2002 | | | | |
| 2003 | 904.9 | 28.3 | 1,402.1 | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2007 | | | | |
| 2008 | 904.9 | 28.3 | 1,402.1 | |
| 2009 | | | | |
| 2010 | | | | |
| 2011 | | | | |
| 2012 | | | | |
| 2013 | | | | |
| 2014 | | | | |
| 2015 | | | | TOTAL IN US$ (US$,x1000) |
| TOTAL COST | 7,669.0 | $239.7 | $13,746.2 | $13,985.8 |

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 64.6% | 69.4% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 11.8% | 10.2% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | 11.8% | 10.2% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | 11.8% | 10.2% |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |



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**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL P1 P3
Technology: Distribution Piping w/L.D.Sensors in Pernik Heating District
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | 90.9 | | 90.9 | 1,390.0 | | | 1,390.0 |
| 10b | Heating Distribution Piping | | 117,529.6 | | 117,529.6 | 11,958.6 | | | 11,958.6 |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 117,620.5 | | 117,620.5 | $13,348.5 | | | $13,348.5 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 8,821.5 | Plant Design Engineering 7.5% | 1,001.1 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 3,793.3 | Owner's Costs 3.0% | 430.5 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 130,235.3 | SUBTOTAL | 14,780.2 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 19,535.3 | CONTINGENCY 15.0% | 2,217.0 |
| | TOTAL COST (Bulgaria part) | | 149,770.6 | TOTAL COST (Foreign Exch. part) | 16,997.2 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 1,390.0 | 2.6 | | | 100% | |
| 11,956.6 | 3,672.8 | | | 100% | |
| 13,346.5 | 3,675.6 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 5,841.1 | 182.5 | 659.5 |
| 1995 | 16,729.4 | 522.8 | 1,882.9 |
| 1996 | 20,893.0 | 652.9 | 2,325.2 |
| 1997 | 21,552.0 | 673.5 | 2,403.4 |
| 1998 | 22,001.3 | 687.5 | 2,454.4 |
| 1999 | 12,550.8 | 392.2 | 1,458.4 |
| 2000 | 12,550.8 | 392.2 | 1,458.4 |
| 2001 | 12,550.8 | 392.2 | 1,458.4 |
| 2002 | 12,550.8 | 392.2 | 1,458.4 |
| 2003 | 12,550.8 | 392.2 | 1,458.4 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 149,770.6 | $4,680.3 | $16,997.2 |

TOTAL IN US$ (US$,x1000): $21,677.5

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 3.9% | 3.9% |
| 1995 | 11.2% | 11.0% |
| 1996 | 14.0% | 13.7% |
| 1997 | 14.4% | 14.1% |
| 1998 | 14.7% | 14.4% |
| 1999 | 8.4% | 8.6% |
| 2000 | 8.4% | 8.6% |
| 2001 | 8.4% | 8.6% |
| 2002 | 8.4% | 8.6% |
| 2003 | 8.4% | 8.6% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL P1 P3
Technology: Control System Upgrade for Pernik Heating District
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000 | | | | Foreign Exchange Expenditures in US$,x1000 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | 24,040.1 | | 24,040.1 | 6,661.1 | 293.6 | | 6,954.7 |
| 11 | Heating Substation I&C | | 22,176.0 | | 22,176.0 | 4,410.0 | | | 4,410.0 |
| TOTAL DIRECT COST | | | 46,216.1 | | 46,216.1 | $11,071.1 | $293.6 | | $11,364.7 |
| | | Plant Design Engineering | | 7.5% | 3,466.2 | Plant Design Engineering | | 7.5% | 852.4 |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | Included | Freight/Shipping | | | Included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 1,490.5 | Owner's Costs | | 3.0% | 366.5 |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 51,172.8 | SUBTOTAL | | | 12,583.6 |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 7,675.9 | CONTINGENCY | | 15.0% | 1,887.5 |
| | | TOTAL COST (Bulgaria part) | | | 58,848.7 | TOTAL COST (Foreign Exch. part) | | | 14,471.1 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000 | | | PERCENT OF TOTAL $ = LOCAL | | |
|---|---|---|---|---|---|
| Equipment and Material | Construction & Labor | Engineering & Home Office | Equipment and Material | Construction & Labor | Engineering & Home Office |
| 6,661.1 | 1,044.6 | | | 72% | |
| 4,410.0 | 693.0 | | | 100% | |
| 11,071.1 | 1,737.6 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 623.9 | 25.7 | 202.6 |
| 1995 | 10,004.3 | 312.6 | 2,460.1 |
| 1996 | 12,005.1 | 375.2 | 2,952.1 |
| 1997 | 12,005.1 | 375.2 | 2,952.1 |
| 1998 | 12,005.1 | 375.2 | 2,952.1 |
| 1999 | 12,005.1 | 375.2 | 2,952.1 |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 58,848.7 | $1,839.0 | $14,471.1 |

TOTAL IN US$ (US$,x1000): $16,310.1

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 1.4% | 1.4% |
| 1995 | 17.0% | 17.0% |
| 1996 | 20.4% | 20.4% |
| 1997 | 20.4% | 20.4% |
| 1998 | 20.4% | 20.4% |
| 1999 | 20.4% | 20.4% |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL P3
Technology: Fluidized Bed Boiler Addition at Republika Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | 97,932.0 | | 97,932.0 | 76,508.6 | 7,107.3 | | 83,615.9 |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 97,932.0 | | 97,932.0 | $76,508.6 | $7,107.3 | | $83,615.9 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 7,344.9 | Plant Design Engineering 7.5% | 6,271.2 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | included | Freight/Shipping | included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 3,158.3 | Owner's Costs 3.0% | 2,696.6 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 108,435.2 | SUBTOTAL | 92,583.7 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 16,265.3 | CONTINGENCY 15.0% | 13,887.6 |
| | TOTAL COST (Bulgaria part) | | 124,700.5 | TOTAL COST (Foreign Exch. part) | 106,471.3 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 76,508.6 | 10,167.7 | | | 30% | |
| 76,508.6 | 10,167.7 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 1,745.6 | 54.6 | 1,490.6 |
| 1995 | | | |
| 1996 | | | |
| 1997 | 18,206.3 | 568.9 | 15,544.8 |
| 1998 | 27,309.4 | 853.4 | 23,317.2 |
| 1999 | 15,088.6 | 471.5 | 12,883.0 |
| 2000 | 18,705.1 | 584.5 | 15,970.7 |
| 2001 | 28,057.6 | 876.8 | 23,956.0 |
| 2002 | 15,587.6 | 487.1 | 13,308.9 |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 124,700.5 | $3,898.9 | $106,471.3 |

TOTAL IN US$ (US$,x1000): $110,368.2

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 1.4% | 1.4% |
| 1995 | | |
| 1996 | | |
| 1997 | 14.6% | 14.6% |
| 1998 | 21.9% | 21.9% |
| 1999 | 12.1% | 12.1% |
| 2000 | 15.0% | 15.0% |
| 2001 | 22.5% | 22.5% |
| 2002 | 12.5% | 12.5% |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL P3
Technology: Steam Turbine Generator Rehabilitation at Republika Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | 6,847.4 | | 6,847.4 | 11,909.4 | 529.3 | | 12,438.7 |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 6,847.4 | | 6,847.4 | $11,909.4 | $529.3 | | $12,438.7 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 513.6 | Plant Design Engineering 7.5% | 932.9 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 220.6 | Owner's Costs 3.0% | 401.1 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 7,581.6 | SUBTOTAL | 13,772.6 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 1,137.3 | CONTINGENCY 15.0% | 2,065.9 |
| | TOTAL COST (Bulgaria part) | | 8,719.0 | TOTAL COST (Foreign Exch. part) | 15,838.7 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 11,909.4 | 743.3 | | | 29% | |
| 11,909.4 | 743.3 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 898.1 | 28.1 | 1,409.6 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 906.8 | 28.3 | 1,393.8 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | 3,060.4 | 95.6 | 6,145.4 |
| 2003 | 2,947.0 | 92.1 | 5,496.0 |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | 906.8 | 28.3 | 1,393.8 |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 8,719.0 | $272.5 | $15,838.7 |

TOTAL IN US$ (US$,x1000): $16,111.2

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 10.3% | 8.9% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 10.4% | 8.8% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | 35.1% | 38.8% |
| 2003 | 33.8% | 34.7% |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | 10.4% | 8.8% |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

Variant / Plant: DETAIL P3
Technology: Boiler Rehabilitation at Existing Republika Station
Demand:

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | | | | | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | 71,323.2 | | 71,323.2 | 59,294.9 | 4,824.2 | | 64,119.1 |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | | 71,323.2 | | 71,323.2 | $59,294.9 | $4,824.2 | | $64,119.1 |

| | | | | | |
|---|---|---|---|---|---|
| | Plant Design Engineering | 7.5% | 5,349.2 | Plant Design Engineering 7.5% | 4,808.9 |
| | Construction Supervision | | | Construction Supervision | |
| 32 = Assumed 1993 | Freight/Shipping | | Included | Freight/Shipping | Included |
| Exchange Lev/US$ | Owner's Costs | 3.0% | 2,300.2 | Owner's Costs 3.0% | 2,067.8 |
| | Taxes and Permits | | | Taxes and Permits | |
| | Other | | | Other | |
| | SUBTOTAL | | 78,972.6 | SUBTOTAL | 70,995.9 |
| | ESCALATION | | w/economics | ESCALATION | w/economics |
| | CONTINGENCY | 15.0% | 11,845.9 | CONTINGENCY 15.0% | 10,649.4 |
| | TOTAL COST (Bulgaria part) | | 90,818.5 | TOTAL COST (Foreign Exch. part) | 81,645.3 |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 59,294.9 | 7,053.1 | | | 32% | |
| 59,294.9 | 7,053.1 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 79,738.7 | 2,491.8 | 72,092.8 |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | 11,079.9 | 346.2 | 9,552.5 |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 90,818.5 | $2,838.1 | $81,645.3 |

TOTAL IN US$ (US$,x1000): $84,483.4

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 87.8% | 88.3% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | 12.2% | 11.7% |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**BULGARIA DISTRICT HEATING STUDY**
**CAPITAL COST AND CASH FLOW**

| | |
|---|---|
| Variant / Plant: | DETAIL P3 |
| Technology: | Demolition–Boiler 1, 2 & Reserve; |
| Demand: | Turbine Gen. 2, 4 & Utility Grid 25MW |

INPUT AREA

| Code | Description | Local Expenditures in Lev,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | Total Local Expenditures | Foreign Exchange Expenditures in US$,x1000: Equipment and Material | Construction Labor | Engineering & Home Office | Total For. Exch Expenditures |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Site Improvements | | | | | | | | |
| 1b | Demolition | 23,932.8 | 21,244.6 | | 45,177.4 | | | | |
| 2 | Foundations | | | | | | | | |
| 3 | Structures/Buildings | | | | | | | | |
| 4a | Combustion Turbine Generator | | | | | | | | |
| 4b | Steam Turbine Generator | | | | | | | | |
| 5a | Standard Boilers | | | | | | | | |
| 5b | Fluid Bed Boilers | | | | | | | | |
| 5c | Heat Recovery Steam Generators | | | | | | | | |
| 6 | Environmental Controls | | | | | | | | |
| 7a | Material Handling & Fuel Supply | | | | | | | | |
| 7b | Feedwater, Condensate, etc. | | | | | | | | |
| 7c | Other Mechanical Equipment | | | | | | | | |
| 8 | Electrical and I&C | | | | | | | | |
| 9 | Power Distribution & Transmissio | | | | | | | | |
| 10a | Heating Distribution Equipment | | | | | | | | |
| 10b | Heating Distribution Piping | | | | | | | | |
| 10c | Heating Distribution I&C | | | | | | | | |
| 11 | Heating Substation I&C | | | | | | | | |
| | TOTAL DIRECT COST | 23,932.8 | 21,244.6 | | 45,177.4 | | | | |
| | | Plant Design Engineering | | 7.5% | 3,388.3 | Plant Design Engineering | | 7.5% | |
| | | Construction Supervision | | | | Construction Supervision | | | |
| 32 | = Assumed 1993 | Freight/Shipping | | | included | Freight/Shipping | | | included |
| | Exchange Lev/US$ | Owner's Costs | | 3.0% | 1,457.0 | Owner's Costs | | 3.0% | |
| | | Taxes and Permits | | | | Taxes and Permits | | | |
| | | Other | | | | Other | | | |
| | | SUBTOTAL | | | 50,022.7 | SUBTOTAL | | | |
| | | ESCALATION | | | w/economics | ESCALATION | | | w/economics |
| | | CONTINGENCY | | 15.0% | 7,503.4 | CONTINGENCY | | 15.0% | |
| | | TOTAL COST (Bulgaria part) | | | 57,526.1 | TOTAL COST (Foreign Exch. part) | | | |

CAPITAL COSTS:

| TOTAL CAPITAL COST, US$,x1000: Equipment and Material | Construction & Labor | Engineering & Home Office | PERCENT OF TOTAL $ = LOCAL: Equipment and Material | Construction & Labor | Engineering & Home Office |
|---|---|---|---|---|---|
| 747.9 | 663.9 | | 100% | 100% | |
| 747.9 | 663.9 | | | | |

| Year | Total Local Expenditures (Lev,x1000) | Total Local Expenditures (US$,x1000) | Total Foreign Expenditures (US$x,1000) |
|---|---|---|---|
| 1993 | | | |
| 1994 | 57,526.1 | 1,797.7 | |
| 1995 | | | |
| 1996 | | | |
| 1997 | | | |
| 1998 | | | |
| 1999 | | | |
| 2000 | | | |
| 2001 | | | |
| 2002 | | | |
| 2003 | | | |
| 2004 | | | |
| 2005 | | | |
| 2006 | | | |
| 2007 | | | |
| 2008 | | | |
| 2009 | | | |
| 2010 | | | |
| 2011 | | | |
| 2012 | | | |
| 2013 | | | |
| 2014 | | | |
| 2015 | | | |
| TOTAL COST | 57,526.1 | $1,797.7 | |

TOTAL IN US$ (US$,x1000): $1,797.7

Notes:

1.

CASH FORECAST PERCENTS

| CASH F/C Year | Total Local Expenditures %/Year | Total Foreign Expenditures %/Year |
|---|---|---|
| 1993 | | |
| 1994 | 100.0% | 100.0% |
| 1995 | | |
| 1996 | | |
| 1997 | | |
| 1998 | | |
| 1999 | | |
| 2000 | | |
| 2001 | | |
| 2002 | | |
| 2003 | | |
| 2004 | | |
| 2005 | | |
| 2006 | | |
| 2007 | | |
| 2008 | | |
| 2009 | | |
| 2010 | | |
| 2011 | | |
| 2012 | | |
| 2013 | | |
| 2014 | | |
| 2015 | | |
| TOTAL % | 100.000% | 100.000% |

**REPUBLIKA CASE P1, P3**

**DETAILED ESTIMATE BACKUP INFORMATION**

FILE: SBURMR1.WK3
DATE: 13-Jan-94
TIME: 12:45PM

| CALCULATION FACTORS | Shipping/Freight | | % Material | |
|---|---|---|---|---|
| | OCEAN - U.S. | 15% | % Local | |
| | INLAND - U.S. | 2% | % Foreign | 100% |

60% LABOR (60% OF MAT'L)
32 LEVA/$
20% Foreign % Labor

50.00 US LABOR RATE
6.25 BULG RATE US $
156 BULG RATE LEVA

1.1 PRODUCTIVITY
0.1155 Composite Local Labor Factor $

## THERMAL BOILER MODIFICATIONS -- REPUBLIKA PLANTS -- t MTL

| | ITEM | NO. OF PLANTS | MATERIAL COST $x1000 | | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN C.F. TOTAL /YEAR $ U.S. 1994 | 1996 | 2003 | LOCAL LABOR US $ 1994 | 1996 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REPUBLIKA 1-4 | ECONOMIZER | 4 | 1543.1 | 6,172.4 | REPLACE NOW | NECESSITY | | 0.060 | 1994 | | 1,048.3 | $7,221.7 | 7,221.7 | | 3,066.2 | 617.2 | 286.16 | 9,125.3 | 7,638.9 | | | 286.2 | | |
| | SUPERHEATER | | 2840.1 | 11,360.4 | REPLACE NOW | NECESSITY | | 0.147 | 1994 | | 1,931.3 | $13,291.7 | 13,291.7 | | 5,660.2 | 1,136.0 | 524.85 | 16,786.2 | 14,427.7 | | | 524.9 | | |
| | WATERWALLS | | 2156.9 | 8,627.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.111 | 1996 | | 1,466.7 | $10,094.3 | 10,094.3 | | 4,313.8 | 862.8 | 399.60 | 12,766.0 | | 10,967.1 | | | 399.6 | |
| | PULVERIZERS & FANS | | 5326 | 21,304.0 | REPLACE NOW | NECESSITY | | 0.276 | 1994 | | 3,621.7 | $24,925.7 | 24,925.7 | | 10,652.0 | 2,130.4 | 984.24 | 31,485.6 | 27,066.1 | | | 984.2 | | |
| | CONTROLS | | * | | REPLACE NOW | NECESSITY | | | 1994 | 6177.60 | 1,050.2 | $7,227.8 | 7,227.8 | | 652.0 | 130.4 | 60.24 | 1,927.6 | 7,356.2 | | | 60.2 | | |
| | SH HEADER OPTION | | 85.3 | 341.2 | REPLACE NOW | NECESSITY | | 0.004 | 1994 | | 58.0 | $399.2 | 399.2 | | 170.6 | 34.1 | 15.76 | 504.4 | 433.3 | | | 15.8 | | |
| | PRECIPITATORS | | 1750.0 | | REPLACE 5 - 10 YEAR | ENHANCEMENT | | | 2003 | | | | | | | | | | | | | | | 97.6 |
| | BURNERS & FANS | | 527.8 | 2,111.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.027 | 1996 | | 368.0 | $2,479.6 | 2,479.6 | | 1,055.6 | 211.2 | 97.56 | 3,121.6 | | 2,681.7 | | | | |
| | BAGHOUSE | | 2517.5 | 10,070.0 | REPLACE NOW | NECESSITY | | 0.130 | 1994 | | 1,711.9 | $11,781.9 | 11,781.9 | | 5,035.0 | 1,007.0 | 466.23 | 14,897.5 | 12,789.9 | | | 466.2 | | |
| | BACKEND CLEANUP OPTIONS | | | | | | | | | | | | | | | | | | | | | | | |
| | SNCR | | | | ONE OF THESE | NECESSITY | | | 1994 | | | | | | | | | | | | | | | |
| | DRY SCRUB | | | | ONE OF THESE | NECESSITY | | | 1994 | | | | | | | | | | | | | | | |
| | WET SCRUB | | 4375.0 | 17,500.0 | ONE OF THESE | NECESSITY | | 0.226 | 1994 | | 2,975.0 | $20,475.0 | 20,475.0 | | 8,750.0 | 1,750.0 | 808.50 | 26,872.0 | 22,225.0 | | | 808.5 | | |
| | ESP SOX | | | | ONE OF THESE | NECESSITY | | | 1994 | | | | | | | | | | | | | | | |
| | SCR | | | | ONE OF THESE | NECESSITY | | | 1994 | | | | | | | | | | | | | | | |
| | SUBTOTAL | | | 77,487.2 | | | 80% | | | 6,177.6 | 14,223.6 | $97,887.6 | 97,887.6 | | 38,386.6 | 7,678.1 | 3,640.2 | 116,464.9 | 82,128.2 | 13,636.8 | | 3,144.0 | 496.2 | |
| REPUBLIKA 5 | ECONOMIZER | 1 | 3044.2 | 3,044.2 | REPLACE NOW | NECESSITY | | 0.040 | 1994 | | 524.7 | $3,610.9 | 3,610.9 | | 1,543.1 | 308.6 | 142.56 | 4,582.6 | 3,918.6 | | | 142.6 | | |
| | SUPERHEATER | | 5680.3 | 5,680.3 | REPLACE NOW | NECESSITY | | 0.073 | 1994 | | 965.7 | $6,646.0 | 6,646.0 | | 2,840.2 | 568.0 | 262.43 | 8,387.6 | 7,214.0 | | | 262.4 | | |
| | WATERWALLS | | 4313.8 | 4,313.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.056 | 1996 | | 733.3 | $5,047.1 | 5,047.1 | | 2,156.9 | 431.4 | 199.30 | 6,377.5 | | 5,476.6 | | | 199.3 | |
| | PULVERIZERS & FANS | | 6326.0 | 6,326.0 | REPLACE NOW | NECESSITY | | 0.086 | 1994 | | 905.4 | $6,231.4 | 6,231.4 | | 2,663.0 | 532.6 | 246.08 | 7,874.0 | 6,784.0 | | | 246.1 | | |
| | CONTROLS | | * | | REPLACE NOW | NECESSITY | | | 1994 | 1544.40 | 262.5 | $1,806.9 | 1,806.9 | | 163.0 | 32.6 | 15.06 | 482.0 | 1,638.6 | | | 15.1 | | |
| | SH HEADER OPTION | | 170.7 | 170.7 | REPLACE NOW | NECESSITY | | 0.002 | 1994 | | 29.0 | $199.7 | 199.7 | | 85.4 | 17.1 | 7.89 | 252.4 | 216.8 | | | 7.9 | | |
| | PRECIPITATORS | | 3650.0 | | REPLACE 5 - 10 YEAR | ENHANCEMENT | | | 2003 | | | | | | | | | | | | | | | 36.6 |
| | BURNERS & FANS | | 791.8 | 791.8 | REPLACE 5 YEARS | ENHANCEMENT | | 0.010 | 1996 | | 134.6 | $926.4 | 926.4 | | 395.9 | 79.2 | 36.58 | 1,170.6 | | 1,005.6 | | | | |
| | BAGHOUSE | | 4090 | 4,090.0 | REPLACE NOW | NECESSITY | | 0.053 | 1994 | | 695.3 | $4,785.3 | 4,785.3 | | 2,045.0 | 409.0 | 188.98 | 6,046.7 | 5,194.3 | | | 189.0 | | |
| | BACKEND CLEANUP OPTIONS | | | | | | | | | | | | | | | | | | | | | | | |
| | SNCR | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | |
| | DRY SCRUB | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | |
| | WET SCRUB | | 9625.0 | 9,625.0 | ONE OF THESE | NECESSITY | | 0.124 | 1994 | | 1,636.3 | $11,261.3 | 11,261.3 | | 4,812.5 | 962.5 | 444.69 | 14,229.8 | 12,223.8 | | | 444.7 | | |
| | ESP SOX | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | |
| | SCR | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | |
| | SUBTOTAL | | | 33083.8 | | | 0.200 | | | 1544.40 | 5886.79 | 40514.99 | 40514.99 | | 16704.90 | 3340.99 | 1543.53 | 49393.06 | 37371.56 | 6484.11 | | 1307.65 | 235.86 | |
| | | | | 110,571.0 | | | | | | 7722.00 | 20109.81 | 138402.81 | 138402.81 | | 55100.50 | 11220.10 | 5183.68 | 165857.96 | 129500.01 | 20122.90 | | 4451.66 | 732.03 | |

*TOTAL REPUBLIKA COSTS*
*TOTAL ALL UNITS AT PLANT THE COST E 5
INSTALLATION & STARTUP
SINCE THIS PROPOSED FOR TOTAL PLANT IT
SHOULD BE DONE AT THE SAME TIME (NOW).

| | |
|---|---|
| 7,722.0 | TOTAL I&C MATERIAL |
| 616.0 | TOTAL I&C INSTALLATION |

| C.F.TOTAL $ | 1994 | 1996 | 2003 | $148,622.6 | 1994 | 1996 | 2003 | $5,183.7 |
|---|---|---|---|---|---|---|---|---|
| % OF TOTAL | 0.865 | 0.134 | | | 0.859 | 0.141 | | |

| MODEL COST SUMMARY (US $) | EQUIP/ MATL | LABOR | PERCENT LOCAL MATL | LABOR |
|---|---|---|---|---|
| | 138,402.8 | 16,403.8 | | 31.601% |

242

| | | | | |
|---|---|---|---|---|
| FILE: | STGMODR1.WK1 | S1 | 18/26 | 25/50 |
| DATE: | 13-Jan-94 | S2 | CAP. | CAP. |
| TIME: | 12:59 PM | S3 | EXP. | EXP. |
| | | | 1.78 | 1.78 |

| |
|---|
| OCEAN - U.S. |
| 15% |
| INLAND - U.S. |
| 2% |

| | |
|---|---|
| HOTEL/DAY | 100 |
| MEALS/DAY | 15 |
| CAR/DAY | 60 |
| US Daily Est | 175 |

| | | |
|---|---|---|
| Outage Hours | 50.00 | U.S.Base Rate |
| Local # MEN | 8 | |
| WEEKS-Base | 6 | |
| WEEKS-Alt. | 5 | |
| 5 / 8 | 40 | |
| Foreign # Men | 2 | |
| Expense DAYS | 7 | |

| | |
|---|---|
| 1.1 | Productivity-Local |
| 0.1155 | Composite Local Labor Factor |
| 5.25 | BULG IN US $ |
| 168 | BULG IN LEVA |
| 32 | Exchange Rate Lev/$ |

## TURBINE GENERATOR - MODIFICATIONS - REPUBLIKA PLANTS - 4 b

| | ITEM | NO. OF PLANTS | UNIT COST | SUBTOTAL MTL $ | C.F. YEAR | FREIGHT | TOTAL MTL. Per Outage $ | TOTAL MTL /Unit/Outage U.S. $ | TOTAL # OUTAGES | TOTAL MTL U.S. $ | LABOR & EXPENSES U.S $ EXPENSES U.S. $ | FOREIGN INSTALLATION U.S. $ | LOCAL INSTALLATION U.S. $ | LOCAL INSTALLATIO LEV | FOREIGN (U.S. $) 1994 | 1996 | 2003 | 2006 | LOCAL (U.S. $) 1994 | 1996 | 2003 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AIR COOLED GENERATOR | 0 | | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MW | CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 0 | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | AIR COOLED GENERATOR | 0 | | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MW | CLEAN, CHECK, BALANCE ROTOR | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 0 | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | U/C multi. 1.10 | | | | | | | | | | | | | | | | | | | | | |
| REPUBLIKA - | HYDROGEN COOLED GENERATOR | 1 | 242.00 | 242.00 | | 41.14 | 283.14 | | | | 7.35 | 24.00 | 11.09 | 354.82 | 314.49 | 314.49 | 314.49 | 314.49 | 11.068 | 11.068 | 11.068 | 11.068 |
| #5 MW | CLEAN, CHECK, BALANCE ROTOR | | 11.00 | 11.00 | | 1.87 | 12.87 | | | | | | | | 12.87 | 12.87 | 12.87 | 12.87 | 0 | 0 | 0 | 0 |
| COND. 55 | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPLACE LABRYINTH RINGS | 20 | 7.50 165.00 | 165.00 | | 28.05 | 193.05 | | | | | | | | 193.05 | 193.05 | 193.05 | 193.05 | 0 | 0 | 0 | 0 |
| | REPLACE H.P. CYLINDER 1-TIME | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | REPAIR/RECONDITION H.P. | 1 | 80.00 | 88.00 | | 14.96 | 102.96 | | | | | | | | 102.96 | 102.96 | 102.96 | 102.96 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | | 508.00 | | 86.02 | 592.02 | 592.02 | 4 | 2368.08 | 7.35 | 24.00 | 11.09 | 354.82 | 623.37 | 623.37 | 623.37 | 623.37 | 11.09 | 11.09 | 11.09 | 11.09 |
| | U/C multi. 1.00 | | | | | | | | | | | | | | | | | | | | | |
| REPUBLIKA - | HYDROGEN COOLED GENERATOR | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | | | 7.35 | 24.00 | 11.09 | 354.82 | 258.75 | 258.75 | 258.75 | 258.75 | 11.068 | 11.068 | 11.068 | 11.068 |
| MW | CLEAN, CHECK, BALANCE ROTOR | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | 11.7 | 11.7 | 11.7 | 11.7 | 0 | 0 | 0 | 0 |
| 25 | AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WAS #6 | REPLACE LABRYINTH RINGS | 20 | 7.50 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | 175.5 | 175.5 | 175.5 | 175.5 | 0 | 0 | 0 | 0 |
| NOW #3 | REPLACE H.P. CYLINDER 1-TIME | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25MW-BP | REPAIR/RECONDITION H.P. #7 | | 80.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SUBTOTAL | | | 380.00 | | 64.60 | 444.60 | 444.60 | 4 | 1778.40 | 7.35 | 24.00 | 11.09 | 354.82 | 475.95 | 475.95 | 475.95 | 475.95 | 11.09 | 11.09 | 11.09 | 11.09 |
| REPUBLIKA #4 - | NEW 25 MW TURBINE GENERATOR | 1 | 4582.90 | 4582.90 | | 779.09 | 5361.99 | | | | 7.35 | 155.62 | 71.99 | 2303.94 | 5525.18 | | | | 71.99 | | | |
| (NEW) MW | CONDENSER | 1 | 139.00 | 139.00 | | 23.63 | 162.63 | | | | 0.00 | 5.00 | 2.31 | 73.92 | 167.63 | | | | 2.31 | | | |
| 25 | FOUNDATION | 1 | 45.60 | 45.60 | | 7.79 | 53.59 | | | | 7.35 | 20.29 | 9.38 | 299.54 | 61.20 | | | | 9.38 | | | |
| | PIPING | 20 1 | 366.60 | 366.60 | | 62.32 | 428.92 | | | | 0.00 | 19.70 | 9.64 | 276.44 | 447.62 | | | | 9.64 | | | |
| | ELECTRICAL / I & C | 1 | 137.50 | 137.50 | | 23.36 | 160.86 | | | | 0.00 | 15.60 | 7.21 | 230.63 | 176.48 | | | | 7.21 | | | |
| | SUBTOTAL | | 5271.80 | 5271.80 | | 896.21 | 6168.01 | 6168.01 | 1 | 6168.01 | 14.70 | 215.38 | 99.51 | 3184.19 | 6398.09 | | | | 99.51 | | | |
| | TOTAL/PLANT | | | $6,157.8 | | $1,046.8 | $7,204.6 | | | $10,314.5 | $29.4 | $263.4 | $121.7 LEVA = | | $7,497.4 | $1,099.3 | $1,099.3 | $1,099.3 | $121.7 | $22.2 | $22.2 | $22.2 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | C.F. TOTAL $ | | | | 10,795.4 | | | | $168.2 | | | | |
| TOTAL FOREIGN LABOR & EXPENSE | $480.6 | | | | | | 1994 | 1996 | 2003 | 2006 | 1994 | 1996 | 2003 | 2006 |
| | | | | | | % OF TOTAL | 0.695 | 0.102 | 0.102 | 0.102 | 0.647 | 0.118 | 0.118 | 0.118 |
| TOTAL LOCAL LABOR | $168.2 | | | | | | | | | | | | | |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY U.S. $ | 10314.5 | 689.1 | 0.00% | 28.129% |

FILE: R1EQUIP.WK3
DATE: 1-Dec-93

DATE: 01-Feb-94
TIME: 02:11 PM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT | MAT'L | COST /UNIT US $ (1000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | | 60 | 1 | 12 | 2 | 281 | 48.00 | 144 | 0 | 50 | 0 | 158 | 168 | 27 |
| VSD | | | 3 | EA | | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 106 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | | SUBTOTAL | | | | | | | | $1,390 | | | | US | $0 | | LEVA | 91 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 1,390 MATERIAL (US $) | 0 | 1389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 1,389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *91 LABOR(LEVA)* | *0* | *90.92* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **1389.96** | **2.84** | **0.00%** | **100.00%** |

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FILE:R1PIP1O8.WK3
DATE: 22-Nov-93

DATE: 24-Mar-94
TIME: 10:50 AM

# REPUBLIKA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

*LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $/ 12 M | FTGS ALLOW $/12M | PIPE US $/ METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | | LAB.COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 188,570 | 4,652 | 698 | 93 | 5,443 | | 52,249 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 196 | 64.99 | 3,976 | 258 | 39 | 5 | 302 | | 2,902 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 1,938 | 181 | 27 | 4 | 211 | | 2,029 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 2,448 | 279 | 42 | 6 | 327 | | 3,136 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 232 | 31 | 5 | 1 | 36 | | 344 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 5,694 | 826 | 124 | 17 | 966 | | 9,273 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 6,664 | 1,219 | 183 | 24 | 1,426 | | 13,686 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 188.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | – | 232.00 | 1368 | 317 | 48 | 6 | 371 | | 3,565 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.60 | 0.35 | 4,910 | – | 409.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 208,690 | | | US | $9,082 | LEVA | 87,158 |

*LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 11,146 | 276 | 42 | 6 | 325 | | 3,121 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 388 | 144 | 44.30 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 196 | 64.99 | 1,864 | 108 | 16 | 2 | 127 | | 1,215 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 1,424 | 133 | 20 | 3 | 155 | | 1,491 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 3,822 | 436 | 65 | 9 | 510 | | 4,897 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 64 | 9 | 1 | 0 | 11 | | 104 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,908 | 286 | 182.85 | 0 | 0 | 0 | 0 | 0 | | 0 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | – | 188.42 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | – | 232.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | – | 307.00 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.60 | 0.35 | 4,910 | – | 409.17 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | – | 443.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 5,942 | – | 495.17 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 6,921 | – | 576.75 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 7,235 | – | 602.92 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 8,334 | – | 694.50 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 12,055 | – | 1,004.58 | – | 0 | 0 | 0 | 0 | | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 14,755 | – | 1,229.58 | – | 0 | 0 | 0 | 0 | | 0 |
| | | | | | | | | | 18,120 | | | US | $1,128 | LEVA | 10,828 |

(1) LABOR PERCENT PROVIDED BY CLIENT



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## OVERHEAD / COLLECTOR -- INSULATION GLASS WOOL & ALUMINUM SHEET
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL. US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL. US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL. | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL. | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.67 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.48 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 148 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.55 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 158 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 36.06 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.88 | 0.842 | 0 | 168.00 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 341 | 104 | 37.06 | 0 | 0 | 0 | 0 | 0 | 1.55 | 0.775 | 0 | 168.00 | 0 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 0 | 0 | 0 | 0 | 0 | 1.90 | 0.949 | 0 | 168.00 | 0 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 128 | 52.50 | 0 | 0 | 0 | 0 | 0 | 2.04 | 1.020 | 0 | 168.00 | 0 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 802 | 59 | 9 | 1 | 70 | 2.70 | 1.352 | 3,252 | 168.00 | 546 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 806 | 143 | 79.08 | 0 | 0 | 0 | 0 | 0 | 2.98 | 1.490 | 0 | 168.00 | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 88.33 | 0 | 0 | 0 | 0 | 0 | 3.47 | 1.734 | 0 | 168.00 | 0 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 0 | 0 | 0 | 0 | 0 | 3.62 | 1.808 | 0 | 168.00 | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 1,468 | 148 | 22 | 3 | 173 | 3.75 | 1.873 | 8,251 | 168.00 | 1,386 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | – | 104.17 | 0 | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 1,291 | – | 107.58 | 720 | 77 | 12 | 2 | 91 | 4.62 | 2.310 | 4,990 | 168.00 | 838 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | – | 118.33 | – | 0 | 0 | 0 | 0 | 5.02 | 2.508 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | – | 127.00 | 0 | 0 | 0 | 0 | 0 | 5.41 | 2.706 | 0 | 168.00 | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,628 | – | 135.67 | – | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | – | 8.80 | 0.35 | 1,909 | – | 158.08 | 5436 | 865 | 130 | 17 | 1,012 | 6.73 | 4.367 | 71,217 | 168.00 | 11,964 |
| DN | 850 -864/1100 | 34" | – | 8.80 | 0.35 | 2,022 | – | 168.50 | – | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | – | 10.00 | 0.39 | 2,135 | – | 177.92 | 1940 | 345 | 52 | 7 | 404 | 9.78 | 4.890 | 28,457 | 168.00 | 4,781 |
| DN | 1000 -1016/1200 | 40" | – | 10.00 | 0.39 | 2,381 | – | 198.42 | 0 | 0 | 0 | 0 | 0 | 10.90 | 5.451 | 0 | 168.00 | 0 |
| DN | 1100 -1117/1400 | 44" | – | 11.00 | 0.43 | 2,608 | – | 217.33 | – | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | – | 12.00 | 0.47 | 2,854 | – | 237.83 | – | 0 | 0 | 0 | 0 | 13.07 | 6.534 | 0 | 168.00 | 0 |
| | | | | | | | | | 10,366 | | | US | $1,749 | | | | LEVA | 19,516 |

## REPUBLIKA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

CASH FLOW (000) *LAID DOWN IN (EXISTING) DUCT*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9082 | MATERIAL (US $) | | 317.86 | 735.63 | 917.27 | 971.76 | 1008.06 | 1026.25 | 1026.25 | 1026.25 | 1026.25 | 1026.25 |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 87186 | *LABOR(LEVA)* | | *3051.50* | *7062.04* | *8805.75* | *9328.87* | *9677.81* | *9851.98* | *9851.98* | *9851.98* | *9851.98* | *9851.98* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 87186 | *TOTAL (LEVA)* | | *3051.50* | *7062.04* | *8805.75* | *9328.87* | *9677.81* | *9851.98* | *9851.98* | *9851.98* | *9851.98* | *9851.98* |
| | | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 9,081.84 | 2,724.55 | 0.00% | 100.00% |



8/48

**CASH FLOW (000)** ***LAID DOWN – INSULATION FOAM CONCRETE***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 1126 | MATERIAL (US $) | | 56.40 | 225.58 | 281.98 | 281.98 | 281.98 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 10828 | *LABOR(LEVA)* | | *541.40* | *2165.61* | *2707.01* | *2707.01* | *2707.01* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 10828 | *TOTAL (LEVA)* | | *541.40* | *2165.61* | *2707.01* | *2707.01* | *2707.01* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 1,127.92 | 338.38 | 0.00% | 100.00% |

**CASH FLOW (000)** ***OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 1749 | MATERIAL (US $) | | 87.44 | 349.76 | 437.20 | 437.20 | 437.20 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 19516 | *LABOR(LEVA)* | | *975.80* | *3903.18* | *4878.98* | *4878.98* | *4878.98* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 19516 | *TOTAL (LEVA)* | | *975.80* | *3903.18* | *4878.98* | *4878.98* | *4878.98* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 1,748.81 | 609.87 | 0.00% | 100.00% |

**CASH FLOW (000)** ***TOTAL DISTRIBUTION PIPING***

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11959 | MATERIAL (US $) | | 461.70 | 1310.98 | 1638.45 | 1690.94 | 1727.27 | 1026.25 | 1026.25 | 1026.25 | 1026.25 | 1026.25 |
| | | % | 3.86% | 10.96% | 13.68% | 14.14% | 14.44% | 8.58% | 8.58% | 8.58% | 8.58% | 8.58% |
| 117530 | *LABOR(LEVA)* | | *4568.70* | *13130.83* | *16391.74* | *16914.86* | *17263.60* | *9851.96* | *9851.96* | *9851.96* | *9851.96* | *9851.96* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 117530 | *TOTAL (LEVA)* | | *4568.70* | *13130.83* | *16391.74* | *16914.86* | *17263.60* | *9851.96* | *9851.96* | *9851.96* | *9851.96* | *9851.96* |
| | | % | 3.89% | 11.17% | 13.95% | 14.39% | 14.69% | 8.38% | 8.38% | 8.38% | 8.38% | 8.38% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 11,958.58 | 3,672.50 | 0.00% | 100.00% |



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FILE: R1_SCADA.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:10 PM

# REPUBLIKA DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ (000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 3 | 1950 | 260 | 137 | 12.00 | 108 | 22 | 50 | 1 | 95 | 158 | 16 |
| | SUBTOTAL | | | | | | | | $137 | | | | US | $1 | | LEVA | $16 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 5,525,000 | 1 | 828750 | 110500 | 6464 | N/A | N/A | N/A | N/A | 293 | N/A | N/A | 24024 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *60,000* | *1* | – | – | 60 | | | | | | | | |
| | TOTAL US $ | | | | 5,585,000 | | | | 6,661 | | | | | 294 | | | 24,040 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 137 MATERIAL (US $) | 1.92 | 23.27 | 27.93 | 27.93 | 27.93 | 27.93 |
| 1 LABOR (US $) | 0.02 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 |
| SUBTOTAL | 1.93 | 23.45 | 28.15 | 28.15 | 28.15 | 28.15 |
| *16 LABOR(LEVA)* | *0.22* | *2.71* | *3.26* | *3.26* | *3.26* | *3.26* |
| 6,464 WEST. SCADA EQUIPMENT | 90.50 | 1096.92 | 1316.71 | 1316.71 | 1316.71 | 1316.71 |
| 60 FIBER OPTIC LEASING | 0.84 | 10.20 | 12.24 | 12.24 | 12.24 | 12.24 |
| 293 WEST. SCADA LABOR (US $) | 4.10 | 49.73 | 59.67 | 59.67 | 59.67 | 59.67 |
| SUBTOTAL | 95.43 | 1,156.85 | 1,390.62 | 1,390.62 | 1,390.62 | 1,390.62 |
| 7 TOTAL US $ | 97.37 | 1,182.30 | 1,418.76 | 1,418.76 | 1,418.76 | 1,418.76 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *24,024 WEST. SCADA LABOR (LEVA)* | *336.34* | *4084.08* | *4900.90* | *4900.90* | *4900.90* | *4900.90* |
| *24 TOTAL (LEVA)* | *336.56* | *4,086.79* | *4,904.15* | *4,904.15* | *4,904.15* | *4,904.15* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 6,661.14 | 1,044.83 | 0.000% | 71.902% |

FILE: R1HOSTIC.WK3
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:32 PM

# REPUBLIKA HEATING SUBSTATIONS I & C (11)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | | NOTE 1 | 1 LOT | 7000 | 630 | INC | INC | 4410 | 1000 | 630 | 22,176 |
| CONSISTING OF: | | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | | |
| RTD | | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | | |
| | | TOTAL US $ | | | | | | 4,410 | | 0 | 22,176 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 4,410 MATERIAL (US $) | 61.74 | 749.70 | 899.64 | 899.64 | 899.64 | 899.64 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 61.74 | 749.70 | 899.64 | 899.64 | 899.64 | 899.64 |
| *22,176 LABOR(LEVA)* | *310.48* | *3769.92* | *4523.90* | *4523.90* | *4523.90* | *4523.90* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 4,410.00 | 693.00 | 0.000% | 100.000% |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

FILE: FBC_RP3
DATE: 24-Mar-94
TIME: 02:06 PM

| CALCULATION FACTORS | Shipping/Freight | % Material |
|---|---|---|
| | OCEAN – U.S. 16% | % Local |
| | INLAND – U.S. 2% | % Foreign 100% |

9,660.0 U.S. 60% — 35% LABOR (35% OF MAT'L) 32 LEVA/$ 20% Foreign % Labor

50.00 US LABOR RATE
8.36 $ULG RATE US $
166 $ULG RATE LEVA

1.1 PRODUCTIVITY
0.1166 Composite Local Labor Factor $

## FLUIDIZED BED COMBUSTOR – REPUBLIKA PLANTS 5 b

| | ITEM | | NO. OF PLANTS | MATERIAL COST $x1000 | | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd (U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1997 | FOREIGN $ U.S. 1998 | FOREIGN $ U.S. 1999 | C.F. TOTAL /YEAR 1994 | C.F. TOTAL /YEAR 1997 | C.F. TOTAL /YEAR 1998 | C.F. TOTAL /YEAR 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REPUBLIKA | NEW FBC BOILERS | | 2 | 13500.0 | 27,000.0 | REPLACE NOW | NECESSITY | | 0.449 | SEE CF | | 4,692.0 | $32,292.0 | 32,292.0 | | 7,726.6 | 1,932.0 | 669.44 | 21,422.0 | | 8,133.6 | 7,700.4 | 4,279.0 | | 100.4 | 150.6 | 53.7 |
| | INDUCED FAN & MOTOR DRIVE | | 8 6 | 58.0 | 116.0 | REPLACE NOW | NECESSITY | | 0.002 | SEE CF | | 19.7 | $136.7 | 136.7 | | 17.2 | 3.4 | 1.69 | 50.9 | | 30.9 | 31.3 | 17.4 | | 0.2 | 0.4 | 0.2 |
| | BAGHOUSE | | | 4090.0 | 8,180.0 | REPLACE NOW | NECESSITY | | 0.133 | SEE CF | | 1,390.6 | $9,570.6 | 9,570.6 | | 2,843.6 | 572.6 | 264.54 | 8,466.3 | | 1,521.5 | 2,262.2 | 1,267.9 | | 39.7 | 59.5 | 33.1 |
| | FURNACE SAFETY SYS BMS | | 40.0 | 100.0 | 200.0 | REPLACE NOW | NECESSITY | | 0.003 | SEE CF | | 34.0 | $234.0 | 234.0 | | 60.6 | 16.0 | 7.39 | 236.5 | | 37.5 | 56.3 | 31.3 | | 1.1 | 1.7 | 0.9 |
| | INSTRUMENTATION FOR FSS | | w/ABV. | w/ABV. | | REPLACE NOW | NECESSITY | | | SEE CF | 3066.60 | 526.1 | $3,613.9 | 3,613.9 | | 326.6 | 65.2 | 30.13 | 963.9 | | 561.9 | 827.8 | 459.9 | | 4.5 | 6.6 | 3.6 |
| | SNCR SYSTEM | LR | 141.1 | 346.6 | 693.2 | REPLACE NOW | NECESSITY | | 0.011 | SEE CF | | 117.8 | $811.0 | 811.0 | | 202.1 | 56.4 | 26.07 | 834.2 | | 130.1 | 196.2 | 106.4 | | 3.9 | 5.9 | 3.3 |
| | FOUNDATIONS | LR | 621 | 690.0 | 1,380.0 | REPLACE NOW | NECESSITY | | 0.023 | SEE CF | | 234.6 | $1,614.6 | 1,614.6 | | 1,242.0 | 248.4 | 114.76 | 3,672.3 | | 279.8 | 419.2 | 232.9 | | 17.2 | 26.9 | 14.3 |
| | MCC/ELEC. SWGR/ | | 179.4 | 1242.0 | 2,484.0 | REPLACE NOW | NECESSITY | | 0.043 | SEE CF | | 422.3 | $2,906.3 | 2,906.3 | | 359.6 | 71.9 | 33.16 | 1,060.9 | | 446.7 | 670.1 | 372.3 | | 6.6 | 7.6 | 4.1 |
| | POWER WIRING | | | | | | | | | SEE CF | | | | | | | | | | | | | | | | | |
| | PLANT DCS | | 41.7 | 1000.0 | 2,000.0 | REPLACE NOW | NECESSITY | | 0.047 | SEE CF | | 492.7 | $3,390.7 | 3,390.7 | | 83.3 | 16.7 | 7.70 | 246.6 | | 511.1 | 766.6 | 425.9 | | 1.2 | 1.7 | 1.0 |
| | INSTRUMENTATION FOR DCS | | 1390.0 | 2070.0 | 4,140.0 | REPLACE NOW | NECESSITY | | 0.047 | SEE CF | | 703.6 | $4,843.6 | 4,843.6 | | 2,760.0 | 552.0 | 255.02 | 8,169.6 | | 909.4 | 1,214.1 | 674.5 | | 35.3 | 57.4 | 31.9 |
| | PIPING | | 1104.0 | 1440.0 | 2,880.0 | REPLACE NOW | NECESSITY | | 0.047 | SEE CF | | 492.7 | $3,390.7 | 3,390.7 | | 2,208.0 | 441.6 | 204.02 | 6,529.6 | | 574.8 | 662.5 | 476.0 | | 30.6 | 46.9 | 28.5 |
| | ELECTRICAL BULKS | | 2070.0 | 1104.0 | 2,208.0 | REPLACE NOW | NECESSITY | | 0.036 | SEE CF | | 375.4 | $2,583.4 | 2,583.4 | | 4,140.0 | 828.0 | 382.54 | 12,241.2 | | 511.7 | 787.6 | 426.4 | | 37.4 | 56.1 | 47.6 |
| | FUEL & LIMESTONE | | 552.0 | 483.0 | 966.0 | REPLACE NOW | NECESSITY | | 0.016 | SEE CF | | 164.2 | $1,130.2 | 1,130.2 | | 1,104.0 | 220.8 | 102.01 | 3,264.3 | | 302.7 | 304.0 | 168.9 | | 18.3 | 23.0 | 18.6 |
| | RECEIVING, PREP. & CONVEYING SYSTEMS | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | FUEL & LIMESTONE BUNKERS | | w/ABV. | w/ABV. | | REPLACE NOW | NECESSITY | | | | | | | | | 2,208.0 | 441.6 | 204.02 | 6,529.6 | | 792.8 | 1,189.2 | 660.7 | | 50.6 | 45.9 | 36.5 |
| | SPENT ASH CONVEYING | | 1104.0 | 2070.0 | 4,140.0 | REPLACE NOW | NECESSITY | | 0.067 | SEE CF | | 703.6 | $4,843.6 | 4,843.6 | | 2,760.0 | 552.0 | 255.02 | 8,169.6 | | 687.3 | 880.8 | 472.7 | | 35.3 | 57.4 | 31.9 |
| | & STORAGE | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | FEEDWATER/CHEMICAL | | 1380.0 | 1380.0 | 2,760.0 | REPLACE NOW | NECESSITY | | 0.046 | SEE CF | | 469.2 | $3,229.2 | 3,229.2 | | 1,104.0 | 220.8 | 102.01 | 3,264.3 | | 276.3 | 413.0 | 229.4 | | 16.3 | 23.0 | 18.6 |
| | TREATMENT | | | | | | | | | | | | | | | | | | | | 46.8 | 70.2 | 39.0 | | 0.6 | 0.6 | 0.6 |
| | STACK & BREECHING | | 552.0 | 690.0 | 1,380.0 | REPLACE NOW | NECESSITY | | 0.022 | SEE CF | | 234.6 | $1,614.6 | 1,614.6 | | 40.0 | 8.0 | 3.70 | 118.3 | | | | | | | | |
| | STACK CEMS | | 20.0 | 130.0 | 260.0 | REPLACE NOW | NECESSITY | | 0.004 | SEE CF | | 44.2 | $304.2 | 304.2 | | | | | | | | | | | | | |
| | CIVIL & ARCH SITE WORK V | | N/REQD. | N/REQD. | | REPLACE NOW | NECESSITY | | | | | | | | | | | | | | | | | | | | |
| | BLD'G ENCLOSURE & STEEL | | N/REQD. | N/REQD. | | REPLACE NOW | NECESSITY | | | | | | | | | | | | | | | | | | | | |
| | FINISH PAINTING | | N/REQD. | N/REQD. | | REPLACE NOW | NECESSITY | | | | | | | | | | | | | | | | | | | | |
| | SUBTOTAL | | | | 61,406.2 | | | 67% | | | 3,066.6 | 11,116.6 | $76,608.6 | 76,608.6 | | 29,304.6 | 5,247.3 | 2,663.1 | 85,219.3 | | 12,413.4 | 18,620.1 | 10,344.5 | | 399.6 | 599.3 | 332.9 |
| REPUBLIKA 1-3 | REMOVED | | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| REPUBLIKA 6 | INSTALL (PC) UNIT 6 | | 4500.0 | | @ SITE | REPLACE NOW | NECESSITY | | | 1994 | | | @ SITE | | | 4,300.0 | 860.0 | 397.32 | 12,714.2 | 860.0 | | | | 397.3 | | | |
| | WHICH IS IN FIELD STORAGE | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | SUBTOTAL | | | | | | | | | | | | | | | 4,300.0 | 860.0 | 397.3 | 12,714.2 | 860.0 | | | | 397.3 | | | |
| | | | | | | | | | | | | | | | | 33604.47 | 7107.29 | 3060.42 | 97935.55 | 860.00 | 12413.35 | 18620.06 | 10344.49 | 397.32 | 399.47 | 599.20 | 332.89 |
| | TOTAL REPUBLIKA COSTS | | | | 61,406.2 | | | | | | 3066.60 | 11116.64 | 76608.64 | 76608.64 | | | | | C.F.TOTAL $ | | | | $43,239.0 | | | | $1,724.9 |
| | *TOTAL ALL UNITS AT PLANT THE COST IT INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | | 3 | | 4,633.2 | TOTAL I&C MATERIAL | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 489.0 | TOTAL I&C INSTALLATION | | | | | | | | | | | | | | | | | | | | | |

| | MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|---|
| UNIT 6 PC | | | 1,257.3 | | 31.801% |
| FBC (2) | | | 6,910.4 | | 29.888% |
| PC & FBC (2) | | 76,508.6 | 10,167.7 | | 30.099% |

### CASH FLOW (000)

| | | PC 1994 | FBC 1997 | FBC 1998 | FBC 1999 |
|---|---|---|---|---|---|
| UNIT 6 PC & 1st FBC | FORGN(US$) | 860.0 | 12413.4 | 18620.1 | 10344.5 |
| | % OF TOTAL | 0.014 | 0.146 | 0.219 | 0.121 |
| | LOCAL (US$) | 397.3 | 399.5 | 599.2 | 332.9 |

| | | – | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|
| 2nd FBC | FORGN(US$) | – | 12413.4 | 18620.1 | 10344.5 |
| | % OF TOTAL | – | 0.150 | 0.225 | 0.125 |
| | LOCAL (US$) | – | 399.5 | 599.2 | 332.9 |

FILE: SBLRMR3 WK3
DATE: 13-Jan-94
TIME: 12:47 PM

| CALCULATION FACTORS | Shipping\Freight | | % Material | |
|---|---|---|---|---|
| | OCEAN – U.S. | 18% | % Local | |
| | INLAND – U.S. | 2% | % Foreign | 100% |

50% LABOR (50% OF MAT'L)
32 LEVA/$
20% Foreign % Labor

50.00 US LABOR RATE
5.26 BULG RATE US $
166 BULG RATE LEVA

1.1 PRODUCTIVITY
0.1185 Composite Local Labor Factor $

## THERMAL BOILER MODIFICATIONS – REPUBLIKA PLANTS – 5 #

| ITEM | NO OF PLANTS | MATERIAL COST $x1000 | | ACTION | | % TOTAL | % SUBTOTAL | C.F. YEAR | I&C MTL U.S. $ | MTL FREIGHT | TOTAL MTL. U.S. $ | FOREIGN MTL. US$ | LOCAL MTL. U.S. $ | TOTAL LABOR (U.S. $) | FOREIGN LABOR (U.S. $) | LOCAL LABOR Adj'd(U.S. $) | LOCAL LABOR (LEV) | FOREIGN $ U.S. 1994 | FOREIGN $ U.S. 1996 | FOREIGN $ U.S. 2003 | C.F. TOTAL /YEAR | LOCAL LABOR US $ 1994 | LOCAL LABOR US $ 1996 | LOCAL LABOR US $ 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REPUBLIKA 3 – 4 (RETIRE-IN PLACE) | | | | | | | | | | | | | | | | | | | | | | | | |
| REPUBLIKA 6 CONTROLS | 1 | * | | REPLACE NOW | NECESSITY | | | 1994 | 1544.40 | 262.5 | $1,806.9 | 1,806.9 | | 183.0 | 32.6 | 16.06 | 482.0 | 1,836.6 | | | | 16.1 | | |
| BURNERS & FANS | | 791.8 | 791.8 | REPLACE 5 YEARS | ENHANCEMENT | | | 1998 | | 134.6 | $926.4 | 926.4 | | 395.9 | 79.2 | 36.66 | 1,170.6 | | 1,006.6 | | | | 36.6 | |
| BAGHOUSE | | 4090 | 4,090.0 | REPLACE NOW | NECESSITY | | | 1994 | | 695.3 | $4,785.3 | 4,785.3 | | 2,046.0 | 409.0 | 188.96 | 6,046.7 | 6,194.3 | | | | 189.0 | | |
| BACKEND CLEANUP OPTIONS | | | | | | | | | | | | | | | | | | | | | | | | |
| WET SCRUB | | 9625.0 | 9,625.0 | ONE OF THESE | NECESSITY | | | 1994 | | 1,636.3 | $11,261.3 | 11,261.3 | | 4,812.5 | 962.5 | 444.08 | 14,228.6 | 12,223.6 | | | | 444.7 | | |
| SUBTOTAL | | | 14,508.8 | | | 50% | | | 1,544.4 | 2,726.7 | 18,779.9 | 18,779.9 | | 7,418.4 | 1,483.3 | 685.3 | 21,928.8 | 19,267.8 | 1,006.6 | | | 848.7 | 36.6 | |
| REPUBLIKA 1-2 REMOVED | | | | | | | | | | | | | | | | | | | | | | | | |
| REPUBLIKA 6 ECONOMIZER | 1 | 3064.2 | 3,064.2 | REPLACE NOW | NECESSITY | | 0.093 | 1994 | | 624.7 | $3,610.9 | 3,610.9 | | 1,543.1 | 308.6 | 142.08 | 4,642.6 | 3,918.6 | | | | 142.6 | | |
| SUPERHEATER | | 5680.3 | 5,680.3 | REPLACE NOW | NECESSITY | | 0.172 | 1994 | | 966.7 | $6,646.0 | 6,646.0 | | 2,640.2 | 668.0 | 262.43 | 8,387.6 | 7,214.0 | | | | 262.4 | | |
| WATERWALLS | | 4313.6 | 4,313.6 | REPLACE 5 YEARS | ENHANCEMENT | | 0.130 | 1998 | | 733.3 | $5,047.1 | 5,047.1 | | 2,156.6 | 431.4 | 199.30 | 6,377.6 | | 5,478.6 | | | | 199.3 | |
| PULVERIZERS & FANS | | 5326.0 | 5,326.0 | REPLACE NOW | NECESSITY | | 0.161 | 1994 | | 906.4 | $6,231.4 | 6,231.4 | | 2,663.0 | 532.6 | 246.06 | 7,674.0 | 6,764.0 | | | | 246.1 | | |
| CONTROLS | | * | | REPLACE NOW | NECESSITY | | | 1994 | 1544.40 | 262.5 | $1,806.9 | 1,806.9 | | 183.0 | 32.6 | 15.06 | 482.0 | 1,836.6 | | | | 16.1 | | |
| SH HEADER OPTION | | 170.7 | 170.7 | REPLACE NOW | NECESSITY | | 0.005 | 1994 | | 29.0 | $199.7 | 199.7 | | 85.4 | 17.1 | 7.89 | 252.4 | 216.8 | | | | 7.9 | | |
| PRECIPITATORS | | 3850.0 | | REPLACE 5 – 10 YEAR | ENHANCEMENT | | | 2003 | | | | | | | | | | | 1,006.6 | | | | 36.6 | |
| BURNERS & FANS | | 791.8 | 791.8 | REPLACE 5 YEARS | ENHANCEMENT | | 0.024 | 1998 | | 134.6 | $926.4 | 926.4 | | 395.9 | 79.2 | 36.66 | 1,170.6 | | | | | | | |
| BAGHOUSE | | 4090 | 4,090.0 | REPLACE NOW | NECESSITY | | 0.124 | 1994 | | 695.3 | $4,785.3 | 4,785.3 | | 2,046.0 | 409.0 | 188.96 | 6,046.7 | 6,194.3 | | | | 189.0 | | |
| BACKEND CLEANUP OPTIONS | | | | | | | | | | | | | | | | | | | | | | | | |
| SNCR | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | | |
| DRY SCRUB | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | | |
| WET SCRUB | | 9625.0 | 9,625.0 | ONE OF THESE | NECESSITY | | 0.291 | 1994 | | 1,636.3 | $11,261.3 | 11,261.3 | | 4,812.5 | 962.5 | 444.08 | 14,228.6 | 12,223.6 | | | | 444.7 | | |
| ESP SOX | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | | |
| SCR | | | | ONE OF THESE | NECESSITY | | | | | | | | | | | | | | | | | | | |
| SUBTOTAL | | | 33083.8 | | | 0.500 | | | 1544.40 | 5866.78 | 40514.98 | 40514.98 | | 16704.80 | 3340.96 | 1543.53 | 48383.06 | 37371.66 | 6484.11 | | | 1307.86 | 235.88 | |
| | | | | | | | | | 3088.80 | 8615.50 | 59294.90 | 59294.90 | | 24121.30 | 4824.26 | 2228.81 | 71321.96 | 56639.46 | 7488.70 | | | 1856.36 | 272.48 | |
| TOTAL REPUBLIKA COSTS | | | 47,580.6 | | | | | | | | | | | | | | C.F.TOTAL $ | | | $84,119.2 | | | | $2,228.8 |
| *TOTAL ALL UNITS AT PLANT THE COST II INSTALLATION & STARTUP SINCE THIS PROPOSED FOR TOTAL PLANT IT SHOULD BE DONE AT THE SAME TIME (NOW). | 2 | 3,088.8 | TOTAL I&C MATERIAL | | | | | | | | | | | | | | | 1994 | 1996 | 2003 | | 1994 | 1996 | 2003 |
| | | 326.0 | TOTAL I&C INSTALLATION | | | | | | | | | | | | | | % OF TOTAL | 0.883 | 0.117 | | | 0.878 | 0.122 | |

| MODEL COST SUMMARY (US $) | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| | 59,294.9 | 7,053.1 | | 31.601% |

| | | | | |
|---|---|---|---|---|
| FILE: | STGMOOR3.WK3 | S1 | 18/25 | 25/50 |
| DATE: | 23-Mar-94 | S2 | CAP. | CAP. |
| TIME: | 09:09 AM | S3 | EXP. | EXP. |
| | | | 1.78 | 1.78 |

| |
|---|
| OCEAN – U.S. |
| 15% |
| INLAND – U.S. |
| 2% |

| | |
|---|---|
| HOTEL/DAY | 100 |
| MEALS/DAY | 15 |
| CAR/DAY | 60 |
| US Daily Est | 175 |

| | | |
|---|---|---|
| Outage Hours | 50.00 | U.S.Base Rate |
| Local # MEN | 6 | |
| WEEKS-Base | 8 | |
| WEEKS-Alt. | 5 | |
| 5/6 | 40 | |
| Foreign # Men | 2 | |
| Expense DAYS | 7 | |

| | |
|---|---|
| 1.1 | Productivity-Local |
| 0.1155 | Composite Local Labor Factor |
| 5.25 | BULG IN US $ |
| 166 | BULG IN LEVA |
| 32 | Exchange Rate Lev/$ |

## TURBINE GENERATOR – MODIFICATIONS – REPUBLIKA PLANTS – 4 b

| ITEM | NO. OF PLANTS | UNIT COST | SUBTOTAL MTL $ | C.F. YEAR | FREIGHT | TOTAL MTL. Per Outage $ | /Unit/Outage U.S. $ | TOTAL # OUTAGES | TOTAL MTL U.S. $ | LABOR & EXPENSES U.S $ EXPENSES U.S. $ | FOREIGN INSTALLATION U.S. $ | LOCAL INSTALLATION U.S. $ | LOCAL INSTALLATIO LEV | FOREIGN (U.S. $) 1994 | 1996 | 2002 | 2003 | 2006 | LOCAL (U.S. $) 1994 | 1996 | 2002 | 2003 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REPUBLKA – #5 MW COND. 55 — U/C multi. 1.10 | | | | | | | | | | | | | | | | | | | | | | | |
| HYDROGEN COOLED GENERATOR | 1 | 242.00 | 242.00 | | 41.14 | 283.14 | | | | 7.35 | 24.00 | 11.09 | 354.82 | 314.49 | 314.49 | | 314.49 | 314.49 | 11.066 | 11.066 | | 11.066 | 11.066 |
| CLEAN, CHECK, BALANCE ROTOR | | 11.00 | 11.00 | | 1.87 | 12.87 | | | | | | | | 12.87 | 12.87 | | 12.87 | 12.87 | 0 | 0 | | 0 | 0 |
| AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 |
| REPLACE LABRYINTH RINGS | 20 | 165.00 | 165.00 | | 28.05 | 193.05 | | | | | | | | 193.05 | 193.05 | | 193.05 | 193.05 | 0 | 0 | | 0 | 0 |
| REPLACE H.P. CYLINDER 1-TIME | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 |
| REPAIR/RECONDITION H.P. | 1 | 88.00 | 88.00 | | 14.96 | 102.96 | | | | | | | | 102.96 | 102.96 | | 102.96 | 102.96 | 0 | 0 | | 0 | 0 |
| SUBTOTAL | | 506.00 | 506.00 | | 86.02 | 592.02 | 592.02 | 4 | 2368.08 | 7.35 | 24.00 | 11.09 | 354.82 | 623.37 | 623.37 | | 623.37 | 623.37 | 11.09 | 11.09 | | 11.09 | 11.09 |
| REPUBLKA – MW 25 — U/C multi. 1.00 | | | | | | | | | | | | | | | | | | | | | | | |
| HYDROGEN COOLED GENERATOR | 1 | 220.00 | 220.00 | | 37.40 | 257.40 | | | | 7.35 | 24.00 | 11.09 | 354.82 | 268.75 | 268.75 | | 268.75 | 268.75 | 11.066 | 11.066 | | 11.066 | 11.066 |
| CLEAN, CHECK, BALANCE ROTOR | | 10.00 | 10.00 | | 1.70 | 11.70 | | | | | | | | 11.7 | 11.7 | | 11.7 | 11.7 | 0 | 0 | | 0 | 0 |
| AT SHOP | | | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 |
| REPLACE LABRYINTH RINGS | 20 | 150.00 | 150.00 | | 25.50 | 175.50 | | | | | | | | 175.5 | 175.5 | | 175.5 | 175.5 | 0 | 0 | | 0 | 0 |
| REPLACE H.P. CYLINDER 1-TIME | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 |
| REPAIR/RECONDITION H.P. ?? | | 0.00 | 0.00 | | 0.00 | 0.00 | | | | | | | | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 |
| SUBTOTAL | | 380.00 | 380.00 | | 64.60 | 444.60 | 444.60 | 4 | 1778.40 | 7.35 | 24.00 | 11.09 | 354.82 | 475.95 | 475.95 | | 475.95 | 475.95 | 11.09 | 11.09 | | 11.09 | 11.09 |
| REPUBLKA #4 – (NEW) MW 25 — NEW 25 MW TURBINE GENERATOR | 0 | 4582.90 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| CONDENSER | 0 | 139.00 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| FOUNDATION | 0 | 45.50 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| PIPING | 0 | 368.60 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| ELECTRICAL / I & C | 0 | 137.50 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| SUBTOTAL | | 5271.50 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| REPUBLKA #2 (NEW) MW 35 — NEW 35 MW TURBINE GENERATOR | 1 | 5800.00 | 5800.00 | | 866.00 | 6666.00 | | | | 7.35 | 197.18 | 91.10 | 2915.17 | | | 4194.32 | 2796.21 | | | | 54.66 | 36.44 | |
| CONDENSER | 1 | 139.00 | 139.00 | | 23.63 | 162.63 | | | | 0.00 | 5.00 | 2.31 | 73.92 | | | 100.56 | 67.05 | | | | 1.39 | 0.92 | |
| FOUNDATION | 1 | 56.00 | 56.00 | | 9.56 | 67.56 | | | | 0.00 | 25.63 | 11.84 | 378.94 | | | 58.10 | 37.40 | | | | 7.11 | 4.74 | |
| PIPING | 1 | 464.00 | 464.00 | | 78.88 | 542.88 | | | | 0.00 | 23.68 | 10.93 | 349.85 | | | 339.93 | 226.62 | | | | 6.58 | 4.37 | |
| ELECTRICAL / I & C | 1 | 174.00 | 174.00 | | 29.58 | 203.58 | | | | 0.00 | 19.72 | 9.11 | 291.52 | | | 133.86 | 89.32 | | | | 5.47 | 3.64 | |
| SUBTOTAL | | 6635.00 | 6635.00 | | 1127.95 | 7762.95 | 7762.95 | 1 | 7762.95 | 7.35 | 271.20 | 125.28 | 4009.40 | | | 4824.90 | 3216.60 | | | | 75.18 | 50.12 | |
| REPUBLKA #5 (NEW) MW 55 — NEW 55 MW TURBINE GENERATOR | 0 | 8900.00 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| CONDENSER | | 190.00 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| FOUNDATION | | 89.00 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| PIPING | | 552.00 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| ELECTRICAL / I & C | | 207.00 | 0.00 | | 0.00 | 0.00 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| SUBTOTAL | | 7918.00 | 0.00 | | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | 0.00 | | | | |
| TOTAL/PLANT | | | $7,521.0 | | $1,278.6 | $8,799.6 | | | $11,909.4 | $22.1 | $319.2 | $147.5 | | $1,099.3 | $1,099.3 | $4,824.9 | $4,315.9 | $1,099.3 | $22.2 | $22.2 | $75.2 | $72.3 | $22.2 |
| | | | | | | | | | | | | LEVA = | $4,719.0 | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C.F. TOTAL $ | | | | | 12,435.8 | | | | | | $214.0 |
| | 1994 | 1996 | 2002 | 2003 | 2006 | 1994 | 1996 | 2002 | 2003 | 2006 |
| % OF TOTAL | 0.088 | 0.086 | 0.388 | 0.347 | 0.088 | 0.104 | 0.104 | 0.351 | 0.338 | 0.104 |

| | |
|---|---|
| TOTAL FOREIGN LABOR & EXPENSE | $529.3 |
| TOTAL LOCAL LABOR | $214.0 |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY U.S. $ | 11,909.4 | 743.3 | 0.00% | 28.788% |

852

FILE: R3EQUIP.WK3
DATE: 1-Dec-93

DATE: 01-Feb-94
TIME: 02:13 PM

# HEATING DISTRIBUTION EQUIPMENT (10a)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ (1000) | QTY OF SUB-STATION | FREIGHT OCEAN US $ (000) | INLAND US $ (000) | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE / HR US $ | TOTAL LABOR US $ | BUL. MNHRS | RATE / HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOTOR | | | 3 | EA | 80 | 1 | 12 | 2 | 281 | 48.00 | 144 | 0 | 50 | 0 | 156 | 168 | 27 |
| VSD | | | 3 | EA | 200 | 1 | 30 | 4 | 702 | 32.00 | 96 | 0 | 50 | 0 | 108 | 168 | 18 |
| STEP-UP TRANSFORMER | | | 3 | EA | 60 | 1 | 9 | 1 | 211 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| ISOLATION TRANSFORMER | | | 3 | EA | 54 | 1 | 8 | 1 | 190 | 24.00 | 72 | 0 | 50 | 0 | 79 | 168 | 13 |
| WIRING & CONDUIT | | | 3 | LT | 2 | 1 | 0 | 0 | 7 | 36.00 | 108 | 0 | 50 | 0 | 119 | 168 | 20 |
| | | SUBTOTAL | | | | | | | $1,390 | | | | US | $0 | | LEVA | 91 |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VALUES | | | | | | | | | | | | | | | | | |
| 1,390 MATERIAL (US $) | 0 | 1389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0 LABOR (US $) | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | | 1,389.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *91 LABOR(LEVA)* | *0* | *90.92* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| **MODEL COST SUMMARY (US $)** | **1389.96** | **2.84** | **0.00%** | **100.00%** |

FILE:R3PIP10B.WK3
DATE: 22-Nov-93

DATE: 24-Mar-94
TIME: 10:51 AM

## REPUBLIKA PLANTS ( 10 b 1 )

## HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

### *LAID DOWN IN (EXISTING) DUCT*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE US $ / 12 M | FTGS ALLOW $ /12M | PIPE US $ / METER | QTY REQ (METERS) | MATERIAL COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | PIPE/FTGS INC FGT. US $(000) | LAB.COST (1) 30% OF MAT'L (LEVA-000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 186,570 | 4,652 | 698 | 93 | 5,443 | 52,249 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 388 | 144 | 44.30 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 3,976 | 258 | 39 | 5 | 302 | 2,902 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 1,938 | 181 | 27 | 4 | 211 | 2,029 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 2,448 | 279 | 42 | 6 | 327 | 3,136 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 232 | 31 | 5 | 1 | 36 | 344 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 5,694 | 826 | 124 | 17 | 966 | 9,273 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.65 | 6,664 | 1,219 | 183 | 24 | 1,426 | 13,686 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | 1366 | 317 | 46 | 6 | 371 | 3,565 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | 208,690 | | | US | $9,062 | LEVA 87,168 |

### *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 107 | 100 | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 130 | 91 | 18.42 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 157 | 110 | 22.24 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 187 | 112 | 24.93 | 11,146 | 278 | 42 | 6 | 325 | 3,121 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 256 | 143 | 33.28 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 311 | 134 | 37.06 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.18 | 388 | 144 | 44.30 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 582 | 198 | 64.99 | 1,664 | 108 | 16 | 2 | 127 | 1,215 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 895 | 224 | 93.23 | 1,424 | 133 | 20 | 3 | 155 | 1,491 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 1,095 | 274 | 114.06 | 3,822 | 438 | 65 | 9 | 510 | 4,897 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 1,320 | 264 | 132.00 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 1,450 | 290 | 145.00 | 64 | 9 | 1 | 0 | 11 | 104 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 1,610 | 242 | 154.29 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,906 | 286 | 182.65 | 0 | 0 | 0 | 0 | 0 | 0 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 2,261 | - | 188.42 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 600 -609/780 | 24" | 10 | 7.10 | 0.28 | 2,784 | - | 232.00 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 3,684 | - | 307.00 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 4,910 | - | 409.17 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 5,322 | - | 443.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 5,942 | - | 495.17 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 6,921 | - | 576.75 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 7,235 | - | 602.92 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 8,334 | - | 694.50 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 12,055 | - | 1,004.58 | - | 0 | 0 | 0 | 0 | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 14,755 | - | 1,229.58 | - | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | 18,120 | | | US | $1,128 | LEVA 10,828 |

(1) LABOR PERCENT PROVIDED BY CLIENT



858

## OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET
*(REMOVE OLD INSULATION, CLEAN PIPE, SUPPLY & INSTALL NEW INSULATION)*

| | METRIC DIMENSION | U.S. DIA. | U.S. SCH | WALL (MM) | WALL (IN) | PIPE INSUL. US $ / 12 M | FTGS INSUL. ALLOW $ /12M | PIPE/FTGS INSUL. US $ / METER | QTY REQ (METERS) | INSULATION COST US $(000) | FREIGHT OCEAN US $(000) | FREIGHT INLAND US $(000) | INSULATION INC FGT. US $(000) | UNIT MH/M INSUL. | UNIT MH/M REMOVAL | TOTAL MNHRS INSUL | RATE / HR (LEVA) | LAB.COST INSULATION (LEVA--000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DN | 40 -48/100 | 1 1/2" | 40 | 2.60 | 0.10 | 127 | 97 | 18.87 | 0 | 0 | 0 | 0 | 0 | 1.40 | 0.699 | 0 | 168.00 | 0 |
| DN | 50 -60/125 | 2" | 40 | 2.90 | 0.11 | 138 | 105 | 20.27 | 0 | 0 | 0 | 0 | 0 | 1.46 | 0.729 | 0 | 168.00 | 0 |
| DN | 65 -76/140 | 2 1/2" | 40 | 2.90 | 0.11 | 147 | 148 | 24.42 | 0 | 0 | 0 | 0 | 0 | 1.66 | 0.829 | 0 | 168.00 | 0 |
| DN | 80 -89/160 | 3" | 40 | 3.20 | 0.13 | 158 | 131 | 23.92 | 0 | 0 | 0 | 0 | 0 | 1.60 | 0.798 | 0 | 168.00 | 0 |
| DN | 100 -114/200 | 4" | 40 | 3.60 | 0.14 | 269 | 164 | 36.08 | 0 | 0 | 0 | 0 | 0 | 1.74 | 0.869 | 0 | 168.00 | 0 |
| DN | 125 -139/225 | 5" | 40 | 3.60 | 0.14 | 305 | 139 | 37.00 | 0 | 0 | 0 | 0 | 0 | 1.88 | 0.842 | 0 | 168.00 | 0 |
| DN | 150 -168/250 | 6" | 40 | 4.00 | 0.16 | 341 | 104 | 37.08 | 0 | 0 | 0 | 0 | 0 | 1.55 | 0.776 | 0 | 168.00 | 0 |
| DN | 200 -219/315 | 8" | 20 | 4.50 | 0.18 | 404 | 123 | 43.92 | 0 | 0 | 0 | 0 | 0 | 1.90 | 0.949 | 0 | 168.00 | 0 |
| DN | 250 -273/400 | 10" | 20 | 5.00 | 0.20 | 502 | 128 | 52.50 | 0 | 0 | 0 | 0 | 0 | 2.04 | 1.020 | 0 | 168.00 | 0 |
| DN | 300 -323/450 | 12" | 20 | 5.60 | 0.22 | 724 | 165 | 74.08 | 802 | 59 | 9 | 1 | 70 | 2.70 | 1.352 | 3,252 | 168.00 | 546 |
| DN | 350 -355/500 | 14" | 10 | 5.60 | 0.22 | 808 | 143 | 79.08 | 0 | 0 | 0 | 0 | 0 | 2.98 | 1.490 | 0 | 168.00 | 0 |
| DN | 400 -406/520 | 16" | 10 | 6.30 | 0.25 | 861 | 175 | 68.33 | 0 | 0 | 0 | 0 | 0 | 3.47 | 1.734 | 0 | 168.00 | 0 |
| DN | 450 -457/560 | 18" | 10 | 6.30 | 0.25 | 905 | 104 | 84.08 | 0 | 0 | 0 | 0 | 0 | 3.62 | 1.808 | 0 | 168.00 | 0 |
| DN | 500 -508/630 | 20" | 10 | 6.30 | 0.25 | 1,137 | 72 | 100.75 | 1,468 | 148 | 22 | 3 | 173 | 3.75 | 1.873 | 5,251 | 168.00 | 1,388 |
| DN | 550 -558/710 | 22" | 10 | 6.30 | 0.25 | 1,250 | - | 104.17 | 0 | 0 | 0 | 0 | 0 | 4.33 | 2.167 | 0 | 168.00 | 0 |
| DN | 600 -609/760 | 24" | 10 | 7.10 | 0.28 | 1,291 | - | 107.58 | 720 | 77 | 12 | 2 | 91 | 4.62 | 2.310 | 4,990 | 168.00 | 838 |
| DN | 650 -660/840 | 26" | 10 | 8.00 | 0.31 | 1,420 | - | 118.33 | - | 0 | 0 | 0 | 0 | 5.02 | 2.506 | 0 | 168.00 | 0 |
| DN | 700 -711/900 | 28" | 10 | 8.80 | 0.35 | 1,524 | - | 127.00 | 0 | 0 | 0 | 0 | 0 | 5.41 | 2.706 | 0 | 168.00 | 0 |
| DN | 750 -762/900 | 30" | 10 | 8.80 | 0.35 | 1,626 | - | 135.67 | - | 0 | 0 | 0 | 0 | 5.78 | 2.888 | 0 | 168.00 | 0 |
| DN | 800 -813/1000 | 32" | - | 8.80 | 0.35 | 1,909 | - | 159.08 | 5438 | 865 | 130 | 17 | 1,012 | 8.73 | 4.367 | 71,217 | 168.00 | 11,964 |
| DN | 850 -864/1100 | 34" | - | 8.80 | 0.35 | 2,022 | - | 168.50 | - | 0 | 0 | 0 | 0 | 9.27 | 4.637 | 0 | 168.00 | 0 |
| DN | 900 -914/1100 | 36" | - | 10.00 | 0.39 | 2,135 | - | 177.92 | 1940 | 345 | 52 | 7 | 404 | 9.76 | 4.880 | 28,457 | 168.00 | 4,781 |
| DN | 1000 -1016/1200 | 40" | - | 10.00 | 0.39 | 2,361 | - | 196.42 | 0 | 0 | 0 | 0 | 0 | 10.90 | 5.451 | 0 | 168.00 | 0 |
| DN | 1100 -1117/1400 | 44" | - | 11.00 | 0.43 | 2,608 | - | 217.33 | - | 0 | 0 | 0 | 0 | 11.95 | 5.973 | 0 | 168.00 | 0 |
| DN | 1200 -1220/1400 | 48" | - | 12.00 | 0.47 | 2,854 | - | 237.83 | - | 0 | 0 | 0 | 0 | 13.07 | 6.534 | 0 | 168.00 | 0 |
| | | | | | | | | | 10,368 | | | US | $1,749 | | | | LEVA | 19,516 |

# REPUBLIKA PLANTS ( 10 b 1 ) HEATING DISTRIBUTION PIPING WO/ ALARM COMPONENTS (10b1)

**CASH FLOW (000)** *LAID DOWN IN (EXISTING) DUCT*

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9082 | MATERIAL (US $) | 317.86 | 735.63 | 917.27 | 971.76 | 1008.08 | 1026.25 | 1026.25 | 1026.25 | 1026.25 | 1026.25 |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |
| 87186 | *LABOR(LEVA)* | *3051.50* | *7062.04* | *8805.75* | *9328.87* | *9677.81* | *9851.98* | *9851.98* | *9851.98* | *9851.98* | *9851.98* |
| 0 | *EXCAV.MAT'L(LEVA)* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 87186 | *TOTAL (LEVA)* | *3051.50* | *7062.04* | *8805.75* | *9328.87* | *9677.81* | *9851.98* | *9851.98* | *9851.98* | *9851.98* | *9851.98* |
| | % | 3.50% | 8.10% | 10.10% | 10.70% | 11.10% | 11.30% | 11.30% | 11.30% | 11.30% | 11.30% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 9,081.84 | 2,724.55 | 0.00% | 100.00% |

## CASH FLOW (000) *LAID DOWN – INSULATION FOAM CONCRETE*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 1128 | MATERIAL (US $) | | 56.40 | 225.56 | 281.96 | 281.96 | 281.96 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 10828 | *LABOR(LEVA)* | | *541.40* | *2165.61* | *2707.01* | *2707.01* | *2707.01* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 10828 | *TOTAL (LEVA)* | | *541.40* | *2165.61* | *2707.01* | *2707.01* | *2707.01* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 1,127.92 | 336.38 | 0.00% | 100.00% |

## CASH FLOW (000) *OVERHEAD / COLLECTOR – INSULATION GLASS WOOL & ALUMINUM SHEET*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| 1749 | MATERIAL (US $) | | 87.44 | 349.76 | 437.20 | 437.20 | 437.20 |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |
| 19516 | *LABOR(LEVA)* | | *975.80* | *3903.18* | *4878.98* | *4878.98* | *4878.98* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 19516 | *TOTAL (LEVA)* | | *975.80* | *3903.18* | *4878.98* | *4878.98* | *4878.98* |
| | | % | 5.00% | 20.00% | 25.00% | 25.00% | 25.00% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 1,746.81 | 609.67 | 0.00% | 100.00% |

## CASH FLOW (000) *TOTAL DISTRIBUTION PIPING*

| | | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11959 | MATERIAL (US $) | | 461.70 | 1310.98 | 1638.45 | 1690.94 | 1727.27 | 1026.25 | 1026.25 | 1026.25 | 1026.25 | 1026.25 |
| | | % | 3.86% | 10.96% | 13.68% | 14.14% | 14.44% | 8.58% | 8.58% | 8.58% | 8.58% | 8.58% |
| 117530 | *LABOR(LEVA)* | | *4568.70* | *13130.83* | *16391.74* | *16914.86* | *17263.60* | *9851.98* | *9851.98* | *9851.98* | *9851.98* | *9851.98* |
| 0 | *EXCAV.MAT'L(LEVA)* | | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* |
| 117530 | *TOTAL (LEVA)* | | *4568.70* | *13130.83* | *16391.74* | *16914.86* | *17263.60* | *9851.98* | *9851.98* | *9851.98* | *9851.98* | *9851.98* |
| | | % | 3.89% | 11.17% | 13.95% | 14.39% | 14.69% | 8.38% | 8.38% | 8.38% | 8.38% | 8.38% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 11,958.58 | 3,672.80 | 0.00% | 100.00% |



958

FILE: R3_SCADA.WK
DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:14 PM

# REPUBLIKA DISTRICT HEATING DISTRIBUTION I & C (SCADA) (10c)

| ITEM | DESCRIPTION | VENDOR | QTY | UNIT MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | UNIT MNHR | TOTAL MNHRS | US MNHRS | RATE /HR US $ | TOTAL LABOR US $ (000) | BUL. MNHRS | RATE /HR LEVA | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW ELEMENTS | | | 3 | EA | 13000 | 3 | 1950 | 280 | 137 | 12.00 | 108 | 22 | 50 | 1 | 95 | 168 | 16 |
| | SUBTOTAL | | | | | | | | $137 | | | | US | $1 | | LEVA | $16 |
| SCADA EQUIPMENT (WESTINGHOUSE) | | | 1 | LT | 5,525,000 | 1 | 828750 | 110500 | 6484 | N/A | N/A | N/A | N/A | 293 | N/A | N/A | 24024 |
| *FIBER OPTIC LEASING* | | | *1* | *LT* | *60,000* | *1* | – | – | 60 | | | | | 294 | | | 24,040 |
| | TOTAL US $ | | | | 5,585,000 | | | | 6,661 | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 137 MATERIAL (US $) | 1.92 | 23.27 | 27.93 | 27.93 | 27.93 | 27.93 |
| 1 LABOR (US $) | 0.02 | 0.18 | 0.22 | 0.22 | 0.22 | 0.22 |
| SUBTOTAL | 1.93 | 23.45 | 28.15 | 28.15 | 28.15 | 28.15 |
| *16 LABOR(LEVA)* | *0.22* | *2.71* | *3.26* | *3.26* | *3.26* | *3.26* |
| 6,464 WEST. SCADA EQUIPMENT | 90.50 | 1098.92 | 1318.71 | 1318.71 | 1318.71 | 1318.71 |
| 60 FIBER OPTIC LEASING | 0.84 | 10.20 | 12.24 | 12.24 | 12.24 | 12.24 |
| 293 WEST. SCADA LABOR (US $) | 4.10 | 49.73 | 59.67 | 59.67 | 59.67 | 59.67 |
| SUBTOTAL | 95.43 | 1,158.85 | 1,390.62 | 1,390.62 | 1,390.62 | 1,390.62 |
| 7 TOTAL US $ | 97.37 | 1,182.30 | 1,418.78 | 1,418.78 | 1,418.78 | 1,418.78 |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |
| *24,024 WEST. SCADA LABOR (LEVA)* | *336.34* | *4084.06* | *4900.90* | *4900.90* | *4900.90* | *4900.90* |
| *24 TOTAL (LEVA)* | *336.56* | *4,086.79* | *4,904.15* | *4,904.15* | *4,904.15* | *4,904.15* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 6,661.14 | 1,044.83 | 0.000% | 71.902% |

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DATE: 1-Dec-93

DATE: 23-Mar-94
TIME: 04:35 PM

# REPUBLIKA HEATING SUBSTATIONS I & ; (11)

| ITEM | DESCRIPTION | VENDOR | UNIT QTY MAT'L | COST /UNIT US $ | QTY OF SUB-STATION | FREIGHT OCEAN US $ | INLAND US $ | TOT.MAT'L INC FGT. US $ (000) | LABOR /SUBSTATION US $ | TOTAL LABOR US $ (000) | TOTAL LABOR LEVA (000) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBSTATION (AVERAGE SIZE) | | NOTE 1 | 1 LOT | 7000 | 630 | INC | INC | 4410 | 1000 | 630 | 22.176 |
| CONSISTING OF: | | | | | | | | | | | |
| CONTROLLER | | | | | | | | | | | |
| RTD | | | | | | | | | | | |
| CONTROL VALVES | | | | | | | | | | | |
| HEAT EXCHANGERS | | | | | | | | | | | |
| CIRC. WATER PUMPS | | | | | | | | | | | |
| WATER FILTER | | | | | | | | | | | |
| INLET/OUTLET SHUT-OFF VALVES | | | | | | | | | | | |
| | | | | | | | | --- | | --- | --- |
| | | | | | | | | 4,410 | | 0 | 22.176 |
| | TOTAL US $ | | | | | | | | | | |

## CASH FLOW (000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|
| VALUES | | | | | | |
| 4,410 MATERIAL (US $) | 61.74 | 749.70 | 899.64 | 899.64 | 899.64 | 899.64 |
| 0 LABOR (US $) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| SUBTOTAL | 61.74 | 749.70 | 899.64 | 899.64 | 899.64 | 899.64 |
| *22,176 LABOR(LEVA)* | *310.46* | *3769.92* | *4523.90* | *4523.90* | *4523.90* | *4523.90* |
| % | 1.400% | 17.000% | 20.400% | 20.400% | 20.400% | 20.400% |

| | EQUIP/ MAT'L | LABOR | PERCENT LOCAL MAT'L | PERCENT LOCAL LABOR |
|---|---|---|---|---|
| MODEL COST SUMMARY (US $) | 4,410.00 | 693.00 | 0.000% | 100.000% |

NOTE 1:
COSTS (MATERIAL, LABOR & SUBSTATION QUANITY) SUPPLIED BY CLIENT

# SECTION 8

## Economic Analysis

Vol. 9

FEB - 2 1995

# Bulgarian District Heating System Feasibility Study

0207

Gilbert/Commonwealth International, Inc.

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# 8.0 ECONOMIC ANALYSIS

## 8.1 INTRODUCTION

The economic analysis described in this section develops the present worth of projected district heating operating costs as simulated under each alternative system configuration defined in Section 4.0. For each location, these results are compared to projected costs considering no system changes other than modifications required to maintain continued operation and to satisfy environmental constraints. Conclusions and recommendations for further system development are then set forth considering primarily the least cost options.

### 8.1.1 OBJECTIVES

It is the purpose of this section to set forth the criteria, inputs and methodology employed in establishing measures of the relative merit of each district heating system configuration as considered from an economic perspective.

### 8.1.2 SCOPE OF WORK AND LIMITATIONS

A computer spreadsheet model was specifically created as a vehicle for the simulation of annual system operations over the projected period through the year 2010. Typical model output illustrative of analysis application are contained in Subsection 8.3. Analysis results developed for each variant are summarized in Subsection 8.4, and sensitivity analyses are accomplished in Subsection 8.5. Also, in this section, certain system modification components, uniformly incorporated in each case as initially developed, are explicitly examined to determine their individual viability. "Baseline" cash flows at each plant location are then established, consisting only of those operating and capital costs associated with future developments previously demonstrating economic merit.

Finally, conclusions established on the basis of the economic analysis are enumerated in Subsection 8.6. These conclusions and the analysis upon which they are based are limited by the necessarily generalized approach taken in their development. While every effort has been made to establish a realistic basis for the evaluation of alternatives, such projections are by their nature not a precise determination of actual results and should not be considered as such. To the extent that projected results are influenced by general and specific assumptions



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underlying the analysis, those assumptions are set forth in the following paragraphs.

## 8.2 ANALYSIS ASSUMPTIONS

By its nature, any projection of future circumstances necessitates the adoption of certain assumptions with respect to study elements that cannot be predetermined with any degree of certainty. In order to ensure credible analyses, it is important that all assumptions remain consistent for all cases studied unless specific conditions, properly noted, require otherwise. Further, it is essential that such assumptions be explicitly stated so that analysis results may be properly interpreted. Details of the assumptions underlying technical criteria are presented in earlier sections. Additional major assumptions employed in this analysis are as follows:

1. Because District Heating demands vary significantly throughout the year, simulations are developed under conditions prevailing in each calendar month. Actual data available for the period April, 1992 through March, 1993 are adapted for this purpose in the manner described in Subsection 8.3.1.

2. It is assumed that load shape characteristics represented in historical data will be equally representative through the analysis period.

3. Similarly, in the absence of overall load projections, it is assumed that increases in system demand and improvements in operating efficiencies through the reduction of losses, etc. will directly offset each other with the net effect that total peak loads and annual energy requirements will remain constant throughout the forecast period.

4. Electrical loads including pumping and operational requirements as developed from actual operating statistics are also assumed to apply throughout the analysis period.

5. All capital expenditures and operating expense unit costs are assumed at year 1993 price levels. In all cases where currency conversions are required, a conversion rate of 32 Leva per $US has been applied.

6. A provision for minor commodity (hot water) shortfall penalties is assumed at a level of US $10.00 per mWH.



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7. In other respects, the following (1993) unit costs have been adopted in the development of operating expenses:

| Fuel Costs: | US $/mmBTU | Other O&M: | US $/mWH |
|---|---|---|---|
| Natural Gas | $2.027 | Raw Water & Treating | $0.03 |
| Mazut | $2.407 | Demineralized Water | $0.34 |
| Lignite | $0.668 | Other O&M | $0.75 |
| Black Coal | $2.34 | | US $/Ton |
| | | Sorbent (Limestone) | $3.28 |

8. Fuel costs listed above are based upon subsidized levels presently prevalent in Bulgaria. However, it is assumed that the cost of oil will reach world price levels within three years and that costs for natural gas and coal will reach world price levels within five years. This relationship is shown graphically in Exhibit 8-1.

9. Costs for purchased power, if, and as required, and prices associated with sales of excess electric generation are assumed at the following 1993 tariff levels:

| | Power Purchases | | Power Sales | |
|---|---|---|---|---|
| | Leva/KWh | US Cents/KWh | Leva/KWh | US Cents/KWh |
| Winter: (1) | | | | |
| Peak Tariff | 1.527 | | 1.475 | |
| Day Tariff | 0.826 | | 0.799 | |
| Night Tariff | 0.407 | | 0.395 | |
| Weighted (2) | 0.862 | 2.692 | 0.933 | 2.604 |
| Summer: (1) | | | | |
| Peak Tariff | 1.324 | | 1.284 | |
| Day Tariff | 0.716 | | 1.691 | |
| Night Tariff | 0.351 | | 0.340 | |
| Weighted (2) | 0.746 | 2.332 | 0.722 | 2.257 |

Note: (1) Winter: 1 October - 31 March; Summer: 1 April - 30 September
(2) Winter
Peak 0800 - 1100; 1800 - 2100
Night 2200 - 0600
Day All Other Hours

Summer:
Peak 0800 - 1200; 2000 - 2200
Night 2300 - 0700
Day All Other Hours



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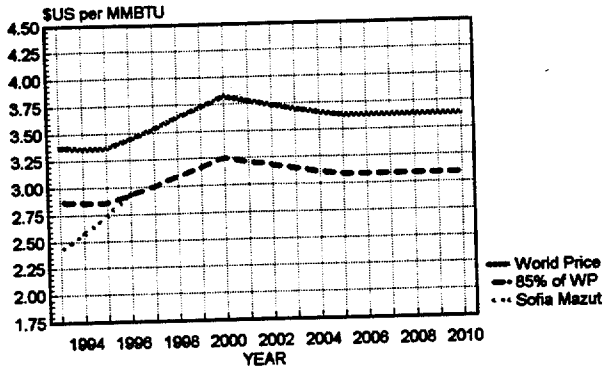
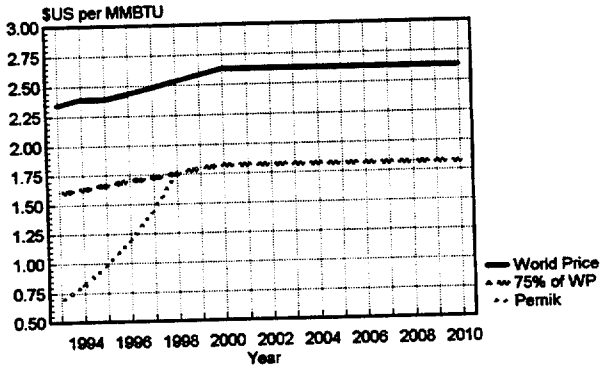
# Exhibit 8-1

## Fuel Price Projections

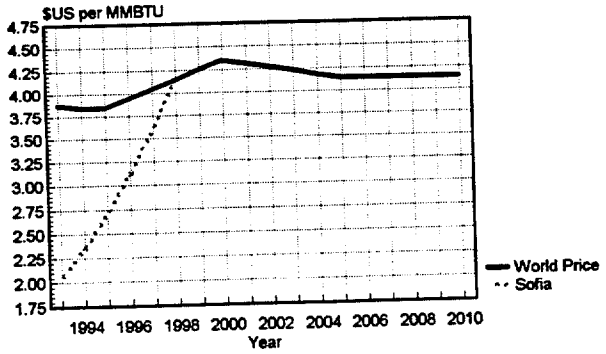
OIL




COAL




NATURAL GAS



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It is further assumed that a market exists for all electrical generation in excess of internal requirements.

10. Assumed scheduled maintenance is based on estimates for individual plants based upon allocation of 1993 budget figures as developed in Exhibit 8-2 and as summarized in Exhibit 8-3.

11. In order to give consideration particularly for the temperature sensitive characteristics of gas turbines (Cases S2 and S3), the following ambient temperatures are adopted for the respective months:

| Month | °C | Month | °C |
|---|---|---|---|
| January | -1.7 | July | 21 |
| February | 1 | August | 21 |
| March | 5 | September | 17 |
| April | 11 | October | 11 |
| May | 16 | November | 6 |
| June | 19 | December | 1 |

12. In the model simulation or projected operating results, emissions and emissions penalties for individual units are based upon assigned emissions codes and reference to criteria contained in an Emissions Matrix as shown on Exhibit 8-4.

13. Unit dispatching is prioritized generally giving consideration to fuel types, operating efficiencies and power cogeneration capabilities. While we believe dispatching sequences to be a reasonable representation of probable operations, no attempt has been made to fully optimize unit dispatch.

14. For purposes of Economic Analysis, projected costs are developed in thousands of U.S. Dollars, in all cases exclusive of General Inflation. Where appropriate, however, estimated Real Escalation has been employed at levels as shown in Exhibit 8-5.

15. No equity participation has been assumed for project expenditures.

16. Accordingly, in establishing Present Worth criteria, a Real Discount Rate of 8% is applied, equivalent to the assumed cost of domestic loans in the absence of inflation. For discounting purposes, it is assumed that all expenditures occur at mid-year.



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# Exhibit 8-2

## Projected Maintenance Expense

SOFIA

| UNIT | TYPE | YEAR INSTALLED | OPERATING HRS TO 1992 | INSTALLED CAPACITY (MW) | WEIGHTING FACTOR (1) | ADJUSTED FACTOR (2) | ALLOCATED '93 BUDGET (3) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | U.S $(000) | | | | | | | | | | | | | | | | |
| ENERGETIC BOILERS | | | | | | 1.2 | | | | | | | | | | | | | | | | | | |
| PGST #1 | B & W | 1959 | 238,256 | 54.7 | 1047480 | 3.84 | 278.7 | 557 | 287 | 296 | 305 | 314 | 627 | 323 | 333 | 343 | 353 | 706 | 364 | 375 | 386 | 397 | 795 | 409 |
| PGST #2 | B & W | 1947 | 235,000 | 54.7 | 1080234 | | | | | | | | | | | | | | | | | | | |
| PGST #3 | B & W | 1949 | 236,917 | 54.7 | 1074276 | | | | | | | | | | | | | | | | | | | |
| PGST #4 | TG-170-1M | 1956 | 223,796 | 151.2 | 2724217 | 9.45 | 685.8 | 706 | 1413 | 728 | 749 | 772 | 795 | 1590 | 819 | 843 | 869 | 895 | 1790 | 922 | 949 | 978 | 1007 | 2014 |
| PGST #5 | TG-170-1M | 1957 | 216,742 | 151.2 | 2634691 | | | | | | | | | | | | | | | | | | | |
| PGST #6 | TG-170-1M | 1957 | 207,301 | 151.2 | 2519927 | | | | | | | | | | | | | | | | | | | |
| PGST #7 | TSM-151B | 1963 | 171,287 | 157.0 | 2185272 | 3.02 | 219.3 | 226 | 233 | 465 | 240 | 247 | 254 | 262 | 524 | 270 | 278 | 286 | 295 | 590 | 304 | 313 | 322 | 332 |
| PGST #8 | TSM-151B | 1964 | 162,261 | 157.0 | 2061604 | 5.12 | 371.4 | 383 | 394 | 406 | 812 | 418 | 431 | 443 | 457 | 914 | 470 | 485 | 499 | 514 | 1028 | 530 | 545 | 562 |
| PGST #9 | 1-ST BRNO | 1965 | 46,719 | 157.9 | 1296099 | 4.05 | 294.0 | 303 | 312 | 321 | 331 | 662 | 341 | 351 | 362 | 372 | 745 | 384 | 395 | 407 | 419 | 838 | 432 | 445 |
| HOT WATER BOILERS | | | | | | 1.0 | | | | | | | | | | | | | | | | | | |
| VVK ST #1 | PTBM-100 | 1967 | 32,688 | 116.3 | 318389 | 2.43 | 176.0 | 181 | 187 | 192 | 198 | 396 | 204 | 210 | 216 | 223 | 446 | 230 | 237 | 244 | 251 | 502 | 258 | 266 |
| VVK ST #2 | PTBM-100 | 1967 | 34,069 | 116.3 | 331641 | | | | | | | | | | | | | | | | | | | |
| VVK ST #3 | PTBM-100 | 1973 | 34,461 | 116.3 | 369680 | | | | | | | | | | | | | | | | | | | |
| VVK ST #4 | PTBM-100 | 1973 | 44,882 | 116.3 | 481732 | | | | | | | | | | | | | | | | | | | |
| VVK ST #5 | PTBM-100 | 1983 | 32,251 | 116.3 | 543770 | | | | | | | | | | | | | | | | | | | |
| VVK ST #6 | PTBM-100 | 1981 | 26,038 | 116.3 | 361069 | | | | | | | | | | | | | | | | | | | |
| STEAM TURBINES | | | | | | 1.5 | | | | | | | | | | | | | | | | | | |
| TG ST #4 | VT-25-4 | 1956 | 215,456 | 25 | 433647 | 0.65 | 47.2 | 142 | 0 | 0 | 0 | 159 | 0 | 0 | 0 | 179 | 0 | 0 | 0 | 202 | 0 | 0 | 0 | 227 |
| TG ST #5 | VT-25-4 | 1957 | 213,130 | 25 | 428370 | 0.64 | 46.6 | 0 | 140 | 0 | 0 | 0 | 157 | 0 | 0 | 0 | 177 | 0 | 0 | 0 | 199 | 0 | 0 | 0 |
| TG ST #6 | VPT-50-2 | 1962 | 211,420 | 50 | 855286 | 1.28 | 93.1 | 0 | 0 | 279 | 0 | 0 | 0 | 314 | 0 | 0 | 0 | 354 | 0 | 0 | 0 | 398 | 0 | 0 |
| TG ST #9 | R-25 90/10 | 1965 | 74,955 | 25 | 329233 | 0.49 | 35.8 | 0 | 0 | 0 | 107 | 0 | 0 | 0 | 121 | 0 | 0 | 0 | 136 | 0 | 0 | 0 | 153 | 0 |
| | | | | | | | 30.99 | 2,248.0 | 2498 | 2965 | 2587 | 2742 | 2968 | 2810 | 3494 | 2831 | 3144 | 3338 | 3339 | 3715 | 3252 | 3537 | 3956 | 3513 | 4255 |

NOTE: (1) ((Operating Hours + Years in Service) * 1.03 ^ (Years in Service)) * Installed Capacity
(2) (Weighting factor + 1000000) * Group Weighting Factor
(3) Total DHC Sofia 1993 Budget for "Outside Repair" prorated to HE Sofia based on 1992 distribution of costs.
(4) Major overhauls in five year cycles at a cost equivalent to 2 times normal cost for boilers and 3 times normal cost for turbines.

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| UNIT | TYPE | YEAR INSTALLED | OPERATING HRS TO 1992 | INSTALLED CAPACITY (MW) | WEIGHTING FACTOR (1) | ADJUSTED FACTOR (2) | ALLOCATED '93 BUDGET (3) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | U.S $(000) | | | | | | | | | | | | | | | | |
| ENERGETIC BOILERS | | | | | | 1.2 | | | | | | | | | | | | | | | | | | |
| PGST #1 | 1-ST BRNO | 1964 | 156032 | 157 | 2001694 | 9.06 | 1,473.8 | 1518 | 3036 | 1564 | 1611 | 1659 | 3318 | 1709 | 1760 | 1813 | 3625 | 1867 | 1923 | 1981 | 3962 | 2040 | 2101 | 2164 |
| PGST #2 | 1-ST BRNO | 1964 | 147724 | 157 | 1895112 | | | | | | | | | | | | | | | | | | | |
| PGST #3 | 1-ST BRNO | 1967 | 133661 | 157 | 1757499 | | | | | | | | | | | | | | | | | | | |
| PGST #4 | 1-ST BRNO | 1968 | 144035 | 157 | 1915357 | | | | | | | | | | | | | | | | | | | |
| PGST #5 | 1-ST BRNO | 1988 | 21939 | 152 | 938316 | 3.47 | 563.1 | 580 | 597 | 1195 | 615 | 634 | 653 | 1306 | 672 | 693 | 713 | 1427 | 735 | 757 | 779 | 1559 | 803 | 827 |
| PGST #6 | 1-ST BRNO | 1988 | 21169 | 152 | 905384 | | | | | | | | | | | | | | | | | | | |
| PGST #7 | 1-ST BRNO | 1989 | 18933 | 152 | 1048222 | | | | | | | | | | | | | | | | | | | |
| HOT WATER BOILERS | | | | | | 1.0 | | | | | | | | | | | | | | | | | | |
| VVK ST #1 | VK-100 | 1974 | 46118 | 116.3 | 507280 | 2.13 | 345.5 | 356 | 367 | 378 | 755 | 389 | 401 | 413 | 825 | 425 | 438 | 451 | 902 | 464 | 478 | 493 | 985 | 507 |
| VVK ST #2 | VK-100 | 1974 | 39123 | 116.3 | 430336 | | | | | | | | | | | | | | | | | | | |
| VVK ST #3 | VK-100 | 1975 | 30906 | 116.3 | 349457 | | | | | | | | | | | | | | | | | | | |
| VVK ST #4 | VK-100 | 1975 | 33544 | 116.3 | 379296 | | | | | | | | | | | | | | | | | | | |
| VVK ST #5 | VK-100 | 1977 | 38348 | 116.3 | 463222 | | | | | | | | | | | | | | | | | | | |
| VVK ST #6 | VK-100 | 1981 | 31177 | 116.3 | 456279 | 1.51 | 245.7 | 253 | 261 | 269 | 277 | 553 | 285 | 293 | 302 | 604 | 311 | 321 | 330 | 660 | 340 | 350 | 361 | 722 |
| VVK ST #7 | VK-100 | 1982 | 37588 | 116.3 | 587491 | | | | | | | | | | | | | | | | | | | |
| VVK ST #8 | VK-100 | 1982 | 30110 | 116.3 | 470612 | | | | | | | | | | | | | | | | | | | |
| STEAM TURBINES | | | | | | 1.5 | | | | | | | | | | | | | | | | | | |
| TG ST #1 | VPT - 30 | 1964 | 163876 | 30 | 401716 | 0.60 | 97.8 | 293 | 0 | 0 | 0 | 0 | 330 | 0 | 0 | 0 | 0 | 372 | 0 | 0 | 0 | 0 | 418 | 0 |
| TG ST #2 | VPT - 30 | 1964 | 140406 | 30 | 344184 | 0.52 | 83.8 | 0 | 251 | 0 | 0 | 0 | 0 | 283 | 0 | 0 | 0 | 0 | 318 | 0 | 0 | 0 | 0 | 358 |
| TG ST #3 | VPT - 30 | 1967 | 166866 | 30 | 419256 | 0.63 | 102.0 | 0 | 0 | 306 | 0 | 0 | 0 | 0 | 345 | 0 | 0 | 0 | 0 | 388 | 0 | 0 | 0 | 0 |
| TG ST #4 | VPT - 30 | 1967 | 150961 | 30 | 379296 | 0.57 | 92.3 | 0 | 0 | 0 | 277 | 0 | 0 | 0 | 0 | 312 | 0 | 0 | 0 | 0 | 351 | 0 | 0 | 0 |
| TG ST #5 | VPT - 30 | 1988 | 31099 | 30 | 262516 | 0.39 | 63.8 | 0 | 0 | 0 | 0 | 192 | 0 | 0 | 0 | 0 | 216 | 0 | 0 | 0 | 0 | 243 | 0 | 0 |
| | | | | | | | 16.91 | 3066 | 3000 | 4512 | 3711 | 3534 | 3420 | 4006 | 4003 | 3904 | 3846 | 5303 | 4437 | 4206 | 4250 | 5910 | 4685 | 4669 | 4579 |

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| UNIT | TYPE | YEAR INSTALLED | OPERATING HRS TO 1992 | INSTALLED CAPACITY (MW) | WEIGHTING FACTOR (1) | ADJUSTED FACTOR (2) | ALLOCATED '93 BUDGET (3) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | U.S $(000) | | | | | | | | | | | | | | | | |
| HOT WATER BOILERS | | | | | | 1.0 | | | | | | | | | | | | | | | | | | |
| VVK ST #1 | PTBM-100 | 1977 | 51567 | 116.3 | 622901 | 2.76 | 868.9 | 895 | 1790 | 922 | 949 | 978 | 1956 | 1007 | 1038 | 1069 | 2137 | 1101 | 1134 | 1168 | 2336 | 1203 | 1239 | 1276 |
| VVK ST #2 | PTBM-100 | 1977 | 67560 | 116.3 | 816087 | | | | | | | | | | | | | | | | | | | |
| VVK ST #3 | PTBM-100 | 1979 | 45861 | 116.3 | 602509 | | | | | | | | | | | | | | | | | | | |
| VVK ST #4 | PTBM-100 | 1979 | 54178 | 116.3 | 711776 | | | | | | | | | | | | | | | | | | | |
| VVK ST #5 | VK-100 | 1989 | 12946 | 116.3 | 548410 | 0.55 | 173.1 | 178 | 184 | 189 | 378 | 195 | 201 | 207 | 413 | 213 | 219 | 226 | 452 | 233 | 240 | 247 | 494 | 254 |
| | | | | | | | 3.30 | 1042 | 1073 | 1974 | 1111 | 1328 | 1173 | 2157 | 1214 | 1451 | 1282 | 2357 | 1327 | 1585 | 1400 | 2675 | 1450 | 1732 | 1530 |

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| UNIT | TYPE | YEAR INSTALLED | OPERATING HRS TO 1992 | INSTALLED CAPACITY (MW) | WEIGHTING FACTOR (1) | ADJUSTED FACTOR (2) | ALLOCATED '93 BUDGET (3) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | U.S $(000) | | | | | | | | | | | | | | | | |
| HOT WATER BOILERS | | | | | | 1.0 | | | | | | | | | | | | | | | | | | |
| VVK ST #1 | PTBM-100 | 1972 | 89362 | 116.3 | 938528 | 3.16 | 996.0 | 1026 | 1057 | 2113 | 1088 | 1121 | 1155 | 2309 | 1189 | 1225 | 1262 | 2523 | 1300 | 1339 | 1379 | 2757 | 1420 | 1463 |
| VVK ST #2 | PTBM-100 | 1972 | 82407 | 116.3 | 865483 | | | | | | | | | | | | | | | | | | | |
| VVK ST #3 | PTBM-100 | 1976 | 62489 | 116.3 | 728885 | | | | | | | | | | | | | | | | | | | |
| VVK ST #4 | PTBM-100 | 1976 | 53415 | 116.3 | 523044 | | | | | | | | | | | | | | | | | | | |
| VVK ST #5 | PTBM-100 | 1982 | 24820 | 116.3 | 387930 | 0.39 | 122.4 | 126 | 130 | 134 | 138 | 276 | 142 | 146 | 151 | 301 | 155 | 160 | 165 | 329 | 169 | 175 | 180 | 360 |
| | | | | | | | 3.54 | 768 | 1152 | 1187 | 2247 | 1226 | 1397 | 1297 | 2455 | 1340 | 1526 | 1417 | 2683 | 1464 | 1668 | 1548 | 2932 | 1600 | 1622 |



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# Exhibit 8-3

## Maintenance Expense Matrix

VARIABLE MAINTENANCE

Scale = 1:10

| Unit | Code | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Y | E | A | R | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| | | 1 | 1.002 | 1.003 | 1.00401 | 1.00501 | 1.00602 | 1.00702 | 1.00803 | 1.00904 | 1.01005 | 1.01106 | 1.01207 | 1.01308 | 1.01409 | 1.01511 | 1.01612 | 1.01714 |
| Republika Blr #1 | Blr #1 | 1.25 | 1.25 | 1.26 | 1.26 | 1.27 | 1.28 | 1.28 | 1.29 | 1.31 | 1.32 | 1.33 | 1.35 | 1.37 | 1.39 | 1.41 | 1.43 | 1.46 |
| Republika Blr #2 | Blr #2 | 1.25 | 1.25 | 1.26 | 1.26 | 1.27 | 1.28 | 1.28 | 1.29 | 1.31 | 1.32 | 1.33 | 1.35 | 1.37 | 1.39 | 1.41 | 1.43 | 1.46 |
| Republika Blr #3 | Blr #3 | 1.10 | 1.10 | 1.11 | 1.11 | 1.12 | 1.12 | 1.13 | 1.14 | 1.15 | 1.16 | 1.17 | 1.19 | 1.20 | 1.22 | 1.24 | 1.26 | 1.28 |
| Republika Blr #4 | Blr #4 | 1.00 | 1.00 | 1.01 | 1.01 | 1.01 | 1.02 | 1.03 | 1.04 | 1.04 | 1.06 | 1.07 | 1.08 | 1.09 | 1.11 | 1.13 | 1.14 | 1.16 |
| Republika Blr #5 | Blr #5 | 1.00 | 1.00 | 1.01 | 1.01 | 1.01 | 1.02 | 1.03 | 1.04 | 1.04 | 1.06 | 1.07 | 1.08 | 1.09 | 1.11 | 1.13 | 1.14 | 1.16 |
| Republika Blr #6 | Blr #6 | 1.00 | 1.00 | 1.01 | 1.01 | 1.01 | 1.02 | 1.03 | 1.04 | 1.04 | 1.06 | 1.07 | 1.08 | 1.09 | 1.11 | 1.13 | 1.14 | 1.16 |
| Republika CFB #1 | CFB #1 | | – | – | – | – | 0.80 | 0.81 | 0.81 | 0.82 | 0.83 | 0.84 | 0.85 | 0.86 | 0.87 | 0.88 | 0.90 | 0.91 |
| Republika CFB #2 | CFB #2 | | – | – | – | – | 0.80 | 0.81 | 0.81 | 0.82 | 0.83 | 0.84 | 0.85 | 0.86 | 0.87 | 0.88 | 0.90 | 0.91 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

SCHEDULED MAINTENANCE

| | | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| | | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) | $(000) |
| Sofia Boilers #3 | SB3 | 186 | 96 | 99 | 102 | 105 | 209 | 108 | 111 | 114 | 118 | 235 | 121 | 125 | 129 | 132 | 265 | 136 |
| Sofia Boilers #4–6 | SB4 | 530 | 1060 | 546 | 562 | 579 | 596 | 1193 | 614 | 632 | 652 | 671 | 1343 | 692 | 712 | 734 | 755 | 1511 |
| Sofia Boiler #7 | SB7 | 226 | 233 | 465 | 240 | 247 | 254 | 262 | 524 | 270 | 278 | 286 | 295 | 590 | 304 | 313 | 322 | 332 |
| Sofia Boiler #8 | SB8 | 383 | 394 | 406 | 812 | 418 | 431 | 443 | 457 | 914 | 470 | 485 | 499 | 514 | 1028 | 530 | 545 | 562 |
| Sofia Boiler #9 | SB9T8 | 303 | 312 | 321 | 439 | 662 | 341 | 351 | 483 | 372 | 745 | 384 | 531 | 407 | 419 | 838 | 585 | 445 |
| Sofia HWB #3–6 | SHWB | 121 | 125 | 128 | 132 | 264 | 136 | 140 | 144 | 149 | 297 | 153 | 159 | 163 | 168 | 335 | 172 | 177 |
| Sofia Turb #4 | ST4 | 142 | | | | 159 | | | | 179 | | | | 202 | | | | 227 |
| Sofia Turb #5 | ST5 | | 140 | | | | 157 | | | | 177 | | | | 199 | | | |
| Sofia Turb #6 | ST6 | | | 279 | | | | 314 | | | | 354 | | | | 398 | | |
| Sofia GT Case S2 | GT–LM6 | | | | 1400 | 1800 | 1800 | 1800 | 2170 | 2170 | 2170 | 1400 | 1800 | 1800 | 1800 | 2170 | 2170 | 2170 |
| Sofia CC Case S3 | GT–6FA | | | | | | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 |
| Sofia Turb S3 | STS3 | | | | | | | | | | 200 | | | | | 200 | | |
| Republika Blr #1 | PB1 | 150 | | | | | 150 | | | | | 150 | | | | | 150 | |
| Republika Blr #2 | PB2 | | 150 | | | | | 150 | | | | | 150 | | | | | 150 |
| Republika Blr #3 | PB3 | | | 250 | | | | | 250 | | | | | 250 | | | | |
| Republika Blr #4 | PB4 | | | | 300 | | | | | 300 | | | | | 300 | | | |
| Republika Blr #5 | PB5 | | | | | 300 | | | | | 300 | | | | | 300 | | |
| Republika Blr #6 | PB6 | | | | | | 300 | | | | | 300 | | | | | 300 | |
| Republika CFB | CFB1 | | | | | | | | | 500 | | 500 | | | 500 | | 500 | |
| Liulin HW Blrs 1–4 | LHWB | 1026 | 1057 | 2113 | 1088 | 1121 | 1155 | 2309 | 1189 | 1225 | 1262 | 2523 | 1300 | 1339 | 1379 | 2757 | 1420 | 1463 |
| Liulin HW Blr #5 | LHWB5 | 126 | 130 | 134 | 138 | 276 | 142 | 146 | 151 | 301 | 155 | 160 | 165 | 329 | 169 | 175 | 180 | 360 |

# Exhibit 8-4

## Emissions Matrix

| CODE | Boiler Size/Type/Fuel | Limeston Required lb/MMBTU | Ash Disposal lb/MMBTU | Emission Factor Summary: Particulate lb/MMBTU | $SO_2$ lb/MMBTU | NOx lb/MMBTU | CO lb/MMBTU | Emission Penalties: Particulate $/MMBTU | SO2 $/MMBTU | NOx $/MMBTU | CO $/MMBTU | Composite |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Individual Boilers 50 to 300 MWt** | | | | | | | | | | | | |
| PC2-A1 | PC-brown coal w/o particulate control | | 85.09 | 45.817 | 6.532 | 0.594 | 0.018 | $0.1296 | $0.0253 | $0.0003 | – | $0.1551 |
| PC2-AL1 | PC-brown coal w/o particulate control & LNB | | 85.09 | 45.817 | 6.532 | 0.594 | 0.018 | $0.1296 | $0.0253 | – | – | $0.1549 |
| PC2-E1 | PC-brown coal w/ existing ESP | | 128.94 | 1.961 | 6.532 | 0.594 | 0.018 | $0.0053 | $0.0253 | $0.0003 | – | $0.0308 |
| PC2-EL1 | PC-brown coal w/ existing ESP & LNB | | 128.94 | 1.961 | 6.532 | 0.357 | 0.018 | $0.0053 | $0.0253 | – | – | $0.0306 |
| PC2-EF1 | PC-brown coal w/ existing ESP & wet FGD | 10.41 | 136.44 | 1.961 | 0.523 | 0.594 | 0.018 | $0.0053 | – | $0.0003 | – | $0.0056 |
| PC2-EFL1 | PC-brown coal w/ existing ESP, wet FGD & LNB | 10.41 | 135.44 | 1.961 | 0.523 | 0.357 | 0.018 | $0.0053 | – | – | – | $0.0053 |
| PC2-E2F1 | PC-brown coal w/ upgrade ESP & wet FGD | 10.41 | 138.12 | 0.229 | 0.523 | 0.594 | 0.018 | $0.0004 | – | $0.0003 | – | $0.0007 |
| PC2-E2FL1 | PC-brown coal w/ upgrade ESP, wet FGD & LNB | 10.41 | 135.17 | 0.229 | 0.523 | 0.357 | 0.018 | $0.0004 | – | – | – | $0.0004 |
| PC2-B1 | PC-brown coal w/ baghouse | | 130.81 | 0.092 | 6.532 | 0.594 | 0.016 | – | | $0.0003 | – | $0.0003 |
| PC2-BL1 | PC-brown coal w/ baghouse & LNB | | 130.81 | 0.092 | 6.532 | 0.357 | 0.015 | – | $0.0253 | – | – | $0.0253 |
| PC2-BF1 | PC-brown coal w/ baghouse & wet FGD | 10.41 | 138.35 | 0.046 | 0.523 | 0.594 | 0.018 | – | – | $0.0003 | – | $0.0003 |
| PC2-BFL1 | PC-brown coal w/ baghouse, wet FGD & LNB | 10.41 | 138.35 | 0.046 | 0.523 | 0.357 | 0.018 | – | – | – | – | – |
| PC2-BF21 | PC-brown coal w/ baghouse & dry FGD | 11.18 | 138.86 | 0.092 | 0.98 | 0.594 | 0.018 | – | $0.0018 | $0.0003 | – | $0.0021 |
| PC2-BF2L1 | PC-brown coal w/ baghouse, dry FGD & LNB | 11.18 | 138.86 | 0.092 | 0.98 | 0.357 | 0.018 | – | $0.0018 | – | – | $0.0018 |
| FB2-E1 | CFB-brown coal w/ new ESP | 38.14 | 158.04 | 0.327 | 0.588 | 0.307 | 0.018 | $0.0007 | – | – | – | $0.0007 |
| FB2-BL1 | CFB-brown coal w/ baghouse | 38.14 | 158.29 | 0.082 | 0.588 | 0.307 | 0.018 | – | – | – | – | – |
| ST2-A6 | Heavy oil w/o particulate control | | 0.10 | 0.276 | 3.863 | 0.495 | 0.073 | $0.0007 | $0.0146 | $0.0011 | – | $0.0164 |
| ST2-AL6 | Heavy oil w/o particulate cntrl & low NOx burners | | 0.1 | 0.276 | 3.863 | 0.321 | 0.073 | $0.0007 | $0.0146 | $0.0001 | – | $0.0154 |
| ST2-E6 | Heavy Oil w/ existing ESP | | 0.37 | 0.006 | 3.863 | 0.495 | 0.073 | – | $0.0146 | $0.0011 | – | $0.0157 |
| ST2-EL6 | Heavy oil w/ existing ESP & low NOx burners | | 0.37 | 0.006 | 3.863 | 0.321 | 0.073 | – | $0.0146 | $0.0001 | – | $0.0148 |
| ST2-B6 | Heavy Oil w/ baghouse | | 0.38 | 0.001 | 3.863 | 0.495 | 0.073 | – | $0.0146 | $0.0011 | – | $0.0157 |
| ST2-BL6 | Heavy Oil w/ baghouse & low NOx burners | | 0.38 | 0.001 | 3.863 | 0.321 | 0.073 | – | $0.0146 | $0.0001 | – | $0.0148 |
| ST2-A7 | Light oil | | 0.05 | 0.016 | 1.055 | 0.156 | 0.013 | – | $0.0026 | – | – | $0.0026 |
| ST2-AL7 | Light Oil w/ low NOx burners | | 0.05 | 0.016 | 1.055 | 0.093 | 0.013 | – | $0.0026 | – | – | $0.0026 |
| ST2-A8 | Light oil – low sulfur | | 0.04 | 0.016 | 0.422 | 0.156 | 0.013 | – | – | – | – | – |
| ST2-AL8 | Light oil – low sulfur & low NOx burners | | 0.04 | 0.016 | 0.422 | 0.093 | 0.013 | – | – | – | – | – |
| ST2-A9 | Natural Gas | | – | – | – | 0.140 | 0.014 | – | – | – | – | – |
| ST2-AL9 | Natural Gas w/ low NOx burners | | – | – | – | 0.077 | 0.014 | – | – | – | – | – |
| ST2-A95 | 95% Gas/5% Mazut | | 0.01 | 0.014 | 0.193 | 0.158 | 0.017 | $0.0000 | $0.0007 | $0.0001 | – | $0.0008 |
| **Individual Boilers 5 to 50 MWt** | | | | | | | | | | | | |
| ST3-C1 | Grate-brown coal wo particulate cntrl | | 129.44 | 1.463 | 6.532 | 0.438 | 0.229 | $0.0038 | $0.0200 | – | – | $0.0238 |
| ST3-E1 | Grate-brown coal w/ cyclones | | 130.17 | 0.732 | 6.532 | 0.438 | 0.229 | $0.0018 | $0.0200 | – | – | $0.0218 |
| ST3-B1 | Grate-brown coal w/ baghouse | | 130.90 | 0.007 | 6.532 | 0.438 | 0.229 | – | $0.0200 | – | – | $0.0200 |
| ST3-A6 | Heavy oil w/o particulate control | | 0.10 | 0.276 | 3.863 | 0.495 | 0.073 | $0.0007 | $0.0136 | $0.0011 | – | $0.0154 |
| ST3-E6 | Heavy oil w/ existing ESP | | 0.37 | 0.003 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0011 | – | $0.0147 |
| ST3-EL6 | Heavy oil w/ existing ESP & low NOx burners | | 0.37 | 0.003 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0001 | – | $0.0138 |
| ST3-B6 | Heavy Oil w/ baghouse | | 0.38 | 0.001 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0011 | – | $0.0147 |
| ST3-BL6 | Heavy Oil w/ baghouse & low NOx burners | | 0.38 | 0.001 | 3.863 | 0.495 | 0.073 | – | $0.0136 | $0.0001 | – | $0.0138 |
| ST3-A7 | Light oil | | 0.05 | 0.016 | 1.055 | 0.156 | 0.013 | – | $0.0017 | – | – | $0.0017 |
| ST3-A8 | Light oil – low sulfur | | 0.04 | 0.016 | 0.422 | 0.156 | 0.013 | – | – | – | – | – |
| ST3-AL8 | Light oil – low sulfur & low NOx burners | | 0.04 | 0.016 | 0.422 | 0.156 | 0.013 | – | – | – | – | – |
| ST3-A9 | Natural Gas | | – | – | – | 0.120 | 0.014 | – | – | – | – | – |
| ST3-AL9 | Natural Gas w/ low NOx burners | | – | – | – | 0.120 | 0.014 | – | – | – | – | – |
| GT-251 | W251 on Natural Gas | | – | – | – | 0.092 | 0.012 | – | – | – | – | – |
| GT-643 | Siemens 64.3 on Natural Gas | | – | – | – | 0.092 | 0.012 | – | – | – | – | – |
| GT-B13 | BBC Type 13 on Natural Gas | | – | – | – | 0.092 | 0.012 | – | – | – | – | – |
| GT-LM6 | GE LM6000 | | – | – | – | 0.102 | 0.062 | – | – | – | – | – |
| GT-6FA | GE 6FA | | – | – | – | 0.102 | 0.030 | – | – | – | – | – |

# Exhibit 8-5

## Estimated Real Escalation Rates

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Real Escalation | | | | | | | | | | | | | | | | | |
| Natural Gas | 0.1532 | 0.1532 | 0.1532 | 0.1532 | 0.1532 | 0.0253 | 0.0254 | −0.0100 | −0.0100 | −0.0100 | −0.0100 | −0.0100 | – | – | – | – | – |
| Oil | 0.0666 | 0.0666 | 0.0666 | 0.0261 | 0.0262 | 0.0262 | 0.0263 | −0.0103 | −0.0103 | −0.0103 | −0.0103 | −0.0103 | – | – | – | – | – |
| Lignite | 0.2315 | 0.2315 | 0.2315 | 0.2315 | 0.2315 | 0.0195 | 0.0196 | | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Steam Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 0.0666 | 0.0666 | 0.0666 | 0.0261 | 0.0262 | 0.0262 | 0.0263 | | – | – | – | – | – | – | – | – | – |
| Power Sales Revenues | 0.0666 | 0.0666 | 0.0666 | 0.0261 | 0.0262 | 0.0262 | 0.0263 | | – | – | – | – | – | – | – | – | – |
| Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Other O&M | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Capital Cost – Foreign | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Capital Cost – Domestic | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| COMPOUNDED: | | | | | | | | | | | | | | | | | |
| Real Escalation | | | | | | | | | | | | | | | | | |
| Natural Gas | 1.1532 | 1.3299 | 1.5336 | 1.7686 | 2.0395 | 2.0911 | 2.1442 | 2.1228 | 2.1015 | 2.0805 | 2.0597 | 2.0391 | 2.0391 | 2.0391 | 2.0391 | 2.0391 | 2.0391 |
| Oil | 1.0666 | 1.1376 | 1.2133 | 1.2449 | 1.2776 | 1.3110 | 1.3455 | 1.3317 | 1.3179 | 1.3044 | 1.2909 | 1.2776 | 1.2776 | 1.2776 | 1.2776 | 1.2776 | 1.2776 |
| Lignite | 1.2315 | 1.5165 | 1.8675 | 2.2998 | 2.8321 | 2.8873 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 | 2.9439 |
| Black Coal | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Purchased Steam Cost | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Purchased Power Cost | 1.0666 | 1.1376 | 1.2133 | 1.2449 | 1.2776 | 1.3110 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 |
| Power Sales Revenues | 1.0666 | 1.1376 | 1.2133 | 1.2449 | 1.2776 | 1.3110 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 | 1.3455 |
| Ash Removal | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Other O&M | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Emissions Penalties | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Capital Cost – Foreign | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Capital Cost – Domestic | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |



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## 8.3 THE ECONOMIC MODEL AND AN ILLUSTRATIVE APPLICATION

### 8.3.1 MODEL FLOW DIAGRAM

As previously indicated, the primary tool for investigating the economic merit of alternative district heating system configurations is a spreadsheet model designed to simulate plant operations under each circumstance. A simplified flow diagram illustrating the logic employed in the model is shown in Exhibit 8-6.

### 8.3.2 ILLUSTRATIVE MODEL APPLICATION

Since, except for specific component operating characteristics and relevant inputs, the same model and therefore the same methodology has been applied in the analysis of each variant, a description of model outputs related to Case S2 will be generally descriptive.

The unique characteristics of each variant are represented in a "Facilities Data Sheet" descriptive of all plant facilities in place. The initial data sheet for Case S2 is illustrated in Exhibit 8-7.

This Data Sheet, which characterizes the present situation, includes specifics as to the operating efficiencies, minimum operating levels, and maximum outputs of each applicable commodity (steam, hot water, electricity). In addition, primary and secondary fuels and other operation and maintenance expense criteria are identified, as well as each unit's availability during each month of the year. Individual Data Sheets of this type are, in fact, the essence of each case.

Since, however, system components and characteristics obviously vary over time even within a given case, multiple Data Sheets are required to represent the evolving situation at each pertinent interval. For example, in connection with the year by year simulation of operating results under the subject variant , replacement Facilities Data Sheets, similar in form but different in content, are read into the model in the respective years on account of the following circumstances:

- 1994 Present Situation
- 1995 Revised Efficiencies
- 1997 Two gas turbines (Model LM6000), and HRSG's are introduced replacing existing Boiler #7
- 1999 Revised Efficiencies
- 2004 Revised Efficiencies

In the simulation for intervening years, facilities as represented in the most recently introduced Data Sheet are utilized in meeting current loads. That is, the operating characteristics as represented in a particular Data Sheet remain in effect until such time as a new data sheet is read into the model.



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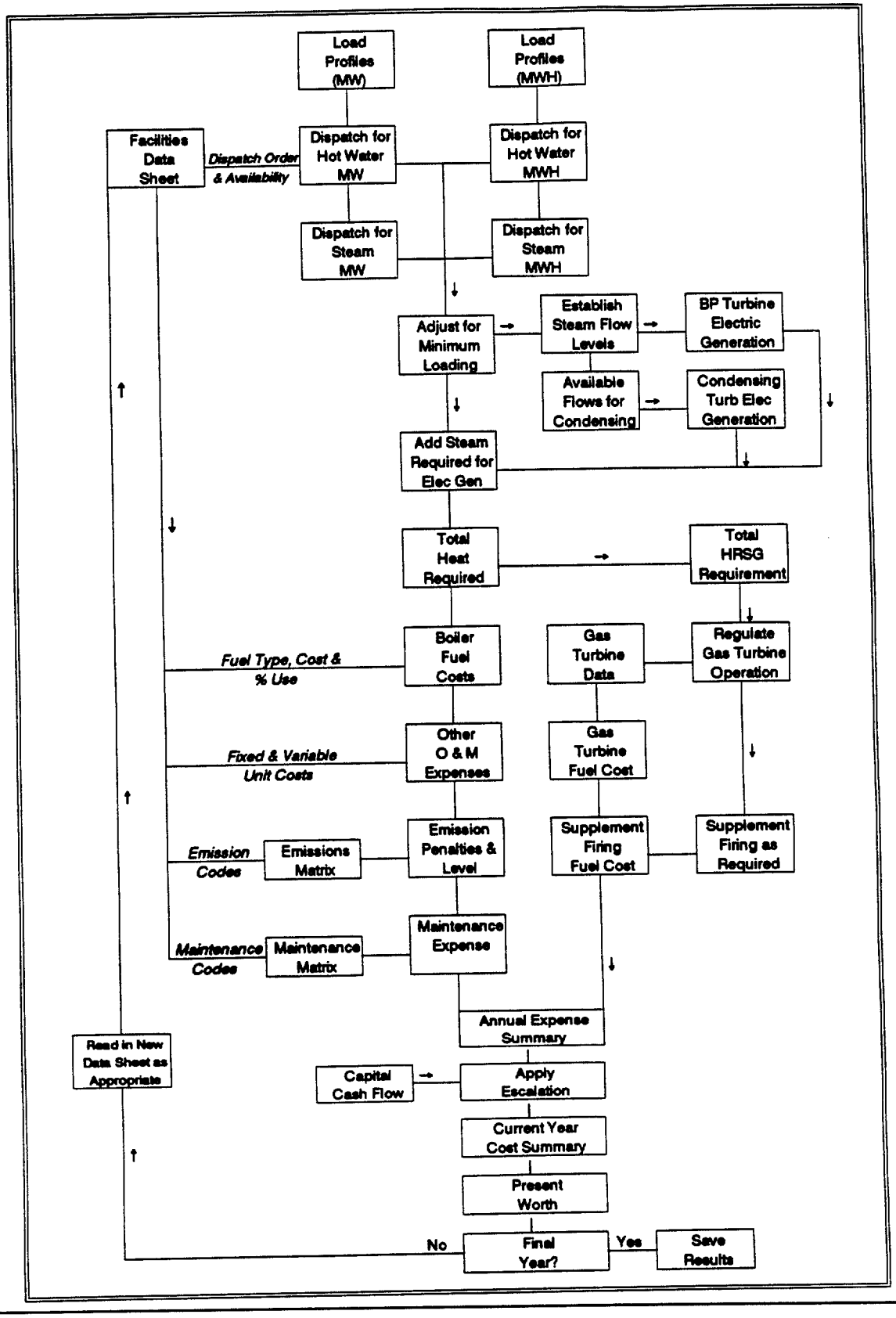
## Exhibit 8-6

## Economic Model Flow Diagram



# Exhibit 8-7

## Typical Facilities Data Sheet

Test Year = 1994

CASE S2

Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | |
| | | | | Blrs 4–5 | | Blrs 5–6 | | Boiler #7 | Boiler #8 | | | | Blr #9 | Blr #3 | HWB 3–6 |
| THERMAL DATA | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 84.2% | | 84.2% | | 84.2% | 84.2% | | | | 84.2% | 84.2% | 84.2% |
| Half Load | %2 | | | 84.2% | | 84.2% | | 84.2% | 84.2% | | | | 84.2% | 84.2% | 84.2% |
| Minimum Load | %3 | | | 84.2% | | 84.2% | | 84.2% | 84.2% | | | | 84.2% | 84.2% | 84.2% |
| Minimum Operation | % | | | 26.7% | | 26.7% | | 40.0% | 40.0% | | | | 40.0% | 40.0% | 10.0% |
| Feedwater Temp | | | | 419° | | 419° | | 419° | 419° | | | | 439° | 212° | 158° |
| Operation Adjustment Factor | Factor | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | 8 | 7 | | | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | 135.000 | 135.000 | | | | | | |
| Quantity | Mlb/Hr | | | 727.65 | 52.292 | 727.65 | 52.292 | 485.1 | 485.1 | | | 142 | 485.1 | | |
| Pressure | PSIA | | | 1451 | – | 1451 | – | 1451 | 1451 | | | 115.751 | 1451 | | |
| Temperature | Temp °F | | | 950° | 12.333 | 950° | 12.333 | 1004° | 1004° | | | 36.908 | 1004° | | |
| Enthalpy | MBTU/lb | | | 1.458 | 48.695 | 1.458 | 48.695 | 1.496 | 1.496 | | | 115.342 | 1.496 | | |
| PRODUCT – LP STEAM | Priority | * | | | | | | | | 5 | | | 2 | | |
| Quantity | Mlb/Hr | | | | | | | | | 507.15 | | | 430.000 | 132.300 | |
| | MWts | | | | | | | | | 166.700 | | | 159.000 | 53.000 | |
| Pressure | PSIA | | | | | | | | | 185 | | | 142.25 | 363 | |
| Temperature | Temp °F | | | | | | | | | 559.4° | | | – | 770° | |
| Enthalpy | MBTU/lb | | | | | | | | | 1.302 | | | 1.266 | 1.403 | |
| PRODUCT – HOT WATER | Priority | | Cooling | 4 | | 3 | | | | | 1 | | 2 | | 6 |
| Quantity | MWtw | | 200.000 | 35.190 | | 35.190 | | | | | 101.300 | | 41.000 | | 484.000 |
| Temperature – Supply | Temp °F | | | 240° | | 240° | | | | | 240° | | 240° | | 302° |
| Return | Temp °F | | | 140° | | 140° | | | | | 140° | | 140° | | 158° |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | | Turb 6a | Turb 6b | Turb 6c | Turb 8 | | |
| | Priority | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | 25000 | | 25000 | | | | | 55000 | 25000 | | |
| Capability – Max Steam | KW1 | | | 12540 | 18000 | 12540 | 18000 | | | 29227 | 34727 | 50000 | 25000 | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | 21920 | 26046 | | 18375 | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | 14613 | 17364 | | 11875 | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | 7307 | 8682 | | 4375 | | |
| Steam Required – Maximum | M#/Hr_Max | | | 114.660 | | 114.660 | | | | 507.150 | 352.800 | | 480.640 | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | 192.260 | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | 185 | 22.75 | | 142.2 | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | 0.1849 | 0.307 | | 0.228 | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | 1.1218 | 0.9801 | | 0.9790 | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | 98.6% | 98.6% | 98.6% | 97.5% | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | 0.357 | | | |
| FUELS DATA | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | Mazut | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 740 | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 3.0 | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $298.0 | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.34 | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $0.75 | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.28 | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | – | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | ST2–A9 | | | | ST2–A9 | | ST2–A9 |
| Emissions Code –Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | ST2–A6 | | | | ST2–A6 | | ST2–A6 |
| Scheduled Maintenance | CODE m | | | SB4 | ST4 | SB5 | ST5 | SB7 | SB8 | | ST6 | | SB9T8 | | SHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | $0.0269 | | | | | | | | | | | | |
| Summer | Cents/KWHs | | $0.0233 | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | AVAILABILITY | | | | | | | | | | | |
| Jan | –1.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Mar | 4.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| May | 15.6 | | | 33% | 33% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | – |
| June | 19.0 | | | 67% | 67% | 67% | 67% | 100% | 100% | 100% | 100% | 100% | 100% | | – |
| July | 21.2 | | | 100% | 100% | 33% | 33% | 100% | – | 50% | 50% | 50% | 100% | | – |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | – | 100% | 50% | 50% | 50% | 100% | | – |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | | – |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Nov | 5.9 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Dec | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |



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In the simulation for each year, available facilities are dispatched to meet steam and hot water demands in accordance with a dispatching order stipulated in the currently effective Data Sheet. Loading is assumed in accordance with load duration curve characteristics defined for each month of the year. Load durations, measured in hours at each tenth percentile increment of peak demand, and cumulative MWH expressed as a percent of total production are developed from data representative of historical loading conditions in the respective months as summarized in Exhibit 8-8. Absolute requirements in terms of peak MW demands and total KWH of energy produced in each month are based on actual reported statistics.

The projected energy requirements of each commodity in the year 2010 and the assigned duty cycles for each of the then available facilities in meeting the respective loads are shown in Page 1, Exhibit 8-9. Initially indicated without regard to minimum restrictions, loadings are subsequently adjusted in recognition of individual unit criteria.

In Page 2 of Exhibit 8-9, service to meet steam and hot water loads is consolidated as cumulative outputs for individual facilities. Although electric outputs are summarized in subsequent exhibits, related thermal requirements for both back pressure and condensing turbines[1] are combined at this point to establish total thermal unit utilization expressed in megawatt hours (MWh) as illustrated graphically in Exhibit 8-10.

Finally, in Exhibit 8-9, energy requirements are restated in mmBTU's preparatory to the application of individual plant efficiencies in establishing gross energy inputs.

Based upon these data, fuel costs are developed in Exhibit 8-11 recognizing the specific fuel or fuels applicable for each operating unit. Unit prices indicated in this schedule are a weighted composite expressing the relative utilization of primary and secondary fuels. This exhibit serves further to demonstrate the manner and basis under which other variable expenses including emissions penalties are incorporated in total projected costs.

Average electrical output (in kW) for back pressure turbine/generators is shown in Exhibit 8-12 giving recognition to the level of flow through each extraction stage of the respective turbines measured relative to the level of flow necessary to attain maximum electrical output Output at reduced flow levels is interpolated linearly from data at 25% flow intervals for the respective turbine components included in the currently effective Facilities Data Sheet. The electrical output indicated for

1 It may be noted that steam turbines 4, 5 and 6 requirements are identified as "a", "b" or "c". This convention has been adopted to maintain the indentity of steam deliveries thorugh the extraction stage (a) and hot water through the exhaust (or secondary extraction stage) (b) of steam turbine generators. The subscript "c" identifies condensing units.



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# Exhibit 8-8

## Hot Water and Steam Load Simulation Criteria

TPS Sofia

| HOT WATER | Percentile (% of Peak) | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TEST YEAR PERIODS: | | | | | | | | | | | |
| | | Hot Water Hours at Percentile | | | | | | | | | | | |
| | 0 | 744 | 672 | 744 | 720 | 744 | 360 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 10 | 744 | 672 | 744 | 720 | 744 | 360 | 728 | 744 | 720 | 744 | 720 | 744 |
| | 20 | 744 | 672 | 744 | 720 | 744 | 360 | 712 | 744 | 720 | 744 | 720 | 744 |
| | 30 | 744 | 672 | 744 | 720 | 744 | 360 | 678 | 744 | 720 | 624 | 720 | 744 |
| | 40 | 744 | 672 | 732 | 700 | 744 | 353 | 636 | 744 | 720 | 408 | 720 | 744 |
| | 50 | 744 | 672 | 640 | 644 | 740 | 336 | 585 | 744 | 720 | 264 | 696 | 744 |
| | 60 | 696 | 672 | 528 | 588 | 576 | 312 | 520 | 730 | 678 | 186 | 576 | 720 |
| | 70 | 516 | 672 | 396 | 496 | 144 | 260 | 432 | 580 | 612 | 130 | 476 | 592 |
| | 80 | 336 | 552 | 248 | 312 | 72 | 108 | 288 | 312 | 480 | 84 | 312 | 456 |
| | 90 | 212 | 360 | 116 | 120 | 36 | 48 | 120 | 120 | 84 | 42 | 90 | 216 |
| | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Cumulative % of Total Hot Water MWH at Percentile | | | | | | | | | | | |
| | 0 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| | 10 | 12.80% | 11.29% | 14.28% | 13.46% | 15.09% | 13.42% | 14.26% | 12.61% | 12.13% | 20.59% | 13.62% | 12.43% |
| | 20 | 25.80% | 22.59% | 28.55% | 26.92% | 30.18% | 26.84% | 27.94% | 25.21% | 24.26% | 41.18% | 27.24% | 24.85% |
| | 30 | 38.40% | 33.88% | 42.83% | 40.38% | 45.27% | 40.26% | 41.61% | 37.82% | 36.39% | 60.46% | 40.87% | 37.28% |
| | 40 | 51.20% | 45.17% | 56.53% | 53.11% | 60.36% | 52.33% | 53.86% | 50.43% | 48.53% | 74.12% | 54.49% | 49.71% |
| | 50 | 62.98% | 56.46% | 66.92% | 65.28% | 74.70% | 64.41% | 65.13% | 63.03% | 60.66% | 84.81% | 67.39% | 62.14% |
| | 60 | 74.78% | 67.78% | 80.51% | 78.55% | 88.67% | 78.49% | 78.40% | 74.80% | 71.59% | 89.15% | 78.97% | 73.73% |
| | 70 | 86.16% | 79.05% | 89.05% | 86.63% | 96.63% | 87.52% | 86.86% | 85.90% | 82.34% | 93.49% | 88.16% | 84.13% |
| | 80 | 93.02% | 87.39% | 94.96% | 94.41% | 98.67% | 95.49% | 93.83% | 94.22% | 92.39% | 96.86% | 96.08% | 92.75% |
| | 90 | 97.04% | 96.08% | 99.01% | 98.39% | 99.52% | 98.97% | 97.71% | 98.39% | 98.96% | 99.34% | 98.68% | 98.41% |
| | 100 | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |
| Max Full Duty Load as % of Peak Load | | 54.0 | 71.5 | 39.0 | 37.0 | 49.1 | 30.0 | 17.1 | 57.9 | 51.0 | 25.0 | 49.0 | 58.5 |

| STEAM | Percentile (% of Peak) | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Steam Hours at Percentile | | | | | | | | | | | |
| | 0 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 10 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 20 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 30 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 40 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 50 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 60 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 70 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 80 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 90 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | 100 | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| | | Cumulative % of Total Steam MWH at Percentile | | | | | | | | | | | |
| | 0 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| | 10 | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% | 10.00% |
| | 20 | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% |
| | 30 | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% | 30.00% |
| | 40 | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% | 40.00% |
| | 50 | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% | 50.00% |
| | 60 | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% | 60.00% |
| | 70 | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% | 70.00% |
| | 80 | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% | 80.00% |
| | 90 | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% | 90.00% |
| | 100 | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |
| Max Full Duty Load as % of Peak Load | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

| BASE DATA | | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max Full Duty – Hot Water | MW | 310.4 | 350.0 | 180.1 | 102.2 | 75.4 | 31.7 | 21.8 | 59.2 | 54.8 | 62.4 | 219.2 | 232.3 |
| Max Full Duty – Steam | MW | 124.8 | 140.4 | 78.1 | 63.7 | 39.5 | 36.7 | 28.3 | 25.0 | 29.0 | 36.4 | 62.9 | 85.8 |
| Peak Load – Hot Water | MW | 574.7 | 469.7 | 461.9 | 275.9 | 153.6 | 105.7 | 127.7 | 102.2 | 107.1 | 249.5 | 447.1 | 398.8 |
| Peak Load – Steam | MW | 124.8 | 140.4 | 78.1 | 63.7 | 39.5 | 36.7 | 28.3 | 25.0 | 29.0 | 36.4 | 62.9 | 85.8 |
| MWH – Hot Water | MWh | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239167 |
| MWH – Steam | MWh | 92836 | 94341 | 58085 | 45688 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63644 |
| Electricity–KW | Avg KW | 20215 | 19805 | 13831 | 11632 | 9421 | 4821 | 7047 | 6008 | 9092 | 10027 | 15907 | 18207 |
| Monthly Thermal Capacity Factor | | 78.08% | 88.42% | 69.57% | 74.26% | 65.62% | 35.94% | 66.64% | 77.90% | 79.30% | 47.42% | 73.85% | 81.01% |



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# Exhibit 8-9

## Load Dispatch and Energy Use - Year 2010

TPS Sofia – Case S2

## (Page 1 of 2)

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 85556 | 87033 | 53664 | 42629 | 27705 | 25926 | 19405 | 16779 | 19019 | 24378 | 41269 | 58894 |
| Station Use, Losses, etc. | MWH | – | 7282 | 7308 | 4421 | 3059 | 1678 | 1965 | 1648 | 1855 | 1831 | 2668 | 4035 | 4950 |
| | | | 92838 | 94341 | 58085 | 45688 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | Average Loading – MW | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 166.700 | 1 | 6.6 | 22.3 | – | – | – | – | – | – | 29.0 | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Bir #9 | 159.000 | | 118.0 | 118.1 | 78.1 | 63.7 | 39.5 | 38.7 | 26.3 | 25.0 | – | 36.4 | 62.9 | 85.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5046 | 14998 | – | – | – | – | – | – | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Bir #9 | | | 87792 | 79342 | 58085 | 45688 | 29383 | 27891 | 21053 | 18634 | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45688 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 290369 | 249102 | 202460 | 117762 | 37406 | 12028 | 34221 | 30955 | 35821 | 62321 | 183229 | 272620 |
| Station Use, Losses, etc. | MWH | – | 43359 | 41906 | 36617 | 29762 | 37589 | 15321 | 29079 | 28296 | 25349 | 25695 | 54506 | –33433 |
| | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 464.000 | | 236.1 | 220.7 | 127.0 | 31.7 | – | – | – | – | – | 26.1 | 118.0 | 108.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Birs 4–5 | 35.190 | | 35.2 | 35.1 | 31.0 | 30.2 | – | – | – | – | – | 30.2 | 34.7 | 35.2 |
| Birs 5–6 | 35.190 | | 35.0 | 35.1 | 33.5 | 32.2 | 10.0 | 8.8 | 12.1 | – | 7.6 | 25.3 | 35.2 | 35.2 |
| Bir #9 | 41.000 | | 41.0 | 40.9 | 40.6 | 37.1 | 14.7 | 26.9 | 26.9 | 13.4 | – | 26.9 | 41.0 | 41.0 |
| Header | 101.300 | 1 | 101.3 | 101.2 | 100.6 | 100.3 | 94.2 | 23.5 | 84.5 | 71.3 | 84.5 | 88.4 | 101.3 | 101.3 |
| Total | | | 448.6 | 433.0 | 332.7 | 231.4 | 118.8 | 61.2 | 103.5 | 84.7 | 92.1 | 199.0 | 330.2 | 321.5 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | 175631 | 148298 | 88021 | 11593 | – | – | – | – | – | 1618 | 84987 | 80953 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Birs 4–5 | | | 26159 | 23608 | 23080 | 18562 | – | – | – | – | – | 3773 | 24955 | 26181 |
| Birs 5–6 | | | 26067 | 23608 | 24954 | 20445 | 265 | 595 | 1214 | – | 347 | 5290 | 25337 | 26181 |
| Bir #9 | | | 30504 | 27508 | 30192 | 26741 | 4681 | 9826 | 14073 | 6226 | – | 11529 | 29520 | 30504 |
| Header | | | 75367 | 67986 | 74850 | 72181 | 70049 | 16926 | 48013 | 53025 | 60824 | 65806 | 72936 | 75367 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |
| **ADJUSTED FOR MINIMUM LOADING – MWH** | | | | | | | | | | | | | | |
| Steam | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5046 | 14998 | – | – | – | – | – | – | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Bir #9 | | | 87792 | 79342 | 58085 | 45688 | 29383 | 27891 | 21053 | 18634 | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45688 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| Hot Water | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | 177392 | 148342 | 88880 | 18442 | – | – | – | – | – | 2675 | 89062 | 84203 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Birs 4–5 | | | 24402 | 23571 | 20454 | 9781 | – | – | – | – | – | 2555 | 20880 | 22931 |
| Birs 5–6 | | | 26063 | 23608 | 24954 | 20595 | 265 | 595 | 1214 | – | 347 | 5625 | 25337 | 26181 |
| Bir #9 | | | 30504 | 27517 | 30040 | 27389 | 6481 | 10366 | 14643 | 8534 | – | 11519 | 29520 | 30504 |
| Header | | | 75367 | 67970 | 74770 | 71316 | 66250 | 16367 | 47443 | 50717 | 60824 | 65443 | 72936 | 75367 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |



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# Exhibit 8-9

## Load Dispatch and Energy Use - Year 2010

## (Page 2 of 2)

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION - MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements - MWH | | | | | | | | | | | |
| | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - |
| HWB 3-6 | 177392 | 148342 | 88880 | 18442 | - | - | - | - | - | 2675 | 89082 | 84203 |
| Header | 5046 | 14998 | - | - | - | - | - | - | 20850 | - | - | - |
| Blrs 4-5 | 24402 | 23571 | 20454 | 9781 | - | - | - | - | - | 2555 | 20880 | 22931 |
| Blrs 5-6 | 26063 | 23608 | 24954 | 20595 | 285 | 595 | 1214 | - | 347 | 5825 | 25337 | 26181 |
| Blr #9 | 118296 | 108659 | 88125 | 73277 | 35843 | 38257 | 35697 | 27188 | - | 38564 | 74844 | 94348 |
| Header | 75367 | 67970 | 74770 | 71316 | 68250 | 16387 | 47443 | 50717 | 60824 | 65443 | 72936 | 75367 |
| Total | 426566 | 385348 | 297163 | 193411 | 104378 | 55239 | 84353 | 77885 | 82020 | 115062 | 283059 | 303031 |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES - MWH

| | Basis %g | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Thermal output represented in electric generation - MWHt | | | | | | | | | | | |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Turb 6a | 0.99 | 896 | 2668 | - | - | - | - | - | - | 3709 | - | - | - |
| Turb 4a | 0.97 | 8925 | 6621 | 7481 | 3577 | - | - | - | - | - | 934 | 7637 | 8367 |
| Turb 5a | 0.97 | 9532 | 8635 | 9127 | 7533 | 104 | 217 | 444 | - | 127 | 2057 | 9267 | 9576 |
| Turb 6 | 0.96 | 19077 | 17231 | 16223 | 13338 | 5612 | 6226 | 5580 | 3677 | - | 6220 | 13643 | 17450 |
| Turb 6b | 0.99 | 26206 | 23634 | 25999 | 24796 | 23731 | 5698 | 16497 | 17635 | 21150 | 22756 | 25361 | 26206 |
| Total | | 64638 | 60788 | 58830 | 49246 | 29448 | 12144 | 22520 | 21312 | 24985 | 31967 | 55907 | 61619 |

STEAM TO CONDENSING TURBINES AND REJECTION - MWH

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Incremental thermal output represented in electric generation and rejection - MWHt | | | | | | | | | | | |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| Turb 4c | | 7773 | 6204 | 9880 | 10126 | - | - | - | - | - | 2123 | 8981 | 8558 |
| Turb 5c | | 6887 | 6184 | 7478 | 6763 | 588 | 280 | - | - | 1094 | 2843 | 6903 | 6823 |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| Turb 6c | | 16982 | 12461 | 16754 | 16762 | 22590 | - | - | - | 19066 | 24241 | 17809 | 18402 |

UNIT UTILIZATION - TOTAL MWH

| Unit | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit Utilization MWH | | | | | | | | | | | |
| Boiler #8 | - | 40176 | 36288 | 40176 | 38880 | 40176 | - | 40176 | 40176 | 38880 | 40176 | 38880 | 40176 |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HWB 3-6 | - | 177392 | 148342 | 88880 | 18442 | - | - | - | - | - | 2675 | 89082 | 84203 |
| HRSG #2 | - | 34103 | 40082 | 29127 | 27396 | 24175 | - | - | 28176 | 38117 | 22044 | 28626 | 29580 |
| Blrs 4-5 | - | 41100 | 36396 | 37814 | 23484 | - | - | - | - | - | 5812 | 37499 | 39676 |
| Blrs 5-6 | - | 42462 | 38427 | 41559 | 34891 | 978 | 1072 | 1657 | - | 1568 | 10524 | 41207 | 42580 |
| Blr #9 | - | 137373 | 124090 | 104348 | 88615 | 41456 | 44485 | 41276 | 30845 | - | 44784 | 88486 | 111798 |
| HRSG #1 | - | 50220 | 45360 | 50220 | 48600 | 50220 | 22086 | 23763 | - | 48600 | 50220 | 48600 | 50220 |
| Total | | 522846 | 470985 | 392104 | 278308 | 157005 | 67843 | 106873 | 99198 | 127165 | 176235 | 372359 | 396433 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT - BOILERS ONLY

| | BTU/kW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Energy Input before Efficiency Adjustment - MMBTU | | | | | | | | | | | |
| Boiler #8 | 3.412 | 137081 | 123815 | 137081 | 132659 | 137081 | - | 137081 | 137081 | 132659 | 137081 | 132659 | 137081 |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| HWB 3-6 | 3.412 | 605260 | 506143 | 303190 | 62923 | - | - | - | - | - | 9808 | 303880 | 287300 |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| Blrs 4-5 | 3.412 | 140234 | 131006 | 129022 | 80126 | - | - | - | - | - | 19149 | 127945 | 136057 |
| Blrs 5-6 | 3.412 | 144948 | 131112 | 141799 | 119047 | 3337 | 3657 | 5655 | - | 5348 | 35909 | 140598 | 145285 |
| Blr #9 | 3.412 | 468716 | 423394 | 356036 | 295532 | 141447 | 151784 | 140835 | 105245 | - | 152803 | 301915 | 381455 |
| | | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | | 1498239 | 1315472 | 1067128 | 690286 | 281865 | 155441 | 283570 | 242325 | 138007 | 354750 | 1006997 | 1087177 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Efficiency | | | | | | | | | | | |
| Boiler #8 | - | - | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | - | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% |
| | | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HWB 3-6 | - | - | 84.5% | 84.5% | 84.5% | 84.5% | - | - | - | - | - | 84.5% | 84.5% | 84.5% |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Blrs 4-5 | - | - | 84.8% | 84.8% | 84.8% | 84.8% | - | - | - | - | - | 84.8% | 84.8% | 84.8% |
| Blrs 5-6 | - | - | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | - | 84.8% | 84.8% | 84.8% | 84.8% |
| Blr #9 | - | - | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | - | 84.4% | 84.4% | 84.4% |
| | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

INPUT ENERGY REQUIRED

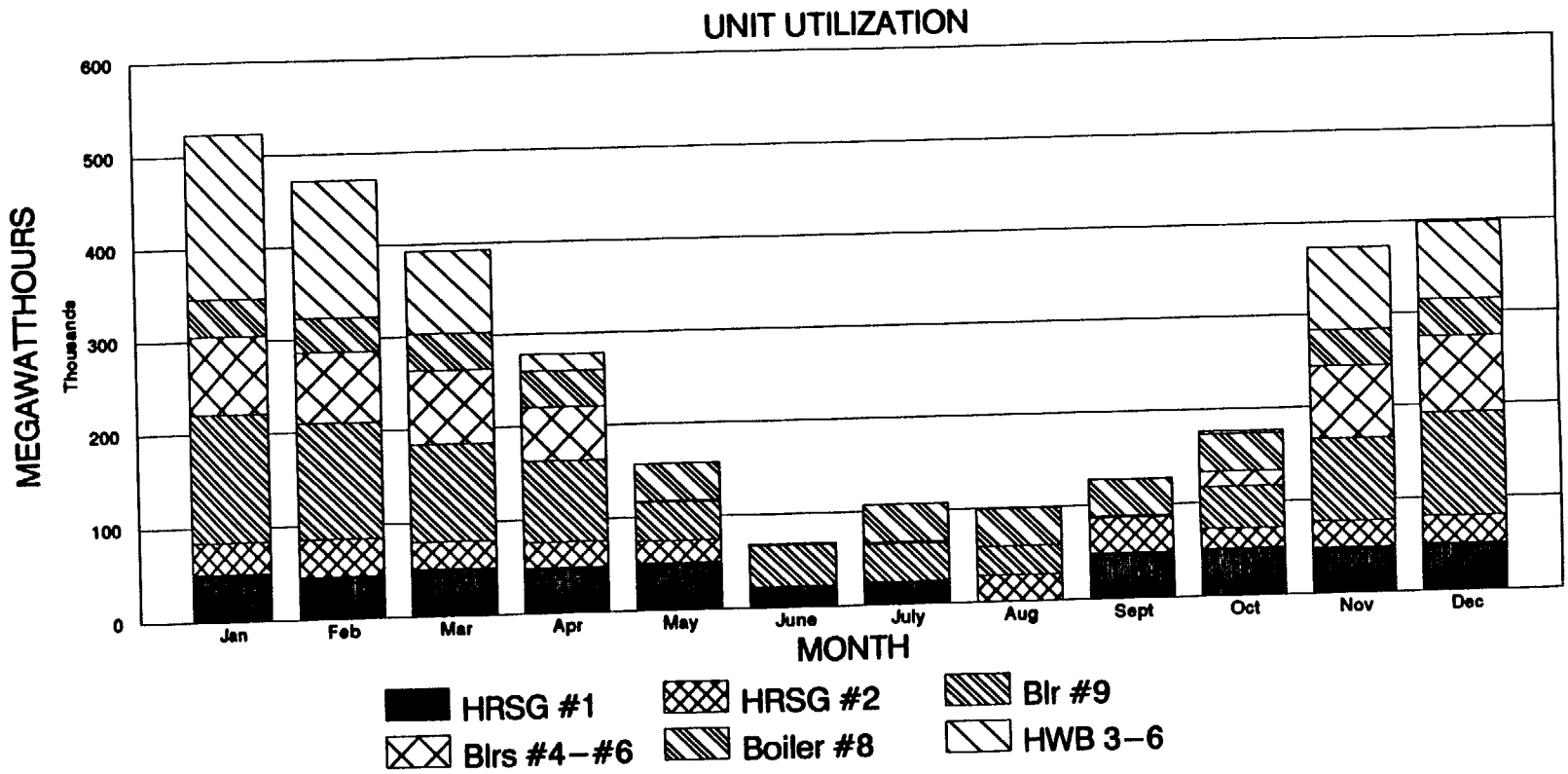
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit Energy Input MMBTU | | | | | | | | | | | | |
| Boiler #8 | - | 161747 | 146094 | 161747 | 156529 | 161747 | - | 161747 | 161747 | 156529 | 161747 | 156529 | 161747 |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HWB 3-6 | - | 716284 | 599866 | 358805 | 74485 | - | - | - | - | - | 11607 | 359621 | 340000 |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Blrs 4-5 | - | 165487 | 154562 | 152239 | 94546 | - | - | - | - | - | 22595 | 150966 | 160539 |
| Blrs 5-6 | - | 171031 | 154704 | 167314 | 140468 | 3937 | 4315 | 6673 | - | 6311 | 42371 | 165897 | 171427 |
| Blr #9 | - | 555351 | 501652 | 421844 | 350156 | 167592 | 179838 | 166866 | 124696 | - | 181046 | 357719 | 451961 |
| | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | | 1769880 | 1556018 | 1261949 | 816165 | 333276 | 184154 | 335286 | 286444 | 162840 | 419366 | 1190735 | 1285674 |



887

## Exhibit 8-10

### Unit Utilization for Thermal Loads - Case S2






488

# Exhibit 8-11

## Fuel Cost and Other O&M Expense - Year 2010

TPS Sofia – Case S2

FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Boiler #8 | $1.93 | 312 | 282 | 312 | 302 | 312 | – | 312 | 312 | 302 | 312 | 302 | 31 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | $1.93 | 1381 | 1155 | 692 | 144 | – | – | – | – | – | 22 | 694 | 6 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $1.93 | 319 | 298 | 294 | 182 | – | – | – | – | – | 44 | 291 | 31 |
| Blrs 5–6 | $1.93 | 330 | 298 | 323 | 271 | 8 | 8 | 13 | – | 12 | 82 | 320 | 3 |
| Blr #9 | $1.93 | 1071 | 967 | 814 | 675 | 323 | 347 | 322 | 240 | – | 349 | 690 | 8 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 3413 | 3001 | 2434 | 1574 | 643 | 355 | 647 | 552 | 314 | 809 | 2296 | 24 |

FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
| Boiler #8 | $0.12 | 19 | 18 | 19 | 19 | 19 | – | 19 | 19 | 19 | 19 | 19 | 1 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | $0.12 | 86 | 72 | 43 | 9 | – | – | – | – | – | 1 | 43 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $0.12 | 20 | 19 | 18 | 11 | – | – | – | – | – | 3 | 18 | 1 |
| Blrs 5–6 | $0.12 | 21 | 19 | 20 | 17 | 0 | 1 | 1 | – | 1 | 5 | 20 | |
| Blr #9 | $0.12 | 67 | 60 | 51 | 42 | 20 | 22 | 20 | 15 | – | 22 | 43 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 213 | 188 | 152 | 98 | 40 | 22 | 40 | 35 | 20 | 51 | 143 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | MWH | – | – | – | – | – | – | – | – | – | – | – | – | |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | – | – | – | – | – | – | – | – | – | – | – | – | |

Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Variable O&M Expense $(000) | | | | | | | | | | | |
| Boiler #8 | $0.03 | $0.75 | 36 | 33 | 36 | 35 | 36 | – | 34 | 34 | 36 | 36 | 35 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | $0.03 | $0.75 | 137 | 115 | 69 | 14 | – | – | – | – | – | 2 | 69 | |
| HRSG #2 | $0.03 | $0.75 | 31 | 37 | 26 | 24 | 22 | – | – | 24 | 36 | 20 | 25 | |
| Blrs 4–5 | $0.03 | $0.75 | 37 | 34 | 35 | 22 | – | – | – | – | – | 5 | 34 | |
| Blrs 5–6 | $0.03 | $0.75 | 38 | 34 | 37 | 31 | 1 | 1 | 1 | – | 2 | 10 | 37 | |
| Blr #9 | $0.03 | $0.75 | 140 | 126 | 104 | 86 | 43 | 45 | 40 | 31 | – | 45 | 87 | 11 |
| HRSG #1 | $0.03 | $0.75 | 45 | 41 | 45 | 43 | 45 | 19 | 20 | – | 45 | 45 | 43 | |
| Total | | – | 464 | 421 | 351 | 256 | 147 | 65 | 96 | 89 | 119 | 164 | 330 | 3 |

Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
| Boiler #8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By-Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions Penalties $(000) | | | | | | | | | | | |
| Boiler #8 | 0.0008 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 0.0008 | 1 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | |
| HRSG #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | |
| Blrs 5–6 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | |
| Blr #9 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | |
| HRSG #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |

Emissions by Type – Tons

| | Pounds per Tonne | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions – Tons | | | | | | | | | | | |
| Particulate | 2205 | 11.1 | 9.7 | 7.9 | 5.1 | 2.1 | 1.2 | 2.1 | 1.8 | 1.0 | 2.6 | 7.5 | 8 |
| $SO_x$ | 2205 | 155.0 | 136.3 | 110.5 | 71.5 | 29.2 | 16.1 | 29.4 | 25.1 | 14.3 | 36.7 | 104.3 | 112 |
| NOx | 2205 | 126.6 | 111.3 | 90.3 | 58.4 | 23.8 | 13.2 | 24.0 | 20.5 | 11.6 | 30.0 | 85.2 | 92 |
| CO | 2205 | 13.6 | 12.0 | 9.7 | 6.3 | 2.6 | 1.4 | 2.6 | 2.2 | 1.3 | 3.2 | 9.2 | 9 |



889

# Exhibit 8-12

## Electrical Generation, Net Power Interchange and Gas Turbine Fuel Cost

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITs | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 1189 | 3912 | – | – | – | – | – | – | 5076 | – | – | – |
| Turb 4a | 11684 | 12496 | 9794 | 6346 | – | – | – | – | – | 7296 | 10331 | 10980 |
| Turb 5a | 12479 | 12515 | 11948 | 11551 | 3636 | 3128 | 4303 | – | 2698 | 9583 | 12536 | 12536 |
| Turb 8 | 25000 | 25000 | 21260 | 18082 | 7355 | 8434 | 7312 | 4819 | – | 8151 | 18474 | 22868 |
| Turb 6b | 34713 | 34660 | 34438 | 33942 | 31435 | 7800 | 21852 | 23360 | 28948 | 30142 | 34713 | 34713 |
| Total T/G Output | 85065 | 88582 | 77440 | 69901 | 42626 | 19361 | 33467 | 28178 | 36722 | 55172 | 76054 | 81096 |
| Balance Required | –64850 | –68777 | –63609 | –58089 | –33205 | –14540 | –26420 | –20170 | –27631 | –45145 | –60147 | –62889 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 97.4% | 3663 | 3237 | 4856 | 6467 | – | – | – | – | – | 5968 | 4374 | 4033 |
| Turb 5c | 97.4% | 3246 | 3227 | 3525 | 3733 | 7785 | 1345 | – | – | 8383 | 4767 | 3216 | 3216 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 98.6% | 8039 | 6531 | 8678 | 9178 | 10694 | – | – | – | 9327 | 11478 | 8712 | 8712 |
| Total Condens Turb Output | | 14948 | 12995 | 17059 | 19378 | 18479 | 1345 | – | – | 17710 | 22211 | 16302 | 15961 |
| Balance Required | | –79798 | –81772 | –80868 | –77448 | –51685 | –15885 | –26420 | –20170 | –45341 | –67356 | –76449 | –78850 |
| GT Capability @ Full Load | | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | – | 37266 | 37266 | 37266 | 37266 | 37266 |
| GT–LM6000 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | – | 37266 | 37266 | 37266 | 37266 |
| Total GT Output (KW) | 74532 | 74532 | 74532 | 74532 | 74532 | 74532 | 37266 | 37266 | 74532 | 74532 | 74532 | 74532 |
| Balance Required (KW) | –154330 | –156304 | –155200 | –151960 | –126217 | –90417 | –63686 | –57436 | –119673 | –141888 | –150961 | –153382 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –114822 | –105037 | –115489 | –105938 | –85567 | –62183 | –44813 | –42733 | –52005 | –89675 | –108706 | –114116 |
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| POWER SALES | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 2990.2 | 2735.4 | 3007.0 | 2391.0 | 1931.2 | 1403.5 | 1008.9 | 964.5 | 1173.8 | 2335.3 | 2830.9 | 2971.8 |

GAS TURBINE
Percent Load

| | Percent Load | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| GT–LM6000 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% | 100.0% |

Interpolated Fuel Flow – MMBTU

| | Fuel Flow – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 254106 | 229515 | 254106 | 245909 | 254106 | 245909 | – | 254106 | 245909 | 254106 | 245909 | 254106 |
| GT–LM6000 | 254106 | 229515 | 254106 | 245909 | 254106 | 245909 | 254106 | – | 245909 | 254106 | 245909 | 254106 |
| Total | 508212 | 459030 | 508212 | 491818 | 508212 | 491818 | 254106 | 254106 | 491818 | 508212 | 491818 | 508212 |

Fuel Cost – Gas Turbine(s) (Gas) $(000)

| | Unit Cost | Fuel Cost – Gas $(000) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | $2.03 | 515.8 | 465.9 | 515.8 | 499.2 | 515.8 | 499.2 | – | 515.8 | 499.2 | 515.8 | 499.2 | 515.8 | |
| GT–LM6000 | $2.03 | 515.8 | 465.9 | 515.8 | 499.2 | 515.8 | 499.2 | 515.8 | – | 499.2 | 515.8 | 499.2 | 515.8 | |
| Total | | 1031.7 | 931.8 | 1031.7 | 998.4 | 1031.7 | 998.4 | 515.8 | 515.8 | 998.4 | 1031.7 | 998.4 | 1031.7 | |

condensing turbines (Stage C) is established based on formulae taking into account total capabilities and the steam flows and electrical production previously established in connection with extraction stages of the respective turbines. Since, in the sample case, two Type LM6000 Gas Turbines have been introduced, substantial increments of electrical output are available from this source as further indicated in Exhibit 8-12 and Exhibit 8-13.

Although regulated by the thermal requirements of the HRSG's served from gas turbine exhausts, the dispatching priority assigned to this source dictates that the gas turbines are fully utilized whenever available for duty.

To the extent that total electrical generation exceeds internal system requirements, it is a basic assumption of this analysis that a ready market exists for sales to the local network. As further shown in Exhibit 8-12, in the sample case, substantial excess electrical generation (represented as negative requirements) results in all months. Revenues from external sales are credited to Case S2 in aggregate amounts developed by applying the appropriate seasonal price to the level of excess generation represented in the respective months.

The availability and utilization of gas turbine exhaust heat in each simulation month is detailed in Exhibit 8-14. Although the simulation model provides for recognition of alternative operating characteristics on account of variations in ambient temperature throughout the year, the LM6000 gas turbine represented in the sample case is configured to compensate for such effects with the result that outputs are maintained at constant levels under all conditions. (The effect of such variations may be seen in Case S3 where a Type 6FA gas turbine is included.).

Utilized HRSG energy in thermal MW as reflected in Exhibit 8-14 is the average requirement developed by dividing dispatched MWH (see Unit Utilization in Page 2 of Exhibit 8-9) by the number of hours of HRSG service in the respective simulation months. Where this requirement exceeds energy directly available from gas turbine exhaust heat, incremental energy from duct burner firing is induced. Recognition of the additional fuel costs associated with such supplementary firing is also included in Exhibit 8-14

In the manner described above, available facilities were hypothetically dispatched to meet projected load requirements in each analysis year 1994 through 2010. For each year, fuel costs, other variable operating expenses and revenues (expense credits) for sales of electricity were developed, but at this stage, always in terms of base year (1993) dollars. Exhibit 8-15, which also characterizes the facilities in place in year 2010, provides a summary of net operating expenses on this basis by time periods for that year. However, maintenance expenses are not included at this point.

For economic analysis purposes, annual expenses determined in the manner described above are adjusted only for estimated real escalation in the summary of projected operating and capital expenditures shown for Case S2 in Exhibit 8-16. In addition to those expenses detailed through the discussion of the preceding model outputs, maintenance expenses are included in this summary on the basis of the maintenance schedule previously referenced in connection with the list of assumptions set forth above, but only to the extent that specific facilities are among those available for any specific case in any projection year.



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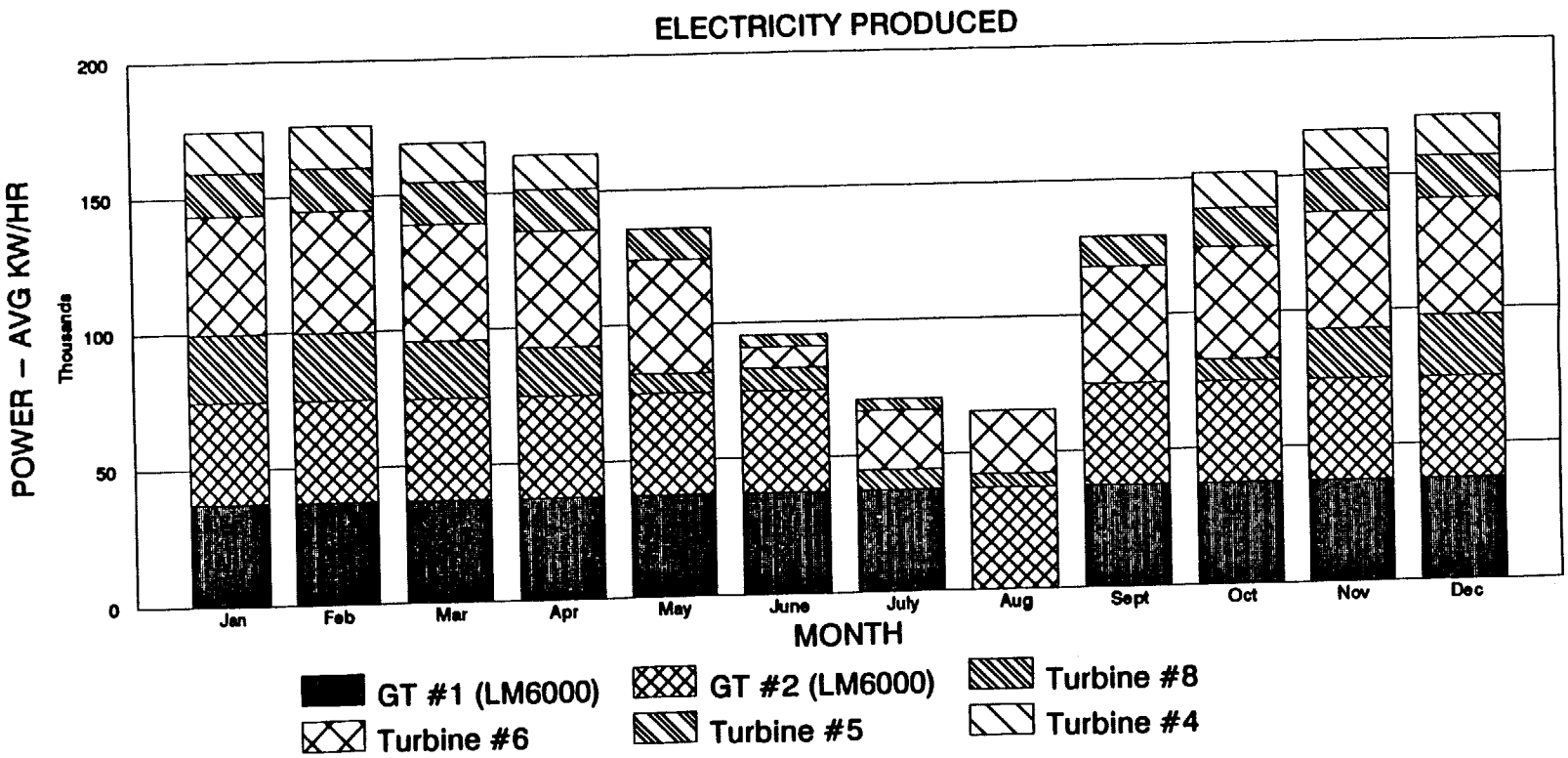
## Exhibit 8-13

## Electrical Generation by Source



# Exhibit 8-14

## Gas Turbine Exhaust Heat Utilization and Supplementary Firing

GAS TURBINE

Interpolated Exhaust Temperature °F

| | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | Oct | WINTER Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Exhaust Temperature °F | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 880 | 880 | 880 | 880 | 880 | 880 | – | 880 | 880 | 880 | 880 | 880 |
| GT–LM6000 | 880 | 880 | 880 | 880 | 880 | 880 | 880 | – | 880 | 880 | 880 | 880 |

Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | – | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 |
| GT–LM6000 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | – | 956.2 | 956.2 | 956.2 | 956.2 |

Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | – | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 |
| GT–LM6000 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | – | 156.618 | 156.618 | 156.618 | 156.618 |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 3.412 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | – | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 |
| HRSG #1 | 3.412 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | – | 45.902 | 45.902 | 45.902 | 45.902 |
| | | 91.804 | 91.804 | 91.804 | 91.804 | 91.804 | 91.804 | 45.902 | 45.902 | 91.804 | 91.804 | 91.804 | 91.804 |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | – | – | – | – | – | – | – | – | 28.636 | 5.324 | 15.454 | 15.454 |
| HRSG #1 | 21.533 | 35.342 | 14.844 | 13.745 | 6.189 | – | – | – | 28.636 | 5.324 | 15.454 | 15.454 |
| | 21.533 | 35.342 | 14.844 | 13.745 | 6.189 | – | – | – | 28.636 | 5.324 | 15.454 | 15.454 |

Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 45.6 | 59.6 | 39.1 | 38.0 | 32.5 | – | – | 37.9 | 52.9 | 29.6 | 39.6 | 39.6 |
| HRSG #1 | 67.5 | 67.5 | 67.5 | 67.5 | 67.5 | 30.7 | 31.9 | – | 67.5 | 67.5 | 67.5 | 67.5 |
| | 113.3 | 127.1 | 106.6 | 105.5 | 100.0 | 30.7 | 31.9 | 37.9 | 120.4 | 97.1 | 107.3 | 107.3 |
| Electric Output Ratio | 39.7% | 37.0% | 41.1% | 41.4% | 42.7% | 70.8% | 53.6% | 49.6% | 38.2% | 43.4% | 41.0% | 41.0% |
| Utilized Heat Ratio | 60.3% | 63.0% | 58.9% | 58.6% | 57.3% | 29.2% | 46.2% | 50.4% | 61.8% | 56.6% | 59.0% | 59.0% |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 27.3 | 23.7 | 31.1 | 35.4 | 36.8 | 15.0 | 27.9 | 55.9 | 60.3 | 40.5 | 29.7 | 29.1 |
| From Gas Turbines | 200.000 | – | – | – | – | – | 61.1 | 14.0 | 8.0 | – | – | – | – |
| Total | | 27.3 | 23.7 | 31.1 | 35.4 | 36.8 | 76.1 | 41.9 | 63.9 | 60.3 | 40.5 | 29.7 | 29.1 |

Supplementary Firing Energy Input = MMBTU

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | | – | – | – | – | – | – | – | – | 70349 | 13516 | 37964 | 39229 |
| HRSG #1 | | 54662 | 61035 | 37883 | 33767 | 20767 | – | – | – | | | | |

Supplementary Firing Fuel Cost (Gas)

| | Unit Cost $/MMBTU | Supplementary Firing Fuel Cost $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 2.03 | – | – | – | – | – | – | – | – | 143 | 27 | 77 | 80 |
| HRSG #1 | 2.03 | 111 | 165 | 76 | 69 | 42 | – | – | – | 143 | 27 | 77 | 80 |
| Total | | 111 | 165 | 76 | 69 | 42 | – | – | – | | | | |



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# Exhibit 8-15

## Facilities Data Sheet and Simulated Results - Year 2010

CASE B2 — Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EXISTING FACILITIES | | | | | | | | | | | | | | |
| | | | | Brs 4-5 | | Brs 5-6 | | Boiler #8 | HRSG #1 | HRSG #2 | | | | Br #9 | Br #3 | HWB 3-6 |
| THERMAL DATA | | | | | | | | | | | | | | | | |
| Efficiency - 80% to Full Load | %1 | | | 84.6% | | 84.6% | | 84.6% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Half Load | %2 | | | 84.6% | | 84.6% | | 84.6% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Load | %3 | | | 84.6% | | 84.6% | | 84.6% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Operation | % | | | 13.3% | | 13.3% | | 40.0% | 20.0% | 20.0% | | | | 40.0% | 40.0% | 10.0% |
| Feedwater Temp | | | | 419° | | 419° | | 419° | | | | | | 436° | 212° | 158° |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | 8 | 1 | 5 | | | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | 135.000 | 67.500 | 67.500 | | | | | | |
| Quantity | Mlb/Hr | | | 485.1 | 52.292 | 485.1 | 52.292 | 485.1 | | | | | 142 | 485.1 | | |
| Pressure | PSIA | | | 1451 | - | 1451 | - | 1451 | | | | | 116.751 | 1451 | | |
| Temperature | Temp °F | | | 860° | 12.333 | 860° | 12.333 | 1004° | | | | | 36.906 | 1004° | | |
| Enthalpy | MBTU/lb | | | 1.456 | 48.685 | 1.456 | 48.685 | 1.496 | | | | | 115.342 | 1.496 | | |
| PRODUCT - LP STEAM | Priority | * | | | | | | | | | 5 | | | 2 | | |
| Quantity | Mlb/Hr | | | | | | | | | | 507.15 | | | 430.000 | 132.300 | |
| | MWts | | | | | | | | | | 166.700 | | | 169.000 | 53.000 | |
| Pressure | PSIA | | | | | | | | | | 185 | | | 142.25 | 363 | |
| Temperature | Temp °F | | | | | | | | | | 559.4° | | | - | 770° | |
| Enthalpy | MBTU/lb | | | | | | | | | | 1.302 | | | 1.296 | 1.403 | |
| PRODUCT - HOT WATER | Priority | | Cooling | 4 | | 3 | | | | | | 1 | | 2 | | 6 |
| Quantity | MWtw | | 200.000 | 35.190 | | 35.190 | | | | | | 101.300 | | 41.000 | | 464.000 |
| Temperature - Supply | Temp °F | | | 240° | | 240° | | | | | | 240° | | 240° | | 302° |
| Return | Temp °F | | | 140° | | 140° | | | | | | 140° | | 140° | | 158° |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | GT-LM6000 | GT-LM6000 | Turb 8a | Turb 8b | Turb 8c | Turb 8 | | |
| | Priority | | | | | | | | 1 | 2 | | | | | | |
| Rated Capacity - Electric | KW | | | | 25000 | | 25000 | | | | | | 55000 | 25000 | | |
| Capability - Max Steam | KW1 | | | 12540 | 19000 | 12540 | 19000 | | | | 29227 | 34727 | 50000 | 25000 | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | | 21920 | 26046 | | 16375 | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | | 14613 | 17364 | | 11875 | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | | 7307 | 8682 | | 4375 | | |
| Steam Required - Maximum | M#/Hr Max | | | 114.660 | | 114.660 | | | | | 507.150 | 352.800 | | 480.640 | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | 192.290 | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | | 185 | 22.76 | | 142.2 | | |
| Enthalpy Drop - Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | | 0.1849 | 0.307 | | 0.228 | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | | 1.1218 | 0.9801 | | 0.9790 | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | | 98.6% | 98.6% | 98.6% | 97.5% | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | | 0.367 | | | |
| FUELS DATA | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | Gas | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | 100.0% | 100.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | | | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 740 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $298.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | - | | | | | | | | | | | | | | |
| Emissions Code - Fuel 1 | CODEe1 | | | ST2-A9 | | ST2-A9 | | ST2-A9 | GT-LM6 | GT-LM6 | | | | ST2-A9 | | ST2-A9 |
| Emissions Code - Fuel 2 | CODEe2 | | | ST2-A6 | | ST2-A6 | | ST2-A6 | | | | | | ST2-A6 | | ST2-A6 |
| Scheduled Maintenance | CODE m | | | SB4 | ST4 | SB5 | ST5 | SB8 | GT-LM6 | HRSG | | ST6 | | SB8T8 | | 6HWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | |
| Energy Charge - Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | Max GT? | | AVAILABILITY | | | | | | | | | | | | USS |
| Jan | -1.7 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Feb | 0.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Mar | 4.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Apr | 10.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | - |
| May | 15.8 | Yes | | 33% | 33% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | - |
| June | 19.0 | Yes | | 67% | 67% | 67% | 67% | - | 100% | 100% | 50% | 50% | 50% | 100% | | - |
| July | 21.2 | Yes | | 100% | 100% | 33% | 33% | 100% | 100% | - | 75% | 75% | 75% | 100% | | - |
| Aug | 20.8 | Yes | | 100% | 100% | 100% | 100% | 100% | - | 100% | 75% | 75% | 75% | 100% | | - |
| Sept | 16.7 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | - | | - |
| Oct | 11.3 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Nov | 5.9 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Dec | 0.8 | Yes | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4.556 | 4.097 | 3.542 | 2.641 | 1.717 | 1.354 | 1.162 | 1.066 | 1.456 | 1.868 | 3.372 | 3.581 | 30.422 |
| Oil | 213 | 198 | 152 | 96 | 40 | 22 | 40 | 36 | 20 | 51 | 143 | 156 | 1.167 |
| Lignite | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Black Coal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Fuel Cost | 4.769 | 4.295 | 3.694 | 2.738 | 1.757 | 1.376 | 1.203 | 1.103 | 1.475 | 1.918 | 3.515 | 3.746 | 31.578 |
| Supplemental Cost - Shortfall Penalty | | - | | | - | - | - | - | - | - | - | - | - |
| Purchased Power Cost | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for Power Sales | (2.990) | (2.736) | (3.007) | (2.391) | (1.831) | (1.403) | (1.007) | (964) | (1.174) | (2.336) | (2.831) | (2.972) | (25.742) |
| Net Power Interchange Cost | (2.990) | (2.736) | (3.007) | (2.391) | (1.831) | (1.403) | (1.007) | (964) | (1.174) | (2.336) | (2.831) | (2.972) | (25.742) |
| Other O&M - Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2.516 |
| Variable | 464 | 421 | 361 | 256 | 147 | 85 | 96 | 89 | 119 | 164 | 330 | 354 | 2.883 |
| Limestone Injection & Ash Removal | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Credit for By-Product Sales | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Emissions Penalties | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |
| Total Excluding Maintenance | 2.458 | 2.185 | 1.253 | 812 | 167 | 244 | 508 | 442 | 627 | (39) | 1.223 | 1.347 | 11.226 |



BEST AVAILABLE COPY

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# Exhibit 8-16

## Projected Operating and Capital Expenditures

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,428 | 38,549 | 53,925 | 62,187 | 63,704 | 65,322 | 64,669 | 64,022 | 63,382 | 62,661 | 62,034 | 62,034 | 62,034 | 62,034 | 62,034 | 62,034 |
| Oil | 1,678 | 1,787 | 1,906 | 1,446 | 1,484 | 1,520 | 1,560 | 1,544 | 1,528 | 1,513 | 1,494 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,215 | 40,455 | 55,371 | 63,670 | 65,224 | 66,882 | 66,213 | 65,551 | 64,895 | 64,155 | 63,513 | 63,513 | 63,513 | 63,513 | 63,513 | 63,513 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,783) | (14,701) | (32,047) | (32,886) | (33,748) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) |
| Net Power Interchange | (12,923) | (13,783) | (14,701) | (32,047) | (32,886) | (33,748) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,917 | 2,917 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 3,345 | 3,882 | 3,461 | 4,241 | 3,868 | 4,416 | 4,511 | 3,447 | 4,332 | 3,778 | 4,326 | 5,005 | 4,227 | 5,092 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,142 | 33,345 | 32,058 | 40,054 | 40,326 | 41,876 | 40,834 | 40,719 | 40,158 | 38,354 | 38,597 | 38,043 | 38,591 | 39,270 | 38,492 | 39,357 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 19403 | 46312 | 32497 | 16027 | 29981 | 12466 | 4050 | 4050 | 4050 | 16593 | – | – | – | – | – | – | – |
| Domestic | 1058 | 3676 | 4773 | 3444 | 4106 | 2412 | 1174 | 1174 | 1174 | 1681 | – | – | – | – | – | – | – |
| Total | 20460 | 49987 | 37269 | 19470 | 34086 | 14877 | 5224 | 5224 | 5224 | 18275 | – | – | – | – | – | – | – |
| TOTAL COST | 45,400 | 79,129 | 70,615 | 51,528 | 74,140 | 55,203 | 47,100 | 46,058 | 45,943 | 58,433 | 38,354 | 38,597 | 38,043 | 38,591 | 39,270 | 38,492 | 39,357 |
| Present Worth | 43,686 | 70,502 | 58,255 | 39,360 | 52,438 | 36,152 | 28,561 | 25,860 | 23,885 | 28,128 | 17,095 | 15,929 | 14,537 | 13,654 | 12,865 | 11,676 | 11,054 |
| Cumulative Present Worth | 43,686 | 114,188 | 172,443 | 211,803 | 264,242 | 300,393 | 328,954 | 354,814 | 378,698 | 406,826 | 423,921 | 439,850 | 454,387 | 468,041 | 480,907 | 492,583 | 503,637 |
| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 |
| Electricity | 595,117 | 595,117 | 595,117 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $18.44 | $21.04 | $21.55 | $22.07 | $21.86 | $21.65 | $21.45 | $21.19 | $20.99 | $20.99 | $20.99 | $20.99 | $20.99 | $20.99 |
| Hot Water | $10.41 | $11.81 | $13.44 | $18.42 | $21.05 | $21.54 | $22.06 | $21.85 | $21.64 | $21.43 | $21.20 | $21.00 | $21.00 | $21.00 | $21.00 | $21.00 | $21.00 |
| Electricity | $14.28 | $16.18 | $18.40 | $12.09 | $13.82 | $14.14 | $14.48 | $14.34 | $14.20 | $14.07 | $13.92 | $13.79 | $13.79 | $13.79 | $13.79 | $13.79 | $13.79 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 82 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| $SO_2$ | 1,144 | 1,142 | 1,142 | 844 | 844 | 843 | 843 | 843 | 843 | 843 | 841 | 841 | 841 | 841 | 841 | 841 | 841 |
| NOx | 934 | 932 | 932 | 689 | 689 | 688 | 688 | 688 | 688 | 688 | 687 | 687 | 687 | 687 | 687 | 687 | 687 |
| CO | 100 | 100 | 100 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 |

Estimated capital expenditures assumed in connection with modifications of existing facilities or the installation of new facilities are shown in the year incurred. Finally, in Exhibit 8-16 the present worth of annual expenditures is established applying a real discount rate of 8% under the convention of average expenditures occurring at mid-year. The cumulative present worth of such annual costs is then considered the primary figure of merit in the evaluation of proposed alternative system configurations.

Exhibit 8-16 also develops data further indicative of operating consequences under the example case. Total production of each commodity, while generally dictated by demands in the case of steam and hot water, is useful in demonstrating the level of electrical production, and, in isolated cases, of shortfalls occurring primarily in the production of hot water. Unit costs represented in connection with the production of each commodity are developed from a detailed recapitulation of each facility's utilization and may be useful in further comparison of variants or for other purposes. It should be noted, however, that while these costs include fuel and other variable expenses, they do not include maintenance costs, personnel and general plant costs or capital expenditures each of which would require some allocation basis and could be subject to considerable variation from year to year.

Simulation model outputs similar to those discussed above are included for each analysis case in the Appendix to this report. For reference purposes, case descriptions are included as Exhibit 8-17.

## 8.4 ANALYSIS RESULTS

Total projected operating and capital expenditures resulting from model simulations performed under circumstances representative of each alternative case analyzed are summarized by major cost elements in Exhibit 8-18.

The cumulative present worth of these costs and that of cost savings represented in alternative cases in each operating region are detailed in Exhibit 8-19, shown graphically in Exhibit 8-20 and summarized below:

| Plant and Case | Present Worth of Total Cost | | | Present Worth of Cost Savings as Compared to Area Base Case | | |
|---|---|---|---|---|---|---|
| | Capital Requirement | Operating Expenses | Total Expenditure $ | Capital Requirement | Operation Expenses | Total Expenditure $ |
| | US $(000) | US $(000) | US $(000) | US $(000) | US $(000) | US $(000) |
| Sofia | | | | | | |
| S1 (Base) | 115,769 | 383,927 | 499,695 | | | |
| S2 | 161,309 | 342,328 | 503,637 | (45,541) | 41,598 | (3,942) |
| S3 | 165,980 | 344,629 | 510,608 | (50,212) | 39,298 | (10,913) |
| Tr Kostov | | | | | | |
| L1 (Base) | 162,549 | 542,885 | 705,434 | | | |
| L2 | 213,784 | 508,347 | 722,132 | (51,236) | 34,538 | (16,698) |
| Liulin | | | | | | |
| L1 (Base) | 59,456 | 208,519 | 267,974 | | | |
| L2 | 110,117 | 163,732 | 273,848 | (50,661) | 44,787 | (5,874) |
| Pernik (Republika) | | | | | | |
| P1 (Base) | 155,529 | 122,408 | 277,936 | | | |
| P2 | 143,546 | 117,396 | 260,942 | 11,983 | 5,011 | 16,994 |



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## Exhibit 8-17

## Economic Analysis Case Studies

| CASE | DESCRIPTION | GAS TURBINE | REPLACE | COMMENTS |
|---|---|---|---|---|
| S1 | Existing Plant with Boiler, Steam Turbine, Distribution System and I&C Upgrades. | | | |
| S2 | As S1, except 2–LM6000 Gas Turbines and HRSG's replacing Boiler #7. | 2 x LM6000 | Boiler #7 | Use existing Steam Turbines only |
| S3 | As S1, with a Type 6FA Gas Turbine and HRSG with new Steam Turbine; retire one hot water boiler. | 1 x 6FA | HWB #3 | Add Combined Cycle |
| K1 | Existing Plant with Boiler, Steam Turbine, Distribution System and I&C Upgrades. | | | |
| K2 | As K1 with new combined cycle unit replacing one hot water boiler. | 1 x 6FA | HWB #8 | Add Combined Cycle |
| L1 | Existing Plant with Boiler, Steam Turbine, Distribution System and I&C Upgrades. | | | |
| L2 | As L1 with new combined cycle unit replacing one hot water boiler. | 1 x 6FA | HWB #1 | Add Combined Cycle |
| P1 | Existing Plant with Boiler, Steam Turbine, Distribution System and I&C Upgrades. | | | |
| P3 | As P1 with 2–CFB replacing Boilers #1 & #2; Install Boiler #6 to replace Boiler #3 | | | |

# Exhibit 8-18

## Summary of Costs

CUMULATIVE COST 1994 – 2010 $(000)

| CASE | Capital & Removal Costs | FUEL COST | | | | | Net Power Interchange | Fixed & Variable Expenses | Sorbent, Ash Removal & Penalties | Maintenance | Total Operating Expenses | Total Capital & Operating Expenses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Gas | Oil | Lignite | Black Coal | Total | | | | | | |
| S1 (Base) | 159,064 | 819,128 | 33,710 | – | – | 852,838 | (267,191) | 92,403 | 182 | 41,942 | 720,174 | 879,238 |
| S2 | 210,097 | 973,089 | 26,329 | – | – | 999,418 | (521,080) | 91,634 | 143 | 64,045 | 634,158 | 844,255 |
| S3 | 223,992 | 1,016,907 | 28,631 | – | – | 1,045,538 | (572,045) | 98,523 | 155 | 58,545 | 630,716 | 854,708 |
| K1 (Base) | 222,488 | 1,515,668 | 62,373 | – | – | 1,578,041 | (805,864) | 132,198 | 336 | 121,256 | 1,025,967 | 1,248,455 |
| K2 | 287,880 | 1,704,304 | 56,936 | – | – | 1,761,240 | (1,079,649) | 137,690 | 307 | 127,563 | 947,151 | 1,235,032 |
| L1 (Base) | 84,517 | 300,380 | 12,362 | – | – | 312,742 | 17,575 | 29,023 | 67 | 28,963 | 388,370 | 472,887 |
| L2 | 149,300 | 517,637 | 8,091 | – | – | 525,728 | (319,868) | 36,587 | 44 | 43,763 | 286,254 | 435,554 |
| P1 (Base) | 179,903 | – | – | 4,929 | 239,173 | 244,101 | (162,752) | 107,365 | 2,607 | 33,309 | 224,630 | 404,533 |
| P3 | 204,776 | – | – | 111,694 | 103,182 | 214,875 | (158,418) | 106,603 | 18,550 | 31,215 | 212,825 | 417,601 |

# Exhibit 8-19

## Summary of Economic Analysis Results

CUMULATIVE PRESENT WORTH $(000)

| CASE | Capital & Removal Costs | FUEL COST | | | | | Net Power Interchange | Fixed & Variable Expenses | Sorbent, Ash Removal & Penalties | Maintenance | Total Operating Expenses | Total Capital & Operating Expenses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Gas | Oil | Lignite | Black Coal | Total | | | | | | |
| S1 (Base) | 115,768 | 437,363 | 18,566 | – | – | 455,930 | (145,939) | 51,525 | 101 | 22,309 | 383,927 | 499,695 |
| S2 | 161,309 | 511,878 | 14,975 | – | – | 526,853 | (268,615) | 51,152 | 82 | 32,856 | 342,328 | 503,637 |
| S3 | 165,980 | 525,548 | 16,300 | – | – | 541,848 | (281,211) | 54,244 | 89 | 29,658 | 344,629 | 510,608 |
| K1 (Base) | 182,549 | 809,116 | 34,347 | – | – | 843,463 | (440,161) | 73,716 | 187 | 65,680 | 542,885 | 705,434 |
| K2 | 213,764 | 893,236 | 31,922 | – | – | 925,158 | (561,647) | 76,155 | 175 | 68,508 | 508,347 | 722,132 |
| L1 (Base) | 59,456 | 160,434 | 6,811 | – | – | 167,245 | 9,599 | 16,184 | 37 | 15,454 | 208,519 | 267,974 |
| L2 | 110,117 | 257,375 | 4,908 | – | – | 262,283 | (140,133) | 19,543 | 27 | 22,012 | 163,732 | 273,848 |
| P1 (Base) | 155,529 | – | – | 4,743 | 126,154 | 130,897 | (88,895) | 59,869 | 2,285 | 18,252 | 122,406 | 277,936 |
| P3 | 143,546 | – | – | 48,378 | 69,826 | 118,203 | (86,332) | 59,424 | 8,799 | 17,303 | 117,396 | 260,942 |

PRESENT WORTH COST SAVINGS $(000) (Versus Base Case)

| CASE | Capital & Removal Costs | FUEL COST | | | | | Net Power Interchange | Fixed & Variable Expenses | Sorbent, Ash Removal & Penalties | Maintenance | Total Operating Expenses | Total Capital & Operating Expenses | Internal Rate of Return |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Gas | Oil | Lignite | Black Coal | Total | | | | | | | |
| S1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | (1) BASE |
| S2 | (45,541) | (74,514) | 3,591 | – | – | (70,923) | 122,676 | 374 | 19 | (10,547) | 41,598 | (3,942) | 6.69% |
| S3 | (50,212) | (88,185) | 2,266 | – | – | (85,919) | 135,272 | (2,718) | 12 | (7,349) | 39,298 | (10,913) | 4.35% |
| K1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| K2 | (51,236) | (84,121) | 2,425 | – | – | (81,695) | 121,466 | (2,440) | 13 | (2,826) | 34,538 | (16,698) | 2.40% |
| L1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| L2 | (50,661) | (96,941) | 1,903 | – | – | (95,038) | 149,733 | (3,360) | 10 | (6,558) | 44,787 | (5,874) | 6.16% |
| P1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| P3 | 11,983 | – | – | (43,635) | 56,329 | 12,694 | (2,563) | 445 | (6,514) | 949 | 5,011 | 18,994 | NA |



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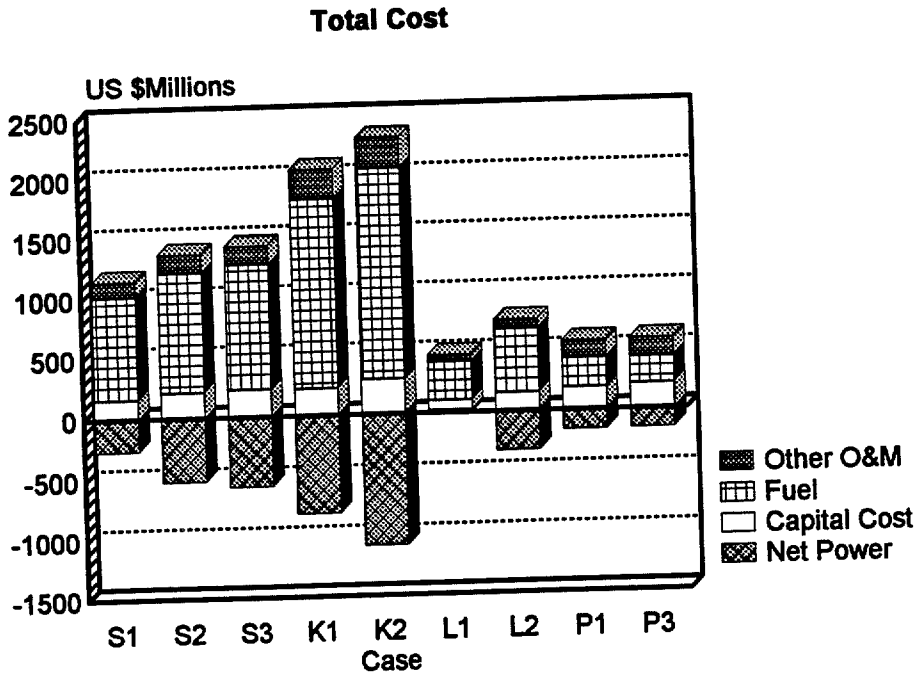
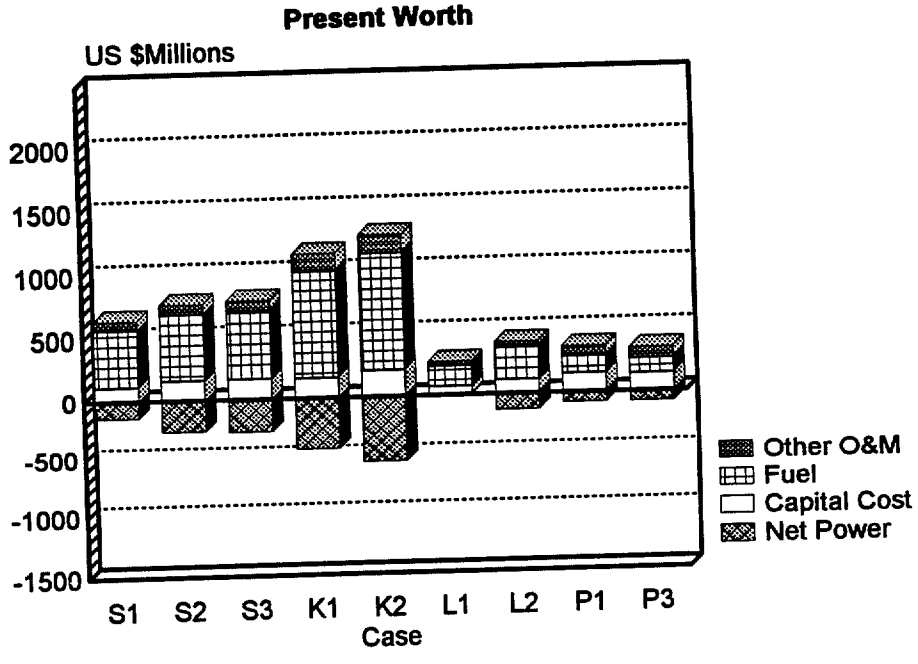
## Exhibit 8-20

## Summary of Economic Analysis Results



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From a strict interpretation of the results summarized above, it may be concluded that, given the level of fuel prices, power sales revenues, capital costs and other factors assumed in the analysis, only in Pernik (TPS Republika) is the introduction of alternative technology (CFB) an economic choice. It would appear that for all Sofia locations, the restoration of existing facilities represents a lower cost than that for any of the alternatives posed. However, even in Sofia, in no instance is the present worth of an alternative case more than 3% greater than that for the corresponding base case.

With results defined within such a narrow range, clear-cut "winners" are not readily apparent, and the future courses of action may necessarily be dictated by factors other than those drawn exclusively from the economic analysis of alternatives.

The above results and related conclusions are, of course, based on those capital costs and other assumptions underlying the analyses as previously described. In order to investigate the potential impact of alternative factors on initial conclusions, additional analyses were performed as set forth in Subsection 8.5.

## 8.5 SENSITIVITY ANALYSES

Several sensitivity analyses were conducted to explore the effect of changes to selected initial assumptions and potential outcomes. A "Breakeven Analysis" is employed to quantify the magnitude of adjustments necessary to make costs associated with each variant, as developed above, comparable to those projected under the Base Case in each area. Secondly, since all analyses to this point include, in addition to critical production plant restoration, the combined capital costs and composite effect of proposed (1) control system upgrades, (2) production plant "enhancements" and (3) transmission/distribution piping and related improvements, it is pertinent to examine the efficacy of each of these components independently. Finally, so-called "Baseline" cases are defined for each area as the end result of the selective elimination of those components determined not to be cost effective.

### 8.5.1 BREAKEVEN ANALYSIS

Rather than performing reanalyses under conditions reflecting somewhat arbitrarily established increases or decreases in sensitive assumptions, i. e., Capital Costs +20%, Fuel Costs -15%, etc., we have chosen instead to represent, for each major component of cost, the unit cost adjustment that would be required in order for the overall present worth of each variant to be equivalent to that for the respective Base Cases.

Exhibit 8-21 indicates the magnitude of adjustments required in each viable cost component under the assumption that all other cost components for that case and the Base Case remain unchanged. For example, in order for the present worth of total costs for Case S2 and for the Base Case (S1) to be equal, Case S2 capital costs would have to be reduced by approximately 2.4%, or the price of natural gas would have to be approximately 5.3% lower. Conversely, the price achieved for external electric sales (net power interchange) would have to be increased by approximately 3.2%. An indication of "NA" means that it is not possible to attain equilibrium through any logical adjustment of this factor in isolation.



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# Exhibit 8-21

## Breakeven Analysis

ADJUSTMENT REQUIRED IN SPECIFIC COST ELEMENTS IN ORDER TO EQUATE CUMULATIVE PRESENT WORTH OF THIS CASE WITH THAT OF THE BASE CASE

| CASE | Capital & Removal Costs (1) | FUEL COST | | | | | Net Power Interchange | Fixed & Variable Expenses | Sorbent, Ash Removal & Penalties | Maintenance | Total Operating Expenses | Total Capital & Operating Expenses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Natural Gas | Oil | Lignite | Black Coal | Total | | | | | | |
| S1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| S2 | −2.4% | −5.3% | 209.8% | NA | NA | −5.6% | 3.2% | 1154.6% | NA | −37.4% | 109.5% | −0.8% |
| S3 | −6.6% | −12.4% | 581.6% | NA | NA | −12.7% | 8.1% | −401.4% | NA | −148.5% | 127.8% | −2.1% |
| K1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| K2 | −7.8% | −19.9% | 788.6% | NA | NA | −20.4% | 13.7% | −684.5% | NA | −590.9% | 148.3% | −2.3% |
| L1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| L2 | −5.3% | −6.1% | NA | NA | NA | −6.2% | 3.9% | −174.8% | NA | −89.6% | 113.1% | −2.1% |
| P1 (Base) | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE | BASE |
| P3 | 11.8% | NA | NA | 38.9% | NA | NA | 663.0% | NA | 260.9% | NA | NA | 6.5% |

NOTE: (1) Adustment in Capital Cost for alternative case only, i.e., no corresponding adjustment in Base Case. All other adjustments apply for both Base Case and Alternative Case.

The fact that relatively minimal adjustments are required in pivotal cost components in order to reverse initial conclusions is further evidence of the narrow margin between alternatives.

### 8.5.2 EVALUATION OF INDIVIDUAL SYSTEM MODIFICATION COMPONENTS

The primary purpose of each system variant developed to this point has been to evaluate the efficacy of alternate production plant technologies in the Sofia and Pernik operating environments: various gas turbine or combined cycle configurations in the former case, and fluidized bed in the coal-fired latter case.

In other respects, all variants to this point are identical in that they each include costs associated with the following system modifications:

- Critical Production Plant restorations
- Upgrades in T&D Control Systems
- Recommended Production Plant Enhancements.
- T&D Piping and related improvements

Although it is considered that the critical Production Plant investments are indispensable to continued operation and are therefore necessary in any case, each of the other proposed modifications is subject to a measure of its cost effectiveness. In order to accomplish this test, the simulation model was reemployed to establish the cumulative present worth of the respective area costs with each of the latter three investments and their assumed consequences on system operations removed in turn. The referenced cases, each accomplished under the specific circumstances for TPS Sofia, TPS Tr Kostov, HS Liulin and TPS Republika (Pernik) are defined as follows:

- Case $0_1$ - Control system costs removed and hot water demands increased by a maximum of 15% to account, on an estimated basis, for the absence of otherwise repressed demands representing price elasticity under more stringent controls and utilization measurements.[2]
- Case $0_2$ - Excluding Production Plant investments categorized as recommended but not critical enhancements. Unit operating criteria do not reflect increments in efficiencies otherwise associated with the proposed modifications.
- Case $0_3$ - Excluding capital costs proposed for improvements in T&D piping and related facilities. Hot water demands increased over the analysis period by a maximum of approximately 23% to account for the fact that loss containment otherwise assumed will not be realized.

2 For purposes of the analyses previously described, it has been assumed that any reduction in requirements for hot water production resulting from implemented controls or loss remediation will be offset by new requirements such that overall demands remain level over time. For the present purpose, it is assumed that such new requirements will remain, and as a consequence, failure to implement controls or remediate losses will result in overall increases in system demand.



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The cumulative present worth of projected operating and capital expenditures under each of the above circumstances is summarized in Exhibit 8.-22. below:

## Exhibit 8-22

## Supplementary Analysis Results

| | | Sofia | | | | | | | Pernik | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Case | TPS Sofia | | TPS Kostov | | HS Liuline | | HS Zemliane | TPS Republika | |
| | Sub No. | S | | K | | L | | Z | P | |
| Reference Case | | 499,695 | (S1) | 705,343 | (K1) | 267,974 | (L1) | (1) | 260,942 | (P3) |
| Modifications: | | | | | | | | | | |
| Excluding Control Upgrades | $0_1$ | 494,452 | - | 711,678 | + | 261,459 | - | (1) | 254,938 | - |
| Excluding Production Plant "Enhancements" | $0_2$ | 483,375 | - | 676,952 | - | 257,350 | - | (1) | 253,992 | - |
| Excluding T&D Piping, etc. | $0_3$ | 494,831 | - | 701,695 | - | 271,749 | + | (1) | 254,512 | - |
| Baseline Case: | | | | | | | | | | |
| Excluding Control Upgrades & Production Plant Enhancements | 0 | **482,565** | | **677,788** | | **257,098** | | **308,287** | **241,677** | |

It follows that if the cumulative present worth of projected operating and capital expenditures under modified circumstances is lower than that for the related reference case as previously established (S1, K1, L1 or P3), the proposed modification is not cost effective. Under these criteria, the implementation of control system upgrades appears beneficial only at Tr Kostov, and distribution piping modifications only at Liuline (and at Zemliane, by inference). In each case, ($K0_1$ and $L0_3$ , respectively) the present worth of projected costs in the absence of the respective improvements is higher than that for the related reference cases wherein they are included. By the same criteria, Production Plant enhancements appear not to be cost effective at any location.[3]

Recognizing these conclusions, a final "Baseline" case is established for each area considering only those components determined to be cost effective. As indicated above, this would include the critical Production Plant restorations at all locations, control system upgrades at Tr Kostov and distribution piping modifications at Liuline and Zemliane. In all Sofia locations, these modifications are incorporated in an overall plan including Production Plant facilities as presently constituted. At Pernik, although none of above modifications appear cost effective, the overall plan does include the phased introduction of fluidized bed technology, the efficacy of which was previously demonstrated in the superiority of Case P3 over Case P1.

3 This is not to say that either program is conclusively impracticable. The basis for measuring the effect of each in this context is tenuous at best, and a well designed test procedure to establish respective impacts more precisely could easily result in conclusions contrary to those represented herein.



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Projected annual costs for operation and maintenance and for capital expenditures established on this basis are summarized in Exhibit 8-23. These costs serve as the basis for the financial analyses which follow.

## 8.6 CONCLUSIONS

On the basis of results developed through the economic analysis described above, the following conclusions are drawn:

1. The present worth of projected capital and operating costs for TPS Sofia, TPS Tr Kostov, HS Liuline and HS Zemliane is least under continued (but restored) operation of facilities as they presently exist.

2. The above conclusions reflect the assumed price for external sales of electricity employed in the analysis. The viability of alternative combined cycle/combustion turbine installations may be substantiated should actual future prices for such sales be even moderately higher than presently anticipated.

3. The present worth of projected capital and operating costs for TPS Republika at Pernik is least when fluidized bed boilers are phased into operation along with a new 35 MW turbine/generator. Timing of the new facilities was not optimized but included in the analysis on the following basis specified by the client:

   CFB #1 - Start construction in 1997; In service 2000

   CFB #2 - Start construction in 2000; In service 2003

   35 MW T/G - Start construction 2002; In service 2003

4. The overriding advantage of the CFB plants is the assumed ability to burn coal as presently utilized at Pernik. Based upon conclusions developed by the client, all existing facilities at Pernik will be forced to switch to substantially higher grade (probably imported) coal at a price significantly higher than that presently experienced.

5. A similar cost advantage is not available at the Sofia area plants since all alternatives investigated are gas fired, the same basis as existing facilities. This factor shifts emphasis to the price for electric sales as indicated in Item 2 above.

6. With respect to component modifications as separately analyzed in Section 7.5.1 above, the following conclusions are drawn:

   a. The implementation of control system upgrades to the degree and at the costs assumed in the economic analysis appears to be cost justified only in the service area of TPS Tr Kostov.

   b. Improvements to distribution piping installations to the degree and at the costs assumed in the economic analysis appear to be cost justified only in the service areas of HS Liuline, and by inference, HS Zemliane.



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c. In all cases, production plant "enhancements" appear not to be cost justified when measured against the economic impact solely of the assumed relatively minor improvements in operating efficiencies.

d. On the other hand, other production plant modifications characterized as "necessities" are considered to be indispensable to continued operation.

e. For analysis purposes, the measure of the impact of system improvements by reason of each of the components described above was possible only in the most general sense. In the final analysis, conclusions must more properly be drawn from analyses including data much more specific than currently available and supplemented by comprehensive field test studies.



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# Exhibit 8-23

## Summary of Costs - Baseline $(000)

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OPERATION & MAINTENANCE EXPENSES – $(000)** | | | | | | | | | | | | | | | | | |
| SOFIA: | | | | | | | | | | | | | | | | | |
| TPS Sofia | 24,940 | 29,530 | 35,258 | 43,049 | 52,312 | 55,030 | 58,747 | 58,189 | 58,336 | 58,221 | 57,635 | 57,606 | 57,515 | 57,877 | 58,326 | 57,691 | 58,664 |
| TPS Tr Kostov | 31,333 | 39,066 | 46,662 | 58,416 | 72,381 | 77,105 | 78,703 | 78,479 | 78,217 | 79,284 | 77,966 | 76,940 | 77,196 | 79,072 | 78,210 | 78,404 | 78,507 |
| HS Liulin | 14,977 | 16,772 | 20,249 | 22,062 | 25,607 | 26,670 | 29,116 | 27,765 | 27,717 | 27,377 | 26,414 | 26,969 | 27,172 | 27,052 | 26,436 | 27,104 | 27,327 |
| HS Zemliane | 17,666 | 19,820 | 23,791 | 26,205 | 30,410 | 31,712 | 34,423 | 33,024 | 32,929 | 32,542 | 33,533 | 32,042 | 32,245 | 32,125 | 33,509 | 32,177 | 32,400 |
| Total Sofia | 88,916 | 105,208 | 125,960 | 149,752 | 180,710 | 190,517 | 200,989 | 197,457 | 197,199 | 197,424 | 197,550 | 193,557 | 194,128 | 196,126 | 196,483 | 195,376 | 196,898 |
| PERNIK: | | | | | | | | | | | | | | | | | |
| TPS Republika | 8,642 | 13,675 | 13,882 | 14,166 | 14,836 | 15,346 | 14,954 | 14,782 | 15,950 | 14,841 | 15,617 | 14,549 | 14,764 | 15,603 | 15,353 | 15,507 | 14,962 |
| TOTAL | 97,558 | 118,883 | 139,842 | 163,918 | 195,546 | 205,863 | 215,943 | 212,239 | 213,149 | 212,265 | 213,167 | 208,106 | 208,892 | 211,729 | 213,836 | 210,883 | 211,860 |
| **CAPITAL COST: Foreign – $(000)** | | | | | | | | | | | | | | | | | |
| SOFIA: | | | | | | | | | | | | | | | | | |
| TPS Sofia | 13,531 | – | – | – | 1,706 | – | – | – | – | 1,706 | – | – | – | – | – | – | – |
| TPS Tr Kostov | 9,755 | 9,257 | 11,109 | 11,109 | 14,472 | 11,109 | – | – | – | 3,363 | – | – | – | – | 3,363 | – | – |
| HS Liulin | 953 | 2,591 | 3,234 | 3,358 | 12,061 | 2,341 | 2,341 | 2,341 | 2,341 | 2,341 | – | – | – | – | – | – | – |
| HS Zemliane | 1,334 | 3,628 | 4,527 | 4,701 | 13,437 | 3,278 | 3,278 | 3,278 | 3,278 | 3,278 | – | – | – | – | – | – | – |
| Total Sofia | 25,573 | 15,476 | 18,870 | 19,168 | 41,676 | 16,728 | 5,619 | 5,619 | 5,619 | 10,688 | – | – | – | – | 3,363 | – | – |
| PERNIK: | | | | | | | | | | | | | | | | | |
| TPS Republika | 29,230 | – | – | 15,545 | 24,711 | 12,883 | 15,971 | 23,956 | 19,454 | 5,496 | – | – | – | – | 1,394 | – | – |
| TOTAL | 54,803 | 15,476 | 18,870 | 34,713 | 66,387 | 29,611 | 21,590 | 29,575 | 25,073 | 16,184 | – | – | – | – | 4,757 | – | – |
| **CAPITAL COST: Domestic – $(000)** | | | | | | | | | | | | | | | | | |
| SOFIA: | | | | | | | | | | | | | | | | | |
| TPS Sofia | 455 | – | – | – | 106 | – | – | – | – | 107 | – | – | – | – | – | – | – |
| TPS Tr Kostov | 314 | 1,362 | 1,634 | 1,634 | 1,705 | 1,634 | – | – | – | 71 | – | – | – | – | 71 | – | – |
| HS Liulin | 276 | 753 | 940 | 975 | 1,192 | 669 | 669 | 669 | 669 | 669 | – | – | – | – | – | – | – |
| HS Zemliane | 387 | 1,054 | 1,315 | 1,365 | 1,592 | 937 | 937 | 937 | 937 | 937 | – | – | – | – | – | – | – |
| Total Sofia | 1,432 | 3,169 | 3,889 | 3,974 | 4,595 | 3,240 | 1,606 | 1,606 | 1,606 | 1,784 | – | – | – | – | 71 | – | – |
| PERNIK: | | | | | | | | | | | | | | | | | |
| TPS Republika | 2,758 | – | – | 569 | 880 | 472 | 585 | 877 | 583 | 92 | – | – | – | – | 28 | – | – |
| TOTAL | 4,190 | 3,169 | 3,889 | 4,543 | 5,475 | 3,712 | 2,191 | 2,483 | 2,189 | 1,876 | – | – | – | – | 99 | – | – |

# ESTIMATED FUEL COSTS

Estimated Fuel Costs (Excluding General Inflation)

I. Based on World Bank Projections

*Constant 1990 Dollars*

| Year | OIL $US PER BARREL World Bank Projection | OIL $US PER BARREL Annual Extrapolation | OIL $US per MMBTU | OIL Incremental Escalation | COAL $US PER TON World Bank Projection | COAL $US PER TON Annual Extrapolation | COAL $US per MMBTU | COAL Incremental Escalation | GAS $US PER 1000 NM³ World Bank Projection | GAS $US PER 1000 NM³ Annual Extrapolation | GAS $US per MMBTU | GAS Incremental Escalation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | $15.70 | $15.70 | $2.74 | – | $36.00 | $36.00 | $1.57 | – | $93.00 | $93.00 | $2.49 | – |
| 1994 | $15.60 | $15.60 | $2.72 | −0.64% | $37.00 | $37.00 | $1.61 | 2.78% | | $92.41 | $2.48 | −0.64% |
| 1995 | $15.60 | $15.60 | $2.72 | 0.00% | $37.00 | $37.00 | $1.61 | 0.00% | | $92.41 | $2.48 | 0.00% |
| 1996 | | $16.05 | $2.80 | 2.90% | | $37.95 | $1.65 | 2.57% | | $95.09 | $2.55 | 2.90% |
| 1997 | | $16.52 | $2.88 | 2.90% | | $38.92 | $1.69 | 2.57% | | $97.85 | $2.62 | 2.90% |
| 1998 | | $17.00 | $2.97 | 2.90% | | $39.92 | $1.74 | 2.57% | | $100.69 | $2.70 | 2.90% |
| 1999 | | $17.49 | $3.05 | 2.90% | | $40.95 | $1.78 | 2.57% | | $103.62 | $2.78 | 2.90% |
| 2000 | $18.00 | $18.00 | $3.14 | 2.90% | $42.00 | $42.00 | $1.83 | 2.57% | | $106.62 | $2.86 | 2.90% |
| 2001 | | $17.80 | $3.10 | −1.14% | | $42.00 | $1.83 | 0.00% | | $105.41 | $2.83 | −1.14% |
| 2002 | | $17.59 | $3.07 | −1.14% | | $42.00 | $1.83 | 0.00% | | $104.21 | $2.79 | −1.14% |
| 2003 | | $17.39 | $3.03 | −1.14% | | $42.00 | $1.83 | 0.00% | | $103.03 | $2.76 | −1.14% |
| 2004 | | $17.20 | $3.00 | −1.14% | | $42.00 | $1.83 | 0.00% | | $101.86 | $2.73 | −1.14% |
| 2005 | $17.00 | $17.00 | $2.97 | −1.14% | $42.00 | $42.00 | $1.83 | 0.00% | | $100.70 | $2.70 | −1.14% |
| 2006 | | $17.00 | $2.97 | 0.00% | | $42.00 | $1.83 | 0.00% | | $100.70 | $2.70 | 0.00% |
| 2007 | | $17.00 | $2.97 | 0.00% | | $42.00 | $1.83 | 0.00% | | $100.70 | $2.70 | 0.00% |
| 2008 | | $17.00 | $2.97 | 0.00% | | $42.00 | $1.83 | 0.00% | | $100.70 | $2.70 | 0.00% |
| 2009 | | $17.00 | $2.97 | 0.00% | | $42.00 | $1.83 | 0.00% | | $100.70 | $2.70 | 0.00% |
| 2010 | | $17.00 | $2.97 | 0.00% | | $42.00 | $1.83 | 0.00% | | $100.70 | $2.70 | 0.00% |

Assume: lbs/Barrel 290.64; BTU/lb 19,720

Assume: BTU/lb 11,500

Assume: SCF/NM³ 37.31; BTU/SCF 1000

II. Modified to 1993 price levels

*Adjusted for 1993/1995 G–5 MUV Index*

| | OIL $US per Barrel | OIL $US per MMBTU | OIL Incremental Escalation | COAL Coal to Oil Ratio | COAL $US per Ton | COAL $US per MMBTU | COAL Incremental Escalation | GAS Gas to Oil Ratio | GAS $US per 1000 NM³ | GAS $US per MMBTU | GAS Incremental Escalation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | $17.35 | $3.03 | – | 0.571 | $39.79 | $1.73 | – | 1.100 | $124.24 | $3.33 | |
| 1994 | $17.24 | $3.01 | −0.64% | 0.591 | $40.90 | $1.78 | 2.78% | 1.100 | $123.45 | $3.31 | −0.64% |
| 1995 | $17.24 | $3.01 | 0.00% | 0.591 | $40.90 | $1.78 | 0.00% | 1.100 | $123.45 | $3.31 | 0.00% |
| 1996 | $17.74 | $3.10 | 2.90% | 0.589 | $41.95 | $1.82 | 2.57% | 1.100 | $127.03 | $3.40 | 2.90% |
| 1997 | $18.26 | $3.19 | 2.90% | 0.587 | $43.02 | $1.87 | 2.57% | 1.100 | $130.72 | $3.50 | 2.90% |
| 1998 | $18.79 | $3.28 | 2.90% | 0.585 | $44.13 | $1.92 | 2.57% | 1.100 | $134.51 | $3.61 | 2.90% |
| 1999 | $19.33 | $3.37 | 2.90% | 0.583 | $45.26 | $1.97 | 2.57% | 1.100 | $138.42 | $3.71 | 2.90% |
| 2000 | $19.89 | $3.47 | 2.90% | 0.582 | $46.42 | $2.02 | 2.57% | 1.100 | $142.44 | $3.82 | 2.90% |
| 2001 | $19.67 | $3.43 | −1.14% | 0.588 | $46.42 | $2.02 | 0.00% | 1.100 | $140.82 | $3.77 | −1.14% |
| 2002 | $19.44 | $3.39 | −1.14% | 0.595 | $46.42 | $2.02 | 0.00% | 1.100 | $139.22 | $3.73 | −1.14% |
| 2003 | $19.22 | $3.35 | −1.14% | 0.602 | $46.42 | $2.02 | 0.00% | 1.100 | $137.64 | $3.69 | −1.14% |
| 2004 | $19.00 | $3.32 | −1.14% | 0.609 | $46.42 | $2.02 | 0.00% | 1.100 | $136.07 | $3.65 | −1.14% |
| 2005 | $18.79 | $3.28 | −1.14% | 0.616 | $46.42 | $2.02 | 0.00% | 1.100 | $134.53 | $3.61 | −1.14% |
| 2006 | $18.79 | $3.28 | 0.00% | 0.616 | $46.42 | $2.02 | 0.00% | 1.100 | $134.53 | $3.61 | 0.00% |
| 2007 | $18.79 | $3.28 | 0.00% | 0.616 | $46.42 | $2.02 | 0.00% | 1.100 | $134.53 | $3.61 | 0.00% |
| 2008 | $18.79 | $3.28 | 0.00% | 0.616 | $46.42 | $2.02 | 0.00% | 1.100 | $134.53 | $3.61 | 0.00% |
| 2009 | $18.79 | $3.28 | 0.00% | 0.616 | $46.42 | $2.02 | 0.00% | 1.100 | $134.53 | $3.61 | 0.00% |
| 2010 | $18.79 | $3.28 | 0.00% | 0.616 | $46.42 | $2.02 | 0.00% | 1.100 | $134.53 | $3.61 | 0.00% |

III. Adjusted for Transportation Costs

Per Barrel $2.00; Per Ton $14.00; Per 1000 NM³ $20.00

| | OIL $US per Barrel | OIL $US per MMBTU | OIL Incremental Escalation | COAL Coal to Oil Ratio | COAL $US per Ton | COAL $US per MMBTU | COAL Incremental Escalation | GAS Gas to Oil Ratio | GAS $US per 1000 NM³ | GAS $US per MMBTU | GAS Incremental Escalation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | $19.35 | $3.38 | – | 0.693 | $53.79 | $2.34 | – | 1.145 | $144.24 | $3.87 | – |
| 1994 | $19.24 | $3.36 | −0.57% | 0.711 | $54.90 | $2.39 | 2.05% | 1.145 | $143.45 | $3.84 | −0.55% |
| 1995 | $19.24 | $3.36 | 0.00% | 0.711 | $54.90 | $2.39 | 0.00% | 1.145 | $143.45 | $3.84 | 0.00% |
| 1996 | $19.74 | $3.44 | 2.60% | 0.706 | $55.95 | $2.43 | 1.91% | 1.144 | $147.03 | $3.94 | 2.50% |
| 1997 | $20.26 | $3.53 | 2.61% | 0.702 | $57.02 | $2.48 | 1.92% | 1.143 | $150.72 | $4.04 | 2.51% |
| 1998 | $20.79 | $3.63 | 2.62% | 0.697 | $58.13 | $2.53 | 1.94% | 1.142 | $154.51 | $4.14 | 2.52% |
| 1999 | $21.33 | $3.72 | 2.62% | 0.692 | $59.26 | $2.58 | 1.95% | 1.141 | $158.42 | $4.25 | 2.53% |
| 2000 | $21.89 | $3.82 | 2.63% | 0.688 | $60.42 | $2.63 | 1.96% | 1.140 | $162.44 | $4.35 | 2.54% |
| 2001 | $21.67 | $3.78 | −1.03% | 0.695 | $60.42 | $2.63 | 0.00% | 1.140 | $160.82 | $4.31 | −1.00% |
| 2002 | $21.44 | $3.74 | −1.03% | 0.702 | $60.42 | $2.63 | 0.00% | 1.141 | $159.22 | $4.27 | −1.00% |
| 2003 | $21.22 | $3.70 | −1.03% | 0.710 | $60.42 | $2.63 | 0.00% | 1.141 | $157.64 | $4.23 | −0.99% |
| 2004 | $21.00 | $3.66 | −1.03% | 0.717 | $60.42 | $2.63 | 0.00% | 1.142 | $156.07 | $4.18 | −0.99% |
| 2005 | $20.79 | $3.63 | −1.03% | 0.724 | $60.42 | $2.63 | 0.00% | 1.142 | $154.53 | $4.14 | −0.99% |
| 2006 | $20.79 | $3.63 | 0.00% | 0.724 | $60.42 | $2.63 | 0.00% | 1.142 | $154.53 | $4.14 | 0.00% |
| 2007 | $20.79 | $3.63 | 0.00% | 0.724 | $60.42 | $2.63 | 0.00% | 1.142 | $154.53 | $4.14 | 0.00% |
| 2008 | $20.79 | $3.63 | 0.00% | 0.724 | $60.42 | $2.63 | 0.00% | 1.142 | $154.53 | $4.14 | 0.00% |
| 2009 | $20.79 | $3.63 | 0.00% | 0.724 | $60.42 | $2.63 | 0.00% | 1.142 | $154.53 | $4.14 | 0.00% |
| 2010 | $20.79 | $3.63 | 0.00% | 0.724 | $60.42 | $2.63 | 0.00% | 1.142 | $154.53 | $4.14 | 0.00% |

**SOFIA TPS**

**Case S1**

TPS Sofia – Case S1

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,428 | 38,549 | 44,455 | 51,265 | 52,467 | 53,799 | 53,261 | 52,729 | 52,202 | 51,576 | 51,060 | 51,060 | 51,060 | 51,060 | 51,060 | 51,060 |
| Oil | 1,678 | 1,787 | 1,906 | 1,955 | 2,007 | 2,055 | 2,109 | 2,088 | 2,066 | 2,045 | 2,020 | 1,999 | 1,999 | 1,999 | 1,999 | 1,999 | 1,999 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,215 | 40,455 | 46,410 | 53,272 | 54,522 | 55,909 | 55,349 | 54,795 | 54,246 | 53,596 | 53,059 | 53,059 | 53,059 | 53,059 | 53,059 | 53,059 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (15,885) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) |
| Net Power Interchange | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (15,885) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 1,915 | 2,703 | 2,222 | 2,516 | 2,619 | 2,333 | 2,827 | 2,568 | 2,830 | 3,148 | 2,379 | 3,254 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,142 | 33,345 | 38,957 | 45,567 | 45,998 | 47,755 | 46,714 | 46,454 | 46,009 | 45,072 | 45,029 | 44,770 | 45,032 | 45,350 | 44,581 | 45,456 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 16126 | 12933 | 15807 | 16027 | 33525 | 12466 | 4050 | 4050 | 4050 | 17430 | – | – | – | – | – | – | – |
| Domestic | 1122 | 2749 | 3382 | 3444 | 4256 | 2412 | 1174 | 1174 | 1174 | 1717 | – | – | – | – | – | – | – |
| Total | 17247 | 15681 | 19189 | 19470 | 37781 | 14877 | 5224 | 5224 | 5224 | 19147 | – | – | – | – | – | – | – |
| TOTAL COST | 42,187 | 44,823 | 52,534 | 58,427 | 83,348 | 60,875 | 52,979 | 51,938 | 51,678 | 65,155 | 45,072 | 45,029 | 44,770 | 45,032 | 45,350 | 44,581 | 45,456 |
| Present Worth | 40,594 | 39,936 | 43,339 | 44,630 | 58,951 | 39,867 | 32,125 | 29,161 | 26,866 | 31,363 | 20,089 | 18,583 | 17,108 | 15,933 | 14,857 | 13,523 | 12,767 |
| Cumulative Present Worth | 40,594 | 80,530 | 123,870 | 168,500 | 227,451 | 267,318 | 299,443 | 328,604 | 355,470 | 386,834 | 406,923 | 425,506 | 442,614 | 458,547 | 473,404 | 486,928 | 499,695 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 |
| Electricity | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $15.44 | $17.57 | $17.99 | $18.42 | $18.24 | $18.07 | $17.90 | $17.68 | $17.52 | $17.52 | $17.52 | $17.52 | $17.52 | $17.52 |
| Hot Water | $10.41 | $11.81 | $13.44 | $15.29 | $17.42 | $17.81 | $18.24 | $18.06 | $17.89 | $17.72 | $17.52 | $17.35 | $17.35 | $17.35 | $17.35 | $17.35 | $17.35 |
| Electricity | $14.28 | $16.18 | $18.40 | $20.92 | $23.83 | $24.34 | $24.93 | $24.69 | $24.46 | $24.22 | $23.96 | $23.73 | $23.73 | $23.73 | $23.73 | $23.73 | $23.73 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 82 | 82 | 82 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 | 81 |
| $SO_2$ | 1,144 | 1,142 | 1,142 | 1,142 | 1,142 | 1,140 | 1,140 | 1,140 | 1,140 | 1,140 | 1,137 | 1,137 | 1,137 | 1,137 | 1,137 | 1,137 | 1,137 |
| NOx | 934 | 932 | 932 | 932 | 932 | 931 | 931 | 931 | 931 | 931 | 929 | 929 | 929 | 929 | 929 | 929 | 929 |
| CO | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Test Year = 2010

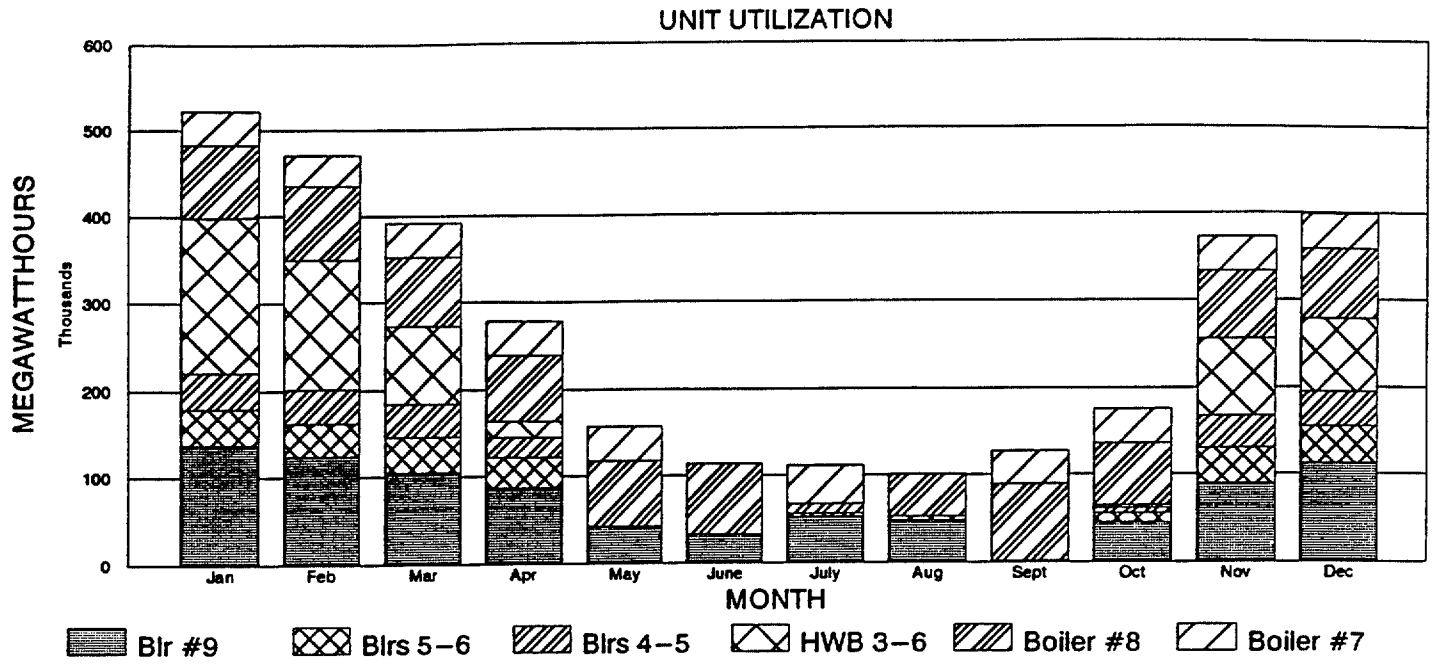
CASE S1

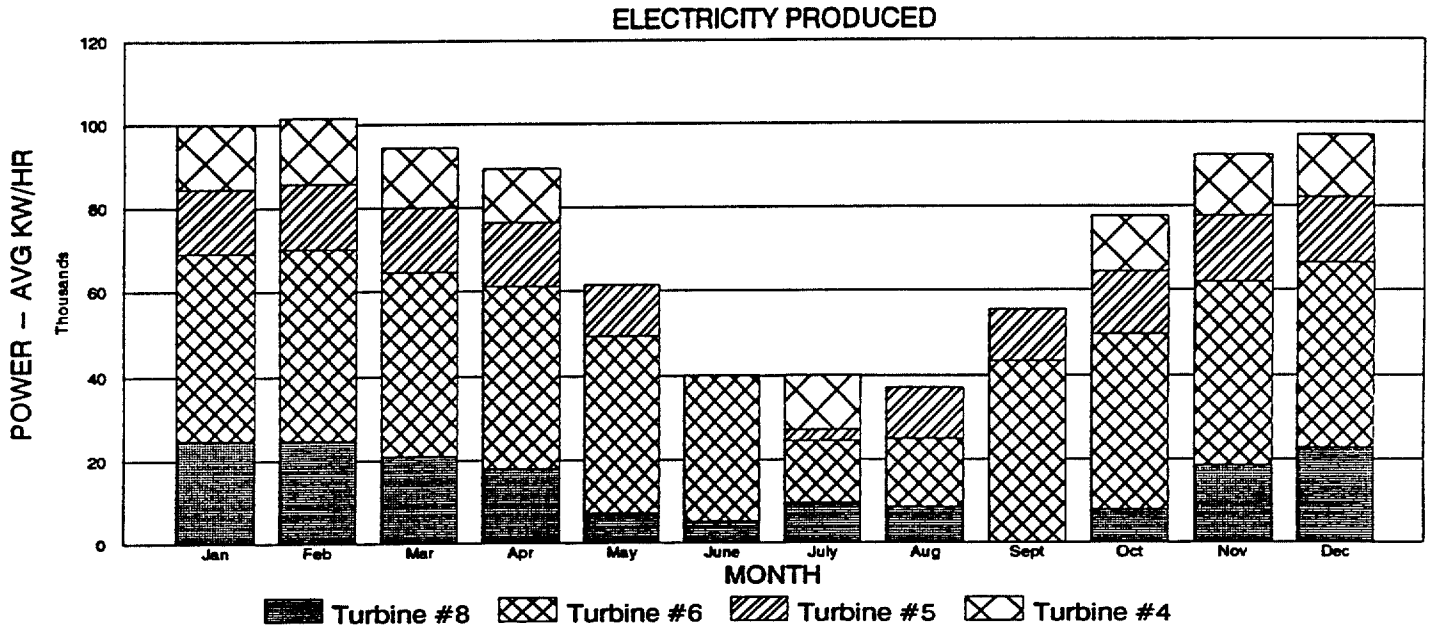
## Facilities Data

| DESCRIPTION | UNIT | BASS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EXISTING FACILITIES | | | | | | | | | | | | | | |
| | | | | Brs 4–5 | | Brs 5–6 | | | Boiler #7 | Boiler #8 | | | | Br #9 | Br #3 | HWB 3–6 |
| THERMAL DATA | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 84.8% | | 84.8% | | | 84.8% | 84.8% | | | | 84.4% | 84.4% | 84.5% |
| Half Load | %2 | | | 84.8% | | 84.8% | | | 84.8% | 84.8% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Load | %3 | | | 84.8% | | 84.8% | | | 84.8% | 84.8% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Operation | % | | | 26.7% | | 26.7% | | | 40.0% | 40.0% | | | | 40.0% | 40.0% | 10.0% |
| Feedwater Temp | | | | 419° | | 419° | | | 419° | 419° | | | | 439° | 212° | 158° |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | | 8 | 7 | | | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | | 135.000 | 135.000 | | | | | | |
| Quantity | Mlb/Hr | | | 727.65 | | 727.65 | | | 485.1 | 485.1 | | | | 485.1 | | |
| Pressure | PSIA | | | 1451 | | 1451 | | | 1451 | 1451 | | | | 1451 | | |
| Temperature | Temp °F | | | 950° | | 950° | | | 1004° | 1004° | | | | 1004° | | |
| Enthalpy | MBTU/lb | | | 1.458 | | 1.458 | | | 1.496 | 1.496 | | | | 1.496 | | |
| PRODUCT – LP STEAM | Priority | * | | | | | | | | | 5 | | | 2 | | |
| Quantity | Mlb/Hr | | | | | | | | | | 507.15 | | | 430.000 | 132.300 | |
| | MWts | | | | | | | | | | 166.700 | | | 159.000 | 53.000 | |
| Pressure | PSIA | | | | | | | | | | 185 | | | 142.25 | 363 | |
| Temperature | Temp °F | | | | | | | | | | 559.4° | | | – | 770° | |
| Enthalpy | MBTU/lb | | | | | | | | | | 1.302 | | | 1.266 | 1.403 | |
| PRODUCT – HOT WATER | Priority | | Cooling | 4 | | 3 | | | | | | 1 | | 2 | | 6 |
| Quantity | MWtw | | 200.000 | 35.190 | | 35.190 | | | | | | 101.300 | | 41.000 | | 464.000 |
| Temperature – Supply | Temp °F | | | 240° | | 240° | | | | | | 240° | | 240° | | 302° |
| Return | Temp °F | | | 140° | | 140° | | | | | | 140° | | 140° | | 158° |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | | | Turb 6a | Turb 6b | Turb 6c | Turb 8 | | |
| | Priority | | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | 25000 | | 25000 | | | | | | 55000 | 25000 | | |
| Capability – Max Steam | KW1 | | | 12540 | 18000 | 12540 | 18000 | | | | 29227 | 34727 | 50000 | 25000 | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | | 21920 | 26046 | | 18375 | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | | 14613 | 17364 | | 11875 | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | | 7307 | 8682 | | 4375 | | |
| Steam Required – Maximum | M#/Hr Max | | | 114.660 | | 114.660 | | | | | 507.150 | 352.800 | | 480.640 | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | 192.260 | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | | 185 | 22.75 | | 142.2 | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | | 0.1849 | 0.307 | | 0.228 | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | | 1.1218 | 0.9801 | | 0.9790 | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | | 98.6% | 98.6% | 98.6% | 97.5% | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | | 0.357 | | | |
| FUELS DATA | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | | Gas | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | | 95.0% | | 95.0% | | | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fue | Type | | | Mazut | | Mazut | | | Mazut | Mazut | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | | 5.0% | | 5.0% | | | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 740 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $296.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | | ST2–A9 | ST2–A9 | | | | ST2–A9 | | ST2–A9 |
| Emissions Code – Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | | ST2–A6 | ST2–A6 | | | | ST2–A6 | | ST2–A6 |
| Scheduled Maintenance | CODE m | | | SB4 | ST4 | SB5 | ST5 | | SB7 | SB8 | | ST6 | | SB9T8 | | SHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | AVAILABILITY | | | | | | | | | | | US$ |
| Jan | –1.7 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mar | 4.8 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% |
| May | 15.6 | | | 33% | 33% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – |
| June | 19.0 | | | 67% | 67% | 67% | 67% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – |
| July | 21.2 | | | 100% | 100% | 33% | 33% | | 100% | – | 50% | 50% | 50% | 100% | 100% | – |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | | – | 100% | 50% | 50% | 50% | 100% | 100% | – |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | – | 100% | – |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Nov | 5.9 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dec | 0.8 | | | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,068 | 3,664 | 3,049 | 2,163 | 1,220 | 882 | 863 | 780 | 987 | 1,369 | 2,896 | 3,099 | 25,040 |
| Oil | 254 | 229 | 191 | 135 | 76 | 55 | 54 | 49 | 62 | 86 | 181 | 194 | 1,565 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 4,322 | 3,893 | 3,240 | 2,299 | 1,296 | 937 | 917 | 828 | 1,049 | 1,454 | 3,077 | 3,293 | 26,605 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (1,546) | (1,431) | (1,563) | (1,180) | (680) | (575) | (399) | (323) | (568) | (891) | (1,433) | (1,528) | (12,117) |
| Net Power Interchange Cost | (1,546) | (1,431) | (1,563) | (1,180) | (680) | (575) | (399) | (323) | (568) | (891) | (1,433) | (1,528) | (12,117) |
| Other O&M – Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,518 |
| Variable | 464 | 421 | 351 | 256 | 147 | 115 | 101 | 90 | 119 | 164 | 330 | 358 | 2,917 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 11 |
| Total Excluding Maintenance | 3,456 | 3,078 | 2,243 | 1,583 | 978 | 684 | 833 | 810 | 807 | 942 | 2,182 | 2,338 | 19,935 |

912


UNIT UTILIZATION
MEGAWATTHOURS
Thousands
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
MONTH
Blr #9
Blrs 5–6
Blrs 4–5
HWB 3–6
Boiler #8
Boiler #7


ELECTRICITY PRODUCED
POWER – AVG KW/HR
Thousands
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
MONTH
Turbine #8
Turbine #6
Turbine #5
Turbine #4

LOAD DISPATCH AND ENERGY USE – YEAR 2010



## PRODUCT – LP STEAM

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Customer Requirement | MWH | | 85556 | 87033 | 53664 | 42829 | 27705 | 25926 | 19405 | 16779 | 19019 | 24378 | 41289 | 58894 |
| Station Use, Losses, etc. | MWH | – | 7282 | 7308 | 4421 | 3059 | 1678 | 1965 | 1648 | 1855 | 1831 | 2668 | 4035 | 4950 |
| | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 166.700 | 1 | 6.8 | 22.3 | – | – | – | – | – | – | 29.0 | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | 159.000 | | 118.0 | 118.1 | 76.1 | 63.7 | 39.5 | 38.7 | 28.3 | 25.0 | – | 36.4 | 62.9 | 85.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5046 | 14998 | – | – | – | – | – | – | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87792 | 79342 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

## PRODUCT – HOT WATER

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Customer Requirement | MWH | | 290369 | 249102 | 202460 | 117762 | 37406 | 12028 | 34221 | 30955 | 35821 | 62321 | 183229 | 272620 |
| Station Use, Losses, etc. | MWH | – | 43359 | 41906 | 36617 | 29762 | 37589 | 15321 | 29079 | 28296 | 25349 | 25695 | 54506 | –33433 |
| | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 464.000 | | 236.1 | 220.7 | 127.0 | 31.7 | – | – | – | – | – | 26.1 | 118.0 | 108.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 35.190 | | 35.2 | 35.1 | 31.0 | 30.2 | – | – | 13.5 | – | – | 30.2 | 34.7 | 35.2 |
| Blrs 5–6 | 35.190 | | 35.0 | 35.1 | 33.5 | 32.2 | 10.0 | – | 9.5 | 8.2 | 7.6 | 25.3 | 35.2 | 35.2 |
| Blr #9 | 41.000 | | 41.0 | 40.9 | 40.6 | 37.1 | 14.7 | 5.9 | 34.4 | 28.5 | – | 28.9 | 41.0 | 41.0 |
| Header | 101.300 | 1 | 101.3 | 101.2 | 100.6 | 100.3 | 94.2 | 37.8 | 45.5 | 49.7 | 84.5 | 88.4 | 101.3 | 101.3 |
| Total | | | 448.6 | 433.0 | 332.7 | 231.4 | 118.8 | 43.7 | 102.9 | 86.5 | 92.1 | 199.0 | 330.2 | 321.5 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | 175631 | 148298 | 86021 | 11593 | – | – | – | – | – | 1618 | 84987 | 60953 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | | | 26159 | 23608 | 23060 | 16562 | – | – | 3688 | – | – | 3773 | 24955 | 26181 |
| Blrs 5–6 | | | 26067 | 23608 | 24954 | 20445 | 265 | – | 3840 | 1040 | 347 | 5290 | 25337 | 26181 |
| Blr #9 | | | 30504 | 27506 | 30192 | 26741 | 4681 | 117 | 21931 | 21204 | – | 11529 | 29520 | 30504 |
| Header | | | 75367 | 67988 | 74850 | 72181 | 70049 | 27231 | 33841 | 37006 | 60824 | 65806 | 72936 | 75367 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

## ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steam | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5046 | 14998 | – | – | – | – | – | – | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87792 | 79342 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| Hot Water | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | 177392 | 148342 | 88860 | 18442 | – | – | – | – | – | 2875 | 89062 | 84203 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | | | 24407 | 23579 | 21098 | 9848 | – | – | 4898 | – | – | 2594 | 20880 | 22931 |
| Blrs 5–6 | | | 26059 | 23608 | 24542 | 20745 | 353 | – | 2896 | 1690 | 610 | 5959 | 25337 | 26181 |
| Blr #9 | | | 30504 | 27509 | 29807 | 27172 | 6393 | 327 | 22933 | 21769 | – | 11146 | 29520 | 30504 |
| Header | | | 75367 | 67970 | 74770 | 71316 | 68250 | 27021 | 32573 | 35793 | 60560 | 65443 | 72936 | 75367 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |

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TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 177392 | 148342 | 88860 | 18442 | – | – | – | – | – | 2875 | 89062 | 84203 |
| Header | 5046 | 14998 | – | – | – | – | – | – | 20850 | – | – | – |
| Blrs 4–5 | 24407 | 23579 | 21096 | 9648 | – | – | 4898 | – | – | 2594 | 20880 | 22931 |
| Blrs 5–6 | 26059 | 23608 | 24542 | 20745 | 353 | – | 2896 | 1690 | 610 | 5959 | 25337 | 26181 |
| Blr #9 | 118298 | 106851 | 87892 | 73060 | 35775 | 28218 | 43986 | 40403 | – | 38191 | 74844 | 94348 |
| Header | 75367 | 67970 | 74770 | 71316 | 68250 | 27021 | 32573 | 35793 | 60560 | 65443 | 72936 | 75367 |
| Total | 426566 | 385348 | 297163 | 193411 | 104378 | 55239 | 84353 | 77885 | 82020 | 115062 | 283059 | 303031 |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 0.99 | 898 | 2668 | – | – | – | – | – | – | 3709 | – | – | – |
| Turb 4a | 0.97 | 8927 | 8624 | 7716 | 3802 | – | – | 1792 | – | – | 949 | 7637 | 8387 |
| Turb 5a | 0.97 | 9531 | 8635 | 8976 | 7588 | 129 | – | 1059 | 618 | 223 | 2179 | 9267 | 9576 |
| Turb 8 | 0.96 | 19077 | 17231 | 16177 | 13296 | 5597 | 3988 | 7429 | 6630 | – | 6136 | 13643 | 17450 |
| Turb 6b | 0.99 | 26206 | 23634 | 25999 | 24798 | 23731 | 9396 | 11326 | 12446 | 21058 | 22756 | 25361 | 26206 |
| Total | | 64638 | 60791 | 58869 | 49284 | 29458 | 13384 | 21606 | 19694 | 24990 | 32020 | 55907 | 61619 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 7770 | 6200 | 9536 | 10090 | – | – | 5019 | – | – | 2102 | 8981 | 8558 |
| Turb 5c | 6889 | 6184 | 7698 | 6683 | 552 | – | – | 2640 | 953 | 2664 | 6603 | 6823 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 16982 | 12461 | 18754 | 18762 | 22590 | 44820 | – | – | 19221 | 24241 | 17809 | 18402 |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | - | 40176 | 36288 | 40176 | 38880 | 40176 | – | 43899 | – | 38880 | 40176 | 38880 | 40176 |
| Boiler #8 | - | 84323 | 85442 | 79347 | 75996 | 74395 | 81238 | – | 48239 | 86517 | 72264 | 77226 | 79800 |
| HWB 3–6 | - | 177392 | 148342 | 88860 | 18442 | – | – | – | – | – | 2875 | 89062 | 84203 |
| | 1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | - | 41104 | 38403 | 38350 | 23540 | – | – | 11709 | – | – | 5645 | 37499 | 39876 |
| Blrs 5–6 | - | 42478 | 38427 | 41217 | 35016 | 1035 | – | 3955 | 4947 | 1787 | 10803 | 41207 | 42580 |
| Blr #9 | - | 137373 | 124082 | 104070 | 86356 | 41373 | 32206 | 51415 | 47033 | – | 44327 | 88486 | 111798 |
| | 2 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | - | 522846 | 470984 | 392019 | 278229 | 156978 | 113444 | 110978 | 100219 | 127184 | 176089 | 372359 | 398433 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | 3.412 | 137081 | 123815 | 137081 | 132659 | 137081 | – | 149783 | – | 132659 | 137081 | 132659 | 137081 |
| Boiler #8 | 3.412 | 287710 | 291529 | 270731 | 259298 | 253835 | 277182 | – | 164590 | 295196 | 246564 | 263494 | 272277 |
| HWB 3–6 | 3.412 | 605260 | 506143 | 303190 | 62923 | – | – | – | – | – | 9808 | 303880 | 287300 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 3.412 | 140246 | 131030 | 130851 | 80318 | – | – | 39951 | – | – | 19260 | 127945 | 136057 |
| Blrs 5–6 | 3.412 | 144936 | 131112 | 140631 | 119473 | 3530 | – | 13496 | 16881 | 6097 | 36859 | 140598 | 145285 |
| Blr #9 | 3.412 | 468716 | 423369 | 355085 | 294647 | 141164 | 109888 | 175427 | 160476 | – | 151245 | 301915 | 381455 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1783949 | 1608997 | 1337589 | 949318 | 535609 | 387070 | 378657 | 341947 | 433951 | 600815 | 1270490 | 1359454 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% |
| Boiler #8 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% |
| HWB 3–6 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | 84.5% | 84.5% | 84.5% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | – | – | 84.8% | – | – | 84.8% | 84.8% | 84.8% |
| Blrs 5–6 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% |
| Blr #9 | – | – | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | – | 84.4% | 84.4% | 84.4% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | | Unit Energy Input MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | 161747 | 146094 | 161747 | 156529 | 161747 | – | 176736 | – | 156529 | 161747 | 156529 | 161747 |
| Boiler #8 | – | 339481 | 343987 | 319446 | 305956 | 299510 | 327059 | – | 194207 | 348313 | 290931 | 310907 | 321271 |
| HWB 3–6 | – | 716284 | 598986 | 358805 | 74465 | – | – | – | – | – | 11607 | 359621 | 340000 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | 165482 | 154507 | 154397 | 94771 | – | – | 47140 | – | – | 22725 | 150968 | 160539 |
| Blrs 5–6 | – | 171016 | 154704 | 165936 | 140971 | 4165 | – | 15924 | 19918 | 7194 | 43491 | 165897 | 171427 |
| Blr #9 | – | 555351 | 501622 | 420717 | 349108 | 167256 | 130199 | 207852 | 190137 | – | 179200 | 357719 | 451961 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 2109361 | 1900000 | 1581049 | 1121800 | 632678 | 457256 | 447652 | 404263 | 512037 | 709701 | 1501642 | 1606945 |

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TPS Sofia–Case S1

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Boiler #7 | $1.93 | 312 | 282 | 312 | 302 | 312 | – | 341 | – | 302 | 312 | 302 | 312 |
| Boiler #8 | $1.93 | 655 | 663 | 616 | 590 | 578 | 631 | – | 375 | 672 | 561 | 600 | 620 |
| HWB 3–6 | $1.93 | 1381 | 1155 | 692 | 144 | – | – | – | – | – | 22 | 694 | 656 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $1.93 | 319 | 298 | 298 | 183 | – | – | 91 | – | – | 44 | 291 | 310 |
| Blrs 5–6 | $1.93 | 330 | 298 | 320 | 272 | 8 | – | 31 | 38 | 14 | 84 | 320 | 331 |
| Blr #9 | $1.93 | 1071 | 967 | 811 | 673 | 323 | 251 | 401 | 367 | – | 346 | 690 | 872 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 4068 | 3664 | 3049 | 2163 | 1220 | 882 | 863 | 780 | 987 | 1369 | 2896 | 3099 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
| Boiler #7 | $0.12 | 19 | 18 | 19 | 19 | 19 | – | 21 | – | 19 | 19 | 19 | 19 |
| Boiler #8 | $0.12 | 41 | 41 | 38 | 37 | 36 | 39 | – | 23 | 42 | 35 | 37 | 39 |
| HWB 3–6 | $0.12 | 86 | 72 | 43 | 9 | – | – | – | – | – | 1 | 43 | 41 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $0.12 | 20 | 19 | 19 | 11 | – | – | 6 | – | – | 3 | 18 | 19 |
| Blrs 5–6 | $0.12 | 21 | 19 | 20 | 17 | 1 | – | 2 | 2 | 1 | 5 | 20 | 21 |
| Blr #9 | $0.12 | 67 | 60 | 51 | 42 | 20 | 16 | 25 | 23 | – | 22 | 43 | 54 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 254 | 229 | 191 | 135 | 76 | 55 | 54 | 49 | 62 | 86 | 181 | 194 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Variable O&M Expense $(000) | | | | | | | | | | | |
| Boiler #7 | $0.03 | $0.75 | 36 | 33 | 36 | 35 | 36 | – | 38 | – | 36 | 36 | 35 | 36 |
| Boiler #8 | $0.03 | $0.75 | 76 | 78 | 71 | 68 | 67 | 80 | – | 41 | 81 | 65 | 69 | 71 |
| HWB 3–6 | $0.03 | $0.75 | 137 | 115 | 69 | 14 | – | – | – | – | – | 2 | 69 | 65 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $0.03 | $0.75 | 37 | 34 | 35 | 23 | – | – | 11 | – | – | 5 | 34 | 36 |
| Blrs 5–6 | $0.03 | $0.75 | 38 | 34 | 37 | 32 | 1 | – | 3 | 5 | 2 | 10 | 37 | 38 |
| Blr #9 | $0.03 | $0.75 | 140 | 126 | 104 | 85 | 43 | 35 | 49 | 44 | – | 45 | 87 | 112 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 464 | 421 | 351 | 256 | 147 | 115 | 101 | 90 | 119 | 164 | 330 | 358 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
| Boiler #7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Boiler #8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions Penalties $(000) | | | | | | | | | | | |
| Boiler #7 | 0.0008 | 0 | 0 | 0 | 0 | 0 | – | 0 | – | 0 | 0 | 0 | 0 |
| Boiler #8 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 |
| HWB 3–6 | 0.0008 | 1 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | 0 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 0.0008 | 0 | 0 | 0 | 0 | – | – | 0 | – | – | 0 | 0 | 0 |
| Blrs 5–6 | 0.0008 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | 0 |
| Blr #9 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

## Emissions by Type – Tons

| | Pounds per Tonne | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions – Tons | | | | | | | | | | | |
| Particulate | 2205 | 13.2 | 11.9 | 9.9 | 7.0 | 4.0 | 2.9 | 2.8 | 2.5 | 3.2 | 4.4 | 9.4 | 10.1 |
| $SO_2$ | 2205 | 184.8 | 166.4 | 138.5 | 98.3 | 55.4 | 40.1 | 39.2 | 35.4 | 44.9 | 62.2 | 131.5 | 140.8 |
| NOx | 2205 | 150.9 | 135.9 | 113.1 | 80.3 | 45.3 | 32.7 | 32.0 | 28.9 | 36.6 | 50.8 | 107.4 | 115.0 |
| CO | 2205 | 16.2 | 14.6 | 12.2 | 8.6 | 4.9 | 3.5 | 3.4 | 3.1 | 3.9 | 5.5 | 11.5 | 12.4 |

TPS Sofia – CASE S1

ELECTRIC GENERATION AND NET POWER INTERCHANGE – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 1189 | 3912 | – | – | – | – | – | – | 5076 | – | – | – |
| Turb 4a | 11686 | 12500 | 10102 | 6390 | – | – | 6389 | – | – | 7408 | 10331 | 10980 |
| Turb 5a | 12477 | 12515 | 11751 | 11635 | 4750 | – | 2540 | 4750 | 4750 | 10152 | 12536 | 12536 |
| Turb 8 | 25000 | 25000 | 21200 | 18005 | 7335 | 5401 | 9736 | 8688 | – | 8041 | 18474 | 22868 |
| Turb 6b | 34713 | 34660 | 34438 | 33942 | 31435 | 12861 | 15003 | 16486 | 28823 | 30142 | 34713 | 34713 |
| Total T/G Output | 85065 | 88586 | 77491 | 69972 | 43520 | 18261 | 33668 | 29925 | 38649 | 55744 | 76054 | 81096 |
| Balance Required | –64850 | –68781 | –63660 | –58140 | –34100 | –13440 | –26621 | –21916 | –29558 | –45717 | –60147 | –62889 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 97.4% | 3662 | 3235 | 4494 | 6444 | – | – | 6444 | – | – | 5909 | 4374 | 4033 |
| Turb 5c | 97.4% | 3247 | 3227 | 3628 | 3689 | 7305 | – | – | 7305 | 7305 | 4468 | 3216 | 3216 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 98.6% | 8039 | 6531 | 8878 | 9178 | 10694 | 21926 | – | – | 9403 | 11476 | 8712 | 8712 |
| Total Condens Turb Output | | 14948 | 12993 | 17000 | 19311 | 17999 | 21926 | 6444 | 7305 | 16708 | 21853 | 16302 | 15961 |
| Balance Required | | –79798 | –81774 | –80661 | –77451 | –52099 | –35366 | –33065 | –29222 | –46265 | –67570 | –76449 | –78850 |
| GT Capability @ Full Load | | 71785 | 71220 | 70317 | 68746 | 67426 | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Total GT Output (KW) | – | – | – | – | – | – | – | – | – | – | – | – |
| Balance Required (KW) | –79798 | –81774 | –80661 | –77451 | –52099 | –35366 | –33065 | –29222 | –46265 | –67570 | –76449 | –78850 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –59370 | –54952 | –60012 | –52271 | –30112 | –25464 | –17699 | –14299 | –25183 | –34205 | –55043 | –58664 |
| **PURCHASED POWER** | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| **POWER SALES** | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 1546.1 | 1431.1 | 1562.8 | 1179.8 | 679.6 | 574.7 | 399.5 | 322.7 | 568.4 | 890.8 | 1433.4 | 1527.7 |

TPS Sofia – CASE S1

HEAT REJECTION – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |

Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |

Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Electric Output Ratio | – | – | – | – | – | – | – | – | – | – | – | – |
| Utilized Heat Ratio | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 27.3 | 23.7 | 31.0 | 35.2 | 35.9 | 65.1 | 11.8 | 41.3 | 58.4 | 39.9 | 29.7 | 29.1 |
| From Gas Turbines | 200.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 27.3 | 23.7 | 31.0 | 35.2 | 35.9 | 65.1 | 11.8 | 41.3 | 58.4 | 39.9 | 29.7 | 29.1 |

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 8.0 | 26.3 | – | – | – | – | – | – | 34.1 | – | – | – |
| Turb 4a | 44.8 | 47.9 | 38.7 | 24.5 | – | – | 24.5 | – | – | 28.4 | 39.6 | 42.1 |
| Turb 5a | 47.8 | 48.0 | 45.1 | 44.6 | 18.2 | – | 9.7 | 18.2 | 18.2 | 38.9 | 48.1 | 48.1 |
| Turb 8 | 184.6 | 184.6 | 139.9 | 119.9 | 55.6 | 44.7 | 69.1 | 63.2 | – | 59.6 | 122.9 | 150.3 |
| Turb 6b | 136.5 | 136.3 | 135.4 | 133.5 | 123.6 | 50.6 | 59.0 | 64.8 | 113.4 | 116.5 | 136.5 | 136.5 |

Maximum Steam Flow – MW

| | BASIS KW1 | Total Boiler MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 18000 | – | 55.2 | 57.1 | 51.5 | 42.9 | 3.0 | 12.5 | 42.9 | 27.9 | 27.9 | 45.3 | 52.1 | 53.6 |
| Turb 5c | 18000 | – | 57.1 | 57.2 | 55.4 | 55.1 | 39.0 | 12.5 | 3.7 | 39.0 | 39.0 | 51.7 | 57.2 | 57.2 |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 50000 | – | 167.3 | 181.1 | 160.6 | 159.5 | 154.0 | 112.8 | 29.4 | 30.2 | 174.2 | 151.1 | 161.3 | 161.3 |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 10.4 | 9.2 | 12.8 | 18.4 | 3.0 | 12.5 | 18.4 | 27.9 | 27.9 | 16.9 | 12.5 | 11.5 |
| Turb 5c | 9.3 | 9.2 | 10.3 | 10.5 | 20.8 | 12.5 | – | 20.8 | 20.8 | 12.7 | 9.2 | 9.2 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 22.8 | 18.5 | 25.2 | 26.1 | 30.4 | 62.3 | – | – | 26.7 | 32.6 | 24.7 | 24.7 |
| | 42.5 | 37.0 | 48.4 | 55.0 | 54.2 | 87.3 | 18.4 | 48.8 | 75.5 | 62.2 | 46.4 | 45.4 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | 744 | 672 | 677 | 366 | – | – | – | – | – | 62 | 720 | 744 |
| Turb 6a | | 744 | 672 | – | – | – | – | – | – | 720 | – | – | – |
| Turb 4a | | 744 | 672 | 744 | 549 | – | – | 273 | – | – | 125 | 720 | 744 |
| Turb 5a | | 744 | 672 | 744 | 635 | 26 | – | 406 | 127 | 46 | 209 | 720 | 744 |
| Turb 8 | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | – | 744 | 720 | 744 |
| Turb 6b | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | 238.4 | 220.7 | 131.2 | 50.4 | – | – | – | – | – | 46.4 | 123.7 | 113.2 |
| Turb 6a | | 6.8 | 22.3 | – | – | – | – | – | – | 29.0 | – | – | – |
| Turb 4a | | 32.8 | 35.1 | 28.4 | 17.9 | – | – | 17.9 | – | – | 20.8 | 29.0 | 30.8 |
| Turb 5a | | 35.0 | 35.1 | 33.0 | 32.7 | 13.3 | – | 7.1 | 13.3 | 13.3 | 28.5 | 35.2 | 35.2 |
| Turb 8 | | 159.0 | 159.0 | 118.1 | 101.5 | 48.1 | 39.2 | 59.1 | 54.3 | – | 51.3 | 103.9 | 126.8 |
| Turb 6b | | 101.3 | 101.1 | 100.5 | 99.1 | 91.7 | 37.5 | 43.8 | 48.1 | 84.1 | 88.0 | 101.3 | 101.3 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1218 | 20.6 | 67.9 | – | – | – | – | – | – | 88.1 | – | – | – |
| | 1.0475 | 106.9 | 114.3 | 92.4 | 58.4 | – | – | 58.4 | – | – | 67.7 | 94.5 | 100.4 |
| | 1.0475 | 114.1 | 114.4 | 107.4 | 106.4 | 43.4 | – | 23.2 | 43.4 | 43.4 | 92.6 | 114.6 | 114.6 |
| | 0.9790 | 554.1 | 554.2 | 411.7 | 353.6 | 167.6 | 136.6 | 206.0 | 189.3 | – | 178.9 | 362.3 | 442.0 |
| | 0.9801 | 352.7 | 352.1 | 349.9 | 344.8 | 319.3 | 130.7 | 152.4 | 167.5 | 292.8 | 306.2 | 352.7 | 352.7 |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | 51.4% | 47.6% | 28.3% | 10.9% | – | – | – | – | – | 10.0% | 26.7% | 24.4% |
| Turb 6a | | 4.1% | 13.4% | – | – | – | – | – | – | 17.4% | – | – | – |
| Turb 4a | | 93.2% | 99.7% | 80.6% | 51.0% | – | – | 51.0% | – | – | 59.1% | 82.4% | 87.6% |
| Turb 5a | | 99.5% | 99.8% | 93.7% | 92.8% | 37.9% | – | 20.3% | 37.9% | 37.9% | 81.0% | 100.0% | 100.0% |
| Turb 8 | | 79.5% | 79.5% | 59.1% | 50.7% | 24.0% | 19.6% | 29.6% | 27.2% | – | 25.7% | 52.0% | 63.4% |
| Turb 6b | | 100.0% | 99.8% | 99.2% | 97.8% | 90.6% | 37.0% | 43.2% | 47.5% | 83.0% | 86.8% | 100.0% | 100.0% |

919

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | |
| | Percent of Total Output | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs #8 & #7 | 4.1% | 12.3% | – | – | – | – | – | – | 16.6% | – | – | – |
| Blrs 4–5 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | 63.9% | 63.9% | 55.8% | 53.1% | 71.0% | 86.6% | 40.9% | 39.6% | – | 61.0% | 51.2% | 57.1% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Steam Supply | | | | | | | | | | | | |
| Gas | 718 | 717 | 453 | 358 | 229 | 217 | 164 | 145 | 137 | 211 | 353 | 498 |
| Oil | 45 | 45 | 28 | 22 | 14 | 14 | 10 | 9 | 9 | 13 | 22 | 31 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 94 | 95 | 58 | 45 | 31 | 30 | 20 | 18 | 20 | 27 | 45 | 64 |
| Total | 857 | 857 | 539 | 426 | 274 | 261 | 194 | 172 | 165 | 251 | 420 | 593 |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | |
| | Percent of Total Output | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 100.0% | 100.0% | 100.0% | 100.0% | – | – | – | – | – | 100.0% | 100.0% | 100.0% |
| Blrs #8 & #7 | 60.5% | 55.8% | 62.6% | 62.1% | 59.6% | 33.3% | 74.2% | 74.2% | 48.3% | 58.2% | 62.8% | 62.8% |
| Blrs 4–5 | 59.4% | 61.4% | 55.0% | 41.8% | – | – | 41.8% | – | – | 46.0% | 55.7% | 57.5% |
| Blrs 5–6 | 61.3% | 61.4% | 59.5% | 59.2% | 34.2% | – | 73.2% | 34.2% | 34.2% | 55.2% | 61.5% | 61.5% |
| Blr #9 | 22.2% | 22.2% | 28.6% | 31.5% | 15.5% | 1.0% | 44.8% | 46.3% | – | 25.1% | 33.4% | 27.3% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Hot Water Supply | | | | | | | | | | | | |
| Gas | 2507 | 2183 | 1771 | 1062 | 502 | 180 | 454 | 418 | 403 | 606 | 1762 | 1771 |
| Oil | 157 | 136 | 111 | 66 | 31 | 11 | 28 | 26 | 25 | 38 | 110 | 111 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 283 | 248 | 207 | 133 | 69 | 27 | 57 | 53 | 57 | 81 | 205 | 208 |
| Total | 2,946 | 2,568 | 2,089 | 1,262 | 602 | 219 | 539 | 497 | 486 | 725 | 2,078 | 2,089 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | |
| | Percent of Total Output | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs #8 & #7 | 35.4% | 31.8% | 37.4% | 37.9% | 40.4% | 66.7% | 25.8% | 25.8% | 35.1% | 41.8% | 37.2% | 37.2% |
| Blrs 4–5 | 40.6% | 38.6% | 45.0% | 58.2% | – | – | 58.2% | – | – | 54.0% | 44.3% | 42.5% |
| Blrs 5–6 | 38.7% | 38.6% | 40.5% | 40.8% | 65.8% | – | 26.8% | 65.8% | 65.8% | 44.8% | 38.5% | 38.5% |
| Blr #9 | 13.9% | 13.9% | 15.5% | 15.4% | 13.5% | 12.4% | 14.4% | 14.1% | – | 13.8% | 15.4% | 15.6% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Electric Supply | | | | | | | | | | | | |
| Gas | 696 | 620 | 684 | 607 | 354 | 388 | 194 | 159 | 299 | 418 | 643 | 688 |
| Oil | 43 | 39 | 43 | 38 | 22 | 24 | 12 | 10 | 19 | 26 | 40 | 43 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 89 | 80 | 87 | 78 | 48 | 58 | 24 | 20 | 42 | 56 | 82 | 88 |
| Total | 828 | 738 | 814 | 724 | 424 | 470 | 230 | 189 | 360 | 501 | 764 | 819 |

920

**SOFIA TPS**

**Case S2**

TPS Sofia – Case S2

PROJECTED OPERATING AND CAPITAL EXPENDITURES

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,428 | 38,549 | 53,925 | 62,187 | 63,704 | 65,322 | 64,669 | 64,022 | 63,382 | 62,661 | 62,034 | 62,034 | 62,034 | 62,034 | 62,034 | 62,034 |
| Oil | 1,678 | 1,787 | 1,906 | 1,446 | 1,484 | 1,520 | 1,560 | 1,544 | 1,528 | 1,513 | 1,494 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,215 | 40,455 | 55,371 | 63,670 | 65,224 | 66,882 | 66,213 | 65,551 | 64,895 | 64,155 | 63,513 | 63,513 | 63,513 | 63,513 | 63,513 | 63,513 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,783) | (14,701) | (32,047) | (32,886) | (33,748) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) |
| Net Power Interchange | (12,923) | (13,783) | (14,701) | (32,047) | (32,886) | (33,748) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) | (34,636) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,917 | 2,917 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 | 2,863 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 3,345 | 3,882 | 3,461 | 4,241 | 3,868 | 4,416 | 4,511 | 3,447 | 4,332 | 3,778 | 4,326 | 5,005 | 4,227 | 5,092 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,142 | 33,345 | 32,058 | 40,054 | 40,326 | 41,876 | 40,834 | 40,719 | 40,158 | 38,354 | 38,597 | 38,043 | 38,591 | 39,270 | 38,492 | 39,357 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 19403 | 46312 | 32497 | 16027 | 29981 | 12466 | 4050 | 4050 | 4050 | 16593 | – | – | – | – | – | – | – |
| Domestic | 1058 | 3676 | 4773 | 3444 | 4106 | 2412 | 1174 | 1174 | 1174 | 1681 | – | – | – | – | – | – | – |
| Total | 20460 | 49987 | 37269 | 19470 | 34086 | 14877 | 5224 | 5224 | 5224 | 18275 | – | – | – | – | – | – | – |
| TOTAL COST | 45,400 | 79,129 | 70,615 | 51,528 | 74,140 | 55,203 | 47,100 | 46,058 | 45,943 | 58,433 | 38,354 | 38,597 | 38,043 | 38,591 | 39,270 | 38,492 | 39,357 |
| Present Worth | 43,686 | 70,502 | 58,255 | 39,360 | 52,438 | 36,152 | 28,561 | 25,860 | 23,885 | 28,128 | 17,095 | 15,929 | 14,537 | 13,654 | 12,865 | 11,676 | 11,054 |
| Cumulative Present Worth | 43,686 | 114,188 | 172,443 | 211,803 | 264,242 | 300,393 | 328,954 | 354,814 | 378,698 | 406,826 | 423,921 | 439,850 | 454,387 | 468,041 | 480,907 | 492,583 | 503,637 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 |
| Electricity | 595,117 | 595,117 | 595,117 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 | 1,148,707 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $18.44 | $21.04 | $21.55 | $22.07 | $21.86 | $21.65 | $21.45 | $21.19 | $20.99 | $20.99 | $20.99 | $20.99 | $20.99 | $20.99 |
| Hot Water | $10.41 | $11.81 | $13.44 | $18.42 | $21.05 | $21.54 | $22.06 | $21.85 | $21.64 | $21.43 | $21.20 | $21.00 | $21.00 | $21.00 | $21.00 | $21.00 | $21.00 |
| Electricity | $14.28 | $16.18 | $18.40 | $12.09 | $13.82 | $14.14 | $14.48 | $14.34 | $14.20 | $14.07 | $13.92 | $13.79 | $13.79 | $13.79 | $13.79 | $13.79 | $13.79 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 82 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| $SO_2$ | 1,144 | 1,142 | 1,142 | 844 | 844 | 843 | 843 | 843 | 843 | 843 | 841 | 841 | 841 | 841 | 841 | 841 | 841 |
| NOx | 934 | 932 | 932 | 689 | 689 | 688 | 688 | 688 | 688 | 688 | 687 | 687 | 687 | 687 | 687 | 687 | 687 |
| CO | 100 | 100 | 100 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 |

22

# FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

CASE S2 — Test Year = 2010

## Facilities Data

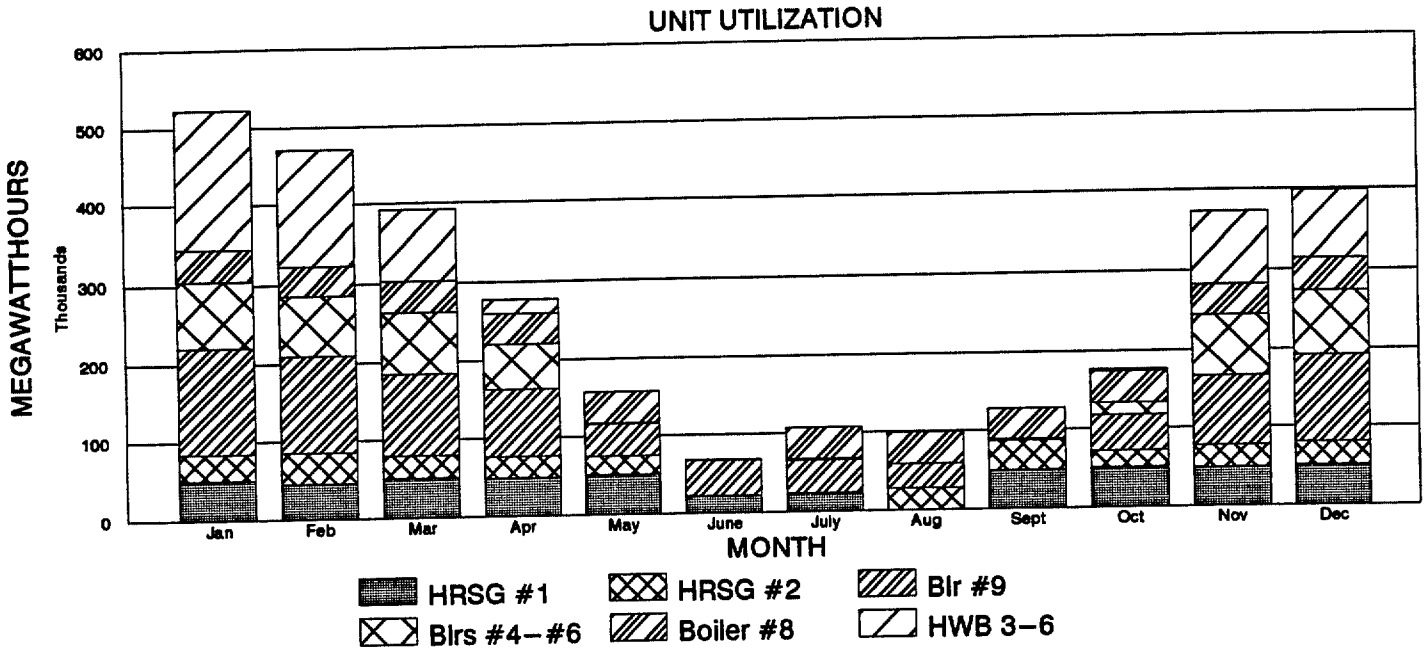
EXISTING FACILITIES

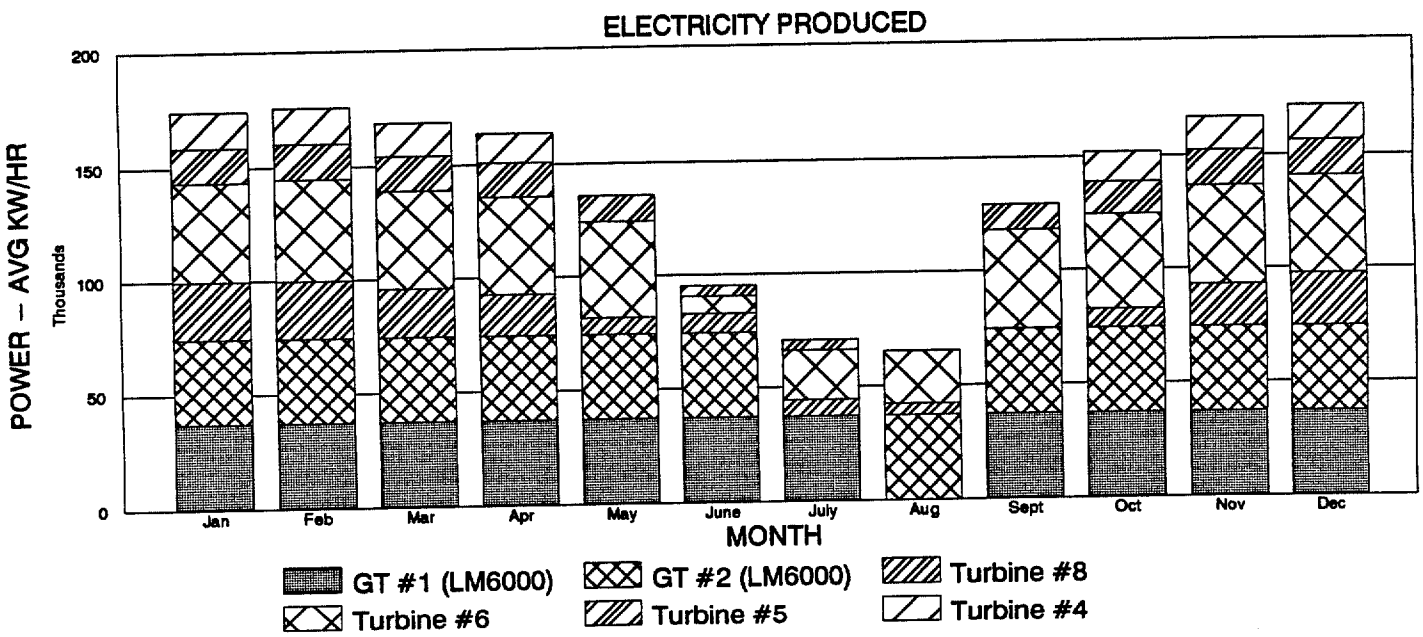
| DESCRIPTION | UNIT | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Blrs 4–5 | | Blrs 5–6 | | Boiler #8 | HRSG #1 | HRSG #2 | | | | Blr #9 | Blr #3 | HWB 3–6 |
| THERMAL DATA | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 84.8% | | 84.8% | | 84.8% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Half Load | %2 | | | 84.8% | | 84.8% | | 84.8% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Load | %3 | | | 84.8% | | 84.8% | | 84.8% | 100.0% | 100.0% | | | | 84.4% | 84.4% | 84.5% |
| Minimum Operation | % | | | 13.3% | | 13.3% | | 40.0% | 20.0% | 20.0% | | | | 40.0% | 40.0% | 10.0% |
| Feedwater Temp | | | | 419° | | 419° | | 419° | | | | | | 439° | 212° | 158° |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | 8 | 1 | 5 | | | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | 135.000 | 67.500 | 67.500 | | | | | | |
| Quantity | Mlb/Hr | | | 485.1 | 52.292 | 485.1 | 52.292 | 485.1 | | | | | 142 | 485.1 | | |
| Pressure | PSIA | | | 1451 | – | 1451 | – | 1451 | | | | | 115.751 | 1451 | | |
| Temperature | Temp °F | | | 950° | 12.333 | 950° | 12.333 | 1004° | | | | | 36.906 | 1004° | | |
| Enthalpy | MBTU/lb | | | 1.458 | 48.685 | 1.458 | 48.685 | 1.496 | | | | | 115.342 | 1.496 | | |
| PRODUCT – LP STEAM | Priority | * | | | | | | | | | 5 | | | 2 | | |
| Quantity | Mlb/Hr | | | | | | | | | | 507.15 | | | 430.000 | 132.300 | |
| | MWts | | | | | | | | | | 166.700 | | | 159.000 | 53.000 | |
| Pressure | PSIA | | | | | | | | | | 185 | | | 142.25 | 363 | |
| Temperature | Temp °F | | | | | | | | | | 559.4° | | | – | 770° | |
| Enthalpy | MBTU/lb | | | | | | | | | | 1.302 | | | 1.266 | 1.403 | |
| PRODUCT – HOT WATER | Priority | | Cooling | 4 | | 3 | | | | | | 1 | | 2 | | 6 |
| Quantity | MWtw | | 200.000 | 35.190 | | 35.190 | | | | | | 101.300 | | 41.000 | | 464.000 |
| Temperature – Supply | Temp °F | | | 240° | | 240° | | | | | | 240° | | 240° | | 302° |
| Return | Temp °F | | | 140° | | 140° | | | | | | 140° | | 140° | | 158° |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | GT–LM6000 | GT–LM6000 | Turb 6a | Turb 6b | Turb 6c | Turb 8 | | |
| | Priority | | | | | | | | 1 | 2 | | | | | | |
| Rated Capacity–Electric | KW | | | | 25000 | | 25000 | | | | | | 55000 | 25000 | | |
| Capability – Max Steam | KW1 | | | 12540 | 18000 | 12540 | 18000 | | | | 29227 | 34727 | 50000 | 25000 | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | | 21920 | 26046 | | 18375 | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | | 14613 | 17364 | | 11875 | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | | 7307 | 8682 | | 4375 | | |
| Steam Required – Maximum | M#/Hr_Max | | | 114.660 | | 114.660 | | | | | 507.150 | 352.800 | | 480.640 | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | | 192.260 | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | | 185 | 22.76 | | 142.2 | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | | 0.1849 | 0.307 | | 0.228 | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | | 1.1218 | 0.9801 | | 0.9790 | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | | 98.6% | 98.6% | 98.6% | 97.5% | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | | 0.357 | | | |
| FUELS DATA | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | Gas | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | 100.0% | 100.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fue | Type | | | Mazut | | Mazut | | Mazut | | | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 740 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $298.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | GT–LM6 | GT–LM6 | | | | ST2–A9 | | ST2–A9 |
| Emissions Code – Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | | | | | | ST2–A6 | | ST2–A6 |
| Scheduled Maintenance | CODE m | | | SB4 | ST4 | SB5 | ST5 | SB8 | GT–LM6 | HRSG | | ST6 | | SB9T8 | | SHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | |

| MONTHLY DATA | Avg Temp °C | Max GT? | AVAILABILITY | | | | | | | | | | | | US$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | –1.7 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Feb | 0.8 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Mar | 4.8 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Apr | 10.8 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| May | 15.6 | Yes | 33% | 33% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | – |
| June | 19.0 | Yes | 67% | 67% | 67% | 67% | – | 100% | 100% | 50% | 50% | 50% | 100% | | – |
| July | 21.2 | Yes | 100% | 100% | 33% | 33% | 100% | 100% | – | 75% | 75% | 75% | 100% | | – |
| Aug | 20.6 | Yes | 100% | 100% | 100% | 100% | 100% | – | 100% | 75% | 75% | 75% | 100% | | – |
| Sept | 16.7 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | | – |
| Oct | 11.3 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Nov | 5.9 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |
| Dec | 0.8 | Yes | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,556 | 4,097 | 3,542 | 2,641 | 1,717 | 1,354 | 1,162 | 1,068 | 1,455 | 1,868 | 3,372 | 3,591 | 30,422 |
| Oil | 213 | 188 | 152 | 98 | 40 | 22 | 40 | 35 | 20 | 51 | 143 | 155 | 1,157 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 4,769 | 4,285 | 3,694 | 2,739 | 1,757 | 1,376 | 1,203 | 1,103 | 1,475 | 1,918 | 3,515 | 3,746 | 31,579 |
| Supplemental Cost–Shortfall Penalty | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (2,990) | (2,735) | (3,007) | (2,391) | (1,931) | (1,403) | (1,007) | (964) | (1,174) | (2,335) | (2,831) | (2,972) | (25,742) |
| Net Power Interchange Cost | (2,990) | (2,735) | (3,007) | (2,391) | (1,931) | (1,403) | (1,007) | (964) | (1,174) | (2,335) | (2,831) | (2,972) | (25,742) |
| Other O&M – Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,518 |
| Variable | 464 | 421 | 351 | 256 | 147 | 65 | 96 | 89 | 119 | 164 | 330 | 358 | 2,863 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |
| Total Excluding Maintenance | 2,458 | 2,165 | 1,253 | 812 | 187 | 244 | 506 | 442 | 627 | (39) | 1,223 | 1,347 | 11,226 |

TPS Sofia – Case S2



TPS Sofia – Case S2

LOAD DISPATCH AND ENERGY USE – YEAR 2010

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 85556 | 87033 | 53664 | 42829 | 27705 | 25926 | 19405 | 16779 | 19019 | 24378 | 41289 | 58894 |
| Station Use, Losses, etc. | MWH | – | 7282 | 7308 | 4421 | 3059 | 1678 | 1965 | 1648 | 1855 | 1831 | 2668 | 4035 | 4950 |
| | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | 29.0 | – | – | – |
| Header | 166.700 | 1 | 6.8 | 22.3 | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | 159.000 | | 118.0 | 118.1 | 78.1 | 63.7 | 39.5 | 38.7 | 28.3 | 25.0 | – | 36.4 | 62.9 | 85.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | 20850 | – | – | – |
| Header | | | 5046 | 14998 | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87792 | 79342 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 290369 | 249102 | 202460 | 117762 | 37406 | 12028 | 34221 | 30955 | 35821 | 62321 | 183229 | 272620 |
| Station Use, Losses, etc. | MWH | – | 43359 | 41906 | 36617 | 29762 | 37589 | 15321 | 29079 | 28296 | 25349 | 25695 | 54506 | –33433 |
| | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 464.000 | | 236.1 | 220.7 | 127.0 | 31.7 | – | – | – | – | – | 26.1 | 118.0 | 108.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 35.190 | | 35.2 | 35.1 | 31.0 | 30.2 | – | – | – | – | – | 30.2 | 34.7 | 35.2 |
| Blrs 5–6 | 35.190 | | 35.0 | 35.1 | 33.5 | 32.2 | 10.0 | 8.8 | 12.1 | – | 7.6 | 25.3 | 35.2 | 35.2 |
| Blr #9 | 41.000 | | 41.0 | 40.9 | 40.6 | 37.1 | 14.7 | 28.9 | 26.9 | 13.4 | – | 28.9 | 41.0 | 41.0 |
| Header | 101.300 | 1 | 101.3 | 101.2 | 100.6 | 100.3 | 94.2 | 23.5 | 64.5 | 71.3 | 84.5 | 88.4 | 101.3 | 101.3 |
| Total | | | 448.6 | 433.0 | 332.7 | 231.4 | 118.8 | 61.2 | 103.5 | 84.7 | 92.1 | 199.0 | 330.2 | 321.5 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | 175631 | 148298 | 86021 | 11593 | – | – | – | – | – | 1618 | 84987 | 80953 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | | | 26159 | 23608 | 23060 | 16562 | – | – | – | – | – | 3773 | 24955 | 26181 |
| Blrs 5–6 | | | 26067 | 23608 | 24954 | 20445 | 265 | 595 | 1214 | – | 347 | 5290 | 25337 | 26181 |
| Blr #9 | | | 30504 | 27506 | 30192 | 26741 | 4681 | 9826 | 14073 | 6226 | – | 11529 | 29520 | 30504 |
| Header | | | 75367 | 67988 | 74850 | 72181 | 70049 | 16928 | 48013 | 53025 | 60824 | 65806 | 72936 | 75367 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | 20850 | – | – | – |
| Header | | | 5046 | 14998 | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87792 | 79342 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | 2875 | 89062 | 84203 |
| HWB 3–6 | | | 177392 | 148342 | 88860 | 18442 | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | 2555 | 20880 | 22931 |
| Blrs 4–5 | | | 24402 | 23571 | 20454 | 9781 | – | – | – | – | – | 5625 | 25337 | 26181 |
| Blrs 5–6 | | | 26063 | 23608 | 24954 | 20595 | 285 | 595 | 1214 | – | 347 | 11519 | 29520 | 30504 |
| Blr #9 | | | 30504 | 27517 | 30040 | 27389 | 6461 | 10366 | 14643 | 8534 | – | 65443 | 72936 | 75367 |
| Header | | | 75367 | 67970 | 74770 | 71316 | 68250 | 16387 | 47443 | 50717 | 60824 | 88016 | 237735 | 239187 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | | | |

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TPS Sofia – Case S2

LOAD DISPATCH AND ENERGY USE – YEAR 2010

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | 2875 | 89062 | 84203 |
| HWB 3–6 | 177392 | 148342 | 88860 | 18442 | – | – | – | – | 20850 | – | – | – |
| Header | 5046 | 14998 | – | – | – | – | – | – | – | 2555 | 20880 | 22931 |
| Blrs 4–5 | 24402 | 23571 | 20454 | 9781 | – | – | – | – | 347 | 5625 | 25337 | 26181 |
| Blrs 5–6 | 26063 | 23608 | 24954 | 20595 | 285 | 595 | 1214 | – | – | 38564 | 74844 | 94348 |
| Blr #9 | 118296 | 106859 | 88125 | 73277 | 35843 | 38257 | 35697 | 27168 | 60824 | 65443 | 72936 | 75367 |
| Header | 75367 | 67970 | 74770 | 71316 | 68250 | 16387 | 47443 | 50717 | 82020 | 115062 | 283059 | 303031 |
| Total | 426566 | 385348 | 297163 | 193411 | 104378 | 55239 | 84353 | 77885 | | | | |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | 3709 | – | – | – |
| Turb 6a | 0.99 | 898 | 2668 | – | – | – | – | – | – | – | 934 | 7637 | 8387 |
| Turb 4a | 0.97 | 8925 | 8621 | 7481 | 3577 | – | – | – | – | 127 | 2057 | 9267 | 9576 |
| Turb 5a | 0.97 | 9532 | 8635 | 9127 | 7533 | 104 | 217 | 444 | – | – | 6220 | 13643 | 17450 |
| Turb 8 | 0.98 | 19077 | 17231 | 16223 | 13338 | 5612 | 6228 | 5580 | 3677 | 21150 | 22756 | 25361 | 26206 |
| Turb 6b | 0.99 | 26206 | 23634 | 25999 | 24798 | 23731 | 5698 | 16497 | 17635 | 24985 | 31967 | 55907 | 61619 |
| Total | | 64638 | 60788 | 58830 | 49246 | 29448 | 12144 | 22520 | 21312 | | | | |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | 2123 | 8981 | 8558 |
| Turb 4c | 7773 | 6204 | 9880 | 10126 | – | – | – | – | 1094 | 2843 | 6603 | 6823 |
| Turb 5c | 6887 | 6184 | 7478 | 6763 | 588 | 260 | – | – | – | – | – | – |
| Turb 6c | – | – | – | – | – | – | – | – | 19066 | 24241 | 17809 | 18402 |
| | 16982 | 12461 | 18754 | 18762 | 22590 | – | – | – | | | | |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | - | 40176 | 36288 | 40176 | 38880 | 40176 | – | 40176 | 40176 | 38880 | 40176 | 38880 | 40176 |
| | - | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | - | 177392 | 148342 | 88860 | 18442 | – | – | – | – | – | 2875 | 89062 | 84203 |
| HRSG #2 | - | 34103 | 40082 | 29127 | 27396 | 24175 | – | – | 28176 | 38117 | 22044 | 28626 | 29580 |
| Blrs 4–5 | - | 41100 | 38396 | 37814 | 23484 | – | – | – | – | – | 5612 | 37499 | 39876 |
| Blrs 5–6 | - | 42482 | 38427 | 41559 | 34891 | 978 | 1072 | 1657 | – | 1568 | 10524 | 41207 | 42580 |
| Blr #9 | - | 137373 | 124090 | 104348 | 86615 | 41456 | 44485 | 41276 | 30845 | – | 44784 | 88486 | 111798 |
| HRSG #1 | - | 50220 | 45360 | 50220 | 48600 | 50220 | 22086 | 23763 | – | 48600 | 50220 | 48600 | 50220 |
| Total | | 522846 | 470985 | 392104 | 278308 | 157005 | 67643 | 106873 | 99198 | 127165 | 176235 | 372359 | 398433 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | 3.412 | 137081 | 123815 | 137081 | 132659 | 137081 | – | 137081 | 137081 | 132659 | 137081 | 132659 | 137081 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 3.412 | 605260 | 506143 | 303190 | 62923 | – | – | – | – | – | 9808 | 303880 | 287300 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 3.412 | 140234 | 131008 | 129022 | 80128 | – | – | – | – | – | 19149 | 127945 | 136057 |
| Blrs 5–6 | 3.412 | 144948 | 131112 | 141799 | 119047 | 3337 | 3657 | 5655 | – | 5348 | 35909 | 140598 | 145285 |
| Blr #9 | 3.412 | 468716 | 423394 | 356036 | 295532 | 141447 | 151784 | 140835 | 105245 | – | 152803 | 301915 | 381455 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1496239 | 1315472 | 1067128 | 690288 | 281865 | 155441 | 283570 | 242325 | 138007 | 354750 | 1006997 | 1087177 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | 84.5% | 84.5% | 84.5% |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | – | – | – | – | – | 84.8% | 84.8% | 84.8% |
| Blrs 5–6 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% |
| Blr #9 | – | – | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | 84.4% | – | 84.4% | 84.4% | 84.4% |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | Unit Energy Input MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | – | 161747 | 146094 | 161747 | 156529 | 161747 | – | 161747 | 161747 | 156529 | 161747 | 156529 | 161747 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | 716284 | 598986 | 358805 | 74465 | – | – | – | – | – | 11607 | 359621 | 340000 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | 165467 | 154582 | 152239 | 94546 | – | – | – | – | – | 22595 | 150968 | 160539 |
| Blrs 5–6 | – | 171031 | 154704 | 167314 | 140468 | 3937 | 4315 | 6673 | – | 6311 | 42371 | 165897 | 171427 |
| Blr #9 | – | 555351 | 501652 | 421844 | 350156 | 167592 | 179838 | 166866 | 124698 | – | 181046 | 357719 | 451961 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1769880 | 1556018 | 1261949 | 816165 | 333276 | 184154 | 335286 | 286444 | 162840 | 419366 | 1190735 | 1285674 |

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TPS Sofia – Case S2

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Boiler #8 | $1.93 | 312 | 282 | 312 | 302 | 312 | – | 312 | 312 | 302 | 312 | 302 | 31 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | $1.93 | 1381 | 1155 | 692 | 144 | – | – | – | – | – | 22 | 694 | 6 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $1.93 | 319 | 298 | 294 | 182 | – | – | – | – | – | 44 | 291 | 31 |
| Blrs 5–6 | $1.93 | 330 | 298 | 323 | 271 | 8 | 8 | 13 | – | 12 | 82 | 320 | 3 |
| Blr #9 | $1.93 | 1071 | 967 | 814 | 675 | 323 | 347 | 322 | 240 | – | 349 | 690 | 8 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 3413 | 3001 | 2434 | 1574 | 643 | 355 | 647 | 552 | 314 | 809 | 2296 | 24 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | $0.12 | 19 | 18 | 19 | 19 | 19 | – | 19 | 19 | 19 | 19 | 19 | 1 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | $0.12 | 86 | 72 | 43 | 9 | – | – | – | – | – | 1 | 43 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | $0.12 | 20 | 19 | 18 | 11 | – | – | – | – | – | 3 | 18 | 1 |
| Blrs 5–6 | $0.12 | 21 | 19 | 20 | 17 | 0 | 1 | 1 | – | 1 | 5 | 20 | |
| Blr #9 | $0.12 | 67 | 60 | 51 | 42 | 20 | 22 | 20 | 15 | – | 22 | 43 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 213 | 188 | 152 | 98 | 40 | 22 | 40 | 35 | 20 | 51 | 143 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Variable O&M Expense $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | $0.03 | $0.75 | 36 | 33 | 36 | 35 | 36 | – | 34 | 34 | 36 | 36 | 35 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | $0.03 | $0.75 | 137 | 115 | 69 | 14 | – | – | – | – | – | 2 | 69 | |
| HRSG #2 | $0.03 | $0.75 | 31 | 37 | 26 | 24 | 22 | – | – | 24 | 36 | 20 | 25 | |
| Blrs 4–5 | $0.03 | $0.75 | 37 | 34 | 35 | 22 | – | – | – | – | – | 5 | 34 | |
| Blrs 5–6 | $0.03 | $0.75 | 38 | 34 | 37 | 31 | 1 | 1 | 1 | – | 2 | 10 | 37 | |
| Blr #9 | $0.03 | $0.75 | 140 | 126 | 104 | 86 | 43 | 45 | 40 | 31 | – | 45 | 87 | 11 |
| HRSG #1 | $0.03 | $0.75 | 45 | 41 | 45 | 43 | 45 | 19 | 20 | – | 45 | 45 | 43 | |
| Total | | – | 464 | 421 | 351 | 256 | 147 | 65 | 96 | 89 | 119 | 164 | 330 | 3 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Emissions Penalties $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | 0.0008 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | 0.0008 | 1 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | |
| HRSG #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | |
| Blrs 5–6 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | |
| Blr #9 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | |
| HRSG #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |

## Emissions by Type – Tons

| | Pounds per Tonne | Emissions – Tons | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulate | 2205 | 11.1 | 9.7 | 7.9 | 5.1 | 2.1 | 1.2 | 2.1 | 1.8 | 1.0 | 2.6 | 7.5 | 8 |
| $SO_2$ | 2205 | 155.0 | 136.3 | 110.5 | 71.5 | 29.2 | 16.1 | 29.4 | 25.1 | 14.3 | 36.7 | 104.3 | 112 |
| NOx | 2205 | 126.6 | 111.3 | 90.3 | 58.4 | 23.8 | 13.2 | 24.0 | 20.5 | 11.6 | 30.0 | 85.2 | 92 |
| CO | 2205 | 13.6 | 12.0 | 9.7 | 6.3 | 2.6 | 1.4 | 2.6 | 2.2 | 1.3 | 3.2 | 9.2 | 9 |

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TPS Sofia – Case S2

ELECTRIC GENERATION, NET POWER INTERCHANGE AND GAS TURBINE FUEL USE

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | 5076 | – | – | – |
| Turb 6a | 1189 | 3912 | – | – | – | – | – | – | – | 7296 | 10331 | 10980 |
| Turb 4a | 11684 | 12496 | 9794 | 6346 | – | – | – | – | 2698 | 9583 | 12536 | 12536 |
| Turb 5a | 12479 | 12515 | 11948 | 11551 | 3836 | 3128 | 4303 | – | – | 8151 | 18474 | 22868 |
| Turb 8 | 25000 | 25000 | 21260 | 18062 | 7355 | 6434 | 7312 | 4819 | 28948 | 30142 | 34713 | 34713 |
| Turb 6b | 34713 | 34660 | 34438 | 33942 | 31435 | 7800 | 21852 | 23360 | 36722 | 55172 | 76054 | 81096 |
| Total T/G Output | 85065 | 88582 | 77440 | 69901 | 42626 | 19361 | 33467 | 28178 | –27631 | –45145 | –60147 | –62889 |
| Balance Required | –64850 | –68777 | –63609 | –58069 | –33205 | –14540 | –26420 | –20170 | | | | |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | 5968 | 4374 | 4033 |
| Turb 4c | 97.4% | 3663 | 3237 | 4656 | 6467 | – | – | – | – | 8383 | 4767 | 3216 | 3216 |
| Turb 5c | 97.4% | 3246 | 3227 | 3525 | 3733 | 7785 | 1345 | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | 9327 | 11476 | 8712 | 8712 |
| Turb 6c | 98.6% | 8039 | 8531 | 8878 | 9178 | 10694 | – | – | – | 17710 | 22211 | 16302 | 15961 |
| Total Condens Turb Output | | 14948 | 12995 | 17059 | 19378 | 18479 | 1345 | – | – | –45341 | –67356 | –76449 | –78850 |
| Balance Required | | –79798 | –81772 | –80668 | –77448 | –51685 | –15885 | –26420 | –20170 | | | | |
| GT Capability @ Full Load | | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | 37266 | 37266 | 37266 | 37266 | 37266 |
| GT–LM6000 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | – | 37266 | 37266 | 37266 | 37266 |
| GT–LM6000 | 37266 | 37266 | 37266 | 37266 | 37266 | 74532 | 37266 | 37266 | 74532 | 74532 | 74532 | 74532 |
| Total GT Output (KW) | 74532 | 74532 | 74532 | 74532 | 74532 | –90417 | –63686 | –57436 | –119873 | –141888 | –150981 | –153382 |
| Balance Required (KW) | –154330 | –156304 | –155200 | –151980 | –126217 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –114822 | –105037 | –115469 | –105938 | –85567 | –62183 | –44613 | –42733 | –52005 | –89675 | –108706 | –114116 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| POWER SALES | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 2990.2 | 2735.4 | 3007.0 | 2391.0 | 1931.2 | 1403.5 | 1006.9 | 964.5 | 1173.8 | 2335.3 | 2830.9 | 2971.8 |

GAS TURBINE
Percent Load

| | Percent Load | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| GT–LM6000 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | – | 100.0% | 100.0% | 100.0% | 100.0% |
| GT–LM6000 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | | | | | |

Interpolated Fuel Flow – MMBTU

| | Fuel Flow – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | 254106 | 245909 | 254106 | 245909 | 254106 |
| GT–LM6000 | 254106 | 229515 | 254106 | 245909 | 254106 | 245909 | – | – | 245909 | 254106 | 245909 | 254106 |
| GT–LM6000 | 254106 | 229515 | 254106 | 245909 | 254106 | 245909 | 254106 | 254106 | 491818 | 508212 | 491818 | 508212 |
| Total | 508212 | 459030 | 508212 | 491818 | 508212 | 491818 | 254106 | | | | | |

Fuel Cost – Gas Turbine(s) (Gas) $(000)

| | Unit Cost | Fuel Cost – Gas $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | 515.8 | 499.2 | 515.8 | 499.2 | 515.8 |
| GT–LM6000 | $2.03 | 515.8 | 465.9 | 515.8 | 499.2 | 515.8 | 499.2 | – | 499.2 | 515.8 | 499.2 | 515.8 |
| GT–LM6000 | $2.03 | 515.8 | 465.9 | 515.8 | 499.2 | 515.8 | 499.2 | 515.8 | 515.8 | 998.4 | 1031.7 | 998.4 | 1031.7 |
| Total | | 1031.7 | 931.8 | 1031.7 | 998.4 | 1031.7 | 998.4 | 515.8 | | | | | |

928

TPS Sofia – Case S2

GAS TURBINE EXHAUST HEAT UTILIZATION AND SUPPLEMENTARY FIRING – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

GAS TURBINE

Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 880 | 880 | 880 | 880 | 880 | 880 | – | 880 | 880 | 880 | 880 | 880 |
| GT–LM6000 | 880 | 880 | 880 | 880 | 880 | 880 | 880 | – | 880 | 880 | 880 | 880 |

Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | – | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 |
| GT–LM6000 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | 956.2 | – | 956.2 | 956.2 | 956.2 | 956.2 |

Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–LM6000 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | – | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 |
| GT–LM6000 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | 156.618 | – | 156.618 | 156.618 | 156.618 | 156.618 |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 3.412 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | – | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 |
| HRSG #1 | 3.412 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | 45.902 | – | 45.902 | 45.902 | 45.902 | 45.902 |
| | | 91.804 | 91.804 | 91.804 | 91.804 | 91.804 | 91.804 | 45.902 | 45.902 | 91.804 | 91.804 | 91.804 | 91.804 |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | – | – | – | – | – | – | – | – | 28.636 | 5.324 | 15.454 | 15.454 |
| HRSG #1 | 21.533 | 35.342 | 14.844 | 13.745 | 8.189 | – | – | – | 28.636 | 5.324 | 15.454 | 15.454 |
| | 21.533 | 35.342 | 14.844 | 13.745 | 8.189 | – | – | – | | | | |

Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 45.8 | 59.6 | 39.1 | 38.0 | 32.5 | – | – | 37.9 | 52.9 | 29.6 | 39.8 | 39.8 |
| HRSG #1 | 67.5 | 67.5 | 67.5 | 67.5 | 67.5 | 30.7 | 31.9 | – | 67.5 | 67.5 | 67.5 | 67.5 |
| | 113.3 | 127.1 | 106.6 | 105.5 | 100.0 | 30.7 | 31.9 | 37.9 | 120.4 | 97.1 | 107.3 | 107.3 |
| Electric Output Ratio | 39.7% | 37.0% | 41.1% | 41.4% | 42.7% | 70.8% | 53.8% | 49.6% | 38.2% | 43.4% | 41.0% | 41.0% |
| Utilized Heat Ratio | 60.3% | 63.0% | 58.9% | 58.6% | 57.3% | 29.2% | 46.2% | 50.4% | 61.8% | 56.6% | 59.0% | 59.0% |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 27.3 | 23.7 | 31.1 | 35.4 | 36.8 | 15.0 | 27.9 | 55.9 | 60.3 | 40.5 | 29.7 | 29.1 |
| From Gas Turbines | 200.000 | – | – | – | – | – | 61.1 | 14.0 | 8.0 | – | – | – | – |
| Total | | 27.3 | 23.7 | 31.1 | 35.4 | 36.8 | 76.1 | 41.9 | 63.9 | 60.3 | 40.5 | 29.7 | 29.1 |

Supplementary Firing Energy Input = MMBTU

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | | – | – | – | – | – | – | – | – | 70349 | 13516 | 37964 | 39229 |
| HRSG #1 | | 54662 | 81035 | 37683 | 33767 | 20787 | – | – | – | | | | |

Supplementary Firing Fuel Cost (Gas)

| | Unit Cost $/MMBTU | Supplementary Firing Fuel Cost $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 2.03 | – | – | – | – | – | – | – | – | 143 | 27 | 77 | 80 |
| HRSG #1 | 2.03 | 111 | 165 | 76 | 69 | 42 | – | – | – | 143 | 27 | 77 | 80 |
| Total | | 111 | 165 | 76 | 69 | 42 | – | – | – | | | | |

929

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 8.0 | 26.3 | – | – | – | – | – | – | 34.1 | – | – | – |
| Turb 4a | 44.8 | 47.9 | 37.5 | 24.3 | – | – | – | – | – | 28.0 | 39.6 | 42.1 |
| Turb 5a | 47.8 | 48.0 | 45.8 | 44.3 | 14.7 | 12.0 | 16.5 | – | 10.3 | 36.7 | 48.1 | 48.1 |
| Turb 8 | 184.6 | 184.7 | 140.3 | 120.3 | 55.7 | 61.8 | 55.5 | 41.5 | – | 60.2 | 122.9 | 150.3 |
| Turb 6b | 136.5 | 136.3 | 135.4 | 133.5 | 123.6 | 30.7 | 85.9 | 91.9 | 113.9 | 118.5 | 136.5 | 136.5 |

Maximum Steam Flow – MW

| | BASIS KW1 | Total Boiler MW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 18000 | – | 55.2 | 57.1 | 50.8 | 42.8 | 3.0 | 12.5 | 27.9 | 27.9 | 27.9 | 45.0 | 52.1 | 53.6 |
| Turb 5c | 18000 | – | 57.1 | 57.2 | 55.9 | 54.9 | 36.9 | 15.8 | 4.1 | 27.9 | 34.3 | 50.3 | 57.2 | 57.2 |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 50000 | – | 167.3 | 181.1 | 160.6 | 159.5 | 154.0 | 25.4 | 74.7 | 76.6 | 174.4 | 151.1 | 161.3 | 161.3 |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 10.4 | 9.2 | 13.3 | 18.4 | 3.0 | 12.5 | 27.9 | 27.9 | 27.9 | 17.0 | 12.5 | 11.5 |
| Turb 5c | 9.3 | 9.2 | 10.1 | 10.6 | 22.2 | 3.8 | – | 27.9 | 23.9 | 13.6 | 9.2 | 9.2 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 22.8 | 18.5 | 25.2 | 26.1 | 30.4 | – | – | – | 26.5 | 32.6 | 24.7 | 24.7 |
| | 42.5 | 37.0 | 48.5 | 55.1 | 55.6 | 16.4 | 27.9 | 55.9 | 78.3 | 63.2 | 46.4 | 45.4 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | 744 | 672 | 677 | 366 | – | – | – | – | – | 62 | 720 | 744 |
| Turb 6a | | 744 | 672 | – | – | – | – | – | – | 720 | – | – | – |
| Turb 4a | | 744 | 672 | 744 | 549 | – | – | – | – | – | 125 | 720 | 744 |
| Turb 5a | | 744 | 672 | 744 | 635 | 26 | 68 | 100 | – | 46 | 209 | 720 | 744 |
| Turb 8 | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | – | 744 | 720 | 744 |
| Turb 6b | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | 238.4 | 220.7 | 131.2 | 50.4 | – | – | – | – | – | 46.4 | 123.7 | 113.2 |
| Turb 6a | | 6.8 | 22.3 | – | – | – | – | – | – | 29.0 | – | – | – |
| Turb 4a | | 32.8 | 35.1 | 27.5 | 17.8 | – | – | – | – | – | 20.5 | 29.0 | 30.8 |
| Turb 5a | | 35.0 | 35.1 | 33.5 | 32.4 | 10.8 | 8.8 | 12.1 | – | 7.6 | 26.9 | 35.2 | 35.2 |
| Turb 8 | | 159.0 | 159.0 | 118.4 | 101.8 | 48.2 | 53.1 | 48.0 | 36.5 | – | 51.8 | 103.9 | 126.8 |
| Turb 6b | | 101.3 | 101.1 | 100.5 | 99.1 | 91.7 | 22.8 | 63.8 | 68.2 | 84.5 | 88.0 | 101.3 | 101.3 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | 88.1 | – | – | – |
| | 1.1218 | 20.6 | 67.9 | – | – | – | – | – | – | – | 66.7 | 94.5 | 100.4 |
| | 1.0475 | 106.8 | 114.3 | 89.5 | 58.0 | – | – | – | – | 24.7 | 87.6 | 114.6 | 114.6 |
| | 1.0475 | 114.1 | 114.4 | 109.2 | 105.6 | 35.1 | 28.6 | 39.3 | – | – | 180.7 | 362.3 | 442.0 |
| | 0.9790 | 554.1 | 554.2 | 412.8 | 354.7 | 167.9 | 185.2 | 167.2 | 127.3 | 294.1 | 306.2 | 352.7 | 352.7 |
| | 0.9801 | 352.7 | 352.1 | 349.9 | 344.8 | 319.3 | 79.2 | 222.0 | 237.3 | | | | |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #8 | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | 51.4% | 47.6% | 28.3% | 10.9% | – | – | – | – | – | 10.0% | 26.7% | 24.4% |
| Turb 6a | | 4.1% | 13.4% | – | – | – | – | – | – | 17.4% | – | – | – |
| Turb 4a | | 93.2% | 99.7% | 78.1% | 50.6% | – | – | – | – | – | 58.2% | 82.4% | 87.6% |
| Turb 5a | | 99.5% | 99.8% | 95.3% | 92.1% | 30.6% | 24.9% | 34.3% | – | 21.5% | 76.4% | 100.0% | 100.0% |
| Turb 8 | | 79.5% | 79.5% | 59.2% | 50.9% | 24.1% | 26.6% | 24.0% | 18.3% | – | 25.9% | 52.0% | 63.4% |
| Turb 6b | | 100.0% | 99.8% | 99.2% | 97.8% | 90.6% | 22.5% | 62.9% | 67.3% | 83.4% | 86.8% | 100.0% | 100.0% |

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| Boiler #8 | | | 4.1% | 12.3% | – | – | – | – | – | – | 16.6% | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 1 | GT | 4.1% | 12.3% | – | – | – | – | – | – | 16.6% | – | – | – |
| Blrs 4–5 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 63.9% | 63.9% | 55.7% | 53.0% | 70.9% | 62.7% | 51.0% | 60.4% | – | 60.4% | 51.2% | 57.1% |
| HRSG #1 | 1 | GT | 4.1% | 12.3% | – | – | – | – | – | – | 16.6% | – | – | – |
| Cost of Steam Supply | | | | | | | | | | | | | | |
| Gas | | | 722 | 731 | 453 | 358 | 229 | 217 | 164 | 145 | 157 | 211 | 353 | 498 |
| Oil | | | 44 | 41 | 28 | 22 | 14 | 14 | 10 | 9 | 3 | 13 | 22 | 31 |
| Lignite | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | | 94 | 95 | 58 | 45 | 31 | 28 | 21 | 19 | 20 | 27 | 45 | 64 |
| Total | | | 860 | 866 | 539 | 426 | 274 | 259 | 195 | 173 | 179 | 251 | 420 | 593 |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| Boiler #8 | | | 60.5% | 55.8% | 62.6% | 62.1% | 59.6% | 74.2% | 74.2% | 74.2% | 48.4% | 58.2% | 62.8% | 62.8% |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | 100.0% | 100.0% | 100.0% | 100.0% | – | – | – | – | – | 100.0% | 100.0% | 100.0% |
| HRSG #2 | 1 | GT | 60.5% | 55.8% | 62.6% | 62.1% | 59.6% | 74.2% | 74.2% | 74.2% | 48.4% | 58.2% | 62.8% | 62.8% |
| Blrs 4–5 | | | 59.4% | 61.4% | 54.1% | 41.6% | – | – | – | – | – | 45.5% | 55.7% | 57.5% |
| Blrs 5–6 | | | 61.4% | 61.4% | 60.0% | 59.0% | 29.2% | 55.5% | 73.2% | – | 22.1% | 53.4% | 61.5% | 61.5% |
| Blr #9 | | | 22.2% | 22.2% | 28.8% | 31.6% | 15.6% | 23.3% | 35.5% | 27.7% | – | 25.7% | 33.4% | 27.3% |
| HRSG #1 | 1 | GT | 60.5% | 55.8% | 62.6% | 62.1% | 59.6% | 74.2% | 74.2% | 74.2% | 48.4% | 58.2% | 62.8% | 62.8% |
| Cost of Hot Water Supply | | | | | | | | | | | | | | |
| Gas | | | 2579 | 2245 | 1844 | 1133 | 571 | 456 | 738 | 298 | 460 | 673 | 1834 | 1845 |
| Oil | | | 137 | 118 | 92 | 49 | 15 | 5 | 22 | 19 | 9 | 22 | 92 | 92 |
| Lignite | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | | 282 | 248 | 207 | 133 | 69 | 25 | 56 | 52 | 57 | 81 | 205 | 208 |
| Total | | | 2,999 | 2,612 | 2,144 | 1,315 | 654 | 486 | 816 | 369 | 526 | 777 | 2,131 | 2,145 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| Boiler #8 | | | 35.4% | 31.8% | 37.4% | 37.9% | 40.4% | 25.8% | 25.8% | 25.8% | 35.0% | 41.8% | 37.2% | 37.2% |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 3–6 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #2 | 1 | GT | 35.4% | 31.8% | 37.4% | 37.9% | 40.4% | 25.8% | 25.8% | 25.8% | 35.0% | 41.8% | 37.2% | 37.2% |
| Blrs 4–5 | | | 40.6% | 38.6% | 45.9% | 58.4% | – | – | – | – | – | 54.5% | 44.3% | 42.5% |
| Blrs 5–6 | | | 38.6% | 38.6% | 40.0% | 41.0% | 70.8% | 44.5% | 26.8% | – | 77.9% | 46.6% | 38.5% | 38.5% |
| Blr #9 | | | 13.9% | 13.9% | 15.5% | 15.4% | 13.5% | 14.0% | 13.5% | 11.9% | – | 13.9% | 15.4% | 15.6% |
| HRSG #1 | 1 | GT | 35.4% | 31.8% | 37.4% | 37.9% | 40.4% | 25.8% | 25.8% | 25.8% | 35.0% | 41.8% | 37.2% | 37.2% |
| Cost of Electric Supply | | | | | | | | | | | | | | |
| Gas | | | 738 | 655 | 729 | 651 | 401 | 181 | 261 | 109 | 340 | 468 | 685 | 732 |
| Oil | | | 32 | 28 | 32 | 27 | 11 | 3 | 8 | 7 | 7 | 15 | 29 | 32 |
| Lignite | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | | 89 | 80 | 87 | 78 | 48 | 12 | 20 | 19 | 42 | 56 | 81 | 87 |
| Total | | | 859 | 763 | 848 | 757 | 460 | 196 | 288 | 135 | 389 | 539 | 796 | 852 |
| Check | | | 516 | 466 | 516 | 499 | 516 | 499 | – | 516 | 499 | 516 | 499 | 516 |
| **Average Cost per Megawatthour:** | | | | | | | | | | | | | | |
| Steam | | | $9.27 | $9.18 | $9.28 | $9.27 | $9.32 | $9.30 | $9.26 | $9.29 | $8.60 | $9.29 | $9.27 | $9.29 |
| Hot Water | | | $8.99 | $8.97 | $8.97 | $8.91 | $8.72 | $17.78 | $12.89 | $6.22 | $8.61 | $8.82 | $8.97 | $8.97 |
| Electricity | | | $6.62 | $6.45 | $6.74 | $6.61 | $4.97 | $2.98 | $5.79 | $2.77 | $6.65 | $5.55 | $6.62 | $6.67 |

**SOFIA TPS**

**CASE S3**

932

TPS Sofia – Case S3

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,428 | 38,549 | 44,455 | 51,265 | 69,105 | 70,860 | 70,152 | 69,450 | 68,756 | 67,990 | 67,311 | 67,311 | 67,311 | 67,311 | 67,311 | 67,311 |
| Oil | 1,678 | 1,787 | 1,906 | 1,955 | 2,007 | 1,627 | 1,670 | 1,653 | 1,636 | 1,619 | 1,599 | 1,583 | 1,583 | 1,583 | 1,583 | 1,583 | 1,583 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,215 | 40,455 | 46,410 | 53,272 | 70,732 | 72,530 | 71,804 | 71,086 | 70,374 | 69,590 | 68,893 | 68,893 | 68,893 | 68,893 | 68,893 | 68,893 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (40,692) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) |
| Net Power Interchange | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (40,692) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) | (41,762) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 | 3,427 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By-Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 11 | 11 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 3,324 | 4,011 | 3,533 | 3,830 | 4,137 | 3,768 | 4,148 | 3,893 | 4,159 | 4,680 | 3,844 | 4,590 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,142 | 33,345 | 38,957 | 45,567 | 39,318 | 40,733 | 39,529 | 39,108 | 38,703 | 37,549 | 37,233 | 36,978 | 37,244 | 37,765 | 36,929 | 37,675 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 16126 | 19140 | 28222 | 43959 | 49043 | 12466 | 4050 | 4050 | 4050 | 17430 | – | – | – | – | – | – | – |
| Domestic | 1122 | 2749 | 3810 | 4443 | 5684 | 2412 | 1174 | 1174 | 1174 | 1717 | – | – | – | – | – | – | – |
| Total | 17247 | 21888 | 32032 | 48402 | 54727 | 14877 | 5224 | 5224 | 5224 | 19147 | – | – | – | – | – | – | – |
| TOTAL COST | 42,187 | 51,030 | 65,377 | 87,359 | 100,294 | 54,195 | 45,957 | 44,753 | 44,331 | 57,850 | 37,549 | 37,233 | 36,978 | 37,244 | 37,765 | 36,929 | 37,675 |
| Present Worth | 40,594 | 45,466 | 53,934 | 66,731 | 70,937 | 35,492 | 27,867 | 25,127 | 23,047 | 27,847 | 16,736 | 15,366 | 14,130 | 13,178 | 12,372 | 11,202 | 10,582 |
| Cumulative Present Worth | 40,594 | 86,061 | 139,995 | 206,726 | 277,662 | 313,154 | 341,022 | 366,149 | 389,196 | 417,043 | 433,779 | 449,144 | 463,275 | 476,452 | 488,824 | 500,027 | 510,608 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 |
| Electricity | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 | 1,365,781 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $15.44 | $17.57 | $18.00 | $18.43 | $18.26 | $18.09 | $17.92 | $17.70 | $17.54 | $17.54 | $17.54 | $17.54 | $17.54 | $17.54 |
| Hot Water | $10.41 | $11.81 | $13.44 | $15.29 | $17.42 | $20.23 | $20.72 | $20.52 | $20.32 | $20.13 | $19.91 | $19.72 | $19.72 | $19.72 | $19.72 | $19.72 | $19.72 |
| Electricity | $14.28 | $16.18 | $18.40 | $20.92 | $23.83 | $19.54 | $20.01 | $19.82 | $19.63 | $19.45 | $19.25 | $19.06 | $19.06 | $19.06 | $19.06 | $19.06 | $19.06 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 82 | 82 | 82 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| $SO_2$ | 1,144 | 1,142 | 1,142 | 1,142 | 1,142 | 902 | 902 | 902 | 902 | 902 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| NOx | 934 | 932 | 932 | 932 | 932 | 737 | 737 | 737 | 737 | 737 | 735 | 735 | 735 | 735 | 735 | 735 | 735 |
| CO | 100 | 100 | 100 | 100 | 100 | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 |

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

CASE S3 — Test Year = 2010

Facilities Data

EXISTING FACILITIES

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Blrs 4–5 | | Blrs 5–6 | | Boiler #7 | Boiler #8 | | | | | HRSG #1 | | Blr #9 | Blr #3 | HWB 4–6 | |
| THERMAL DATA | | | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 84.8% | | 84.8% | | 84.8% | 84.8% | | | | | 100.0% | | 84.4% | 84.4% | 84.5% | |
| Half Load | %2 | | | 84.8% | | 84.8% | | 84.8% | 84.8% | | | | | 100.0% | | 84.4% | 84.4% | 84.5% | |
| Minimum Load | %3 | | | 84.8% | | 84.8% | | 84.8% | 84.8% | | | | | 100.0% | | 84.4% | 84.4% | 84.5% | |
| Minimum Operation | % | | | 26.7% | | 26.7% | | 40.0% | 40.0% | | | | | | | 40.0% | 40.0% | 13.3% | |
| Feedwater Temp | | | | 419° | | 419° | | 419° | 419° | | | | | | | 430° | 212° | 158° | |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | 8 | 6 | | | | | 141.786 | 141.786 | | | | |
| Capacity | MWt | | | 50.000 | | 50.000 | | 135.000 | 135.000 | | | | | 339.09 | | 465.1 | | | |
| Quantity | Mlb/Hr | | | 727.65 | | 727.65 | | 465.1 | 465.1 | | | | | 1541.8 | | 1451 | | | |
| Pressure | PSIA | | | 1451 | | 1451 | | 1451 | 1451 | | | | | 1004 | | 1004° | | | |
| Temperature | Temp °F | | | 950° | | 950° | | 1004° | 1004° | | | | | 1492.2 | | 1.496 | | | |
| Enthalpy | MBTU/lb | | | 1.458 | | 1.458 | | 1.496 | 1.496 | | | | | | | 3 | | | |
| PRODUCT – LP STEAM | Priority | * | | | | | | | | 6 | | | | | | 430.000 | 132.3 | | |
| Quantity | Mlb/Hr | | | | | | | | | 607.15 | | | | | | 159.000 | 53 | | |
| | MWts | | | | | | | | | 166.700 | | | | | | 142.25 | 363 | | |
| Pressure | PSIA | | | | | | | | | 185 | | | | | | – | 770° | | |
| Temperature | Temp °F | | | | | | | | | 559.4° | | | | | | 1.266 | 1.403 | | |
| Enthalpy | MBTU/lb | | | | | | | | | 1.302 | | | | | | 3 | | 7 | |
| PRODUCT – HOT WATER | Priority | Cooling | | 5 | | 4 | | | | | 2 | | | 1 | | 41.000 | | 348.000 | |
| Quantity | MWtw | 200.000 | | 36.190 | | 36.190 | | | | | 101.300 | | | 86.607 | | 240° | | 302° | |
| Temperature – Supply | Temp °F | | | 240° | | 240° | | | | | 240° | | | | | 140° | | 158° | |
| Return | Temp °F | | | 140° | | 140° | | | | | 140° | | | | | | | | |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4c | Turb 5a | Turb 5c | | | Turb 6a | Turb 6b | Turb 6c | GT–6FA | Turb S3a | Turb S3c | Turb 8 | | | |
| | Priority | | | | | | | | | | | | 1 | | | | | | |
| Rated Capacity–Electric | KW | | | | 25000 | | 25000 | | | | | 55000 | | 27665 | 36590 | 25000 | | | |
| Capability – Max Steam | KW1 | | | 12540 | 18000 | 12540 | 18000 | | | 29227 | 34727 | 50000 | | 27665 | 36590 | 25000 | | | |
| 75 % Steam | KW75 | | | 9405 | | 9405 | | | | 21920 | 26046 | | | 19752 | | 18375 | | | |
| 50 % Steam | KW50 | | | 6270 | | 6270 | | | | 14613 | 17364 | | | 11821 | | 11875 | | | |
| 25% Steam | KW25 | | | 3135 | | 3135 | | | | 7307 | 8682 | | | 3898 | | 4375 | | | |
| Steam Required – Maximum | M#/Hr Max | | | 114.660 | | 114.660 | | | | 607.150 | 362.800 | | | 305.181 | | 460.640 | | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | | 192.260 | | | |
| Outlet Steam Pressure | PSI | | | 22.75 | 0.498 | 22.75 | 0.498 | | | 185 | 22.75 | | | 25.0 | | 142.2 | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | 0.293 | | 0.293 | | | | 0.1849 | 0.307 | | | 0.3141 | | 0.228 | | | |
| Sink | MBTU/lbs | | | 1.0475 | | 1.0475 | | | | 1.1218 | 0.9801 | | | 0.9886 | | 0.9790 | | | |
| Generator Efficiency | %g | | | 97.4% | 97.4% | 97.4% | 97.4% | | | 98.6% | 98.6% | 98.6% | | 98.5% | 98.5% | 97.5% | | | |
| Power/Rejection Factor | Factor | | | | 0.360 | | 0.360 | | | | | 0.357 | | | 0.3292 | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | Gas | | | | Gas | | | Gas | Gas | Gas | |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | $2.03 | | | | $2.03 | | | $2.03 | $2.03 | $2.03 | |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | 95.0% | | | | 100.0% | | | 95.0% | 95.0% | 95.0% | |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | Mazut | | | | | | | Mazut | Mazut | Mazut | |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | $2.41 | | | | | | | $2.41 | $2.41 | $2.41 | |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | 5.0% | | | | | | | 5.0% | 5.0% | 5.0% | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 740 | | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 3.0 | | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $298.0 | | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.34 | | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $0.75 | | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.28 | | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | – | | | | | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | ST2–A9 | | | | | | | ST2–A9 | ST2–A9 | ST2–A9 | |
| Emissions Code –Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | ST2–A6 | | | | | | | ST2–A6 | ST2–A6 | ST2–A6 | |
| Scheduled Maintenance | CODE m | | | 884 | ST4 | 885 | ST5 | 887 | 886 | | ST6 | | GT–6FA | STS3 | | 886T8 | 883 | SHWB | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | $0.0269 | | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | | $0.0233 | | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | AVAILABILITY | | | | | | | | | | | | | |
| Jan | –1.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Mar | 4.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | |
| May | 15.6 | | | 33% | 33% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | – | – | 100% | 100% | – | |
| June | 19.0 | | | 67% | 67% | 67% | 67% | 100% | – | 100% | 100% | 100% | – | 100% | 100% | 100% | 100% | – | |
| July | 21.2 | | | 100% | 100% | 33% | 33% | – | 100% | 50% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | – | |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 50% | 50% | 50% | 100% | 100% | 100% | 100% | 100% | – | |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | – | |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Nov | 5.9 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| Dec | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,817 | 4,333 | 3,742 | 2,729 | 2,109 | 862 | 1,543 | 1,449 | 1,936 | 2,069 | 3,575 | 3,826 | 33,010 |
| Oil | 223 | 201 | 157 | 97 | 56 | 55 | 22 | 16 | 48 | 53 | 149 | 162 | 1,239 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 5,040 | 4,534 | 3,899 | 2,826 | 2,165 | 937 | 1,565 | 1,465 | 1,984 | 2,122 | 3,724 | 3,987 | 34,248 |
| Supplemental Cost–Shortfall Penalty | – | – | – | – | – | – | – | – | – | – | – | (0) | (0) |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (3,624) | (3,314) | (3,495) | (2,554) | (2,289) | (575) | (1,827) | (1,739) | (2,206) | (2,546) | (3,338) | (3,533) | (31,038) |
| Net Power Interchange Cost | (3,624) | (3,314) | (3,495) | (2,554) | (2,289) | (575) | (1,827) | (1,739) | (2,206) | (2,546) | (3,338) | (3,533) | (31,038) |
| Other O&M – Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,516 |
| Variable | 509 | 462 | 391 | 281 | 217 | 115 | 144 | 131 | 200 | 206 | 370 | 401 | 3,427 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |
| Total Excluding Maintenance | 2,141 | 1,876 | 1,010 | 780 | 308 | 684 | 96 | 71 | 186 | (3) | 964 | 1,071 | 9,164 |

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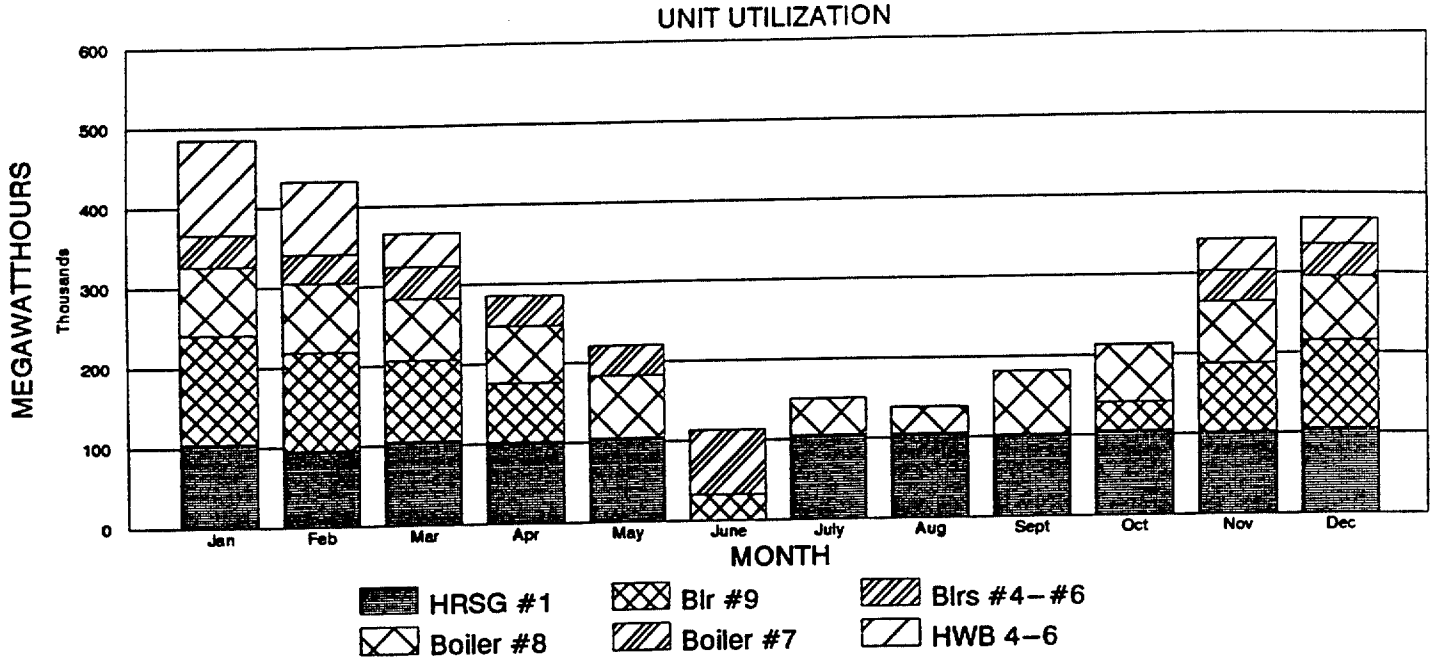
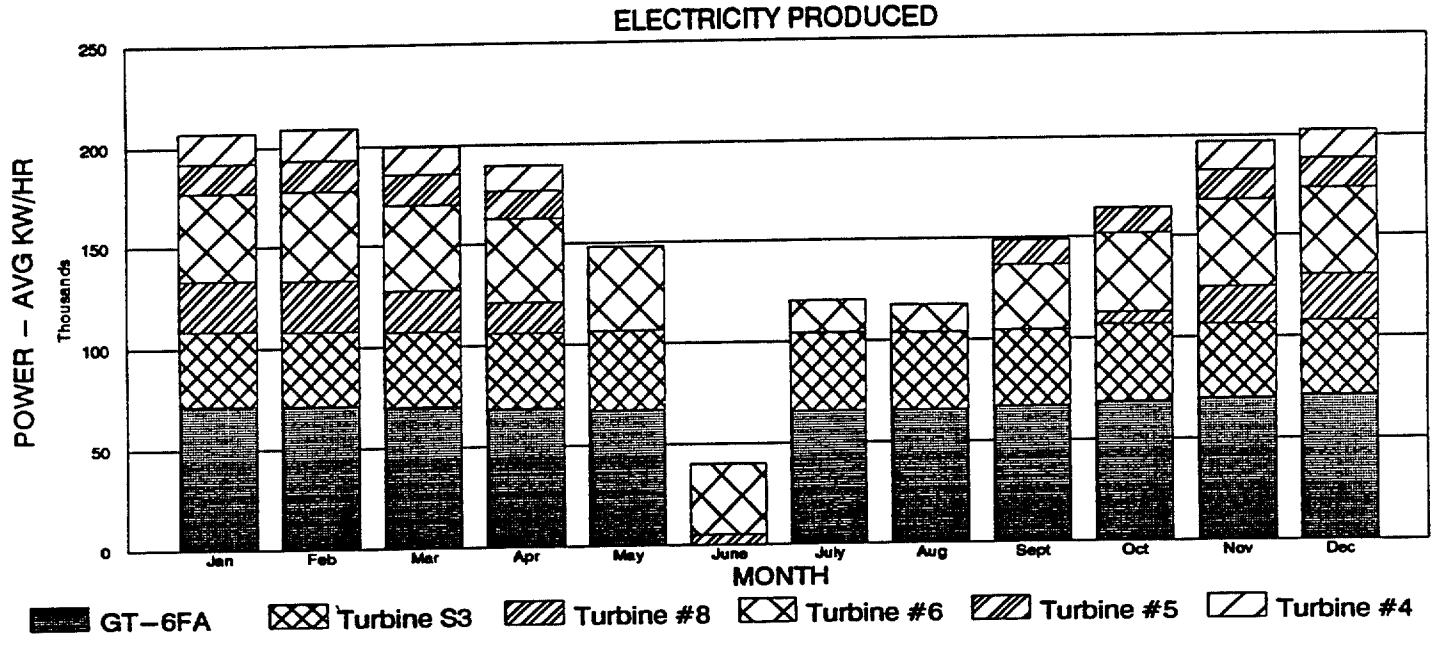
TPS Sofia – Case S3



| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 85556 | 87033 | 53664 | 42829 | 27705 | 25926 | 19405 | 16779 | 19019 | 24378 | 41269 | 58894 |
| Station Use, Losses, etc. | MWH | – | 7282 | 7308 | 4421 | 3059 | 1678 | 1965 | 1648 | 1855 | 1831 | 2668 | 4035 | 4950 |
| | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 166.700 | 1 | 6.7 | 22.3 | – | – | 39.5 | – | 28.3 | 25.0 | 29.0 | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | 159.000 | | 118.0 | 118.1 | 78.1 | 63.7 | – | 38.7 | – | – | – | 36.4 | 62.9 | 85.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5020 | 14998 | – | – | 29383 | – | 21053 | 18634 | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87818 | 79342 | 58085 | 45888 | – | 27891 | – | – | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 290369 | 249102 | 202460 | 117762 | 37406 | 12028 | 34221 | 30955 | 35821 | 62321 | 183229 | 272620 |
| Station Use, Losses, etc. | MWH | – | 43359 | 41906 | 36617 | 29762 | 37589 | 15321 | 29079 | 28296 | 25349 | 25695 | 54506 | –33433 |
| | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | 348.000 | | 155.1 | 134.4 | 79.5 | – | – | – | – | – | – | – | 69.3 | 51.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | 35.190 | | 32.4 | 35.2 | 31.6 | 19.8 | – | – | – | – | – | – | 30.2 | 31.0 |
| Blrs 5–6 | 35.190 | | 32.4 | 35.1 | 32.9 | 21.4 | – | – | – | – | 10.7 | 13.8 | 31.7 | 30.6 |
| Blr #9 | 41.000 | | 41.0 | 40.9 | 36.2 | 31.7 | – | 5.9 | – | – | – | 35.2 | 38.8 | 40.3 |
| Header | 101.300 | 1 | 101.1 | 101.1 | 96.4 | 87.5 | 20.9 | 37.8 | 23.7 | 10.7 | – | 47.3 | 101.3 | 101.3 |
| HRSG #1 | 86.607 | | 86.6 | 86.2 | 85.4 | 85.1 | 82.5 | – | 70.2 | 75.8 | 77.6 | 78.3 | 86.3 | 86.6 |
| Total | | | 448.6 | 433.0 | 363.9 | 245.5 | 103.4 | 43.7 | 93.8 | 86.5 | 88.3 | 174.6 | 357.6 | 341.5 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | | 115363 | 90337 | 37099 | – | – | – | – | – | – | – | 35220 | 26916 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | | | 24074 | 23626 | 17719 | 1132 | – | – | – | – | – | – | 17824 | 19779 |
| Blrs 5–6 | | | 24131 | 23619 | 21222 | 5659 | – | – | – | – | 5310 | 512 | 21667 | 22736 |
| Blr #9 | | | 30478 | 27506 | 26294 | 16473 | – | 117 | – | – | – | 3807 | 27932 | 29952 |
| Header | | | 75246 | 67966 | 73241 | 62992 | 13587 | 27231 | 11088 | 2866 | – | 25478 | 72936 | 75367 |
| HRSG #1 | | | 64436 | 57954 | 63502 | 61268 | 61408 | – | 52212 | 56385 | 55860 | 58220 | 62156 | 64436 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |
| Hot Water Not Served | MWH | | – | –0 | – | – | – | – | – | – | – | – | – | 0 |

ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5020 | 14998 | – | – | 29383 | – | 21053 | 18634 | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87818 | 79342 | 58085 | 45888 | – | 27891 | – | – | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | | 118152 | 90828 | 41174 | – | – | – | – | – | – | – | 38281 | 31867 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | | | 22084 | 23142 | 13644 | 1132 | – | – | – | – | – | – | 15493 | 14984 |
| Blrs 5–6 | | | 24074 | 23627 | 21717 | 6346 | – | – | – | – | 7137 | 694 | 21845 | 23465 |
| Blr #9 | | | 29746 | 27509 | 27205 | 16674 | – | 327 | – | – | – | 3624 | 27453 | 29068 |
| Header | | | 75236 | 68002 | 72142 | 65156 | 35504 | 27021 | 14853 | 7251 | – | 35939 | 72508 | 75367 |
| HRSG #1 | | | 64436 | 57900 | 63195 | 56215 | 39492 | – | 48447 | 52000 | 54034 | 47759 | 62156 | 64436 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 |

936

TPS Sofia – Case S3

LOAD DISPATCH AND ENERGY USE – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | 38281 | 31867 |
| HWB 4–6 | 118152 | 90828 | 41174 | – | – | – | 21053 | 18634 | 20850 | – | – | – |
| Header | 5020 | 14998 | – | – | 29383 | – | – | – | – | – | 15493 | 14984 |
| Blrs 4–5 | 22084 | 23142 | 13844 | 1132 | – | – | – | – | 7137 | 694 | 21845 | 23465 |
| Blrs 5–6 | 24074 | 23627 | 21717 | 6346 | – | – | – | – | – | 30669 | 72777 | 92912 |
| Blr #9 | 117565 | 106851 | 85290 | 62562 | – | 28218 | – | – | – | 35939 | 72508 | 75367 |
| Header | 75236 | 68002 | 72142 | 65156 | 35504 | 27021 | 14853 | 7251 | – | 47759 | 62156 | 64436 |
| HRSG #1 | 64436 | 57900 | 63195 | 58215 | 39492 | – | 48447 | 52000 | 54034 | 115062 | 283059 | 303031 |
| Total | 426566 | 385348 | 297163 | 193411 | 104378 | 55239 | 84353 | 77885 | 82020 | | | |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 0.99 | 893 | 2668 | – | – | 5226 | – | 3745 | 3314 | 3709 | – | – | – |
| Turb 4a | 0.97 | 8077 | 8464 | 4990 | 414 | – | – | – | – | – | – | 5666 | 5480 |
| Turb 5a | 0.97 | 8805 | 8642 | 7943 | 2321 | – | – | – | – | 2610 | 254 | 7990 | 8582 |
| Turb 8 | 0.98 | 19077 | 17231 | 15665 | 11266 | – | 3988 | – | – | – | 4458 | 13242 | 17167 |
| Turb 6b | 0.99 | 26160 | 23645 | 25085 | 22656 | 12345 | 9396 | 5165 | 2521 | – | 12497 | 25212 | 26206 |
| Turb S3a | 0.99 | 20689 | 18756 | 20428 | 18678 | 11629 | – | 14958 | 16276 | 17127 | 14703 | 20140 | 20889 |
| Total | | 83901 | 79405 | 74111 | 55336 | 29201 | 13384 | 23867 | 22112 | 23446 | 31911 | 72249 | 78324 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 9010 | 6433 | 8405 | 994 | – | – | – | – | – | – | 8238 | 9851 |
| Turb 5c | 7948 | 6174 | 6450 | 4003 | – | – | – | – | 10001 | 663 | 7453 | 8273 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 17067 | 12442 | 20300 | 22386 | 33583 | 44820 | – | – | 54848 | 24305 | 18061 | 18402 |
| Turb S3c | 20165 | 18624 | 21866 | 25192 | 54368 | – | 42084 | 37213 | 30925 | 43027 | 19790 | 20165 |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | - | 40176 | 36288 | 40176 | 38880 | 38440 | 81238 | – | – | – | – | 38880 | 40176 |
| HWB 4–6 | - | 118152 | 90828 | 41174 | – | – | – | – | – | – | – | 38281 | 31867 |
| Boiler #8 | - | 84200 | 85467 | 77351 | 71318 | 77602 | – | 44815 | 32506 | 79406 | 72741 | 76900 | 79800 |
| Blrs 4–5 | - | 39171 | 38039 | 27040 | 2540 | – | – | – | – | – | – | 29397 | 30315 |
| Blrs 5–6 | - | 40827 | 38443 | 36110 | 12670 | – | – | – | – | 19747 | 1611 | 37287 | 40320 |
| Blr #9 | - | 136641 | 124082 | 100955 | 73828 | – | 32206 | – | – | – | 35127 | 86019 | 110079 |
| | - | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | - | 105489 | 95280 | 105489 | 102086 | 105489 | – | 105489 | 105489 | 102086 | 105489 | 102086 | 105489 |
| Total | | 564658 | 508426 | 428294 | 301323 | 221530 | 113444 | 150304 | 137995 | 201240 | 214968 | 408850 | 438046 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | 3.412 | 137081 | 123815 | 137081 | 132659 | 131156 | 277182 | – | – | – | – | 132659 | 137081 |
| HWB 4–6 | 3.412 | 403136 | 309905 | 140486 | – | – | – | – | – | – | – | 130616 | 108731 |
| Boiler #8 | 3.412 | 287289 | 291612 | 263921 | 243337 | 264777 | – | 152909 | 110910 | 270934 | 248191 | 262384 | 272277 |
| Blrs 4–5 | 3.412 | 133652 | 129788 | 92259 | 8668 | – | – | – | – | – | – | 100302 | 103436 |
| Blrs 5–6 | 3.412 | 139302 | 131166 | 123206 | 43232 | – | – | – | – | 67376 | 5498 | 127225 | 137573 |
| Blr #9 | 3.412 | 466221 | 423369 | 344459 | 251901 | – | 109888 | – | – | – | 119855 | 293496 | 375588 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1568679 | 1409655 | 1101411 | 679796 | 395933 | 387070 | 152909 | 110910 | 338312 | 373545 | 1046881 | 1134684 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | – | – | – | 84.8% | 84.8% |
| HWB 4–6 | – | – | 84.5% | 84.5% | 84.5% | – | – | – | – | – | – | – | 84.5% | 84.5% |
| Boiler #8 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% |
| Blrs 4–5 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | – | – | – | – | – | – | 84.8% | 84.8% |
| Blrs 5–6 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | – | – | – | – | 84.8% | 84.8% | 84.8% | 84.8% |
| Blr #9 | – | – | 84.4% | 84.4% | 84.4% | 84.4% | – | 84.4% | – | – | – | 84.4% | 84.4% | 84.4% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | | Unit Energy Input MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | 161747 | 146094 | 161747 | 156529 | 154757 | 327059 | – | – | – | – | 156529 | 161747 |
| HWB 4–6 | – | 477083 | 366752 | 166256 | – | – | – | – | – | – | – | 154576 | 128675 |
| Boiler #8 | – | 338984 | 344085 | 311412 | 287123 | 312421 | – | 180424 | 130868 | 319686 | 292851 | 309597 | 321271 |
| Blrs 4–5 | – | 157701 | 153142 | 108860 | 10227 | – | – | – | – | – | – | 118350 | 122047 |
| Blrs 5–6 | – | 164368 | 154769 | 145375 | 51011 | – | – | – | – | 79502 | 6489 | 150118 | 162328 |
| Blr #9 | – | 552394 | 501622 | 408126 | 298461 | – | 130199 | – | – | – | 142008 | 347744 | 445009 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1852277 | 1666463 | 1301776 | 803351 | 467178 | 457258 | 180424 | 130868 | 399188 | 441347 | 1236913 | 1341078 |

TPS Sofia – Case S3

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Boiler #7 | $1.93 | 312 | 282 | 312 | 302 | 298 | 631 | – | – | – | – | 302 | 312 |
| HWB 4–6 | $1.93 | 920 | 707 | 321 | – | – | – | – | – | – | – | 298 | 248 |
| Boiler #8 | $1.93 | 654 | 664 | 601 | 554 | 603 | – | 348 | 252 | 617 | 565 | 597 | 620 |
| Blrs 4–5 | $1.93 | 304 | 295 | 210 | 20 | – | – | – | – | – | – | 228 | 235 |
| Blrs 5–6 | $1.93 | 317 | 298 | 280 | 98 | – | – | – | – | 153 | 13 | 290 | 313 |
| Blr #9 | $1.93 | 1065 | 967 | 787 | 576 | – | 251 | – | – | – | 274 | 671 | 858 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 3572 | 3214 | 2510 | 1549 | 901 | 882 | 348 | 252 | 770 | 851 | 2385 | 2586 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | $0.12 | 19 | 18 | 19 | 19 | 19 | 39 | – | – | – | – | 19 | 19 |
| HWB 4–6 | $0.12 | 57 | 44 | 20 | – | – | – | – | – | – | – | 19 | 16 |
| Boiler #8 | $0.12 | 41 | 41 | 38 | 35 | 38 | – | 22 | 16 | 39 | 35 | 37 | 39 |
| Blrs 4–5 | $0.12 | 19 | 18 | 13 | 1 | – | – | – | – | – | – | 14 | 15 |
| Blrs 5–6 | $0.12 | 20 | 19 | 18 | 6 | – | – | – | – | 10 | 1 | 18 | 20 |
| Blr #9 | $0.12 | 67 | 60 | 49 | 36 | – | 16 | – | – | – | 17 | 42 | 54 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 223 | 201 | 157 | 97 | 56 | 55 | 22 | 16 | 48 | 53 | 149 | 162 |
| HOT WATER SHORTFALL | MWH | – | –0 | – | – | – | – | – | – | – | – | – | 0 |
| Assumed Equivalent Cost | $/MWH $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | – | –0.0 | – | – | – | – | – | – | – | – | – | 0.0 |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Variable O&M Expense $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | $0.03 | $0.75 | 36 | 33 | 36 | 35 | 38 | 80 | – | – | – | – | 35 | 36 |
| HWB 4–6 | $0.03 | $0.75 | 92 | 70 | 32 | – | – | – | – | – | – | – | 30 | 25 |
| Boiler #8 | $0.03 | $0.75 | 76 | 78 | 69 | 64 | 77 | – | 44 | 33 | 86 | 68 | 69 | 71 |
| Blrs 4–5 | $0.03 | $0.75 | 36 | 34 | 25 | 2 | – | – | – | – | – | – | 27 | 28 |
| Blrs 5–6 | $0.03 | $0.75 | 37 | 34 | 32 | 12 | – | – | – | – | 19 | 2 | 34 | 36 |
| Blr #9 | $0.03 | $0.75 | 139 | 126 | 101 | 75 | – | 35 | – | – | – | 37 | 85 | 111 |
| | $0.03 | $0.75 | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | $0.03 | $0.75 | 95 | 85 | 95 | 93 | 102 | – | 99 | 98 | 94 | 100 | 92 | 95 |
| Total | | – | 509 | 462 | 391 | 281 | 217 | 115 | 144 | 131 | 200 | 206 | 370 | 401 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Boiler #8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 4–5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Emissions Penalties $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | – | 0 | 0 |
| HWB 4–6 | 0.0008 | 0 | 0 | 0 | – | – | – | – | – | – | – | 0 | 0 |
| Boiler #8 | 0.0008 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | 0 |
| Blrs 4–5 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | – | 0 | 0 |
| Blrs 5–6 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | 0 | 0 | 0 | 0 |
| Blr #9 | 0.0008 | 0 | 0 | 0 | 0 | – | 0 | – | – | – | 0 | 0 | 0 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | | | | | | | | | | | | | |
| Total | | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

## Emissions by Type – Tons

| | Pounds per Tonne | Emissions – Tons | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulate | 2205 | 11.6 | 10.4 | 8.1 | 5.0 | 2.9 | 2.9 | 1.1 | 0.8 | 2.5 | 2.8 | 7.7 | 8.4 |
| $SO_2$ | 2205 | 162.3 | 146.0 | 114.0 | 70.4 | 40.9 | 40.1 | 15.8 | 11.5 | 35.0 | 38.7 | 108.3 | 117.5 |
| NOx | 2205 | 132.5 | 119.2 | 93.1 | 57.5 | 33.4 | 32.7 | 12.9 | 9.4 | 28.6 | 31.5 | 88.5 | 95.9 |
| CO | 2205 | 14.2 | 12.8 | 10.0 | 6.2 | 3.6 | 3.5 | 1.4 | 1.0 | 3.1 | 3.4 | 9.5 | 10.3 |

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TPS Sofia – Case S3

ELECTRIC GENERATION, NET POWER INTERCHANGE AND GAS TURBINE FUEL COST – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |
| Station Use (incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 1183 | 3912 | – | – | 6923 | – | 4960 | 4390 | 5076 | – | – | – |
| Turb 4a | 10574 | 12268 | 8680 | 7051 | – | – | – | – | – | – | 9348 | 8359 |
| Turb 5a | 11527 | 12525 | 11967 | 8551 | – | – | – | – | 5146 | 6687 | 11381 | 11236 |
| Turb 8 | 25000 | 25000 | 20528 | 15257 | – | 5401 | – | – | – | 5842 | 17931 | 22497 |
| Turb 6b | 34652 | 34676 | 33227 | 31010 | 18689 | 12861 | 10857 | 9252 | – | 22851 | 34509 | 34713 |
| Turb S3a | 27655 | 27492 | 27045 | 25553 | 15396 | – | 19603 | 21548 | 23431 | 19465 | 27553 | 27655 |
| Total T/G Output | 110591 | 115873 | 101449 | 87422 | 41007 | 18261 | 35620 | 35191 | 33653 | 54846 | 100720 | 104459 |
| Balance Required | –90376 | –98068 | –87618 | –75590 | –31587 | –13440 | –28573 | –27183 | –24561 | –44819 | –84813 | –86252 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 97.4% | 4246 | 3357 | 5251 | 6097 | – | – | – | – | – | – | 4891 | 5410 |
| Turb 5c | 97.4% | 3746 | 3222 | 3504 | 5309 | – | – | – | – | 7097 | 6288 | 3822 | 3899 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 96.6% | 8080 | 6521 | 9610 | 10951 | 15869 | 21926 | – | – | 26831 | 15885 | 8835 | 6712 |
| Turb S3c | 96.5% | 8768 | 8987 | 9530 | 11346 | 23998 | – | 18342 | 16219 | 13927 | 18753 | 8913 | 6788 |
| Total Condens Turb Output | | 24860 | 22088 | 27895 | 33702 | 39594 | 21926 | 18342 | 16219 | 47856 | 40925 | 26462 | 26809 |
| Balance Required | | –115236 | –118154 | –115513 | –109292 | –71181 | –35356 | –48915 | –43402 | –72417 | –85744 | –111275 | –113061 |
| GT Capability @ Full Load | | 71785 | 71220 | 70317 | 68746 | 67426 | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 71785 | 71220 | 70317 | 68746 | 67426 | – | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |
| Total GT Output (KW) | 71785 | 71220 | 70317 | 68746 | 67426 | – | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |
| Balance Required (KW) | –187020 | –189374 | –185831 | –178038 | –138807 | –35356 | –112800 | –109452 | –139541 | –154353 | –181344 | –184281 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –139143 | –127259 | –134188 | –113158 | –101385 | –25464 | –80936 | –77033 | –97703 | –97722 | –128173 | –135653 |
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0289 | 0.0289 | 0.0289 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0289 | 0.0289 | 0.0289 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| POWER SALES | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 3623.6 | 3314.1 | 3494.5 | 2554.0 | 2288.3 | 574.7 | 1826.7 | 1738.6 | 2205.2 | 2544.9 | 3337.9 | 3532.7 |

GAS TURBINE

Percent Load

| | Percent Load | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Interpolated Fuel Flow – MMBTU

| | Fuel Flow – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 523297 | 469692 | 514768 | 489755 | 498892 | – | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 |
| Total | 523297 | 469692 | 514768 | 489755 | 498892 | – | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 |

Fuel Cost – Gas Turbine(s) (Gas) $(000)

| | Unit Cost | Fuel Cost – Gas $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | $2.03 | 1062.3 | 953.5 | 1045.0 | 994.2 | 1012.8 | – | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 |
| Total | | 1062.3 | 953.5 | 1045.0 | 994.2 | 1012.8 | – | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 |

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TPS Sofia – Case S3

# GAS TURBINE EXHAUST HEAT UTILIZATION AND SUPPLEMENTARY FIRING – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

## GAS TURBINE

### Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1086 | 1088 | 1091 | 1096 | 1101 | – | 1107 | 1106 | 1102 | 1097 | 1092 | 1088 |

### Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1576.6 | 1568.7 | 1555.6 | 1533.2 | 1514.4 | – | 1492.5 | 1494.8 | 1510.1 | 1531.2 | 1552.0 | 1568.7 |

### Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 363.199 | 362.091 | 360.293 | 357.329 | 354.841 | – | 351.879 | 352.200 | 354.264 | 357.072 | 359.795 | 362.091 |

### Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 3.412 | 106.447 | 106.123 | 105.596 | 104.727 | 103.998 | – | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 |
| | | 106.447 | 106.123 | 105.596 | 104.727 | 103.998 | – | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 |

### Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 35.339 | 35.663 | 36.190 | 37.059 | 37.788 | – | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 |
| | 35.339 | 35.663 | 36.190 | 37.059 | 37.788 | – | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 |

### Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| Electric Output Ratio | 33.6% | 33.4% | 33.2% | 32.7% | 32.2% | – | 31.7% | 31.8% | 32.1% | 32.6% | 33.1% | 33.4% |
| Utilized Heat Ratio | 66.4% | 66.6% | 66.8% | 67.3% | 67.8% | – | 68.3% | 68.2% | 67.9% | 67.4% | 66.9% | 66.6% |

### Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 47.5 | 42.5 | 53.3 | 64.3 | 109.1 | 65.1 | 69.0 | 89.5 | 118.7 | 107.2 | 50.5 | 51.1 |
| From Gas Turbines | 200.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 47.5 | 42.5 | 53.3 | 64.3 | 109.1 | 65.1 | 69.0 | 89.5 | 118.7 | 107.2 | 50.5 | 51.1 |

### Supplementary Firing Energy Input = MMBTU

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | | 89708 | 81771 | 91870 | 91040 | 95926 | – | 98130 | 97891 | 93247 | 94266 | 89265 | 90532 |

### Supplementary Firing Fuel Cost (Gas)

| | Unit Cost $/MMBTU | Supplementary Firing Fuel Cost $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 2.03 | 182 | 166 | 186 | 185 | 195 | – | 199 | 199 | 189 | 191 | 181 | 184 |
| Total | | 182 | 166 | 186 | 185 | 195 | – | 199 | 199 | 189 | 191 | 181 | 184 |

TPS Sofia – Case S3

SUPPLEMENTARY DATA

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 7.9 | 26.3 | – | – | 46.5 | – | 33.3 | 29.5 | 34.1 | – | – | – |
| Turb 4a | 40.5 | 47.0 | 33.2 | 27.0 | – | – | – | – | – | – | 35.8 | 32. |
| Turb 5a | 44.2 | 48.0 | 46.0 | 32.8 | – | – | – | – | 19.7 | 25.7 | 43.6 | 43. |
| Turb 8 | 183.7 | 184.6 | 135.7 | 102.6 | – | 44.7 | – | – | – | 47.2 | 119.5 | 147. |
| Turb 6b | 136.3 | 136.4 | 130.7 | 122.0 | 73.5 | 50.6 | 42.8 | 36.4 | – | 89.9 | 135.7 | 136. |
| Turb S3a | 114.7 | 114.1 | 112.4 | 106.7 | 68.6 | – | 85.1 | 91.7 | 98.8 | 83.9 | 114.3 | 114. |

Maximum Steam Flow – MW

| | BASIS KW1 | Total Boiler MW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 18000 | – | 52.6 | 56.6 | 48.2 | 44.4 | 3.0 | 12.5 | 27.9 | 27.9 | 27.9 | 27.9 | 49.8 | 47. |
| Turb 5c | 18000 | – | 54.9 | 57.2 | 55.9 | 47.9 | 27.9 | 12.5 | 3.0 | 27.9 | 40.0 | 43.6 | 54.5 | 54. |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 50000 | – | 167.2 | 181.2 | 158.0 | 153.1 | 156.0 | 112.8 | 31.2 | 28.6 | 110.3 | 135.0 | 160.8 | 161. |
| Turb S3c | 36590 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141. |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 12.1 | 9.6 | 15.0 | 17.4 | 3.0 | 12.5 | 27.9 | 27.9 | 27.9 | 27.9 | 14.0 | 15. |
| Turb 5c | 10.7 | 9.2 | 10.0 | 15.1 | 27.9 | 12.5 | 3.0 | 27.9 | 20.2 | 17.9 | 10.9 | 11. |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 22.9 | 18.5 | 27.3 | 31.1 | 45.1 | 62.3 | – | – | 76.2 | 45.1 | 25.1 | 24. |
| Turb S3c | 27.1 | 27.7 | 29.4 | 35.1 | 73.2 | – | 56.6 | 50.1 | 43.0 | 57.9 | 27.5 | 27. |
| | 72.8 | 65.0 | 81.7 | 98.7 | 149.3 | 87.3 | 87.6 | 106.0 | 167.4 | 148.9 | 77.5 | 78. |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | 744 | 672 | 467 | – | – | – | – | – | – | – | 508 | 51 |
| Turb 6a | | 744 | 672 | – | – | 744 | – | 744 | 744 | 720 | – | – | – |
| Turb 4a | | 744 | 672 | 561 | 57 | – | – | – | – | – | – | 591 | 63 |
| Turb 5a | | 744 | 672 | 645 | 265 | – | – | – | – | 495 | 37 | 684 | 74 |
| Turb 8 | | 744 | 672 | 744 | 720 | – | 720 | – | – | – | 744 | 720 | 74 |
| Turb 6b | | 744 | 672 | 744 | 720 | 652 | 720 | 470 | 271 | – | 539 | 720 | 74 |
| Turb S3a | | 744 | 672 | 744 | 720 | 744 | – | 744 | 744 | 720 | 744 | 720 | 74 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | 158.8 | 135.2 | 88.3 | – | – | – | – | – | – | – | 75.3 | 61. |
| Turb 6a | | 6.7 | 22.3 | – | – | 39.5 | – | 28.3 | 25.0 | 29.0 | – | – | – |
| Turb 4a | | 29.7 | 34.4 | 24.3 | 19.8 | – | – | – | – | – | – | 26.2 | 23. |
| Turb 5a | | 32.4 | 35.2 | 33.6 | 24.0 | – | – | – | – | 14.5 | 18.8 | 32.0 | 31. |
| Turb 8 | | 158.0 | 159.0 | 114.6 | 86.9 | – | 39.2 | – | – | – | 41.2 | 101.1 | 124. |
| Turb 6b | | 101.1 | 101.2 | 97.0 | 90.5 | 54.5 | 37.5 | 31.7 | 27.0 | – | 66.7 | 100.7 | 101. |
| Turb S3a | | 86.6 | 86.1 | 84.9 | 80.8 | 53.0 | – | 65.1 | 69.8 | 75.0 | 64.1 | 86.3 | 86. |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1218 | 20.5 | 67.9 | – | – | 120.1 | – | 86.1 | 76.2 | 88.1 | – | – | – |
| | 1.0475 | 96.7 | 112.2 | 79.2 | 64.5 | – | – | – | – | – | – | 85.4 | 76. |
| | 1.0475 | 105.4 | 114.5 | 109.6 | 78.2 | – | – | – | – | 47.1 | 61.2 | 104.1 | 102. |
| | 0.9790 | 550.7 | 554.2 | 399.5 | 302.9 | – | 136.6 | – | – | – | 143.7 | 352.3 | 435. |
| | 0.9801 | 352.0 | 352.3 | 337.6 | 315.1 | 189.9 | 130.7 | 110.4 | 94.0 | – | 232.1 | 350.6 | 352. |
| | 0.9686 | 305.1 | 303.5 | 299.1 | 284.6 | 186.8 | – | 229.2 | 245.9 | 264.3 | 225.9 | 304.0 | 305. |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | 45.6% | 38.8% | 25.4% | – | – | – | – | – | – | – | 21.6% | 17.6% |
| Turb 6a | | 4.0% | 13.4% | – | – | 23.7% | – | 17.0% | 15.0% | 17.4% | – | – | – |
| Turb 4a | | 84.4% | 97.9% | 69.1% | 56.2% | – | – | – | – | – | – | 74.5% | 66.7% |
| Turb 5a | | 92.0% | 99.9% | 95.6% | 68.2% | – | – | – | – | 41.1% | 53.4% | 90.8% | 89.6% |
| Turb 8 | | 79.0% | 79.5% | 57.3% | 43.5% | – | 19.6% | – | – | – | 20.6% | 50.5% | 62.4% |
| Turb 6b | | 99.8% | 99.9% | 95.7% | 89.3% | 53.8% | 37.0% | 31.3% | 26.7% | – | 65.8% | 99.4% | 100.0% |
| Turb S3a | | 100.0% | 99.5% | 98.0% | 93.3% | 61.2% | – | 75.1% | 80.6% | 86.6% | 74.1% | 99.6% | 100.0% |

TPS Sofia – Case S3

SUPPLEMENTARY DATA

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| Boiler #7 | | | 4.0% | 12.3% | – | – | 25.3% | – | 46.9% | 58.6% | 26.3% | – | – | – |
| HWB 4–6 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Boiler #8 | | | 4.0% | 12.3% | – | – | 25.3% | – | 46.9% | 58.6% | 26.3% | – | – | – |
| Blrs 4–5 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blrs 5–6 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 64.3% | 63.9% | 57.5% | 62.1% | – | 86.6% | – | – | – | 77.0% | 52.7% | 58.0% |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 | GT | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Steam Supply | | | | | | | | | | | | | | |
| | | Gas | 724 | 735 | 453 | 358 | 228 | 217 | 163 | 148 | 162 | 211 | 353 | 49 |
| | | Oil | 45 | 46 | 28 | 22 | 14 | 14 | 10 | 9 | 10 | 13 | 22 | 3 |
| | | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Other Exp | 94 | 95 | 58 | 47 | 29 | 30 | 21 | 19 | 23 | 29 | 45 | 6 |
| | | Total | 863 | 876 | 540 | 427 | 272 | 261 | 194 | 177 | 195 | 253 | 420 | 59 |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| Boiler #7 | | | 60.5% | 55.9% | 61.4% | 59.1% | 30.6% | 33.3% | 33.2% | 23.0% | – | 49.4% | 62.6% | 62.8% |
| HWB 4–6 | | | 100.0% | 100.0% | 100.0% | – | – | – | – | – | – | – | 100.0% | 100.0% |
| Boiler #8 | | | 60.5% | 55.9% | 61.4% | 59.1% | 30.6% | 33.3% | 33.2% | 23.0% | – | 49.4% | 62.6% | 62.8% |
| Blrs 4–5 | | | 56.4% | 60.8% | 50.5% | 44.6% | – | – | – | – | – | – | 52.7% | 49.4% |
| Blrs 5–6 | | | 59.0% | 61.5% | 60.1% | 50.1% | – | – | – | – | 36.2% | 43.1% | 58.6% | 58.2% |
| Blr #9 | | | 21.8% | 22.2% | 26.9% | 22.6% | – | 1.0% | – | – | – | 10.3% | 31.9% | 26.4% |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 | GT | 61.1% | 60.8% | 59.9% | 57.0% | 37.4% | – | 45.9% | 49.2% | 52.9% | 45.2% | 60.9% | 61.1% |
| Cost of Hot Water Supply | | | | | | | | | | | | | | |
| | | Gas | 2855 | 2493 | 2105 | 1366 | 728 | 212 | 664 | 647 | 673 | 864 | 2089 | 211 |
| | | Oil | 131 | 113 | 85 | 43 | 17 | 13 | 7 | 4 | 3 | 20 | 85 | 8 |
| | | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Other Exp | 290 | 255 | 213 | 136 | 74 | 27 | 60 | 56 | 57 | 83 | 212 | 21 |
| | | Total | 3,275 | 2,861 | 2,404 | 1,545 | 818 | 253 | 732 | 707 | 733 | 966 | 2,386 | 2,41 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| Boiler #7 | | | 35.5% | 31.8% | 38.6% | 40.9% | 44.1% | 66.7% | 19.9% | 18.4% | 73.7% | 50.6% | 37.4% | 37.2% |
| HWB 4–6 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Boiler #8 | | | 35.5% | 31.8% | 38.6% | 40.9% | 44.1% | 66.7% | 19.9% | 18.4% | 73.7% | 50.6% | 37.4% | 37.2% |
| Blrs 4–5 | | | 43.6% | 39.2% | 49.5% | 55.4% | – | – | – | – | – | – | 47.3% | 50.6% |
| Blrs 5–6 | | | 41.0% | 38.5% | 39.9% | 49.9% | – | – | – | – | 63.8% | 56.9% | 41.4% | 41.8% |
| Blr #9 | | | 14.0% | 13.9% | 15.5% | 15.3% | – | 12.4% | – | – | – | 12.7% | 15.4% | 15.6% |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 | GT | 38.9% | 39.2% | 40.1% | 43.0% | 62.6% | – | 54.1% | 50.8% | 47.1% | 54.8% | 39.1% | 38.9% |
| Cost of Electric Supply | | | | | | | | | | | | | | |
| | | Gas | 1238 | 1105 | 1184 | 1005 | 1153 | 452 | 716 | 654 | 1102 | 995 | 1133 | 121 |
| | | Oil | 47 | 42 | 43 | 31 | 25 | 28 | 4 | 3 | 35 | 20 | 42 | 4 |
| | | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Other Exp | 127 | 113 | 120 | 99 | 115 | 58 | 63 | 56 | 120 | 95 | 115 | 12 |
| | | Total | 1,412 | 1,260 | 1,347 | 1,135 | 1,293 | 538 | 783 | 713 | 1,257 | 1,110 | 1,289 | 1,38 |

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**KOSTOV**

**CASE K1**

Kostov Case K1

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 53,726 | 61,818 | 71,289 | 82,210 | 94,805 | 97,001 | 99,465 | 98,470 | 97,486 | 96,511 | 95,517 | 94,562 | 94,562 | 94,562 | 94,562 | 94,562 | 94,562 |
| Oil | 3,105 | 3,304 | 3,524 | 3,616 | 3,711 | 3,800 | 3,900 | 3,860 | 3,820 | 3,781 | 3,741 | 3,702 | 3,702 | 3,702 | 3,702 | 3,702 | 3,702 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 56,831 | 65,122 | 74,813 | 85,826 | 98,515 | 100,801 | 103,365 | 102,330 | 101,306 | 100,292 | 99,257 | 98,264 | 98,264 | 98,264 | 98,264 | 98,264 | 98,264 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (38,977) | (41,571) | (44,339) | (45,496) | (46,688) | (47,911) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) |
| Net Power Interchange | (38,977) | (41,571) | (44,339) | (45,496) | (46,688) | (47,911) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) |
| Fixed O&M and Overheads | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| Other Variable O & M | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Maintenance Expenses | 5,683 | 7,200 | 6,408 | 6,242 | 6,148 | 7,724 | 6,760 | 6,682 | 6,650 | 8,135 | 7,301 | 7,105 | 7,185 | 8,887 | 7,707 | 7,738 | 7,701 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 31,333 | 38,547 | 44,678 | 54,368 | 65,771 | 68,410 | 68,750 | 67,638 | 66,581 | 67,051 | 65,183 | 63,994 | 64,074 | 65,775 | 64,595 | 64,627 | 64,590 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 13153 | 20588 | 25268 | 25489 | 57662 | 15352 | 4243 | 4243 | 4243 | 15965 | – | – | – | – | 3363 | – | – |
| Domestic | 1322 | 4755 | 5874 | 5939 | 6810 | 2862 | 1228 | 1228 | 1228 | 1604 | – | – | – | – | 71 | – | – |
| Total | 14474 | 25343 | 31141 | 31428 | 64472 | 18214 | 5471 | 5471 | 5471 | 17569 | – | – | – | – | 3434 | – | – |
| TOTAL COST | 45,807 | 63,890 | 75,820 | 85,797 | 130,243 | 86,624 | 74,221 | 73,109 | 72,052 | 84,620 | 65,183 | 63,994 | 64,074 | 65,775 | 68,029 | 64,627 | 64,590 |
| Present Worth | 44,078 | 56,924 | 62,549 | 65,537 | 92,119 | 56,729 | 45,006 | 41,048 | 37,458 | 40,733 | 29,053 | 26,410 | 24,484 | 23,272 | 22,287 | 19,604 | 18,141 |
| Cumulative Present Worth | 44,078 | 101,002 | 163,552 | 229,089 | 321,207 | 377,937 | 422,943 | 463,991 | 501,449 | 542,182 | 571,235 | 597,645 | 622,129 | 645,401 | 667,688 | 687,292 | 705,434 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 |
| Hot Water | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 |
| Electricity | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.51 | $11.90 | $13.52 | $15.37 | $17.50 | $17.90 | $18.33 | $18.16 | $17.99 | $17.82 | $17.64 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 |
| Hot Water | $10.43 | $11.83 | $13.46 | $15.31 | $17.44 | $17.80 | $18.23 | $18.06 | $17.89 | $17.72 | $17.54 | $17.38 | $17.38 | $17.38 | $17.38 | $17.38 | $17.38 |
| Electricity | $18.12 | $20.51 | $23.31 | $26.49 | $30.16 | $30.85 | $31.60 | $31.30 | $31.00 | $30.71 | $30.41 | $30.12 | $30.12 | $30.12 | $30.12 | $30.12 | $30.12 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| $SO_2$ | 2,116 | 2,111 | 2,111 | 2,111 | 2,111 | 2,107 | 2,107 | 2,107 | 2,107 | 2,107 | 2,106 | 2,106 | 2,106 | 2,106 | 2,106 | 2,106 | 2,106 |
| NOx | 1,728 | 1,724 | 1,724 | 1,724 | 1,724 | 1,721 | 1,721 | 1,721 | 1,721 | 1,721 | 1,720 | 1,720 | 1,720 | 1,720 | 1,720 | 1,720 | 1,720 |
| CO | 186 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 |

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

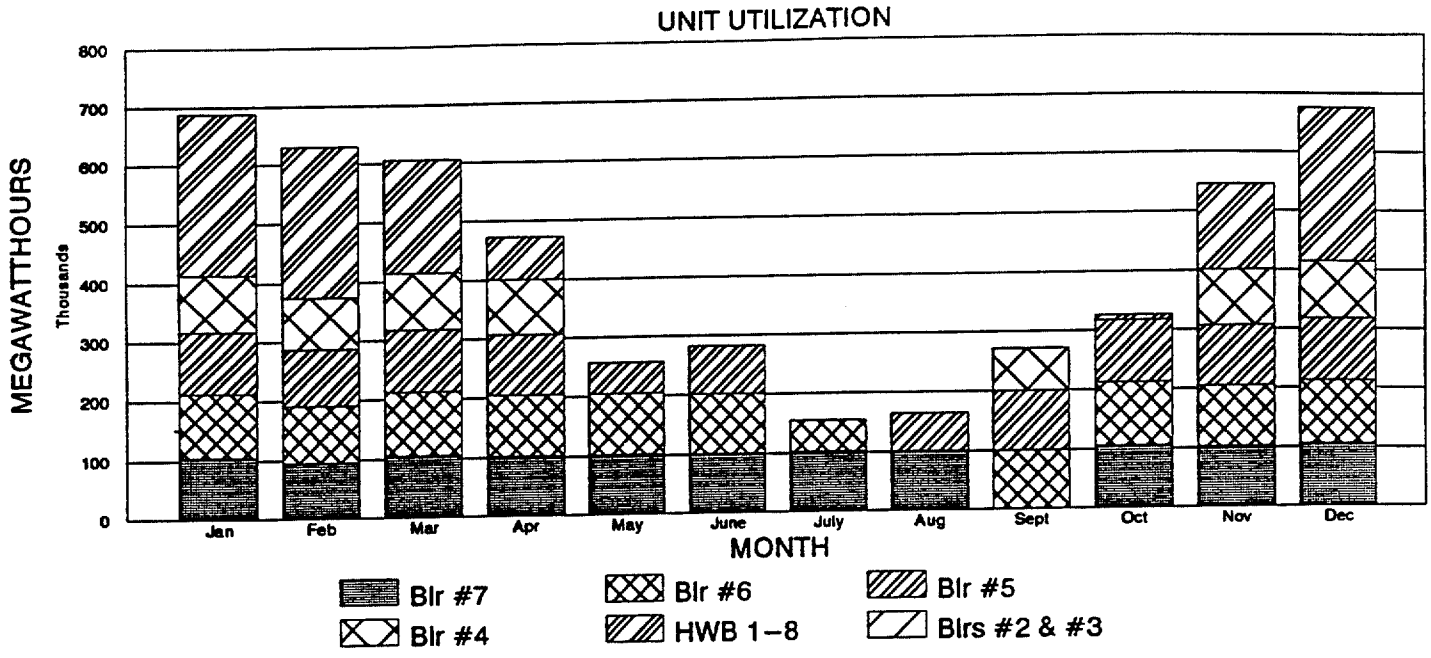
CASE K1 — Test Year = 2010

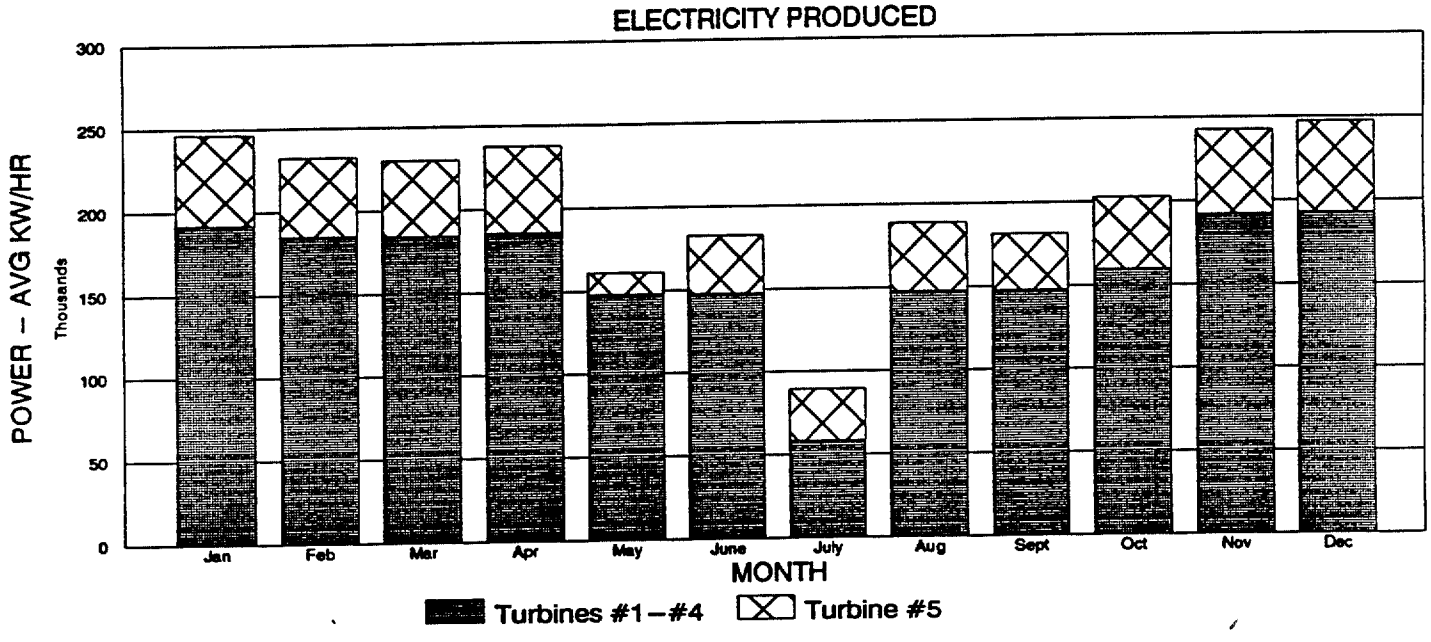
## Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | | | |
| | | | | | Br #1 | Br #2 | Br #3 | Br #4 | | | | Br #5 | Br #6 | Br #7 | | | HWB 1–8 |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | | 84.5% | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% |
| Half Load | %2 | | | | 84.5% | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% |
| Minimum Load | %3 | | | | 84.5% | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% |
| Minimum Operation | % | | | | 40.0% | 40.0% | 40.0% | 40.0% | | | | 40.0% | 40.0% | 40.0% | | | 5.0% |
| Feedwater Temp | | | | | | | | | | | | | | | | | |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | 8 | 7 | 6 | 4 | | | | 3 | 2 | 1 | | | |
| Capacity | MWt | | | | 130.930 | 130.930 | 130.930 | 130.930 | | | | 142.040 | 142.040 | 142.040 | | | |
| Quantity | Mlb/Hr | | | | 407.925 | 407.925 | 407.925 | 407.925 | | | 296.008 | 416.950 | 416.950 | 416.950 | | | |
| Pressure | PSIA | | | | 1393 | 1393 | 1393 | 1393 | | | 208.292 | 1978 | 1978 | 1978 | | | |
| Temperature | Temp °F | | | | 1004° | 1004° | 1004° | 1004° | | | 83.432 | 975° | 975° | 975° | | | |
| Enthalpy | MBTU/lb | | | | 1.499 | 1.499 | 1.499 | 1.499 | | | 296.008 | 1.471 | 1.471 | 1.471 | | | |
| PRODUCT – LP STEAM | Priority | * | | | | | | | 4 | | | | | | 3 | | |
| Quantity | Mlb/Hr | | | | | | | | 793.800 | | | | | | 441.000 | | |
| | MWs | | | | | | | | 274.000 | | | | | | 147.040 | | |
| Pressure | PSIA | | | | | | | | 156.5 | | | | | | 142 | | |
| Temperature | Temp °F | | | | | | | | 559° | | | | | | 930° | | |
| Enthalpy | MBTU/lb | | | | | | | | 1.309 | | | | | | 1.240 | | |
| PRODUCT – HOT WATER | Priority | | | Cooling | | | | | | 2 | | | | | | 1 | 5 |
| Quantity | MWtw | | | 200.000 | | | | | | 177.200 | | | | | | 113.100 | 928.000 |
| Temperature – Supply | Temp °F | | | | | | | | | 310° | | | | | | 185° | 302° |
| Return | Temp °F | | | | | | | | | 156° | | | | | | 116° | 156° |
| TURBINE DATA | UNITe | | | | | | | | Turb 1–4a | Turb 1–4b | Turb 1–4c | | | | Turb 5a | Turb 5b | |
| | Priority | | | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | | | | | | | 120000 | | | | | 66000 | |
| Capability – Max Steam | KW1 | | | | | | | | 56740 | 58284 | 108000 | | | | 29394 | 46620 | |
| 75 % Steam | KW75 | | | | | | | | 42556 | 43716 | | | | | 22045 | 33483 | |
| 50 % Steam | KW50 | | | | | | | | 28372 | 29144 | | | | | 14697 | 18941 | |
| 25% Steam | KW25 | | | | | | | | 14184 | 14572 | | | | | 7167 | 6237 | |
| Steam Required – Maximum | M#/Hr_Max | | | | | | | | 793.800 | 154.350 | | | | | 441.000 | 410.130 | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | | | | 156.5 | 17 | | | | | 142 | 11.38 | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | | | | | 0.185 | 0.293 | | | | | 0.231 | 0.343 | |
| Sink | MBTU/lbs | | | | | | | | 1.178 | 0.979 | | | | | 1.1380 | 0.9410 | |
| Generator Efficiency | %g | | | | | | | | 97.4% | 97.4% | 97.4% | | | | 98.5% | 98.5% | |
| Power/Rejection Factor | Factor | | | | | | | | | | 0.424 | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | | Gas | Gas | Gas | Gas | | | | Gas | Gas | Gas | | | Gas |
| Cost | $/MMBTU | | | | $2.03 | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 | | | $2.03 |
| Percent Use | % Use | | | | 95.0% | 95.0% | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% | | | 95.0% |
| Secondary/Supplemental Fue | Type | | | | Mazut | Mazut | Mazut | Mazut | | | | Mazut | Mazut | Mazut | | | Mazut |
| Cost | $/MMBTU | | | | $2.41 | $2.41 | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 | | | $2.41 |
| Percent Use | % Use | | | | 5.0% | 5.0% | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% | | | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 652 | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $255.0 | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | | ST2–A9 | ST2–A9 | ST2–A9 | ST2–A9 | | | | ST2–A9 | ST2–A9 | ST2–A9 | | | ST2–A9 |
| Emissions Code – Fuel 2 | CODEe2 | | | | ST2–A6 | ST2–A6 | ST2–A6 | ST2–A6 | | | | ST2–A6 | ST2–A6 | ST2–A6 | | | ST2–A6 |
| Scheduled Maintenance | CODE m | | | | | | | KB1–4 | | | KT1–4 | | | KB5–7 | | KT5 | KHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | AVAILABILITY | | | | | | | | | | | | |
| Jan | –1.7 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Feb | 0.8 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mar | 4.8 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Apr | 10.8 | | | | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| May | 15.6 | | | | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – |
| June | 19.0 | | | | 100% | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – |
| July | 21.2 | | | | 100% | 100% | 100% | 100% | 100% | 100% | – | – | 100% | 100% | 100% | 100% | – |
| Aug | 20.6 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | 100% | 100% | – |
| Sept | 16.7 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Oct | 11.3 | | | | 100% | 100% | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Nov | 5.9 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dec | 0.8 | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 6,599 | 5,740 | 5,554 | 4,612 | 2,001 | 2,197 | 1,203 | 1,281 | 2,110 | 3,262 | 5,301 | 6,513 | 46,374 |
| Oil | 412 | 359 | 347 | 288 | 125 | 137 | 75 | 80 | 132 | 204 | 331 | 407 | 2,898 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 7,012 | 6,098 | 5,901 | 4,900 | 2,126 | 2,335 | 1,278 | 1,361 | 2,242 | 3,466 | 5,632 | 6,920 | 49,271 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (4,305) | (3,628) | (4,008) | (3,567) | (2,213) | (2,248) | (1,077) | (1,058) | (2,194) | (3,715) | (4,179) | (4,353) | (36,544) |
| Net Power Interchange Cost | (4,305) | (3,628) | (4,008) | (3,567) | (2,213) | (2,248) | (1,077) | (1,058) | (2,194) | (3,715) | (4,179) | (4,353) | (36,544) |
| Other O&M – Fixed, OH & Other | 188 | 170 | 188 | 182 | 188 | 182 | 188 | 188 | 182 | 188 | 182 | 188 | 2,211 |
| Variable | 770 | 670 | 659 | 561 | 260 | 280 | 142 | 154 | 268 | 410 | 631 | 761 | 5,565 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 20 |
| Total Excluding Maintenance | 3,668 | 3,313 | 2,741 | 2,077 | 361 | 549 | 532 | 646 | 499 | 350 | 2,269 | 3,518 | 20,523 |

Kostov Case K1



LOAD DISPATCH AND ENERGY USE

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 33929 | 35722 | 30155 | 22358 | 8965 | 15801 | 14390 | 11739 | 11443 | 12251 | 16762 | 29858 |
| Station Use, Losses, etc. | MWH | – | 2950 | 3159 | 2691 | 1936 | 782 | 1403 | 1256 | 1111 | 1032 | 1148 | 1583 | 2774 |
| | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 274.000 | 1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 147.040 | 1 | 49.6 | 57.9 | 44.1 | 33.7 | 13.1 | 23.9 | 21.0 | 17.3 | 17.3 | 18.0 | 25.5 | 43.9 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 434909 | 372648 | 330923 | 227886 | 41156 | 58277 | 53161 | 49854 | 53712 | 110894 | 307759 | 421768 |
| Station Use, Losses, etc. | MWH | – | 49879 | 47769 | 43499 | 36800 | 21062 | 27598 | 29248 | 28644 | 31421 | 34865 | 41975 | 54696 |
| | | | 484788 | 420417 | 374422 | 264686 | 62218 | 85875 | 82409 | 78498 | 85133 | 145759 | 349734 | 476464 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | 928.000 | | 367.0 | 374.2 | 249.1 | 120.6 | – | – | – | – | – | 63.6 | 198.0 | 351.8 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 177.200 | 1 | 173.7 | 153.5 | 154.6 | 158.0 | 23.8 | 11.2 | 16.3 | 8.3 | 13.4 | 73.2 | 175.7 | 176.2 |
| Header | 113.100 | 1 | 110.9 | 97.9 | 99.6 | 113.1 | 63.4 | 110.6 | 98.7 | 103.8 | 108.2 | 112.3 | 112.1 | 112.4 |
| Total | | | 651.6 | 625.6 | 503.3 | 391.7 | 87.2 | 121.8 | 115.0 | 112.1 | 121.6 | 249.1 | 485.7 | 640.4 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | | | 273065 | 251480 | 185343 | 69482 | – | – | – | – | – | 7740 | 142531 | 261743 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 129234 | 103129 | 114996 | 113772 | 15067 | 6211 | 8966 | 1264 | 7216 | 54482 | 126476 | 131067 |
| Header | | | 82489 | 65808 | 74083 | 61432 | 47151 | 79664 | 73443 | 77234 | 77917 | 83538 | 80727 | 83655 |
| Total | | | 484788 | 420417 | 374422 | 264686 | 62218 | 85875 | 82409 | 78496 | 85133 | 145759 | 349734 | 476464 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | | | 273739 | 255645 | 190882 | 71590 | – | – | – | – | – | 8950 | 144157 | 261945 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 129351 | 103665 | 114117 | 113204 | 34153 | 29161 | 28884 | 7950 | 28239 | 64085 | 125174 | 131092 |
| Header | | | 81698 | 61107 | 69422 | 79892 | 28065 | 56714 | 53525 | 70548 | 56894 | 72724 | 80403 | 83427 |
| Total | | | 484788 | 420417 | 374422 | 264686 | 62218 | 85875 | 82409 | 78496 | 85133 | 145759 | 349734 | 476464 |

BEST AVAILABLE COPY

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | 273739 | 255645 | 190882 | 71590 | – | – | – | – | – | 8950 | 144157 | 261945 |
| Header | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| Header | 129351 | 103865 | 114117 | 113204 | 34153 | 29161 | 28884 | 7950 | 28239 | 64085 | 125174 | 131092 |
| Header | 81898 | 61107 | 69422 | 79892 | 28065 | 56714 | 53525 | 70548 | 56894 | 72724 | 80403 | 83427 |
| Total | 521667 | 459298 | 407268 | 288980 | 71965 | 103079 | 98055 | 91348 | 97608 | 159158 | 368079 | 509096 |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4a | 0.97 | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 5a | 0.99 | 7393 | 7836 | 6554 | 4807 | 1929 | 3404 | 3096 | 2543 | 2468 | 2651 | 3630 | 6510 |
| Turb 1–4b | 0.97 | 44521 | 40212 | 44521 | 43085 | 37807 | 33319 | 33003 | 9084 | 32266 | 44521 | 43085 | 44521 |
| Turb 5b | 0.99 | 34055 | 24776 | 28265 | 33348 | 7916 | 22196 | 20283 | 28796 | 22290 | 29823 | 33589 | 34871 |
| Total | | 85969 | 72824 | 79341 | 81240 | 47651 | 58919 | 56382 | 40423 | 57024 | 76995 | 80304 | 85901 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 240495 | 205583 | 227031 | 222154 | 137326 | 120195 | – | 32769 | 116395 | 182806 | 232733 | 242034 |
| | – | – | – | – | – | – | – | – | – | – | – | – |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit Utilization MWH | | | | | | | | | | | |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | – | 62535 | 35194 | 38965 | 37708 | – | – | – | – | – | 38965 | 41613 | 63230 |
| Blr #3 | – | 97412 | 72528 | 69347 | 82000 | – | – | – | – | – | 54013 | 94270 | 97412 |
| HWB 1–8 | – | 273739 | 255645 | 190882 | 71590 | – | – | – | – | – | 8950 | 144157 | 261945 |
| Blr #4 | 1 | 97412 | 87985 | 97412 | 94270 | – | – | – | – | 71437 | – | 94270 | 97412 |
| Blr #5 | 1 | 105678 | 95451 | 105678 | 102269 | 53163 | 81205 | – | 64273 | 99795 | 105678 | 102269 | 105678 |
| Blr #6 | 1 | 105678 | 95451 | 105678 | 102269 | 101889 | 100494 | 52028 | – | 99795 | 105678 | 102269 | 105678 |
| Blr #7 | 2 | 105678 | 95451 | 105678 | 102269 | 101889 | 100494 | 102410 | 100266 | – | 105678 | 102269 | 105678 |
| Total | | 848131 | 737705 | 713639 | 592373 | 256942 | 282193 | 154437 | 164539 | 271027 | 418961 | 681116 | 837032 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
| Blr #1 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | 3.412 | 213368 | 120082 | 132948 | 128659 | – | – | – | – | – | 132948 | 141985 | 215741 |
| Blr #3 | 3.412 | 332369 | 247465 | 236612 | 279783 | – | – | – | – | – | 184291 | 321648 | 332369 |
| HWB 1–8 | 3.412 | 933998 | 872262 | 651290 | 244264 | – | – | – | – | – | 30538 | 491863 | 893755 |
| Blr #4 | 3.412 | 332369 | 300205 | 332369 | 321648 | – | – | – | – | 243744 | – | 321648 | 332369 |
| Blr #5 | 3.412 | 360573 | 325678 | 360573 | 348941 | 181392 | 277071 | – | 219300 | 340501 | 360573 | 348941 | 360573 |
| Blr #6 | 3.412 | 360573 | 325678 | 360573 | 348941 | 347647 | 342885 | 177518 | – | 340501 | 360573 | 348941 | 360573 |
| Blr #7 | 3.412 | 360573 | 325678 | 360573 | 348941 | 347647 | 342885 | 349422 | 342108 | – | 360573 | 348941 | 360573 |
| Total | | 2893822 | 2517049 | 2434937 | 2021178 | 876686 | 962841 | 526940 | 561408 | 924745 | 1429494 | 2323967 | 2855952 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Efficiency | | | | | | | | | | | |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | 84.5% | 84.5% | 84.5% |
| Blr #3 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | 84.5% | 84.5% | 84.5% |
| HWB 1–8 | – | – | 84.7% | 84.7% | 84.7% | 84.7% | – | – | – | – | – | 84.7% | 84.7% | 84.7% |
| Blr #4 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | 84.5% | – | 84.5% | 84.5% |
| Blr #5 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% |
| Blr #6 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | – | 84.5% | 84.5% | 84.5% | 84.5% |
| Blr #7 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | – | 84.5% | 84.5% | 84.5% |

INPUT ENERGY REQUIRED

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit Energy Input MMBTU | | | | | | | | | | | |
| Blr #1 – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 – | 252507 | 142109 | 157335 | 152259 | – | – | – | – | – | 157335 | 168030 | 255314 |
| Blr #3 – | 393337 | 292858 | 280015 | 331104 | – | – | – | – | – | 218096 | 380648 | 393337 |
| HWB 1–8 – | 1102713 | 1029826 | 768937 | 288387 | – | – | – | – | – | 36054 | 580712 | 1055201 |
| Blr #4 – | 393337 | 355272 | 393337 | 380648 | – | – | – | – | 288454 | – | 380648 | 393337 |
| Blr #5 – | 426713 | 385418 | 426713 | 412948 | 214666 | 327895 | – | 259527 | 402959 | 426713 | 412948 | 426713 |
| Blr #6 – | 426713 | 385418 | 426713 | 412948 | 411416 | 405781 | 210081 | – | 402959 | 426713 | 412948 | 426713 |
| Blr #7 – | 426713 | 385418 | 426713 | 412948 | 411416 | 405781 | 413517 | 404861 | – | 426713 | 412948 | 426713 |
| Total | 3422032 | 2976319 | 2879762 | 2391244 | 1037498 | 1139457 | 623598 | 664388 | 1094373 | 1691624 | 2748883 | 3377327 |

948

Kostov Case K1

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Blr #1 | $1.93 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | $1.93 | 487 | 274 | 303 | 294 | – | – | – | – | – | 303 | 324 | 492 |
| Blr #3 | $1.93 | 759 | 565 | 540 | 639 | – | – | – | – | – | 421 | 734 | 759 |
| HWB 1–8 | $1.93 | 2127 | 1986 | 1483 | 556 | – | – | – | – | – | 70 | 1120 | 2035 |
| Blr #4 | $1.93 | 759 | 685 | 759 | 734 | – | – | – | – | 556 | – | 734 | 759 |
| Blr #5 | $1.93 | 823 | 743 | 823 | 796 | 414 | 632 | – | 500 | 777 | 823 | 796 | 823 |
| Blr #6 | $1.93 | 823 | 743 | 823 | 796 | 793 | 783 | 405 | – | 777 | 823 | 796 | 823 |
| Blr #7 | $1.93 | 823 | 743 | 823 | 796 | 793 | 783 | 797 | 781 | – | 823 | 796 | 823 |
| Total | | 6599 | 5740 | 5554 | 4612 | 2001 | 2197 | 1203 | 1281 | 2110 | 3262 | 5301 | 6513 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
| Blr #1 | $0.12 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | $0.12 | 30 | 17 | 19 | 18 | – | – | – | – | – | 19 | 20 | 31 |
| Blr #3 | $0.12 | 47 | 35 | 34 | 40 | – | – | – | – | – | 26 | 46 | 47 |
| HWB 1–8 | $0.12 | 133 | 124 | 93 | 35 | – | – | – | – | – | 4 | 70 | 127 |
| Blr #4 | $0.12 | 47 | 43 | 47 | 46 | – | – | – | – | 35 | – | 46 | 47 |
| Blr #5 | $0.12 | 51 | 46 | 51 | 50 | 26 | 40 | – | 31 | 49 | 51 | 50 | 51 |
| Blr #6 | $0.12 | 51 | 46 | 51 | 50 | 50 | 49 | 25 | – | 49 | 51 | 50 | 51 |
| Blr #7 | $0.12 | 51 | 46 | 51 | 50 | 50 | 49 | 50 | 49 | – | 51 | 50 | 51 |
| Total | | 412 | 359 | 347 | 288 | 125 | 137 | 75 | 80 | 132 | 204 | 331 | 407 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Variable O&M Expense $(000) | | | | | | | | | | | |
| Blr #1 | $0.03 | $0.75 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | $0.03 | $0.75 | 61 | 34 | 38 | 37 | – | – | – | – | – | 38 | 40 | 61 |
| Blr #3 | $0.03 | $0.75 | 95 | 71 | 68 | 80 | – | – | – | – | – | 53 | 91 | 94 |
| HWB 1–8 | $0.03 | $0.75 | 212 | 198 | 148 | 55 | – | – | – | – | – | 7 | 112 | 203 |
| Blr #4 | $0.03 | $0.75 | 95 | 86 | 95 | 92 | – | – | – | – | 71 | – | 91 | 94 |
| Blr #5 | $0.03 | $0.75 | 103 | 94 | 103 | 99 | 54 | 81 | – | 60 | 99 | 104 | 99 | 103 |
| Blr #6 | $0.03 | $0.75 | 103 | 94 | 103 | 99 | 103 | 100 | 48 | – | 99 | 104 | 99 | 103 |
| Blr #7 | $0.03 | $0.75 | 103 | 94 | 103 | 99 | 103 | 100 | 94 | 94 | – | 104 | 99 | 103 |
| Total | | – | 770 | 670 | 659 | 561 | 260 | 280 | 142 | 154 | 268 | 410 | 631 | 761 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions Penalties $(000) | | | | | | | | | | | |
| Blr #1 | 0.0008 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | 0 |
| Blr #3 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | 0 |
| HWB 1–8 | 0.0008 | 1 | 1 | 1 | 0 | – | – | – | – | – | 0 | 0 | 1 |
| Blr #4 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | 0 | – | 0 | 0 |
| Blr #5 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 |
| Blr #6 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 |
| Blr #7 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 |
| Total | | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |

## Emissions by Type – Tons

| | Pounds per Tonne | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions – Tons | | | | | | | | | | | |
| Particulate | 2205 | 21.4 | 18.6 | 18.0 | 15.0 | 6.5 | 7.1 | 3.9 | 4.2 | 6.8 | 10.6 | 17.2 | 21.1 |
| $SO_2$ | 2205 | 299.8 | 260.7 | 252.3 | 209.5 | 90.9 | 99.8 | 54.6 | 58.2 | 95.9 | 148.2 | 240.8 | 295.8 |
| NOx | 2205 | 244.8 | 212.9 | 206.0 | 171.1 | 74.2 | 81.5 | 44.6 | 47.5 | 78.3 | 121.0 | 196.7 | 241.6 |
| CO | 2205 | 26.3 | 22.9 | 22.1 | 18.4 | 8.0 | 8.8 | 4.8 | 5.1 | 8.4 | 13.0 | 21.1 | 26.0 |

Kostov Case K1

ELECTRIC GENERATION AND NET POWER INTERCHANGE – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 24480 | 25130 | 23524 | 18375 | 6952 | 10672 | 10044 | 8591 | 9269 | 11023 | 19839 | 22738 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 24480 | 25130 | 23524 | 18375 | 6952 | 10672 | 10044 | 8591 | 9269 | 11023 | 19839 | 22738 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4a | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 5a | 9788 | 11485 | 8678 | 6576 | 2553 | 4657 | 4099 | 3366 | 3377 | 3510 | 4966 | 8619 |
| Turb 1–4b | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 | 58284 |
| Turb 5b | 45087 | 36317 | 37421 | 45622 | 10480 | 30365 | 26854 | 38124 | 30493 | 39483 | 45952 | 46166 |
| Total T/G Output | 113158 | 106086 | 104383 | 110482 | 71317 | 93306 | 89237 | 99774 | 92155 | 101277 | 109202 | 113069 |
| Balance Required | –88678 | –80956 | –80858 | –92107 | –64366 | –82634 | –79192 | –91183 | –82885 | –90254 | –89363 | –90331 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 97.4% | 133493 | 126340 | 126019 | 127422 | 89763 | 89148 | – | 89148 | 89148 | 101472 | 133491 | 134347 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Condens Turb Output | | 133493 | 126340 | 126019 | 127422 | 89763 | 89148 | – | 89148 | 89148 | 101472 | 133491 | 134347 |
| Balance Required | | –222171 | –207297 | –206878 | –219529 | –154129 | –171782 | –79192 | –180331 | –172033 | –191726 | –222853 | –224678 |
| GT Capability @ Full Load | | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Total GT Output (KW) | – | – | – | – | – | – | – | – | – | – | – | – |
| Balance Required (KW) | –222171 | –207297 | –206878 | –219529 | –154129 | –171782 | –79192 | –180331 | –172033 | –191726 | –222853 | –224678 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –165295 | –139303 | –153917 | –158061 | –98061 | –99622 | –47700 | –46857 | –97208 | –142644 | –160454 | –167160 |
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| POWER SALES | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 4304.6 | 3627.7 | 4008.3 | 3567.4 | 2213.2 | 2248.5 | 1076.6 | 1057.6 | 2194.0 | 3714.7 | 4178.6 | 4353.2 |

Kostov Case K1

HEAT REJECTION – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

GAS TURBINE

Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Electric Output Ratio | – | – | – | – | – | – | – | – | – | – | – | – |
| Utilized Heat Ratio | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 186.2 | 176.2 | 175.8 | 177.7 | 125.2 | 124.3 | – | 124.3 | 124.3 | 141.5 | 186.2 | 187.4 |
| From Gas Turbines | 200.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 186.2 | 176.2 | 175.8 | 177.7 | 125.2 | 124.3 | – | 124.3 | 124.3 | 141.5 | 186.2 | 187.4 |

Kostov Case K1

SUPPLEMENTARY DATA

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4a | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 5a | 59.5 | 69.5 | 53.0 | 40.4 | 15.7 | 28.6 | 25.2 | 20.7 | 20.8 | 21.6 | 30.5 | 52.6 |
| Turb 1–4b | 233.7 | 214.1 | 213.2 | 217.1 | 113.9 | 112.2 | 112.2 | 112.2 | 112.2 | 146.0 | 233.7 | 236.0 |
| Turb 5b | 155.6 | 127.8 | 131.3 | 157.3 | 48.4 | 109.6 | 99.2 | 133.5 | 110.0 | 137.8 | 158.3 | 159.0 |

Maximum Steam Flow – MW

| | BASIS KW1 | Total Boiler MW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 108000 | – | 556.9 | 520.0 | 518.4 | 525.6 | 331.3 | 328.1 | – | 328.1 | 328.1 | 391.7 | 556.9 | 561.4 |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 323.2 | 305.9 | 305.1 | 308.5 | 217.4 | 215.9 | – | 215.9 | 215.9 | 245.7 | 323.2 | 325.3 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | 323.2 | 305.9 | 305.1 | 308.5 | 217.4 | 215.9 | – | 215.9 | 215.9 | 245.7 | 323.2 | 325.3 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | | 744 | 672 | 744 | 576 | – | – | – | – | – | 122 | 720 | 744 |
| Turb 1–4a | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 5a | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Turb 1–4b | | 744 | 672 | 744 | 720 | 632 | 557 | 552 | 152 | 539 | 744 | 720 | 744 |
| Turb 5b | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | | 367.9 | 380.4 | 256.6 | 124.3 | – | – | – | – | – | 73.5 | 200.2 | 352.1 |
| Turb 1–4a | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 5a | | 49.6 | 57.9 | 44.1 | 33.7 | 13.1 | 23.9 | 21.0 | 17.3 | 17.3 | 18.0 | 25.5 | 43.9 |
| Turb 1–4b | | 173.9 | 154.3 | 153.4 | 157.2 | 54.1 | 52.4 | 52.4 | 52.4 | 52.4 | 86.1 | 173.9 | 176.2 |
| Turb 5b | | 109.8 | 90.9 | 93.3 | 111.0 | 37.7 | 78.8 | 71.9 | 94.8 | 79.0 | 97.7 | 111.7 | 112.1 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1780 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1380 | 148.6 | 173.5 | 132.4 | 101.2 | 39.3 | 71.6 | 63.1 | 51.8 | 51.9 | 54.0 | 76.4 | 131.5 |
| | 0.9790 | 605.9 | 537.6 | 534.6 | 548.0 | 188.4 | 182.5 | 182.5 | 182.5 | 182.5 | 300.2 | 605.9 | 614.1 |
| | 0.9410 | 398.2 | 329.7 | 338.3 | 402.3 | 136.8 | 285.6 | 260.9 | 343.8 | 286.5 | 354.4 | 404.9 | 406.6 |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–8 | | 39.6% | 41.0% | 27.6% | 13.4% | – | – | – | – | – | 7.9% | 21.6% | 37.9% |
| Turb 1–4a | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 5a | | 33.7% | 39.3% | 30.0% | 22.9% | 8.9% | 16.3% | 14.3% | 11.7% | 11.8% | 12.2% | 17.3% | 29.8% |
| Turb 1–4b | | 98.1% | 87.1% | 86.6% | 88.7% | 30.5% | 29.6% | 29.6% | 29.6% | 29.6% | 48.6% | 98.1% | 99.4% |
| Turb 5b | | 97.1% | 80.4% | 82.5% | 98.1% | 33.4% | 69.6% | 63.6% | 83.8% | 69.9% | 86.4% | 98.7% | 99.1% |

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Kostov Case K1

SUPPLEMENTARY DATA

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

Steam Supply – Percent of Output and Total Cost

| | Percent of Total Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |
| Blr #2 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |
| Blr #3 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |
| HWB 1–8 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |
| Blr #5 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |
| Blr #6 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |
| Blr #7 | 6.4% | 8.1% | 6.3% | 4.7% | 3.8% | 6.1% | 10.1% | 7.8% | 4.6% | 3.3% | 3.4% | 5.7% |

Cost of Steam Supply

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas | 478 | 520 | 443 | 324 | 179 | 307 | 309 | 221 | 173 | 205 | 241 | 423 |
| Oil | 30 | 32 | 28 | 20 | 11 | 19 | 19 | 14 | 11 | 13 | 15 | 26 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 37 | 39 | 33 | 24 | 10 | 18 | 16 | 13 | 12 | 14 | 18 | 33 |
| Total | 545 | 591 | 504 | 368 | 201 | 344 | 344 | 248 | 196 | 232 | 275 | 482 |

Hot Water Supply – Percent of Output and Total Cost

| | Percent of Total Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |
| Blr #2 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |
| Blr #3 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |
| HWB 1–8 | 100.0% | 100.0% | 100.0% | 100.0% | – | – | – | – | – | 100.0% | 100.0% | 100.0% |
| Blr #4 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |
| Blr #5 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |
| Blr #6 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |
| Blr #7 | 36.7% | 34.2% | 35.1% | 37.1% | 24.2% | 30.4% | 53.4% | 47.7% | 31.4% | 33.4% | 38.3% | 37.3% |

Cost of Hot Water Supply

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas | 2737 | 2202 | 2474 | 2572 | 1143 | 1533 | 1627 | 1348 | 1179 | 2096 | 2704 | 2781 |
| Oil | 171 | 138 | 155 | 161 | 71 | 96 | 102 | 84 | 74 | 131 | 169 | 174 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 423 | 364 | 333 | 248 | 66 | 89 | 83 | 80 | 84 | 146 | 316 | 417 |
| Total | 3,331 | 2,704 | 2,962 | 2,981 | 1,281 | 1,718 | 1,812 | 1,512 | 1,337 | 2,375 | 3,189 | 3,371 |

Electric Supply – Percent of Output and Total Cost

| | Percent of Total Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |
| Blr #2 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |
| Blr #3 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |
| HWB 1–8 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |
| Blr #5 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |
| Blr #6 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |
| Blr #7 | 56.8% | 57.8% | 58.6% | 58.3% | 72.0% | 63.5% | 36.5% | 44.5% | 64.0% | 63.4% | 58.3% | 57.0% |

Cost of Electric Supply

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas | 4234 | 3721 | 4130 | 4041 | 3400 | 3197 | 1113 | 1257 | 2402 | 3984 | 4117 | 4251 |
| Oil | 265 | 232 | 258 | 252 | 212 | 200 | 70 | 79 | 150 | 249 | 257 | 266 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 326 | 281 | 308 | 303 | 197 | 186 | 57 | 75 | 172 | 265 | 311 | 327 |
| Total | 4,825 | 4,234 | 4,697 | 4,596 | 3,809 | 3,583 | 1,239 | 1,410 | 2,724 | 4,497 | 4,686 | 4,844 |

**KOSTOV**

**Case K2**

Kostov Case K2

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 53,726 | 61,818 | 71,289 | 82,210 | 94,805 | 112,882 | 115,750 | 114,592 | 113,446 | 112,312 | 111,163 | 110,052 | 110,052 | 110,052 | 110,052 | 110,052 | 110,052 |
| Oil | 3,105 | 3,304 | 3,524 | 3,616 | 3,711 | 3,342 | 3,430 | 3,395 | 3,360 | 3,325 | 3,290 | 3,256 | 3,256 | 3,256 | 3,256 | 3,256 | 3,256 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 56,831 | 65,122 | 74,813 | 85,826 | 98,515 | 116,224 | 119,179 | 117,987 | 116,806 | 115,637 | 114,453 | 113,308 | 113,308 | 113,308 | 113,308 | 113,308 | 113,308 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (38,977) | (41,571) | (44,339) | (45,496) | (46,688) | (70,189) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) |
| Net Power Interchange | (38,977) | (41,571) | (44,339) | (45,496) | (46,688) | (70,189) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) | (72,035) |
| Fixed O&M and Overheads | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| Other Variable O & M | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 | 6,023 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By-Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 20 | 20 | 20 | 20 | 20 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Maintenance Expenses | 5,683 | 7,200 | 6,408 | 6,242 | 6,148 | 8,256 | 7,287 | 7,204 | 7,166 | 8,843 | 7,802 | 7,598 | 7,669 | 9,360 | 8,369 | 8,189 | 8,139 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 31,333 | 38,547 | 44,678 | 54,368 | 65,771 | 62,542 | 62,683 | 61,407 | 60,188 | 60,696 | 58,471 | 57,122 | 57,193 | 58,884 | 57,893 | 57,713 | 57,662 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 13282 | 27056 | 38205 | 54598 | 73684 | 15352 | 4243 | 4243 | 4243 | 13892 | – | – | – | – | 3363 | – | – |
| Domestic | 1323 | 4755 | 6305 | 6946 | 8246 | 2862 | 1228 | 1228 | 1228 | 1527 | – | – | – | – | 71 | – | – |
| Total | 14605 | 31812 | 44510 | 61544 | 81930 | 18214 | 5471 | 5471 | 5471 | 15419 | – | – | – | – | 3434 | – | – |
| TOTAL COST | 45,938 | 70,359 | 89,189 | 115,912 | 147,701 | 80,756 | 68,154 | 66,878 | 65,659 | 76,115 | 58,471 | 57,122 | 57,193 | 58,884 | 61,326 | 57,713 | 57,662 |
| Present Worth | 44,204 | 62,688 | 73,578 | 88,541 | 104,467 | 52,886 | 41,327 | 37,550 | 34,134 | 36,639 | 26,061 | 23,574 | 21,855 | 20,834 | 20,091 | 17,507 | 16,196 |
| Cumulative Present Worth | 44,204 | 106,891 | 180,470 | 269,011 | 373,478 | 426,364 | 467,691 | 505,241 | 539,375 | 576,015 | 602,076 | 625,649 | 647,504 | 668,338 | 688,429 | 705,936 | 722,132 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 |
| Hot Water | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 |
| Electricity | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 | 2,307,745 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.51 | $11.90 | $13.52 | $15.37 | $17.50 | $17.91 | $18.34 | $18.17 | $18.00 | $17.83 | $17.65 | $17.49 | $17.49 | $17.49 | $17.49 | $17.49 | $17.49 |
| Hot Water | $10.43 | $11.83 | $13.46 | $15.31 | $17.44 | $19.20 | $19.67 | $19.48 | $19.30 | $19.11 | $18.93 | $18.75 | $18.75 | $18.75 | $18.75 | $18.75 | $18.75 |
| Electricity | $18.12 | $20.51 | $23.31 | $26.49 | $30.16 | $26.70 | $27.35 | $27.09 | $26.83 | $26.57 | $26.32 | $26.07 | $26.07 | $26.07 | $26.07 | $26.07 | $26.07 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 151 | 151 | 151 | 151 | 151 | 132 | 132 | 132 | 132 | 132 | 132 | 132 | 132 | 132 | 132 | 132 | 132 |
| $SO_2$ | 2,116 | 2,111 | 2,111 | 2,111 | 2,111 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 | 1,853 |
| NOx | 1,728 | 1,724 | 1,724 | 1,724 | 1,724 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 |
| CO | 186 | 185 | 185 | 185 | 185 | 163 | 163 | 163 | 163 | 163 | 163 | 163 | 163 | 163 | 163 | 163 | 163 |

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

Test Year = 2010

CASE K2

## Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | | | | |
| | | | | Blr #1&2 | Blr #3 | Blr #4 | | | | Blr #5 | Blr #6 | Blr #7 | | | HWB 1-7 | | HRSG #1 | |
| THERMAL DATA | | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% | | 100.0% | |
| Half Load | %2 | | | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% | | 100.0% | |
| Minimum Load | %3 | | | 84.5% | 84.5% | 84.5% | | | | 84.5% | 84.5% | 84.5% | | | 84.7% | | 100.0% | |
| Minimum Operation | % | | | 20.0% | 40.0% | 40.0% | | | | 40.0% | 40.0% | 40.0% | | | 5.0% | | | |
| Feedwater Temp | | | | | | | | | | | | | | | | | | |
| Operation Adjustment Factor | Factor, | | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | 8 | 7 | 6 | | | | 4 | 3 | 2 | | | | | | |
| Capacity | MWt | | | 261.860 | 130.930 | 130.930 | | | | 142.040 | 142.040 | 142.040 | | | | | 141.786 | 141.786 |
| Quantity | Mlb/Hr | | | 815.85 | 407.925 | 407.925 | | | | 418.950 | 418.950 | 418.950 | | | | | 339.09 | |
| Pressure | PSIA | | | 1393 | 1393 | 1393 | | | | 1978 | 1978 | 1978 | | | | | 1541.8 | |
| Temperature | Temp °F | | | 1004° | 1004° | 1004° | | | | 975° | 975° | 975° | | | | | 1004° | |
| Enthalpy | MBTU/lb | | | 1.499 | 1.499 | 1.499 | | | | 1.471 | 1.471 | 1.471 | | | | | 1.492 | |
| PRODUCT – LP STEAM | Priority | * | | | | | 5 | | | | | | 4 | | | | | |
| Quantity | Mlb/Hr | | | | | | 793.800 | | | | | | 441.000 | | | | | |
| | MWts | | | | | | 274.000 | | | | | | 147.040 | | | | | |
| Pressure | PSIA | | | | | | 156.5 | | | | | | 142 | | | | | |
| Temperature | Temp °F | | | | | | 559° | | | | | | 830° | | | | | |
| Enthalpy | MBTU/lb | | | | | | 1.309 | | | | | | 1.240 | | | | | |
| PRODUCT – HOT WATER | Priority | Cooling | | | | | | 3 | | | | | | 2 | 6 | | 1 | |
| Quantity | MWtw | 200.000 | | | | | | 177.200 | | | | | | 113.100 | 812.000 | | 86.607 | |
| Temperature – Supply | Temp °F | | | | | | | 310° | | | | | | 185° | 302° | | | |
| Return | Temp °F | | | | | | | 158° | | | | | | 118° | 158° | | | |
| TURBINE DATA | UNITs | | | | | | Turb 1-4a | Turb 1-4b | Turb 1-4c | | | | Turb 5a | Turb 5b | | GT-6FA | Turb K2b | Turb K2c |
| | Priority | | | | | | | | | | | | | | | 1 | | |
| Rated Capacity-Electric | KW | | | | | | | | 120000 | | | | | 66000 | | | 27665 | 36590 |
| Capability – Max Steam | KW1 | | | | | | 56740 | 58284 | 108000 | | | | 29394 | 46620 | | | 27665 | 36590 |
| 75 % Steam | KW75 | | | | | | 42556 | 43716 | | | | | 22045 | 33483 | | | 19752 | |
| 50 % Steam | KW50 | | | | | | 28372 | 29144 | | | | | 14697 | 19941 | | | 11821 | |
| 25% Steam | KW25 | | | | | | 14184 | 14572 | | | | | 7167 | 6237 | | | 2898 | |
| Steam Required – Maximum | M#/Hr Max | | | | | | 793.800 | 154.350 | | | | | 441.000 | 410.130 | | | 305.181 | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | | 156.5 | 17 | | | | | 142 | 11.38 | | | 25 | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | | | 0.185 | 0.293 | | | | | 0.231 | 0.343 | | | 0.3141 | |
| Sink | MBTU/lbs | | | | | | 1.178 | 0.979 | | | | | 1.1380 | 0.9410 | | | 0.9686 | |
| Generator Efficiency | %g | | | | | | 97.4% | 97.4% | 97.4% | | | | 98.5% | 98.5% | | | 98.5% | 0.985 |
| Power/Rejection Factor | Factor | | | | | | | | 0.424 | | | | | | | | | 0.3292 |
| FUELS DATA | | | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | Gas | Gas | | | | Gas | Gas | Gas | | | Gas | Gas | | |
| Cost | $/MMBTU | | | $2.03 | $2.03 | $2.03 | | | | $2.03 | $2.03 | $2.03 | | | $2.03 | $2.03 | | |
| Percent Use | % Use | | | 95.0% | 95.0% | 95.0% | | | | 95.0% | 95.0% | 95.0% | | | 95.0% | 100.0% | | |
| Secondary/Supplemental Fue | Type | | | Mazut | Mazut | Mazut | | | | Mazut | Mazut | Mazut | | | Mazut | | | |
| Cost | $/MMBTU | | | $2.41 | $2.41 | $2.41 | | | | $2.41 | $2.41 | $2.41 | | | $2.41 | | | |
| Percent Use | % Use | | | 5.0% | 5.0% | 5.0% | | | | 5.0% | 5.0% | 5.0% | | | 5.0% | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 652 | | | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $255.0 | | | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | ST2-A9 | ST2-A9 | ST2-A9 | | | | ST2-A9 | ST2-A9 | ST2-A9 | | | ST2-A9 | | | |
| Emissions Code – Fuel 2 | CODEe2 | | | ST2-A6 | ST2-A6 | ST2-A6 | | | | ST2-A6 | ST2-A6 | ST2-A6 | | | ST2-A6 | | | |
| Scheduled Maintenance | CODE m | | | | | KB1-4 | | KT1-4 | | | | KB5-7 | | KT5 | KHWB | GT-6FA | STS3 | |
| Purchased Power | $/KW | | | | | | | | | | | | | | | | | |
| Energy Charge – Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | Max GT? | AVAILABILITY | | | | | | | | | | | | | | | |
| Jan | -1.7 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Feb | 0.8 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Mar | 4.8 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Apr | 10.8 | No | | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| May | 15.6 | No | | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | 100% | 100% |
| June | 19.0 | No | | 100% | 100% | – | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | – | – | – |
| July | 21.2 | No | | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | 100% | 100% | 100% | – | 100% | 100% | 100% |
| Aug | 20.6 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | 100% | 100% | – | 100% | 100% | 100% |
| Sept | 16.7 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | 100% | – | 100% | 100% | 100% |
| Oct | 11.3 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Nov | 5.8 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Dec | 0.8 | No | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 7,382 | 6,527 | 6,376 | 5,116 | 2,639 | 2,197 | 2,592 | 2,568 | 2,500 | 2,870 | 5,964 | 7,259 | 53,970 |
| Oil | 362 | 338 | 321 | 246 | 89 | 137 | 87 | 86 | 83 | 103 | 298 | 376 | 2,548 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 7,745 | 6,864 | 6,698 | 5,361 | 2,728 | 2,335 | 2,679 | 2,654 | 2,583 | 2,974 | 6,263 | 7,635 | 56,519 |
| Supplemental Cost-Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (6,416) | (5,600) | (6,125) | (4,979) | (3,133) | (2,248) | (2,959) | (2,981) | (2,882) | (3,664) | (6,106) | (6,443) | (53,537) |
| Net Power Interchange Cost | (6,416) | (5,600) | (6,125) | (4,979) | (3,133) | (2,248) | (2,959) | (2,981) | (2,882) | (3,664) | (6,106) | (6,443) | (53,537) |
| Other O&M – Fixed, OH & Other | 188 | 170 | 188 | 182 | 188 | 182 | 188 | 188 | 182 | 188 | 182 | 188 | 2,211 |
| Variable | 818 | 727 | 716 | 578 | 295 | 280 | 284 | 281 | 270 | 300 | 568 | 806 | 6,023 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By-Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 17 |
| Total Excluding Maintenance | 2,337 | 2,164 | 1,479 | 1,144 | 78 | 549 | 193 | 142 | 154 | (202) | 1,007 | 2,188 | 11,233 |

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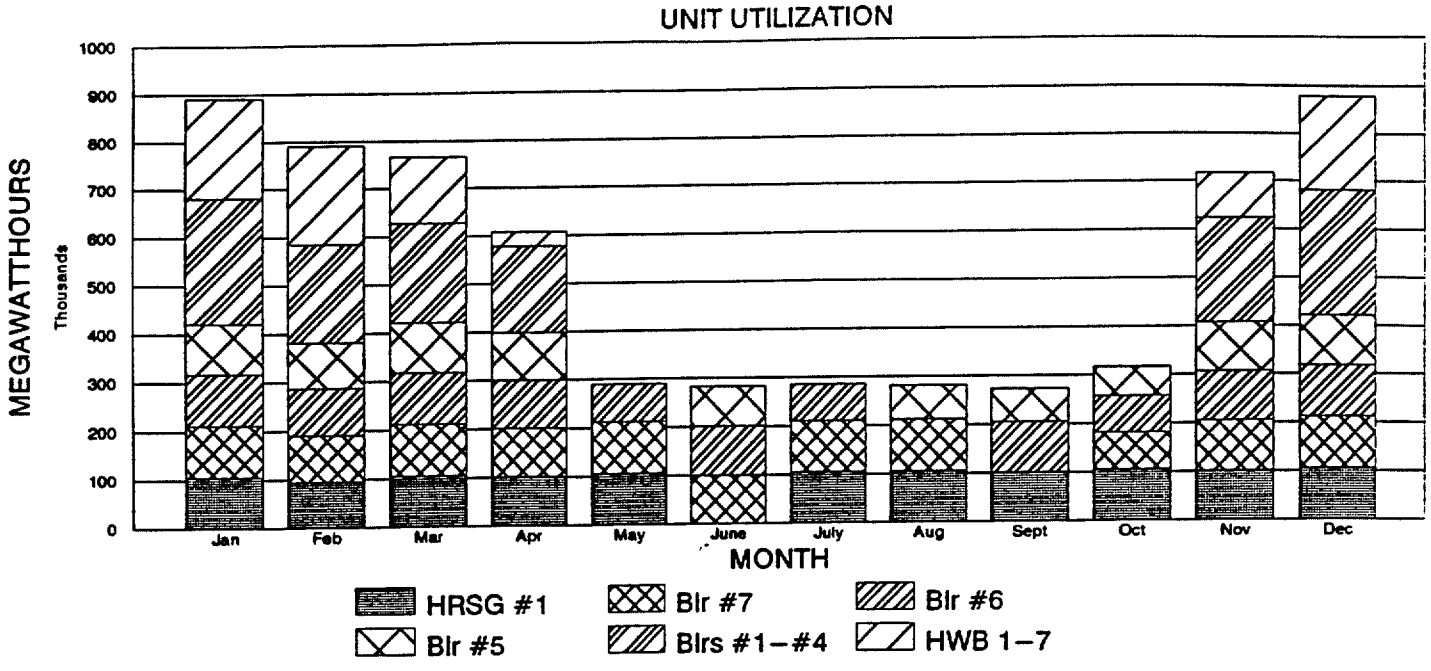
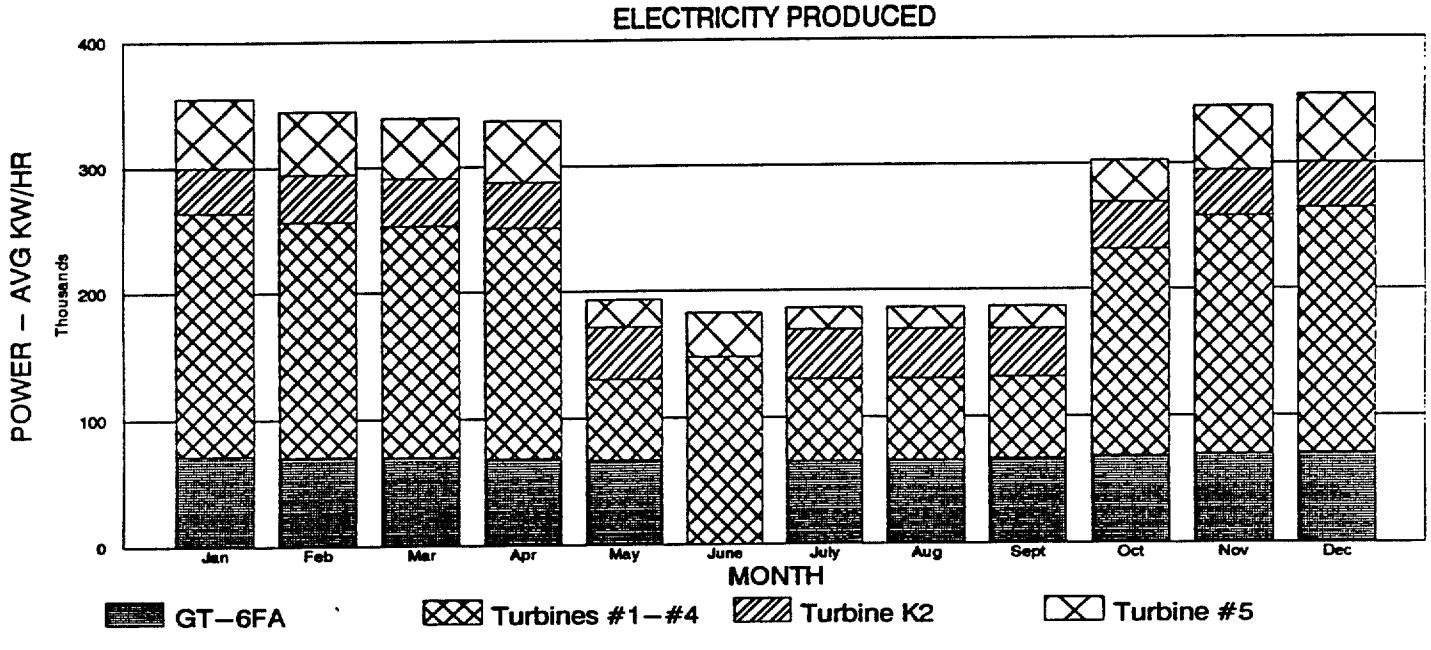
Kostov Case K2

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| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 33929 | 35722 | 30155 | 22358 | 8965 | 15801 | 14390 | 11739 | 11443 | 12251 | 16762 | 29858 |
| Station Use, Losses, etc. | MWH | – | 2950 | 3159 | 2691 | 1936 | 782 | 1403 | 1256 | 1111 | 1032 | 1148 | 1583 | 2774 |
| | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 274.000 | 1 | – | – | – | – | 13.1 | – | 21.0 | 17.3 | 17.3 | – | – | – |
| Header | 147.040 | 1 | 49.6 | 57.9 | 44.1 | 33.7 | – | 23.9 | – | – | – | 18.0 | 25.5 | 43.9 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | – | – | – | – | 9747 | – | 15646 | 12850 | 12475 | – | – | – |
| Header | | | 36879 | 38881 | 32846 | 24294 | – | 17204 | – | – | – | 13399 | 18345 | 32632 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 434909 | 372648 | 330923 | 227886 | 41156 | 58277 | 53161 | 49854 | 53712 | 110894 | 307759 | 421768 |
| Station Use, Losses, etc. | MWH | – | 49879 | 47769 | 43499 | 36800 | 21062 | 27598 | 29248 | 28644 | 31421 | 34865 | 41975 | 54696 |
| | | | 484788 | 420417 | 374422 | 264686 | 62218 | 85875 | 82409 | 78498 | 85133 | 145759 | 349734 | 476464 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | 812.000 | | 282.1 | 299.4 | 194.4 | 67.6 | – | – | – | – | – | 22.2 | 137.6 | 266.0 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 177.200 | 1 | 173.7 | 153.5 | 148.5 | 147.2 | – | 11.2 | – | – | – | 80.6 | 167.5 | 176.1 |
| Header | 113.100 | 1 | 110.8 | 98.0 | 99.6 | 108.0 | 35.8 | 110.6 | 37.4 | 22.8 | 35.1 | 80.2 | 112.1 | 112.4 |
| HRSG #1 | 86.607 | | 84.9 | 74.7 | 75.6 | 85.5 | 47.8 | – | 73.6 | 82.7 | 83.1 | 84.5 | 85.1 | 85.8 |
| Total | | | 651.6 | 625.6 | 518.1 | 408.4 | 83.6 | 121.8 | 111.0 | 105.5 | 118.2 | 267.6 | 502.3 | 640.4 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | | | 209910 | 201225 | 133577 | 26410 | – | – | – | – | – | 897 | 87157 | 197902 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 129242 | 103126 | 110487 | 98901 | – | 6211 | – | – | – | 22279 | 120604 | 131044 |
| Header | | | 82458 | 65837 | 74083 | 77787 | 26647 | 79664 | 27664 | 16983 | 25293 | 59696 | 80727 | 83655 |
| HRSG #1 | | | 63177 | 50229 | 56275 | 61588 | 35571 | – | 54745 | 61515 | 59840 | 62887 | 61246 | 63864 |
| Total | | | 484788 | 420417 | 374422 | 264686 | 62218 | 85875 | 82409 | 78498 | 85133 | 145759 | 349734 | 476464 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | – | – | – | – | 9747 | – | 15646 | 12850 | 12475 | – | – | – |
| Header | | | 36879 | 38881 | 32846 | 24294 | – | 17204 | – | – | – | 13399 | 18345 | 32632 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 36879 | 38881 | 32846 | 24294 | 9747 | 17204 | 15646 | 12850 | 12475 | 13399 | 18345 | 32632 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | | | 210523 | 204889 | 138239 | 29448 | – | – | – | – | – | 1642 | 90820 | 198101 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 129389 | 104189 | 110485 | 98181 | – | 29161 | – | – | – | 26229 | 117283 | 131072 |
| Header | | | 82489 | 65811 | 74083 | 76309 | 46247 | 56714 | 39151 | 38965 | 38253 | 58795 | 80723 | 83655 |
| HRSG #1 | | | 62387 | 45528 | 51615 | 60748 | 15971 | – | 43258 | 39533 | 46880 | 59092 | 60908 | 63636 |
| Total | | | 484788 | 420417 | 374422 | 264686 | 62218 | 85875 | 82409 | 78498 | 85133 | 145759 | 349734 | 476464 |

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TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | 210523 | 204889 | 138239 | 29448 | – | – | – | – | – | 1642 | 90820 | 198101 |
| Header | – | – | – | – | 9747 | – | 15646 | 12850 | 12475 | – | – | – |
| Header | 36879 | 38881 | 32846 | 24294 | – | 17204 | – | – | – | 13399 | 18345 | 32632 |
| Header | 129389 | 104189 | 110485 | 98181 | – | 29161 | – | – | – | 26229 | 117283 | 131072 |
| Header | 82489 | 65811 | 74083 | 76309 | 46247 | 56714 | 39151 | 38965 | 38253 | 58795 | 80723 | 83655 |
| HRSG #1 | 62387 | 45526 | 51615 | 60748 | 15971 | – | 43258 | 39533 | 46880 | 59092 | 60908 | 63636 |
| Total | 521667 | 459296 | 407268 | 288960 | 71965 | 103079 | 98055 | 91348 | 97608 | 159158 | 368079 | 509096 |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4a | 0.97 | – | – | – | – | 2072 | – | 3325 | 2731 | 2652 | – | – | – |
| Turb 5a | 0.99 | 7393 | 7836 | 6554 | 4807 | – | 3404 | – | – | – | 2651 | 3630 | 6510 |
| Turb 1–4b | 0.97 | 44521 | 40212 | 44521 | 40198 | – | 33319 | – | – | – | 16531 | 43085 | 44521 |
| Turb 5b | 0.99 | 34428 | 26995 | 30463 | 31658 | 16484 | 22196 | 13002 | 12887 | 12720 | 23035 | 33739 | 34978 |
| Turb K2b | 0.99 | 20129 | 14167 | 16133 | 19618 | 2169 | – | 13029 | 11644 | 14474 | 18906 | 19677 | 20592 |
| Total | | 106470 | 89210 | 97672 | 96281 | 20725 | 58919 | 29356 | 27263 | 29846 | 61124 | 100131 | 106601 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 240529 | 206046 | 223820 | 200695 | 109232 | 120195 | 108248 | 108714 | 105201 | 70029 | 225759 | 242016 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb K2c | 22973 | 35586 | 37740 | 21721 | 67348 | – | 49202 | 54311 | 40732 | 27490 | 21501 | 21261 |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | - | 63771 | 35194 | 38965 | – | – | – | – | – | – | – | 37708 | 63526 |
| Blr #3 | - | 97412 | 80438 | 69362 | 88755 | – | – | – | – | – | – | 83781 | 97412 |
| HWB 1–7 | - | 210523 | 204889 | 138239 | 29448 | – | – | – | – | – | 1642 | 90820 | 198101 |
| Blr #4 | - | 97412 | 87985 | 97412 | 91052 | – | – | – | – | – | – | 94270 | 97412 |
| Blr #5 | - | 105678 | 95451 | 105678 | 98778 | – | 81205 | – | 70470 | 69032 | 59218 | 102269 | 105678 |
| Blr #6 | - | 105678 | 95451 | 105678 | 98778 | 78104 | 100494 | 74104 | – | 102269 | 75726 | 102269 | 105678 |
| Blr #7 | - | 105678 | 95451 | 105678 | 98778 | 105678 | 100494 | 105268 | 105678 | – | 75726 | 102269 | 105678 |
| HRSG #1 | - | 105489 | 95280 | 105489 | 102086 | 105489 | – | 105489 | 105489 | 102086 | 105489 | 102086 | 105489 |
| Total | | 891639 | 790139 | 788500 | 607676 | 289271 | 282193 | 284860 | 281636 | 273387 | 317801 | 715470 | 878974 |
| | | 258595 | 203617 | 205739 | 179808 | – | – | – | – | – | – | 215758 | 258350 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | 3.412 | 217586 | 120082 | 132948 | – | – | – | – | – | – | – | 128659 | 216752 |
| Blr #3 | 3.412 | 332369 | 274455 | 236664 | 302834 | – | – | – | – | – | – | 285859 | 332369 |
| HWB 1–7 | 3.412 | 718303 | 699083 | 471672 | 100477 | – | – | – | – | – | 5604 | 309877 | 675922 |
| Blr #4 | 3.412 | 332369 | 300205 | 332369 | 310670 | – | – | – | – | – | – | 321648 | 332369 |
| Blr #5 | 3.412 | 360573 | 325678 | 360573 | 337032 | – | 277071 | – | 240442 | 235538 | 202053 | 348941 | 360573 |
| Blr #6 | 3.412 | 360573 | 325678 | 360573 | 337032 | 266491 | 342885 | 252841 | – | 348941 | 258377 | 348941 | 360573 |
| Blr #7 | 3.412 | 360573 | 325678 | 360573 | 337032 | 360573 | 342885 | 359175 | 360573 | – | 258377 | 348941 | 360573 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 2682346 | 2370860 | 2255371 | 1725075 | 627064 | 962841 | 612016 | 601015 | 584479 | 724410 | 2092867 | 2639130 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | – | – | 84.5% | 84.5% | 84.5% | – | – | – | – | – | – | – | 84.5% | 84.5% |
| Blr #3 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | – | 84.5% | 84.5% |
| HWB 1–7 | – | – | 84.7% | 84.7% | 84.7% | 84.7% | – | – | – | – | – | 84.7% | 84.7% | 84.7% |
| Blr #4 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | – | 84.5% | 84.5% |
| Blr #5 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | 84.5% | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% |
| Blr #6 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | – | 84.5% | 84.5% | 84.5% | 84.5% |
| Blr #7 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | 84.5% | – | 84.5% | 84.5% | 84.5% |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | | Unit Energy Input MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | – | 257499 | 142109 | 157335 | – | – | – | – | – | – | – | 152259 | 256511 |
| Blr #3 | – | 393337 | 324799 | 280076 | 358383 | – | – | – | – | – | – | 338295 | 393337 |
| HWB 1–7 | – | 848055 | 825363 | 556874 | 118627 | – | – | – | – | – | 6616 | 365853 | 798019 |
| Blr #4 | – | 393337 | 355272 | 393337 | 367657 | – | – | – | – | – | – | 380648 | 393337 |
| Blr #5 | – | 426713 | 385418 | 426713 | 398854 | – | 327895 | – | 284547 | 278743 | 239115 | 412948 | 426713 |
| Blr #6 | – | 426713 | 385418 | 426713 | 398854 | 315374 | 405781 | 299220 | – | 412948 | 305771 | 412948 | 426713 |
| Blr #7 | – | 426713 | 385418 | 426713 | 398854 | 426713 | 405781 | 425059 | 426713 | – | 305771 | 412948 | 426713 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 3172367 | 2803797 | 2667760 | 2041228 | 742087 | 1139457 | 724279 | 711260 | 691691 | 857274 | 2475900 | 3121342 |

959

Kostov Case K2

FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Blr #1&2 | $1.93 | 497 | 274 | 303 | – | – | – | – | – | – | – | 294 | 495 |
| Blr #3 | $1.93 | 759 | 626 | 540 | 691 | – | – | – | – | – | – | 652 | 759 |
| HWB 1–7 | $1.93 | 1635 | 1592 | 1074 | 229 | – | – | – | – | – | 13 | 706 | 1539 |
| Blr #4 | $1.93 | 759 | 685 | 759 | 709 | – | – | – | – | – | – | 734 | 759 |
| Blr #5 | $1.93 | 823 | 743 | 823 | 769 | – | 632 | – | 549 | 538 | 461 | 796 | 823 |
| Blr #6 | $1.93 | 823 | 743 | 823 | 769 | 608 | 783 | 577 | – | 796 | 590 | 796 | 823 |
| Blr #7 | $1.93 | 823 | 743 | 823 | 769 | 823 | 783 | 820 | 823 | – | 590 | 796 | 823 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 6118 | 5407 | 5145 | 3937 | 1431 | 2197 | 1397 | 1372 | 1334 | 1653 | 4775 | 6020 |

FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | $0.12 | 31 | 17 | 19 | – | – | – | – | – | – | – | 18 | 31 |
| Blr #3 | $0.12 | 47 | 39 | 34 | 43 | – | – | – | – | – | – | 41 | 47 |
| HWB 1–7 | $0.12 | 102 | 99 | 67 | 14 | – | – | – | – | – | 1 | 44 | 96 |
| Blr #4 | $0.12 | 47 | 43 | 47 | 44 | – | – | – | – | – | – | 46 | 47 |
| Blr #5 | $0.12 | 51 | 46 | 51 | 48 | – | 40 | – | 34 | 34 | 29 | 50 | 51 |
| Blr #6 | $0.12 | 51 | 46 | 51 | 48 | 38 | 49 | 36 | – | 50 | 37 | 50 | 51 |
| Blr #7 | $0.12 | 51 | 46 | 51 | 48 | 51 | 49 | 51 | 51 | – | 37 | 50 | 51 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – ** |
| Total | | 382 | 338 | 321 | 246 | 89 | 137 | 87 | 86 | 83 | 103 | 298 | 376 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Variable O&M Expense $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | $0.03 | $0.75 | 62 | 34 | 38 | – | – | – | – | – | – | – | 37 | 62 |
| Blr #3 | $0.03 | $0.75 | 95 | 79 | 68 | 86 | – | – | – | – | – | – | 81 | 94 |
| HWB 1–7 | $0.03 | $0.75 | 163 | 159 | 107 | 23 | – | – | – | – | – | 1 | 70 | 154 |
| Blr #4 | $0.03 | $0.75 | 95 | 86 | 95 | 89 | – | – | – | – | – | – | 91 | 94 |
| Blr #5 | $0.03 | $0.75 | 103 | 93 | 103 | 96 | – | 81 | – | 72 | 70 | 57 | 99 | 103 |
| Blr #6 | $0.03 | $0.75 | 103 | 93 | 103 | 96 | 79 | 100 | 75 | – | 104 | 73 | 99 | 103 |
| Blr #7 | $0.03 | $0.75 | 103 | 93 | 103 | 96 | 106 | 100 | 107 | 107 | – | 73 | 99 | 103 |
| HRSG #1 | $0.03 | $0.75 | 95 | 89 | 99 | 92 | 110 | – | 101 | 102 | 96 | 96 | 92 | 95 |
| Total | | – | 818 | 727 | 716 | 578 | 295 | 280 | 284 | 281 | 270 | 300 | 668 | 806 |

Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Emissions Penalties $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | 0.0008 | 0 | 0 | 0 | – | – | – | – | – | – | – | 0 | 0 |
| Blr #3 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | – | 0 | 0 |
| HWB 1–7 | 0.0008 | 1 | 1 | 0 | 0 | – | – | – | – | – | 0 | 0 | 1 |
| Blr #4 | 0.0008 | 0 | 0 | 0 | 0 | – | – | – | – | – | – | 0 | 0 |
| Blr #5 | 0.0008 | 0 | 0 | 0 | 0 | – | 0 | – | 0 | 0 | 0 | 0 | 0 |
| Blr #6 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 |
| Blr #7 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 |
| HRSG #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |

Emissions by Type – Tons

| | Pounds per Tonne | Emissions – Tons | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulate | 2205 | 19.9 | 17.5 | 16.7 | 12.8 | 4.6 | 7.1 | 4.5 | 4.5 | 4.3 | 5.4 | 15.5 | 19.5 |
| $SO_2$ | 2205 | 277.9 | 245.6 | 233.7 | 178.8 | 65.0 | 99.8 | 63.4 | 62.3 | 60.6 | 75.1 | 216.9 | 273.4 |
| NOx | 2205 | 227.0 | 200.6 | 190.9 | 146.0 | 53.1 | 81.5 | 51.8 | 50.9 | 49.5 | 61.3 | 177.1 | 223.3 |
| CO | 2205 | 24.4 | 21.6 | 20.5 | 15.7 | 5.7 | 8.8 | 5.6 | 5.5 | 5.3 | 6.6 | 19.0 | 24.0 |

Kostov Case K2

ELECTRIC GENERATION AND GAS TURBINE FUEL COST – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 24480 | 25130 | 23524 | 18375 | 6952 | 10672 | 10044 | 8591 | 9269 | 11023 | 19839 | 22738 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 24480 | 25130 | 23524 | 18375 | 6952 | 10672 | 10044 | 8591 | 9269 | 11023 | 19839 | 22738 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4a | – | – | – | – | 2712 | – | 4354 | 3576 | 3587 | – | – | – |
| Turb 5a | 9788 | 11485 | 8678 | 6576 | – | 4857 | – | – | – | 3510 | 4966 | 8619 |
| Turb 1–4b | 58284 | 58284 | 58284 | 58284 | – | 58284 | – | – | – | 58284 | 58284 | 58284 |
| Turb 5b | 45580 | 39569 | 40331 | 43310 | 21823 | 30365 | 17316 | 17062 | 17402 | 30497 | 46157 | 46308 |
| Turb K2b | 26649 | 20765 | 21359 | 26838 | 2872 | – | 17250 | 15416 | 19601 | 25031 | 26920 | 27262 |
| Total T/G Output | 140301 | 130103 | 128652 | 135008 | 27408 | 93306 | 38921 | 36054 | 40790 | 117322 | 136327 | 140473 |
| Balance Required | –115821 | –104974 | –105128 | –116633 | –20456 | –82634 | –28877 | –27462 | –31521 | –106299 | –116488 | –117735 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 97.4% | 133512 | 126625 | 124237 | 123381 | 60632 | 89148 | 60086 | 60345 | 60341 | 104689 | 129490 | 134337 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb K2c | 96.5% | 10012 | 17171 | 16449 | 9782 | 38070 | – | 21444 | 23671 | 18344 | 11981 | 9683 | 9266 |
| Total Condens Turb Output | | 143524 | 143796 | 140686 | 133163 | 98702 | 89148 | 81529 | 84015 | 78685 | 116670 | 139174 | 143603 |
| Balance Required | | –258345 | –248770 | –245813 | –249796 | –119158 | –171782 | –110406 | –111478 | –110206 | –222989 | –255662 | –261339 |
| GT Capability @ Full Load | | 71785 | 71220 | 70317 | 68746 | 67426 | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 71785 | 71220 | 70317 | 68746 | 67426 | – | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |
| Total GT Output (KW) | 71785 | 71220 | 70317 | 68746 | 67426 | – | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |
| Balance Required (KW) | –331130 | –319990 | –316130 | –318542 | –186584 | –171782 | –176291 | –177528 | –177329 | –291577 | –325731 | –332559 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –246360 | –215033 | –235201 | –220587 | –138818 | –99622 | –131063 | –132061 | –127677 | –140703 | –234526 | –247424 |
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| POWER SALES | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 6415.7 | 5599.9 | 6125.1 | 4978.6 | 3133.1 | 2248.5 | 2958.5 | 2981.1 | 2881.7 | 3664.2 | 6107.5 | 6443.4 |

GAS TURBINE
Percent Load

| | Percent Load | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Interpolated Fuel Flow – MMBTU

| | Fuel Flow – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 523297 | 469692 | 514768 | 489755 | 498892 | – | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 |
| Total | 523297 | 469692 | 514768 | 489755 | 498892 | – | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 |

Fuel Cost – Gas Turbine(s) (Gas) $(000)

| | Unit Cost | Fuel Cost – Gas $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | $2.03 | 1062.3 | 953.5 | 1045.0 | 994.2 | 1012.8 | – | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 |
| Total | | 1062.3 | 953.5 | 1045.0 | 994.2 | 1012.8 | – | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 |

Kostov Case K2

GAS TURBINE EXHAUST HEAT UTILIZATION AND SUPPLEMENTARY FIRING – YEAR 2010

GAS TURBINE

Interpolated Exhaust Temperature °F

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | Exhaust Temperature °F | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1086 | 1088 | 1091 | 1096 | 1101 | – | 1107 | 1106 | 1102 | 1097 | 1092 | 1088 |

Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1576.8 | 1568.7 | 1555.6 | 1533.2 | 1514.4 | – | 1492.5 | 1494.8 | 1510.1 | 1531.2 | 1552.0 | 1568.7 |

Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 363.199 | 362.091 | 360.293 | 357.329 | 354.841 | – | 351.879 | 352.200 | 354.264 | 357.072 | 359.795 | 362.091 |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 3.412 | 106.447 | 106.123 | 105.596 | 104.727 | 103.998 | – | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 |
| | | 106.447 | 106.123 | 105.596 | 104.727 | 103.998 | – | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 35.339 | 35.663 | 36.190 | 37.059 | 37.788 | – | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 |
| | 35.339 | 35.663 | 36.190 | 37.059 | 37.788 | – | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 |

Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| Electric Output Ratio | 33.6% | 33.4% | 33.2% | 32.7% | 32.2% | – | 31.7% | 31.8% | 32.1% | 32.6% | 33.1% | 33.4% |
| Utilized Heat Ratio | 66.4% | 66.6% | 66.8% | 67.3% | 67.8% | – | 68.3% | 68.2% | 67.9% | 67.4% | 66.9% | 66.6% |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 206.9 | 212.1 | 207.3 | 192.3 | 163.3 | 124.3 | 128.2 | 133.1 | 122.1 | 170.8 | 200.6 | 206.5 |
| From Gas Turbines | 200.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 206.9 | 212.1 | 207.3 | 192.3 | 163.3 | 124.3 | 128.2 | 133.1 | 122.1 | 170.8 | 200.6 | 206.5 |

Supplementary Firing Energy Input = MMBTU

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | | 89708 | 81771 | 91870 | 91040 | 95926 | – | 98130 | 97891 | 93247 | 94266 | 89265 | 90532 |

Supplementary Firing Fuel Cost (Gas)

| | Unit Cost $/MMBTU | Supplementary Firing Fuel Cost $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 2.03 | 182 | 166 | 186 | 185 | 195 | – | 199 | 199 | 189 | 191 | 181 | 184 |
| Total | | 182 | 166 | 186 | 185 | 195 | – | 199 | 199 | 189 | 191 | 181 | 184 |

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Kostov Case K2

SUPPLEMENTARY DATA

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4a | – | – | – | – | 15.9 | – | 25.5 | 20.9 | 21.0 | – | – | – |
| Turb 5a | 59.5 | 69.5 | 53.0 | 40.4 | – | 28.6 | – | – | – | 21.6 | 30.5 | 52.6 |
| Turb 1–4b | 233.8 | 214.9 | 208.3 | 206.0 | – | 112.2 | – | – | – | 154.8 | 222.7 | 236.0 |
| Turb 5b | 157.1 | 138.1 | 140.5 | 150.0 | 84.3 | 109.6 | 70.5 | 69.7 | 70.8 | 110.0 | 159.0 | 159.5 |
| Turb K2b | 110.9 | 88.8 | 91.1 | 111.6 | 24.4 | – | 75.7 | 68.8 | 85.2 | 104.8 | 111.9 | 113.2 |

Maximum Steam Flow – MW

| | BASIS KWt | Total Boiler MW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 108000 | – | 557.0 | 521.5 | 509.2 | 504.8 | 162.7 | 328.1 | 171.0 | 167.1 | 167.1 | 408.3 | 536.3 | 561.3 |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb K2c | 36590 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 1–4c | 323.3 | 306.6 | 300.8 | 298.8 | 146.8 | 215.9 | 145.5 | 146.1 | 146.1 | 253.5 | 313.6 | 325.3 |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb K2c | 30.9 | 53.0 | 50.7 | 30.2 | 117.4 | – | 66.1 | 73.0 | 56.6 | 36.9 | 29.9 | 28.6 |
| | 354.2 | 359.6 | 351.6 | 328.9 | 264.2 | 215.9 | 211.6 | 219.1 | 202.7 | 290.4 | 343.4 | 353.9 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | | 744 | 672 | 687 | 391 | – | – | – | – | – | 40 | 634 | 744 |
| Turb 1–4a | | – | – | – | – | 744 | – | 744 | 744 | 720 | – | – | – |
| Turb 5a | | 744 | 672 | 744 | 720 | – | 720 | – | – | – | 744 | 720 | 744 |
| Turb 1–4b | | 744 | 672 | 744 | 672 | – | 557 | – | – | – | 276 | 720 | 744 |
| Turb 5b | | 744 | 672 | 744 | 720 | 744 | 720 | 739 | 744 | 720 | 744 | 720 | 744 |
| Turb K2b | | 744 | 672 | 744 | 720 | 744 | – | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | | 283.0 | 304.9 | 201.2 | 75.4 | – | – | – | – | – | 40.6 | 143.4 | 266.3 |
| Turb 1–4a | | – | – | – | – | 13.1 | – | 21.0 | 17.3 | 17.3 | – | – | – |
| Turb 5a | | 49.6 | 57.9 | 44.1 | 33.7 | – | 23.9 | – | – | – | 18.0 | 25.5 | 43.9 |
| Turb 1–4b | | 173.9 | 155.0 | 148.5 | 146.2 | – | 52.4 | – | – | – | 94.9 | 162.9 | 176.2 |
| Turb 5b | | 110.9 | 97.9 | 99.6 | 106.0 | 62.2 | 78.8 | 52.9 | 52.4 | 53.1 | 79.0 | 112.1 | 112.4 |
| Turb K2b | | 83.9 | 67.7 | 69.4 | 84.4 | 21.5 | – | 58.1 | 53.1 | 65.1 | 79.4 | 84.6 | 85.5 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1780 | – | – | – | – | 37.9 | – | 60.9 | 50.0 | 50.2 | – | – | – |
| | 1.1380 | 148.6 | 173.5 | 132.4 | 101.2 | – | 71.6 | – | – | – | 54.0 | 76.4 | 131.5 |
| | 0.9790 | 606.1 | 540.4 | 517.6 | 509.4 | – | 182.5 | – | – | – | 330.9 | 567.7 | 614.0 |
| | 0.9410 | 402.0 | 355.1 | 361.0 | 384.3 | 225.4 | 285.6 | 192.0 | 189.9 | 192.6 | 286.5 | 406.5 | 407.7 |
| | 0.9686 | 295.4 | 238.7 | 244.4 | 297.2 | 75.6 | – | 204.8 | 187.2 | 229.4 | 279.8 | 298.0 | 301.3 |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #1&2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 1–7 | | 34.8% | 37.5% | 24.8% | 9.3% | – | – | – | – | – | 5.0% | 17.7% | 32.8% |
| Turb 1–4a | | – | – | – | – | 4.8% | – | 7.7% | 6.3% | 6.3% | – | – | – |
| Turb 5a | | 33.7% | 39.3% | 30.0% | 22.9% | – | 16.3% | – | – | – | 12.2% | 17.3% | 29.8% |
| Turb 1–4b | | 98.1% | 87.5% | 83.8% | 82.5% | – | 29.6% | – | – | – | 53.6% | 91.9% | 99.4% |
| Turb 5b | | 98.0% | 86.6% | 88.0% | 93.7% | 55.0% | 69.6% | 46.8% | 46.3% | 47.0% | 69.9% | 99.1% | 99.4% |
| Turb K2b | | 96.8% | 78.2% | 80.1% | 97.4% | 24.8% | – | 67.1% | 61.4% | 75.2% | 91.7% | 97.7% | 98.8% |

SUPPLEMENTARY DATA

| | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| Blr #1&2 | | 6.4% | 7.9% | 6.3% | 5.1% | 5.3% | 6.1% | 8.7% | 7.3% | 7.3% | 6.4% | 3.5% | 5.7% |
| Blr #3 | | 6.4% | 7.9% | 6.3% | 5.1% | 5.3% | 6.1% | 8.7% | 7.3% | 7.3% | 6.4% | 3.5% | 5.7% |
| HWB 1–7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | | 6.4% | 7.9% | 6.3% | 5.1% | 5.3% | 6.1% | 8.7% | 7.3% | 7.3% | 6.4% | 3.5% | 5.7% |
| Blr #5 | | 6.4% | 7.9% | 6.3% | 5.1% | 5.3% | 6.1% | 8.7% | 7.3% | 7.3% | 6.4% | 3.5% | 5.7% |
| Blr #6 | | 6.4% | 7.9% | 6.3% | 5.1% | 5.3% | 6.1% | 8.7% | 7.3% | 7.3% | 6.4% | 3.5% | 5.7% |
| Blr #7 | | 6.4% | 7.9% | 6.3% | 5.1% | 5.3% | 6.1% | 8.7% | 7.3% | 7.3% | 6.4% | 3.5% | 5.7% |
| HRSG #1 1 | GT | – | – | – | – | – | – | – | – | – | – | – | – |
| **Cost of Steam Supply** | | | | | | | | | | | | | |
| | Gas | 287 | 303 | 256 | 189 | 76 | 134 | 122 | 100 | 97 | 104 | 143 | 254 |
| | Oil | 18 | 19 | 16 | 12 | 5 | 8 | 8 | 6 | 6 | 7 | 9 | 16 |
| | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | Other Exp | 36 | 38 | 32 | 24 | 10 | 17 | 16 | 13 | 13 | 13 | 18 | 32 |
| | Total | 341 | 360 | 304 | 225 | 90 | 159 | 145 | 119 | 116 | 124 | 170 | 302 |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| Blr #1&2 | | 36.8% | 34.7% | 35.3% | 36.6% | 25.2% | 30.4% | 21.8% | 22.1% | 22.3% | 40.4% | 37.9% | 37.3% |
| Blr #3 | | 36.8% | 34.7% | 35.3% | 36.6% | 25.2% | 30.4% | 21.8% | 22.1% | 22.3% | 40.4% | 37.9% | 37.3% |
| HWB 1–7 | | 100.0% | 100.0% | 100.0% | 100.0% | – | – | – | – | – | 100.0% | 100.0% | 100.0% |
| Blr #4 | | 36.8% | 34.7% | 35.3% | 36.6% | 25.2% | 30.4% | 21.8% | 22.1% | 22.3% | 40.4% | 37.9% | 37.3% |
| Blr #5 | | 36.8% | 34.7% | 35.3% | 36.6% | 25.2% | 30.4% | 21.8% | 22.1% | 22.3% | 40.4% | 37.9% | 37.3% |
| Blr #6 | | 36.8% | 34.7% | 35.3% | 36.6% | 25.2% | 30.4% | 21.8% | 22.1% | 22.3% | 40.4% | 37.9% | 37.3% |
| Blr #7 | | 36.8% | 34.7% | 35.3% | 36.6% | 25.2% | 30.4% | 21.8% | 22.1% | 22.3% | 40.4% | 37.9% | 37.3% |
| HRSG #1 1 | GT | 59.1% | 47.8% | 48.9% | 59.5% | 15.1% | – | 41.0% | 37.5% | 45.9% | 56.0% | 59.7% | 60.3% |
| **Cost of Hot Water Supply** | | | | | | | | | | | | | |
| | Gas | 4021 | 3450 | 3114 | 2289 | 543 | 669 | 795 | 752 | 833 | 1357 | 2957 | 3959 |
| | Oil | 205 | 182 | 157 | 99 | 23 | 42 | 19 | 19 | 19 | 42 | 140 | 201 |
| | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | Other Exp | 427 | 369 | 337 | 248 | 63 | 85 | 81 | 78 | 83 | 137 | 318 | 420 |
| | Total | 4,653 | 4,002 | 3,607 | 2,636 | 629 | 796 | 895 | 849 | 935 | 1,536 | 3,416 | 4,580 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| Blr #1&2 | | 56.8% | 57.4% | 58.4% | 58.3% | 69.5% | 63.5% | 69.5% | 70.6% | 70.4% | 53.3% | 58.6% | 57.0% |
| Blr #3 | | 56.8% | 57.4% | 58.4% | 58.3% | 69.5% | 63.5% | 69.5% | 70.6% | 70.4% | 53.3% | 58.6% | 57.0% |
| HWB 1–7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | | 56.8% | 57.4% | 58.4% | 58.3% | 69.5% | 63.5% | 69.5% | 70.6% | 70.4% | 53.3% | 58.6% | 57.0% |
| Blr #5 | | 56.8% | 57.4% | 58.4% | 58.3% | 69.5% | 63.5% | 69.5% | 70.6% | 70.4% | 53.3% | 58.6% | 57.0% |
| Blr #6 | | 56.8% | 57.4% | 58.4% | 58.3% | 69.5% | 63.5% | 69.5% | 70.6% | 70.4% | 53.3% | 58.6% | 57.0% |
| Blr #7 | | 56.8% | 57.4% | 58.4% | 58.3% | 69.5% | 63.5% | 69.5% | 70.6% | 70.4% | 53.3% | 58.6% | 57.0% |
| HRSG #1 1 | GT | 40.9% | 52.2% | 51.1% | 40.5% | 84.9% | – | 59.0% | 62.5% | 54.1% | 44.0% | 40.3% | 39.7% |
| **Cost of Electric Supply** | | | | | | | | | | | | | |
| | Gas | 3054 | 2773 | 3007 | 2637 | 2020 | 1395 | 1675 | 1716 | 1570 | 1409 | 2864 | 3046 |
| | Oil | 159 | 137 | 149 | 135 | 62 | 87 | 61 | 60 | 59 | 55 | 149 | 160 |
| | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | Other Exp | 358 | 323 | 349 | 308 | 222 | 178 | 187 | 191 | 175 | 150 | 335 | 357 |
| | Total | 3,570 | 3,233 | 3,505 | 3,080 | 2,304 | 1,660 | 1,922 | 1,967 | 1,803 | 1,615 | 3,348 | 3,563 |

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**LIULIN**

**CASE L1**

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Liulin – Case L1

PROJECTED OPERATING AND CAPITAL EXPENDITURES

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 10,649 | 12,280 | 14,162 | 16,331 | 18,833 | 19,241 | 19,730 | 19,532 | 19,337 | 19,144 | 18,896 | 18,707 | 18,707 | 18,707 | 18,707 | 18,707 | 18,707 |
| Oil | 615 | 656 | 700 | 718 | 737 | 754 | 774 | 766 | 758 | 750 | 740 | 732 | 732 | 732 | 732 | 732 | 732 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 11,264 | 12,937 | 14,862 | 17,050 | 19,570 | 19,995 | 20,503 | 20,298 | 20,095 | 19,894 | 19,636 | 19,440 | 19,440 | 19,440 | 19,440 | 19,440 | 19,440 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 850 | 907 | 967 | 992 | 1,018 | 1,045 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange | 850 | 907 | 967 | 992 | 1,018 | 1,045 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 14,977 | 16,741 | 19,787 | 20,979 | 23,697 | 24,048 | 25,742 | 24,422 | 24,404 | 24,094 | 25,103 | 23,688 | 23,891 | 23,771 | 25,155 | 23,823 | 24,046 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 1369 | 7641 | 9293 | 9417 | 18860 | 8400 | 2341 | 2341 | 2341 | 10346 | – | – | – | – | – | – | – |
| Domestic | 337 | 1496 | 1831 | 1866 | 2111 | 1560 | 669 | 669 | 669 | 960 | – | – | – | – | – | – | – |
| Total | 1706 | 9136 | 11124 | 11283 | 20971 | 9961 | 3010 | 3010 | 3010 | 11306 | – | – | – | – | – | – | – |
| TOTAL COST | 16,684 | 25,878 | 30,910 | 32,262 | 44,667 | 34,008 | 28,752 | 27,432 | 27,415 | 35,400 | 25,103 | 23,688 | 23,891 | 23,771 | 25,155 | 23,823 | 24,046 |
| Present Worth | 16,054 | 23,056 | 25,500 | 24,644 | 31,592 | 22,272 | 17,435 | 15,402 | 14,252 | 17,041 | 11,189 | 9,776 | 9,129 | 8,411 | 8,241 | 7,227 | 6,754 |
| Cumulative Present Worth | 16,054 | 39,111 | 64,611 | 89,255 | 120,847 | 143,119 | 160,553 | 175,955 | 190,207 | 207,248 | 218,437 | 228,212 | 237,342 | 245,753 | 253,994 | 261,220 | 267,974 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 |
| Electricity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $17.71 | $18.14 | $17.97 | $17.79 | $17.62 | $17.41 | $17.24 | $17.24 | $17.24 | $17.24 | $17.24 | $17.24 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| $SO_2$ | 419 | 419 | 419 | 419 | 419 | 418 | 418 | 418 | 418 | 418 | 417 | 417 | 417 | 417 | 417 | 417 | 417 |
| NOx | 343 | 343 | 343 | 343 | 343 | 341 | 341 | 341 | 341 | 341 | 340 | 340 | 340 | 340 | 340 | 340 | 340 |
| CO | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

CASE L1

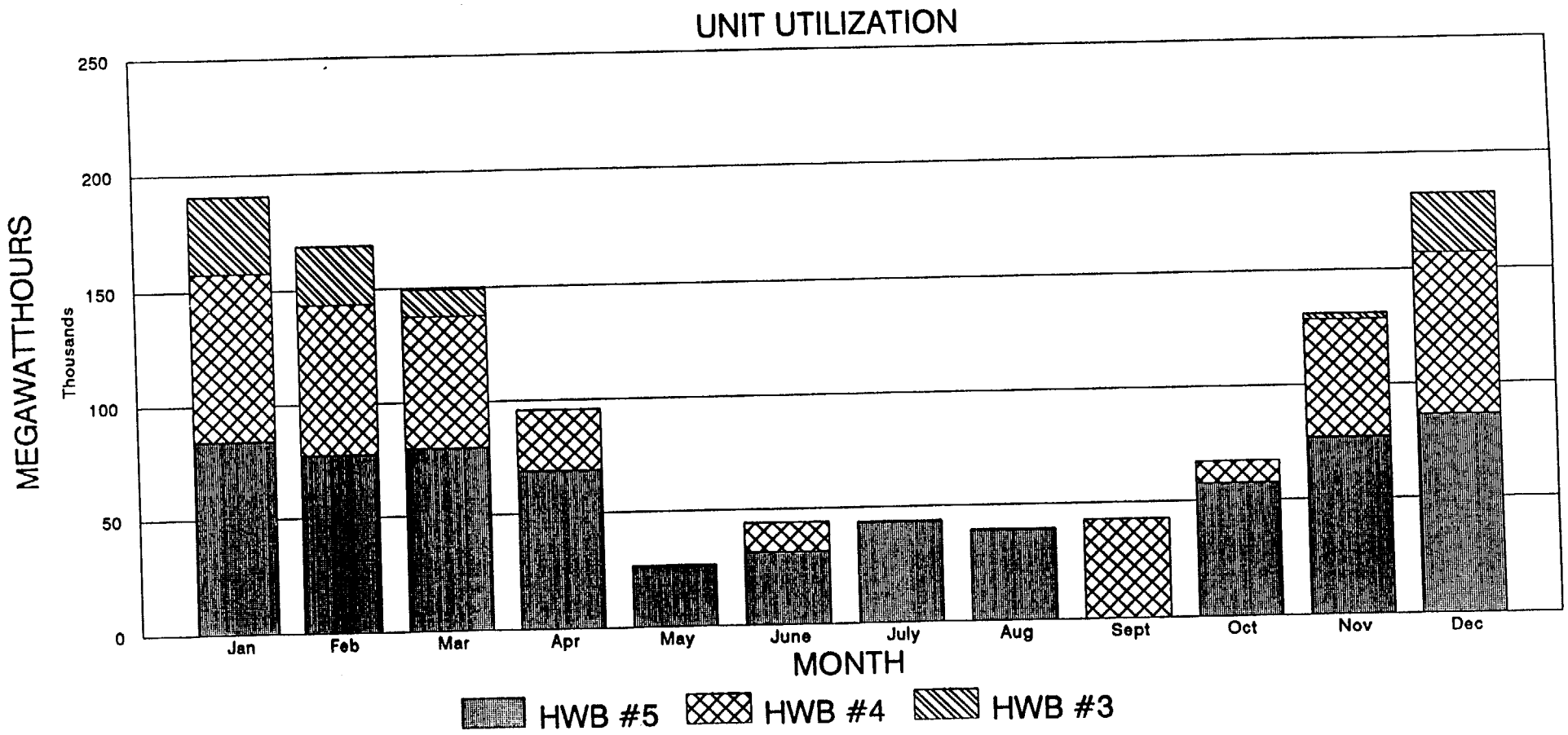
Test Year = 2010

Facilities Data

| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | |
| | | | | HWB #1 | | HWB #2 | | HWB #3 | | HWB #4 | | HWB #5 | | | |
| THERMAL DATA | | | | | | | | | | | | | | | |
| Efficiency – 60% to Full Load | %1 | | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | | |
| Half Load | %2 | | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | | |
| Minimum Load | %3 | | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | 84.7% | | | |
| Minimum Operation | % | | | 40.0% | | 40.0% | | 40.0% | | 40.0% | | 40.0% | | | |
| Feedwater Temp | | | | 156° | | 156° | | 156° | | 156° | | 156° | | | |
| Operation Adjustment Factor | Factor, | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | | | | | | | | |
| Capacity | MWt | | | | | | | | | | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – LP STEAM | Priority | | | | | | | | | | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – HOT WATER | Priority | | | 5 | | 4 | | 3 | | 2 | | 1 | | | |
| Quantity | MWtw | | | 116.000 | | 116.000 | | 116.000 | | 116.000 | | 116.000 | | | |
| Temperature – Supply | Temp °F | | | 302° | | 302° | | 302° | | 302° | | 302° | | | |
| Return | Temp °F | | | 156° | | 156° | | 156° | | 156° | | 156° | | | |
| TURBINE DATA | UNITe | | | | | | | | | | | | | | |
| | Priority | | | | | | | | | | | | | | |
| Rated Capacity–Electric | KW | | | | | | | | | | | | | | |
| Capability – Max Steam | KW1 | | | | | | | | | | | | | | |
| 75 % Steam | KW75 | | | | | | | | | | | | | | |
| 50 % Steam | KW50 | | | | | | | | | | | | | | |
| 25% Steam | KW25 | | | | | | | | | | | | | | |
| Steam Required – Maximum | M#/Hr Max | | | | | | | | | | | | | | |
| Minimum | M#/Hr Min | | | | | | | | | | | | | | |
| Outlet Steam Pressure | PSI | | | | | | | | | | | | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | | | | | | | | | | | |
| Sink | MBTU/lbs | | | | | | | | | | | | | | |
| Generator Efficiency | %g | | | | | | | | | | | | | | |
| Power/Rejection Factor | Factor | | | | | | | | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | | Gas | | Gas | | | |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | | |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | | 95.0% | | 95.0% | | | |
| Secondary/Supplemental Fue | Type | | | Mazut | | Mazut | | Mazut | | Mazut | | Mazut | | | |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | $2.41 | | $2.41 | | | |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | 5.0% | | 5.0% | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 237 | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 3.0 | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $81.0 | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.34 | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $0.75 | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.26 | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | – | | | | | | | | | | | | |
| Emissions Code – Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | | ST2–A9 | | ST2–A9 | | | |
| Emissions Code – Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | | ST2–A6 | | ST2–A6 | | | |
| Scheduled Maintenance | CODE m | | | | | | | | | LHWB | | LHWB5 | | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | $0.0269 | | | | | | | | | | | | |
| Summer | Cents/KWHs | | $0.0233 | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | AVAILABILITY | | | | | | | | | |
| Jan | –1.7 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Feb | 0.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Mar | 4.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Apr | 10.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| May | 15.6 | | | – | | 100% | | 100% | | 100% | | 100% | | | |
| June | 19.0 | | | 100% | | – | | 100% | | 100% | | 100% | | | |
| July | 21.2 | | | 100% | | 100% | | – | | 100% | | 100% | | | |
| Aug | 20.6 | | | 100% | | 100% | | 100% | | – | | – | | | |
| Sept | 16.7 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Oct | 11.3 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Nov | 5.9 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |
| Dec | 0.8 | | | 100% | | 100% | | 100% | | 100% | | 100% | | | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 1,483 | 1,312 | 1,156 | 743 | 206 | 342 | 338 | 306 | 331 | 521 | 1,016 | 1,418 | 9,174 |
| Oil | 93 | 82 | 72 | 46 | 13 | 21 | 21 | 19 | 21 | 33 | 64 | 89 | 573 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 1,576 | 1,394 | 1,230 | 789 | 219 | 364 | 359 | 325 | 352 | 553 | 1,080 | 1,507 | 9,747 |
| Supplemental Cost–Shortfall Penalty, | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 115 | 101 | 106 | 83 | 25 | 29 | 39 | 34 | 42 | 50 | 84 | 88 | 797 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange Cost | 115 | 101 | 106 | 83 | 25 | 29 | 39 | 34 | 42 | 50 | 84 | 88 | 797 |
| Other O&M – Fixed, OH & Other | 67 | 61 | 67 | 65 | 67 | 65 | 67 | 67 | 65 | 67 | 65 | 67 | 792 |
| Variable | 148 | 131 | 116 | 74 | 21 | 34 | 34 | 31 | 33 | 52 | 101 | 141 | 915 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| Total Excluding Maintenance | 1,906 | 1,687 | 1,520 | 1,011 | 332 | 492 | 499 | 458 | 493 | 723 | 1,331 | 1,804 | 12,256 |

Liulin–Case L1



Liulin – Case L1

LOAD DISPATCH AND ENERGY USE – YEAR 2010

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |
| Station Use, Losses, etc. | MWH | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | Average Loading – MW | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| Unit | | | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 171407 | 152205 | 133706 | 83880 | 19100 | 30208 | 28852 | 25089 | 28453 | 18661 | 117628 | 166473 |
| Station Use, Losses, etc. | MWH | – | 19469 | 16628 | 15363 | 11704 | 7372 | 13874 | 14674 | 14336 | 14207 | 48357 | 13208 | 16078 |
| | | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | 116.000 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | 116.000 | | – | – | – | – | – | – | – | – | – | – | 19.2 | 37.0 |
| HWB #3 | 116.000 | | 50.7 | 36.3 | 29.8 | – | – | – | – | – | 59.2 | 38.7 | 64.6 | 104.4 |
| HWB #4 | 116.000 | | 106.2 | 107.3 | 78.0 | 32.5 | – | 23.8 | – | – | – | 80.7 | 115.8 | 116.0 |
| HWB #5 | 116.000 | | 115.9 | 115.8 | 114.0 | 108.2 | 35.6 | 52.3 | 58.5 | 53.0 | 59.2 | 119.4 | 199.5 | 257.4 |
| Total | | | 272.8 | 259.4 | 221.8 | 140.7 | 35.6 | 76.1 | 58.5 | 53.0 | 59.2 | 119.4 | 199.5 | 257.4 |
| | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| Unit | | | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | 987 | 18582 |
| HWB #3 | | | 25649 | 18864 | 7178 | – | – | – | – | – | 42660 | 6962 | 46502 | 77664 |
| HWB #4 | | | 78998 | 72131 | 57110 | 17704 | – | 6431 | – | – | – | 60057 | 83346 | 86304 |
| HWB #5 | | | 86229 | 77838 | 84782 | 77880 | 26472 | 37651 | 43526 | 39425 | – | 67019 | 130835 | 182550 |
| Total | | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |
| **ADJUSTED FOR MINIMUM LOADING – MWH** | | | | | | | | | | | | | | |
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | 2387 | 25647 |
| HWB #3 | | | 33166 | 25474 | 11659 | – | – | – | – | – | 42660 | 9546 | 51323 | 70599 |
| HWB #4 | | | 73343 | 65562 | 57595 | 26650 | – | 12738 | – | – | – | 57473 | 77125 | 86304 |
| HWB #5 | | | 84367 | 77797 | 79815 | 68934 | 26472 | 31345 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |
| Total | | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |

Liulin – Case L1

LOAD DISPATCH AND ENERGY USE – YEAR 2010

## TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | WINTER Feb | WINTER Mar | SUMMER Apr | SUMMER May | SUMMER June | SUMMER July | SUMMER Aug | SUMMER Sept | WINTER Oct | WINTER Nov | WINTER Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | 2387 | 25647 |
| HWB #3 | 33166 | 25474 | 11659 | – | – | – | – | – | 42660 | 9546 | 51323 | 70599 |
| HWB #4 | 73343 | 65562 | 57595 | 26650 | – | 12738 | – | – | – | 57473 | 77125 | 86304 |
| HWB #5 | 84367 | 77797 | 79815 | 68934 | 26472 | 31345 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |
| Total | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |

## ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| Total | | – | – | – | – | – | – | – | – | – | – | – | – |

## STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |

## UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | 2387 | 25647 |
| HWB #3 | – | 33166 | 25474 | 11659 | – | – | – | – | – | 42660 | 9546 | 51323 | 70599 |
| HWB #4 | – | 73343 | 65562 | 57595 | 26650 | – | 12738 | – | – | – | 57473 | 77125 | 86304 |
| HWB #5 | – | 84367 | 77797 | 79815 | 68934 | 26472 | 31345 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |
| Total | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |

## INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | 3.412 | – | – | – | – | – | – | – | – | – | – | 8145 | 87509 |
| HWB #3 | 3.412 | 113163 | 86917 | 39780 | – | – | – | – | – | 145556 | 32569 | 175114 | 240884 |
| HWB #4 | 3.412 | 250247 | 223697 | 196513 | 90931 | – | 43460 | – | – | – | 196098 | 263150 | 294469 |
| HWB #5 | 3.412 | 287861 | 265445 | 272330 | 235202 | 90322 | 106948 | 148511 | 134519 | 145556 | 226868 | 446409 | 622862 |
| Total | | 651271 | 576059 | 508623 | 326133 | 90322 | 150409 | 148511 | 134519 | 145556 | 226868 | 446409 | 622862 |

## BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | – | 84.7% | 84.7% |
| HWB #3 | – | – | 84.7% | 84.7% | 84.7% | – | – | – | – | – | 84.7% | 84.7% | 84.7% | 84.7% |
| HWB #4 | – | – | 84.7% | 84.7% | 84.7% | 84.7% | – | 84.7% | – | – | – | 84.7% | 84.7% | 84.7% |
| HWB #5 | – | – | 84.7% | 84.7% | 84.7% | 84.7% | 84.7% | 84.7% | 84.7% | 84.7% | – | 84.7% | 84.7% | 84.7% |

## INPUT ENERGY REQUIRED

| | Unit Energy Input MMBTU | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | 9616 | 103317 |
| HWB #3 | – | 133604 | 102618 | 46966 | – | – | – | – | – | 171849 | 38453 | 206746 | 284396 |
| HWB #4 | – | 295451 | 264105 | 232011 | 107357 | – | 51311 | – | – | – | 231521 | 310685 | 34766[illegible] |
| HWB #5 | – | 339860 | 313394 | 321523 | 277688 | 106638 | 126267 | 175338 | 158818 | – | 269974 | 527048 | 735374 |
| Total | | 768915 | 680117 | 600500 | 385045 | 106638 | 177578 | 175338 | 158818 | 171849 | 269974 | 527048 | 735374 |

920

Liulin–Case L1

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | $1.93 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | $1.93 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | $1.93 | 258 | 198 | 91 | – | – | – | – | – | – | – | 19 | 199 |
| HWB #4 | $1.93 | 570 | 509 | 447 | 207 | – | 99 | – | – | 331 | 74 | 399 | 548 |
| HWB #5 | $1.93 | 655 | 604 | 620 | 536 | 206 | 244 | 338 | 306 | – | 446 | 599 | 670 |
| Total | | 1483 | 1312 | 1158 | 743 | 206 | 342 | 338 | 306 | 331 | 521 | 1016 | 1418 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | $0.12 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | $0.12 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | $0.12 | 16 | 12 | 6 | – | – | – | – | – | – | – | 1 | 12 |
| HWB #4 | $0.12 | 36 | 32 | 28 | 13 | – | 6 | – | – | 21 | 5 | 25 | 34 |
| HWB #5 | $0.12 | 41 | 38 | 39 | 33 | 13 | 15 | 21 | 19 | – | 28 | 37 | 42 |
| Total | | 93 | 82 | 72 | 46 | 13 | 21 | 21 | 19 | 21 | 33 | 64 | 89 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Variable O&M Expense $(000) | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | $0.03 | $0.75 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | $0.03 | $0.75 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | $0.03 | $0.75 | 26 | 20 | 9 | – | – | – | – | – | – | – | 2 | 20 |
| HWB #4 | $0.03 | $0.75 | 57 | 51 | 45 | 21 | – | 10 | – | – | 33 | 7 | 40 | 55 |
| HWB #5 | $0.03 | $0.75 | 65 | 60 | 62 | 53 | 21 | 24 | 34 | 34 | 31 | – | 45 | 60 | 67 |
| Total | | – | 148 | 131 | 116 | 74 | 21 | 34 | 34 | 31 | 33 | 52 | 101 | 141 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions Penalties $(000) | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | 0.0008 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | 0.0008 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | 0.0008 | 0 | 0 | 0 | – | – | – | – | – | – | – | 0 | 0 |
| HWB #4 | 0.0008 | 0 | 0 | 0 | 0 | – | 0 | – | – | 0 | 0 | 0 | 0 |
| HWB #5 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 |
| Total | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

## Emissions by Type – Tons

| | Pounds per Tonne | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions – Tons | | | | | | | | | | | |
| Particulate | 2205 | 4.8 | 4.3 | 3.8 | 2.4 | 0.7 | 1.1 | 1.1 | 1.0 | 1.1 | 1.7 | 3.3 | 4.6 |
| $SO_2$ | 2205 | 67.4 | 59.6 | 52.6 | 33.7 | 9.3 | 15.6 | 15.4 | 13.9 | 15.1 | 23.6 | 46.2 | 64.4 |
| NOx | 2205 | 55.0 | 48.7 | 43.0 | 27.5 | 7.6 | 12.7 | 12.5 | 11.4 | 12.3 | 19.3 | 37.7 | 52.6 |
| CO | 2205 | 5.9 | 5.2 | 4.6 | 3.0 | 0.8 | 1.4 | 1.3 | 1.2 | 1.3 | 2.1 | 4.1 | 5.7 |

Liulin–Case L1

ELECTRICAL REQUIREMENTS AND PURCHASED POWER COSTS – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Total T/G Output | – | – | – | – | – | – | – | – | – | – | – | – |
| Balance Required | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Condens Turb Output | | – | – | – | – | – | – | – | – | – | – | – | – |
| Balance Required | | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |
| GT Capability @ Full Load | | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Total GT Output (KW) | – | – | – | – | – | – | – | – | – | – | – | – |
| Balance Required (KW) | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | 4272 | 3744 | 3948 | 3552 | 1080 | 1236 | 1658 | 1464 | 1812 | 1872 | 3132 | 3276 |
| **PURCHASED POWER** | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | 7655.9 | 7428.6 | 7075.3 | 6577.8 | 1935.5 | 2288.9 | 2971.3 | 2623.7 | 3355.6 | 3354.8 | 5800.0 | 5871.0 |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWh | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | 115.0 | 100.8 | 106.3 | 82.8 | 25.2 | 28.8 | 38.7 | 34.1 | 42.3 | 50.4 | 84.3 | 88.2 |
| Total – $(000) | 115.0 | 100.8 | 106.3 | 82.8 | 25.2 | 28.8 | 38.7 | 34.1 | 42.3 | 50.4 | 84.3 | 88.2 |

Liulin–Case L1

SUPPLEMENTARY DATA – YEAR 2010

| | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #5 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Steam Supply | | | | | | | | | | | | | |
| Gas | | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | – | – | – | – | – | – | – | – | – | – | – |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | 100.0% | 100.0% | 100.0% | – | – | – | – | – | – | – | 100.0% | 100.0% |
| HWB #4 | | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | – | – | 100.0% | 100.0% | 100.0% | 100.0% |
| HWB #5 | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% |
| Cost of Hot Water Supply | | | | | | | | | | | | | |
| Gas | | 1483 | 1312 | 1158 | 743 | 206 | 342 | 338 | 306 | 331 | 521 | 1016 | 1418 |
| Oil | | 93 | 82 | 72 | 46 | 13 | 21 | 21 | 19 | 21 | 33 | 64 | 89 |
| Lignite | | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | 149 | 131 | 116 | 74 | 21 | 34 | 34 | 31 | 33 | 52 | 102 | 142 |
| Total | | 1,724 | 1,525 | 1,346 | 863 | 239 | 398 | 393 | 356 | 385 | 605 | 1,182 | 1,649 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #1 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #5 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Electric Supply | | | | | | | | | | | | | |
| Gas | | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | – | – | – | – | – | – | – | – | – | – | – |

**LIULIN**

**Case L2**

Liulin – Case L2

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 10,649 | 12,280 | 14,162 | 16,331 | 18,833 | 37,586 | 38,541 | 38,156 | 37,774 | 37,396 | 36,877 | 36,508 | 36,508 | 36,508 | 36,508 | 36,508 | 36,508 |
| Oil | 615 | 656 | 700 | 718 | 737 | 396 | 407 | 402 | 398 | 394 | 384 | 380 | 380 | 380 | 380 | 380 | 380 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 11,264 | 12,937 | 14,862 | 17,050 | 19,570 | 37,983 | 38,948 | 38,558 | 38,172 | 37,791 | 37,262 | 36,889 | 36,889 | 36,889 | 36,889 | 36,889 | 36,889 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Purchased Power Cost | 850 | 907 | 967 | 992 | 1,018 | 33 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| Credit for Power Sales | – | – | – | – | – | (26,446) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) | (27,142) |
| Net Power Interchange | 850 | 907 | 967 | 992 | 1,018 | (26,413) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) | (27,108) |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 915 | 915 | 915 | 915 | 915 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By-Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 2,497 | 3,655 | 2,540 | 2,726 | 2,817 | 3,883 | 2,665 | 2,868 | 2,748 | 4,332 | 2,800 | 3,023 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 14,977 | 16,741 | 19,787 | 20,979 | 23,697 | 16,406 | 17,834 | 16,330 | 16,130 | 15,839 | 16,376 | 14,785 | 14,988 | 14,868 | 16,452 | 14,920 | 15,143 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 1369 | 14110 | 22230 | 38526 | 33953 | 8400 | 2341 | 2341 | 2341 | 8742 | – | – | – | – | – | – | – |
| Domestic | 337 | 1496 | 2262 | 2873 | 3510 | 1560 | 669 | 669 | 669 | 902 | – | – | – | – | – | – | – |
| Total | 1706 | 15605 | 24492 | 41399 | 37462 | 9961 | 3010 | 3010 | 3010 | 9644 | – | – | – | – | – | – | – |
| TOTAL COST | 16,684 | 32,347 | 44,279 | 62,378 | 61,159 | 26,366 | 20,844 | 19,340 | 19,140 | 25,483 | 16,376 | 14,785 | 14,988 | 14,868 | 16,452 | 14,920 | 15,143 |
| Present Worth | 16,054 | 28,820 | 36,529 | 47,648 | 43,257 | 17,267 | 12,640 | 10,859 | 9,950 | 12,267 | 7,299 | 6,102 | 5,727 | 5,261 | 5,390 | 4,526 | 4,253 |
| Cumulative Present Worth | 16,054 | 44,874 | 81,403 | 129,051 | 172,308 | 189,575 | 202,215 | 213,073 | 223,024 | 235,290 | 242,589 | 248,691 | 254,419 | 259,679 | 265,069 | 269,595 | 273,848 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 | 1,180,493 |
| Electricity | 0 | 0 | 0 | 0 | 0 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 | 854,671 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $21.25 | $21.77 | $21.56 | $21.35 | $21.15 | $20.82 | $20.62 | $20.62 | $20.62 | $20.62 | $20.62 | $20.62 |
| Electricity | – | – | – | – | – | $16.90 | $17.31 | $17.14 | $16.98 | $16.81 | $16.65 | $16.49 | $16.49 | $16.49 | $16.49 | $16.49 | $16.49 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | 440 | 440 | 440 | 440 | 440 | 440 | 440 | 440 | 440 | 440 | 440 | 440 |
| Electricity | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 | 1,080 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 30 | 30 | 30 | 30 | 30 | 16 | 16 | 16 | 16 | 16 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| $SO_2$ | 419 | 419 | 419 | 419 | 419 | 220 | 220 | 220 | 220 | 220 | 216 | 216 | 216 | 216 | 216 | 216 | 216 |
| NOx | 343 | 343 | 343 | 343 | 343 | 179 | 179 | 179 | 179 | 179 | 177 | 177 | 177 | 177 | 177 | 177 | 177 |
| CO | 37 | 37 | 37 | 37 | 37 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

Test Year = 2010

CASE L2

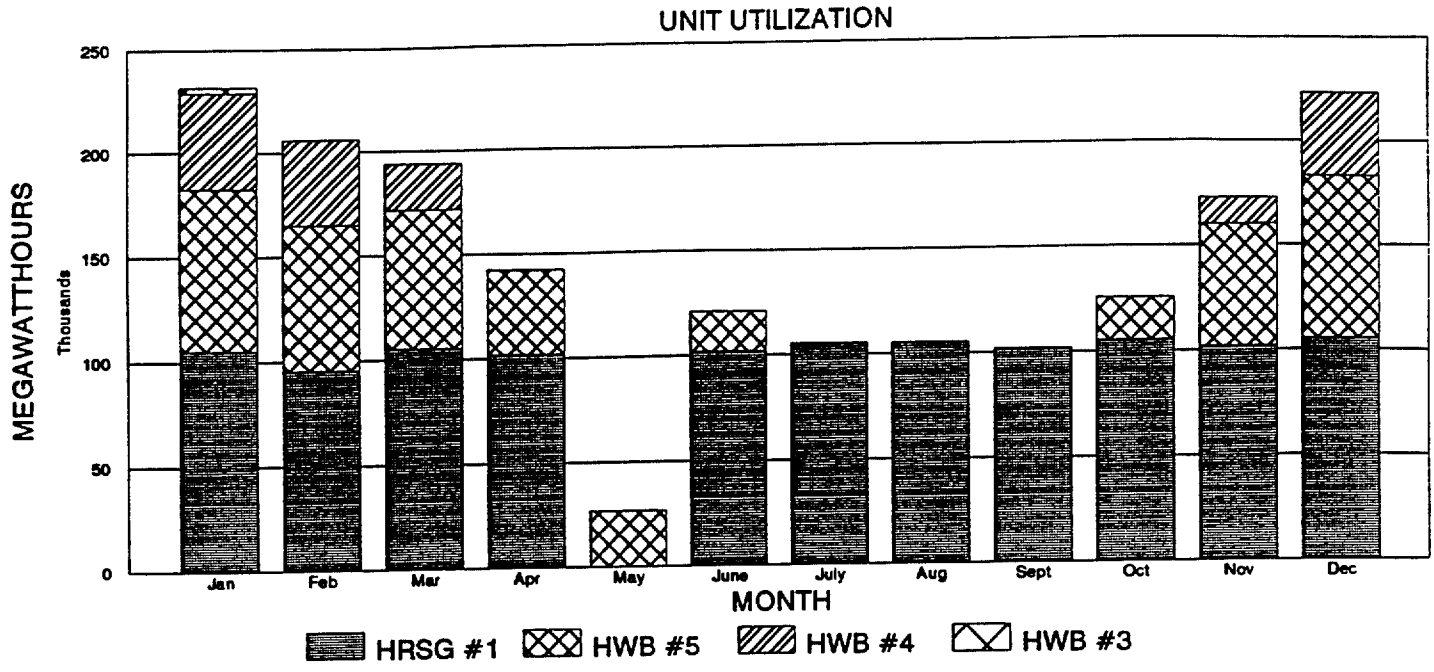
## Facilities Data

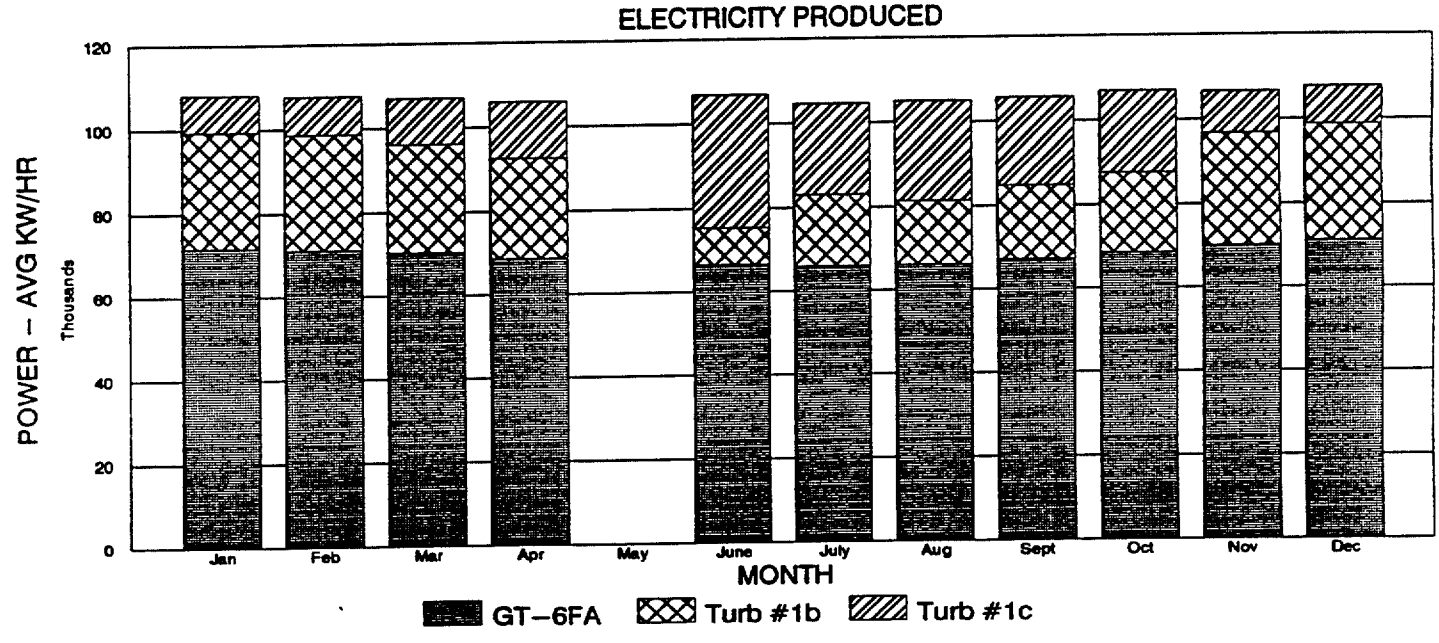
| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EXISTING FACILITIES | | | | | | | | | | | | |
| | | | | HWB #2 | | HWB #3 | | HWB #4 | | HWB #5 | | | HRSG #1 | | |
| THERMAL DATA | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 85.7% | | 85.7% | | 85.7% | | 85.7% | | | 100.0% | | |
| Half Load | %2 | | | 85.7% | | 85.7% | | 85.7% | | 85.7% | | | 100.0% | | |
| Minimum Load | %3 | | | 85.7% | | 85.7% | | 85.7% | | 85.7% | | | 100.0% | | |
| Minimum Operation | % | | | 40.0% | | 40.0% | | 40.0% | | 40.0% | | | | | |
| Feedwater Temp | | | | 156° | | 156° | | 156° | | 156° | | | | | |
| Operation Adjustment Factor | Factor$_o$ | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | | | | | | | | | | 141.786 | 141.786 | |
| Capacity | MWt | | | | | | | | | | | | 339.09 | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | 1541.8 | | |
| Pressure | PSIA | | | | | | | | | | | | 1004° | | |
| Temperature | Temp °F | | | | | | | | | | | | 1.492 | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – LP STEAM | Priority | | | | | | | | | | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | |
| PRODUCT – HOT WATER | Priority | | Cooling | 5 | | 4 | | 3 | | 2 | | | 1 | | |
| Quantity | MWtw | | 200.000 | 116.000 | | 116.000 | | 116.000 | | 116.000 | | | 86.607 | | |
| Temperature – Supply | Temp °F | | | 302° | | 302° | | 302° | | 302° | | | | | |
| Return | Temp °F | | | 156° | | 156° | | 156° | | 156° | | | | | |
| TURBINE DATA | UNITe | | | | | | | | | | | GT–6FA | Turb #1b | Turb #1c | |
| | Priority | | | | | | | | | | | 1 | | | |
| Rated Capacity–Electric | KW | | | | | | | | | | | | 27665 | 36590 | |
| Capability – Max Steam | KW1 | | | | | | | | | | | | 27665 | 36590 | |
| 75 % Steam | KW75 | | | | | | | | | | | | 19752 | | |
| 50 % Steam | KW50 | | | | | | | | | | | | 11821 | | |
| 25% Steam | KW25 | | | | | | | | | | | | 3898 | | |
| Steam Required – Maximum | M#/Hr_Max | | | | | | | | | | | | 305.181 | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | | 25.0 | | |
| Outlet Steam Pressure | PSI | | | | | | | | | | | | 0.3141 | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | | | | | | | | | 0.9686 | | |
| Sink | MBTU/lbs | | | | | | | | | | | | 98.5% | 98.5% | |
| Generator Efficiency | %g | | | | | | | | | | | | | 0.3292 | |
| Power/Rejection Factor | Factor | | | | | | | | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | | Gas | | Gas | | Gas | | Gas | | Gas | | | |
| Cost | $/MMBTU | | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | $2.03 | | | |
| Percent Use | % Use | | | 95.0% | | 95.0% | | 95.0% | | 95.0% | | 100.0% | | | |
| Secondary/Supplemental Fuel | Type | | | Mazut | | Mazut | | Mazut | | Mazut | | | | | |
| Cost | $/MMBTU | | | $2.41 | | $2.41 | | $2.41 | | $2.41 | | | | | |
| Percent Use | % Use | | | 5.0% | | 5.0% | | 5.0% | | 5.0% | | | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 237 | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 3.0 | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $81.0 | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.34 | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $0.75 | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.26 | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | – | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | | ST2–A9 | | ST2–A9 | | ST2–A9 | | ST2–A9 | | | | | |
| Emissions Code –Fuel 2 | CODEe2 | | | ST2–A6 | | ST2–A6 | | ST2–A6 | | ST2–A6 | | | | | |
| Scheduled Maintenance | CODE m | | | | | | | LHWB | | LHWB5 | | GT–6FA | STS3 | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | $0.0269 | | | | | | | | | | | | |
| Summer | Cents/KWHs | | $0.0233 | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | Max GT? | | | | AVAILABILITY | | | | | | | | | |
| Jan | –1.7 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Feb | 0.6 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Mar | 4.8 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Apr | 10.8 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| May | 15.6 | No | | 100% | | 100% | | 100% | | 100% | | – | – | – | |
| June | 19.0 | No | | – | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| July | 21.2 | No | | 100% | | – | | 100% | | 100% | | 100% | 100% | 100% | |
| Aug | 20.6 | No | | 100% | | 100% | | – | | 100% | | 100% | 100% | 100% | |
| Sept | 16.7 | No | | 100% | | 100% | | 100% | | – | | 100% | 100% | 100% | |
| Oct | 11.3 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Nov | 5.9 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |
| Dec | 0.6 | No | | 100% | | 100% | | 100% | | 100% | | 100% | 100% | 100% | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 2,217 | 1,971 | 1,910 | 1,491 | 203 | 1,305 | 1,195 | 1,196 | 1,166 | 1,373 | 1,730 | 2,146 | 17,904 |
| Oil | 61 | 53 | 42 | 19 | 13 | 9 | – | – | – | 10 | 34 | 57 | 298 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 2,277 | 2,025 | 1,952 | 1,510 | 216 | 1,315 | 1,195 | 1,196 | 1,166 | 1,383 | 1,764 | 2,203 | 18,202 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | 4 | – | – | – | 0 | – | 4 |
| Purchased Power Cost | – | – | – | – | 25 | – | – | – | – | – | – | – | 25 |
| Credit for Power Sales | (1,986) | (1,787) | (1,973) | (1,642) | – | (1,711) | (1,719) | (1,733) | (1,677) | (2,023) | (1,920) | (2,001) | (20,172) |
| Net Power Interchange Cost | (1,986) | (1,787) | (1,973) | (1,642) | 25 | (1,711) | (1,719) | (1,733) | (1,677) | (2,023) | (1,920) | (2,001) | (20,147) |
| Other O&M – Fixed, OH & Other | 67 | 61 | 67 | 65 | 67 | 65 | 67 | 67 | 65 | 67 | 65 | 67 | 792 |
| Variable | 193 | 171 | 154 | 125 | 21 | 118 | 101 | 102 | 98 | 116 | 147 | 186 | 1,541 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | 0 | 0 | 0 | 2 |
| Emissions Penalties | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | – | 57 | 456 | 394 |
| Total Excluding Maintenance | 552 | 470 | 211 | 58 | 329 | (214) | (351) | (367) | (348) | (457) | | | |

976

Liulin-Case L2




977

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |
| Station Use, Losses, etc. | MWH | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 171407 | 152205 | 133706 | 83880 | 19100 | 30206 | 28852 | 25089 | 28453 | 18661 | 117628 | 166473 |
| Station Use, Losses, etc. | MWH | – | 19469 | 16628 | 15363 | 11704 | 7372 | 13874 | 14674 | 14336 | 14207 | 48357 | 13208 | 16078 |
| | | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43526 | 39425 | 42660 | 67019 | 130835 | 182550 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | 116.000 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | 116.000 | | 26.7 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | 116.000 | | 64.3 | 50.1 | 41.1 | – | – | – | – | – | – | – | 16.6 | 55.4 |
| HWB #5 | 116.000 | | 110.0 | 114.9 | 93.2 | 54.6 | 35.6 | 47.5 | – | – | – | 41.0 | 89.2 | 111.7 |
| HRSG #1 | 86.607 | | 86.6 | 86.2 | 85.3 | 82.9 | – | 39.0 | 57.9 | 53.0 | 59.2 | 71.4 | 86.3 | 86.6 |
| Total | | | 287.6 | 251.2 | 219.7 | 137.5 | 35.6 | 86.5 | 57.9 | 53.0 | 59.2 | 112.4 | 192.2 | 253.6 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | 1731 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | 42870 | 33659 | 16227 | – | – | – | – | – | – | – | 4445 | 35028 |
| HWB #5 | | | 81841 | 77232 | 69355 | 35904 | 26472 | 16000 | – | – | – | 13889 | 64245 | 83087 |
| HRSG #1 | | | 64436 | 57942 | 63487 | 59680 | – | 28082 | 43086 | 39425 | 42660 | 53129 | 62145 | 64436 |
| Total | | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43086 | 39425 | 42660 | 67019 | 130835 | 182550 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | 440 | – | – | – | 0 | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ADJUSTED FOR MINIMUM LOADING – MWH | | | | | | | | | | | | | | |
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | 3013 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | 46782 | 41399 | 22057 | – | – | – | – | – | – | – | 12408 | 40398 |
| HWB #5 | | | 76822 | 69545 | 66289 | 40576 | 26472 | 18801 | – | – | – | 20290 | 58024 | 77717 |
| HRSG #1 | | | 64259 | 57889 | 60722 | 55008 | – | 25281 | 43086 | 39425 | 42660 | 46728 | 60403 | 64436 |
| Total | | | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43086 | 39425 | 42660 | 67019 | 130835 | 182550 |

978

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | 3013 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | 46782 | 41399 | 22057 | – | – | – | – | – | – | – | 12406 | 40398 |
| HWB #5 | 76822 | 69545 | 66289 | 40576 | 26472 | 18801 | – | – | – | 20290 | 58024 | 77717 |
| HRSG #1 | 64259 | 57889 | 60722 | 55008 | – | 25281 | 43086 | 39425 | 42660 | 46728 | 60403 | 64436 |
| Total | 190877 | 168833 | 149069 | 95584 | 26472 | 44082 | 43086 | 39425 | 42660 | 67019 | 130835 | 182550 |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb #1b | 0.99 | 20823 | 18752 | 19511 | 17489 | – | 6447 | 12965 | 11604 | 12905 | 14319 | 19490 | 20889 |
| Total | | 20823 | 18752 | 19511 | 17489 | – | 6447 | 12965 | 11604 | 12905 | 14319 | 19490 | 20889 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb #1c | 20407 | 18639 | 25255 | 29589 | – | 70358 | 49438 | 54459 | 46521 | 44441 | 22193 | 20165 |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | - | – | – | – | – | – | – | – | – | – | – | – | – |
| | - | – | – | – | – | – | – | – | – | – | – | – | – |
| | - | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | - | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | - | 3013 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | - | 46782 | 41399 | 22057 | – | – | – | – | – | – | – | 12406 | 40398 |
| HWB #5 | - | 76822 | 69545 | 66289 | 40576 | 26472 | 18801 | – | – | – | 20290 | 58024 | 77717 |
| HRSG #1 | - | 105489 | 95280 | 105489 | 102086 | – | 102086 | 105489 | 105489 | 102086 | 105489 | 102086 | 105489 |
| Total | | 232106 | 206224 | 193835 | 142662 | 26472 | 120887 | 105489 | 105489 | 102086 | 125779 | 172518 | 223604 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | 3.412 | 10280 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | 3.412 | 159621 | 141255 | 75260 | – | – | – | – | – | – | – | 42335 | 137838 |
| HWB #5 | 3.412 | 262118 | 237286 | 226179 | 138446 | 90322 | 64150 | – | – | – | 69231 | 197978 | 265170 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 432020 | 378541 | 301439 | 138446 | 90322 | 64150 | – | – | – | 69231 | 240314 | 403008 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | – | – | 85.7% | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | – | – | 85.7% | 85.7% | 85.7% | – | – | – | – | – | – | – | 85.7% | 85.7% |
| HWB #5 | – | – | 85.7% | 85.7% | 85.7% | 85.7% | 85.7% | 85.7% | – | – | – | 85.7% | 85.7% | 85.7% |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | Unit Energy Input MMBTU | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | – | 11996 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | – | 186255 | 164825 | 87818 | – | – | – | – | – | – | – | 49399 | 160837 |
| HWB #5 | – | 305855 | 276880 | 263919 | 161548 | 105393 | 74854 | – | – | – | 80783 | 231013 | 309417 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 504107 | 441705 | 351737 | 161548 | 105393 | 74854 | – | – | – | 80783 | 280413 | 470254 |

979

Liulin–Case L2

# FUEL COST AND OTHER O&M EXPENSE

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | $1.93 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | $1.93 | 23 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | $1.93 | 359 | 318 | 169 | – | – | – | – | – | – | – | 95 | 31 |
| HWB #5 | $1.93 | 590 | 534 | 509 | 312 | 203 | 144 | – | – | – | 156 | 446 | 59 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 972 | 852 | 678 | 312 | 203 | 144 | – | – | – | 156 | 541 | 90 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | $0.12 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | $0.12 | 1 | – | – | – | – | – | – | – | – | – | 6 | 1 |
| HWB #4 | $0.12 | 22 | 20 | 11 | – | – | – | – | – | – | – | 28 | 3 |
| HWB #5 | $0.12 | 37 | 33 | 32 | 19 | 13 | 9 | – | – | – | 10 | 28 | 3 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 61 | 53 | 42 | 19 | 13 | 9 | – | – | – | 10 | 34 | 5 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | 440 | – | – | – | 0 | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | 4.4 | – | – | – | 0.0 | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Variable O&M Expense $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | $0.03 | $0.75 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | $0.03 | $0.75 | 2 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | $0.03 | $0.75 | 36 | 32 | 17 | – | – | – | – | – | – | – | 10 | 3 |
| HWB #5 | $0.03 | $0.75 | 60 | 54 | 51 | 31 | 21 | 15 | – | – | – | 16 | 45 | 6 |
| HRSG #1 | $0.03 | $0.75 | 95 | 85 | 96 | 94 | – | 103 | 101 | 102 | 98 | 100 | 92 | 9 |
| Total | | – | 193 | 171 | 164 | 125 | 21 | 118 | 101 | 102 | 98 | 116 | 147 | 18 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Emissions Penalties $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | 0.0008 | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | 0.0008 | 0 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | 0.0008 | 0 | 0 | 0 | – | – | – | – | – | – | – | 0 | |
| HWB #5 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | 0 | 0 | |
| HRSG #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | 0 | 0 | |

## Emissions by Type – Tons

| | Pounds per Tonne | Emissions – Tons | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulate | 2205 | 3.2 | 2.8 | 2.2 | 1.0 | 0.7 | 0.5 | – | – | – | 0.5 | 1.8 | 2. |
| $SO_2$ | 2205 | 44.2 | 38.7 | 30.8 | 14.2 | 9.2 | 6.6 | – | – | – | 7.1 | 24.6 | 41. |
| NOx | 2205 | 36.1 | 31.6 | 25.2 | 11.6 | 7.5 | 5.4 | – | – | – | 5.8 | 20.1 | 33. |
| CO | 2205 | 3.9 | 3.4 | 2.7 | 1.2 | 0.8 | 0.6 | – | – | – | 0.6 | 2.2 | 3. |

Liulin–Case L2

ELECTRIC GENERATION AND GAS TURBINE FUEL COST – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 5742 | 5571 | 5306 | 4933 | 1452 | 1717 | 2228 | 1968 | 2517 | 2516 | 4350 | 4403 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITs | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb #1b | 27568 | 27486 | 25831 | 23926 | – | 8820 | 17165 | 15363 | 17655 | 18958 | 26663 | 27655 |
| Total T/G Output | 27568 | 27486 | 25831 | 23926 | – | 8820 | 17165 | 15363 | 17655 | 18958 | 26663 | 27655 |
| Balance Required | –21826 | –21914 | –20525 | –18992 | 1452 | –7103 | –14937 | –13395 | –15139 | –16441 | –22313 | –23252 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb #1c | 96.5% | 8894 | 8994 | 11007 | 13326 | – | 31687 | 21547 | 23735 | 20951 | 19369 | 9995 | 8788 |
| Total Condens Turb Output | | 8894 | 8994 | 11007 | 13326 | – | 31687 | 21547 | 23735 | 20951 | 19369 | 9995 | 8788 |
| Balance Required | | –30720 | –30908 | –31532 | –32318 | 1452 | –36790 | –36483 | –37131 | –36090 | –35811 | –32308 | –32040 |
| GT Capability @ Full Load | | 71785 | 71220 | 70317 | 68746 | 67426 | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 71785 | 71220 | 70317 | 68746 | – | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |
| Total GT Output (KW) | 71785 | 71220 | 70317 | 68746 | – | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 |
| Balance Required (KW) | –102505 | –102129 | –101849 | –101064 | 1452 | –105280 | –102368 | –103181 | –103213 | –104419 | –102377 | –103260 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –76264 | –68630 | –75776 | –72766 | 1080 | –75802 | –76162 | –76767 | –74313 | –77688 | –73711 | –76826 |
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | 1935.5 | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | 25.2 | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | 25.2 | – | – | – | – | – | – | – |
| POWER SALES | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 1986.1 | 1787.3 | 1973.4 | 1642.3 | – | 1710.8 | 1719.0 | 1732.6 | 1677.3 | 2023.1 | 1919.6 | 2000.7 |

GAS TURBINE
Percent Load

| | Percent Load | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Interpolated Fuel Flow – MMBTU

| | Fuel Flow – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 523297 | 469692 | 514768 | 489755 | – | 477869 | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 |
| Total | 523297 | 469692 | 514768 | 489755 | – | 477869 | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 |

Fuel Cost – Gas Turbine(s) (Gas) $(000)

| | Unit Cost | Fuel Cost – Gas $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | $2.03 | 1062.3 | 953.5 | 1045.0 | 994.2 | – | 970.1 | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 |
| Total | | 1062.3 | 953.5 | 1045.0 | 994.2 | – | 970.1 | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 |

Liulin–Case L2

# GAS TURBINE EXHAUST HEAT UTILIZATION AND SUPPLEMENTARY FIRING – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

## GAS TURBINE

### Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1086 | 1088 | 1091 | 1096 | – | 1105 | 1107 | 1106 | 1102 | 1097 | 1092 | 1088 |

### Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1576.8 | 1568.7 | 1555.8 | 1533.2 | – | 1501.1 | 1492.5 | 1494.8 | 1510.1 | 1531.2 | 1552.0 | 1568.7 |

### Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 363.199 | 362.091 | 360.293 | 357.329 | – | 353.050 | 351.679 | 352.200 | 354.264 | 357.072 | 359.795 | 362.091 |

### Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 3.412 | 106.447 | 106.123 | 105.596 | 104.727 | – | 103.473 | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 |
| | | 106.447 | 106.123 | 105.596 | 104.727 | – | 103.473 | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 |

### Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 35.339 | 35.663 | 36.190 | 37.059 | – | 38.313 | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 |
| | 35.339 | 35.663 | 36.190 | 37.059 | – | 38.313 | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 |

### Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| Electric Output Ratio | 33.6% | 33.4% | 33.2% | 32.7% | – | 31.9% | 31.7% | 31.8% | 32.1% | 32.6% | 33.1% | 33.4% |
| Utilized Heat Ratio | 66.4% | 66.6% | 66.8% | 67.3% | – | 68.1% | 68.3% | 68.2% | 67.9% | 67.4% | 66.9% | 66.6% |

### Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 18.4 | 18.6 | 22.8 | 27.8 | – | 65.6 | 44.6 | 49.1 | 43.3 | 40.1 | 20.7 | 18.2 |
| From Gas Turbines | 200.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 18.4 | 18.6 | 22.8 | 27.8 | – | 65.6 | 44.6 | 49.1 | 43.3 | 40.1 | 20.7 | 18.2 |

### Supplementary Firing Energy Input = MMBTU

| | | | | | | | | | | | | | |
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | | 89706 | 81771 | 91870 | 91040 | – | 94121 | 98130 | 97891 | 93247 | 94266 | 89265 | 90532 |

### Supplementary Firing Fuel Cost (Gas)

| | Unit Cost $/MMBTU | Supplementary Firing Fuel Cost $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| HRSG #1 | 2.03 | 182 | 166 | 186 | 185 | – | 191 | 199 | 199 | 189 | 191 | 181 | 184 |
| Total | | 182 | 166 | 186 | 185 | – | 191 | 199 | 199 | 189 | 191 | 181 | 184 |

Liulin – Case L2

SUPPLEMENTARY DATA

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Average MW utilized before Incremental MWe and Rejection – Cogen Units Only** | | | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| Turb #1b | | | 114.4 | 114.0 | 107.8 | 100.7 | – | 44.1 | 75.3 | 68.6 | 77.2 | 82.1 | 111.0 | 114.7 |
| **Maximum Steam Flow – MW** | BASIS KWt | Total Boiler MW | | | | | | | | | | | | |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb #1c | 36590 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |
| **Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)** | | | | | | | | | | | | | | |
| | | | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| Turb #1c | | | 27.4 | 27.7 | 33.9 | 41.1 | – | 97.7 | 66.4 | 73.2 | 64.6 | 59.7 | 30.8 | 27.1 |
| | | | 27.4 | 27.7 | 33.9 | 41.1 | – | 97.7 | 66.4 | 73.2 | 64.6 | 59.7 | 30.8 | 27.1 |
| **Maximum Hours Use** | | | | | | | | | | | | | | |
| | | | Maximum Hours Use | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | 65 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | 666 | 672 | 394 | – | – | – | – | – | – | – | 267 | 633 |
| HWB #5 | | | 744 | 672 | 744 | 657 | 744 | 337 | – | – | – | 339 | 720 | 744 |
| Turb #1b | | | 744 | 672 | 744 | 720 | – | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| **Average Load – MW** | | | | | | | | | | | | | | |
| | | | Average Load – MWt | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | 46.4 | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | 70.2 | 61.6 | 55.9 | – | – | – | – | – | – | – | 46.4 | 63.8 |
| HWB #5 | | | 103.3 | 103.5 | 89.1 | 61.8 | 35.6 | 55.8 | – | – | – | 59.9 | 80.6 | 104.5 |
| Turb #1b | | | 86.4 | 86.1 | 81.6 | 76.4 | – | 35.1 | 57.9 | 53.0 | 59.2 | 62.8 | 83.9 | 86.6 |
| **Average Load – Mlb/Hr** | | | | | | | | | | | | | | |
| | | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | 0.9886 | 304.2 | 303.5 | 287.5 | 269.1 | – | 123.7 | 204.0 | 186.7 | 208.7 | 221.2 | 295.5 | 305.1 |
| **Average Load – %** | | | | | | | | | | | | | | |
| | | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | 40.0% | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | 60.5% | 53.1% | 48.2% | – | – | – | – | – | – | – | 40.0% | 55.0% |
| HWB #5 | | | 89.0% | 89.2% | 76.8% | 53.2% | 30.7% | 48.1% | – | – | – | 51.7% | 69.5% | 90.1% |
| Turb #1b | | | 99.7% | 99.5% | 94.2% | 88.2% | – | 40.5% | 66.9% | 61.2% | 68.4% | 72.5% | 96.9% | 100.0% |

SUPPLEMENTARY DATA

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
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| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #5 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 | GT | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Steam Supply | | | | | | | | | | | | | | |
| | | Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Other Exp | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Total | – | – | – | – | – | – | – | – | – | – | – | – |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | 100.0% | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | 100.0% | 100.0% | 100.0% | – | – | – | – | – | – | – | 100.0% | 100.0% |
| HWB #5 | | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | – | – | 100.0% | 100.0% | 100.0% |
| HRSG #1 | 1 | GT | 60.9% | 60.8% | 57.8% | 53.9% | – | 24.8% | 40.8% | 37.4% | 41.8% | 44.3% | 59.2% | 61.1% |
| Cost of Hot Water Supply | | | | | | | | | | | | | | |
| | | Gas | 1742 | 1542 | 1395 | 951 | 206 | 434 | 488 | 447 | 487 | 697 | 1251 | 1675 |
| | | Oil | 61 | 54 | 43 | 20 | 13 | 9 | – | – | – | 10 | 34 | 57 |
| | | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Other Exp | 156 | 138 | 124 | 82 | 21 | 40 | 41 | 38 | 41 | 60 | 109 | 150 |
| | | Total | 1,959 | 1,734 | 1,562 | 1,052 | 239 | 483 | 529 | 485 | 528 | 767 | 1,395 | 1,882 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | | |
| | | | Percent of Total Output | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #2 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #3 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #4 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB #5 | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 | GT | 39.1% | 39.2% | 42.4% | 46.1% | – | 75.2% | 59.2% | 62.6% | 58.2% | 55.7% | 40.8% | 38.9% |
| Cost of Electric Supply | | | | | | | | | | | | | | |
| | | Gas | 486 | 439 | 523 | 544 | – | 874 | 707 | 749 | 679 | 678 | 486 | 482 |
| | | Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Lignite | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| | | Other Exp | 37 | 34 | 41 | 43 | – | 77 | 60 | 64 | 57 | 56 | 38 | 37 |
| | | Total | 523 | 473 | 563 | 587 | – | 951 | 767 | 813 | 736 | 734 | 523 | 519 |

**REPUBLIKA**

**Case P1**

985

TPS Republika – Case P1

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 4,929 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | 13,823 | 14,087 | 14,357 | 14,636 | 14,921 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 |
| Total Fuel Cost | 4,929 | 13,823 | 14,087 | 14,357 | 14,636 | 14,921 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 | 15,214 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (7,872) | (8,396) | (8,955) | (9,188) | (9,429) | (9,676) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) |
| Net Power Interchange | (7,872) | (8,396) | (8,955) | (9,188) | (9,429) | (9,676) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) | (9,931) |
| Fixed O&M and Overheads | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| Other Variable O & M | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 | 3,192 |
| Sorbent and Ash Removal | 1,156 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 930 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maintenance Expenses | 1,772 | 1,773 | 2,016 | 1,793 | 1,959 | 1,816 | 1,984 | 1,782 | 2,025 | 2,039 | 2,083 | 1,748 | 2,071 | 2,141 | 2,364 | 1,843 | 2,099 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 7,230 | 13,548 | 13,496 | 13,310 | 13,514 | 13,410 | 13,615 | 13,413 | 13,656 | 13,670 | 13,714 | 13,379 | 13,702 | 13,772 | 13,996 | 13,474 | 13,730 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 108541 | 4323 | 5277 | 5356 | 32426 | 4411 | 1458 | 1458 | 1458 | 2861 | – | – | – | – | 1402 | – | – |
| Domestic | 3605 | 835 | 1028 | 1049 | 2021 | 767 | 392 | 392 | 392 | 421 | – | – | – | – | 28 | – | – |
| Total | 112146 | 5158 | 6305 | 6404 | 34448 | 5178 | 1851 | 1851 | 1851 | 3281 | – | – | – | – | 1430 | – | – |
| TOTAL COST | 119,376 | 18,706 | 19,802 | 19,714 | 47,962 | 18,588 | 15,466 | 15,264 | 15,507 | 16,951 | 13,714 | 13,379 | 13,702 | 13,772 | 15,426 | 13,474 | 13,730 |
| Present Worth | 114,869 | 16,667 | 16,336 | 15,059 | 33,923 | 12,173 | 9,378 | 8,570 | 8,062 | 8,160 | 6,112 | 5,521 | 5,236 | 4,873 | 5,054 | 4,087 | 3,857 |
| Cumulative Present Worth | 114,869 | 131,536 | 147,872 | 162,931 | 196,854 | 209,027 | 218,405 | 226,975 | 235,037 | 243,196 | 249,308 | 254,830 | 260,066 | 264,939 | 269,992 | 274,080 | 277,936 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 |
| Hot Water | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 |
| Electricity | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 | 409,490 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $6.97 | $12.60 | $12.60 | $12.60 | $12.60 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 |
| Hot Water | $6.97 | $12.60 | $12.60 | $12.60 | $12.60 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 | $12.57 |
| Electricity | $12.19 | $22.01 | $22.01 | $22.01 | $22.01 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 | $21.95 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 124,501 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| $SO_2$ | 17,750 | 622 | 622 | 622 | 622 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 | 620 |
| NOx | 1,614 | 870 | 870 | 870 | 870 | 868 | 868 | 868 | 868 | 868 | 868 | 868 | 868 | 868 | 868 | 868 | 868 |
| CO | 49 | 45 | 45 | 45 | 45 | 44 | 44 | 44 | 44 | 44 | 44 | 44 | 44 | 44 | 44 | 44 | 44 |

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

CASE P1 — Test Year = 2010

## Facilities Data

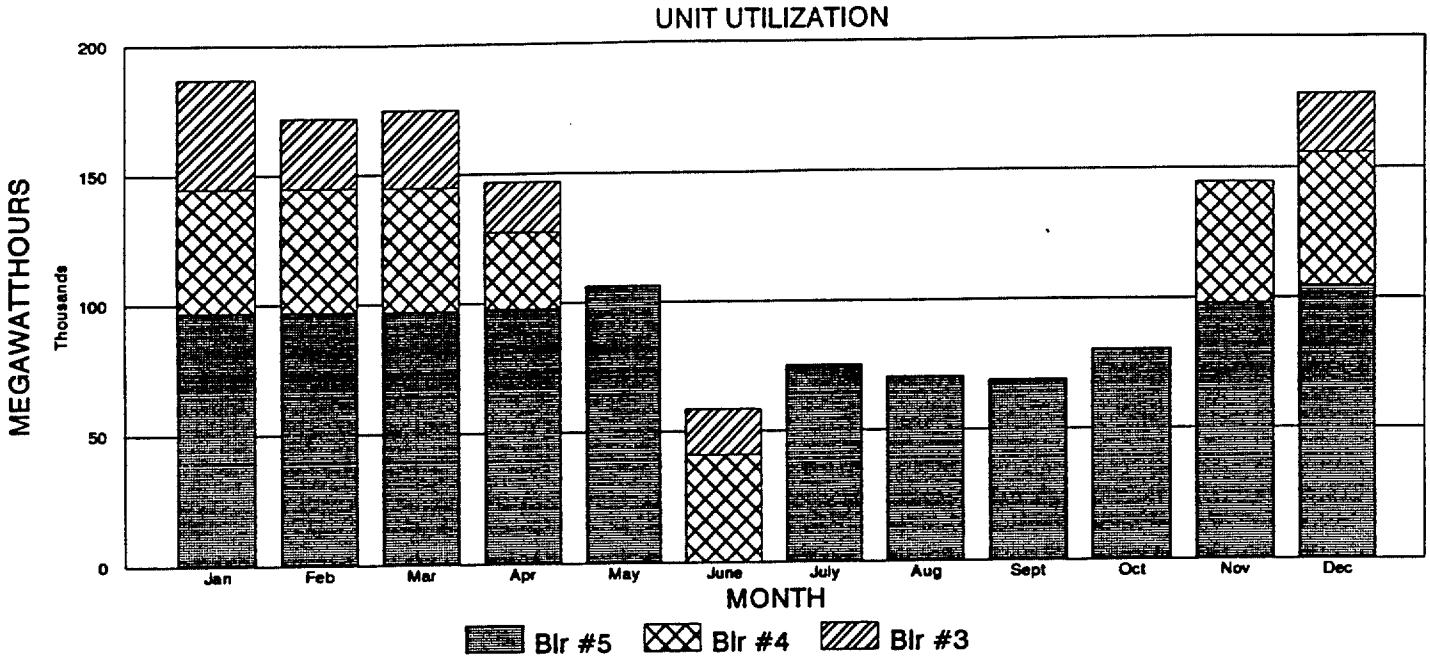
EXISTING FACILITIES

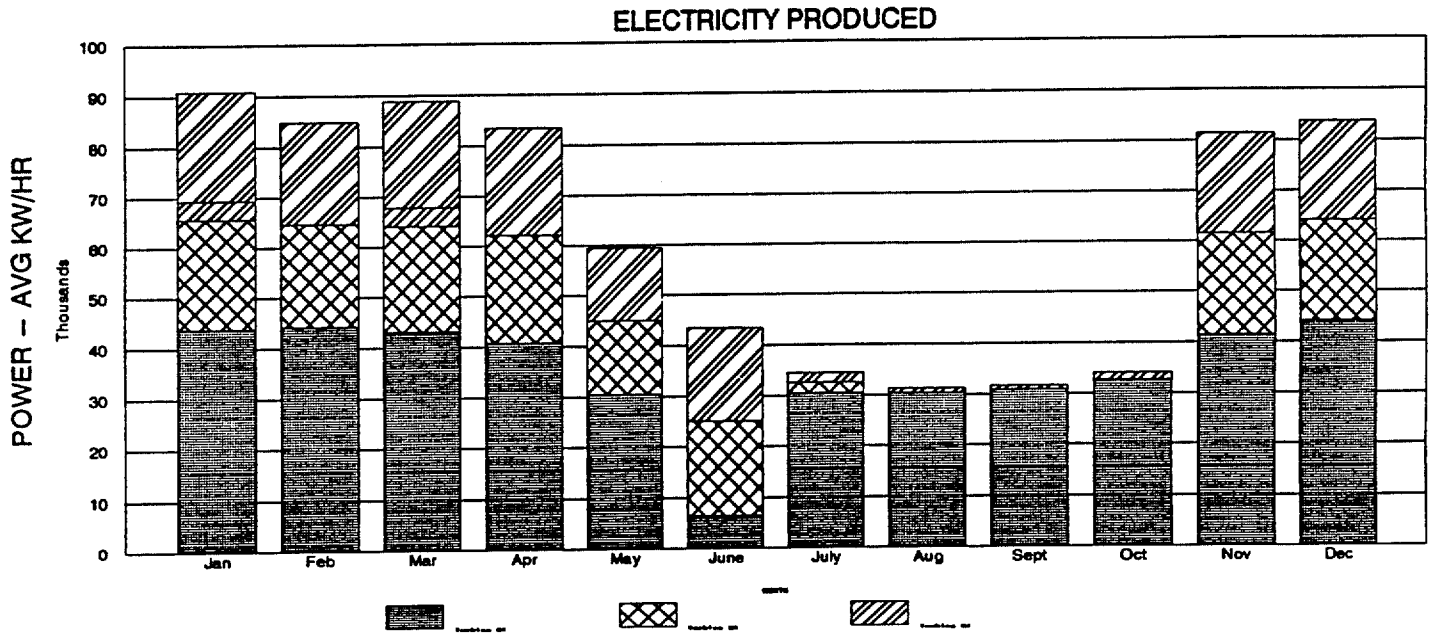
| DESCRIPTION | UNIT | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BASIS | | Br #4 | | | | Br #5 | | | Br #3 | | | Br #1 | Br #2 | | |
| THERMAL DATA | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | 85.3% | | | | 87.3% | | | 85.3% | | | 84.3% | 84.3% | | |
| Half Load | %2 | | 85.3% | | | | 87.3% | | | 85.3% | | | 84.3% | 84.3% | | |
| Minimum Load | %3 | | 85.3% | | | | 87.3% | | | 85.3% | | | 84.3% | 84.3% | | |
| Minimum Operation | % | | 40.0% | | | | 40.0% | | | 40.0% | | | 10.0% | 40.0% | | |
| Feedwater Temp | | | 397° | | | | 413° | | | 410° | | | 320° | 320° | | |
| Operation Adjustment Factor | $Factor_n$ | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | 5 | | | | 4 | | | 6 | | | 7 | 8 | | |
| Capacity | MWt | | 70.960 | | | | 144.800 | | | 71.690 | | | 57.200 | 68.400 | | |
| Quantity | Mlb/Hr | | 223.830 | | | 77.878 | 453.390 | | 147.723 | 229.100 | | | 166.68 | 199.550 | | |
| Pressure | PSIA | | 1024 | | | 35.303 | 1060 | | – | 997.2 | | | 953 | 1010 | | |
| Temperature | Temp °F | | 923.5° | | | 18.169 | 958° | | 36.9705 | 921° | | | 900° | 925° | | |
| Enthalpy | MBTU/lb | | 1.455 | | | 77.869 | 1.460 | | 161.121 | 1.457 | | | 1.450 | 1.463 | | |
| PRODUCT – LP STEAM | Priority | * | | 4 | | | | | | | 5 | | | | | |
| Quantity | Mlb/Hr | | | 176.4 | | | | | | | 110.250 | | | | | |
| | MWts | | | 54.890 | | | | | | | 35.7 | | | | | |
| Pressure | PSIA | | | 142 | | | | | | | 142 | | | | | |
| Temperature | Temp °F | | | 527° | | | | | | | 540° | | | | | |
| Enthalpy | MBTU/lb | | | 1.285 | | | | | | | 1.293 | | | | | |
| PRODUCT – HOT WATER | Priority | | | | 2 | | | 1 | | | | 3 | | | Cooling | |
| Quantity | MWhw | | | | 48.210 | | | 97.100 | | | | 67.780 | | | 300.000 | |
| Temperature – Supply | Temp °F | | | | 302° | | | 302° | | | | 248° | | | | |
| Return | Temp °F | | | | 227° | | | 227° | | | | 227° | | | | |
| TURBINE DATA | UNITe | | | Turb 4a | Turb 4b | Turb 4c | | Turb 6b | Turb 6c | | Turb 6a | Turb 6b | | | | |
| | Priority | | | | | 25000 | | | 55000 | | | 25000 | | | | |
| Rated Capacity–Electric | KW | | | 10406 | 12162 | 25000 | | 36661 | 55000 | | 6113 | 22174 | | | | |
| Capability – Max Steam | KW1 | | | 7804 | 9121 | | | 27510 | | | 4584 | 15386 | | | | |
| 75 % Steam | KW75 | | | 5205 | 6061 | | | 18340 | | | 3056 | 8598 | | | | |
| 50 % Steam | KW50 | | | 2601 | 3040 | | | 9170 | | | 1528 | 1089 | | | | |
| 25% Steam | KW25 | | | 176.400 | 154.350 | | | 330.750 | | | 110.250 | 242.990 | | | | |
| Steam Required – Maximum | M#/Hr_Max | | | | | | | | | | | 54.180 | | | | |
| Minimum | M#/Hr_Min | | | 142.0 | 15.5 | | | 17.0 | | | 142.0 | 17.8 | | | | |
| Outlet Steam Pressure | PSI | | | 0.17 | 0.24 | | | 0.325 | | | 0.164 | 0.284 | | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | 1.062 | 1.066 | | | 1.002 | | | 1.105 | 0.952 | | | | |
| Sink | MBTU/lbs | | | 97.4% | 97.4% | 97.4% | | 97.6% | 97.6% | | 97.4% | 97.4% | | | | |
| Generator Efficiency | %g | | | | | 0.336 | | | 0.392 | | | | | | | |
| Power/Rejection Factor | Factor | | | | | | | | | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | | | |
| Primary Fuel | Type | | Coal | | | | Coal | | | Coal | | | Coal | Coal | | |
| Cost | $/MMBTU | | $2.39 | | | | $2.39 | | | $2.39 | | | $2.39 | $2.39 | | |
| Percent Use | % Use | | 100.0% | | | | 100.0% | | | 100.0% | | | 100.0% | 100.0% | | |
| Secondary/Supplemental Fue | Type | | | | | | | | | | | | | | | |
| Cost | $/MMBTU | | | | | | | | | | | | | | | |
| Percent Use | % Use | | | | | | | | | | | | | | | |
| COST DATA (1993 Basis) | CK$ = | | | | | | | | | | | | | | | |
| Number of Personnel | Number | 963 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 2.6 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $568.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.30 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $1.96 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | $5.00 | | | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | PC2–B2 | | | | PC2–B2 | | | PC2–B2 | | | PC2–B2 | PC2–B2 | | |
| Emissions Code –Fuel 2 | CODEe2 | | | | | | | | | | | | | | | |
| Scheduled Maintenance | CODE m | | PB4 | ST4 | | | PB5 | ST5 | | PB3 | ST6 | | PB1 | PB2 | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | AVAILABILITY | | | | | | | | | | |
| Jan | –1.7 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Feb | 0.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Mar | 4.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Apr | 10.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | 100% | | |
| May | 15.6 | | 100% | 100% | 100% | 100% | – | 50% | 50% | 100% | 100% | 100% | 100% | 100% | | |
| June | 19.0 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| July | 21.2 | | – | 50% | 50% | 50% | 100% | 100% | 100% | – | 50% | 50% | 100% | 100% | | |
| Aug | 20.6 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | – | | |
| Sept | 16.7 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Oct | 11.3 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Nov | 5.9 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Dec | 0.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | 1,766 | 1,622 | 1,653 | 1,360 | 994 | 560 | 704 | 660 | 646 | 753 | 1,360 | 1,683 | 13,783 |
| Total Fuel Cost | 1,766 | 1,622 | 1,653 | 1,360 | 994 | 560 | 704 | 660 | 646 | 753 | 1,360 | 1,683 | 13,783 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (917) | (853) | (968) | (735) | (574) | (198) | (398) | (373) | (331) | (405) | (774) | (853) | (7,381) |
| Net Power Interchange Cost | (917) | (853) | (968) | (735) | (574) | (198) | (398) | (373) | (331) | (405) | (774) | (853) | (7,381) |
| Other O&M – Fixed, OH & Other | 265 | 240 | 265 | 257 | 265 | 257 | 265 | 265 | 257 | 265 | 257 | 265 | 3,124 |
| Variable | 404 | 371 | 378 | 320 | 238 | 129 | 167 | 157 | 153 | 177 | 314 | 384 | 3,192 |
| Limestone Injection & Ash Removal | 4 | 4 | 4 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 4 | 33 |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 178 | 163 | 166 | 139 | 100 | 56 | 71 | 66 | 65 | 76 | 137 | 169 | 1,384 |
| Total Excluding Maintenance | 1,701 | 1,545 | 1,496 | 1,364 | 1,026 | 805 | 811 | 777 | 791 | 868 | 1,296 | 1,653 | 14,135 |

987

TPS Republika – Case P1




988

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 26699 | 23634 | 20380 | 15412 | 8900 | 6270 | 4951 | 2769 | 2091 | 3507 | 10396 | 18145 |
| Station Use, Losses, etc. | MWH | – | 7395 | 7347 | 6284 | 5429 | 2967 | 2522 | 2230 | 1303 | 978 | 2271 | 4115 | 6546 |
| | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | 4072 | 3069 | 5778 | 14511 | 24691 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | Average Loading – MW | | | | | | | | | | | |
| | MWts | | | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 35.700 | 1 | – | – | – | – | – | – | – | 5.5 | 4.3 | 7.8 | – | – |
| Header | 54.890 | 1 | 45.8 | 46.1 | 35.8 | 28.9 | 15.9 | 12.2 | 9.7 | – | – | – | 20.2 | 33.2 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| Unit | | | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | 4072 | 3069 | 5778 | – | – |
| Header | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | – | – | – | 14511 | 24691 |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | 4072 | 3069 | 5778 | 14511 | 24691 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 75009 | 70285 | 69715 | 45613 | 10974 | 11462 | 9220 | 9557 | 10885 | 17574 | 51015 | 73894 |
| Station Use, Losses, etc. | MWH | – | 9635 | 9461 | 8577 | 8813 | 6446 | 7445 | 8343 | 7474 | 7530 | 7900 | 7779 | 10812 |
| | | | 84644 | 79746 | 78292 | 54425 | 17420 | 18907 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | Average Loading – MW | | | | | | | | | | | |
| BASIS UNIT | MWtw | | | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 67.780 | 1 | 11.8 | – | 6.7 | – | – | – | – | – | – | – | 8.0 | 23.6 |
| Header | 48.210 | 1 | 25.8 | 23.0 | 25.7 | 7.3 | – | 11.1 | – | – | – | – | 7.9 | 94.7 |
| Header | 97.100 | 1 | 93.6 | 96.1 | 88.5 | 75.0 | 23.4 | 22.0 | 23.6 | 22.9 | 25.6 | 34.2 | 80.1 | 118.3 |
| Total | | | 131.3 | 119.1 | 120.9 | 82.3 | 23.4 | 33.1 | 23.6 | 22.9 | 25.6 | 34.2 | 88.1 | 118.3 |
| | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| Unit | | | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 76 | – | 305 | – | – | – | – | – | – | – | 1111 | 14241 |
| Header | | | 14900 | 15142 | 12150 | 404 | – | 3102 | – | – | – | – | 57684 | 70465 |
| Header | | | 69669 | 64604 | 65837 | 54022 | 17420 | 15806 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |
| Total | | | 84644 | 79746 | 78292 | 54425 | 17420 | 18907 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | 4072 | 3069 | 5778 | – | – |
| Header | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | – | – | – | 14511 | 24691 |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | 4072 | 3069 | 5778 | 14511 | 24691 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 147 | – | 1044 | – | – | – | – | – | – | – | 3171 | 17375 |
| Header | | | 18170 | 18632 | 14030 | 1265 | – | 6416 | – | – | – | – | 55624 | 67331 |
| Header | | | 66327 | 61114 | 63218 | 53161 | 17420 | 12491 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |
| Total | | | 84644 | 79746 | 78292 | 54425 | 17420 | 18907 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Unit | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | 4072 | 3069 | 5778 | – | – |
| Header | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | – | – | – | 14511 | 24691 |
| Header | 147 | – | 1044 | – | – | – | – | – | – | – | – | – |
| Header | 18170 | 18832 | 14030 | 1265 | – | 6416 | – | – | – | – | 3171 | 17375 |
| Header | 66327 | 61114 | 63218 | 53161 | 17420 | 12491 | 17563 | 17031 | 18415 | 25475 | 55624 | 67331 |
| Header | 118739 | 110727 | 104955 | 75267 | 29286 | 27699 | 24744 | 21103 | 21484 | 31252 | 73306 | 109397 |
| Total | | | | | | | | | | | | |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | 716 | 539 | 1015 | – | – |
| Turb 6a | 0.97 | – | – | – | – | – | – | – | – | – | – | 2824 | 4805 |
| Turb 4a | 0.97 | 6634 | 6028 | 5189 | 4057 | 2309 | 1710 | 1397 | – | – | – | – | – |
| Turb 6b | 0.97 | 24 | – | 174 | – | – | – | – | – | – | – | – | – |
| Turb 4b | 0.97 | 4705 | 4824 | 3633 | 326 | – | 1861 | – | – | – | – | 821 | 4499 |
| Turb 5b | 0.98 | 25664 | 23647 | 24461 | 20569 | 6740 | 4833 | 6795 | 6590 | 7125 | 9857 | 21522 | 26052 |
| Total | | 37027 | 34499 | 33456 | 24953 | 9049 | 8205 | 8193 | 7305 | 7664 | 10872 | 25167 | 35356 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | 22767 | 14140 |
| Turb 4c | 11338 | 9107 | 15270 | 22076 | 25931 | 22645 | 349 | – | – | – | 23150 | 19457 |
| Turb 5c | 19912 | 17439 | 21321 | 24267 | 42075 | – | 42010 | 42251 | 40012 | 38425 | | |

UNIT UTILIZATION – TOTAL MWH

| Unit | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 – | 42370 | 27154 | 30506 | 19396 | – | 17534 | – | – | – | – | – | 22542 |
| Blr #4 – | 47572 | 47563 | 47523 | 29227 | – | 41015 | – | – | – | – | 46365 | 51243 |
| Blr #5 – | 97074 | 97056 | 96974 | 97940 | 106341 | – | 75296 | 70659 | 69160 | 80549 | 98025 | 104565 |
| – | – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 187016 | 171772 | 175003 | 146563 | 106341 | 58549 | 75296 | 70659 | 69160 | 80549 | 144390 | 178350 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | 3.412 | 144567 | 92648 | 104086 | 66179 | – | 59826 | – | – | – | – | – | 76914 |
| Blr #4 | 3.412 | 162315 | 162284 | 162148 | 99724 | – | 139942 | – | – | – | – | 158199 | 174840 |
| Blr #5 | 3.412 | 331217 | 331154 | 330876 | 334171 | 362836 | – | 256910 | 241090 | 235975 | 274833 | 334461 | 356775 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 638099 | 586087 | 597110 | 500074 | 362836 | 199768 | 256910 | 241090 | 235975 | 274833 | 492660 | 608529 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | 82.3% | 82.3% | 82.3% | 82.3% | – | 82.3% | – | – | – | – | – | 82.3% |
| Blr #4 | – | – | 82.3% | 82.3% | 82.3% | 82.3% | – | 82.3% | – | – | – | – | 82.3% | 82.3% |
| Blr #5 | – | – | 84.3% | 84.3% | 84.3% | 84.3% | 84.3% | – | 84.3% | 84.3% | 84.3% | 84.3% | 84.3% | 84.3% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | Unit Energy Input MMBTU | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 – | 175765 | 112643 | 126549 | 80461 | – | 72737 | – | – | – | – | – | – | 93512 |
| Blr #4 – | 197343 | 197306 | 197140 | 121245 | – | 170142 | – | – | – | – | 192339 | 212571 |
| Blr #5 – | 393136 | 393061 | 392731 | 396643 | 430666 | – | 304938 | 286160 | 280089 | 326212 | 396987 | 423472 |
| – | – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 766245 | 703010 | 716420 | 598348 | 430666 | 242880 | 304938 | 286160 | 280089 | 326212 | 589326 | 729556 |

TPS Republika – Case P1

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Coal)

| | Weighted $/MMBTU | WINTER Jan | WINTER Feb | WINTER Mar | SUMMER Apr | SUMMER May | SUMMER June | SUMMER July | SUMMER Aug | SUMMER Sept | WINTER Oct | WINTER Nov | WINTER Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Black Coal $(000) | | | | | | | | | | | |
| Blr #2 | 2.390 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | 2.390 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | 2.390 | 405 | 260 | 292 | 186 | – | 168 | – | – | – | – | – | 216 |
| Blr #4 | 2.390 | 455 | 455 | 455 | 280 | – | 392 | – | – | – | – | 444 | 490 |
| Blr #5 | 2.390 | 907 | 907 | 906 | 915 | 994 | – | 704 | 660 | 646 | 753 | 916 | 977 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1768 | 1622 | 1653 | 1380 | 994 | 560 | 704 | 660 | 646 | 753 | 1360 | 1683 |

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | – | – | – | – | – | – | – | – | – | – | – |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | – | – | – | – | – | – | – | – | – | – | – | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Variable O&M Expense $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | $0.03 | $1.98 | 92 | 59 | 66 | 42 | – | 39 | – | – | – | – | – | 49 |
| Blr #4 | $0.03 | $1.98 | 103 | 103 | 103 | 64 | – | 90 | – | – | – | – | 101 | 110 |
| Blr #5 | $0.03 | $1.98 | 210 | 209 | 210 | 214 | 238 | – | 167 | 157 | 153 | 177 | 213 | 225 |
| | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | 404 | 371 | 378 | 320 | 238 | 129 | 167 | 157 | 153 | 177 | 314 | 384 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | 0.006 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | 0.006 | – | – | – | – | – | – | – | – | – | – | – | 1 |
| Blr #3 | – | 0.006 | 1 | 1 | 1 | 0 | – | 0 | – | – | – | – | 1 | 1 |
| Blr #4 | – | 0.006 | 1 | 1 | 1 | 1 | – | 1 | – | – | – | – | 2 | 2 |
| Blr #5 | – | 0.006 | 2 | 2 | 2 | 2 | 2 | – | 2 | 2 | 2 | 2 | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 4 | 4 | 4 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 4 |
| Removal Costs Only | | | 4 | 4 | 4 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 4 |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Emissions Penalties $(000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | 0.2400 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | 0.2400 | – | – | – | – | – | – | – | – | – | – | – | 22 |
| Blr #3 | 0.2400 | 41 | 26 | 29 | 19 | – | 17 | – | – | – | – | 45 | 49 |
| Blr #4 | 0.2400 | 46 | 46 | 46 | 28 | – | 39 | – | – | – | – | 92 | 98 |
| Blr #5 | 0.2400 | 91 | 91 | 91 | 92 | 100 | – | 71 | 66 | 65 | 76 | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 178 | 163 | 166 | 139 | 100 | 56 | 71 | 66 | 65 | 76 | 137 | 169 |

## Emissions by Type – Tons

| | Pounds per Tonne | Emissions – Tons | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Particulate | 2205 | 0.7 | 0.6 | 0.6 | 0.5 | 0.4 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.5 | 0.6 |
| $SO_2$ | 2205 | 79.5 | 72.9 | 74.3 | 62.1 | 44.7 | 25.2 | 31.6 | 29.7 | 29.1 | 33.9 | 61.1 | 75.7 |
| NOx | 2205 | 185.5 | 170.2 | 173.4 | 144.9 | 104.3 | 58.8 | 73.8 | 69.3 | 67.8 | 79.0 | 142.7 | 176.6 |
| CO | 2205 | 5.7 | 5.2 | 5.3 | 4.5 | 3.2 | 1.8 | 2.3 | 2.1 | 2.1 | 2.4 | 4.4 | 5.4 |

TPS Republika – Case P1

ELECTRIC GENERATION AND NET POWER INTERCHANGE – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
| Average KW Required | 16457 | 15693 | 11604 | 11552 | 10796 | 9271 | 8798 | 9091 | 11277 | 13121 | 15555 | 18585 | 12633 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 16457 | 15693 | 11604 | 11552 | 10796 | 9271 | 8798 | 9091 | 11277 | 13121 | 15555 | 18585 | 12633 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | 937 | 730 | 1329 | – | – | |
| Turb 6a | – | – | – | – | – | – | – | – | – | – | 3821 | 6291 | |
| Turb 4a | 8685 | 8738 | 6793 | 5488 | 3023 | 2314 | 1829 | – | – | – | – | – | |
| Turb 6b | 3716 | – | 3716 | – | – | – | – | – | – | – | 5770 | 7259 | |
| Turb 4b | 7944 | 7124 | 7486 | 5770 | – | 5810 | – | – | – | – | 29175 | 34176 | |
| Turb 5b | 33667 | 34344 | 32088 | 27882 | 8842 | 6552 | 8914 | 8644 | 9659 | 12930 | 38765 | 47726 | |
| Total T/G Output | 54012 | 50205 | 50064 | 39141 | 11865 | 14675 | 10743 | 9581 | 10388 | 14259 | | | |
| Balance Required | –37555 | –34512 | –38479 | –27589 | –1069 | –5404 | –1945 | –490 | 889 | –1139 | –23211 | –29141 | |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | 10410 | 6257 | 1.027 |
| Turb 4c | 97.4% | 5017 | 4461 | 6757 | 10094 | 11474 | 10354 | 154 | – | – | – | 12302 | 10006 | 1.025 |
| Turb 5c | 97.6% | 10240 | 9929 | 10964 | 12895 | 21636 | – | 21603 | 21727 | 21261 | 19759 | 22711 | 16262 | |
| Total Condens Turb Output | | 15257 | 14390 | 17721 | 22989 | 33111 | 10354 | 21758 | 21727 | 21261 | 19759 | | | |
| Balance Required | | –52811 | –48902 | –56200 | –50578 | –34179 | –15758 | –23703 | –22217 | –20373 | –20898 | –45922 | –45403 | |
| GT Capability @ Full Load | | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total GT Output (KW) | – | – | – | – | – | – | – | – | – | – | – | – | |
| Balance Required (KW) | –52811 | –48902 | –56200 | –50578 | –34179 | –15758 | –23703 | –22217 | –20373 | –20898 | –45922 | –45403 | |
| Hours In Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 | |
| Balance Required (MWH) | –35222 | –32774 | –37186 | –32580 | –25429 | –8781 | –17635 | –16530 | –14668 | –15548 | –29709 | –32761 | |
| **PURCHASED POWER** | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – | |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – | |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 | |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – | |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – | |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **POWER SALES** | | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 | |
| Energy Credit $(000) | 917.3 | 853.5 | 968.4 | 735.3 | 573.9 | 198.2 | 398.0 | 373.1 | 331.1 | 404.9 | 773.7 | 853.2 | 7380.5 |

992

TPS Republika – Case P1

HEAT REJECTION – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

GAS TURBINE

Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Electric Output Ratio | – | – | – | – | – | – | – | – | – | – | – | – |
| Utilized Heat Ratio | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 300.000 | 26.4 | 24.7 | 31.0 | 40.8 | 57.5 | 20.8 | 34.6 | 73.5 | 72.7 | 70.3 | 40.5 | 28.5 |
| From Gas Turbines | 300.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 26.4 | 24.7 | 31.0 | 40.8 | 57.5 | 20.8 | 34.6 | 73.5 | 72.7 | 70.3 | 40.5 | 28.5 |

TPS Pernik – Case P1

SUPPLEMENTARY DATA

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct. | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | 14.4 | – | 6.4 | 5.0 | 9.1 | – | – |
| Turb 6a | 54.7 | 55.1 | 42.8 | 34.6 | 19.1 | – | 11.5 | – | – | – | 24.1 | 39.6 |
| Turb 4a | 26.7 | – | 26.7 | – | – | – | – | – | – | – | – | – |
| Turb 6b | 39.7 | 35.6 | 37.4 | 28.8 | – | 29.0 | – | – | – | – | 28.8 | 36.2 |
| Turb 4b | 123.6 | 126.1 | 117.8 | 102.4 | 32.5 | 24.1 | 32.7 | 31.7 | 35.5 | 47.5 | 107.1 | 125.5 |
| Turb 5b | | | | | | | | | | | | |

Maximum Steam Flow – MW

| | BASIS KW1 | Total Boiler MW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 25000 | – | 100.7 | 103.5 | 87.1 | 87.5 | 53.9 | 56.7 | 12.0 | 38.9 | 38.9 | 38.9 | 61.2 | 88.0 |
| Turb 5c | 55000 | – | 150.4 | 152.1 | 146.5 | 136.1 | 89.0 | 20.8 | 89.2 | 88.5 | 91.0 | 99.1 | 139.3 | 151.7 |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 4c | 15.2 | 13.6 | 20.5 | 30.7 | 34.9 | 27.7 | 0.5 | 38.9 | 38.9 | 38.9 | 31.6 | 19.0 |
| Turb 5c | 26.8 | 26.0 | 26.7 | 33.7 | 56.6 | – | 56.5 | 56.8 | 55.6 | 51.6 | 32.2 | 26.2 |
| | 42.0 | 39.5 | 49.2 | 64.4 | 91.4 | 27.7 | 56.9 | 95.7 | 94.5 | 90.6 | 63.8 | 45.2 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | | – | – | – | – | – | 720 | – | 744 | 720 | 744 | – | – |
| Turb 4a | | 744 | 672 | 744 | 720 | 744 | – | 744 | – | – | – | 720 | 744 |
| Turb 6b | | 6 | – | 46 | – | – | – | – | – | – | – | – | – |
| Turb 4b | | 577 | 660 | 473 | 55 | – | 279 | – | – | – | – | 139 | 604 |
| Turb 5b | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | | – | – | – | – | – | 12.2 | – | 5.5 | 4.3 | 7.8 | – | – |
| Turb 4a | | 45.8 | 46.1 | 35.8 | 26.9 | 15.9 | – | 9.7 | – | – | – | 20.2 | 33.2 |
| Turb 6b | | 22.9 | – | 22.9 | – | – | – | – | – | – | – | – | – |
| Turb 4b | | 31.5 | 28.2 | 29.7 | 22.9 | – | 23.0 | – | – | – | – | 22.9 | 28.8 |
| Turb 5b | | 89.1 | 90.9 | 85.0 | 73.8 | 23.4 | 17.3 | 23.6 | 22.9 | 25.6 | 34.2 | 77.3 | 90.5 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1050 | – | – | – | – | – | 37.7 | – | 16.9 | 13.2 | 24.0 | – | – |
| | 1.0620 | 147.2 | 148.1 | 115.1 | 93.0 | 51.2 | – | 31.0 | – | – | – | 64.8 | 106.6 |
| | 0.9520 | 82.0 | – | 82.0 | – | – | – | – | – | – | – | – | – |
| | 1.0660 | 100.8 | 90.4 | 95.0 | 73.2 | – | 73.7 | – | – | – | – | 73.2 | 92.1 |
| | 1.0020 | 303.6 | 309.7 | 289.3 | 251.4 | 79.7 | 59.1 | 80.4 | 77.9 | 87.1 | 116.6 | 263.1 | 308.2 |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | | – | – | – | – | – | 34.2% | – | 15.3% | 11.9% | 21.8% | – | – |
| Turb 4a | | 83.5% | 84.0% | 65.3% | 52.7% | 29.1% | – | 17.6% | – | – | – | 36.7% | 60.5% |
| Turb 6b | | 33.8% | – | 33.8% | – | – | – | – | – | – | – | – | – |
| Turb 4b | | 65.3% | 58.6% | 61.6% | 47.5% | – | 47.8% | – | – | – | – | 47.5% | 59.7% |
| Turb 5b | | 91.8% | 93.7% | 87.5% | 76.0% | 24.1% | 17.9% | 24.3% | 23.6% | 26.3% | 35.3% | 79.6% | 93.2% |

994

TPS Pernik – Case P1

SUPPLEMENTARY DATA

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

Steam Supply – Percent of Output and Total Cost

| | Percent of Total Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | 18.2% | 18.0% | 15.2% | 14.2% | 11.2% | 20.2% | 9.5% | 5.8% | 4.4% | 7.2% | 10.1% | 13.8% |
| Blr #5 | 18.2% | 18.0% | 15.2% | 14.2% | 11.2% | 20.2% | 9.5% | 5.8% | 4.4% | 7.2% | 10.1% | 13.8% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

| Cost of Steam Supply | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 100 | 99 | 84 | 73 | 54 | 12 | 33 | 19 | 14 | 26 | 56 | 82 |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 92 | 91 | 77 | 64 | 42 | 19 | 26 | 14 | 11 | 20 | 51 | 75 |
| Total | 193 | 191 | 161 | 137 | 96 | 30 | 58 | 33 | 25 | 47 | 107 | 158 |

Hot Water Supply – Percent of Output and Total Cost

| | Percent of Total Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | 45.3% | 46.4% | 44.7% | 37.1% | 16.4% | 43.5% | 23.3% | 24.1% | 26.6% | 31.6% | 40.7% | 47.5% |
| Blr #5 | 45.3% | 46.4% | 44.7% | 37.1% | 16.4% | 43.5% | 23.3% | 24.1% | 26.6% | 31.6% | 40.7% | 47.5% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

| Cost of Hot Water Supply | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 249 | 256 | 246 | 191 | 79 | 26 | 80 | 78 | 84 | 116 | 225 | 282 |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 229 | 235 | 227 | 166 | 62 | 40 | 62 | 60 | 65 | 90 | 207 | 259 |
| Total | 479 | 491 | 473 | 357 | 142 | 66 | 142 | 138 | 149 | 206 | 432 | 541 |

Electric Supply – Percent of Output and Total Cost

| | Percent of Total Output | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #2 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #3 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #4 | 36.5% | 35.5% | 40.0% | 48.6% | 72.5% | 36.2% | 67.1% | 70.1% | 68.9% | 61.2% | 49.2% | 38.7% |
| Blr #5 | 36.5% | 35.5% | 40.0% | 48.6% | 72.5% | 36.2% | 67.1% | 70.1% | 68.9% | 61.2% | 49.2% | 38.7% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |

| Cost of Electric Supply | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 201 | 196 | 220 | 250 | 351 | 21 | 230 | 226 | 217 | 225 | 272 | 229 |
| Coal | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | 185 | 180 | 203 | 218 | 275 | 33 | 180 | 176 | 169 | 174 | 250 | 211 |
| Total | 386 | 376 | 423 | 468 | 627 | 55 | 410 | 402 | 386 | 399 | 522 | 440 |

995

**REPUBLIKA**

**Case P3**

TPS Republika – Case P3

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 4,929 | – | – | – | – | – | 6,635 | 6,635 | 6,635 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 |
| Black Coal | – | 13,823 | 13,650 | 13,912 | 14,182 | 14,458 | 6,593 | 6,593 | 6,593 | 1,672 | 1,672 | 1,672 | 1,672 | 1,672 | 1,672 | 1,672 | 1,672 |
| Total Fuel Cost | 4,929 | 13,823 | 13,650 | 13,912 | 14,182 | 14,458 | 13,227 | 13,227 | 13,227 | 12,530 | 12,530 | 12,530 | 12,530 | 12,530 | 12,530 | 12,530 | 12,530 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (7,872) | (8,396) | (8,513) | (8,735) | (8,964) | (9,199) | (9,440) | (9,440) | (9,440) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) |
| Net Power Interchange | (7,872) | (8,396) | (8,513) | (8,735) | (8,964) | (9,199) | (9,440) | (9,440) | (9,440) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) |
| Fixed O&M and Overheads | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| Other Variable O & M | 3,192 | 3,192 | 3,113 | 3,113 | 3,113 | 3,113 | 3,113 | 3,113 | 3,113 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 |
| Sorbent and Ash Removal | 1,156 | 33 | 32 | 32 | 32 | 32 | 1,417 | 1,417 | 1,417 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 |
| Credit: By–Product Sales | – | – | – | – | – | – | (394) | (394) | (394) | (644) | (644) | (644) | (644) | (644) | (644) | (644) | (644) |
| Emission Penalties | 930 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maintenance Expenses | 1,772 | 1,773 | 1,965 | 1,742 | 1,908 | 1,915 | 1,607 | 1,304 | 2,294 | 1,716 | 2,407 | 1,268 | 1,486 | 2,301 | 2,020 | 2,143 | 1,594 |
| Plant Removal Costs | 1,412 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 8,642 | 13,548 | 13,370 | 13,187 | 13,394 | 13,443 | 12,654 | 12,350 | 13,341 | 12,388 | 13,078 | 11,939 | 12,158 | 12,973 | 12,692 | 12,815 | 12,265 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 30092 | 4323 | 5277 | 20900 | 39663 | 17294 | 17429 | 25414 | 20913 | 6954 | – | – | – | – | 1394 | – | – |
| Domestic | 2967 | 835 | 1028 | 1618 | 2291 | 1239 | 977 | 1269 | 975 | 484 | – | – | – | – | 28 | – | – |
| Total | 33059 | 5158 | 6305 | 22518 | 41954 | 18532 | 18406 | 26683 | 21888 | 7439 | – | – | – | – | 1422 | – | – |
| TOTAL COST | 41,700 | 18,706 | 19,676 | 35,705 | 55,348 | 31,975 | 31,059 | 39,033 | 35,229 | 19,826 | 13,078 | 11,939 | 12,158 | 12,973 | 14,114 | 12,815 | 12,265 |
| Present Worth | 40,126 | 16,667 | 16,232 | 27,274 | 39,147 | 20,940 | 18,834 | 21,916 | 18,314 | 9,544 | 5,829 | 4,927 | 4,646 | 4,590 | 4,624 | 3,887 | 3,445 |
| Cumulative Present Worth | 40,126 | 56,793 | 73,025 | 100,299 | 139,446 | 160,386 | 179,220 | 201,136 | 219,450 | 228,994 | 234,823 | 239,750 | 244,396 | 248,986 | 253,610 | 257,497 | 260,942 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 |
| Hot Water | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 |
| Electricity | 409,490 | 409,490 | 394,208 | 394,208 | 394,208 | 394,208 | 394,208 | 394,208 | 394,208 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $6.97 | $11.65 | $11.75 | $11.93 | $12.12 | $12.31 | $12.15 | $12.15 | $12.15 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 |
| Hot Water | $6.97 | $11.65 | $11.75 | $11.93 | $12.12 | $12.31 | $12.15 | $12.15 | $12.15 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 |
| Electricity | $12.19 | $20.35 | $20.32 | $20.63 | $20.96 | $21.29 | $20.99 | $20.99 | $20.99 | $20.76 | $20.76 | $20.76 | $20.76 | $20.76 | $20.76 | $20.76 | $20.76 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 124,501 | 5 | 5 | 5 | 5 | 5 | 128 | 128 | 128 | 206 | 206 | 206 | 206 | 206 | 206 | 206 | 206 |
| $SO_2$ | 17,750 | 622 | 602 | 602 | 602 | 602 | 1,169 | 1,169 | 1,169 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 |
| NOx | 1,614 | 871 | 844 | 844 | 844 | 844 | 847 | 847 | 847 | 864 | 864 | 864 | 864 | 864 | 864 | 864 | 864 |
| CO | 49 | 45 | 43 | 43 | 43 | 43 | 47 | 47 | 47 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

TPS Republika – Case P3

FACILITIES DATA SHEET AND SIMULATED RESULT – YEAR 2010

CASE P3 — Test Year = 2010

## Facilities Data

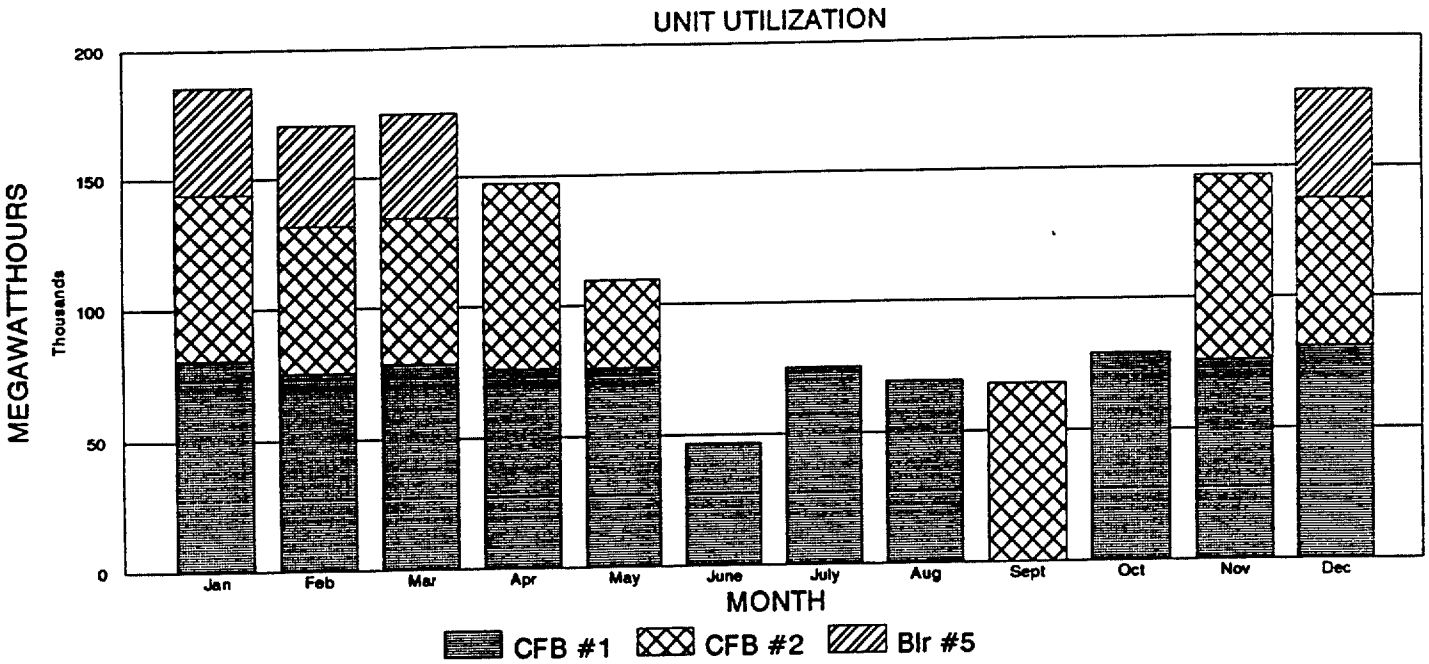
EXISTING FACILITIES

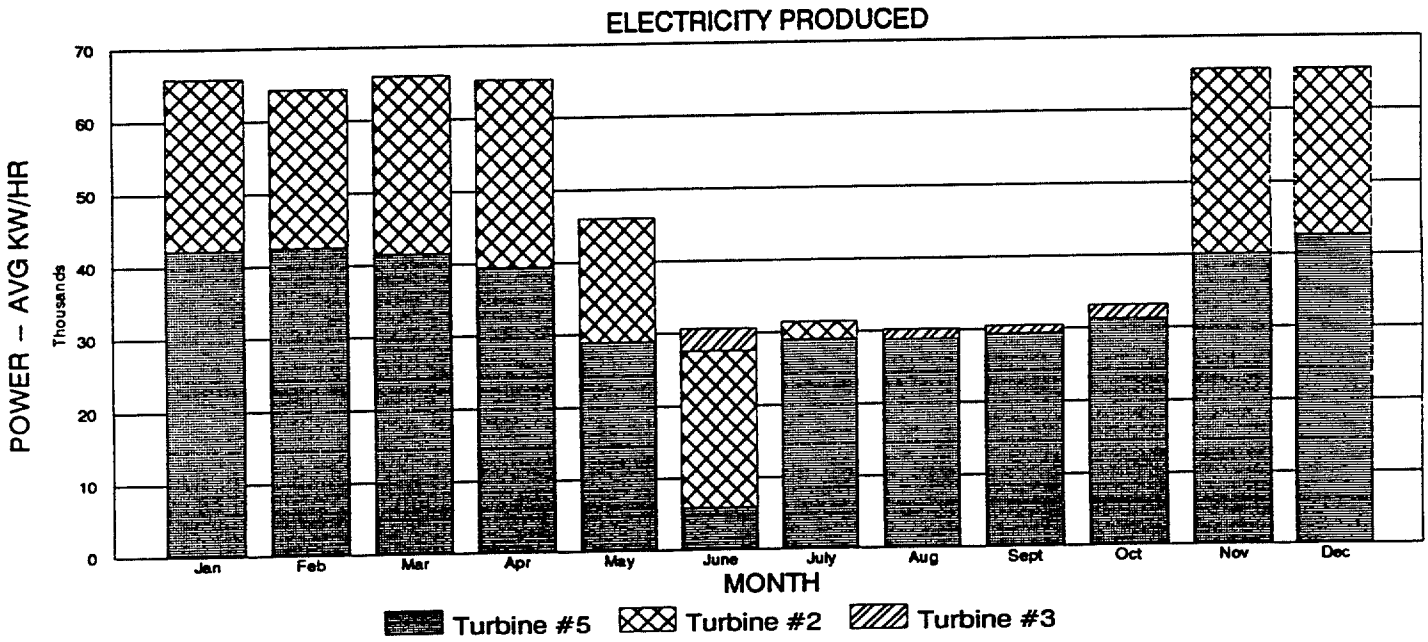
| DESCRIPTION | UNIT | BASIS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Br #4 | | | | Br #5 | | | | | | Br #6 | CFB #1 | CFB #2 | |
| THERMAL DATA | | | | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | | 85.3% | | | | 87.3% | | | | | | 87.3% | 79.7% | 79.7% | |
| Half Load | %2 | | | 85.3% | | | | 87.3% | | | | | | 87.3% | 79.7% | 79.7% | |
| Minimum Load | %3 | | | 85.3% | | | | 87.3% | | | | | | 87.3% | 79.7% | 79.7% | |
| Minimum Operation | % | | | 40.0% | | | | 40.0% | | | | | | 40.0% | 30.0% | 40.0% | |
| Feedwater Temp | | | | 397° | | | | 413° | | | | | | 413° | | | |
| Operation Adjustment Factor | Factor | | | | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | | 8 | | | | 6 | | | | | | 7 | 4 | 5 | |
| Capacity | MWt | | | 70.960 | | | | 144.800 | | | | | | 144.800 | 112.640 | 112.640 | |
| Quantity | Mlb/Hr | | | 223.830 | | | 96.15 | 453.390 | | 144.141 | | | | 453.390 | | | |
| Pressure | PSIA | | | 1024 | | | 27.444 | 1060 | | | | | | 1060 | | | |
| Temperature | Temp °F | | | 923.5° | | | 25.671 | 956° | | 36.092 | | | | 956° | | | |
| Enthalpy | MBTU/lb | | | 1.455 | | | 97.786 | 1.480 | | 157.305 | | | | 1.480 | | | |
| PRODUCT – LP STEAM | Priority | * | | | 4 | | | | | | | 5 | | | | | |
| Quantity | Mlb/Hr | | | | | | | | | | | 106.6 | | | | | |
| | MWts | | | | 57.070 | | | | | | | | | | | | |
| Pressure | PSIA | | | | | | | | | | | | | | | | |
| Temperature | Temp °F | | | | | | | | | | | | | | | | |
| Enthalpy | MBTU/lb | | | | | | | | | | | | | | | | |
| PRODUCT – HOT WATER | Priority | Cooling | | | | 2 | | | 1 | | | | 3 | | | | |
| Quantity | MWtw | 300.000 | | | | 65.680 | | | 97.100 | | | | 68.000 | | | | |
| Temperature – Supply | Temp °F | | | | | | | | 302° | | | | 248° | | | | |
| Return | Temp °F | | | | | | | | 227° | | | | 227° | | | | |
| TURBINE DATA | UNITs | | | | Turb 2a | Turb 2b | Turb 2c | | Turb 6b | Turb 6c | | Turb 6a | Turb 6b | | | | |
| | Priority | | | | | | 35000 | | | 55000 | | | 25000 | | | | |
| Rated Capacity–Electric | KW | | | | 8639 | 21611 | 35000 | | 37235 | 55000 | | 24825 | 24400 | | | | |
| Capability – Max Steam | KW1 | | | | 6500 | 16155 | | | 27926 | | | 19392 | 16947 | | | | |
| 75 % Steam | KW75 | | | | 4363 | 10730 | | | 18617 | | | 13122 | 9628 | | | | |
| 50 % Steam | KW50 | | | | 2194 | 5345 | | | 9309 | | | 6633 | 2040 | | | | |
| 25% Steam | KW25 | | | | 154.350 | 218.000 | | | 330.750 | | | 330.750 | 243.800 | | | | |
| Steam Required – Maximum | M#/Hr_Max | | | | | | | | | | | | 54.180 | | | | |
| Minimum | M#/Hr_Min | | | | | | | | 17.0 | | | 142.0 | 17.8 | | | | |
| Outlet Steam Pressure | PSI | | | | 0.189 | 0.303 | | | 0.34 | | | 0.19 | 0.309 | | | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | 1.262 | 1.028 | | | 1.001 | | | 1.100 | 0.955 | | | | |
| Sink | MBTU/lbe | | | | 97.6% | 97.6% | 97.6% | | 97.6% | 97.6% | | 97.4% | 97.4% | | | | |
| Generator Efficiency | %g | | | | | | 0.359 | | | 0.375 | | | | | | | |
| Power/Rejection Factor | Factor | | | | | | | | | | | | | | | | |
| FUELS DATA | | | | | | | | | | | | | | Coal | Lignite | Lignite | |
| Primary Fuel | Type | | | Coal | | | | Coal | | | | | | $2.39 | $0.67 | $0.67 | |
| Cost | $/MMBTU | | | $2.39 | | | | $2.39 | | | | | | 100.0% | 100.0% | 100.0% | |
| Percent Use | % Use | | | 100.0% | | | | 100.0% | | | | | | | | | |
| Secondary/Supplemental Fue | Type | | | | | | | | | | | | | | | | |
| Cost | $/MMBTU | | | | | | | | | | | | | | | | |
| Percent Use | % Use | | | | | | | | | | | | | | | | |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | | | | |
| Number of Personnel | Number | | 983 | | | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | | 2.6 | | | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | | $568.0 | | | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | | $0.03 | | | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | | $0.30 | | | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | | $1.98 | | | | | | | | | | | | | | |
| Limestone | $/Ton' | | $3.28 | | | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | | $5.00 | | | | | | | | | | | PC2–B2 | FB2–BL1 | FB2–BL1 | |
| Emissions Code –Fuel 1 | CODEe1 | | | PC2–B2 | | | | PC2–B2 | | | | | | | | | |
| Emissions Code –Fuel 2 | CODEe2 | | | | | | | | | | | ST6 | | PB6 | CFB1 | CFB2 | |
| Scheduled Maintenance | CODE m | | | PB4 | ST4 | | | PB5 | ST5 | | | | | | | | |
| Purchased Power | $/kW | | | | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | | | | | | | | | | | | | | | | |
| Summer | Cents/KWHs | | | | | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | | AVAILABILITY | | | | | | | | | | |
| Jan | –1.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Feb | 0.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Mar | 4.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Apr | 10.8 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | – | 100% | 100% | |
| May | 15.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| June | 19.0 | | | 100% | 100% | 100% | 100% | – | 50% | 50% | | 100% | 100% | 100% | 100% | 100% | |
| July | 21.2 | | | – | 50% | 50% | 50% | 100% | 100% | 100% | | 50% | 50% | 100% | 100% | – | |
| Aug | 20.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | – | 100% | |
| Sept | 16.7 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Oct | 11.3 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Nov | 5.9 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |
| Dec | 0.6 | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% | 100% | 100% | |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 412 | 377 | 384 | 421 | 314 | 134 | 215 | 199 | 194 | 227 | 419 | 393 | 3,688 |
| Black Coal | 389 | 363 | 377 | – | – | – | – | – | – | – | – | 391 | 1,519 |
| Total Fuel Cost | 800 | 739 | 762 | 421 | 314 | 134 | 215 | 199 | 194 | 227 | 419 | 784 | 5,208 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (907) | (847) | (974) | (735) | (592) | (130) | (380) | (354) | (311) | (388) | (795) | (871) | (7,285) |
| Net Power Interchange Cost | (907) | (847) | (974) | (735) | (592) | (130) | (380) | (354) | (311) | (388) | (795) | (871) | (7,285) |
| Other O&M – Fixed, OH & Other | 265 | 240 | 265 | 257 | 265 | 257 | 265 | 265 | 257 | 265 | 257 | 265 | 3,124 |
| Variable | 401 | 368 | 378 | 321 | 246 | 102 | 167 | 154 | 150 | 174 | 319 | 386 | 3,166 |
| Limestone Injection & Ash Removal | 257 | 235 | 240 | 262 | 195 | 83 | 134 | 124 | 121 | 141 | 261 | 245 | 2,299 |
| Credit for By–Product Sales | (72) | (66) | (67) | (73) | (55) | (23) | (38) | (35) | (34) | (40) | (73) | (69) | (644) |
| Emissions Penalties | 0 | 0 | 0 | – | – | – | – | – | – | – | – | 0 | 0 |
| Total Excluding Maintenance | 744 | 669 | 604 | 452 | 373 | 422 | 364 | 353 | 377 | 381 | 387 | 741 | 5,867 |

BEST AVAILABLE COPY

TPS Republika – Case P3

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999

LOAD DISPATCH AND ENERGY USE – YEAR 2010

| | | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **PRODUCT – LP STEAM** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 26699 | 23634 | 20380 | 15412 | 8900 | 6270 | 4951 | 2769 | 2091 | 3507 | 10396 | 18145 |
| Station Use, Losses, etc. | MWH | – | 7395 | 7347 | 6284 | 5429 | 2967 | 2522 | 2230 | 1303 | 978 | 2271 | 4115 | 6546 |
| | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | 4072 | 3069 | 5778 | 14511 | 24691 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | MWts | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 106.600 | 1 | – | – | – | – | – | 12.2 | – | 5.5 | 4.3 | 7.8 | – | – |
| Header | 57.070 | 1 | 45.8 | 48.1 | 35.8 | 28.9 | 15.9 | – | 9.7 | – | – | – | 20.2 | 33.2 |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | 8792 | – | 4072 | 3069 | 5778 | – | – |
| Header | | | 34095 | 30982 | 26664 | 20842 | 11866 | – | 7181 | – | – | – | 14511 | 24691 |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | 4072 | 3069 | 5778 | 14511 | 24691 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PRODUCT – HOT WATER** | | | | | | | | | | | | | | |
| Customer Requirement | MWH | | 75009 | 70285 | 69715 | 45613 | 10974 | 11462 | 9220 | 9557 | 10685 | 17574 | 51015 | 73894 |
| Station Use, Losses, etc. | MWH | – | 9635 | 9461 | 8577 | 8813 | 6446 | 7445 | 8343 | 7474 | 7530 | 7900 | 7779 | 10812 |
| | | | 84644 | 79746 | 78292 | 54425 | 17420 | 18907 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 68.000 | 1 | – | – | – | – | – | – | – | – | – | – | 8.0 | 23.6 |
| Header | 65.680 | 1 | 26.0 | 23.0 | 26.4 | 7.3 | – | 11.1 | – | – | – | – | 80.1 | 94.7 |
| Header | 97.100 | 1 | 93.6 | 96.1 | 88.5 | 75.0 | 23.4 | 22.0 | 23.6 | 22.9 | 25.6 | 34.2 | 88.1 | 118.3 |
| Total | | | 119.6 | 119.1 | 114.8 | 82.3 | 23.4 | 33.1 | 23.6 | 22.9 | 25.6 | 34.2 | 88.1 | 118.3 |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | – | – | – | – | – | – | – | – | – | – | 1111 | 14241 |
| Header | | | 14976 | 15142 | 12455 | 404 | – | 3102 | – | – | – | – | 57684 | 70465 |
| Header | | | 69669 | 64604 | 65837 | 54022 | 17420 | 15806 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |
| Total | | | 84644 | 79746 | 78292 | 54425 | 17420 | 18907 | 17563 | 17031 | 18415 | 25475 | – | – |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – |

ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | 8792 | – | 4072 | 3069 | 5778 | – | – |
| Header | | | 34095 | 30982 | 26664 | 20842 | 11866 | – | 7181 | – | – | – | 14511 | 24691 |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 34095 | 30982 | 26664 | 20842 | 11866 | 8792 | 7181 | 4072 | 3069 | 5778 | 14511 | 24691 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 20207 | 20753 | 16423 | 1569 | – | 7905 | – | – | – | – | 3933 | 18819 |
| Header | | | 64437 | 58993 | 61869 | 52856 | 17420 | 11002 | 17563 | 17031 | 18415 | 25475 | 54861 | 65887 |
| Total | | | 84644 | 79746 | 78292 | 54425 | 17420 | 18907 | 17563 | 17031 | 18415 | 25475 | 58795 | 84706 |

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1000

TPS Republika – Case P3

LOAD DISPATCH AND ENERGY USE – YEAR 2010

TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | 8792 | – | 4072 | 3069 | 5778 | – | – |
| Header | 34095 | 30982 | 26664 | 20642 | 11866 | – | 7181 | – | – | – | 14511 | 24691 |
| Header | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | 20207 | 20753 | 18423 | 1589 | – | 7905 | – | – | – | – | 3933 | 18819 |
| Header | 64437 | 58993 | 61869 | 52856 | 17420 | 11002 | 17563 | 17031 | 18415 | 25475 | 54861 | 65887 |
| Header | 118739 | 110727 | 104955 | 75267 | 29286 | 27699 | 24744 | 21103 | 21484 | 31252 | 73306 | 109397 |
| Total | | | | | | | | | | | | |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | 2246 | – | 1040 | 784 | 1476 | – | – |
| Turb 6a | 0.97 | – | – | – | – | 1867 | – | 1131 | – | – | – | 2278 | 3856 |
| Turb 2a | 0.98 | 5299 | 4815 | 4158 | 3263 | – | – | – | – | – | – | – | – |
| Turb 6b | 0.97 | – | – | – | – | – | – | – | – | – | – | 1316 | 6297 |
| Turb 2b | 0.98 | 6767 | 6944 | 5499 | 525 | – | 2644 | – | – | – | – | 21570 | 25904 |
| Turb 5b | 0.98 | 25335 | 23194 | 24325 | 20781 | 6849 | 4326 | 6905 | 6696 | 7240 | 10016 | 25163 | 36057 |
| Total | | 37400 | 34953 | 33983 | 24569 | 8716 | 9216 | 8036 | 7736 | 8024 | 11492 | | |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | 26851 | 16107 |
| Turb 2c | 11078 | 8705 | 16355 | 25068 | 31164 | 9687 | 2098 | – | – | – | 21232 | 17594 |
| Turb 5c | 18279 | 16136 | 19493 | 22179 | 40493 | – | 40426 | 40677 | 38451 | 36688 | | |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | 41573 | 38822 | 40344 | – | – | – | – | – | – | – | – | 41826 |
| CFB #2 | – | 63074 | 56199 | 55983 | 70895 | 33522 | – | – | – | 67959 | – | 70298 | 55987 |
| CFB #1 | – | 80849 | 75500 | 78459 | 76188 | 76137 | 46802 | 75304 | 69516 | – | 79431 | 76254 | 81341 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 185496 | 170521 | 174786 | 147083 | 109659 | 46802 | 75304 | 69516 | 67959 | 79431 | 146552 | 179155 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | 3.412 | 141847 | 132462 | 137653 | – | – | – | – | – | – | – | – | 142710 |
| CFB #2 | 3.412 | 215209 | 191751 | 191015 | 241894 | 114376 | – | – | – | 231878 | – | 239857 | 191029 |
| CFB #1 | 3.412 | 275857 | 257605 | 267701 | 259952 | 259781 | 159688 | 256938 | 237190 | – | 271020 | 260178 | 277536 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 632912 | 581818 | 596369 | 501846 | 374157 | 159688 | 256938 | 237190 | 231878 | 271020 | 500035 | 611275 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | – | 87.3% | 87.3% | 87.3% | – | – | – | – | – | – | – | – | 87.3% |
| CFB #2 | – | – | 79.7% | 79.7% | 79.7% | 79.7% | 79.7% | – | – | – | 79.7% | – | 79.7% | 79.7% |
| CFB #1 | – | – | 79.7% | 79.7% | 79.7% | 79.7% | 79.7% | 79.7% | 79.7% | 79.7% | – | 79.7% | 79.7% | 79.7% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | | Unit Energy Input MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | – | 162575 | 151819 | 157768 | – | – | – | – | – | – | – | – | 163585 |
| CFB #2 | – | 270023 | 240591 | 239668 | 303506 | 143508 | – | – | – | 290938 | – | 300950 | 239685 |
| CFB #1 | – | 346119 | 323218 | 335885 | 326163 | 325949 | 200362 | 322381 | 297604 | – | 340050 | 326446 | 348226 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 778717 | 715628 | 733321 | 629669 | 469457 | 200362 | 322381 | 297604 | 290938 | 340050 | 627396 | 751476 |

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TPS Republika – Case P3

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Lignite)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Lignite $(000) | | | | | | | | | | | |
| Br #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #5 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #2 | $0.67 | 180 | 161 | 160 | 203 | 96 | – | – | – | 194 | – | 201 | 160 |
| CFB #1 | $0.67 | 231 | 216 | 224 | 218 | 218 | 134 | 215 | 199 | – | 227 | 218 | 233 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 412 | 377 | 384 | 421 | 314 | 134 | 215 | 199 | 194 | 227 | 419 | 393 |

## FUEL COST – BOILERS (Coal)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Black Coal $(000) | | | | | | | | | | | |
| Br #4 | 2.390 | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | 2.390 | – | – | – | – | – | – | – | – | – | – | – | 391 |
| Br #5 | 2.390 | 389 | 363 | 377 | – | – | – | – | – | – | – | – | – |
| CFB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 389 | 363 | 377 | – | – | – | – | – | – | – | – | 391 |

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | |
| Br #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #5 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | – | – | – | – | – | – | – | – | – | – | – |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Mazut $(000) | | | | | | | | | | | |
| Br #4 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #5 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | – | – | – | – | – | – | – | – | – | – | – |

| | | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | | MWH | – | – | – | – | – | – | – | – | – | – | – | – |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHtu | Basis $/MWH | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Variable O&M Expense $(000) | | | | | | | | | | | |
| Br #4 | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #5 | $0.03 | $1.98 | 90 | 84 | 87 | – | – | – | – | – | – | – | – | 90 |
| CFB #2 | $0.03 | $1.98 | 136 | 121 | 121 | 155 | 75 | – | – | – | 150 | – | 153 | 121 |
| CFB #1 | $0.03 | $1.98 | 175 | 163 | 170 | 166 | 171 | 102 | 167 | 154 | – | 174 | 166 | 175 |
| | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| | $0.03 | $1.98 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | – | 401 | 368 | 378 | 321 | 246 | 102 | 167 | 154 | 150 | 174 | 319 | 386 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | |
| Br #4 | – | 0.006 | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | – | 0.006 | – | – | – | – | – | – | – | – | – | – | – | 1 |
| Br #5 | – | 0.006 | 1 | 1 | 1 | – | – | – | – | – | 121 | – | 125 | 100 |
| CFB #2 | 0.057 | 0.359 | 112 | 100 | 100 | 126 | 60 | – | – | 124 | – | 141 | 136 | 145 |
| CFB #1 | 0.057 | 0.359 | 144 | 134 | 140 | 136 | 135 | 83 | 134 | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 257 | 235 | 240 | 262 | 195 | 83 | 134 | 124 | 121 | 141 | 261 | 245 |
| Removal Costs Only | | | 222 | 203 | 207 | 226 | 169 | 72 | 116 | 107 | 104 | 122 | 225 | 212 |
| By–Product Sales $(000) | | | 72 | 66 | 67 | 73 | 55 | 23 | 38 | 35 | 34 | 40 | 73 | 69 |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions Penalties $(000) | | | | | | | | | | | |
| Br #4 | 0.0002 | – | – | – | – | – | – | – | – | – | – | – | – |
| Br #6 | 0.0002 | – | – | – | – | – | – | – | – | – | – | – | 0 |
| Br #5 | 0.0002 | 0 | 0 | 0 | – | – | – | – | – | – | – | – | – |
| CFB #2 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| CFB #1 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 0 | 0 | 0 | – | – | – | – | – | – | – | – | 0 |

## Emissions by Type – Tons

| | Pounds per Tonne | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions – Tons | | | | | | | | | | | |
| Particulate | 2205 | 23.1 | 21.1 | 21.5 | 23.4 | 17.5 | 7.5 | 12.0 | 11.1 | 10.8 | 12.6 | 23.3 | 22.0 |
| $SO_2$ | 2205 | 181.8 | 166.7 | 170.4 | 167.9 | 125.2 | 53.4 | 86.0 | 79.4 | 77.6 | 90.7 | 167.3 | 174.4 |
| NOx | 2205 | 126.6 | 116.6 | 119.7 | 87.7 | 65.4 | 27.9 | 44.9 | 41.4 | 40.5 | 47.3 | 87.4 | 122.9 |
| CO | 2205 | 6.3 | 5.8 | 5.9 | 5.1 | 3.8 | 1.6 | 2.6 | 2.4 | 2.4 | 2.8 | 5.1 | 6.1 |

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TPS Republika – Case P3

## ELECTRIC GENERATION AND NET POWER INTERCHANGE – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Average KW Required | 16457 | 15693 | 11604 | 11552 | 10796 | 9271 | 8798 | 9091 | 11277 | 13121 | 15555 | 18585 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 16457 | 15693 | 11604 | 11552 | 10796 | 9271 | 8798 | 9091 | 11277 | 13121 | 15555 | 18585 |

### BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | – | – | – | – | – | 3038 | – | 1362 | 1061 | 1932 | – | – |
| Turb 2a | 6951 | 6993 | 5455 | 4423 | 2449 | – | 1484 | – | – | – | 3088 | 5058 |
| Turb 6b | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2b | 11450 | 10275 | 11357 | 9266 | – | 9266 | – | – | – | – | 9266 | 10182 |
| Turb 5b | 33235 | 33687 | 31910 | 28170 | 8985 | 5864 | 9059 | 8784 | 9815 | 13139 | 29239 | 33982 |
| Total T/G Output | 51636 | 50954 | 48721 | 41859 | 11434 | 18168 | 10542 | 10146 | 10875 | 15071 | 41592 | 49222 |
| Balance Required | –35178 | –35261 | –37117 | –30307 | –638 | –8897 | –1744 | –1055 | 402 | –1950 | –26038 | –30637 |

### CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2c | 97.6% | 5213 | 4535 | 7696 | 12189 | 14664 | 12428 | 987 | – | – | – | 13056 | 7579 |
| Turb 5c | 97.6% | 9002 | 8798 | 9599 | 11286 | 19941 | – | 19908 | 20032 | 19567 | 18067 | 10804 | 8665 |
| Total Condens Turb Output | | 14214 | 13333 | 17295 | 23475 | 34605 | 12428 | 20895 | 20032 | 19567 | 18067 | 23860 | 16244 |
| Balance Required | | –49393 | –48594 | –54412 | –53783 | –35243 | –21325 | –22639 | –21087 | –19165 | –20018 | –49898 | –46880 |
| GT Capability @ Full Load | | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 | 37266 |

### GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Total GT Output (KW) | – | – | – | – | – | – | – | – | – | – | – | – |
| Balance Required (KW) | –49393 | –48594 | –54412 | –53783 | –35243 | –21325 | –22639 | –21087 | –19165 | –20018 | –49898 | –46880 |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |
| Balance Required (MWH) | –34834 | –32527 | –37401 | –32564 | –26221 | –5776 | –16844 | –15688 | –13799 | –14893 | –30539 | –33449 |
| **PURCHASED POWER** | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – Cents/KWH | 0.0269 | 0.0269 | 0.0269 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0269 | 0.0269 | 0.0269 |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – |
| **POWER SALES** | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 |
| Energy Credit $(000) | 907.1 | 847.1 | 974.0 | 735.0 | 591.8 | 130.4 | 380.2 | 354.1 | 311.4 | 387.8 | 795.3 | 871.1 |

TPS Republika – Case P3

HEAT REJECTION – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |

GAS TURBINE

Interpolated Exhaust Temperature °F

| | Exhaust Temperature °F | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
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Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
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Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Electric Output Ratio | – | – | – | – | – | – | – | – | – | – | – | – |
| Utilized Heat Ratio | – | – | – | – | – | – | – | – | – | – | – | – |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 300.000 | 24.9 | 23.3 | 30.5 | 41.6 | 60.9 | 22.8 | 35.7 | 83.4 | 82.6 | 80.1 | 42.3 | 28.7 |
| From Gas Turbines | 300.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 24.9 | 23.3 | 30.5 | 41.6 | 60.9 | 22.8 | 35.7 | 83.4 | 82.6 | 80.1 | 42.3 | 28.7 |

TPS Republika – Case P3

SUPPLEMENTARY DATA

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | – | – | – | – | – | 15.3 | – | 6.9 | 5.4 | 9.7 | – | – |
| Turb 2a | 52.9 | 53.3 | 41.4 | 33.5 | 18.5 | – | 11.2 | – | – | – | 23.3 | 38.4 |
| Turb 6b | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2b | 46.8 | 42.0 | 46.4 | 37.9 | – | 37.9 | – | – | – | – | 37.9 | 41.6 |
| Turb 5b | 120.7 | 122.3 | 115.9 | 102.3 | 32.6 | 21.3 | 32.9 | 31.9 | 35.6 | 47.7 | 106.2 | 123.4 |

Maximum Steam Flow – MW

| | BASIS KW1 | Total Boiler MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
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| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2c | 35000 | – | 104.1 | 107.4 | 92.9 | 71.2 | 60.3 | 73.4 | 14.0 | 49.3 | 49.3 | 49.3 | 67.9 | 93.8 |
| Turb 5c | 55000 | – | 145.2 | 146.3 | 142.1 | 133.1 | 87.0 | 19.9 | 87.2 | 86.6 | 89.0 | 97.0 | 135.6 | 147.0 |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
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| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2c | 14.9 | 13.0 | 22.0 | 34.8 | 41.9 | 35.5 | 2.8 | 49.3 | 49.3 | 49.3 | 37.3 | 21.6 |
| Turb 5c | 24.6 | 24.0 | 26.2 | 30.8 | 54.4 | – | 54.3 | 54.7 | 53.4 | 49.3 | 29.5 | 23.6 |
| | 39.5 | 37.0 | 48.2 | 65.6 | 96.3 | 35.5 | 57.2 | 103.9 | 102.7 | 98.6 | 66.8 | 45.3 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | | – | – | – | – | – | 720 | – | 744 | 720 | 744 | – | – |
| Turb 2a | | 744 | 672 | 744 | 720 | 744 | – | 744 | – | – | – | 720 | 744 |
| Turb 6b | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2b | | 577 | 660 | 473 | 55 | – | 279 | – | – | – | – | 139 | 604 |
| Turb 5b | | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | | – | – | – | – | – | 12.2 | – | 5.5 | 4.3 | 7.8 | – | – |
| Turb 2a | | 45.8 | 46.1 | 35.8 | 28.9 | 15.9 | – | 9.7 | – | – | – | 20.2 | 33.2 |
| Turb 6b | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2b | | 35.0 | 31.5 | 34.7 | 28.4 | – | 28.4 | – | – | – | – | 28.4 | 31.2 |
| Turb 5b | | 86.6 | 87.8 | 83.2 | 73.4 | 23.4 | 15.3 | 23.6 | 22.9 | 25.6 | 34.2 | 76.2 | 88.6 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1000 | – | – | – | – | – | 37.9 | – | 17.0 | 13.2 | 24.1 | – | – |
| | 1.2620 | 123.9 | 124.6 | 96.9 | 78.3 | 43.1 | – | 26.1 | – | – | – | 54.5 | 89.7 |
| | 0.9550 | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.0283 | 116.2 | 104.4 | 115.3 | 94.2 | – | 94.2 | – | – | – | – | 94.2 | 103.5 |
| | 1.0010 | 295.2 | 299.2 | 283.4 | 250.2 | 79.8 | 52.1 | 80.5 | 78.0 | 87.2 | 116.7 | 259.7 | 301.9 |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blr #4 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #6 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #5 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | | – | – | – | – | – | 11.5% | – | 5.1% | 4.0% | 7.3% | – | – |
| Turb 2a | | 80.3% | 80.8% | 62.8% | 50.7% | 27.9% | – | 16.9% | – | – | – | 35.3% | 58.2% |
| Turb 6b | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 2b | | 53.3% | 47.9% | 52.9% | 43.2% | – | 43.2% | – | – | – | – | 43.2% | 47.5% |
| Turb 5b | | 89.2% | 90.4% | 85.6% | 75.6% | 24.1% | 15.7% | 24.3% | 23.6% | 26.3% | 35.3% | 78.5% | 91.2% |

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TPS Republika – Case P3

SUPPLEMENTARY DATA

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | |
| | Percent of Total Output | | | | | | | | | | | |
| Blr #4 | 18.4% | 18.2% | 15.3% | 14.2% | 10.8% | 18.8% | 9.5% | 5.9% | 4.5% | 7.3% | 9.9% | 13.8% |
| Blr #6 | 18.4% | 18.2% | 15.3% | 14.2% | 10.8% | 18.8% | 9.5% | 5.9% | 4.5% | 7.3% | 9.9% | 13.8% |
| Blr #5 | 18.4% | 18.2% | 15.3% | 14.2% | 10.8% | 18.8% | 9.5% | 5.9% | 4.5% | 7.3% | 9.9% | 13.8% |
| CFB #2 | 18.4% | 18.2% | 15.3% | 14.2% | 10.8% | 18.8% | 9.5% | 5.9% | 4.5% | 7.3% | 9.9% | 13.8% |
| CFB #1 | 18.4% | 18.2% | 15.3% | 14.2% | 10.8% | 18.8% | 9.5% | 5.9% | 4.5% | 7.3% | 9.9% | 13.8% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| **Cost of Steam Supply** | | | | | | | | | | | | |
| Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 76 | 68 | 59 | 60 | 34 | 25 | 21 | 12 | 9 | 17 | 41 | 54 |
| Coal | 71 | 66 | 58 | – | – | – | – | – | – | – | – | 54 |
| Other Exp | 121 | 110 | 94 | 83 | 48 | 35 | 29 | 16 | 12 | 23 | 57 | 87 |
| Total | 268 | 244 | 210 | 142 | 82 | 60 | 49 | 28 | 21 | 39 | 99 | 195 |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | |
| | Percent of Total Output | | | | | | | | | | | |
| Blr #4 | 45.6% | 46.8% | 44.8% | 37.0% | 15.9% | 40.4% | 23.3% | 24.5% | 27.1% | 32.1% | 40.1% | 47.3% |
| Blr #6 | 45.6% | 46.8% | 44.8% | 37.0% | 15.9% | 40.4% | 23.3% | 24.5% | 27.1% | 32.1% | 40.1% | 47.3% |
| Blr #5 | 45.6% | 46.8% | 44.8% | 37.0% | 15.9% | 40.4% | 23.3% | 24.5% | 27.1% | 32.1% | 40.1% | 47.3% |
| CFB #2 | 45.6% | 46.8% | 44.8% | 37.0% | 15.9% | 40.4% | 23.3% | 24.5% | 27.1% | 32.1% | 40.1% | 47.3% |
| CFB #1 | 45.6% | 46.8% | 44.8% | 37.0% | 15.9% | 40.4% | 23.3% | 24.5% | 27.1% | 32.1% | 40.1% | 47.3% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| **Cost of Hot Water Supply** | | | | | | | | | | | | |
| Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 188 | 176 | 172 | 156 | 50 | 54 | 50 | 49 | 53 | 73 | 168 | 186 |
| Coal | 177 | 170 | 169 | – | – | – | – | – | – | – | – | 185 |
| Other Exp | 300 | 282 | 277 | 216 | 70 | 75 | 70 | 68 | 73 | 101 | 232 | 299 |
| Total | 665 | 628 | 618 | 371 | 120 | 129 | 120 | 117 | 126 | 174 | 401 | 669 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | |
| | Percent of Total Output | | | | | | | | | | | |
| Blr #4 | 36.0% | 35.1% | 40.0% | 48.8% | 73.3% | 40.8% | 67.1% | 69.6% | 68.4% | 60.7% | 50.0% | 38.9% |
| Blr #6 | 36.0% | 35.1% | 40.0% | 48.8% | 73.3% | 40.8% | 67.1% | 69.6% | 68.4% | 60.7% | 50.0% | 38.9% |
| Blr #5 | 36.0% | 35.1% | 40.0% | 48.8% | 73.3% | 40.8% | 67.1% | 69.6% | 68.4% | 60.7% | 50.0% | 38.9% |
| CFB #2 | 36.0% | 35.1% | 40.0% | 48.8% | 73.3% | 40.8% | 67.1% | 69.6% | 68.4% | 60.7% | 50.0% | 38.9% |
| CFB #1 | 36.0% | 35.1% | 40.0% | 48.8% | 73.3% | 40.8% | 67.1% | 69.6% | 68.4% | 60.7% | 50.0% | 38.9% |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| **Cost of Electric Supply** | | | | | | | | | | | | |
| Gas | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 148 | 132 | 154 | 205 | 230 | 55 | 145 | 138 | 133 | 138 | 209 | 153 |
| Coal | 140 | 127 | 151 | – | – | – | – | – | – | – | – | 152 |
| Other Exp | 237 | 211 | 247 | 285 | 323 | 76 | 202 | 194 | 185 | 192 | 290 | 246 |
| Total | 525 | 471 | 551 | 490 | 553 | 130 | 347 | 332 | 318 | 329 | 499 | 551 |

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# SENSITIVITY AND SUPPLEMENTARY ANALYSIS RESULTS

TPS Sofia – Case S0

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Baseline

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,783 | 40,323 | 48,287 | 57,590 | 60,844 | 63,943 | 63,819 | 63,639 | 63,395 | 63,070 | 62,556 | 62,701 | 62,788 | 62,904 | 63,016 | 63,098 |
| Oil | 1,678 | 1,806 | 1,993 | 2,124 | 2,254 | 2,384 | 2,507 | 2,502 | 2,494 | 2,483 | 2,470 | 2,449 | 2,455 | 2,458 | 2,463 | 2,467 | 2,470 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,589 | 42,316 | 50,411 | 59,844 | 63,228 | 66,450 | 66,321 | 66,133 | 65,878 | 65,540 | 65,005 | 65,156 | 65,246 | 65,366 | 65,483 | 65,568 |
| Supplemental Cost (Shortfall) | – | 0 | (0) | 8 | 36 | 110 | 172 | 198 | 222 | 243 | 263 | 270 | 279 | 284 | 291 | 301 | 309 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,797) | (14,768) | (15,224) | (15,662) | (16,077) | (16,506) | (16,505) | (16,511) | (16,514) | (16,514) | (16,514) | (16,513) | (16,513) | (16,513) | (16,513) | (16,513) |
| Net Power Interchange | (12,923) | (13,797) | (14,768) | (15,224) | (15,662) | (16,077) | (16,506) | (16,505) | (16,511) | (16,514) | (16,514) | (16,514) | (16,513) | (16,513) | (16,513) | (16,513) | (16,513) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,945 | 3,036 | 3,139 | 3,235 | 3,323 | 3,397 | 3,422 | 3,445 | 3,464 | 3,481 | 3,487 | 3,495 | 3,499 | 3,505 | 3,510 | 3,514 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 1,915 | 2,703 | 2,222 | 2,516 | 2,619 | 2,333 | 2,827 | 2,568 | 2,830 | 3,148 | 2,379 | 3,254 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,530 | 35,258 | 43,049 | 52,312 | 55,030 | 58,747 | 58,189 | 58,336 | 58,221 | 57,635 | 57,606 | 57,515 | 57,877 | 58,328 | 57,691 | 58,664 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 13531 | – | – | – | 1706 | – | – | – | – | 1706 | – | – | – | – | – | – | – |
| Domestic | 455 | – | – | – | 106 | – | – | – | – | 107 | – | – | – | – | – | – | – |
| Total | 13986 | – | – | – | 1812 | – | – | – | – | 1813 | – | – | – | – | – | – | – |
| TOTAL COST | 38,926 | 29,530 | 35,258 | 43,049 | 54,125 | 55,030 | 58,747 | 58,189 | 58,336 | 60,034 | 57,635 | 57,606 | 57,515 | 57,877 | 58,328 | 57,691 | 58,664 |
| Present Worth | 37,456 | 26,310 | 29,087 | 32,884 | 38,281 | 36,039 | 35,623 | 32,671 | 30,327 | 28,898 | 25,688 | 23,774 | 21,978 | 20,478 | 19,109 | 17,500 | 16,477 |
| Cumulative Present Worth | 37,456 | 63,766 | 92,854 | 125,737 | 164,018 | 200,057 | 235,680 | 268,352 | 298,679 | 327,577 | 353,265 | 377,039 | 399,016 | 419,494 | 438,603 | 456,103 | 472,581 |

| OPERATING STATISTICS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,894,185 | 1,999,408 | 2,117,089 | 2,227,067 | 2,330,742 | 2,416,868 | 2,445,889 | 2,471,458 | 2,493,617 | 2,513,941 | 2,520,697 | 2,529,129 | 2,534,188 | 2,540,934 | 2,547,420 | 2,552,137 |
| Electricity | 595,117 | 597,589 | 605,940 | 615,726 | 624,067 | 631,073 | 637,020 | 638,943 | 640,875 | 642,487 | 643,874 | 644,334 | 644,901 | 645,239 | 645,696 | 646,163 | 646,513 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $15.43 | $17.57 | $17.98 | $18.41 | $18.24 | $18.07 | $17.90 | $17.68 | $17.51 | $17.51 | $17.51 | $17.51 | $17.51 | $17.51 |
| Hot Water | $10.41 | $11.81 | $13.44 | $15.28 | $17.41 | $17.82 | $18.25 | $18.08 | $17.90 | $17.73 | $17.56 | $17.39 | $17.39 | $17.39 | $17.39 | $17.39 | $17.39 |
| Electricity | $14.28 | $16.16 | $18.31 | $20.78 | $23.62 | $24.12 | $24.67 | $24.42 | $24.18 | $23.94 | $23.70 | $23.47 | $23.47 | $23.47 | $23.47 | $23.46 | $23.46 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | 0 | (0) | 764 | 3,643 | 10,963 | 17,210 | 19,848 | 22,215 | 24,266 | 26,290 | 26,984 | 27,863 | 28,391 | 29,095 | 30,057 | 30,927 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 85 | 89 | 92 | 94 | 97 | 98 | 98 | 99 | 99 | 100 | 100 | 100 | 100 | 100 | 100 |
| $SO_2$ | 1,144 | 1,154 | 1,194 | 1,240 | 1,283 | 1,322 | 1,355 | 1,366 | 1,375 | 1,384 | 1,391 | 1,393 | 1,397 | 1,399 | 1,401 | 1,404 | 1,406 |
| NOx | 934 | 942 | 975 | 1,013 | 1,048 | 1,079 | 1,106 | 1,115 | 1,123 | 1,130 | 1,136 | 1,138 | 1,141 | 1,142 | 1,144 | 1,146 | 1,148 |
| CO | 100 | 101 | 105 | 109 | 113 | 116 | 119 | 120 | 121 | 121 | 122 | 122 | 123 | 123 | 123 | 123 | 123 |

1007

TPS Tr Kostov – Case K0

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

Baseline

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 53,726 | 62,720 | 74,434 | 87,774 | 103,151 | 107,777 | 111,775 | 111,775 | 111,807 | 111,433 | 111,005 | 110,123 | 110,402 | 110,560 | 110,770 | 110,977 | 111,132 |
| Oil | 3,105 | 3,352 | 3,679 | 3,861 | 4,037 | 4,222 | 4,383 | 4,381 | 4,381 | 4,365 | 4,347 | 4,311 | 4,322 | 4,328 | 4,337 | 4,345 | 4,351 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 56,831 | 66,072 | 78,114 | 91,635 | 107,189 | 111,999 | 116,158 | 116,157 | 116,188 | 115,798 | 115,352 | 114,435 | 114,724 | 114,888 | 115,107 | 115,322 | 115,483 |
| Supplemental Cost (Shortfall) | – | – | (0) | (0) | – | – | – | 0 | – | – | (0) | – | (0) | – | 0 | – | 0 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (38,977) | (42,109) | (46,037) | (47,820) | (49,495) | (51,380) | (52,992) | (53,227) | (53,586) | (53,679) | (53,769) | (53,799) | (53,834) | (53,845) | (53,857) | (53,869) | (53,877) |
| Net Power Interchange | (38,977) | (42,109) | (46,037) | (47,820) | (49,495) | (51,380) | (52,992) | (53,227) | (53,586) | (53,679) | (53,769) | (53,799) | (53,834) | (53,845) | (53,857) | (53,869) | (53,877) |
| Fixed O&M and Overheads | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| Other Variable O & M | 5,565 | 5,646 | 5,809 | 5,931 | 6,035 | 6,149 | 6,213 | 6,271 | 6,334 | 6,372 | 6,407 | 6,419 | 6,434 | 6,442 | 6,452 | 6,463 | 6,471 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| Maintenance Expenses | 5,683 | 7,246 | 6,544 | 6,438 | 6,419 | 8,104 | 7,090 | 7,044 | 7,048 | 8,559 | 7,743 | 7,651 | 7,639 | 9,353 | 8,275 | 8,254 | 8,196 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 31,333 | 39,086 | 46,662 | 58,416 | 72,381 | 77,105 | 78,703 | 78,479 | 78,217 | 79,284 | 77,968 | 76,940 | 77,196 | 79,072 | 78,210 | 78,404 | 78,507 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 9755 | 9257 | 11109 | 11109 | 14472 | 11109 | – | – | – | 3363 | – | – | – | – | 3363 | – | – |
| Domestic | 314 | 1362 | 1634 | 1634 | 1705 | 1634 | – | – | – | 71 | – | – | – | – | 71 | – | – |
| Total | 10069 | 10619 | 12742 | 12742 | 16176 | 12742 | – | – | – | 3434 | – | – | – | – | 3434 | – | – |
| TOTAL COST | 41,402 | 49,704 | 59,404 | 71,159 | 88,557 | 89,847 | 78,703 | 78,479 | 78,217 | 82,717 | 77,968 | 76,940 | 77,196 | 79,072 | 81,644 | 78,404 | 78,507 |
| Present Worth | 39,839 | 44,285 | 49,007 | 54,356 | 62,635 | 58,840 | 47,724 | 44,063 | 40,663 | 39,817 | 34,751 | 31,753 | 29,498 | 27,977 | 26,747 | 23,783 | 22,050 |
| Cumulative Present Worth | 39,839 | 84,124 | 133,131 | 187,487 | 250,121 | 308,961 | 356,685 | 400,748 | 441,411 | 481,228 | 515,979 | 547,732 | 577,230 | 605,207 | 631,954 | 655,738 | 677,788 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 |
| Hot Water | 2,910,403 | 2,954,059 | 3,044,282 | 3,140,325 | 3,227,637 | 3,312,039 | 3,367,336 | 3,416,813 | 3,460,469 | 3,498,304 | 3,533,229 | 3,544,871 | 3,559,423 | 3,568,154 | 3,579,796 | 3,591,437 | 3,600,169 |
| Electricity | 1,614,913 | 1,638,004 | 1,683,591 | 1,709,127 | 1,728,162 | 1,752,276 | 1,763,669 | 1,773,890 | 1,787,925 | 1,792,903 | 1,797,635 | 1,799,205 | 1,801,123 | 1,801,914 | 1,802,900 | 1,803,886 | 1,804,590 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.51 | $11.90 | $13.53 | $15.38 | $17.51 | $17.91 | $18.34 | $18.16 | $17.99 | $17.82 | $17.65 | $17.49 | $17.49 | $17.49 | $17.49 | $17.49 | $17.49 |
| Hot Water | $10.43 | $11.83 | $13.46 | $15.30 | $17.43 | $17.84 | $18.27 | $18.10 | $17.93 | $17.75 | $17.59 | $17.42 | $17.42 | $17.42 | $17.42 | $17.42 | $17.42 |
| Electricity | $18.12 | $20.53 | $23.40 | $26.59 | $30.28 | $31.00 | $31.75 | $31.45 | $31.18 | $30.87 | $30.58 | $30.29 | $30.28 | $30.28 | $30.28 | $30.28 | $30.28 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | (0) | (0) | – | – | – | 0 | – | – | (0) | – | (0) | – | 0 | – | 0 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 151 | 153 | 158 | 161 | 164 | 167 | 169 | 171 | 173 | 174 | 175 | 175 | 176 | 176 | 176 | 177 | 177 |
| $SO_2$ | 2,116 | 2,142 | 2,205 | 2,254 | 2,297 | 2,341 | 2,368 | 2,392 | 2,417 | 2,433 | 2,448 | 2,453 | 2,459 | 2,463 | 2,467 | 2,472 | 2,476 |
| NOx | 1,728 | 1,750 | 1,801 | 1,841 | 1,876 | 1,912 | 1,934 | 1,953 | 1,974 | 1,987 | 1,999 | 2,003 | 2,009 | 2,011 | 2,015 | 2,019 | 2,022 |
| CO | 186 | 188 | 193 | 198 | 202 | 205 | 208 | 210 | 212 | 213 | 215 | 215 | 216 | 216 | 217 | 217 | 217 |

1689

Liulin–Case L0

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Baseline

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 10,649 | 12,306 | 14,553 | 17,282 | 20,506 | 21,538 | 22,689 | 22,462 | 22,238 | 22,015 | 21,795 | 21,577 | 21,577 | 21,577 | 21,577 | 21,577 | 21,577 |
| Oil | 615 | 658 | 719 | 760 | 803 | 844 | 890 | 880 | 871 | 862 | 854 | 845 | 845 | 845 | 845 | 845 | 845 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 11,264 | 12,964 | 15,272 | 18,042 | 21,308 | 22,382 | 23,579 | 23,343 | 23,109 | 22,878 | 22,649 | 22,422 | 22,422 | 22,422 | 22,422 | 22,422 | 22,422 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 850 | 909 | 994 | 1,050 | 1,109 | 1,170 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange | 850 | 909 | 994 | 1,050 | 1,109 | 1,170 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 915 | 917 | 940 | 968 | 996 | 1,025 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 14,977 | 16,772 | 20,249 | 22,082 | 25,607 | 26,670 | 29,116 | 27,765 | 27,717 | 27,377 | 28,414 | 26,969 | 27,172 | 27,052 | 28,436 | 27,104 | 27,327 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 953 | 2591 | 3234 | 3358 | 12061 | 2341 | 2341 | 2341 | 2341 | 2341 | – | – | – | – | – | – | – |
| Domestic | 276 | 753 | 940 | 975 | 1192 | 669 | 669 | 669 | 669 | 669 | – | – | – | – | – | – | – |
| Total | 1229 | 3344 | 4173 | 4333 | 13253 | 3010 | 3010 | 3010 | 3010 | 3010 | – | – | – | – | – | – | – |
| TOTAL COST | 16,207 | 20,117 | 24,422 | 26,415 | 38,860 | 29,680 | 32,126 | 30,775 | 30,728 | 30,387 | 28,414 | 26,969 | 27,172 | 27,052 | 28,436 | 27,104 | 27,327 |
| Present Worth | 15,595 | 17,923 | 20,148 | 20,178 | 27,485 | 19,437 | 19,481 | 17,279 | 15,974 | 14,627 | 12,664 | 11,130 | 10,383 | 9,572 | 9,316 | 8,222 | 7,675 |
| Cumulative Present Worth | 15,595 | 33,518 | 53,666 | 73,844 | 101,328 | 120,765 | 140,246 | 157,525 | 173,500 | 188,127 | 200,791 | 211,921 | 222,305 | 231,876 | 241,192 | 249,414 | 257,089 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,180,933 | 1,183,413 | 1,213,526 | 1,249,663 | 1,285,800 | 1,321,936 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 |
| Electricity | 0 | 0 | 0 | (0) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $17.71 | $18.14 | $17.97 | $17.79 | $17.62 | $17.46 | $17.29 | $17.29 | $17.29 | $17.29 | $17.29 | $17.29 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | 31,046 | 31,111 | 31,903 | 32,853 | 33,803 | 34,753 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 30 | 30 | 31 | 32 | 33 | 33 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| $SO_2$ | 419 | 420 | 431 | 444 | 457 | 468 | 481 | 481 | 481 | 481 | 481 | 481 | 481 | 481 | 481 | 481 | 481 |
| NOx | 343 | 343 | 352 | 363 | 373 | 382 | 393 | 393 | 393 | 393 | 393 | 393 | 393 | 393 | 393 | 393 | 393 |
| CO | 37 | 37 | 38 | 39 | 40 | 41 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 |

Zemliane–Case Z0

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Baseline

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 12,802 | 14,794 | 17,494 | 20,775 | 24,651 | 25,893 | 27,276 | 27,003 | 26,733 | 26,466 | 26,201 | 25,939 | 25,939 | 25,939 | 25,939 | 25,939 | 25,939 |
| Oil | 740 | 791 | 865 | 914 | 965 | 1,014 | 1,069 | 1,058 | 1,048 | 1,037 | 1,026 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 13,542 | 15,585 | 18,359 | 21,689 | 25,616 | 26,907 | 28,346 | 28,062 | 27,781 | 27,503 | 27,227 | 26,955 | 26,955 | 26,955 | 26,955 | 26,955 | 26,955 |
| Supplemental Cost (Shortfall) | – | – | 0 | 0 | – | 0 | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 1,075 | 1,149 | 1,257 | 1,328 | 1,402 | 1,479 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange | 1,075 | 1,149 | 1,257 | 1,328 | 1,402 | 1,479 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 1,100 | 1,103 | 1,131 | 1,164 | 1,198 | 1,232 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 17,666 | 19,820 | 23,791 | 26,205 | 30,410 | 31,712 | 34,423 | 33,024 | 32,929 | 32,542 | 33,533 | 32,042 | 32,245 | 32,125 | 33,509 | 32,177 | 32,400 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 1334 | 3628 | 4527 | 4701 | 13437 | 3278 | 3278 | 3278 | 3278 | 3278 | – | – | – | – | – | – | – |
| Domestic | 387 | 1054 | 1315 | 1365 | 1592 | 937 | 937 | 937 | 937 | 937 | – | – | – | – | – | – | – |
| Total | 1721 | 4682 | 5842 | 6066 | 15030 | 4214 | 4214 | 4214 | 4214 | 4214 | – | – | – | – | – | – | – |
| TOTAL COST | 19,387 | 24,502 | 29,633 | 32,270 | 45,440 | 35,927 | 38,637 | 37,239 | 37,144 | 36,757 | 33,533 | 32,042 | 32,245 | 32,125 | 33,509 | 32,177 | 32,400 |
| Present Worth | 18,655 | 21,831 | 24,446 | 24,650 | 32,139 | 23,528 | 23,429 | 20,908 | 19,310 | 17,693 | 14,946 | 13,224 | 12,322 | 11,367 | 10,978 | 9,761 | 9,100 |
| Cumulative Present Worth | 18,655 | 40,486 | 64,932 | 89,582 | 121,721 | 145,249 | 168,678 | 189,586 | 208,897 | 226,590 | 241,536 | 254,760 | 267,081 | 278,448 | 289,426 | 299,187 | 308,287 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,419,673 | 1,422,655 | 1,458,856 | 1,502,298 | 1,545,740 | 1,589,183 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 | 1,632,625 |
| Electricity | – | 0 | 0 | – | – | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $17.71 | $18.14 | $17.97 | $17.79 | $17.62 | $17.46 | $17.29 | $17.29 | $17.29 | $17.29 | $17.29 | $17.29 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | 0 | 0 | – | 0 | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | 39,300 | 39,383 | 40,385 | 41,587 | 42,790 | 43,992 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 | 45,195 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 36 | 36 | 37 | 38 | 39 | 40 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 |
| $SO_2$ | 504 | 505 | 518 | 534 | 549 | 562 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 | 578 |
| NOx | 412 | 413 | 423 | 436 | 448 | 459 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 |
| CO | 44 | 44 | 45 | 47 | 48 | 49 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |

1011

TPS Republika – Case P0

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Baseline

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 4,929 | – | – | – | – | – | 6,551 | 6,519 | 6,391 | 11,411 | 11,431 | 11,093 | 11,448 | 11,453 | 11,461 | 11,469 | 11,475 |
| Black Coal | – | 13,906 | 14,026 | 14,646 | 15,279 | 15,925 | 8,484 | 8,632 | 9,007 | 2,973 | 3,021 | 3,463 | 3,055 | 3,066 | 3,080 | 3,095 | 3,106 |
| Total Fuel Cost | 4,929 | 13,906 | 14,026 | 14,646 | 15,279 | 15,925 | 15,035 | 15,151 | 15,398 | 14,385 | 14,452 | 14,557 | 14,502 | 14,519 | 14,541 | 14,563 | 14,580 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (7,872) | (8,382) | (8,497) | (8,719) | (8,952) | (9,198) | (9,463) | (9,476) | (9,600) | (9,862) | (9,869) | (9,872) | (9,876) | (9,878) | (9,881) | (9,883) | (9,885) |
| Net Power Interchange | (7,872) | (8,382) | (8,497) | (8,719) | (8,952) | (9,198) | (9,463) | (9,476) | (9,600) | (9,862) | (9,869) | (9,872) | (9,876) | (9,878) | (9,881) | (9,883) | (9,885) |
| Fixed O&M and Overheads | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| Other Variable O & M | 3,192 | 3,209 | 3,191 | 3,264 | 3,333 | 3,400 | 3,458 | 3,478 | 3,524 | 3,550 | 3,564 | 3,568 | 3,574 | 3,578 | 3,583 | 3,587 | 3,591 |
| Sorbent and Ash Removal | 1,156 | 33 | 33 | 33 | 34 | 35 | 1,403 | 1,396 | 1,370 | 2,418 | 2,423 | 2,352 | 2,426 | 2,427 | 2,429 | 2,431 | 2,432 |
| Credit: By–Product Sales | – | – | – | – | – | – | (389) | (387) | (379) | (677) | (678) | (658) | (679) | (679) | (680) | (680) | (681) |
| Emission Penalties | 930 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maintenance Expenses | 1,772 | 1,786 | 2,005 | 1,818 | 2,019 | 2,061 | 1,786 | 1,495 | 2,513 | 1,903 | 2,603 | 1,478 | 1,693 | 2,512 | 2,237 | 2,366 | 1,822 |
| Plant Removal Costs | 1,412 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 8,642 | 13,675 | 13,882 | 14,166 | 14,836 | 15,346 | 14,954 | 14,782 | 15,950 | 14,841 | 15,617 | 14,549 | 14,764 | 15,603 | 15,353 | 15,507 | 14,982 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 29230 | – | – | 15545 | 24711 | 12883 | 15971 | 23956 | 19454 | 5496 | – | – | – | – | 1394 | – | – |
| Domestic | 2758 | – | – | 569 | 880 | 472 | 585 | 877 | 583 | 92 | – | – | – | – | 28 | – | – |
| Total | 31988 | – | – | 16114 | 25591 | 13355 | 16555 | 24833 | 20037 | 5588 | – | – | – | – | 1422 | – | – |
| TOTAL COST | 40,630 | 13,675 | 13,882 | 30,280 | 40,427 | 28,700 | 31,509 | 39,614 | 35,987 | 20,429 | 15,617 | 14,549 | 14,764 | 15,603 | 16,775 | 15,507 | 14,982 |
| Present Worth | 39,096 | 12,184 | 11,452 | 23,130 | 28,593 | 18,796 | 19,107 | 22,242 | 18,709 | 9,834 | 6,961 | 6,004 | 5,642 | 5,521 | 5,496 | 4,704 | 4,208 |
| Cumulative Present Worth | 39,096 | 51,280 | 62,732 | 85,862 | 114,455 | 133,251 | 152,358 | 174,600 | 193,309 | 203,142 | 210,103 | 216,107 | 221,749 | 227,270 | 232,765 | 237,469 | 241,677 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 |
| Hot Water | 555,418 | 564,916 | 596,297 | 631,621 | 665,280 | 698,383 | 725,931 | 735,373 | 743,705 | 750,925 | 757,590 | 759,812 | 762,589 | 764,255 | 766,477 | 768,698 | 770,365 |
| Electricity | 409,490 | 410,874 | 401,723 | 408,632 | 415,367 | 422,163 | 428,183 | 430,388 | 436,039 | 445,287 | 446,801 | 447,318 | 447,963 | 448,349 | 448,863 | 449,376 | 449,759 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $6.97 | $11.65 | $11.74 | $11.92 | $12.11 | $12.31 | $12.19 | $12.19 | $12.20 | $11.97 | $11.97 | $12.00 | $11.97 | $11.98 | $11.98 | $11.98 | $11.98 |
| Hot Water | $6.97 | $11.65 | $11.74 | $11.92 | $12.11 | $12.31 | $12.19 | $12.19 | $12.21 | $11.97 | $11.97 | $11.99 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 |
| Electricity | $12.19 | $20.25 | $19.89 | $19.87 | $19.88 | $19.88 | $19.41 | $19.34 | $19.46 | $18.82 | $18.76 | $18.77 | $18.72 | $18.71 | $18.69 | $18.67 | $18.66 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 124,501 | 5 | 5 | 5 | 5 | 6 | 127 | 126 | 124 | 217 | 217 | 211 | 218 | 218 | 218 | 218 | 218 |
| $SO_2$ | 17,750 | 625 | 619 | 634 | 649 | 663 | 1,235 | 1,237 | 1,235 | 1,669 | 1,674 | 1,646 | 1,677 | 1,678 | 1,680 | 1,682 | 1,683 |
| NOx | 1,614 | 876 | 867 | 888 | 909 | 929 | 949 | 956 | 968 | 978 | 982 | 984 | 985 | 986 | 988 | 989 | 990 |
| CO | 49 | 45 | 44 | 45 | 47 | 48 | 52 | 52 | 53 | 56 | 56 | 56 | 56 | 57 | 57 | 57 | 57 |

1012

TPS Sofia – Case $S0_1$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Control System Upgrades

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,472 | 39,209 | 46,063 | 54,120 | 56,402 | 58,871 | 58,283 | 57,700 | 57,123 | 56,436 | 55,871 | 55,871 | 55,871 | 55,871 | 55,871 | 55,871 |
| Oil | 1,678 | 1,789 | 1,938 | 2,026 | 2,118 | 2,210 | 2,308 | 2,285 | 2,261 | 2,238 | 2,210 | 2,187 | 2,187 | 2,187 | 2,187 | 2,187 | 2,187 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,261 | 41,148 | 48,089 | 56,238 | 58,611 | 61,180 | 60,567 | 59,961 | 59,360 | 58,646 | 58,059 | 58,059 | 58,059 | 58,059 | 58,059 | 58,059 |
| Supplemental Cost (Shortfall) | – | – | (0) | 0 | 1 | 5 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,785) | (14,723) | (15,133) | (15,569) | (16,012) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) |
| Net Power Interchange | (12,923) | (13,785) | (14,723) | (15,133) | (15,569) | (16,012) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) | (16,468) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,921 | 2,961 | 3,010 | 3,061 | 3,110 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 | 3,160 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 1,915 | 2,703 | 2,222 | 2,516 | 2,619 | 2,333 | 2,827 | 2,568 | 2,830 | 3,148 | 2,379 | 3,254 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,189 | 34,060 | 40,680 | 48,588 | 50,160 | 53,114 | 52,021 | 51,708 | 51,211 | 50,210 | 50,117 | 49,858 | 50,120 | 50,438 | 49,669 | 50,544 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 15548 | 5920 | 7392 | 7611 | 25109 | 4050 | 4050 | 4050 | 4050 | 17430 | – | – | – | – | – | – | – |
| Domestic | 1037 | 1717 | 2144 | 2206 | 3018 | 1174 | 1174 | 1174 | 1174 | 1717 | – | – | – | – | – | – | – |
| Total | 16585 | 7637 | 9536 | 9817 | 28128 | 5224 | 5224 | 5224 | 5224 | 19147 | – | – | – | – | – | – | – |
| TOTAL COST | 41,525 | 36,826 | 43,595 | 50,497 | 76,716 | 55,384 | 58,338 | 57,244 | 56,932 | 70,358 | 50,210 | 50,117 | 49,858 | 50,120 | 50,438 | 49,669 | 50,544 |
| Present Worth | 39,957 | 32,811 | 35,965 | 38,573 | 54,260 | 36,270 | 35,375 | 32,141 | 29,598 | 33,868 | 22,379 | 20,683 | 19,052 | 17,733 | 16,524 | 15,067 | 14,196 |
| Cumulative Present Worth | 39,957 | 72,768 | 108,733 | 147,306 | 201,566 | 237,836 | 273,211 | 305,352 | 334,949 | 368,817 | 391,196 | 411,879 | 430,931 | 448,664 | 465,188 | 480,255 | 494,452 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,866,250 | 1,913,740 | 1,970,728 | 2,027,653 | 2,084,197 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 | 2,140,741 |
| Electricity | 595,117 | 595,423 | 599,079 | 603,472 | 608,316 | 612,989 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 | 617,655 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $15.43 | $17.57 | $17.98 | $18.41 | $18.24 | $18.07 | $17.90 | $17.68 | $17.51 | $17.51 | $17.51 | $17.51 | $17.51 | $17.51 |
| Hot Water | $10.41 | $11.81 | $13.44 | $15.29 | $17.42 | $17.80 | $18.23 | $18.06 | $17.88 | $17.71 | $17.51 | $17.34 | $17.34 | $17.34 | $17.34 | $17.34 | $17.34 |
| Electricity | $14.28 | $16.18 | $18.36 | $20.83 | $23.70 | $24.19 | $24.75 | $24.51 | $24.28 | $24.05 | $23.79 | $23.56 | $23.56 | $23.56 | $23.56 | $23.56 | $23.56 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | (0) | 0 | 62 | 506 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 83 | 85 | 86 | 88 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 | 89 |
| $SO_2$ | 1,144 | 1,143 | 1,161 | 1,183 | 1,205 | 1,225 | 1,247 | 1,247 | 1,247 | 1,247 | 1,245 | 1,245 | 1,245 | 1,245 | 1,245 | 1,245 | 1,245 |
| NOx | 934 | 934 | 948 | 966 | 984 | 1,001 | 1,019 | 1,019 | 1,019 | 1,019 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 |
| CO | 100 | 100 | 102 | 104 | 106 | 108 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 |

TPS Sofia – Case $SO_2$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Production Plant "Enhancements"

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,482 | 38,611 | 44,526 | 51,348 | 52,647 | 53,898 | 53,359 | 52,825 | 52,297 | 51,774 | 51,245 | 51,245 | 51,245 | 51,245 | 51,245 | 51,245 |
| Oil | 1,678 | 1,790 | 1,909 | 1,958 | 2,010 | 2,062 | 2,113 | 2,092 | 2,070 | 2,049 | 2,028 | 2,006 | 2,006 | 2,006 | 2,006 | 2,006 | 2,006 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,271 | 40,520 | 46,485 | 53,358 | 54,709 | 56,011 | 55,450 | 54,895 | 54,345 | 53,801 | 53,251 | 53,251 | 53,251 | 53,251 | 53,251 | 53,251 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (15,885) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) |
| Net Power Interchange | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (15,885) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) | (16,303) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 1,915 | 2,703 | 2,222 | 2,516 | 2,619 | 2,333 | 2,827 | 2,568 | 2,830 | 3,148 | 2,379 | 3,254 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,198 | 33,410 | 39,031 | 45,653 | 46,185 | 47,857 | 46,815 | 46,554 | 46,108 | 45,277 | 45,221 | 44,962 | 45,224 | 45,542 | 44,773 | 45,648 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 16126 | 12933 | 15807 | 16027 | 17875 | 12466 | 4050 | 4050 | 4050 | 5756 | – | – | – | – | – | – | – |
| Domestic | 1122 | 2749 | 3382 | 3444 | 3591 | 2412 | 1174 | 1174 | 1174 | 1280 | – | – | – | – | – | – | – |
| Total | 17247 | 15681 | 19189 | 19470 | 21467 | 14877 | 5224 | 5224 | 5224 | 7037 | – | – | – | – | – | – | – |
| TOTAL COST | 42,187 | 44,879 | 52,599 | 58,502 | 67,120 | 61,062 | 53,081 | 52,039 | 51,778 | 53,144 | 45,277 | 45,221 | 44,962 | 45,224 | 45,542 | 44,773 | 45,648 |
| Present Worth | 40,594 | 39,986 | 43,393 | 44,687 | 47,473 | 39,989 | 32,187 | 29,218 | 26,918 | 25,582 | 20,181 | 18,662 | 17,181 | 16,001 | 14,920 | 13,581 | 12,821 |
| Cumulative Present Worth | 40,594 | 80,581 | 123,974 | 168,661 | 216,133 | 256,123 | 288,310 | 317,528 | 344,446 | 370,028 | 390,208 | 408,870 | 426,051 | 442,052 | 456,972 | 470,554 | 483,375 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | – | – | – | 545,176 | – | 545,176 | 545,176 | 545,176 | 545,176 | – | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | – | – | – | 1,862,339 | – | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | – | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 |
| Electricity | 595,117 | – | – | – | 595,117 | – | 595,117 | 595,117 | 595,117 | 595,117 | – | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | – | – | – | $17.57 | – | $18.42 | $18.25 | $18.08 | $17.90 | – | $17.57 | $17.57 | $17.57 | $17.57 | $17.57 | $17.57 |
| Hot Water | $10.41 | – | – | – | $17.45 | – | $18.27 | $18.10 | $17.92 | $17.75 | – | $17.41 | $17.41 | $17.41 | $17.41 | $17.41 | $17.41 |
| Electricity | $14.28 | – | – | – | $23.88 | – | $24.99 | $24.75 | $24.51 | $24.28 | – | $23.82 | $23.82 | $23.82 | $23.82 | $23.82 | $23.82 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | – | – | – | 82 | – | 82 | 82 | 82 | 82 | – | 82 | 82 | 82 | 82 | 82 | 82 |
| $SO_2$ | 1,144 | – | – | – | 1,144 | – | 1,142 | 1,142 | 1,142 | 1,142 | – | 1,141 | 1,141 | 1,141 | 1,141 | 1,141 | 1,141 |
| NOx | 934 | – | – | – | 934 | – | 932 | 932 | 932 | 932 | – | 932 | 932 | 932 | 932 | 932 | 932 |
| CO | 100 | – | – | – | 100 | – | 100 | 100 | 100 | 100 | – | 100 | 100 | 100 | 100 | 100 | 100 |

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TPS Sofia – Case $SO_3$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Piping Modifications

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,740 | 39,647 | 46,654 | 54,774 | 57,018 | 59,107 | 59,084 | 58,966 | 58,772 | 58,423 | 57,957 | 58,105 | 58,193 | 58,311 | 58,428 | 58,516 |
| Oil | 1,678 | 1,803 | 1,960 | 2,052 | 2,144 | 2,234 | 2,318 | 2,316 | 2,311 | 2,302 | 2,288 | 2,269 | 2,275 | 2,278 | 2,283 | 2,287 | 2,291 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,543 | 41,607 | 48,706 | 56,918 | 59,251 | 61,424 | 61,400 | 61,276 | 61,074 | 60,711 | 60,226 | 60,379 | 60,471 | 60,594 | 60,716 | 60,807 |
| Supplemental Cost (Shortfall) | – | 0 | – | 0 | 4 | 8 | 11 | 13 | 26 | 41 | 56 | 60 | 67 | 70 | 75 | 80 | 84 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,795) | (14,736) | (15,160) | (15,591) | (16,033) | (16,475) | (16,490) | (16,494) | (16,496) | (16,497) | (16,497) | (16,497) | (16,497) | (16,497) | (16,497) | (16,496) |
| Net Power Interchange | (12,923) | (13,795) | (14,736) | (15,160) | (15,591) | (16,033) | (16,475) | (16,490) | (16,494) | (16,496) | (16,497) | (16,497) | (16,497) | (16,497) | (16,497) | (16,497) | (16,496) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,941 | 2,990 | 3,044 | 3,094 | 3,141 | 3,171 | 3,199 | 3,222 | 3,241 | 3,259 | 3,265 | 3,272 | 3,277 | 3,283 | 3,289 | 3,293 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 1,915 | 2,703 | 2,222 | 2,516 | 2,619 | 2,333 | 2,827 | 2,568 | 2,830 | 3,148 | 2,379 | 3,254 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,482 | 34,535 | 41,304 | 49,282 | 50,811 | 53,364 | 52,874 | 53,076 | 53,009 | 52,392 | 52,412 | 52,320 | 52,682 | 53,133 | 52,497 | 53,472 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 14108 | 7013 | 8416 | 8416 | 25771 | 8416 | – | – | – | 13380 | – | – | – | – | – | – | – |
| Domestic | 540 | 1031 | 1238 | 1238 | 2009 | 1238 | – | – | – | 543 | – | – | – | – | – | – | – |
| Total | 14648 | 8044 | 9653 | 9653 | 27780 | 9653 | – | – | – | 13923 | – | – | – | – | – | – | – |
| TOTAL COST | 39,588 | 37,527 | 44,188 | 50,958 | 77,062 | 60,465 | 53,364 | 52,874 | 53,076 | 66,932 | 52,392 | 52,412 | 52,320 | 52,682 | 53,133 | 52,497 | 53,472 |
| Present Worth | 38,094 | 33,435 | 36,454 | 38,925 | 54,505 | 39,598 | 32,359 | 29,687 | 27,593 | 32,219 | 23,352 | 21,630 | 19,993 | 18,640 | 17,407 | 15,925 | 15,019 |
| Cumulative Present Worth | 38,094 | 71,529 | 107,983 | 146,907 | 201,412 | 241,010 | 273,369 | 303,055 | 330,648 | 362,867 | 386,219 | 407,849 | 427,841 | 446,481 | 463,888 | 479,812 | 494,831 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,890,274 | 1,948,007 | 2,009,464 | 2,064,979 | 2,118,567 | 2,153,676 | 2,185,089 | 2,211,676 | 2,234,413 | 2,255,321 | 2,262,281 | 2,270,981 | 2,276,201 | 2,283,161 | 2,290,110 | 2,295,319 |
| Electricity | 595,117 | 597,291 | 601,638 | 606,792 | 611,394 | 615,848 | 618,704 | 621,136 | 623,021 | 624,568 | 625,982 | 626,445 | 627,021 | 627,365 | 627,824 | 628,277 | 628,616 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $15.43 | $17.57 | $17.98 | $18.41 | $18.24 | $18.07 | $17.90 | $17.68 | $17.51 | $17.51 | $17.51 | $17.51 | $17.51 | $17.51 |
| Hot Water | $10.41 | $11.81 | $13.44 | $15.29 | $17.42 | $17.80 | $18.23 | $18.06 | $17.88 | $17.71 | $17.51 | $17.34 | $17.34 | $17.34 | $17.34 | $17.34 | $17.34 |
| Electricity | $14.28 | $16.16 | $18.33 | $20.82 | $23.69 | $24.18 | $24.74 | $24.49 | $24.25 | $24.00 | $23.73 | $23.50 | $23.50 | $23.49 | $23.49 | $23.49 | $23.48 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | 0 | – | 0 | 355 | 775 | 1,051 | 1,297 | 2,646 | 4,119 | 5,559 | 6,049 | 6,660 | 7,027 | 7,517 | 8,017 | 8,394 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 84 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 92 | 92 | 92 | 93 | 93 | 93 | 93 |
| $SO_2$ | 1,144 | 1,152 | 1,174 | 1,198 | 1,220 | 1,239 | 1,252 | 1,264 | 1,274 | 1,283 | 1,288 | 1,291 | 1,294 | 1,296 | 1,299 | 1,302 | 1,303 |
| NOx | 934 | 941 | 959 | 979 | 996 | 1,012 | 1,023 | 1,033 | 1,041 | 1,048 | 1,052 | 1,054 | 1,057 | 1,059 | 1,061 | 1,063 | 1,065 |
| CO | 100 | 101 | 103 | 105 | 107 | 109 | 110 | 111 | 112 | 113 | 113 | 113 | 114 | 114 | 114 | 114 | 114 |

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TPS Tr Kostov – Case $K0_1$

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

Excluding Control System Upgrades

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 53,726 | 61,950 | 73,194 | 86,618 | 101,810 | 106,405 | 111,140 | 110,029 | 108,929 | 107,839 | 106,728 | 105,661 | 105,661 | 105,661 | 105,661 | 105,661 | 105,661 |
| Oil | 3,105 | 3,311 | 3,618 | 3,810 | 3,985 | 4,168 | 4,358 | 4,313 | 4,268 | 4,224 | 4,180 | 4,137 | 4,137 | 4,137 | 4,137 | 4,137 | 4,137 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 56,831 | 65,261 | 76,812 | 90,427 | 105,794 | 110,574 | 115,498 | 114,342 | 113,197 | 112,064 | 110,908 | 109,797 | 109,797 | 109,797 | 109,797 | 109,797 | 109,797 |
| Supplemental Cost (Shortfall) | – | 0 | (0) | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (38,977) | (41,648) | (45,380) | (47,516) | (49,175) | (51,121) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) |
| Net Power Interchange | (38,977) | (41,648) | (45,380) | (47,516) | (49,175) | (51,121) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) | (52,898) |
| Fixed O&M and Overheads | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| Other Variable O & M | 5,565 | 5,577 | 5,713 | 5,859 | 5,962 | 6,085 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 | 6,190 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Maintenance Expenses | 5,683 | 7,319 | 6,492 | 6,407 | 6,358 | 8,078 | 7,080 | 7,005 | 6,976 | 8,463 | 7,633 | 7,442 | 7,526 | 9,232 | 8,057 | 8,095 | 8,063 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 31,333 | 38,740 | 45,869 | 57,409 | 71,171 | 75,849 | 78,103 | 76,872 | 75,698 | 76,052 | 74,066 | 72,764 | 72,849 | 74,555 | 73,380 | 73,417 | 73,386 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 12390 | 11330 | 14159 | 14380 | 46554 | 4243 | 4243 | 4243 | 4243 | 15965 | – | – | – | – | 3363 | – | – |
| Domestic | 1210 | 3394 | 4240 | 4306 | 5176 | 1228 | 1228 | 1228 | 1228 | 1604 | – | – | – | – | 71 | – | – |
| Total | 13600 | 14724 | 18399 | 18686 | 51730 | 5471 | 5471 | 5471 | 5471 | 17569 | – | – | – | – | 3434 | – | – |
| TOTAL COST | 44,933 | 53,465 | 64,268 | 76,095 | 122,901 | 81,320 | 83,575 | 82,343 | 81,169 | 93,621 | 74,066 | 72,764 | 72,849 | 74,555 | 76,813 | 73,417 | 73,386 |
| Present Worth | 43,236 | 47,635 | 53,019 | 58,126 | 86,926 | 53,256 | 50,678 | 46,233 | 42,198 | 45,066 | 33,012 | 30,029 | 27,837 | 26,379 | 25,165 | 22,271 | 20,612 |
| Cumulative Present Worth | 43,236 | 90,872 | 143,891 | 202,017 | 288,943 | 342,199 | 392,877 | 439,110 | 481,307 | 526,373 | 559,385 | 589,415 | 617,252 | 643,630 | 668,795 | 691,066 | 711,678 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 |
| Hot Water | 2,910,403 | 2,916,515 | 2,990,730 | 3,079,788 | 3,168,847 | 3,257,905 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 | 3,346,963 |
| Electricity | 1,614,913 | 1,618,184 | 1,656,920 | 1,695,268 | 1,714,112 | 1,740,802 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 | 1,759,526 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.51 | $11.90 | $13.53 | $15.38 | $17.50 | $17.91 | $18.34 | $18.16 | $17.99 | $17.82 | $17.65 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 |
| Hot Water | $10.43 | $11.83 | $13.46 | $15.31 | $17.44 | $17.79 | $18.22 | $18.05 | $17.88 | $17.71 | $17.53 | $17.37 | $17.37 | $17.37 | $17.37 | $17.37 | $17.37 |
| Electricity | $18.12 | $20.52 | $23.36 | $26.60 | $30.27 | $31.00 | $31.75 | $31.45 | $31.15 | $30.85 | $30.55 | $30.26 | $30.26 | $30.26 | $30.26 | $30.26 | $30.26 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | 0 | (0) | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 151 | 151 | 155 | 159 | 162 | 165 | 168 | 168 | 168 | 168 | 168 | 168 | 168 | 168 | 168 | 168 | 168 |
| $SO_2$ | 2,116 | 2,116 | 2,168 | 2,225 | 2,267 | 2,311 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 |
| NOx | 1,728 | 1,728 | 1,771 | 1,817 | 1,852 | 1,888 | 1,923 | 1,923 | 1,923 | 1,923 | 1,922 | 1,922 | 1,922 | 1,922 | 1,922 | 1,922 | 1,922 |
| CO | 186 | 186 | 190 | 195 | 199 | 203 | 207 | 207 | 207 | 207 | 207 | 207 | 207 | 207 | 207 | 207 | 207 |

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TPS Tr Kostov – Case $K0_2$

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

Excluding Production Plant "Enhancements"

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 53,726 | 61,818 | 71,289 | 82,210 | 94,805 | 97,129 | 99,597 | 98,601 | 97,615 | 96,638 | 95,672 | 94,715 | 94,715 | 94,715 | 94,715 | 94,715 | 94,715 |
| Oil | 3,105 | 3,304 | 3,524 | 3,616 | 3,711 | 3,805 | 3,905 | 3,865 | 3,825 | 3,786 | 3,747 | 3,708 | 3,708 | 3,708 | 3,708 | 3,708 | 3,708 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 56,831 | 65,122 | 74,813 | 85,826 | 98,515 | 100,934 | 103,502 | 102,465 | 101,440 | 100,424 | 99,419 | 98,423 | 98,423 | 98,423 | 98,423 | 98,423 | 98,423 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (38,977) | (41,571) | (44,339) | (45,496) | (46,688) | (47,911) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) |
| Net Power Interchange | (38,977) | (41,571) | (44,339) | (45,496) | (46,688) | (47,911) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) | (49,171) |
| Fixed O&M and Overheads | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| Other Variable O & M | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 | 5,565 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Maintenance Expenses | 5,683 | 7,200 | 6,408 | 6,242 | 6,148 | 7,724 | 6,760 | 6,682 | 6,650 | 8,135 | 7,301 | 7,105 | 7,185 | 8,887 | 7,707 | 7,738 | 7,701 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 31,333 | 38,547 | 44,678 | 54,368 | 65,771 | 68,543 | 68,887 | 67,773 | 66,715 | 67,184 | 65,345 | 64,154 | 64,234 | 65,935 | 64,755 | 64,787 | 64,749 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 13153 | 20588 | 25268 | 25489 | 29002 | 15352 | 4243 | 4243 | 4243 | – | – | – | – | – | 3363 | – | – |
| Domestic | 1322 | 4755 | 5874 | 5939 | 6055 | 2862 | 1228 | 1228 | 1228 | – | – | – | – | – | 71 | – | – |
| Total | 14474 | 25343 | 31141 | 31428 | 35056 | 18214 | 5471 | 5471 | 5471 | – | – | – | – | – | 3434 | – | – |
| TOTAL COST | 45,807 | 63,890 | 75,820 | 85,797 | 100,828 | 86,757 | 74,358 | 73,244 | 72,186 | 67,184 | 65,345 | 64,154 | 64,234 | 65,935 | 68,189 | 64,787 | 64,749 |
| Present Worth | 44,078 | 56,924 | 62,549 | 65,537 | 71,314 | 56,816 | 45,089 | 41,124 | 37,528 | 32,340 | 29,125 | 26,476 | 24,545 | 23,329 | 22,339 | 19,652 | 18,186 |
| Cumulative Present Worth | 44,078 | 101,002 | 163,552 | 229,089 | 300,402 | 357,219 | 402,308 | 443,432 | 480,960 | 513,299 | 542,424 | 568,900 | 593,445 | 616,774 | 639,113 | 658,766 | 676,952 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 |
| Hot Water | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 | 2,910,403 |
| Electricity | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 | 1,614,913 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.51 | $11.90 | $13.52 | $15.37 | $17.50 | $17.90 | $18.33 | $18.16 | $17.99 | $17.82 | $17.65 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 |
| Hot Water | $10.43 | $11.83 | $13.46 | $15.31 | $17.44 | $17.85 | $18.28 | $18.11 | $17.93 | $17.76 | $17.59 | $17.43 | $17.43 | $17.43 | $17.43 | $17.43 | $17.43 |
| Electricity | $18.12 | $20.51 | $23.31 | $26.49 | $30.16 | $30.85 | $31.60 | $31.30 | $31.00 | $30.71 | $30.42 | $30.13 | $30.13 | $30.13 | $30.13 | $30.13 | $30.13 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 |
| $SO_2$ | 2,116 | 2,111 | 2,111 | 2,111 | 2,111 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 | 2,110 |
| NOx | 1,728 | 1,724 | 1,724 | 1,724 | 1,724 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 | 1,723 |
| CO | 186 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 | 185 |

1811

TPS Tr Kostov – Case $K0_3$

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

Excluding Piping Modifications

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 53,726 | 62,720 | 74,434 | 87,774 | 103,151 | 107,614 | 111,603 | 111,601 | 111,630 | 111,255 | 110,791 | 109,908 | 110,188 | 110,344 | 110,552 | 110,760 | 110,914 |
| Oil | 3,105 | 3,352 | 3,679 | 3,861 | 4,037 | 4,216 | 4,376 | 4,374 | 4,374 | 4,358 | 4,339 | 4,303 | 4,314 | 4,320 | 4,328 | 4,336 | 4,342 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 56,831 | 66,072 | 78,114 | 91,635 | 107,189 | 111,829 | 115,979 | 115,975 | 116,004 | 115,613 | 115,129 | 114,211 | 114,501 | 114,664 | 114,880 | 115,096 | 115,257 |
| Supplemental Cost (Shortfall) | – | – | (0) | (0) | – | – | – | 0 | – | – | (0) | – | (0) | – | 0 | – | 0 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (38,977) | (42,109) | (46,037) | (47,820) | (49,495) | (51,380) | (52,992) | (53,227) | (53,586) | (53,679) | (53,769) | (53,799) | (53,834) | (53,845) | (53,857) | (53,869) | (53,877) |
| Net Power Interchange | (38,977) | (42,109) | (46,037) | (47,820) | (49,495) | (51,380) | (52,992) | (53,227) | (53,586) | (53,679) | (53,769) | (53,799) | (53,834) | (53,845) | (53,857) | (53,869) | (53,877) |
| Fixed O&M and Overheads | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| Other Variable O & M | 5,565 | 5,646 | 5,809 | 5,931 | 6,035 | 6,149 | 6,213 | 6,271 | 6,334 | 6,372 | 6,407 | 6,419 | 6,434 | 6,442 | 6,452 | 6,463 | 6,471 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By-Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| Maintenance Expenses | 5,683 | 7,246 | 6,544 | 6,438 | 6,419 | 8,104 | 7,090 | 7,044 | 7,048 | 8,559 | 7,743 | 7,651 | 7,639 | 9,353 | 8,275 | 8,254 | 8,196 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 31,333 | 39,086 | 46,662 | 58,416 | 72,381 | 76,935 | 78,524 | 78,297 | 78,034 | 79,098 | 77,745 | 76,716 | 76,973 | 78,848 | 77,984 | 78,178 | 78,280 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 9755 | 9257 | 11109 | 11109 | 43132 | 11109 | – | – | – | 11722 | – | – | – | – | 3363 | – | – |
| Domestic | 314 | 1362 | 1634 | 1634 | 2460 | 1634 | – | – | – | 375 | – | – | – | – | 71 | – | – |
| Total | 10069 | 10619 | 12742 | 12742 | 45591 | 12742 | – | – | – | 12098 | – | – | – | – | 3434 | – | – |
| TOTAL COST | 41,402 | 49,704 | 59,404 | 71,159 | 117,972 | 89,677 | 78,524 | 78,297 | 78,034 | 91,196 | 77,745 | 76,716 | 76,973 | 78,848 | 81,417 | 78,178 | 78,280 |
| Present Worth | 39,839 | 44,285 | 49,007 | 54,356 | 83,440 | 58,729 | 47,615 | 43,961 | 40,568 | 43,898 | 34,652 | 31,660 | 29,413 | 27,898 | 26,673 | 23,715 | 21,987 |
| Cumulative Present Worth | 39,839 | 84,124 | 133,131 | 187,487 | 270,926 | 329,655 | 377,271 | 421,232 | 461,799 | 505,698 | 540,349 | 572,009 | 601,423 | 629,320 | 655,993 | 679,708 | 701,695 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 | 265,198 |
| Hot Water | 2,910,403 | 2,954,059 | 3,044,282 | 3,140,325 | 3,227,637 | 3,312,039 | 3,367,336 | 3,416,813 | 3,460,469 | 3,498,304 | 3,533,229 | 3,544,871 | 3,559,423 | 3,568,154 | 3,579,796 | 3,591,437 | 3,600,169 |
| Electricity | 1,614,913 | 1,638,004 | 1,683,591 | 1,709,127 | 1,728,162 | 1,752,276 | 1,763,669 | 1,773,890 | 1,787,925 | 1,792,903 | 1,797,635 | 1,799,205 | 1,801,123 | 1,801,914 | 1,802,900 | 1,803,886 | 1,804,590 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.51 | $11.90 | $13.53 | $15.38 | $17.51 | $17.91 | $18.34 | $18.16 | $17.99 | $17.82 | $17.65 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 | $17.48 |
| Hot Water | $10.43 | $11.83 | $13.46 | $15.30 | $17.43 | $17.79 | $18.22 | $18.05 | $17.87 | $17.70 | $17.53 | $17.36 | $17.36 | $17.36 | $17.36 | $17.36 | $17.36 |
| Electricity | $18.12 | $20.53 | $23.40 | $26.59 | $30.28 | $31.00 | $31.75 | $31.45 | $31.18 | $30.87 | $30.57 | $30.27 | $30.27 | $30.27 | $30.27 | $30.27 | $30.26 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | (0) | (0) | – | – | – | 0 | – | – | (0) | – | (0) | – | 0 | – | 0 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 151 | 153 | 158 | 161 | 164 | 167 | 169 | 171 | 172 | 174 | 175 | 175 | 175 | 176 | 176 | 176 | 177 |
| $SO_2$ | 2,116 | 2,142 | 2,205 | 2,254 | 2,297 | 2,338 | 2,364 | 2,388 | 2,413 | 2,429 | 2,443 | 2,448 | 2,454 | 2,458 | 2,463 | 2,467 | 2,471 |
| NOx | 1,728 | 1,750 | 1,801 | 1,841 | 1,876 | 1,909 | 1,931 | 1,950 | 1,971 | 1,984 | 1,995 | 2,000 | 2,005 | 2,007 | 2,011 | 2,015 | 2,018 |
| CO | 186 | 188 | 193 | 198 | 202 | 205 | 207 | 210 | 212 | 213 | 214 | 215 | 215 | 216 | 216 | 217 | 217 |

Liulin–Case L0,

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Control System Upgrades

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 10,649 | 12,306 | 14,553 | 17,282 | 20,506 | 21,538 | 22,689 | 22,462 | 22,238 | 22,015 | 21,731 | 21,514 | 21,514 | 21,514 | 21,514 | 21,514 | 21,514 |
| Oil | 615 | 658 | 719 | 760 | 803 | 844 | 890 | 880 | 871 | 862 | 851 | 842 | 842 | 842 | 842 | 842 | 842 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 11,264 | 12,964 | 15,272 | 18,042 | 21,308 | 22,382 | 23,579 | 23,343 | 23,109 | 22,878 | 22,582 | 22,356 | 22,356 | 22,356 | 22,356 | 22,356 | 22,356 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 850 | 909 | 994 | 1,050 | 1,109 | 1,170 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange | 850 | 909 | 994 | 1,050 | 1,109 | 1,170 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 915 | 917 | 940 | 968 | 996 | 1,025 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 14,977 | 16,772 | 20,249 | 22,082 | 25,607 | 26,670 | 29,116 | 27,765 | 27,717 | 27,377 | 28,347 | 26,903 | 27,106 | 26,986 | 28,370 | 27,038 | 27,261 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 953 | 2592 | 3234 | 3358 | 12800 | 2341 | 2341 | 2341 | 2341 | 10346 | – | – | – | – | – | – | – |
| Domestic | 276 | 753 | 940 | 975 | 1220 | 669 | 669 | 669 | 669 | 960 | – | – | – | – | – | – | – |
| Total | 1229 | 3345 | 4173 | 4333 | 14020 | 3010 | 3010 | 3010 | 3010 | 11306 | – | – | – | – | – | – | – |
| TOTAL COST | 16,207 | 20,117 | 24,422 | 26,415 | 39,627 | 29,680 | 32,126 | 30,775 | 30,728 | 38,683 | 28,347 | 26,903 | 27,106 | 26,986 | 28,370 | 27,038 | 27,261 |
| Present Worth | 15,595 | 17,924 | 20,148 | 20,178 | 28,027 | 19,437 | 19,481 | 17,279 | 15,974 | 18,621 | 12,635 | 11,103 | 10,358 | 9,548 | 9,294 | 8,202 | 7,657 |
| Cumulative Present Worth | 15,595 | 33,519 | 53,666 | 73,844 | 101,871 | 121,308 | 140,789 | 158,068 | 174,043 | 192,663 | 205,298 | 216,401 | 226,758 | 236,307 | 245,601 | 253,803 | 261,459 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,180,933 | 1,183,413 | 1,213,526 | 1,249,663 | 1,285,800 | 1,321,936 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 | 1,358,073 |
| Electricity | 0 | 0 | 0 | (0) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $17.71 | $18.14 | $17.97 | $17.79 | $17.62 | $17.41 | $17.24 | $17.24 | $17.24 | $17.24 | $17.24 | $17.24 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | 31,046 | 31,111 | 31,903 | 32,853 | 33,803 | 34,753 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 | 35,703 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 30 | 30 | 31 | 32 | 33 | 33 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| $SO_2$ | 419 | 420 | 431 | 444 | 457 | 468 | 481 | 481 | 481 | 481 | 479 | 479 | 479 | 479 | 479 | 479 | 479 |
| NOx | 343 | 343 | 352 | 363 | 373 | 382 | 393 | 393 | 393 | 393 | 391 | 391 | 391 | 391 | 391 | 391 | 391 |
| CO | 37 | 37 | 38 | 39 | 40 | 41 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 |

Liulin–Case $LO_2$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Production Plant "Enhancements"

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 10,649 | 12,280 | 14,162 | 16,331 | 18,833 | 19,241 | 19,730 | 19,532 | 19,337 | 19,144 | 18,952 | 18,763 | 18,763 | 18,763 | 18,763 | 18,763 | 18,763 |
| Oil | 615 | 656 | 700 | 718 | 737 | 754 | 774 | 766 | 758 | 750 | 742 | 735 | 735 | 735 | 735 | 735 | 735 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 11,264 | 12,937 | 14,862 | 17,050 | 19,570 | 19,995 | 20,503 | 20,298 | 20,095 | 19,894 | 19,695 | 19,497 | 19,497 | 19,497 | 19,497 | 19,497 | 19,497 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | 850 | 907 | 967 | 992 | 1,018 | 1,045 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange | 850 | 907 | 967 | 992 | 1,018 | 1,045 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 | 1,072 |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 | 915 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 14,977 | 16,741 | 19,787 | 20,979 | 23,697 | 24,048 | 25,742 | 24,422 | 24,404 | 24,094 | 25,161 | 23,746 | 23,949 | 23,829 | 25,213 | 23,881 | 24,104 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 1369 | 7641 | 9293 | 9417 | 9500 | 8400 | 2341 | 2341 | 2341 | 2341 | – | – | – | – | – | – | – |
| Domestic | 337 | 1496 | 1831 | 1866 | 1891 | 1560 | 669 | 669 | 669 | 669 | – | – | – | – | – | – | – |
| Total | 1706 | 9136 | 11124 | 11283 | 11391 | 9961 | 3010 | 3010 | 3010 | 3010 | – | – | – | – | – | – | – |
| TOTAL COST | 16,684 | 25,878 | 30,910 | 32,262 | 35,087 | 34,008 | 28,752 | 27,432 | 27,415 | 27,104 | 25,161 | 23,746 | 23,949 | 23,829 | 25,213 | 23,881 | 24,104 |
| Present Worth | 16,054 | 23,056 | 25,500 | 24,644 | 24,817 | 22,272 | 17,435 | 15,402 | 14,252 | 13,047 | 11,214 | 9,800 | 9,151 | 8,431 | 8,260 | 7,244 | 6,770 |
| Cumulative Present Worth | 16,054 | 39,111 | 64,611 | 89,255 | 114,071 | 136,343 | 153,778 | 169,180 | 183,432 | 196,479 | 207,693 | 217,493 | 226,644 | 235,075 | 243,335 | 250,579 | 257,350 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 | 1,180,933 |
| Electricity | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $17.71 | $18.14 | $17.97 | $17.79 | $17.62 | $17.46 | $17.29 | $17.29 | $17.29 | $17.29 | $17.29 | $17.29 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 | 31,046 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| $SO_2$ | 419 | 419 | 419 | 419 | 419 | 419 | 418 | 418 | 418 | 418 | 418 | 418 | 418 | 418 | 418 | 418 | 418 |
| NOx | 343 | 343 | 343 | 343 | 343 | 343 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 | 341 |
| CO | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

0204

Liulin–Case $L0_3$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Distribution Piping Modifications

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 10,649 | 12,465 | 14,813 | 17,621 | 20,886 | 21,896 | 22,827 | 22,931 | 22,992 | 23,011 | 22,940 | 22,786 | 22,879 | 22,935 | 23,010 | 23,085 | 23,141 |
| Oil | 615 | 666 | 732 | 775 | 817 | 858 | 895 | 899 | 901 | 901 | 898 | 892 | 896 | 898 | 901 | 904 | 906 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 11,264 | 13,131 | 15,545 | 18,396 | 21,703 | 22,754 | 23,722 | 23,830 | 23,893 | 23,912 | 23,839 | 23,678 | 23,775 | 23,833 | 23,911 | 23,989 | 24,047 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | 0 | – | (0) | (0) | – | (0) | – | – | 0 | – |
| Purchased Power Cost | 850 | 920 | 1,011 | 1,071 | 1,129 | 1,189 | 1,241 | 1,259 | 1,275 | 1,289 | 1,302 | 1,306 | 1,311 | 1,315 | 1,319 | 1,323 | 1,327 |
| Credit for Power Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Net Power Interchange | 850 | 920 | 1,011 | 1,071 | 1,129 | 1,189 | 1,241 | 1,259 | 1,275 | 1,289 | 1,302 | 1,306 | 1,311 | 1,315 | 1,319 | 1,323 | 1,327 |
| Fixed O&M and Overheads | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| Other Variable O & M | 915 | 929 | 957 | 988 | 1,015 | 1,042 | 1,059 | 1,074 | 1,088 | 1,100 | 1,111 | 1,115 | 1,119 | 1,122 | 1,126 | 1,129 | 1,132 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Maintenance Expenses | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 14,977 | 16,963 | 20,557 | 22,477 | 26,041 | 27,078 | 29,274 | 28,300 | 28,579 | 28,515 | 29,731 | 28,360 | 28,670 | 28,615 | 30,084 | 28,838 | 29,126 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 416 | 5049 | 6059 | 6059 | 15419 | 6059 | – | – | – | 8005 | – | – | – | – | – | – | – |
| Domestic | 61 | 743 | 891 | 891 | 1112 | 891 | – | – | – | 291 | – | – | – | – | – | – | – |
| Total | 477 | 5792 | 6950 | 6950 | 16530 | 6950 | – | – | – | 8296 | – | – | – | – | – | – | – |
| TOTAL COST | 15,455 | 22,755 | 27,508 | 29,427 | 42,571 | 34,029 | 29,274 | 28,300 | 28,579 | 36,811 | 29,731 | 28,360 | 28,670 | 28,615 | 30,084 | 28,838 | 29,126 |
| Present Worth | 14,871 | 20,274 | 22,693 | 22,478 | 30,110 | 22,285 | 17,751 | 15,889 | 14,857 | 17,720 | 13,251 | 11,704 | 10,956 | 10,124 | 9,856 | 8,748 | 8,181 |
| Cumulative Present Worth | 14,871 | 35,145 | 57,838 | 80,317 | 110,427 | 132,712 | 150,463 | 166,352 | 181,209 | 198,929 | 212,180 | 223,884 | 234,840 | 244,964 | 254,820 | 263,568 | 271,749 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | 1,180,933 | 1,198,647 | 1,235,256 | 1,274,226 | 1,309,654 | 1,343,901 | 1,366,339 | 1,386,415 | 1,404,129 | 1,419,481 | 1,433,652 | 1,438,376 | 1,444,281 | 1,447,824 | 1,452,547 | 1,457,271 | 1,460,814 |
| Electricity | 0 | – | 0 | – | – | (0) | – | – | (0) | 0 | 0 | – | 0 | (0) | (0) | – | 0 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | $10.32 | $11.73 | $13.36 | $15.22 | $17.35 | $17.71 | $18.14 | $17.97 | $17.79 | $17.62 | $17.41 | $17.24 | $17.24 | $17.24 | $17.24 | $17.24 | $17.24 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | 0 | – | (0) | (0) | – | (0) | – | – | 0 | – |
| Electricity | 31,046 | 31,512 | 32,474 | 33,499 | 34,430 | 35,330 | 35,920 | 36,448 | 36,914 | 37,317 | 37,690 | 37,814 | 37,969 | 38,062 | 38,187 | 38,311 | 38,404 |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 30 | 30 | 31 | 32 | 33 | 34 | 35 | 35 | 36 | 36 | 36 | 36 | 36 | 37 | 37 | 37 | 37 |
| $SO_2$ | 419 | 426 | 439 | 453 | 465 | 476 | 484 | 491 | 497 | 502 | 506 | 508 | 510 | 511 | 513 | 514 | 515 |
| NOx | 343 | 348 | 358 | 370 | 380 | 388 | 395 | 401 | 406 | 410 | 413 | 415 | 416 | 417 | 419 | 420 | 421 |
| CO | 37 | 37 | 39 | 40 | 41 | 42 | 42 | 43 | 44 | 44 | 44 | 45 | 45 | 45 | 45 | 45 | 45 |

TPS Republika – Case $P0_1$

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 4,929 | – | – | – | – | – | 6,765 | 6,765 | 6,765 | 10,841 | 10,841 | 10,841 | 10,841 | 10,841 | 10,841 | 10,841 | 10,841 |
| Black Coal | – | 13,835 | 13,788 | 14,215 | 14,657 | 15,120 | 7,283 | 7,283 | 7,283 | 2,488 | 2,488 | 2,488 | 2,488 | 2,488 | 2,488 | 2,488 | 2,488 |
| Total Fuel Cost | 4,929 | 13,835 | 13,788 | 14,215 | 14,657 | 15,120 | 14,048 | 14,048 | 14,048 | 13,329 | 13,329 | 13,329 | 13,329 | 13,329 | 13,329 | 13,329 | 13,329 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (7,872) | (8,394) | (8,503) | (8,722) | (8,946) | (9,181) | (9,423) | (9,423) | (9,423) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) |
| Net Power Interchange | (7,872) | (8,394) | (8,503) | (8,722) | (8,946) | (9,181) | (9,423) | (9,423) | (9,423) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) | (9,793) |
| Fixed O&M and Overheads | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| Other Variable O & M | 3,192 | 3,194 | 3,141 | 3,175 | 3,208 | 3,244 | 3,278 | 3,278 | 3,278 | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 |
| Sorbent and Ash Removal | 1,156 | 33 | 32 | 32 | 33 | 33 | 1,446 | 1,446 | 1,446 | 2,297 | 2,297 | 2,297 | 2,297 | 2,297 | 2,297 | 2,297 | 2,297 |
| Credit: By–Product Sales | – | – | – | – | – | – | (401) | (401) | (401) | (643) | (643) | (643) | (643) | (643) | (643) | (643) | (643) |
| Emission Penalties | 930 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maintenance Expenses | 1,772 | 1,779 | 1,980 | 1,773 | 1,957 | 1,981 | 1,689 | 1,386 | 2,377 | 1,798 | 2,490 | 1,352 | 1,571 | 2,388 | 2,108 | 2,232 | 1,684 |
| Plant Removal Costs | 1,412 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 8,642 | 13,571 | 13,562 | 13,597 | 14,033 | 14,321 | 13,760 | 13,457 | 14,448 | 13,431 | 14,123 | 12,985 | 13,205 | 14,021 | 13,741 | 13,866 | 13,317 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 29890 | 1863 | 2325 | 17948 | 36711 | 14341 | 17429 | 25414 | 20913 | 6954 | – | – | – | – | 1394 | – | – |
| Domestic | 2941 | 523 | 643 | 1242 | 1916 | 864 | 977 | 1269 | 975 | 484 | – | – | – | – | 28 | – | – |
| Total | 32830 | 2386 | 2968 | 19191 | 38627 | 15205 | 18406 | 26683 | 21888 | 7439 | – | – | – | – | 1422 | – | – |
| TOTAL COST | 41,472 | 15,957 | 16,530 | 32,787 | 52,659 | 29,526 | 32,165 | 40,140 | 36,336 | 20,870 | 14,123 | 12,985 | 13,205 | 14,021 | 15,163 | 13,866 | 13,317 |
| Present Worth | 39,907 | 14,217 | 13,637 | 25,045 | 37,245 | 19,336 | 19,504 | 22,537 | 18,890 | 10,046 | 6,295 | 5,359 | 5,046 | 4,961 | 4,968 | 4,206 | 3,740 |
| Cumulative Present Worth | 39,907 | 54,124 | 67,760 | 92,805 | 130,050 | 149,387 | 168,891 | 191,428 | 210,318 | 220,364 | 226,659 | 232,018 | 237,063 | 242,024 | 246,992 | 251,198 | 254,938 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 |
| Hot Water | 555,418 | 556,584 | 570,748 | 587,743 | 604,739 | 621,735 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 | 638,731 |
| Electricity | 409,490 | 409,658 | 396,907 | 400,155 | 403,335 | 406,685 | 410,022 | 410,022 | 410,022 | 421,330 | 421,330 | 421,330 | 421,330 | 421,330 | 421,330 | 421,330 | 421,330 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $6.97 | $11.66 | $11.74 | $11.93 | $12.11 | $12.30 | $12.15 | $12.15 | $12.15 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 |
| Hot Water | $6.97 | $11.65 | $11.74 | $11.93 | $12.11 | $12.30 | $12.15 | $12.15 | $12.15 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 | $11.97 |
| Electricity | $12.19 | $20.34 | $20.15 | $20.28 | $20.43 | $20.60 | $20.16 | $20.16 | $20.16 | $19.83 | $19.83 | $19.83 | $19.83 | $19.83 | $19.83 | $19.83 | $19.83 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 124,501 | 5 | 5 | 5 | 5 | 5 | 130 | 130 | 130 | 206 | 206 | 206 | 206 | 206 | 206 | 206 | 206 |
| $SO_2$ | 17,750 | 622 | 608 | 615 | 623 | 630 | 1,215 | 1,215 | 1,215 | 1,572 | 1,572 | 1,572 | 1,572 | 1,572 | 1,572 | 1,572 | 1,572 |
| NOx | 1,614 | 872 | 852 | 862 | 872 | 882 | 896 | 896 | 896 | 910 | 910 | 910 | 910 | 910 | 910 | 910 | 910 |
| CO | 49 | 45 | 44 | 44 | 45 | 45 | 49 | 49 | 49 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 |

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TPS Republika – Case $P0_2$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Production Plant "Enhancements"

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 4,929 | – | – | – | – | – | 6,635 | 6,635 | 6,635 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 | 10,858 |
| Black Coal | – | 13,823 | 13,650 | 13,912 | 14,182 | 14,458 | 6,612 | 6,612 | 6,612 | 1,677 | 1,677 | 1,677 | 1,677 | 1,677 | 1,677 | 1,677 | 1,677 |
| Total Fuel Cost | 4,929 | 13,823 | 13,650 | 13,912 | 14,182 | 14,458 | 13,246 | 13,246 | 13,246 | 12,535 | 12,535 | 12,535 | 12,535 | 12,535 | 12,535 | 12,535 | 12,535 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (7,872) | (8,396) | (8,513) | (8,735) | (8,964) | (9,199) | (9,440) | (9,440) | (9,440) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) |
| Net Power Interchange | (7,872) | (8,396) | (8,513) | (8,735) | (8,964) | (9,199) | (9,440) | (9,440) | (9,440) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) | (9,802) |
| Fixed O&M and Overheads | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| Other Variable O & M | 3,192 | 3,192 | 3,113 | 3,113 | 3,113 | 3,113 | 3,113 | 3,113 | 3,113 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 | 3,166 |
| Sorbent and Ash Removal | 1,156 | 33 | 32 | 32 | 32 | 32 | 1,417 | 1,417 | 1,417 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 | 2,299 |
| Credit: By-Product Sales | – | – | – | – | – | – | (394) | (394) | (394) | (644) | (644) | (644) | (644) | (644) | (644) | (644) | (644) |
| Emission Penalties | 930 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maintenance Expenses | 1,772 | 1,773 | 1,965 | 1,742 | 1,908 | 1,915 | 1,607 | 1,304 | 2,294 | 1,716 | 2,407 | 1,268 | 1,486 | 2,301 | 2,020 | 2,143 | 1,594 |
| Plant Removal Costs | 1,412 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 8,642 | 13,548 | 13,370 | 13,187 | 13,394 | 13,443 | 12,673 | 12,369 | 13,360 | 12,392 | 13,083 | 11,944 | 12,163 | 12,978 | 12,697 | 12,820 | 12,270 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 30092 | 4323 | 5277 | 20900 | 30118 | 17294 | 17429 | 25414 | 20913 | 6954 | – | – | – | – | 1394 | – | – |
| Domestic | 2967 | 835 | 1028 | 1618 | 1945 | 1239 | 977 | 1269 | 975 | 484 | – | – | – | – | 28 | – | – |
| Total | 33059 | 5158 | 6305 | 22518 | 32062 | 18532 | 18406 | 26683 | 21888 | 7439 | – | – | – | – | 1422 | – | – |
| TOTAL COST | 41,700 | 18,706 | 19,676 | 35,705 | 45,456 | 31,975 | 31,078 | 39,052 | 35,248 | 19,831 | 13,083 | 11,944 | 12,163 | 12,978 | 14,119 | 12,820 | 12,270 |
| Present Worth | 40,126 | 16,667 | 16,232 | 27,274 | 32,151 | 20,940 | 18,845 | 21,927 | 18,324 | 9,546 | 5,831 | 4,929 | 4,648 | 4,592 | 4,625 | 3,889 | 3,446 |
| Cumulative Present Worth | 40,126 | 56,793 | 73,025 | 100,299 | 132,449 | 153,390 | 172,235 | 194,162 | 212,486 | 222,032 | 227,863 | 232,792 | 237,440 | 242,032 | 246,657 | 250,546 | 253,992 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 |
| Hot Water | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 | 555,418 |
| Electricity | 409,490 | 409,490 | 394,208 | 394,208 | 394,208 | 394,208 | 394,208 | 394,208 | 394,208 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 | 405,203 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $6.97 | $11.65 | $11.75 | $11.93 | $12.12 | $12.31 | $12.16 | $12.16 | $12.16 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 |
| Hot Water | $6.97 | $11.65 | $11.75 | $11.93 | $12.12 | $12.31 | $12.16 | $12.16 | $12.16 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 | $11.95 |
| Electricity | $12.19 | $20.35 | $20.32 | $20.63 | $20.96 | $21.29 | $21.01 | $21.01 | $21.01 | $20.77 | $20.77 | $20.77 | $20.77 | $20.77 | $20.77 | $20.77 | $20.77 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 124,501 | 5 | 5 | 5 | 5 | 5 | 128 | 128 | 128 | 206 | 206 | 206 | 206 | 206 | 206 | 206 | 206 |
| $SO_2$ | 17,750 | 622 | 602 | 602 | 602 | 602 | 1,170 | 1,170 | 1,170 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 | 1,541 |
| NOx | 1,614 | 871 | 844 | 844 | 844 | 844 | 848 | 848 | 848 | 865 | 865 | 865 | 865 | 865 | 865 | 865 | 865 |
| CO | 49 | 45 | 43 | 43 | 43 | 43 | 47 | 47 | 47 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

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TPS Republika – Case $P0_3$

PROJECTED OPERATING AND CAPITAL EXPENDITURES

Excluding Piping Modifications

| COST EXCL INFLATION (000) | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Oil | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Lignite | 4,929 | – | – | – | – | – | 6,770 | 6,787 | 6,440 | 11,066 | 11,093 | 11,108 | 11,122 | 11,130 | 11,141 | 11,152 | 11,161 |
| Black Coal | – | 13,898 | 13,883 | 14,324 | 14,773 | 15,226 | 7,317 | 7,405 | 7,911 | 2,505 | 2,541 | 2,546 | 2,559 | 2,567 | 2,577 | 2,587 | 2,594 |
| Total Fuel Cost | 4,929 | 13,898 | 13,883 | 14,324 | 14,773 | 15,226 | 14,087 | 14,192 | 14,351 | 13,571 | 13,633 | 13,654 | 13,681 | 13,697 | 13,718 | 13,739 | 13,755 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (7,872) | (8,383) | (8,502) | (8,717) | (8,950) | (9,182) | (9,424) | (9,425) | (9,426) | (9,802) | (9,804) | (9,806) | (9,808) | (9,809) | (9,811) | (9,813) | (9,814) |
| Net Power Interchange | (7,872) | (8,383) | (8,502) | (8,717) | (8,950) | (9,182) | (9,424) | (9,425) | (9,426) | (9,802) | (9,804) | (9,806) | (9,808) | (9,809) | (9,811) | (9,813) | (9,814) |
| Fixed O&M and Overheads | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| Other Variable O & M | 3,192 | 3,206 | 3,161 | 3,197 | 3,232 | 3,265 | 3,286 | 3,306 | 3,323 | 3,377 | 3,390 | 3,395 | 3,400 | 3,404 | 3,409 | 3,413 | 3,417 |
| Sorbent and Ash Removal | 1,156 | 33 | 32 | 33 | 33 | 33 | 1,447 | 1,450 | 1,378 | 2,345 | 2,350 | 2,353 | 2,356 | 2,358 | 2,361 | 2,363 | 2,365 |
| Credit: By–Product Sales | – | – | – | – | – | – | (402) | (403) | (382) | (656) | (658) | (659) | (660) | (660) | (661) | (662) | (662) |
| Emission Penalties | 930 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Maintenance Expenses | 1,772 | 1,786 | 1,990 | 1,785 | 1,969 | 1,992 | 1,693 | 1,399 | 2,409 | 1,822 | 2,520 | 1,385 | 1,608 | 2,426 | 2,149 | 2,277 | 1,731 |
| Plant Removal Costs | 1,412 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 8,642 | 13,664 | 13,688 | 13,745 | 14,181 | 14,458 | 13,811 | 13,643 | 14,776 | 13,780 | 14,555 | 13,446 | 13,701 | 14,539 | 14,288 | 14,442 | 13,915 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 29433 | 2460 | 2952 | 18497 | 37209 | 15835 | 15971 | 23956 | 19454 | 5496 | – | – | – | – | 1394 | – | – |
| Domestic | 2784 | 313 | 375 | 944 | 1604 | 847 | 585 | 877 | 583 | 92 | – | – | – | – | 28 | – | – |
| Total | 32217 | 2773 | 3327 | 19441 | 38812 | 16682 | 16555 | 24833 | 20037 | 5588 | – | – | – | – | 1422 | – | – |
| TOTAL COST | 40,858 | 16,437 | 17,016 | 33,186 | 52,993 | 31,140 | 30,366 | 38,476 | 34,813 | 19,368 | 14,555 | 13,446 | 13,701 | 14,539 | 15,710 | 14,442 | 13,915 |
| Present Worth | 39,316 | 14,644 | 14,038 | 25,350 | 37,481 | 20,393 | 18,414 | 21,603 | 18,098 | 9,323 | 6,487 | 5,549 | 5,235 | 5,144 | 5,147 | 4,381 | 3,908 |
| Cumulative Present Worth | 39,316 | 53,961 | 67,998 | 93,348 | 130,829 | 151,222 | 169,636 | 191,238 | 209,337 | 218,660 | 225,147 | 230,696 | 235,932 | 241,076 | 246,222 | 250,603 | 254,512 |

| OPERATING STATISTICS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 | 192,542 |
| Hot Water | 555,418 | 563,749 | 580,967 | 599,296 | 615,959 | 632,066 | 642,619 | 652,061 | 660,392 | 667,612 | 674,277 | 676,499 | 679,276 | 680,942 | 683,164 | 685,386 | 687,052 |
| Electricity | 409,490 | 410,699 | 398,889 | 402,268 | 405,653 | 408,719 | 410,814 | 412,691 | 414,345 | 427,237 | 428,615 | 429,101 | 429,707 | 430,070 | 430,555 | 431,033 | 431,392 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $6.97 | $11.66 | $11.74 | $11.92 | $12.11 | $12.30 | $12.15 | $12.16 | $12.17 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 |
| Hot Water | $6.97 | $11.65 | $11.74 | $11.92 | $12.11 | $12.30 | $12.15 | $12.16 | $12.17 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 | $11.96 |
| Electricity | $12.19 | $20.27 | $20.04 | $20.17 | $20.33 | $20.50 | $20.13 | $20.05 | $20.00 | $19.54 | $19.47 | $19.45 | $19.43 | $19.41 | $19.40 | $19.38 | $19.36 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 124,501 | 5 | 5 | 5 | 5 | 5 | 131 | 131 | 125 | 210 | 211 | 211 | 211 | 211 | 212 | 212 | 212 |
| $SO_2$ | 17,750 | 625 | 613 | 620 | 627 | 634 | 1,217 | 1,223 | 1,197 | 1,603 | 1,608 | 1,610 | 1,613 | 1,614 | 1,616 | 1,618 | 1,619 |
| NOx | 1,614 | 876 | 858 | 869 | 879 | 889 | 898 | 904 | 909 | 927 | 931 | 932 | 934 | 935 | 936 | 938 | 939 |
| CO | 49 | 45 | 44 | 44 | 45 | 45 | 50 | 50 | 50 | 53 | 53 | 54 | 54 | 54 | 54 | 54 | 54 |

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**TPS SOFIA**

**Case 3 - Alternate**

TPS Sofia - Case 3 - Alternate

## PROJECTED OPERATING AND CAPITAL EXPENDITURES

**COST EXCL INFLATION (000)**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | | | | | |
| Fuel Cost – Natural Gas | 29,034 | 33,428 | 38,549 | 44,455 | 51,265 | 66,126 | 67,805 | 67,127 | 66,456 | 65,791 | 65,053 | 64,403 | 64,403 | 64,403 | 64,403 | 64,403 | 64,403 |
| Oil | 1,678 | 1,787 | 1,906 | 1,955 | 2,007 | 1,510 | 1,550 | 1,534 | 1,518 | 1,503 | 1,484 | 1,469 | 1,469 | 1,469 | 1,469 | 1,469 | 1,469 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 30,712 | 35,215 | 40,455 | 46,410 | 53,272 | 67,636 | 69,355 | 68,661 | 67,974 | 67,294 | 66,537 | 65,872 | 65,872 | 65,872 | 65,872 | 65,872 | 65,872 |
| Supplemental Cost (Shortfall) | – | – | – | – | – | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (36,849) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) |
| Net Power Interchange | (12,923) | (13,783) | (14,701) | (15,085) | (15,480) | (36,849) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) | (37,818) |
| Fixed O&M and Overheads | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| Other Variable O & M | 2,917 | 2,917 | 2,917 | 2,917 | 2,917 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 | 3,229 |
| Sorbent and Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit: By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emission Penalties | 11 | 11 | 11 | 11 | 11 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Maintenance Expenses | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 2,571 | 2,818 | 2,919 | 3,019 | 3,308 | 3,097 | 2,805 | 2,999 | 3,248 | 3,946 | 3,089 | 2,852 |
| Plant Removal Costs | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total O&M Expense | 24,940 | 29,142 | 33,345 | 38,957 | 45,567 | 39,166 | 40,163 | 39,570 | 38,983 | 38,592 | 37,625 | 36,667 | 36,861 | 37,110 | 37,808 | 36,951 | 36,714 |
| CAPITAL COSTS | | | | | | | | | | | | | | | | | |
| Foreign | 9455 | 19140 | 28222 | 43959 | 42611 | 12466 | 4050 | 4050 | 4050 | 12288 | – | – | – | – | – | – | – |
| Domestic | 875 | 2749 | 3810 | 4443 | 5381 | 2412 | 1174 | 1174 | 1174 | 1468 | – | – | – | – | – | – | – |
| Total | 10330 | 21888 | 32032 | 48402 | 47992 | 14877 | 5224 | 5224 | 5224 | 13756 | – | – | – | – | – | – | – |
| TOTAL COST | 35,269 | 51,030 | 65,377 | 87,359 | 93,559 | 54,043 | 45,387 | 44,794 | 44,207 | 52,348 | 37,625 | 36,667 | 36,861 | 37,110 | 37,808 | 36,951 | 36,714 |
| Present Worth | 33,938 | 45,466 | 53,934 | 66,731 | 66,173 | 35,393 | 27,522 | 25,150 | 22,982 | 25,198 | 16,770 | 15,132 | 14,085 | 13,130 | 12,386 | 11,209 | 10,312 |
| Cumulative Present Worth | 33,938 | 79,404 | 133,339 | 200,069 | 266,242 | 301,635 | 329,157 | 354,307 | 377,289 | 402,488 | 419,257 | 434,390 | 448,475 | 461,605 | 473,991 | 485,200 | 495,512 |

**OPERATING STATISTICS**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL PRODUCTION – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 | 545,176 |
| Hot Water | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,862,339 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 | 1,856,977 |
| Electricity | 595,117 | 595,117 | 595,117 | 595,117 | 595,117 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 | 1,251,691 |
| COST OF PRODUCTION – $/MWH (Variable Costs only) | | | | | | | | | | | | | | | | | |
| LP Steam | $10.54 | $11.95 | $13.58 | $15.44 | $17.57 | $18.01 | $18.44 | $18.26 | $18.09 | $17.92 | $17.71 | $17.54 | $17.54 | $17.54 | $17.54 | $17.54 | $17.54 |
| Hot Water | $10.41 | $11.81 | $13.44 | $15.29 | $17.42 | $20.23 | $20.72 | $20.52 | $20.33 | $20.13 | $19.92 | $19.73 | $19.73 | $19.73 | $19.73 | $19.73 | $19.73 |
| Electricity | $14.28 | $16.18 | $18.40 | $20.92 | $23.83 | $18.77 | $19.22 | $19.04 | $18.86 | $18.67 | $18.49 | $18.31 | $18.31 | $18.31 | $18.31 | $18.31 | $18.31 |
| NOT SERVED – MWH | | | | | | | | | | | | | | | | | |
| LP Steam | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Hot Water | – | – | – | – | – | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 | 5,363 |
| Electricity | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| EMISSIONS – TONS | | | | | | | | | | | | | | | | | |
| Particulates | 82 | 82 | 82 | 82 | 82 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| $SO_2$ | 1,144 | 1,142 | 1,142 | 1,142 | 1,142 | 837 | 837 | 837 | 837 | 837 | 836 | 836 | 836 | 836 | 836 | 836 | 836 |
| NOx | 934 | 932 | 932 | 932 | 932 | 684 | 684 | 684 | 684 | 684 | 683 | 683 | 683 | 683 | 683 | 683 | 683 |
| CO | 100 | 100 | 100 | 100 | 100 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 | 73 |

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TPS Sofia - Case 3 - Alternate

FACILITIES DATA SHEET AND SIMULATED RESULTS – YEAR 2010

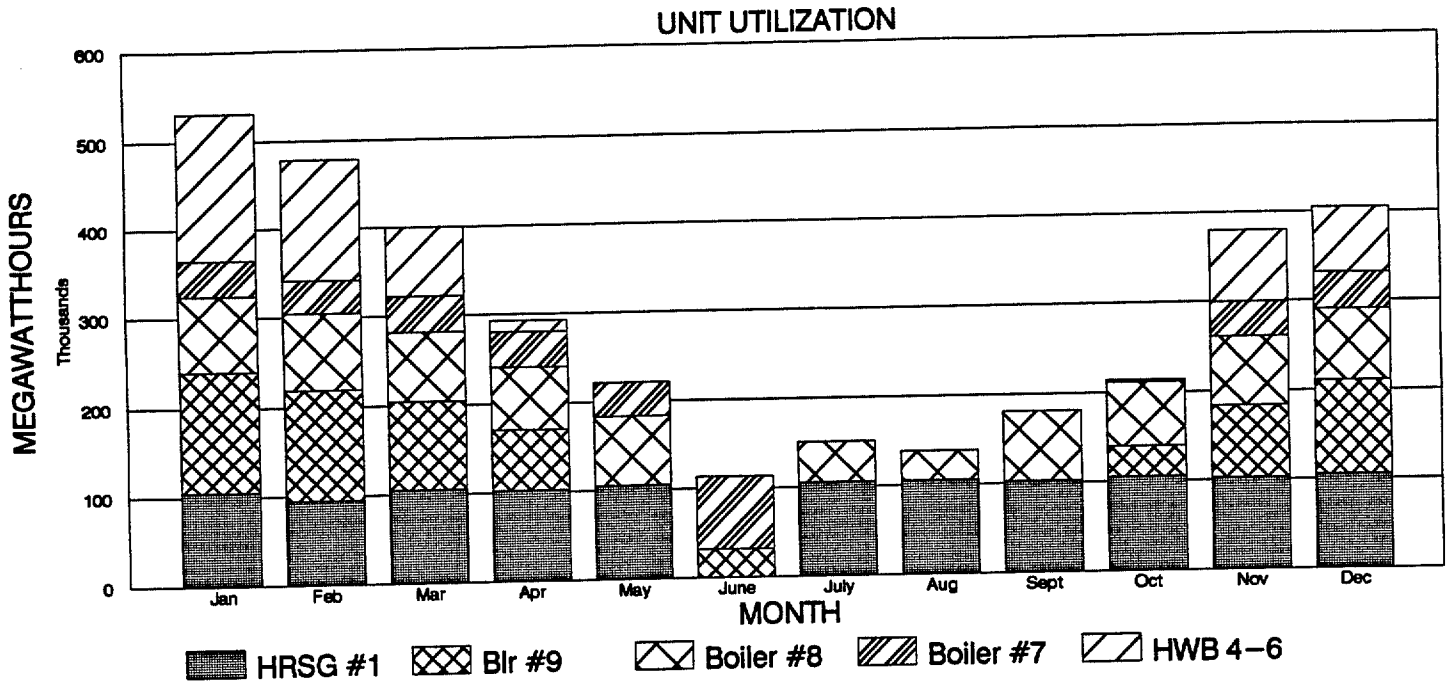
CASE 83 — Test Year = 2010

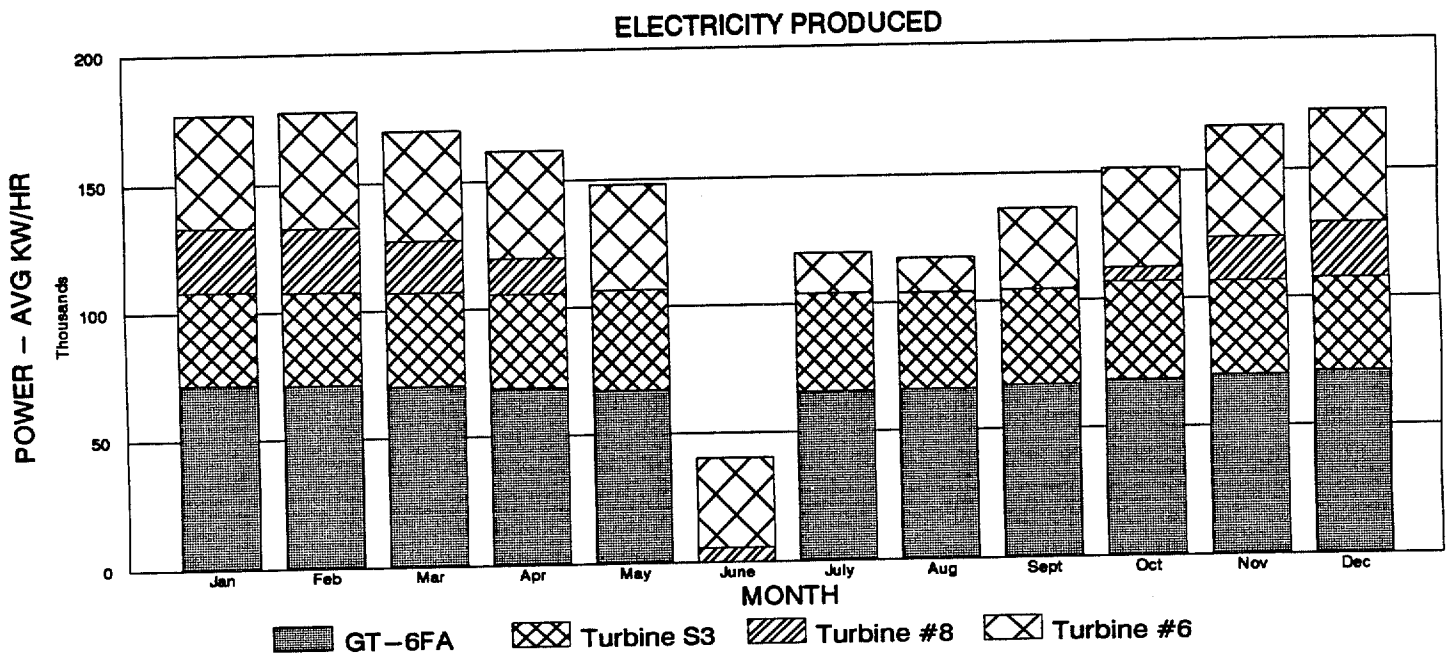
## Facilities Data

| DESCRIPTION | UNIT | BASIS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Boiler #7 | Boiler #8 | | | | | HRSG #1 | | | Bir #9 | Bir #3 | HWB 4–6 |
| THERMAL DATA | | | | | | | | | | | | | | |
| Efficiency – 80% to Full Load | %1 | | 84.8% | 84.8% | | | | | 100.0% | | | 84.4% | 84.4% | 84.5% |
| Half Load | %2 | | 84.8% | 84.8% | | | | | 100.0% | | | 84.4% | 84.4% | 84.5% |
| Minimum Load | %3 | | 84.8% | 84.8% | | | | | 100.0% | | | 84.4% | 84.4% | 84.5% |
| Minimum Operation | % | | 40.0% | 40.0% | | | | | | | | 40.0% | 40.0% | 13.3% |
| Feedwater Temp | | | 419° | 419° | | | | | | | | 439° | 212° | 158° |
| Operation Adjustment Factor | Factor$_n$ | | | | | | | | | | | | | |
| BOILER OUTPUT | Priority | | 8 | 8 | | | | | 141.786 | 141.786 | | | | |
| Capacity | MWt | | 135.000 | 135.000 | | | 142 | | 339.09 | | | 485.1 | | |
| Quantity | Mlb/Hr | | 485.1 | 485.1 | | | 115.751 | | 1541.8 | | | 1451 | | |
| Pressure | PSIA | | 1451 | 1451 | | | 36.908 | | 1004 | | | 1004° | | |
| Temperature | Temp °F | | 1004° | 1004° | | | 115.942 | | 1492.2 | | | 1.496 | | |
| Enthalpy | MBTU/lb | | 1.496 | 1.496 | | | | | | | | 3 | | |
| PRODUCT – LP STEAM | Priority | * | | | 6 | | | | | | | 430.000 | 132.3 | |
| Quantity | Mlb/Hr | | | | 507.15 | | | | | | | 159.000 | 53 | |
| | MWts | | | | 166.700 | | | | | | | 142.25 | 363 | |
| Pressure | PSIA | | | | 185 | | | | | | | – | 770° | |
| Temperature | Temp °F | | | | 559.4° | | | | | | | 1.266 | 1.403 | |
| Enthalpy | MBTU/lb | | | | 1.302 | | | | | | | 3 | | 7 |
| PRODUCT – HOT WATER | Priority | Cooling | | | | 2 | | | 1 | | | 41.000 | | 348.000 |
| Quantity | MWtw | 200.000 | | | | 101.300 | | | 86.607 | | | 240° | | 302° |
| Temperature – Supply | Temp °F | | | | | 240° | | | | | | 140° | | 158° |
| Return | Temp °F | | | | | 140° | | | | | | | | |
| TURBINE DATA | UNITs | | | | Turb 6a | Turb 6b | Turb 6c | GT–6FA | Turb S3a | Turb S3c | | Turb 8 | | |
| | Priority | | | | | | | 1 | | | | | | |
| Rated Capacity–Electric | KW | | | | | | 55000 | | 27665 | 36590 | | 25000 | | |
| Capability – Max Steam | KW1 | | | | 29227 | 34727 | 50000 | | 27665 | 36590 | | 25000 | | |
| 75 % Steam | KW75 | | | | 21920 | 26046 | | | 19752 | | | 18375 | | |
| 50 % Steam | KW50 | | | | 14613 | 17364 | | | 11821 | | | 11875 | | |
| 25% Steam | KW25 | | | | 7307 | 8682 | | | 3898 | | | 4375 | | |
| Steam Required – Maximum | M#/Hr_Max | | | | 507.150 | 352.600 | | | 305.181 | | | 480.640 | | |
| Minimum | M#/Hr_Min | | | | | | | | | | | 192.260 | | |
| Outlet Steam Pressure | PSI | | | | 185 | 22.75 | | | 25.0 | | | 142.2 | | |
| Enthalpy Drop – Turbine | MBTU/lbt | | | | 0.1849 | 0.307 | | | 0.3141 | | | 0.228 | | |
| Sink | MBTU/lbs | | | | 1.1218 | 0.9601 | | | 0.9686 | | | 0.9790 | | |
| Generator Efficiency | %g | | | | 98.6% | 98.6% | 98.6% | | 98.5% | 98.5% | | 97.5% | | |
| Power/Rejection Factor | Factor | | | | | | 0.357 | | | 0.3292 | | | | |
| FUELS DATA | | | | | | | | | | | | | | |
| Primary Fuel | Type | | Gas | Gas | | | | Gas | | | | Gas | Gas | Gas |
| Cost | $/MMBTU | | $2.03 | $2.03 | | | | $2.03 | | | | $2.03 | $2.03 | $2.03 |
| Percent Use | % Use | | 95.0% | 95.0% | | | | 100.0% | | | | 95.0% | 95.0% | 95.0% |
| Secondary/Supplemental Fuel | Type | | Mazut | Mazut | | | | | | | | Mazut | Mazut | Mazut |
| Cost | $/MMBTU | | $2.41 | $2.41 | | | | | | | | $2.41 | $2.41 | $2.41 |
| Percent Use | % Use | | 5.0% | 5.0% | | | | | | | | 5.0% | 5.0% | 5.0% |
| COST DATA (1993 Basis) | CK/$ = | | | | | | | | | | | | | |
| Number of Personnel | Number | 740 | | | | | | | | | | | | |
| Average Wage & Benefits | $(000) | 3.0 | | | | | | | | | | | | |
| Other Fixed Costs | $(000) | $298.0 | | | | | | | | | | | | |
| Raw Water & Treating Costs | $/MWHw | $0.03 | | | | | | | | | | | | |
| Demineralized Water Costs | $/MWHs | $0.34 | | | | | | | | | | | | |
| Other Variable O&M Costs | $/MWH | $0.75 | | | | | | | | | | | | |
| Limestone | $/Ton' | $3.28 | | | | | | | | | | | | |
| Waste Disposal Costs | $/Ton | – | | | | | | | | | | | | |
| Emissions Code –Fuel 1 | CODEe1 | | ST2–A9 | ST2–A9 | | | | | | | | ST2–A9 | ST2–A9 | ST2–A9 |
| Emissions Code –Fuel 2 | CODEe2 | | ST2–A6 | ST2–A6 | | | | | | | | ST2–A6 | ST2–A6 | ST2–A6 |
| Scheduled Maintenance | CODE m | | SB7 | SB8 | | ST6 | | GT–6FA | STS3 | | | SB9T8 | SB3 | SHWB |
| Purchased Power | $/kW | | | | | | | | | | | | | |
| Energy Charge–Winter | Cents/KWHw | $0.0269 | | | | | | | | | | | | |
| Summer | Cents/KWHs | $0.0233 | | | | | | | | | | | | |
| MONTHLY DATA | Avg Temp °C | | | | | | | | | | | | | |
| Jan | –1.7 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% |
| Feb | 0.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% |
| Mar | 4.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | – | 100% |
| Apr | 10.8 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | – |
| May | 15.6 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | – |
| June | 19.0 | | 100% | – | 100% | 100% | 100% | – | – | – | | 100% | 100% | – |
| July | 21.2 | | – | 100% | 50% | 50% | 50% | 100% | 100% | 100% | | 100% | 100% | – |
| Aug | 20.6 | | 100% | 100% | 50% | 50% | 50% | 100% | 100% | 100% | | 100% | 100% | – |
| Sept | 16.7 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | – | 100% | 100% |
| Oct | 11.3 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% |
| Nov | 5.9 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% |
| Dec | 0.6 | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | 100% | 100% | 100% |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |

| TEST YEAR SIMULATION RESULTS: | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING EXPENSES | | | | | | | | | | | | | |
| Natural Gas | 4,555 | 4,104 | 3,525 | 2,661 | 2,109 | 882 | 1,543 | 1,449 | 1,763 | 2,060 | 3,343 | 3,571 | 31,584 |
| Oil | 207 | 166 | 143 | 93 | 56 | 55 | 22 | 16 | 39 | 53 | 135 | 146 | 1,150 |
| Lignite | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Black Coal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fuel Cost | 4,762 | 4,290 | 3,668 | 2,754 | 2,165 | 937 | 1,565 | 1,465 | 1,821 | 2,113 | 3,477 | 3,716 | 32,733 |
| Supplemental Cost–Shortfall Penalty) | – | – | – | – | – | – | – | – | 54 | – | – | 0 | 54 |
| Purchased Power Cost | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for Power Sales | (3,041) | (2,765) | (3,023) | (2,433) | (2,289) | (575) | (1,827) | (1,739) | (2,065) | (2,527) | (2,831) | (2,991) | (28,107) |
| Net Power Interchange Cost | (3,041) | (2,765) | (3,023) | (2,433) | (2,289) | (575) | (1,827) | (1,739) | (2,065) | (2,527) | (2,831) | (2,991) | (28,107) |
| Other O&M – Fixed, OH & Other | 214 | 193 | 214 | 207 | 214 | 207 | 214 | 214 | 207 | 214 | 207 | 214 | 2,518 |
| Variable | 473 | 429 | 360 | 272 | 217 | 115 | 144 | 131 | 180 | 205 | 337 | 366 | 3,229 |
| Limestone Injection & Ash Removal | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Credit for By–Product Sales | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Emissions Penalties | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |
| Total Excluding Maintenance | 2,409 | 2,149 | 1,220 | 800 | 308 | 684 | 96 | 71 | 196 | 5 | 1,192 | 1,306 | 10,435 |

TPS Sofia - Case 3 - Alternate

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## PRODUCT – LP STEAM

| | | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Customer Requirement | MWH | | 85556 | 87033 | 53664 | 42829 | 27705 | 25926 | 19405 | 16779 | 19019 | 24378 | 41289 | 58894 | 502477 |
| Station Use, Losses, etc. | MWH | – | 7282 | 7306 | 4421 | 3059 | 1678 | 1965 | 1648 | 1855 | 1831 | 2668 | 4035 | 4950 | 42699 |
| | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 | 545176 |
| | 2 | 3 | | | | | | | | | | | | | |
| | MWts | | Average Loading – MW | | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Header | 166.700 | 1 | 6.7 | 22.3 | – | – | 39.5 | – | 28.3 | 25.0 | 29.0 | – | – | – | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | 159.000 | | 118.0 | 118.1 | 78.1 | 63.7 | – | 38.7 | – | – | – | 36.4 | 62.9 | 85.8 | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Header | | | 5020 | 14998 | – | – | 29383 | – | 21053 | 18634 | 20850 | – | – | – | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | | | 87818 | 79342 | 58085 | 45888 | – | 27891 | – | – | – | 27046 | 45324 | 63844 | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 | 545176 |
| Steam Not Served | MWH | | – | – | – | – | – | – | – | – | – | – | – | – | – |

## PRODUCT – HOT WATER

| | | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Customer Requirement | MWH | | 290369 | 249102 | 202480 | 117762 | 37406 | 12028 | 34221 | 30955 | 35821 | 62321 | 183229 | 272620 | 1528294 |
| Station Use, Losses, etc. | MWH | – | 43359 | 41906 | 36617 | 29762 | 37589 | 15321 | 29079 | 28296 | 25349 | 25695 | 54506 | –33433 | 334045 |
| | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 61170 | 88016 | 237735 | 239187 | 1862339 |
| | 2 | 3 | | | | | | | | | | | | | |
| BASIS UNIT | MWtw | | Average Loading – MW | | | | | | | | | | | | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| HWB 4–6 | 348.000 | | 219.8 | 204.7 | 117.8 | 25.7 | – | – | – | – | – | 13.8 | 107.7 | 93.3 | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | 41.000 | | 41.0 | 40.9 | 36.2 | 31.7 | – | 5.9 | – | – | – | 35.2 | 38.8 | 40.2 | |
| Header | 101.300 | 1 | 101.1 | 101.1 | 98.4 | 87.5 | 20.9 | 37.8 | 23.7 | 10.7 | – | 47.3 | 101.3 | 101.3 | |
| HRSG #1 | 86.607 | | 86.6 | 86.2 | 85.3 | 85.0 | 82.5 | – | 70.1 | 75.7 | 77.5 | 78.2 | 86.3 | 86.6 | |
| Total | | | 448.6 | 433.0 | 337.8 | 230.0 | 103.4 | 43.7 | 93.8 | 86.4 | 77.5 | 174.5 | 334.1 | 321.5 | |
| Unit | | | Unit Energy Output – MWH (Before Adjustment for Minimum Loading Limitation) | | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| HWB 4–6 | | | 163568 | 137589 | 76059 | 6803 | – | – | – | – | – | 513 | 74732 | 69439 | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | | | 30478 | 27506 | 26294 | 16492 | – | 117 | – | – | – | 3813 | 27936 | 29945 | |
| Header | | | 75246 | 67968 | 73244 | 63000 | 13646 | 27231 | 11148 | 2893 | – | 25501 | 72936 | 75367 | |
| HRSG #1 | | | 64436 | 57947 | 63481 | 61228 | 61350 | – | 52152 | 56358 | 55808 | 58190 | 62132 | 64436 | |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 55808 | 88016 | 237735 | 239187 | 1856977 |
| Hot Water Not Served | MWH | | – | – | – | – | – | – | – | – | 5363 | – | – | 0 | 5363 |

## ADJUSTED FOR MINIMUM LOADING – MWH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Steam) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Header | | | 5020 | 14998 | – | – | 29383 | – | 21053 | 18634 | 20850 | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 87818 | 79342 | 58085 | 45888 | – | 27891 | – | – | – | 27046 | 45324 | 63844 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | | 92838 | 94341 | 58085 | 45888 | 29383 | 27891 | 21053 | 18634 | 20850 | 27046 | 45324 | 63844 |
| **Hot Water** | | | Unit Utilization after Adjustment for Minimum Loading – MWH (Hot Water) | | | | | | | | | | | |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | | 166283 | 137624 | 78053 | 12438 | – | – | – | – | – | 1717 | 79126 | 74183 |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | | 27773 | 27490 | 25706 | 11742 | – | 327 | – | – | – | 2609 | 23968 | 25201 |
| Header | | | 75236 | 68002 | 72143 | 65164 | 35552 | 27021 | 14897 | 7308 | – | 35971 | 72509 | 75367 |
| HRSG #1 | | | 64436 | 57893 | 63175 | 58179 | 39443 | – | 48403 | 51943 | 55808 | 47719 | 62132 | 64436 |
| Total | | | 333728 | 291008 | 239077 | 147524 | 74995 | 27349 | 63300 | 59251 | 55808 | 88016 | 237735 | 239187 |

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TOTAL UNIT UTILIZATION BEFORE REQUIREMENT FOR ELECTRIC GENERATION – MWH

| Unit | Output to meet Steam and Hot Water Requirements – MWH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| HWB 4–6 | 166283 | 137624 | 78053 | 12438 | – | – | – | – | – | 1717 | 79126 | 74183 | |
| Header | 5020 | 14998 | – | – | 29383 | – | 21053 | 18634 | 20850 | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | 115592 | 106832 | 83791 | 57630 | – | 26218 | – | – | – | 29654 | 69292 | 89045 | |
| Header | 75236 | 68002 | 72143 | 65164 | 35552 | 27021 | 14897 | 7306 | – | 35971 | 72509 | 75367 | |
| HRSG #1 | 64436 | 57893 | 63175 | 58179 | 39443 | – | 48403 | 51943 | 55808 | 47719 | 62132 | 64436 | |
| Total | 426566 | 385348 | 297163 | 193411 | 104378 | 55239 | 84353 | 77885 | 76657 | 115062 | 283059 | 303031 | 2402153 |

ADDITIONAL REQUIREMENT FOR BACK PRESSURE STEAM TURBINES – MWH

| | Basis %g | Thermal output represented in electric generation – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 8a | 0.99 | 893 | 2668 | – | – | 5226 | – | 3745 | 3314 | 3709 | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 8 | 0.98 | 19077 | 17231 | 15369 | 10313 | – | 3988 | – | – | – | 4232 | 12568 | 16405 |
| Turb 6b | 0.99 | 26160 | 23645 | 25085 | 22659 | 12362 | 9396 | 5180 | 2541 | – | 12508 | 25212 | 26206 |
| Turb S3a | 0.99 | 20889 | 18753 | 20421 | 18665 | 11611 | – | 14942 | 16255 | 17785 | 14688 | 20131 | 20889 |
| Total | | 67019 | 62297 | 60875 | 51636 | 29200 | 13384 | 23866 | 22110 | 21494 | 31427 | 57911 | 63499 |

STEAM TO CONDENSING TURBINES AND REJECTION – MWH

| | Incremental thermal output represented in electric generation and rejection – MWHt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 17067 | 12442 | 20299 | 22361 | 33555 | 44820 | – | – | 54848 | 24334 | 18060 | 18402 |
| Turb S3c | 20165 | 18634 | 21893 | 25242 | 54435 | – | 42144 | 37292 | 28493 | 43062 | 19823 | 20165 |

UNIT UTILIZATION – TOTAL MWH

| Unit | | Unit Utilization MWH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | - | 40176 | 36288 | 40176 | 38880 | 38453 | 81238 | – | – | – | – | 38880 | 40176 | 354266 |
| HWB 4–6 | - | 166283 | 137624 | 78053 | 12438 | – | – | – | – | – | 1717 | 79126 | 74183 | 549424 |
| Boiler #8 | - | 84200 | 85467 | 77352 | 71324 | 77626 | – | 44874 | 32531 | 79406 | 72813 | 76901 | 79600 | 782293 |
| | - | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | - | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | - | 134669 | 124063 | 99160 | 67943 | – | 32206 | – | – | – | 33886 | 81860 | 105450 | 679236 |
| | - | – | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | - | 105489 | 95280 | 105489 | 102086 | 105489 | – | 105489 | 105489 | 102086 | 105489 | 102086 | 105489 | 1139959 |
| Total | | 530816 | 478721 | 400230 | 292671 | 221567 | 113444 | 150363 | 138020 | 181492 | 213904 | 378853 | 405097 | 3505179 |

INPUT ENERGY REQUIRED BEFORE EFFICIENCY ADJUSTMENT – BOILERS ONLY

| | BTU/kW | Energy Input before Efficiency Adjustment – MMBTU | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | 3.412 | 137081 | 123815 | 137081 | 132659 | 131200 | 277182 | – | – | – | – | 132659 | 137081 |
| HWB 4–6 | 3.412 | 567359 | 469572 | 266318 | 42439 | – | – | – | – | – | 5858 | 269979 | 253112 |
| Boiler #8 | 3.412 | 287289 | 291612 | 263924 | 243357 | 264859 | – | 153111 | 110997 | 270934 | 248437 | 262387 | 272277 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | 3.412 | 459489 | 423302 | 338334 | 231820 | – | 109888 | – | – | – | 115619 | 279305 | 359795 |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1451217 | 1308301 | 1005657 | 650275 | 396059 | 387070 | 153111 | 110997 | 270934 | 369913 | 944330 | 1022264 |

BOILER EFFICIENCIES

| | BASIS %1 | BASIS %2 | Efficiency | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | – | – | – | 84.8% | 84.8% |
| HWB 4–6 | – | – | 84.5% | 84.5% | 84.5% | 84.5% | – | – | – | – | – | 84.5% | 84.5% | 84.5% |
| Boiler #8 | – | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | – | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% | 84.8% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | – | – | 84.4% | 84.4% | 84.4% | 84.4% | – | 84.4% | – | – | – | 84.4% | 84.4% | 84.4% |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

INPUT ENERGY REQUIRED

| | Unit Energy Input MMBTU | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | – | 161747 | 146094 | 161747 | 156529 | 154808 | 327059 | – | – | – | – | 156529 | 161747 | 1426260 |
| HWB 4–6 | – | 671430 | 555706 | 315170 | 50224 | – | – | – | – | – | 6932 | 319502 | 299541 | 2218504 |
| Boiler #8 | – | 338984 | 344085 | 311415 | 287147 | 312518 | – | 180661 | 130970 | 319686 | 293140 | 309601 | 321271 | 3149480 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | – | 544418 | 501543 | 400870 | 274668 | – | 130199 | – | – | – | 136989 | 330931 | 426297 | 2745915 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 1716580 | 1547428 | 1189202 | 768568 | 467326 | 457258 | 180661 | 130970 | 319686 | 437062 | 1116563 | 1208856 | 9540160 |

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TPS Sofia - Case 3 - Alternate

# FUEL COST AND OTHER O&M EXPENSE – YEAR 2010

## FUEL COST – BOILERS (Gas)

| | Weighted $/MMBTU | WINTER Jan | Feb | Mar | SUMMER Apr | May | June | July | Aug | Sept | WINTER Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Natural Gas $(000) | | | | | | | | | | | | |
| Boiler #7 | $1.93 | 312 | 282 | 312 | 302 | 299 | 631 | – | – | – | – | 302 | 312 | 2751 |
| HWB 4–6 | $1.93 | 1295 | 1072 | 608 | 97 | – | – | – | – | – | 13 | 616 | 578 | 4278 |
| Boiler #8 | $1.93 | 654 | 664 | 601 | 554 | 603 | – | 348 | 253 | 617 | 565 | 597 | 620 | 6074 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | $1.93 | 1050 | 967 | 773 | 530 | – | 251 | – | – | – | 264 | 638 | 822 | 5295 |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 3310 | 2984 | 2293 | 1482 | 901 | 882 | 348 | 253 | 617 | 843 | 2153 | 2331 | 18398 |

## FUEL COST – BOILERS (Mazut)

| | Weighted $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Cost – Mazut $(000) | | | | | | | | | | | | |
| Boiler #7 | $0.12 | 19 | 18 | 19 | 19 | 19 | 39 | – | – | – | – | 19 | 19 | |
| HWB 4–6 | $0.12 | 81 | 67 | 38 | 6 | – | – | – | – | – | 1 | 38 | 36 | |
| Boiler #8 | $0.12 | 41 | 41 | 38 | 35 | 38 | – | 22 | 16 | 39 | 35 | 37 | 39 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | $0.12 | 66 | 60 | 48 | 33 | – | 16 | – | – | – | 17 | 40 | 51 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Total | | 207 | 186 | 143 | 93 | 56 | 55 | 22 | 16 | 39 | 53 | 135 | 146 | 1150 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HOT WATER SHORTFALL | MWH | – | – | – | – | – | – | – | – | 5363 | – | – | 0 | | |
| Assumed Equivalent Cost | $/MWH | $10.00 | | | | | | | | | | | | | |
| SUPPLEMENTAL HOT WATER COST – $(000) | | – | – | – | – | – | – | – | – | 53.6 | – | – | 0.0 | 53.6 | |

## Water and Other Variable O&M Expenses – Boilers $(000)

| | Basis $/MWHw | Basis $/MWH | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Variable O&M Expense $(000) | | | | | | | | | | | | |
| Boiler #7 | $0.03 | $0.75 | 36 | 33 | 36 | 35 | 38 | 80 | – | – | – | – | 35 | 36 | |
| HWB 4–6 | $0.03 | $0.75 | 129 | 107 | 60 | 10 | – | – | – | – | – | 1 | 61 | 57 | |
| Boiler #8 | $0.03 | $0.75 | 76 | 78 | 69 | 64 | 77 | – | 44 | 33 | 86 | 68 | 69 | 71 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | $0.03 | $0.75 | 138 | 126 | 100 | 70 | – | 35 | – | – | – | 36 | 81 | 107 | |
| | $0.03 | $0.75 | – | – | – | – | – | – | – | – | – | – | – | – | |
| HRSG #1 | $0.03 | $0.75 | 95 | 85 | 95 | 93 | 102 | – | 100 | 98 | 94 | 100 | 92 | 95 | |
| Total | | – | 473 | 429 | 360 | 272 | 217 | 115 | 144 | 131 | 180 | 205 | 337 | 366 | 3,229 |

## Limestone and Ash Removal Expenses – Boilers $(000)

| | Limestone $/MMBTU | Removal $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Limestone Injection & Ash Removal Expenses $(000) | | | | | | | | | | | | |
| Boiler #7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| HWB 4–6 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Boiler #8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Total | | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Removal Costs Only | | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| By–Product Sales $(000) | | | – | – | – | – | – | – | – | – | – | – | – | – | – |

## Emissions Penalties – Boilers $(000)

| | Emissions $/MMBTU | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions Penalties $(000) | | | | | | | | | | | | |
| Boiler #7 | 0.0008 | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | – | 0 | 0 | |
| HWB 4–6 | 0.0008 | 1 | 0 | 0 | 0 | – | – | – | – | – | 0 | 0 | 0 | |
| Boiler #8 | 0.0008 | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | 0 | 0 | 0 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Blr #9 | 0.0008 | 0 | 0 | 0 | 0 | – | 0 | – | – | – | 0 | 0 | 0 | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| HRSG #1 | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Total | | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 8 |

## Emissions by Type – Tons

| | Pounds per Tonne | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emissions – Tons | | | | | | | | | | | | |
| Particulate | 2205 | 10.7 | 9.7 | 7.4 | 4.8 | 2.9 | 2.9 | 1.1 | 0.8 | 2.0 | 2.7 | 7.0 | 7.6 | 59.7 |
| $SO_2$ | 2205 | 150.4 | 135.5 | 104.2 | 67.3 | 40.9 | 40.1 | 15.8 | 11.5 | 28.0 | 38.3 | 97.8 | 105.9 | 835.7 |
| NOx | 2205 | 122.8 | 110.7 | 85.1 | 55.0 | 33.4 | 32.7 | 12.9 | 9.4 | 22.9 | 31.3 | 79.9 | 86.5 | 682.5 |
| CO | 2205 | 13.2 | 11.9 | 9.1 | 5.9 | 3.6 | 3.5 | 1.4 | 1.0 | 2.5 | 3.4 | 8.6 | 9.3 | 73.3 |

TPS Sofia - Case 3 - Alternate

ELECTRIC GENERATION, NET POWER INTERCHANGE AND GAS TURBINE FUEL COST – YEAR 2010

| | WINTER | | | SUMMER | | | | | | WINTER | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | |
| Average KW Required | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 | 12311 |
| Station Use (Incl Above) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | 20215 | 19805 | 13831 | 11832 | 9421 | 4821 | 7047 | 8008 | 9092 | 10027 | 15907 | 18207 | 12311 |

BACK PRESSURE TURBINE/GENERATOR OUTPUT – AVERAGE KW

| BASIS UNITe | Back Pressure Turbine/Generator Output & Contract Purchase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 1183 | 3912 | – | – | 6923 | – | 4980 | 4390 | 5076 | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 8 | 25000 | 25000 | 20141 | 13965 | – | 5401 | – | – | – | 5545 | 17019 | 21498 |
| Turb 6b | 34852 | 34676 | 33228 | 31014 | 18689 | 12861 | 10870 | 9252 | – | 22848 | 34509 | 34713 |
| Turb S3a | 27655 | 27488 | 27036 | 25535 | 15372 | – | 19782 | 21520 | 24331 | 19445 | 27540 | 27655 |
| Total T/G Output | 88490 | 91076 | 80405 | 70514 | 40984 | 18261 | 35612 | 35163 | 29407 | 47839 | 79068 | 83865 |
| Balance Required | –68274 | –71271 | –68574 | –58682 | –31564 | –13440 | –28565 | –27155 | –20316 | –37812 | –63162 | –65658 |

CONDENSING TURBINE OUTPUT – AVERAGE KW

| | Generator Efficiency | Condensing Turbine Output – KW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 98.6% | 8080 | 6521 | 9610 | 10949 | 15885 | 21928 | – | – | 26831 | 15887 | 8835 | 8712 | 1.015 |
| Turb S3c | 98.5% | 8788 | 8992 | 9542 | 11368 | 23725 | – | 18368 | 16253 | 12832 | 18777 | 8928 | 8788 | 1.015 |
| Total Condens Turb Output | | 16868 | 15513 | 19152 | 22317 | 39610 | 21928 | 18368 | 16253 | 39663 | 34663 | 17762 | 17500 | |
| Balance Required | | –85143 | –86784 | –85725 | –80999 | –71173 | –35368 | –46933 | –43406 | –59979 | –72475 | –80924 | –83159 | |
| GT Capability @ Full Load | | 71785 | 71220 | 70317 | 68746 | 67428 | 66490 | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 | |

GAS TURBINE OUTPUT – AVERAGE KW

| | Gas Turbine Output – KW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| GT–6FA | 71785 | 71220 | 70317 | 68746 | 67428 | – | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 | 758450 |
| Total GT Output (KW) | 71785 | 71220 | 70317 | 68746 | 67428 | – | 65885 | 66050 | 67123 | 68609 | 70069 | 71220 | |
| Balance Required (KW) | –156927 | –158004 | –156043 | –149745 | –138599 | –35368 | –112818 | –109458 | –127102 | –141084 | –150993 | –154379 | |
| Hours in Period | 744 | 672 | 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 | 744 | |
| Balance Required (MWH) | –116754 | –106179 | –116096 | –107816 | –101396 | –25464 | –80954 | –77057 | –91514 | –97045 | –108715 | –114858 | |
| PURCHASED POWER | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | 75% | |
| Peak Demand KW | – | – | – | – | – | – | – | – | – | – | – | – | |
| Demand Charge – $/KW | – | – | – | – | – | – | – | – | – | – | – | – | |
| Energy Charge – Cents/KWH | 0.0289 | 0.0289 | 0.0289 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0233 | 0.0289 | 0.0289 | 0.0289 | |
| Demand Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – | |
| Energy Charge – $(000) | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total – $(000) | – | – | – | – | – | – | – | – | – | – | – | – | |
| POWER SALES | | | | | | | | | | | | | |
| Energy Credit – Cents/KWH | 0.0260 | 0.0260 | 0.0260 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0226 | 0.0260 | 0.0260 | 0.0260 | |
| Energy Credit $(000) | 3040.5 | 2765.1 | 3023.4 | 2433.4 | 2288.5 | 574.7 | 1827.1 | 1739.2 | 2065.5 | 2527.2 | 2831.2 | 2991.1 | 28106.9 |

GAS TURBINE
Percent Load

| | Percent Load | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | – | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Interpolated Fuel Flow – MMBTU

| | Fuel Flow – MMBTU | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| GT–6FA | 523297 | 469692 | 514768 | 489755 | 498892 | – | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 | 5481623 |
| Total | 523297 | 469692 | 514768 | 489755 | 498892 | – | 490502 | 491401 | 481204 | 505331 | 496765 | 520017 | |

Fuel Cost – Gas Turbine(s) (Gas) $(000)

| | Unit Cost | Fuel Cost – Gas $(000) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| GT–6FA | $2.03 | 1062.3 | 953.5 | 1045.0 | 994.2 | 1012.8 | – | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 | 11,128 |
| Total | | 1062.3 | 953.5 | 1045.0 | 994.2 | 1012.8 | – | 995.7 | 997.5 | 976.8 | 1025.8 | 1008.4 | 1055.6 | |

1032

TPS Sofia - Case 3 - Alternate

## ELECTRIC GENERATION, NET POWER INTERCHANGE AND GAS TURBINE FUEL COST – YEAR 2010

GAS TURBINE

Interpolated Exhaust Temperature °F

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | Exhaust Temperature °F | | | | | | | | | | | |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1086 | 1088 | 1091 | 1096 | 1101 | – | 1107 | 1106 | 1102 | 1097 | 1092 | 1088 |

Interpolated Exhaust Flow M#/Hr

| | Exhaust Flow M#/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 1576.8 | 1568.7 | 1555.6 | 1533.2 | 1514.4 | – | 1492.5 | 1494.8 | 1510.1 | 1531.2 | 1552.0 | 1568.7 |

Available Exhaust Heat MMBTU/Hr

| | Exhaust Heat MMBTU/Hr | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| GT–6FA | 363.199 | 362.091 | 360.293 | 357.329 | 354.841 | – | 351.879 | 352.200 | 354.284 | 357.072 | 359.795 | 362.091 |

Steam Available – MW per Hour (Without Supplementary Firing)

| | Enthalpy Rise | Total Steam Available without Supplementary Firing MW/Hr | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – | |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – | |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – | |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – | |
| | 3.412 | – | – | – | – | – | – | – | – | – | – | – | – | |
| HRSG #1 | 3.412 | 106.447 | 106.123 | 105.596 | 104.727 | 103.996 | – | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 | 1153.3 |
| | | 106.447 | 106.123 | 105.596 | 104.727 | 103.996 | – | 103.130 | 103.224 | 103.829 | 104.652 | 105.450 | 106.123 | |

Steam Supplied from Supplemental Firing – MW per Hour

| | Steam Supplied from Supplementary Firing – MW per Hour | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| HRSG #1 | 35.339 | 35.663 | 36.190 | 37.059 | 37.788 | – | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 | 406.3 |
| | 35.339 | 35.663 | 36.190 | 37.059 | 37.788 | – | 38.656 | 38.562 | 37.957 | 37.134 | 36.336 | 35.663 | |

Utilized HRSG Energy MW per Hr

| | HRSG Energy Utilized – MW/Hr | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | |
| HRSG #1 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 1559.6 |
| | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | |
| Electric Output Ratio | 33.6% | 33.4% | 33.2% | 32.7% | 32.2% | – | 31.7% | 31.8% | 32.1% | 32.6% | 33.1% | 33.4% | |
| Utilized Heat Ratio | 66.4% | 66.6% | 66.8% | 67.3% | 67.8% | – | 68.3% | 68.2% | 67.9% | 67.4% | 66.9% | 66.6% | |

Steam Rejection – Avg MW (To Cooling Tower)

| | Maximum Capacity | Steam Rejection – Average MW | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Condensing | 200.000 | 32.9 | 30.5 | 37.3 | 43.5 | 78.1 | 40.0 | 38.0 | 33.6 | 75.5 | 67.8 | 34.6 | 34.1 |
| From Gas Turbines | 200.000 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total | | 32.9 | 30.5 | 37.3 | 43.5 | 78.1 | 40.0 | 38.0 | 33.6 | 75.5 | 67.8 | 34.6 | 34.1 |

Supplementary Firing Energy Input = MMBTU

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | | 89708 | 81771 | 91870 | 91040 | 95926 | – | 98130 | 97891 | 93247 | 94266 | 89265 | 90532 |

Supplementary Firing Fuel Cost (Gas)

| | Unit Cost $/MMBTU | Supplementary Firing Fuel Cost $(000) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| HRSG #1 | 2.03 | 182 | 166 | 186 | 185 | 195 | – | 199 | 199 | 189 | 191 | 181 | 184 | 2057.70 |
| Total | | 182 | 166 | 186 | 185 | 195 | – | 199 | 199 | 189 | 191 | 181 | 184 | |

TPS Sofia - Case 3 - Alternate

SUPPLEMENTARY DATA – YEAR 2010

Average MW utilized before Incremental MWe and Rejection – Cogen Units Only

| | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6a | 7.9 | 26.3 | – | – | 46.5 | – | 33.3 | 29.5 | 34.1 | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6 | 181.0 | 184.6 | 133.3 | 94.4 | – | 44.7 | – | – | – | 45.5 | 113.7 | 141.7 |
| Turb 6b | 136.3 | 136.4 | 130.7 | 122.0 | 73.5 | 50.6 | 42.8 | 36.4 | – | 89.9 | 135.7 | 138.5 |
| Turb S3a | 114.7 | 114.1 | 112.4 | 106.7 | 68.6 | – | 85.1 | 91.7 | 102.2 | 83.9 | 114.3 | 114.7 |

Maximum Steam Flow – MW

| | BASIS KWt | Total Boiler MW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 50000 | – | 167.2 | 181.2 | 158.0 | 153.1 | 156.0 | 112.8 | 31.2 | 28.6 | 110.3 | 135.0 | 160.8 | 161.3 |
| Turb S3c | 36590 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | – | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 | 141.8 |

Establish Cogen Unit Incremental MW (to Condensing Turbine & Cooling Tower)

| | Steam to Condensing Turbine – Average MW (Maximum Steam less Steam Utilized for Process and Hot Water) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6c | 22.9 | 18.5 | 27.3 | 31.1 | 45.1 | 62.3 | – | – | 76.2 | 45.1 | 25.1 | 24.7 |
| Turb S3c | 27.1 | 27.7 | 29.4 | 35.1 | 73.2 | – | 56.6 | 50.1 | 39.6 | 57.9 | 27.5 | 27.1 |
| | 50.0 | 46.2 | 56.7 | 66.1 | 118.3 | 62.3 | 56.6 | 50.1 | 115.8 | 103.0 | 52.6 | 51.8 |

Maximum Hours Use

| | | Maximum Hours Use | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | 744 | 672 | 645 | 265 | – | – | – | – | – | 37 | 694 | 744 |
| Turb 6a | | 744 | 672 | – | – | 744 | – | 744 | 744 | 720 | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6 | | 744 | 672 | 744 | 720 | – | 720 | – | – | – | 744 | 720 | 744 |
| Turb 6b | | 744 | 672 | 744 | 720 | 652 | 720 | 470 | 271 | – | 539 | 720 | 744 |
| Turb S3a | | 744 | 672 | 744 | 720 | 744 | – | 744 | 744 | 720 | 744 | 720 | 744 |

Average Load – MW

| | | Average Load – MWt | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | 223.5 | 204.8 | 120.9 | 47.0 | – | – | – | – | – | 46.3 | 114.0 | 99.7 |
| Turb 6a | | 6.7 | 22.3 | – | – | 39.5 | – | 28.3 | 25.0 | 29.0 | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6 | | 155.4 | 159.0 | 112.6 | 80.0 | – | 39.2 | – | – | – | 39.9 | 96.2 | 119.7 |
| Turb 6b | | 101.1 | 101.2 | 97.0 | 90.5 | 54.5 | 37.5 | 31.7 | 27.0 | – | 66.7 | 100.7 | 101.3 |
| Turb S3a | | 86.6 | 86.1 | 84.9 | 80.8 | 53.0 | – | 65.1 | 69.8 | 77.5 | 64.1 | 86.3 | 86.6 |

Average Load – Mlb/Hr

| | BASIS MBTU/lb | Average Load – Thousand Pounds per Hour | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 1.1218 | 20.5 | 67.9 | – | – | 120.1 | – | 86.1 | 76.2 | 88.1 | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | 0.9790 | 541.5 | 554.1 | 392.5 | 279.0 | – | 136.6 | – | – | – | 138.9 | 335.4 | 417.1 |
| | 0.9801 | 352.0 | 352.3 | 337.6 | 315.1 | 189.9 | 130.7 | 110.4 | 94.0 | – | 232.1 | 350.6 | 352.7 |
| | 0.9686 | 305.1 | 303.5 | 299.1 | 284.6 | 186.8 | – | 229.2 | 245.9 | 273.0 | 225.9 | 304.0 | 305.1 |

Average Load – %

| | | Average Load – Percent of Rated Capacity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boiler #7 | | – | – | – | – | – | – | – | – | – | – | – | – |
| HWB 4–6 | | 64.2% | 58.8% | 34.7% | 13.5% | – | – | – | – | – | 13.3% | 32.8% | 28.7% |
| Turb 6a | | 4.0% | 13.4% | – | – | 23.7% | – | 17.0% | 15.0% | 17.4% | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Turb 6 | | 77.7% | 79.5% | 56.3% | 40.0% | – | 19.6% | – | – | – | 19.9% | 48.1% | 59.8% |
| Turb 6b | | 99.8% | 99.9% | 95.7% | 89.3% | 53.8% | 37.0% | 31.3% | 26.7% | – | 65.8% | 99.4% | 100.0% |
| Turb S3a | | 100.0% | 99.5% | 98.0% | 93.3% | 61.2% | – | 75.1% | 80.6% | 89.5% | 74.1% | 99.6% | 100.0% |

TPS Sofia - Case 3 - Alternate

SUPPLEMENTARY DATA – YEAR 2010

| | | WINTER | | | SUMMER | | | | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Steam Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| Boiler #7 | | 4.0% | 12.3% | – | – | 25.3% | – | 46.9% | 58.6% | 26.3% | – | – | – |
| HWB 4–6 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Boiler #8 | | 4.0% | 12.3% | – | – | 25.3% | – | 46.9% | 58.6% | 26.3% | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | 65.2% | 64.0% | 58.6% | 67.5% | – | 86.6% | – | – | – | 79.8% | 55.4% | 60.5% |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 GT | – | – | – | – | – | – | – | – | – | – | – | – |
| Cost of Steam Supply | | | | | | | | | | | | | |
| Gas | | 724 | 735 | 453 | 358 | 228 | 217 | 163 | 148 | 162 | 211 | 353 | 498 | 4,250 |
| Oil | | 45 | 46 | 28 | 22 | 14 | 14 | 10 | 9 | 10 | 13 | 22 | 31 | 266 |
| Lignite | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | 95 | 95 | 59 | 48 | 29 | 30 | 21 | 19 | 23 | 29 | 45 | 65 | 557 |
| Total | | 863 | 876 | 540 | 428 | 272 | 261 | 194 | 177 | 195 | 253 | 421 | 594 | 5,072 |
| **Hot Water Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| Boiler #7 | | 60.5% | 55.9% | 61.4% | 59.1% | 30.6% | 33.3% | 33.2% | 23.0% | – | 49.4% | 62.6% | 62.6% |
| HWB 4–6 | | 100.0% | 100.0% | 100.0% | 100.0% | – | – | – | – | – | 100.0% | 100.0% | 100.0% |
| Boiler #8 | | 60.5% | 55.9% | 61.4% | 59.1% | 30.6% | 33.3% | 33.2% | 23.0% | – | 49.4% | 62.6% | 62.6% |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | 20.6% | 22.2% | 25.9% | 17.3% | – | 1.0% | – | – | – | 7.7% | 29.3% | 23.9% |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 GT | 61.1% | 60.8% | 59.9% | 57.0% | 37.4% | – | 45.9% | 49.2% | 54.7% | 45.2% | 60.9% | 61.1% |
| Cost of Hot Water Supply | | | | | | | | | | | | | |
| Gas | | 2856 | 2494 | 2106 | 1366 | 728 | 212 | 664 | 647 | 637 | 864 | 2090 | 2116 | 16,780 |
| Oil | | 131 | 113 | 85 | 43 | 17 | 13 | 7 | 4 | – | 20 | 85 | 85 | 604 |
| Lignite | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | 283 | 249 | 208 | 134 | 74 | 27 | 60 | 56 | 51 | 83 | 206 | 208 | 1,640 |
| Total | | 3,270 | 2,857 | 2,400 | 1,543 | 818 | 253 | 732 | 707 | 689 | 966 | 2,381 | 2,410 | 19,025 |
| **Electric Supply – Percent of Output and Total Cost** | | | | | | | | | | | | | |
| | | Percent of Total Output | | | | | | | | | | | |
| Boiler #7 | | 35.5% | 31.8% | 38.6% | 40.9% | 44.1% | 66.7% | 19.9% | 18.4% | 73.7% | 50.6% | 37.4% | 37.2% |
| HWB 4–6 | | – | – | – | – | – | – | – | – | – | – | – | – |
| Boiler #8 | | 35.5% | 31.8% | 38.6% | 40.9% | 44.1% | 66.7% | 19.9% | 18.4% | 73.7% | 50.6% | 37.4% | 37.2% |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| Blr #9 | | 14.2% | 13.9% | 15.5% | 15.2% | – | 12.4% | – | – | – | 12.5% | 15.4% | 15.6% |
| | | – | – | – | – | – | – | – | – | – | – | – | – |
| HRSG #1 | 1 GT | 38.9% | 39.2% | 40.1% | 43.0% | 62.6% | – | 54.1% | 50.8% | 45.3% | 54.8% | 39.1% | 38.9% |
| Cost of Electric Supply | | | | | | | | | | | | | |
| Gas | | 976 | 875 | 966 | 937 | 1153 | 452 | 716 | 654 | 983 | 986 | 900 | 957 | 10,553 |
| Oil | | 31 | 27 | 30 | 27 | 25 | 26 | 4 | 3 | 26 | 20 | 27 | 30 | 280 |
| Lignite | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Coal | | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Other Exp | | 96 | 87 | 94 | 91 | 115 | 58 | 63 | 56 | 106 | 94 | 87 | 93 | 1,040 |
| Total | | 1,102 | 988 | 1,090 | 1,055 | 1,293 | 538 | 783 | 713 | 1,116 | 1,099 | 1,014 | 1,080 | 11,873 |

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**SECTION 9**

**Investment Program and Financial Strategy**

Vol. 10

FEB - 2 1995

# Bulgarian District Heating System Feasibility Study

0297

*Gilbert/Commonwealth International, Inc.*

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# 9.0 INVESTMENT PROGRAM AND FINANCIAL STRATEGY

## 9.1 INTRODUCTION

At the current time, the Country of Bulgaria is experiencing the transition from a socialized form of Government, to that of what could be called a quasi-capitalistic society based on democratic principles. Previously all planning was done on a centralized basis with investment funds provided by Government.

For the situation facing the Municipal District Heating Systems of Sofia and Pernik, the government no longer has the resources to adequately supply all sectors of the economy with funds for refurbishment, renewal, or new facilities. It is now a case of each sector competing for funds from a variety of sources.

During the conduct of this assignment, many discussions were held with representatives of the District Heating organizations, and with the Committee of Energy about the funding sources available. Basically, the District Heating Companies prepare a budget, which is submitted to the Municipality, and then the Municipality request subsidies from the Government for the expected shortfall in revenues.

At the current time, resources are limited for use in actually providing for the much needed capital to build new facilities, or in fact, provide funds for required capital funds for maintenance. Indications are that the expected shortfall for the upcoming year is well beyond the available funds that Government is willing to provide.

Under these conditions there are limited options that the District Heating Companies can pursue for the betterment of the Systems. However, given the need for the Heating Systems to provide for the citizens of Sofia and Pernik, investment programs has been proposed around the technical requirements of the system in the long-run.



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### 9.1.1 GOALS AND OBJECTIVES

The economic analysis presented herein has identified the least-cost program for the next 15 years for each of the four districts in Sofia and for Pernik. This program has assumed a level of demand and the technical assets required to meet that demand. It consists of a combination of existing and new facilities. The question now facing the Management of the District Heating Companies and Government is how to secure the funding, both for capital expenditures and operating costs over the period in question?

The investment program proposed is highly dependent on the ownership options pursued by the Authorities in charge. At this point in the transition period facing the Country of Bulgaria, three primary ownership options are currently available for the District Heating Companies. These ownership options include the following: (1) Continued Municipal ownership and operation; (2) a move toward private ownership by either the citizens of the municipality or private investors from either within the country or from others outside Bulgaria; or (3) project ownership requiring project financing for all or parts of the least-cost program.

During subsequent discussions presented in this section, each ownership option will be discussed in detail. The positive and negative aspects of each will be presented and a final recommendation made after the financial analysis is conducted.

As presented herein, the several financing options available to the District Heating Companies must be evaluated separately in order to provide clear-cut direction to the organizations involved. Based on the economic evaluation conducted previously the program(s) determined to provide the least-cost alternative for each District has been identified and discussed in detail in the Economic analysis Section. This program must now be presented under the selected financing scheme described above. The actual benefit to the consumers, the Municipalities, and possible ownership structures are presented in subsequent Sections.

In order to present the findings of the financial analysis, a computer model was developed to present the results of the analysis for each of the districts under evaluation. At the request of the European Development Bank, Sofia District Heating Company was split into the four main areas of the City and treated as a separate entity for the purposes of this evaluation.

### 9.1.2 SCOPE OF WORK & LIMITATIONS

After review of the ownership options available to the District Heating Companies, a financial analysis was carried out to show the impact on revenues to each of the districts in Sofia and for Pernik. The analysis was conducted using the information developed in the Technical and Economic Sections of the Report. A number of alternatives were developed for each district in the technical section, and evaluated as part of the economic analysis. A least-cost solution was selected from the alternatives evaluated in the economic section, and this program was then evaluated as part of the financial analysis.

As previously stated, a computerized financial model was developed specifically for this project to ensure that each district would be evaluated on the same basis.



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Capital costs were determined as part of the technical structuring of the alternatives capable of meeting the demands on the systems. Likewise, operating costs were determined using a model which synthesized the operations of each system. In this manner, fuel and O&M costs were developed which would meet the hourly demands of the system on a minimum cost basis.

The capital and operating costs were then transferred to the financial model and an investment program structured to pay for all new capital expenditures and to determine the amount of revenue requirements that are faced by each of the Systems over the study period. Inflation and exchange rate deterioration were factored into the analysis in order to present the results in current Leva amounts. The question to be answered by the results of the financial analysis is whether the District Heating companies can in fact afford to proceed with the least-cost development program structured from the technical and economic analysis.

### 9.1.3 ORGANIZATION OF SECTION

The Financial and Investment Program Section includes a discussion on the ownership options currently considered available to the District Heating Companies; a brief discussion on the organizational aspects of the Companies as it relates to the ownership option selected; a discussion on the input data required for the analysis; a description of the computer model developed for this analysis; the results of the analysis; and the conclusions and recommendations.

In addition, since the financial analysis and investment programs are structured around the four systems which comprise Sofia (TPS Sofia, Liulin, Trajco Kostov, and Zemliane) and Pernik, separate discussions on each will be presented in this Section.

### 9.1.4 ASSUMPTIONS

During the conduct of the financial analysis, a number of assumptions had to be made regarding the data utilized and the structure of the analysis itself. Inherent in the analysis is the primary assumption that capital funds will be available for the replacement, enhancement, or addition of new facilities for each of the systems. Also, the analyze was presented in current Leva which requires estimates on inflation for both the world economy and specifically for Bulgaria. All amounts shown in the evaluation are in Leva requiring conversion of U.S. dollars to Leva based on an estimate of the exchange rate each year of the analysis.

Following is a brief description of each of the assumptions utilized during the conduct of the financial analysis:

1. **Study Period** - The evaluation period was from 1994 through the year 2010.

2. **Inflation Rates** - A separate estimate was made for both foreign and domestic inflation. The foreign estimate was derived from recent World Bank projections regarding inflation in the developed countries, while the domestic inflation was estimated from discussions with Bulgarian experts. It is believed that the domestic inflation figures are somewhat optimistic based on the current trends, but the intent is in using the inflation figures to derive reasonable expectations in the revenue requirements of the systems and to



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indicate the level of revenues that must be generated by the systems to cover all expenses.

3. **Ownership Structure** - The ownership structure utilized for the financial analysis was assumed to be that of municipal ownership. Further discussion on that selection will be presented later.

4. **Interest rates** - For all foreign loans, the interest rate was assumed to be 8%. Domestic loans were assumed to be 40% throughout the study period.

5. **Terms and duration of Loans** - All foreign loans were assumed to be for 20 years with a five year grace period beginning with the initiation of the loan. That is, the principal payments will commence five years after the loan is originated unless otherwise noted. Domestic loans were assumed to be for five years, with principal payments beginning the year after origination.

6. **Depreciation on Assets** - As of 1993, the District Heating Company of Sofia had Assets valued at about 4.2 billion Leva. Since each of the districts was analyzed separately, that total was allocated on a percentage basis based on the 1992 balance for each of the areas. Pernik was assumed to have depreciable assets of about 867 million Leva as shown on the budgeted balance sheet for 1993. These assets were then added to the new facilities and depreciated at 5% unless a greater amount was needed to repay loans outstanding.

7. **Taxes** - Since the municipalities are in effect a private enterprise from the Governments standpoint, they are subject to taxes at a 42% rate on income derived from the sale of hot water, steam, and electricity.

8. **Revenue Requirements** - Based on the expenses and loans outstanding for each of the systems under evaluation, a revenue amount is calculated to cover all cash requirements of the system. The split between hot water and steam was done on the basis of energy content.

9. All amounts shown on the Exhibits are in thousands of Leva.

## 9.2 DISCUSSION OF INPUT DATA

### 9.2.1 INTRODUCTION

As a result of the technical and economic analysis conducted for the District Heating Companies of Sofia and Pernik, a program for upgrading the existing system was judged to provide the least cost alternative for supplying the heating needs of the consumers in those cities in the foreseeable future. This was considered to be the minimum program given the current financial condition of the companies.

Given the institutional, managerial, and technical constraints existing in Bulgaria at the present time, the proposed investment program focuses on the continued municipal ownership of the District Heating entities. Until and when free market



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conditions are commonplace in Bulgaria; when direct subsidies are replaced with prevailing market pricing for basic commodities; when regulatory and institutional guidelines are in place for the active participation of private venture entities; then the financial alternatives will become available for future investment opportunities.

In the following Sections of this Report, discussions are presented on the details of the financial analysis and the investment program structured to upgrade the existing systems. Overriding the technical need for replacement of antiquated plant and equipment was the realization that the financial conditions facing the two companies are of such a nature to preclude investments beyond a certain level at this point in the changeover in the political arena.

As part of the analysis presented herein, the District Heating Company of Sofia was split into the four Districts of Sofia, Liulin, Zemliane, and Trajco Kostov. The District Heating Company of Pernik was treated as a single entity for financial purposes. One of the reasons for splitting the Sofia District Heating Company into the four areas was to provide financial entities with a specific package of investment that would not be lost within the greater scope of the entire company. In this manner, specific fundable programs are identified for the ease of the financial institutions.

### 9.2.2 General Data Development

Key to the structuring of any investment program is the assumed criteria to be used in the analysis and the development of that information as it impacts the analysis itself. The factors that will influence decisions on the level of investments include: (1) estimates of inflation rates for both foreign and local inputs; (2) foreign exchange levels throughout the analysis; (3) operating expenses; and (4) the revenue required to support the investment program.

All of the items listed are subject to change over time from that presented herein. That said, it behooves the analyst to present the best estimate at the current time given the conditions known and the possibility of minimizing the chance that change will affect the outcome of the analysis.

#### 9.2.2.1 Inflation Rates

For the purpose of this analysis, both foreign and domestic inflation rates have been estimated in order to present the results of the analysis in current Leva. In the economic analysis only real growth in the systems was treated as cost changes in the analysis. In the financial analysis, inflation is introduced for the various commodities associated with both capital and operating costs, primarily through the use of the exchange rate deterioration of the Leva to the U.S. dollar.

The differential in inflation rates between domestic and foreign inflation is used to calculate a current exchange rate for the Leva. Since capital and operating costs have been estimated in U.S. dollars, foreign inflation is applied to each estimate and then the current exchange rate is used to present the results in current Leva. Exhibit 9-1 under the specific District provides the details of those calculations.

The World Bank projections of foreign inflation serve as the basis for foreign inflation. Domestic inflation has been estimated based on the current situation in



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Bulgaria, with a general decline in subsequent years as the economy makes the changeover to market based economic decisions. If domestic inflation is not brought under control, the estimated revenue requirements from the sale of steam, hot water, and electricity will necessarily be greater by the amount of the difference in inflation rates.

#### 9.2.2.2 Capital Cost Estimates

Under the Baseline scenario, minimum expenditures are projected in order to keep the systems operating throughout the study horizon. The details of those criteria are presented in the technical portion of this Report.

The annual capital expenditures have been estimated in constant 1993 U.S. dollars for each year of the study. These constant dollars are then converted to current Leva via the mechanism described in the previous Section.

#### 9.2.2.3 Operating Expenses

For each of the Districts under review (Pernik and the four systems in Sofia) operating expenses have been estimated through the use of a computerized production model designed to meet the needs of the systems in the least cost possible. Those costs were estimated in constant U.S. dollars and then converted to current Leva as described above.

For those systems which produce electricity for the national grid, the sale of that electricity is treated as an operating revenue for the system. The cost to produce that electricity is included in the various expenses presented in the analysis. In the first Exhibit under each of the individual Districts, the capital and operating expenses are presented in their various forms for review.

## 9.3 DESCRIPTION OF MODEL

The financial model developed for the evaluation of investment programs for each of the five systems is done in Lotus 1.2.3 Version 3.1, and is comprised of six separate areas or spreadsheets interconnected to each other. The six spreadsheets are as follows:

1. **General Data Development** - In this area, beginning at the top, the inflation estimates are presented for both foreign and domestic price increases. As shown for each of the five systems, these inflation figures are common to the analysis. Following the presentation of inflation estimates is a section whereby the inflation figures are compounded in order to develop a foreign exchange ratio which is used to develop the exchange rate between the Leva and the U.S. dollar. To determine the current exchange rate utilized in the analysis, the base exchange rate of 32 Leva/ dollar is multiplied times the Forex ratio to give the current years exchange rate.

   Since the capital cost estimates were made in constant 1993 dollars, the next portion of the spreadsheet converts the foreign capital costs from 1993 dollars to current year estimates in Leva by first escalating the expenditure by the compounded figure for foreign inflation and then multiplying times the current year exchange rate. For domestic expenditures, the dollar estimate



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was converted to 1993 Leva by multiplying the dollar amount by 32 Leva. The resulting amount was then multiplied by the compounded domestic figure for inflation. Operating expenses were likewise first estimated in 1993 U.S. dollars, and converted to current Leva by multiplying the 1993 amount by the foreign inflation figure and then multiplying the resulting figure by the estimated exchange rate.

The resulting figures for capital expenditures are then transferred to the next spreadsheet which is used in developing the investment program for the system. The operating costs are transferred directly to the Income Statement which is another separate spreadsheet.

2. **Projected Investment Program** - The next spreadsheet is utilized to develop a specific investment program for each of the systems. The capital expenditures are presented at the top of the spreadsheet for both foreign and domestic expenditures. For each system an investment program is structured independently based on the level of expenditures and the timing of the expenditures. The next section of the spreadsheet shows the series of loans structured to meet the foreign capital requirement. Provisions were made in the model to allow for four series of loans over the study period for foreign expenditures. At the bottom of the top section of the spreadsheet is the estimated amount for all local or domestic capital requirements.

   Underneath the Projected Investment Program section is a section which shows the capitalization schedule and the application of funds. Inherent is this spreadsheet is the fact that interest is capitalized during the first year of investment, and is added to the amount of the loan. Likewise, a commitment fee for the foreign component is added in the event that the loan is longer than a year.

   The top portion of the lower section shows the available capital funding for both foreign and domestic loans. The next section shows the utilization of the proceeds, followed by the calculated amount for interest. When a project takes longer than a year, it is considered to be construction work in progress, and is not closed to the plant accounts until it becomes commercial.

   The annual amounts for both foreign and domestic loans are transferred to the next spreadsheet, while the amount closed to plant is used in calculating depreciation expenses and is likewise transferred to the Balance Sheet.

3. **Debt Service Schedule** - The next spreadsheet provides the details on each loan shown in the previous spreadsheet. At the top of the spreadsheet are the balances and interest and principal payments made for each foreign loan. Under the foreign loan calculations are those of the domestic loans. Each loan is considered to be of equal payments for the length of the loan. At the bottom of the spreadsheet is a summary of all loans outstanding. The interest amount shown is transferred to the Income Statement, while the principal payments are shown in the Cash Flow Statement.

4. **Income Statement** - All items on the Income Statement are transferred from previous spreadsheets except for the revenue calculations and the provision for taxes. Revenues are set to cover all operating expenses, debt service



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and taxes, and still provide the system with minimum amounts of cash flow at the end of the year. As described previously, the split in revenues between hot water and steam is based on energy content.

5. **Analysis of Cash and Cash Balances** - In this spreadsheet, the adjusted net income from the Income Statement is transferred over, and all uses of funds are accounted for. Principal payments are transferred from the Debt Service Schedule along with the cash receipts from financing. Capital expenditures are transferred in from the Investment program. Separate calculations are made for the change in working capital. Maintenance spares are estimated at 2% of the maintenance expense shown on the Income Statement, while Accounts Receivable are based on 6% of the previous years revenue amounts. Accounts payable are estimated at 6% of the fixed and variable O&M amounts. The change in working capital is calculated each year and included in the Cash Flow Statement. The ending cash balances are then transferred to the Balance Sheet.

6. **Balance Sheet** - The final spreadsheet is completely filled in from previous spreadsheets and is presented as a balancing spreadsheet to ensure that all items are accounted for in the financial structure. The only item to note is the amount of Paid in Capital which is the amount of assets carried forward from previous years. That amount is likewise included in the Plant in Service amounts under the Asset portion of the Balance Sheet.

## 9.4 ANALYSIS AND RESULTS

### 9.4.1 INFRASTRUCTURE ANALYSIS

Following is a discussion on the various aspects of the organizational framework in Bulgaria which influences actions conducted by the District Heating Companies.

#### 9.4.1.1 Regulatory Requirements

There is a limited amount of regulatory oversight apparent in Bulgaria. Much of the power over the Municipal Heating Systems lies with the Committee of Energy and the Cabinet of the Government of Bulgaria through the setting of prices that the Systems can charge to the consumers. This has led to a continuing shortfall in the revenues to allow the Heating Systems to adequately maintain and improve their facilities.

In 1992, by Cabinet decree, the long-term debts of the Sofia and Pernik District Heating Systems were remitted. While this resulted in an obviously stronger balance sheet, this is but a symptom of the financial problems facing the country as a whole. Short-term loans are being used to purchase fuels and provide for maintenance to the System. Bad debts are on the rise as consumers are unable to pay for the services provided. The lack of legislation over sanctions for bad debts is likewise a major concern of the management of the District Heating Companies.

The financial program selected for the continuous development of the Systems will be monitored by the financial institutions providing the funds, and they will insist on major oversight authority of the Committee of Energy and the Cabinet in future years. However, those organizations must respond with appropriate guidelines,



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and if necessary, new legislation to insure adequate financial resources independent of the Government. The financial plan should be approved at the highest level of regulatory authority.

Consideration might be given to the establishment of a regulatory body at the municipal level to provide the guidelines for pricing and policy matters. Adequate review of operations and financial status at the local level would provide management with the required guidance during the anticipated reform period as subsidies are removed.

#### 9.4.1.2 Budgetary Constraints

As previously mentioned, the current budget requirements of the District Heating Systems are woefully inadequate to meet the capital and operating needs of the Systems. Revenue projections are about one-third of the needs anticipated for the heating season in 1993-94. Unless a program designed to meet the financial requirements of the systems is approved, then further deterioration in facilities and manpower will lead to the complete collapse of the heating companies.

Short-term borrowings are now used for both fuel and maintenance. This should be eliminated as quickly as possible, with borrowings only used for replacement equipment. In this manner, the assets can be used as collateral for local expenditures of a capital nature. The budget should recognize the cost of production at the District Heating Companies, and the revenue budget reflective of that cost. When revenues fall far short of just the production costs, major effort has to be placed on conservation and adequate rate relief or the organization and, ultimately, the consumers suffer.

Starting in heating season 1994-95, a concise budgetary process should be implemented for both Sofia and Pernik District Heating Companies. The need for such a program would be beneficial in securing much needed capital funds for the proposed least-cost program. Otherwise, no financial institution would be willing to provide funding for the program.

Given the current budgetary constraints imposed on the Systems by Government, it is not likely that any program will be able to be implemented. Therefore, it is critical to get adequate Government assurances that they will raise tariffs to a level to support the program over the period of the financial plan. This also assumes that Government is willing to bear the risk of any devaluation of the Leva. Immediate discussions should be held with Cabinet by the Committee of Energy and the management of the District Heating Companies to get rate relief as soon as practical.

#### 9.4.1.3 Environmental Standards

As documented in many official circles, the need for Bulgaria to impose stricter environmental regulations on the utilization of its energy forms is likewise a matter of priority. The lack of adequate funds to accomplish both the clean-up of the older plants and the need to modernize cannot realistically be done all at once. Therefore, as part of the least-cost program, the imposition of stricter environmental standards is part of the program. Funds are available from various development organizations for cleaning up the environment. One example is the



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Global Environmental Fund set up by the World Bank. Funds from that source and others should be pursued to assist in the modernization of the heating systems.

The standards to be applied during the implementation of the proposed program are documented in the technical sections of this Report. The phased in implementation of the environmental standards will force the major polluters to recognize that this too is a cost of doing business.

### 9.4.2 ORGANIZATIONAL REVIEW

A cursory review of the organizational structure currently in place in Bulgaria which impacts the operations of the District Heating Companies was conducted as part of the overall effort to determine the least-cost development program. As with any Government controlled business, there is an element of politics involved which has the potential to either promote or hinder the efficiency of the organization. Following are brief discussions on the various elements affecting the operations of the organizations.

#### 9.4.2.1 Government Interface

The management of the District Heating Companies report to the Municipality in which they provide services. The elected officials of the Municipality have the immediate authority over the operations and financial well being of the Systems. Providing additional authority over the District Heating Companies is the Committee of Energy which oversees the supply of energy in Bulgaria. This Committee is responsible for setting the prices that each organization pays for its energy and the prices that are charged by local distribution companies for all forms of energy. It is also understood that Cabinet has a role in the setting of prices for the District Heating Companies. This would appear to be too much oversight by the authorities in regards to pricing.

The changeover from Government interference in all aspects of operations for District Heating Companies, to one of limited oversight appears to be proceeding, albeit at a relatively slow rate. Undoing fifty years of Communist control is not a simple process. The willingness of the Government to set policy and pass legislation, and then let local authorities and industry proceed, will take more than the several years since the breakdown of the previous system of government.

#### 9.4.2.2 Management Responsibilities

As with any organization, the Sofia and Pernik District Heating Companies are only as good as the people who are charged with managing the assets, the personnel, and insuring the financial well-being of the company. Given that the current organization is a municipal owned business designed to provide the citizens with a basic need (heat), it is apparent that they are fulfilling that need for the majority of citizens connected to the district heating system. There is a concern over the ability of any management team to continue fulfilling that need with antiquated facilities in dire need of repair, and the need to replace equipment and plant with new, more efficient plant. The current financial situation has forced management to forego much needed repairs to the detriment of the system for the long-run.

With the management forced to buy fuel and materials at "free-market" prices, while adhering to the desires of Government for fixed prices on the commodities they sell, the district heating companies have operated at a loss for the last several years. Management and Government must learn to operate the systems in a manner more consistent with the principles of a free market economy. This is not to say that subsidies must be eliminated for those that are truly in need of assistance due to the income levels prevailing in Bulgaria today. Heat is a basic need of the citizens, and it is the responsibility of Government and Management to provide all citizens with this commodity.

With that as the overall goal of the district heating systems, it is then up to management to prepare a detailed program designed to provide heat to those that need it at the lowest cost, safely, and in the most efficient manner possible. Once the program has been approved, then it is up to Management and Government to assure that the financial means are available to meet that goal. The establishment of adequate tariffs, designed to recover the actual cost of service is elementary to the success of the program. Where subsidies are required, at the consumer level, the Government must prioritize its expenditures to meet that need.

The technical program presented herein, and the financial program designed around that program, are but a first step in identifying the ultimate management structure for the balance of the decade and beyond. Increased emphasis must be placed on the financial management and administration of the district heating organizations.

#### 9.4.2.3 Need For Training

In the functional area of finance, depending on the future ownership options, there should be added emphasis on plant accounting, billing, and tariff and tax administration. To some degree this weakness is probably due to the previous reporting requirements under the central planning aspects of the Government itself. As more sophistication in business is developed, along the lines of private companies, even if ownership remains in the hands of the Municipalities, these areas of the business will have to be improved.

Much will depend on new legislation forthcoming from the Government of Bulgaria. As tax laws are promulgated, the finance and accounting functions will have to improve to provide management with the appropriate information to succeed in today's business environment. While some of this information is available in books, western philosophies regarding finance will prevail as long as capital funds are secured from western financial institutions. Loan convenience will dictate the type of information to be developed in order to satisfy conditions imposed by the lending agencies.

The training needs and computer assisted programs available to assist in the development of a first class business organization should be implemented as soon as possible. Selected individuals within the organization should be identified to pursue the training programs recommended as part of this assignment. Fortunately, with guidance from many in the western communities, the training can be implemented in a relatively short period of time, at a reasonable cost.



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### 9.4.3 OWNERSHIP OPTIONS

In the following sections, discussions are provided on the ownership options considered for the operation of the District Heating Systems under review. The three options considered viable under the current and proposed investment program to modernize the systems are believed to be limited in their scope when one considers the current financial situation facing the systems.

#### 9.4.3.1 Municipal Ownership

The continued municipal ownership of the District Heating Company will probably result in a continuation of subsidies for an extended period. The political realities facing the Government (both at the local and federal level) mean that the consumers will resist any attempt to increase rates to a level where all costs are covered by the revenue stream from the sale of hot water, steam, and electricity.

With the proposed investment program approaching $U.S. 185 million, $177 million in foreign exchange funds, and $8 million in local expenditures for Pernik and almost $225 million in Sofia ($194 million in foreign exchange funds, and $30 million in local expenditures) over the study period, the magnitude of the program will severely test the capabilities of both District Heating Companies. The primary option available to the Municipality is for the central government to secure funding for the forex portion of the program from one of the development banks, either I.B.R.D. (World Bank) or the E.D.B. (European Development Bank). The local funds can be secured from the Central Bank of Bulgaria or a consortium of local banks. At the current high level of interest rates for the local funds, this may not be the most beneficial source of funds at this time.

On the positive side, continued ownership by the local municipality allows for the Government to pursue a more relax transition from subsidized pricing to market pricing. This mindset regarding public ownership for services such as district heating is not uncommon in many countries, including the United States. Due to the critical nature of the services provided, many feel it is more appropriate for Government to be the owner of the company.

Since Government ownership generally foregoes taxes on the enterprise (with the possible exception of in-lieu of taxes), and with the ability to finance all or a portion of the investment with long-term debt, many also feel that Government provided services can be provided at a lower cost than private enterprise. In the case of Bulgaria municipal ownership, an income tax is imposed on the business. This has not been a factor in recent years due to the losses generated by the companies. The backing of the enterprise by Government also results in lower interest rates from the financial institutions. The ability of Government to raise taxes for designated projects is certainly a positive aspect for lenders.

On the negative side, municipal ownership is often considered to be less efficient than private companies, and with regulatory authority provided by Government in an oversight role, many believe that consumers are protected from any rate abuses from private ownership. More on private ownership will be discussed in later sections of this Report.

Another concern facing a continuation of municipal ownership is the current high rate of interest at the local level. Short-term borrowings by the District Heating Companies are over 50% interest rate for a maximum term of about three years. Most development entities will not finance local expenditures. Therefore, while the cost associated with local equipment and/or construction may be substantially lower, the high cost of lending may actually offset this lower cost.

#### 9.4.3.2 Private Ownership Options

As previously mentioned, there are several private initiatives available for consideration. One which is currently in vogue in Eastern Europe is the selling off of public business through a so-called voucher system whereby vouchers are provided to the citizens of the country (under the premise that they were the original owners of all state owned property). Then enterprises are offered to the public and the vouchers can buy shares in the business. For the most part, the existing management team remains in place and actually continues to operate the business as before.

While meeting with some success in the Czech Republic, there is the potential for over stating the value of the business, and uninformed citizens, with no previous experience in evaluating businesses, can lose part or all of this one time windfall. With old line management teams in place, there is no guarantee that the business will improve without adequate financing available. This could lead to high cost debt and little equity in the business except for generally wornout equipment and plant with little or no value to the financial institutions.

It is believed that a more realistic private scheme is to have qualified international firms participate in the ownership of these previous state enterprises. These multi-national firms have the expertise and financial strength to take these businesses from a subsidized state position to one which provides profit to the investors. Arrangements can be made for these firms to take a majority role for several years and then a minority position once the business is on its feet from a financial standpoint. While this may seem unfair to those taking the risk, it does provide government with the incentive to make these types of private ownership deals. Otherwise there would be considerable resentment at the local level to having part of the local businesses sold off to firms outside the country.

Under this privatization scheme, there could be considerable technology and business transfers to the local economy. The Japanese and Koreans are past masters of bringing in multi-national firms to begin the build-up of selected industries. After the market is developed and training provided by the multi-national, then local entities buy out the majority positions of these firms (as opposed to nationalization of assets). In some respects its a win-win position for all parties. The multi-national firm gets a position in the local market, while in the long-run, Bulgaria gets the benefit of training and development of an ailing industry.

For any of the privatization options, the owners would provide a certain amount of equity towards the proposed development program. The balance of the financial requirements would be financed through a combination of debt instruments. Local Bulgarian expenditures would most likely be financed through short-term borrowings, while foreign exchange capital requirements would be financed



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through a variety of sources. Initially, the Government of Bulgaria, and the Municipalities would have to negotiate side deals regarding the level of tariffs to support coverage levels of the foreign debt.

The transfer of existing assets to potential owners would necessarily call for a valuation assessment. At the current time, with the business operating at such a severe loss, would indicate a minimum value or a negative value for the immediate future. A possible alternative is for the municipal to take a minority interest in the business in the form of stock. Under the circumstances facing the District Heating Companies, that might be the best possible solution in regards to privatization options.

#### 9.4.3.4 Project Financing

The final option considered to be a viable financing scheme for consideration by the District Heating Companies would be some form of project financing. Depending on the structure of the least-cost program, pieces can be designated as being available for project financing. In this manner, the ownership of the existing system remains with the Municipality, while much needed capital is raised by developers. The length and type of project financing could work to the benefit of the District Heating Company through a build, own, operate, and then transfer (BOOT) of the selected assets at the end of some reasonable time period.

In a project financing deal, a developer or more likely in this case, a vendor or engineering/constructor, would carve out a portion of the proposed program which it feels will serve as collateral for any debt requirements plus provide a return on the equity provided. Contractual arrangements would have to made between the Municipality and the developer for revenues to support that portion of the program. Additional arrangements would have to be worked out with Government to ensure repatriation of foreign exchange, at least equal to a minimum level of return given the performance guarantees agreed to with the Municipality.

While appearing to be complex, project financing is a much used method of financing in today's investment community. Experienced lenders will assure themselves that all agreements are in place prior to any finalization of equity and debt instruments related to the project. The financiers will likewise assure themselves that the revenue stream is sufficiently strong to provide repayment under conservative estimates. Since the revenue stream and assets are the only source of repayment available to the lenders, sufficient guarantees must be obtained from both the Municipality and Government.

Concerning the overall development of the selected portion of the investment program, the project developer is responsible for securing any sales agreements for steam, hot water, and electricity unless specific payments are forthcoming from the Municipality. The developer is also responsible for securing fuel contracts, meeting environmental standards, conducting the pre-engineering necessary for estimating the capital and operating costs associated with their portion of the program.

As the program becomes sufficiently developed to determine the operating criteria and other aspects of the project, the developer must prepare bankable documents, arrange for financial guarantees, prepare the engineering and construction



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packages, secure insurance, and ultimately support all legal efforts associated with the contracting documents. Upon completion of all those activities, the developer secures adequate financing, including the infusion of equity for at least 15-20% of the project. At financial closing, the developer secures his fees and the project implementation can proceed.

Each option is a stand alone possibility, and it is up to the Authorities to decide which one best fits the needs of the communities involved and the consumers. In actuality, each is probably workable within the frameworks described above, however, they may not satisfy the requirements of the financiers under certain circumstances, leading to an alternative structure for the Municipalities to evaluate.

### 9.4.4 RESULTS OF FINANCIAL ANALYSIS

#### 9.4.4.1 Investment Program - Pernik

The proposed investment program structured for the District Heating Companies falls under the Municipal Ownership structure described in Section 4.3.1 above. With the current institutional, regulatory, and financial situation facing Bulgaria, it is not believed that private options for ownership are viable at this time. As discussed in Section 3.0, Exhibit 9-1 presents the inflation rates, exchange rates, and capital and operating expenses for Pernik.

Under this program, the foreign related capital expenditures are segregated from the domestic expenditures. In this investment plan, the foreign capital expenditures over the study period are financed by four separate development bank issues. The 1994 issue is followed by an issue for the first unit of the FBC. This is followed by a third issue for the second unit. A final issue for the expenditures in 2008 is structured with no grace period on principal repayments. The Pernik District Heating Company will not have any principal repayment responsibilities for the five years following the beginning of the of the first three issues. Interest during the first year of each drawdown is capitalized, and in the following year is paid out of the operating revenues of the Company. A commitment fee of 1/2% is applied to the outstanding balance of the loan, and is likewise capitalized. The term of the loan is for 20 years following the five year grace period, and the interest rate is assumed to be 8%.

For the Domestic portion of the capital expenditures, a local loan is obtained from the National Bank. Like the foreign loan, the interest during the first year is capitalized, but repayment begins the following year. The length of the domestic loan is for five years at the current interest rate of 40%. Exhibit 9-2 presents the investment program for both the foreign and domestic portion of the capital expenditures, while Exhibit 9-3 presents the Debt Service Schedule for all of the loans.

As indicated in the Exhibits, all of the loans are presented in Leva. It is assumed that the Government of Bulgaria will have to support the loan from the Development Bank, but that the District Heating Company will generate sufficient Leva through the charges to the consumers to pay off that obligation. In this analysis, the exchange rate losses are borne by the Companies themselves, or through the charges to the consumers. As an alternative, the exchange rate loss

could be treated as a subsidy by the Government since it is due to the Government's policies that exchange rates deteriorate to the extent projected. This is an item that needs to be resolved by the Companies and Government.

At Pernik the amount of foreign loans is estimated to be 25.5 billion Leva over the study period. Of that, 24.3 billion Leva is related to the actual cost of the capital requirements, while 1.2 billion Leva is the amount of financial charges, including interest that is capitalized.

Exhibits 9-4, 9-5, and 9-6 present the Income Statement, Cash Flow Analysis, and Balance Sheet of the Company in Pernik from the starting point of the Investment Program. Attempts were made to try and incorporate the existing financial situation of the Pernik District Heating Company, but this proved to be impossible given that all previous loans were forgiven by the Government, and the fact that financial statements in a format conducive to this type of analysis were unavailable. Therefore, it was deemed acceptable to present the financial situation of the Pernik system from the date of the initial loan (fiscal year 1994). If appropriate, the company's financial advisors and accountants can, in the future, add to their financial statements, the results of this analysis.

The operating revenues presented in this analysis are calculated on the basis of keeping the Pernik system on sound financial footing through the study period. In other words, the revenues shown are considered to be the minimum amounts necessary to pay all operating expenses, cover debt service, and result in minimum earnings over the study period. Those earning should be designated toward continuous improvement in the system at the desecration of the management of the District Heating Company.

The estimated revenue requirements to support the investment program in Pernik projects revenue increases from 770 million Leva in 1994 to over 15 billion Leva in 2010. Given that the investment program is about the same size as the four districts of Sofia where revenues are expected to increase to over 137 billion through the study period, Pernik is in good shape by pursuing coal-fired generation of its steam and hot water requirements.

### 9.4.4.2 Investment Program - Sofia

Based on discussions held with the European Development Bank, the four segregated systems in Sofia are treated on an individual basis for this analysis. In this manner, discreet programs are presented to again maintain the existing system at a minimum level to provide the necessary services to the consumers. In the following Sections, details are presented for each of the four districts comprising the Sofia District Heating Company.

#### TPS Sofia

As with Pernik described above, TPS Sofia was analyzed on the same basis. The technical program was discussed in previous Sections, but was designed to maintain the System in a manner whereby demands of the consumers would be met through a minimum cost basis. Of the four districts in Sofia, this one had by far the least cost of the four. Total foreign capital expenditures related to the investment program are estimated to be almost 1.4 billion Leva spread over three separate issues, while domestic expenditures were about 76 million Leva.

Exhibit 9-7 provides the details behind the capital and operating costs for this program. Exhibits 9-8 and 9-9 provide the details of the investment program. The structure of the loans is the same as that proposed for Pernik in that there is a five year grace period on principal repayment from the initiation of the loan.

Exhibits 9-10, 9-11, and 9-12 provide the details on the Income Statement, Cash Flow Analysis, and Balance Sheet. As with Pernik, the revenues are those calculated to achieve a small operating surplus over the study horizon.

### TPS Zemliane

The estimated capital requirements for Zemlaine is slightly less than 9 billion Leva. Total foreign capital expenditures is estimated at 7.1 billion Leva, and 1.9 billion Leva for domestic requirements. Exhibit 9-13 provides the details of the capital and operating expenses. The Investment Program is show in Exhibit 9-14, while the Debt Service Schedule to support the investment is shown on Exhibit 9-15. Since annual expenditures are projected through 2003, two series of development loans were structured of five years worth of foreign expenditures each. As with the previous districts, a grace period before principal repayment was structured beginning at the end of the drawdown period. The domestic loans were a series of one year drawdowns with immediate repayment of principal in the following year.

The calculated revenue requirements for Zemlaine are purely based on the sale of hot water and increase almost 19 fold over the 1994-2010 period, reaching a level greater than 17 billion Leva by 2010. Exhibit 9-16 provides the details of the Income Statement. The Cash Flow Analysis is shown on Exhibit 9-17 and the Balance Sheet on Exhibit 9-18. While the revenues, expenses, and capital requirements are increasing dramatically over the study period it must be remembered that the primary influence of that rise is the increase in the Exchange Rate from 32 Leva/dollar in 1993 to over 300 Leva/dollar in 2010.

### TPS Liulin

Liulin's capital requirements are the second lowest behind TPS Sofia of the four segregated systems making up the Sofia District Heating Company. Almost 5.4 billion Leva of foreign capital expenditures are require for Liulin, and slightly more than 1.2 billion Leva of domestic expenditures. Exhibit 9-19 gives the details for Liulin. The total loans for Liulin are estimated to be over 6.7 billion for both foreign and domestic expenditures. Exhibits 9-20 and 9-21 provide the details of the loans. As with Zemliane, the foreign loans are structured around two five year series with the same grace period as previously described

As with the other Districts, Liulin is faced with a substantial increase in revenue requirements to cover its expenses for operations and capital requirements. Revenues are required to increase from 676 million Leva in 1994 to over 14.4 billion in 2010. Exhibits 9-22, 9-23, and 9-24 give the financial statements related to Liulin.

### TPS Trajco Kostov

By far the largest capital requirements of the four districts in Sofia is that of Trajco Kostov. Almost 10 billion Leva in foreign expenditures is estimated to be needed by Trajco Kostov. Slightly less than 850 million Leva are required for the domestic capital requirements. Exhibit 9-25 gives the annual details of the capital and

operating costs. Exhibits 9-26 and 9-27 provide the details of the various loans associated with Trajco Kostov's investment program. For Trajco Kostov, four series of loans for the foreign expenditures were structured. The first two were for three years of expenditures each, with the same five year grace period before principal repayment is required from the origination of the loan. The last two issues were for a single year, no grace period. Principal repayment begins the year following the expenditure.

Revenue requirements at Trajco Kostov go from 3.2 billion in 1994 to over 68 billion in 2010. The three financial statements are provided in Exhibits 9-28, 9-29, and 9-30.

### Sofia Summary

The total investment program estimated for Sofia is approximately 27.8 billion Leva through 2010. Revenue requirements are estimated to be almost 6.5 billion in 1994, and by 2010 they are estimated to approach 137.7 billion. While staggering in their magnitude, the District Heating Company of Sofia must undertake these programs to maintain the system in good operating condition. It must also be pointed out that this investment program is the minimum in terms of capital requirements.

Two primary factors are driving the revenue requirements to the levels described above. These are the deterioration of the exchange rate to world currencies, and the cost of fuel, which for the most part, is paid for in foreign exchange. Since natural gas is the primary fuel utilized in Sofia, and since it is not a domestic commodity, this will continue to drive the price of hot water and steam up to the projected levels. One factor which could mitigate this revenue increase is the control of the inflation rate. In the short run this is not considered possible.

## 9.5 CONCLUSIONS AND RECOMMENDATIONS

With the current financial situation facing both Pernik and Sofia District Heating Companies, there is little doubt as to the challenge facing them in the next several years. Based on the technical review and evaluation of alternatives, the least-cost program is a combination of replacement, renewal, and new facilities to meet the expected demand of the systems. Demand is expected to remain relatively flat throughout the study horizon, with new growth allowed when efficiency gains are made in the system, along with conservation by the consumers in response to price increases.

After review of the ownership options available for the District Heating Companies, the current structure of Municipal ownership appears to be the only solution in the immediate future. The economic environment that Bulgaria finds itself in at the present time basically prohibits private options from being part of the equation. This is not to say that in the future privatization should not be on the agenda for the Companies. In fact, the investment program has been structured to allow the Companies to consider privatization at discreet times throughout the study horizon. By structuring the debt in series gives the Companies time to re-evaluate private options on a periodic basis.

The amount or level of the investment program proposed for the two Companies is not substantial by western standards. However, given that most of the investment



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is in foreign exchange material and equipment, this poses a problem for the Government of Bulgaria since the Government must guarantee the loan repayments to the international lending agencies. Given that Bulgaria suspended foreign currency payments back in 1990 due to a severe lack of foreign exchange, it will be difficult for the Government to proceed with the proposed program without certain restrictions imposed by the lending agencies.

At this time, the World Bank is probably more interested in the electricity sector for investment options, but the European Development Bank has expressed interest in specific projects within the proposed investment program. The balance of the program not financed by the development banks must be pursued with other lending agencies from the developed countries or from private international banks. In addition, the export agencies of many countries are lenders who may be interested in supplying debt to Bulgaria to promote national interests. A listing of potential export lenders is provided in the Appendix. Likewise, some direct aid through grants from donor countries might also be available to the District Heating Companies.

To promote lending activity, it is critical that the Government and the Municipalities institute a more rapid movement from subsidized pricing to market pricing for the commodities that are produced. While this is envisioned to take place over a period of time, steps must be taken immediately to convince the lending institutions that the Companies and Government are serious in their attempts to move in that direction. The structuring of a specific pricing policy and program as part of a bankable document to be presented to potential lenders would be a good first step in securing interest by the multi-national lending institutions.

The critical need for replacement and improvements in the District Heating Companies require that the Government and the Municipalities work together in improving the organizational strengths of the Companies, along with the technical aspects of providing heat and electricity. As long as the bulk of Bulgaria's energy needs are supplied by imports, it is in the best interest of the consumers and the companies that are supplied by the District Heating Companies to conserve energy through programs initiated by the DHC's themselves. This too is an important part of the investment program.

Specific Recommendations for Implementation would include the following action items:

1. Preparation must begin on a bankable document as soon as the investment program is approved by the appropriate authorities. This document should serve as the basis for opening negotiations with international lending institutions to cover the proposed investment program.

2. Part of this assignment is a training component for both technical and financial aspects of managing the business. This training should commence as soon as practical, with particular emphasis on the development of sound business practices for the pricing, billing and accounting functions related to the delivery of energy to the consumer.



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3. Discussions should be held with Government at the national level to secure input as to the national perspective regarding energy importation to the local level. These discussions should focus on the need to eliminate energy subsidies at both the national and local level.

4. Legal and regulatory frameworks should be promulgated at both the national and local levels of Government to support the transition to private enterprise activities. In the long run, it would be in the best interest of Bulgaria to support privatization in the energy sector. This would allow additional sources of capital to find its way into the economy from sources now unavailable to the District Heating Companies. Policy initiatives are underway by a number of agencies assisting both local and national agencies currently in Bulgaria. These programs should be supported by the Companies to ensure that their interests are taken into account.

In summary, the propose investment program is modest when compared to other higher priority issues facing the Government of Bulgaria and the local municipalities. It is a minimum level undertaking to ensure the adequate delivery of heat and steam, while at the same time providing for efficiency gains, environmental clean-up, and replacement of antiquated plant and equipment necessary to providing the consumers of the District Heating Company with energy at the lowest possible cost.

Its implementation relies on the management of the Companies to take the initiative in securing the necessary funding for the program. Assistance can be provided to management in both the technical and financial areas of the program as it proceeds, but a number of political and personnel actions will have to be undertaken during this implementation phase. This can only be accomplished by the management of the organizations and the appropriate authorities in Bulgaria.

The proposed investment program relies heavily on the international development organizations of the World Bank and the European Development Bank. As organizational strengths are developed and initiatives promoted to push privatization into the Bulgarian economy, other resources will become available over time to the Companies. Other efforts should be pursued with export agencies of other countries with one caveat; the technical need should over ride the economic and financial opportunity for those types of funds.



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# PERNIK TPS

## Baseline Case

### Exhibit 9-1 to 9-6

# Exhibit 9-1
## General Data Development
## Pernik District Heating Company
## Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GENERAL INFLATION | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.860% | 2.670% | 3.500% | 3.500% | 3.500% | 3.500% | 3.500% | 3.350% | 3.200% | 3.060% | 2.930% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% |
| DOMESTIC | 40.000% | 40.000% | 35.000% | 30.000% | 25.000% | 20.000% | 18.000% | 16.000% | 14.000% | 12.000% | 10.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% |
| COMPOUNDED: | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.0186 | 1.0458 | 1.0824 | 1.1203 | 1.1595 | 1.2001 | 1.2421 | 1.2837 | 1.3248 | 1.3653 | 1.4053 | 1.4447 | 1.4851 | 1.5267 | 1.5694 | 1.6134 | 1.6586 |
| DOMESTIC | 1.4000 | 1.9600 | 2.6460 | 3.4398 | 4.2998 | 5.1597 | 6.0884 | 7.0626 | 8.0514 | 9.0175 | 9.9193 | 10.7128 | 11.5698 | 12.4954 | 13.4951 | 14.5747 | 15.7406 |
| FOREX RATIO | 1.3744 | 1.8742 | 2.4446 | 3.0705 | 3.7063 | 4.2995 | 4.9018 | 5.5016 | 6.0776 | 6.6048 | 7.0584 | 7.4155 | 7.7906 | 8.1847 | 8.5987 | 9.0336 | 9.4906 |
| EXCHANGE RATE (LEVA/US) | 43.98 | 59.97 | 78.23 | 98.26 | 118.67 | 137.58 | 156.86 | 176.06 | 194.48 | 211.35 | 225.87 | 237.30 | 249.30 | 261.91 | 275.16 | 289.06 | 303.70 |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN (US 1993$) | $29,230 | $0 | $0 | $15,545 | $24,711 | $12,863 | $15,971 | $23,956 | $19,454 | $5,496 | $0 | $0 | $0 | $0 | $1,394 | $0 | $0 |
| FOREIGN (CURRENT) | $29,774 | $0 | $0 | $17,415 | $28,652 | $15,461 | $19,837 | $30,752 | $25,772 | $7,504 | $0 | $0 | $0 | $0 | $2,188 | $0 | $0 |
| FOREIGN (LEVA-CURRENT) | 1,309,504 | 0 | 0 | 1,711,094 | 3,400,036 | 2,127,117 | 3,111,834 | 5,414,131 | 5,012,196 | 1,585,930 | 0 | 0 | 0 | 0 | 601,986 | 0 | 0 |
| DOMESTIC (US 1993) | $2,758 | $0 | $0 | $569 | $860 | $472 | $565 | $877 | $563 | $92 | $0 | $0 | $0 | $0 | $28 | $0 | $0 |
| DOMESTIC (LEVA 1993) | 88,256 | 0 | 0 | 18,208 | 28,160 | 15,104 | 18,720 | 28,064 | 18,656 | 2,944 | 0 | 0 | 0 | 0 | 896 | 0 | 0 |
| DOMESTIC (LEVA-CURRENT) | 123,558 | 0 | 0 | 62,632 | 121,081 | 77,932 | 113,976 | 196,205 | 150,206 | 26,548 | 0 | 0 | 0 | 0 | 12,092 | 0 | 0 |
| DOMESTIC (CURRENT US) | $2,809 | $0 | $0 | $637 | $1,020 | $566 | $727 | $1,126 | $772 | $126 | $0 | $0 | $0 | $0 | $44 | $0 | $0 |
| OPERATING EXPENSES (US $1993) | | | | | | | | | | | | | | | | | |
| FUEL COST-LIGNITE | 4,929 | 13,908 | 14,026 | 14,646 | 15,279 | 15,925 | 15,035 | 15,151 | 15,398 | 14,365 | 14,452 | 14,557 | 14,502 | 14,519 | 14,541 | 14,563 | 14,580 |
| FUEL COST-OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PURCHASED POWER (NET) | (7,872) | (8,362) | (8,497) | (8,719) | (8,952) | (9,198) | (9,463) | (9,476) | (9,600) | (9,862) | (9,869) | (9,872) | (9,876) | (9,878) | (9,881) | (9,883) | (9,885) |
| FIXED O & M | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 | 3,124 |
| VARIABLE O & M | 3,192 | 3,209 | 3,191 | 3,264 | 3,333 | 3,400 | 3,456 | 3,476 | 3,524 | 3,550 | 3,564 | 3,566 | 3,574 | 3,578 | 3,583 | 3,587 | 3,591 |
| SORBENT & ASH REMOVAL | 1,156 | 33 | 33 | 33 | 34 | 35 | 1,403 | 1,396 | 1,370 | 2,418 | 2,423 | 2,352 | 2,426 | 2,427 | 2,429 | 2,431 | 2,432 |
| CREDIT: BY-PRODUCT SALES | 0 | 0 | 0 | 0 | 0 | 0 | (369) | (367) | (379) | (677) | (676) | (658) | (679) | (679) | (660) | (660) | (661) |
| EMISSION PENALTIES | 930 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MAINTENANCE EXPENSES | 3,184 | 1,786 | 2,005 | 1,818 | 2,019 | 2,061 | 1,786 | 1,495 | 2,513 | 1,903 | 2,603 | 1,478 | 1,693 | 2,512 | 2,237 | 2,366 | 1,622 |
| TOTAL O & M EXPENSES | 8,643 | 13,678 | 13,882 | 14,166 | 14,837 | 15,347 | 14,954 | 14,781 | 15,950 | 14,641 | 15,619 | 14,549 | 14,764 | 15,603 | 15,353 | 15,508 | 14,983 |
| OPERATING EXPENSES (LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FUEL COST-LIGNITE | 220,819 | 872,164 | 1,187,609 | 1,612,136 | 2,102,266 | 2,629,363 | 2,929,273 | 3,424,173 | 3,967,195 | 4,150,947 | 4,587,306 | 4,990,266 | 5,369,148 | 5,805,478 | 6,279,416 | 6,792,030 | 7,343,956 |
| FUEL COST-OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PURCHASED POWER | (352,666) | (525,719) | (719,456) | (959,732) | (1,231,724) | (1,518,665) | (1,843,679) | (2,141,606) | (2,473,376) | (2,845,786) | (3,132,587) | (3,364,222) | (3,656,441) | (3,949,756) | (4,267,032) | (4,609,327) | (4,979,081) |
| FIXED O & M | 139,955 | 195,937 | 264,515 | 343,870 | 429,837 | 515,805 | 608,650 | 706,034 | 804,878 | 901,464 | 991,610 | 1,070,939 | 1,156,614 | 1,249,143 | 1,349,075 | 1,457,001 | 1,573,561 |
| VARIABLE O & M | 143,002 | 201,266 | 270,166 | 359,280 | 456,594 | 561,375 | 673,723 | 786,039 | 907,936 | 1,024,391 | 1,131,274 | 1,223,147 | 1,323,220 | 1,430,677 | 1,547,290 | 1,672,939 | 1,808,789 |
| SORBENT & ASH REMOVAL | 51,789 | 2,070 | 2,794 | 3,632 | 4,678 | 5,779 | 273,347 | 315,500 | 352,972 | 697,740 | 769,101 | 806,290 | 896,190 | 970,445 | 1,046,945 | 1,133,793 | 1,225,000 |
| CREDIT: BY-PRODUCT SALES | 0 | 0 | 0 | 0 | 0 | 0 | (75,789) | (87,463) | (97,647) | (195,356) | (215,209) | (225,569) | (251,390) | (271,501) | (293,653) | (317,145) | (343,020) |
| EMISSION PENALTIES | 41,664 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MAINTENANCE EXPENSES | 142,643 | 112,016 | 169,767 | 200,114 | 277,796 | 340,293 | 347,967 | 337,875 | 647,458 | 549,131 | 626,236 | 506,673 | 626,808 | 1,004,433 | 966,031 | 1,103,478 | 817,743 |
| TOTAL O & M EXPENSES | 367,206 | 857,759 | 1,175,417 | 1,559,303 | 2,041,453 | 2,533,849 | 2,913,492 | 3,340,552 | 4,109,415 | 4,282,531 | 4,957,734 | 4,987,546 | 5,466,150 | 6,238,919 | 6,630,072 | 7,232,766 | 7,546,947 |



0/10

# Exhibit 9-2
## Projected Investment Program - Municipal Ownership
## Pernik District Heating Company
## Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPITAL EXPENDITURES (000'S LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FOREIGN | 1,309,504 | 0 | 0 | 1,711,094 | 3,400,036 | 2,127,117 | 3,111,634 | 5,414,131 | 5,012,198 | 1,585,930 | 0 | 0 | 0 | 0 | 601,988 | 0 | 0 |
| DOMESTIC | 123,558 | 0 | 0 | 62,632 | 121,081 | 77,932 | 113,976 | 198,205 | 150,206 | 26,548 | 0 | 0 | 0 | 0 | 12,092 | 0 | 0 |
| MUNICIPAL OWNERSHIP: | | | | | | | | | | | | | | | | | |
| INVESTMENT PROGRAM | | | | | | | | | | | | | | | | | |
| FOREIGN | | | | | | | | | | | | | | | | | |
| SERIES 94-98 | 1,361,884 | 0 | 0 | | | | | | | | | | | | | | |
| DRAWDOWN | 1,361,884 | 0 | 0 | | | | | | | | | | | | | | |
| UNDISBURED | 0 | 0 | 0 | | | | | | | | | | | | | | |
| SERIES 97-99 | | | | 7,602,240 | 5,786,511 | 2,222,838 | | | | | | | | | | | |
| DRAWDOWN | | | | 1,815,729 | 3,563,673 | 2,222,838 | | | | | | | | | | | |
| UNDISBURED | | | | 5,786,511 | 2,222,838 | 0 | | | | | | | | | | | |
| SERIES 2000-03 | | | | | | | 15,905,449 | 12,593,730 | 6,902,973 | 1,657,297 | | | | | | | |
| DRAWDOWN | | | | | | | 3,311,719 | 5,690,757 | 5,245,676 | 1,657,297 | | | | | | | |
| UNDISBURED | | | | | | | 12,593,730 | 6,902,973 | 1,657,297 | (0) | | | | | | | |
| SERIES 08 | | | | | | | | | | | | | | | 626,067 | 0 | 0 |
| DRAWDOWN | | | | | | | | | | | | | | | 626,067 | 0 | 0 |
| UNDISBURED | | | | | | | | | | | | | | | 0 | 0 | 0 |
| DOMESTIC | | | | | | | | | | | | | | | | | |
| ANNUAL REQUIREMENT | 142,092 | 0 | 0 | 72,027 | 139,243 | 89,622 | 131,072 | 227,935 | 172,737 | 30,530 | 0 | 0 | 0 | 0 | 13,905 | 0 | 0 |

CAPITALIZATION SCHEDULE AND
APPLICATION OF CONSTRUCTION FUNDS
PERNIK DISTRICT HEATING COMPANY
BASELINE CASE

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING BALANCE | | | | | | | | | | | | | | | | | |
| CAPITAL FUNDING | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 1,361,884 | 0 | 0 | 1,815,729 | 3,563,673 | 2,222,838 | 3,311,719 | 5,690,757 | 5,245,676 | 1,657,297 | 0 | 0 | 0 | 0 | 626,067 | 0 | 0 |
| DOMESTIC LOANS | 142,092 | 0 | 0 | 72,027 | 139,243 | 89,622 | 131,072 | 227,935 | 172,737 | 30,530 | 0 | 0 | 0 | 0 | 13,905 | 0 | 0 |
| TOTAL NEW CAPITAL | 1,503,976 | 0 | 0 | 1,887,756 | 3,702,916 | 2,312,459 | 3,442,791 | 5,918,693 | 5,418,413 | 1,687,827 | 0 | 0 | 0 | 0 | 639,973 | 0 | 0 |
| INTERNAL FUNDS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PROCEEDS AVAILABLE | 1,503,976 | 0 | 0 | 1,887,756 | 3,702,916 | 2,312,459 | 3,442,791 | 5,918,693 | 5,418,413 | 1,687,827 | 0 | 0 | 0 | 0 | 639,973 | 0 | 0 |
| UTILIZATION OF PROCEEDS | | | | | | | | | | | | | | | | | |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN COSTS | 1,309,504 | 0 | 0 | 1,711,094 | 3,400,036 | 2,127,117 | 3,111,634 | 5,414,131 | 5,012,198 | 1,585,930 | 0 | 0 | 0 | 0 | 601,988 | 0 | 0 |
| DOMESTIC COSTS | 123,558 | 0 | 0 | 62,632 | 121,081 | 77,932 | 113,976 | 198,205 | 150,206 | 26,548 | 0 | 0 | 0 | 0 | 12,092 | 0 | 0 |
| COMMITMENT FEES | 0 | 0 | 0 | 36,191 | 27,636 | 10,636 | 75,619 | 60,061 | 32,991 | 7,930 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOND DISCOUNT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RES. FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER EXPENSES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL UTILIZATION | 1,433,062 | 0 | 0 | 1,809,917 | 3,548,753 | 2,215,685 | 3,301,229 | 5,672,397 | 5,195,394 | 1,620,407 | 0 | 0 | 0 | 0 | 614,080 | 0 | 0 |
| BALANCE ON DEPOSIT | | | | | | | | | | | | | | | | | |
| INTEREST EARNED ON: | | | | | | | | | | | | | | | | | |
| CONSTRUCTION FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RESERVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE AVAILABLE | 70,914 | 0 | 0 | 77,839 | 154,164 | 96,775 | 141,562 | 246,296 | 223,019 | 67,419 | 0 | 0 | 0 | 0 | 25,893 | 0 | 0 |
| INTEREST CHARGES | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 52,380 | 0 | 0 | 68,444 | 136,001 | 85,085 | 124,465 | 216,565 | 200,488 | 63,437 | 0 | 0 | 0 | 0 | 24,080 | 0 | 0 |
| DOMESTIC LOANS | 18,534 | 0 | 0 | 9,395 | 18,162 | 11,690 | 17,096 | 29,731 | 22,531 | 3,982 | 0 | 0 | 0 | 0 | 1,814 | 0 | 0 |
| TOTAL INTEREST | 70,914 | 0 | 0 | 77,839 | 154,164 | 96,775 | 141,562 | 246,296 | 223,019 | 67,419 | 0 | 0 | 0 | 0 | 25,893 | 0 | 0 |
| NET END OF PERIOD | 0 | 0 | 0 | (0) | (0) | 0 | 0 | (0) | (0) | (0) | 0 | 0 | 0 | 0 | (0) | 0 | 0 |
| AMOUNT CLOSED TO PLANT | 1,503,976 | 0 | 0 | 0 | 0 | 7,903,131 | 0 | 0 | 0 | 16,467,724 | 0 | 0 | 0 | 0 | 639,973 | 0 | 0 |

BEST AVAILABLE COPY



1071

# Exhibit 9-3
## Debt Service Schedule
## Pernik District Heating Company
## Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOREIGN LOANS: | | | | | | | | | | | | | | | | | |
| SERIES 94-96 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 1,361,884 | 1,361,884 | 1,361,884 | 1,361,884 | 1,361,884 | 1,332,647 | 1,301,025 | 1,266,822 | 1,229,628 | 1,189,815 | 1,146,536 | 1,099,729 | 1,049,100 | 994,340 | 935,111 | 871,050 |
| AMOUNT DRAWN DOWN | 1,361,884 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 108,951 | 108,951 | 108,951 | 108,951 | 108,377 | 105,992 | 103,411 | 100,620 | 97,602 | 94,337 | 90,805 | 86,986 | 82,854 | 78,366 | 73,553 | 68,325 |
| PRINCIPAL REPAYMENT | 0 | 0 | 0 | 0 | 0 | 29,237 | 31,623 | 34,203 | 36,994 | 40,013 | 43,278 | 46,809 | 50,629 | 54,760 | 59,228 | 64,061 | 69,289 |
| TOTAL DEBT SERVICE | 0 | 108,951 | 108,951 | 108,951 | 108,951 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 | 137,614 |
| SERIES 97-99 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | 0 | 1,815,729 | 5,379,402 | 7,602,240 | 7,602,240 | 7,602,240 | 7,439,036 | 7,262,514 | 7,071,588 | 6,865,082 | 6,641,726 | 6,400,144 | 6,138,849 | 5,856,232 |
| AMOUNT DRAWN DOWN | | | | 1,815,729 | 3,563,673 | 2,222,838 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | 0 | 145,258 | 430,352 | 608,179 | 608,179 | 604,979 | 591,662 | 577,257 | 561,678 | 544,827 | 526,601 | 506,888 | 485,566 | 462,505 |
| PRINCIPAL REPAYMENT | | | | 0 | 0 | 0 | 0 | 0 | 163,204 | 176,522 | 190,926 | 206,505 | 223,356 | 241,582 | 261,295 | 282,617 | 305,679 |
| TOTAL DEBT SERVICE | | | | 0 | | 430,352 | 608,179 | 608,179 | 768,183 | 768,183 | 768,183 | 768,183 | 768,183 | 768,183 | 768,183 | 768,183 | 768,183 |
| SERIES 00-03 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | 0 | 3,311,719 | 9,002,476 | 14,248,152 | 15,905,449 | 15,905,449 | 15,563,992 | 15,194,673 | 14,795,216 | 14,363,165 | 13,895,857 |
| AMOUNT DRAWN DOWN | | | | | | | 3,311,719 | 5,690,757 | 5,245,676 | 1,657,297 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | | 0 | 264,938 | 720,198 | 1,139,852 | 1,272,436 | 1,265,741 | 1,237,878 | 1,207,741 | 1,175,146 | 1,139,890 | 1,101,758 |
| PRINCIPAL REPAYMENT | | | | | | | 0 | 0 | 0 | 0 | 0 | 341,457 | 369,320 | 399,456 | 432,052 | 467,307 | 505,440 |
| TOTAL DEBT SERVICE | | | | | | | 0 | | | | 1,272,436 | 1,607,198 | 1,607,198 | 1,607,198 | 1,607,198 | 1,607,198 | 1,607,198 |
| SERIES 08 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | 0 | 0 | 626,067 | 612,627 |
| AMOUNT DRAWN DOWN | | | | | | | | | | | | | | 0 | 626,067 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | | | | | | | | | 0 | 0 | 49,822 | 48,725 |
| PRINCIPAL REPAYMENT | | | | | | | | | | | | | | 0 | 0 | 13,440 | 14,537 |
| TOTAL DEBT SERVICE | | | | | | | | | | | | | | 0 | 0 | 63,262 | 63,262 |
| BALANCE, END OF PERIOD | 1,361,884 | 1,361,884 | 1,361,884 | 3,177,613 | 6,741,266 | 8,934,887 | 12,214,984 | 17,871,538 | 22,917,016 | 24,357,778 | 24,123,575 | 23,528,604 | 22,885,499 | 22,189,700 | 22,063,192 | 21,235,766 | 20,340,822 |
| DOMESTIC LOANS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | | | | |
| SERIES 94 | 0 | 142,092 | 120,348 | 95,686 | 67,713 | 35,988 | | | | | | | | | | | |
| SERIES 95 | | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | |
| SERIES 96 | | | | 0 | 0 | 0 | 0 | 0 | | | | | | | | | |
| SERIES 97 | | | | | 72,027 | 61,005 | 48,503 | 34,324 | 18,241 | | | | | | | | |
| SERIES 98 | | | | | | 139,243 | 117,935 | 93,767 | 66,356 | 35,264 | | | | | | | |
| SERIES 99 | | | | | | | 89,622 | 75,907 | 60,352 | 42,709 | 22,697 | | | | | | |
| SERIES 00 | | | | | | | | 131,072 | 111,015 | 88,255 | 62,462 | 33,195 | | | | | |
| SERIES 01 | | | | | | | | | 227,935 | 193,055 | 153,493 | 108,621 | 57,726 | | | | |
| SERIES 02 | | | | | | | | | | 172,737 | 146,304 | 116,323 | 82,317 | 43,747 | | | |
| SERIES 03 | | | | | | | | | | | 30,530 | 25,858 | 20,559 | 14,549 | 7,732 | | |
| SERIES 04 | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| SERIES 05 | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| SERIES 06 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| SERIES 07 | | | | | | | | | | | | | | | 0 | 0 | 0 |
| SERIES 08 | | | | | | | | | | | | | | | | 13,905 | 11,777 |
| SERIES 09 | | | | | | | | | | | | | | | | | 0 |
| SERIES 10 | | | | | | | | | | | | | | | | | |
| TOTAL OUTSTANDING | 0 | 142,092 | 120,348 | 95,686 | 139,740 | 236,234 | 256,060 | 335,071 | 483,899 | 532,031 | 415,486 | 283,997 | 160,602 | 58,296 | 7,732 | 13,905 | 11,777 |
| AMOUNT DRAWN DOWN | 142,092 | 0 | 0 | 72,027 | 139,243 | 89,622 | 131,072 | 227,935 | 172,737 | 30,530 | 0 | 0 | 0 | 0 | 13,905 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 17,788 | 14,869 | 11,559 | 16,821 | 28,513 | 31,649 | 41,069 | 58,985 | 64,535 | 49,874 | 33,035 | 17,658 | 5,987 | 762 | 1,741 | 1,455 |
| PRINCIPAL REPAYMENT | 0 | 21,744 | 24,662 | 27,973 | 42,749 | 69,795 | 52,062 | 79,107 | 124,605 | 147,074 | 131,489 | 123,395 | 102,307 | 50,584 | 7,732 | 2,128 | 2,413 |
| TOTAL DEBT SERVICE | 0 | 39,531 | 39,531 | 39,531 | 59,570 | 98,309 | 83,711 | 120,176 | 183,590 | 211,609 | 181,364 | 156,430 | 119,965 | 56,551 | 8,494 | 3,869 | 3,869 |
| BALANCE, END OF PERIOD | 142,092 | 120,348 | 95,686 | 139,740 | 236,234 | 256,060 | 335,071 | 483,899 | 532,031 | 415,486 | 283,997 | 160,602 | 58,296 | 7,732 | 13,905 | 11,777 | 9,364 |
| TOTALS ALL DEBT: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 1,503,976 | 1,482,232 | 1,457,570 | 3,317,353 | 6,977,520 | 9,190,948 | 12,550,054 | 18,355,437 | 23,449,047 | 24,773,265 | 24,407,572 | 23,689,406 | 22,943,795 | 22,197,432 | 22,077,097 | 21,247,543 |
| AMOUNT DRAWN DOWN | 1,503,976 | 0 | 0 | 1,887,756 | 3,702,916 | 2,312,459 | 3,442,791 | 5,918,693 | 5,418,413 | 1,687,827 | 0 | 0 | 0 | 0 | 639,973 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 126,738 | 123,820 | 120,509 | 271,030 | 567,243 | 745,820 | 1,017,597 | 1,484,782 | 1,893,850 | 1,993,904 | 1,951,259 | 1,887,348 | 1,823,184 | 1,761,181 | 1,750,572 | 1,682,768 |
| PRINCIPAL REPAYMENT | 0 | 21,744 | 24,662 | 27,973 | 42,749 | 99,032 | 83,684 | 113,310 | 324,804 | 363,609 | 365,693 | 718,166 | 745,611 | 746,362 | 760,307 | 829,554 | 897,354 |
| BALANCE, END OF PERIOD | 1,503,976 | 1,482,232 | 1,457,570 | 3,317,353 | 6,977,520 | 9,190,948 | 12,550,054 | 18,355,437 | 23,449,047 | 24,773,265 | 24,407,572 | 23,689,406 | 22,943,795 | 22,197,432 | 22,077,097 | 21,247,543 | 20,350,186 |
| TOTAL DEBT SERVICE | 0 | 148,482 | 148,482 | 148,482 | 313,779 | 666,275 | 829,504 | 1,130,907 | 1,809,586 | 2,257,259 | 2,359,597 | 2,669,425 | 2,632,960 | 2,569,546 | 2,521,489 | 2,580,126 | 2,580,126 |

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1072

# Exhibit 9-4
## Statement of Income
## Pernik District Heating Company
## Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING REVENUES: | | | | | | | | | | | | | | | | | |
| STEAM | 108,056 | 267,969 | 348,012 | 435,001 | 599,147 | 773,064 | 896,978 | 1,126,216 | 1,431,599 | 1,570,342 | 1,658,413 | 1,869,833 | 1,950,879 | 2,125,054 | 2,227,792 | 2,383,858 | 2,432,381 |
| HOT WATER | 311,706 | 774,623 | 1,031,604 | 1,327,861 | 1,881,809 | 2,496,291 | 2,975,598 | 3,736,063 | 4,749,127 | 5,209,387 | 6,165,025 | 6,202,907 | 6,471,768 | 7,049,567 | 7,390,385 | 7,908,114 | 8,069,083 |
| ELECTRICITY | 352,666 | 525,719 | 719,458 | 959,732 | 1,231,724 | 1,518,685 | 1,843,679 | 2,141,606 | 2,473,378 | 2,845,786 | 3,132,587 | 3,384,222 | 3,656,441 | 3,949,756 | 4,267,032 | 4,609,327 | 4,979,081 |
| TOTAL SALES REVENUE | 772,428 | 1,568,311 | 2,099,074 | 2,722,594 | 3,712,679 | 4,788,040 | 5,716,255 | 7,003,885 | 8,654,104 | 9,625,515 | 11,156,026 | 11,456,963 | 12,079,088 | 13,124,376 | 13,885,209 | 14,901,300 | 15,480,546 |
| OTHER OPER. REVENUES | 0 | 0 | 0 | 0 | 0 | 0 | 75,789 | 87,463 | 97,647 | 195,356 | 215,209 | 225,569 | 251,390 | 271,501 | 293,653 | 317,145 | 343,020 |
| TOTAL OPERATING REVENUES | 772,428 | 1,568,311 | 2,099,074 | 2,722,594 | 3,712,679 | 4,788,040 | 5,792,044 | 7,091,348 | 8,751,751 | 9,820,871 | 11,371,234 | 11,682,532 | 12,330,477 | 13,395,877 | 14,178,862 | 15,218,445 | 15,823,566 |
| OPERATING EXPENSES: | | | | | | | | | | | | | | | | | |
| OPER. & MAIN. | | | | | | | | | | | | | | | | | |
| FUEL – GAS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OIL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LIGNITE | 220,819 | 872,184 | 1,187,609 | 1,612,138 | 2,102,268 | 2,629,383 | 2,929,273 | 3,424,173 | 3,967,195 | 4,150,947 | 4,587,308 | 4,990,288 | 5,369,148 | 5,805,478 | 6,279,416 | 6,792,030 | 7,343,956 |
| COAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUEL COST | 220,819 | 872,184 | 1,187,609 | 1,612,138 | 2,102,268 | 2,629,383 | 2,929,273 | 3,424,173 | 3,967,195 | 4,150,947 | 4,587,308 | 4,990,288 | 5,369,148 | 5,805,478 | 6,279,416 | 6,792,030 | 7,343,956 |
| PURCHASED POWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FIXED O & M | 139,955 | 195,937 | 264,515 | 343,670 | 429,637 | 515,805 | 608,650 | 706,034 | 804,878 | 901,464 | 991,610 | 1,070,939 | 1,156,614 | 1,249,143 | 1,349,075 | 1,457,001 | 1,573,561 |
| OTHER VAR. O & M | 143,002 | 201,268 | 270,188 | 359,260 | 458,594 | 561,375 | 673,723 | 788,039 | 907,936 | 1,024,391 | 1,131,274 | 1,223,147 | 1,323,220 | 1,430,677 | 1,547,290 | 1,672,939 | 1,808,789 |
| SORB. & ASH REMOVAL | 51,789 | 2,070 | 2,794 | 3,632 | 4,678 | 5,779 | 273,347 | 315,500 | 352,972 | 697,740 | 769,101 | 806,290 | 898,190 | 970,445 | 1,048,945 | 1,133,793 | 1,225,000 |
| EMISSION PENALTIES | 41,664 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MAINTENACE EXPENSE | 142,643 | 112,018 | 169,767 | 200,114 | 277,798 | 340,293 | 347,967 | 337,875 | 647,458 | 549,131 | 626,236 | 506,673 | 626,808 | 1,004,433 | 986,031 | 1,103,478 | 917,743 |
| PLANT REMOVAL COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL O & M | 739,872 | 1,383,478 | 1,894,875 | 2,519,034 | 3,273,176 | 4,052,635 | 4,832,960 | 5,569,621 | 6,680,440 | 7,323,673 | 8,305,529 | 8,597,337 | 9,373,980 | 10,460,176 | 11,190,757 | 12,159,241 | 12,869,048 |
| DEPRECIATION EXPENSE | 62,169 | 115,460 | 109,687 | 104,203 | 98,992 | 192,632 | 479,558 | 455,580 | 432,801 | 617,007 | 1,203,697 | 1,143,512 | 1,086,336 | 1,032,019 | 988,418 | 962,996 | 914,846 |
| OTHER OPER. EXPENSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING EXPENSES | 802,041 | 1,498,938 | 2,004,562 | 2,623,237 | 3,372,168 | 4,245,467 | 5,312,517 | 6,025,201 | 7,113,241 | 7,940,680 | 9,509,226 | 9,740,849 | 10,460,317 | 11,492,195 | 12,179,175 | 13,122,237 | 13,783,894 |
| OPERATING SURPLUS | (29,614) | 69,373 | 94,512 | 99,357 | 340,511 | 542,573 | 479,526 | 1,066,148 | 1,638,510 | 1,880,191 | 1,862,008 | 1,941,683 | 1,870,161 | 1,903,682 | 1,999,687 | 2,096,208 | 2,039,672 |
| LONG TERM DEBT INTEREST | | | | | | | | | | | | | | | | | |
| FOREIGN | 0 | 108,951 | 108,951 | 108,951 | 254,209 | 538,730 | 714,171 | 976,528 | 1,425,798 | 1,829,116 | 1,944,030 | 1,918,224 | 1,869,690 | 1,817,197 | 1,760,420 | 1,748,831 | 1,681,313 |
| DOMESTIC | 0 | 17,788 | 14,869 | 11,559 | 16,821 | 28,513 | 31,649 | 41,069 | 58,985 | 64,535 | 49,874 | 33,035 | 17,658 | 5,987 | 762 | 1,741 | 1,455 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST EXPENSE | 0 | 126,738 | 123,820 | 120,509 | 271,030 | 567,243 | 745,820 | 1,017,597 | 1,484,782 | 1,893,650 | 1,993,904 | 1,951,259 | 1,887,348 | 1,823,184 | 1,761,181 | 1,750,572 | 1,682,768 |
| NET INCOME FOR YEAR | (29,614) | (57,365) | (29,308) | (21,153) | 69,481 | (24,670) | (266,294) | 48,550 | 153,728 | (13,459) | (131,896) | (9,576) | (17,188) | 80,498 | 238,505 | 345,636 | 356,903 |
| PROVISION FOR TAXES @42% | 0 | 0 | 0 | 0 | 29,182 | 0 | 0 | 20,391 | 64,566 | 0 | 0 | 0 | 0 | 33,809 | 100,172 | 145,167 | 149,899 |
| ADJUSTED NET INCOME | (29,614) | (57,365) | (29,308) | (21,153) | 40,299 | (24,670) | (266,294) | 28,159 | 89,162 | (13,459) | (131,896) | (9,576) | (17,188) | 46,689 | 138,333 | 200,469 | 207,004 |
| RETAINED EARNINGS, FIRST OF YEAR | 0 | (29,614) | (86,979) | (116,286) | (137,439) | (97,140) | (121,810) | (388,104) | (359,944) | (270,782) | (284,241) | (416,137) | (425,714) | (442,901) | (396,213) | (257,880) | (57,411) |
| RETAINED EARNINGS, END OF YEAR | (29,614) | (86,979) | (116,286) | (137,439) | (97,140) | (121,810) | (388,104) | (359,944) | (270,782) | (284,241) | (416,137) | (425,714) | (442,901) | (396,213) | (257,880) | (57,411) | 149,593 |



1073

# Exhibit 9-5
## Analysis of Cash & Cash Balances
## Pernik District Heating Company
## Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING CASH BALANCES | 0 | 30,876 | 44,153 | 59,212 | 91,943 | 160,637 | 180,437 | 257,653 | 585,173 | 712,128 | 867,803 | 1,521,906 | 1,862,508 | 2,176,731 | 2,476,196 | 2,793,683 | 3,093,210 |
| PLUS FUNDS GENERATED: | | | | | | | | | | | | | | | | | |
| ADJUSTED NET INCOME | (29,614) | (57,365) | (29,308) | (21,153) | 40,299 | (24,670) | (266,294) | 28,159 | 89,162 | (13,459) | (131,896) | (9,576) | (17,188) | 46,689 | 138,333 | 200,469 | 207,004 |
| NON CASH ITEMS | | | | | | | | | | | | | | | | | |
| DEPRECIATION | 62,169 | 115,460 | 109,687 | 104,203 | 98,992 | 192,832 | 479,558 | 455,580 | 432,801 | 617,007 | 1,203,697 | 1,143,512 | 1,086,336 | 1,032,019 | 988,418 | 962,996 | 914,846 |
| TOTAL FUNDS GENERATED | 32,556 | 58,095 | 80,379 | 83,050 | 139,291 | 168,162 | 213,264 | 483,739 | 521,963 | 603,548 | 1,071,801 | 1,133,935 | 1,069,149 | 1,078,708 | 1,126,751 | 1,163,465 | 1,121,850 |
| DEDUCT USES OF FUNDS: | | | | | | | | | | | | | | | | | |
| REDEMPTION – LOANS | 0 | 21,744 | 24,662 | 27,973 | 42,749 | 99,032 | 83,684 | 113,310 | 324,804 | 363,609 | 365,693 | 718,166 | 745,611 | 746,362 | 760,307 | 829,554 | 897,358 |
| FINANCING COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CHANGE IN WORKING CAPITAL | (1,679) | (23,074) | (40,658) | (22,346) | (27,848) | (49,330) | (52,364) | (42,909) | (70,205) | (84,264) | (52,005) | (75,167) | (9,314) | (32,881) | (46,957) | (34,384) | (42,106) |
| MAINTENANCE SPARES | (2,853) | 613 | (1,155) | (607) | (1,554) | (1,250) | (153) | 202 | (6,192) | 1,967 | (5,542) | 6,391 | (2,403) | (7,552) | 768 | (2,749) | 3,715 |
| ACCOUNTS RECEIVABLE | (15,804) | (30,542) | (47,753) | (31,846) | (37,411) | (59,405) | (64,522) | (55,693) | (77,258) | (99,013) | (58,285) | (91,831) | (18,056) | (37,328) | (62,717) | (45,650) | (60,965) |
| ACCOUNTS PAYABLE | 16,977 | 6,855 | 6,250 | 10,107 | 11,117 | 11,325 | 12,312 | 12,582 | 13,245 | 12,782 | 11,822 | 10,272 | 11,145 | 11,999 | 12,993 | 14,014 | 15,145 |
| CAPITAL EXPENDITURES | 1,503,976 | 0 | 0 | 1,887,756 | 3,702,916 | 2,312,459 | 3,442,791 | 5,916,693 | 5,418,413 | 1,687,827 | 0 | 0 | 0 | 0 | 639,973 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUNDS USED | 1,505,656 | 44,818 | 65,320 | 1,938,074 | 3,773,514 | 2,460,822 | 3,578,839 | 6,074,912 | 5,613,422 | 2,135,699 | 417,698 | 793,333 | 754,925 | 779,243 | 1,449,237 | 863,938 | 939,464 |
| CASH RECEIPTS FROM FINANCING | 1,503,976 | 0 | 0 | 1,887,756 | 3,702,916 | 2,312,459 | 3,442,791 | 5,916,693 | 5,418,413 | 1,687,827 | 0 | 0 | 0 | 0 | 639,973 | 0 | 0 |
| ENDING CASH BALANCES | 30,876 | 44,153 | 59,212 | 91,943 | 160,637 | 180,437 | 257,653 | 585,173 | 712,128 | 867,803 | 1,521,906 | 1,862,508 | 2,176,731 | 2,476,196 | 2,793,683 | 3,093,210 | 3,275,596 |

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1074

# Exhibit 9-6
## Balance Sheet
## Pernik District Heating Company
## Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASSETS: | | | | | | | | | | | | | | | | | |
| PLANT IN SERVICE | 2,371,366 | 2,371,366 | 2,371,366 | 2,371,366 | 2,371,366 | 10,274,496 | 10,274,496 | 10,274,496 | 10,274,496 | 26,742,222 | 26,742,222 | 26,742,222 | 26,742,222 | 26,742,222 | 27,362,194 | 27,362,194 | 27,362,194 |
| C.W.I.P. | 0 | 0 | 0 | 1,667,756 | 5,590,672 | 0 | 3,442,791 | 9,361,484 | 14,779,897 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LESS: ACCUM. PROV. FOR DEPR. | 62,169 | 177,629 | 287,316 | 391,518 | 490,511 | 683,343 | 1,162,901 | 1,618,480 | 2,051,261 | 2,668,289 | 3,871,965 | 5,015,497 | 6,101,833 | 7,133,853 | 8,122,271 | 9,065,267 | 10,000,113 |
| NET PLANT | 2,309,197 | 2,193,737 | 2,084,050 | 3,867,604 | 7,471,527 | 9,591,155 | 12,554,386 | 18,017,501 | 23,003,114 | 24,073,933 | 22,870,236 | 21,726,724 | 20,640,388 | 19,608,369 | 19,259,923 | 18,296,927 | 17,362,081 |
| CURRENT ASSETS | | | | | | | | | | | | | | | | | |
| CASH | 30,676 | 44,153 | 59,212 | 91,943 | 160,637 | 180,437 | 257,653 | 565,173 | 712,128 | 867,603 | 1,521,906 | 1,862,506 | 2,178,731 | 2,476,196 | 2,793,683 | 3,093,210 | 3,275,596 |
| STORES & MATERIALS | 2,853 | 2,240 | 3,395 | 4,002 | 5,556 | 6,606 | 6,959 | 6,757 | 12,949 | 10,983 | 16,525 | 10,133 | 12,536 | 20,089 | 19,321 | 22,070 | 18,355 |
| ACCOUNTS RECEIVABLE | 15,804 | 46,346 | 94,099 | 125,944 | 163,356 | 222,761 | 287,282 | 342,975 | 420,233 | 519,246 | 577,531 | 669,362 | 687,416 | 724,745 | 787,463 | 833,113 | 894,078 |
| TOTAL CURRENT ASSETS | 49,533 | 92,739 | 156,706 | 221,890 | 329,549 | 410,004 | 551,895 | 934,906 | 1,145,310 | 1,398,032 | 2,115,961 | 2,542,003 | 2,878,685 | 3,221,030 | 3,600,466 | 3,948,392 | 4,188,029 |
| EXCHANGE RATE VARIANCES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNAMORTIZED FIN. COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL ASSETS | 2,358,730 | 2,286,476 | 2,240,756 | 4,089,493 | 7,801,076 | 10,001,159 | 13,106,283 | 18,952,407 | 24,148,423 | 25,471,965 | 24,986,198 | 24,268,727 | 23,517,073 | 22,829,399 | 22,860,390 | 22,245,319 | 21,570,110 |
| LIABILITIES: | | | | | | | | | | | | | | | | | |
| PAID IN CAPITAL | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 | 867,390 |
| RESERVE FUNDS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET INCOME FOR PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRANSFERS & CONTRIBUTIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE, END OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LOANS OUTSTANDING | | | | | | | | | | | | | | | | | |
| DOMESTIC LOANS | 120,348 | 95,666 | 67,713 | 96,991 | 166,439 | 203,999 | 255,964 | 359,294 | 384,956 | 283,997 | 160,602 | 58,296 | 7,732 | (0) | 11,777 | 9,364 | 6,627 |
| FOREIGN LOANS | 1,361,884 | 1,361,884 | 1,361,884 | 3,177,613 | 6,712,050 | 8,903,265 | 12,180,781 | 17,671,340 | 22,700,482 | 24,123,575 | 23,528,804 | 22,885,499 | 22,189,700 | 21,437,125 | 21,235,766 | 20,340,822 | 19,477,613 |
| TOTAL LONG-TERM DEBT | 1,482,232 | 1,457,570 | 1,429,597 | 3,274,604 | 6,878,488 | 9,107,263 | 12,436,744 | 18,030,633 | 23,085,438 | 24,407,572 | 23,689,406 | 22,943,795 | 22,197,432 | 21,437,125 | 21,247,543 | 20,350,186 | 19,484,240 |
| CURRENT LIABILITIES | | | | | | | | | | | | | | | | | |
| SHORT TERM LOANS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CURRENT PORTION-LONG-TERM DEBT | 21,744 | 24,662 | 27,973 | 42,749 | 99,032 | 83,684 | 113,310 | 324,804 | 363,609 | 365,693 | 718,166 | 745,611 | 746,362 | 760,307 | 829,554 | 897,358 | 865,946 |
| ACCOUNTS PAYABLE | 16,977 | 23,832 | 32,082 | 42,189 | 53,306 | 64,631 | 76,942 | 89,524 | 102,769 | 115,551 | 127,373 | 137,645 | 146,790 | 160,769 | 173,782 | 187,796 | 202,941 |
| TOTAL CURRENT LIABILITIES | 38,721 | 48,495 | 60,055 | 84,938 | 152,338 | 148,315 | 190,253 | 414,328 | 466,377 | 481,244 | 845,539 | 883,256 | 895,152 | 921,097 | 1,003,336 | 1,085,154 | 1,068,887 |
| TOTAL LIABILITIES | 1,520,954 | 1,506,065 | 1,489,652 | 3,359,542 | 7,030,826 | 9,255,578 | 12,626,997 | 18,444,961 | 23,551,815 | 24,888,816 | 24,534,945 | 23,827,051 | 23,092,585 | 22,358,221 | 22,250,879 | 21,435,340 | 20,553,127 |
| RETAINED EARNINGS | (29,614) | (66,979) | (116,266) | (137,439) | (97,140) | (121,810) | (388,104) | (359,944) | (270,782) | (284,241) | (416,137) | (425,714) | (442,901) | (396,213) | (257,860) | (57,411) | 149,593 |
| TOTAL LIABILITIES & CAPITAL | 2,358,730 | 2,286,476 | 2,240,756 | 4,089,493 | 7,801,076 | 10,001,159 | 13,106,283 | 18,952,407 | 24,148,423 | 25,471,965 | 24,986,198 | 24,268,727 | 23,517,073 | 22,829,399 | 22,860,390 | 22,245,319 | 21,570,110 |

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1075

# SOFIA TPS

## Baseline Case

### Exhibit 9-7 to 9-12

# Exhibit 9-7
## General Data Development
## Sofia District Heating Company
## TPS Sofia - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GENERAL INFLATION | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.860% | 2.670% | 3.500% | 3.500% | 3.500% | 3.500% | 3.500% | 3.350% | 3.200% | 3.060% | 2.930% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% |
| DOMESTIC | 40.000% | 40.000% | 35.000% | 30.000% | 25.000% | 20.000% | 18.000% | 16.000% | 14.000% | 12.000% | 10.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% |
| COMPOUNDED: | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.0186 | 1.0458 | 1.0824 | 1.1203 | 1.1595 | 1.2001 | 1.2421 | 1.2837 | 1.3248 | 1.3653 | 1.4053 | 1.4447 | 1.4851 | 1.5267 | 1.5694 | 1.6134 | 1.6586 |
| DOMESTIC | 1.4000 | 1.9600 | 2.6460 | 3.4398 | 4.2998 | 5.1597 | 6.0884 | 7.0626 | 8.0514 | 9.0175 | 9.9193 | 10.7128 | 11.5698 | 12.4954 | 13.4951 | 14.5747 | 15.7406 |
| FOREX RATIO | 1.3744 | 1.6742 | 2.4446 | 3.0705 | 3.7083 | 4.2995 | 4.9018 | 5.5018 | 6.0776 | 6.6048 | 7.0584 | 7.4155 | 7.7906 | 8.1847 | 8.5987 | 9.0336 | 9.4906 |
| EXCHANGE RATE (LEVA/US) | 43.96 | 59.97 | 78.23 | 98.26 | 118.67 | 137.58 | 156.86 | 176.06 | 194.46 | 211.35 | 225.87 | 237.30 | 249.30 | 261.91 | 275.16 | 289.06 | 303.70 |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN (US 1993$) | $13,531 | $0 | $0 | $0 | $1,706 | $0 | $0 | $0 | $0 | $1,706 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| FOREIGN (CURRENT) | $13,783 | $0 | $0 | $0 | $1,978 | $0 | $0 | $0 | $0 | $2,329 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| FOREIGN (LEVA-CURRENT) | 606,189 | 0 | 0 | 0 | 234,732 | 0 | 0 | 0 | 0 | 492,285 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (US 1993) | $455 | $0 | $0 | $0 | $106 | $0 | $0 | $0 | $0 | $107 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOMESTIC (LEVA 1993) | 14,560 | 0 | 0 | 0 | 3,392 | 0 | 0 | 0 | 0 | 3,424 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (LEVA-CURRENT) | 20,384 | 0 | 0 | 0 | 14,585 | 0 | 0 | 0 | 0 | 30,876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (CURRENT US) | $463 | $0 | $0 | $0 | $123 | $0 | $0 | $0 | $0 | $146 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| OPERATING EXPENSES (US $1993) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 29,034 | 33,783 | 40,323 | 48,287 | 57,590 | 60,844 | 63,943 | 63,819 | 63,639 | 63,395 | 63,070 | 62,556 | 62,701 | 62,788 | 62,904 | 63,016 | 63,096 |
| FUEL COST-OIL | 1,678 | 1,806 | 1,983 | 2,124 | 2,254 | 2,384 | 2,507 | 2,502 | 2,494 | 2,483 | 2,470 | 2,449 | 2,455 | 2,458 | 2,463 | 2,467 | 2,470 |
| PURCHASED POWER (NET) | (12,923) | (13,797) | (14,768) | (15,224) | (15,662) | (16,077) | (16,506) | (16,506) | (16,511) | (16,514) | (16,514) | (16,514) | (16,513) | (16,513) | (16,513) | (16,513) | (16,513) |
| FIXED O & M | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 | 2,518 |
| VARIABLE O & M | 2,917 | 2,945 | 3,036 | 3,139 | 3,235 | 3,323 | 3,397 | 3,422 | 3,445 | 3,464 | 3,481 | 3,487 | 3,495 | 3,499 | 3,505 | 3,510 | 3,514 |
| EMISSION PENALTIES | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| MAINTENANCE EXPENSES | 1,705 | 2,264 | 2,145 | 2,185 | 2,329 | 1,915 | 2,703 | 2,222 | 2,516 | 2,619 | 2,333 | 2,827 | 2,568 | 2,630 | 3,148 | 2,379 | 3,254 |
| TOTAL O & M EXPENSES | 24,940 | 29,530 | 35,248 | 43,041 | 52,276 | 54,919 | 58,575 | 57,990 | 58,114 | 57,978 | 57,371 | 57,336 | 57,237 | 57,593 | 58,038 | 57,390 | 58,352 |
| OPERATING EXPENSES (LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 1,300,723 | 2,118,670 | 3,414,229 | 5,315,124 | 7,923,923 | 10,045,977 | 12,458,032 | 14,423,293 | 16,396,178 | 18,293,311 | 20,019,481 | 21,444,835 | 23,214,106 | 25,106,022 | 27,164,597 | 29,390,001 | 31,781,497 |
| FUEL COST-OIL | 75,174 | 113,272 | 167,905 | 233,796 | 310,132 | 393,623 | 488,439 | 585,460 | 642,563 | 716,496 | 784,020 | 839,542 | 908,927 | 982,841 | 1,063,627 | 1,150,583 | 1,244,141 |
| PURCHASED POWER | (578,950) | (865,348) | (1,250,436) | (1,675,760) | (2,154,966) | (2,654,480) | (3,215,868) | (3,730,407) | (4,253,953) | (4,765,293) | (5,241,622) | (5,661,166) | (6,113,691) | (6,602,786) | (7,131,009) | (7,701,490) | (8,317,609) |
| FIXED O & M | 112,808 | 157,929 | 213,204 | 277,165 | 346,457 | 415,746 | 490,583 | 569,076 | 646,746 | 726,598 | 799,256 | 863,196 | 932,252 | 1,006,832 | 1,087,378 | 1,174,369 | 1,268,318 |
| VARIABLE O & M | 130,682 | 164,710 | 257,064 | 345,521 | 445,110 | 548,662 | 661,838 | 773,383 | 887,582 | 999,575 | 1,104,928 | 1,195,379 | 1,293,971 | 1,399,089 | 1,513,607 | 1,637,027 | 1,770,004 |
| EMISSION PENALTIES | 493 | 690 | 931 | 1,321 | 1,651 | 1,981 | 2,533 | 2,938 | 3,349 | 3,751 | 4,126 | 4,457 | 4,813 | 5,198 | 5,614 | 6,063 | 6,548 |
| MAINTENANCE EXPENSES | 76,384 | 141,998 | 181,621 | 240,511 | 320,452 | 316,166 | 526,626 | 502,179 | 648,231 | 755,741 | 740,534 | 969,124 | 950,764 | 1,131,586 | 1,359,439 | 1,109,541 | 1,639,042 |
| TOTAL O & M EXPENSES | 1,117,312 | 1,652,122 | 2,964,519 | 4,737,678 | 7,192,759 | 9,067,698 | 11,412,183 | 13,105,921 | 14,972,697 | 16,730,177 | 18,210,522 | 19,655,366 | 21,191,142 | 23,028,781 | 25,063,253 | 26,766,093 | 29,391,941 |

BEST AVAILABLE COPY



1077

# Exhibit 9-8
## Projected Investment Program - Municipal Ownership
## Sofia District Heating Company
## TPS Sofia - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPITAL EXPENDITURES (000'S LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FOREIGN | 606,189 | 0 | 0 | 0 | 234,732 | 0 | 0 | 0 | 0 | 492,285 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC | 20,384 | 0 | 0 | 0 | 14,585 | 0 | 0 | 0 | 0 | 30,876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MUNICIPAL OWNERSHIP: | | | | | | | | | | | | | | | | | |
| INVESTMENT PROGRAM | | | | | | | | | | | | | | | | | |
| FOREIGN | | | | | | | | | | | | | | | | | |
| SERIES 94-97 | 630,436 | 0 | 0 | 0 | | | | | | | | | | | | | |
| DRAWDOWN | 630,436 | 0 | 0 | 0 | | | | | | | | | | | | | |
| UNDISBURED | 0 | 0 | 0 | 0 | | | | | | | | | | | | | |
| SERIES 98-2002 | | | | | 244,121 | 0 | 0 | 0 | 0 | | | | | | | | |
| DRAWDOWN | | | | | 244,121 | 0 | 0 | 0 | 0 | | | | | | | | |
| UNDISBURED | | | | | 0 | 0 | 0 | 0 | 0 | | | | | | | | |
| SERIES 03-06 | | | | | | | | | | 511,976 | 0 | 0 | 0 | | | | |
| DRAWDOWN | | | | | | | | | | 511,976 | 0 | 0 | 0 | | | | |
| UNDISBURED | | | | | | | | | | 0 | 0 | 0 | 0 | | | | |
| DOMESTIC | | | | | | | | | | | | | | | | | |
| ANNUAL REQUIREMENT | 23,442 | 0 | 0 | 0 | 16,772 | 0 | 0 | 0 | 0 | 35,507 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

CAPITALIZATION SCHEDULE AND
APPLICATION OF CONSTRUCTION FUNDS
SOFIA DISTRICT HEATING COMPANY
TPS SOFIA - BASELINE CASE

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING BALANCE | | | | | | | | | | | | | | | | | |
| CAPITAL FUNDING | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 630,436 | 0 | 0 | 0 | 244,121 | 0 | 0 | 0 | 0 | 511,976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC LOANS | 23,442 | 0 | 0 | 0 | 16,772 | 0 | 0 | 0 | 0 | 35,507 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL NEW CAPITAL | 653,878 | 0 | 0 | 0 | 260,894 | 0 | 0 | 0 | 0 | 547,483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INTERNAL FUNDS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PROCEEDS AVAILABLE | 653,878 | 0 | 0 | 0 | 260,894 | 0 | 0 | 0 | 0 | 547,483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UTILIZATION OF PROCEEDS | | | | | | | | | | | | | | | | | |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN COSTS | 606,189 | 0 | 0 | 0 | 234,732 | 0 | 0 | 0 | 0 | 492,285 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC COSTS | 20,384 | 0 | 0 | 0 | 14,585 | 0 | 0 | 0 | 0 | 30,876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COMMITMENT FEES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOND DISCOUNT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RES. FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER EXPENSES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL UTILIZATION | 626,573 | 0 | 0 | 0 | 249,317 | 0 | 0 | 0 | 0 | 523,161 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE ON DEPOSIT | | | | | | | | | | | | | | | | | |
| INTEREST EARNED ON: | | | | | | | | | | | | | | | | | |
| CONSTRUCTION FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RESERVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE AVAILABLE | 27,305 | 0 | 0 | 0 | 11,577 | 0 | 0 | 0 | 0 | 24,323 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INTEREST CHARGES | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 24,248 | 0 | 0 | 0 | 9,389 | 0 | 0 | 0 | 0 | 19,691 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC LOANS | 3,058 | 0 | 0 | 0 | 2,188 | 0 | 0 | 0 | 0 | 4,631 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST | 27,305 | 0 | 0 | 0 | 11,577 | 0 | 0 | 0 | 0 | 24,323 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET END OF PERIOD | (0) | 0 | 0 | 0 | (0) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AMOUNT CLOSED TO PLANT | 653,878 | 0 | 0 | 0 | 260,894 | 0 | 0 | 0 | 0 | 547,483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



1078

# Exhibit 9-9
## Debt Service Schedule
## Sofia District Heating Company
## TPS Sofia - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOREIGN LOANS: | | | | | | | | | | | | | | | | | |
| SERIES 94-97 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 630,436 | 630,436 | 630,436 | 630,436 | 630,436 | 616,902 | 602,264 | 586,431 | 569,306 | 550,783 | 530,749 | 509,081 | 485,644 | 460,295 | 432,877 | 403,222 |
| AMOUNT DRAWN DOWN | 630,436 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 50,435 | 50,435 | 50,435 | 50,435 | 50,170 | 49,065 | 47,871 | 46,579 | 45,181 | 43,670 | 42,035 | 40,267 | 38,354 | 36,286 | 34,049 | 31,629 |
| PRINCIPAL REPAYMENT | 0 | 0 | 0 | 0 | 0 | 13,534 | 14,639 | 15,833 | 17,125 | 18,522 | 20,034 | 21,669 | 23,437 | 25,349 | 27,416 | 29,655 | 32,075 |
| TOTAL DEBT SERVICE | 0 | 50,435 | 50,435 | 50,435 | 50,435 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 | 63,704 |
| SERIES 98-02 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | 0 | 244,121 | 244,121 | 244,121 | 244,121 | 244,121 | 238,880 | 233,212 | 227,081 | 220,450 | 213,277 | 205,520 | 197,129 |
| AMOUNT DRAWN DOWN | | | | | 244,121 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | 0 | 19,530 | 19,530 | 19,530 | 19,530 | 19,427 | 18,999 | 18,537 | 18,036 | 17,495 | 16,910 | 16,277 | 15,592 |
| PRINCIPAL REPAYMENT | | | | | 0 | 0 | 0 | 0 | 0 | 5,241 | 5,668 | 6,131 | 6,631 | 7,172 | 7,758 | 8,391 | 9,075 |
| TOTAL DEBT SERVICE | | | | | 0 | 19,530 | 19,530 | 19,530 | 19,530 | 24,668 | 24,668 | 24,668 | 24,668 | 24,668 | 24,668 | 24,668 | 24,668 |
| SERIES 03-07 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | 0 | 511,976 | 511,976 | 511,976 | 511,976 | 511,976 | 500,985 | 489,097 |
| AMOUNT DRAWN DOWN | | | | | | | | | | 511,976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | | | | | 0 | 40,958 | 40,958 | 40,958 | 40,958 | 40,743 | 39,846 | 38,876 |
| PRINCIPAL REPAYMENT | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 10,991 | 11,888 | 12,858 |
| TOTAL DEBT SERVICE | | | | | | | | | | | 40,958 | 40,958 | 40,958 | 40,958 | 51,734 | 51,734 | 51,734 |
| BALANCE, END OF PERIOD | 630,436 | 630,436 | 630,436 | 630,436 | 874,558 | 861,023 | 846,385 | 830,552 | 813,427 | 1,301,640 | 1,275,937 | 1,248,138 | 1,218,070 | 1,185,548 | 1,139,382 | 1,089,448 | 1,035,440 |
| DOMESTIC LOANS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | | | | |
| SERIES 94 | 0 | 23,442 | 19,854 | 15,786 | 11,171 | 5,937 | | | | | | | | | | | |
| SERIES 95 | | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | |
| SERIES 96 | | | | 0 | 0 | 0 | 0 | 0 | | | | | | | | | |
| SERIES 97 | | | | | 0 | 0 | 0 | 0 | 0 | | | | | | | | |
| SERIES 98 | | | | | | 16,772 | 14,206 | 11,295 | 7,993 | 4,248 | | | | | | | |
| SERIES 99 | | | | | | | 0 | 0 | 0 | 0 | 0 | | | | | | |
| SERIES 00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | | | | | |
| SERIES 01 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | | | | |
| SERIES 02 | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | | | |
| SERIES 03 | | | | | | | | | | | 35,507 | 30,074 | 23,911 | 16,921 | 8,993 | | |
| SERIES 04 | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| SERIES 05 | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| SERIES 06 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| SERIES 07 | | | | | | | | | | | | | | | 0 | 0 | 0 |
| SERIES 08 | | | | | | | | | | | | | | | | 0 | 0 |
| SERIES 09 | | | | | | | | | | | | | | | | | 0 |
| SERIES 10 | | | | | | | | | | | | | | | | | 0 |
| TOTAL OUTSTANDING | 0 | 23,442 | 19,854 | 15,786 | 11,171 | 22,709 | 14,206 | 11,295 | 7,993 | 4,248 | 35,507 | 30,074 | 23,911 | 16,921 | 8,993 | 0 | 0 |
| AMOUNT DRAWN DOWN | 23,442 | 0 | 0 | 0 | 16,772 | 0 | 0 | 0 | 0 | 35,507 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 2,934 | 2,453 | 1,907 | 1,287 | 2,685 | 1,755 | 1,364 | 921 | 419 | 4,445 | 3,716 | 2,888 | 1,950 | 886 | 0 | 0 |
| PRINCIPAL REPAYMENT | 0 | 3,587 | 4,069 | 4,615 | 5,234 | 8,503 | 2,911 | 3,302 | 3,745 | 4,248 | 5,434 | 6,163 | 6,990 | 7,928 | 8,993 | 0 | 0 |
| TOTAL DEBT SERVICE | 0 | 6,522 | 6,522 | 6,522 | 6,522 | 11,188 | 4,666 | 4,666 | 4,666 | 4,666 | 9,878 | 9,878 | 9,878 | 9,878 | 9,878 | 0 | 0 |
| BALANCE, END OF PERIOD | 23,442 | 19,854 | 15,786 | 11,171 | 22,709 | 14,206 | 11,295 | 7,993 | 4,248 | 35,507 | 30,074 | 23,911 | 16,921 | 8,993 | (0) | 0 | 0 |
| TOTALS ALL DEBT: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 653,878 | 650,291 | 646,222 | 641,607 | 697,267 | 675,229 | 657,680 | 638,545 | 817,675 | 1,337,147 | 1,306,011 | 1,272,049 | 1,234,991 | 1,194,541 | 1,139,382 | 1,089,448 |
| AMOUNT DRAWN DOWN | 653,878 | 0 | 0 | 0 | 260,894 | 0 | 0 | 0 | 0 | 547,483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 53,369 | 52,888 | 52,342 | 51,722 | 72,364 | 70,350 | 68,765 | 67,030 | 65,027 | 106,072 | 105,248 | 102,150 | 98,758 | 94,825 | 90,171 | 86,097 |
| PRINCIPAL REPAYMENT | 0 | 3,587 | 4,069 | 4,615 | 5,234 | 22,038 | 17,550 | 19,135 | 20,870 | 28,011 | 31,136 | 33,962 | 37,058 | 40,450 | 55,159 | 49,934 | 54,008 |
| BALANCE, END OF PERIOD | 653,878 | 650,291 | 646,222 | 641,607 | 697,267 | 675,229 | 657,680 | 638,545 | 617,675 | 1,337,147 | 1,306,011 | 1,272,049 | 1,234,991 | 1,194,541 | 1,139,382 | 1,089,448 | 1,035,440 |
| TOTAL DEBT SERVICE | 0 | 56,957 | 56,957 | 56,957 | 56,957 | 94,421 | 87,900 | 87,900 | 87,900 | 93,038 | 139,208 | 139,208 | 139,208 | 139,208 | 149,984 | 140,105 | 140,105 |



BEST AVAILABLE COPY

1079

# Exhibit 9-10
## Statement of Income
## Sofia District Heating Company
## TPS Sofia - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING REVENUES: | | | | | | | | | | | | | | | | | |
| STEAM | 94,973 | 165,174 | 252,900 | 388,896 | 571,416 | 710,169 | 863,009 | 981,257 | 1,115,830 | 1,253,362 | 1,358,155 | 1,462,692 | 1,574,884 | 1,719,271 | 1,862,557 | 1,994,339 | 2,180,234 |
| HOT WATER | 1,042,275 | 1,616,505 | 2,852,044 | 4,493,090 | 6,827,847 | 8,724,286 | 10,691,706 | 12,384,072 | 14,082,470 | 15,818,205 | 17,140,756 | 18,460,082 | 19,876,013 | 21,698,267 | 23,506,624 | 25,169,787 | 27,515,900 |
| ELECTRICITY | 578,950 | 865,348 | 1,250,436 | 1,675,760 | 2,154,966 | 2,654,480 | 3,215,668 | 3,730,407 | 4,253,953 | 4,765,293 | 5,241,822 | 5,661,168 | 6,113,691 | 6,602,786 | 7,131,009 | 7,701,490 | 8,317,609 |
| TOTAL SALES REVENUE | 1,716,198 | 2,647,028 | 4,355,380 | 6,555,747 | 9,554,229 | 12,088,935 | 14,970,584 | 17,095,736 | 19,452,253 | 21,836,860 | 23,740,735 | 25,583,942 | 27,564,588 | 30,020,324 | 32,500,190 | 34,865,615 | 38,013,742 |
| OTHER OPER. REVENUES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING REVENUES | 1,716,198 | 2,647,028 | 4,355,380 | 6,555,747 | 9,554,229 | 12,088,935 | 14,970,584 | 17,095,736 | 19,452,253 | 21,836,860 | 23,740,735 | 25,583,942 | 27,564,588 | 30,020,324 | 32,500,190 | 34,865,615 | 38,013,742 |
| OPERATING EXPENSES: | | | | | | | | | | | | | | | | | |
| OPER. & MAIN. | | | | | | | | | | | | | | | | | |
| FUEL– GAS | 1,300,723 | 2,118,870 | 3,414,229 | 5,315,124 | 7,923,923 | 10,045,977 | 12,458,032 | 14,423,293 | 16,396,178 | 18,293,311 | 20,019,481 | 21,444,835 | 23,214,106 | 25,106,022 | 27,164,597 | 29,390,001 | 31,781,497 |
| OIL | 75,174 | 113,272 | 167,905 | 233,796 | 310,132 | 393,623 | 488,439 | 565,460 | 642,563 | 716,496 | 784,020 | 839,542 | 908,927 | 982,841 | 1,063,627 | 1,150,583 | 1,244,141 |
| LIGNITE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUEL COST | 1,375,898 | 2,232,142 | 3,582,134 | 5,548,920 | 8,234,056 | 10,439,600 | 12,946,472 | 14,988,753 | 17,038,741 | 19,009,807 | 20,803,501 | 22,284,377 | 24,123,033 | 26,088,862 | 28,228,224 | 30,540,584 | 33,025,637 |
| PURCHASED POWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FIXED O & M | 112,606 | 157,929 | 213,204 | 277,165 | 346,457 | 415,748 | 490,583 | 569,076 | 648,746 | 726,596 | 799,256 | 863,196 | 932,252 | 1,006,832 | 1,087,378 | 1,174,369 | 1,268,318 |
| OTHER VAR. O & M | 130,682 | 184,710 | 257,064 | 345,521 | 445,110 | 546,662 | 661,838 | 773,383 | 887,582 | 999,575 | 1,104,928 | 1,195,379 | 1,293,971 | 1,399,069 | 1,513,607 | 1,637,027 | 1,770,004 |
| EMISSION PENALTIES | 493 | 690 | 931 | 1,321 | 1,651 | 1,981 | 2,533 | 2,938 | 3,349 | 3,751 | 4,126 | 4,457 | 4,813 | 5,198 | 5,614 | 6,063 | 6,548 |
| MAINTENACE EXPENSE | 76,364 | 141,998 | 181,621 | 240,511 | 320,452 | 318,188 | 526,626 | 502,179 | 648,231 | 755,741 | 740,534 | 969,124 | 950,764 | 1,131,586 | 1,359,439 | 1,109,541 | 1,639,042 |
| PLANT REMOVAL COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL O & M | 1,696,262 | 2,717,469 | 4,234,955 | 6,413,438 | 9,347,725 | 11,722,178 | 14,628,052 | 16,836,328 | 19,226,650 | 21,495,469 | 23,452,344 | 25,316,534 | 27,304,833 | 29,631,567 | 32,194,262 | 34,467,583 | 37,709,550 |
| DEPRECIATION EXPENSE | 74,323 | 95,128 | 90,371 | 85,853 | 83,191 | 90,445 | 85,923 | 81,627 | 77,546 | 77,090 | 97,188 | 92,329 | 87,712 | 83,326 | 79,160 | 75,202 | 71,442 |
| OTHER OPER. EXPENSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING EXPENSES | 1,770,586 | 2,812,597 | 4,325,326 | 6,499,291 | 9,430,916 | 11,812,623 | 14,713,975 | 16,917,955 | 19,304,196 | 21,572,559 | 23,549,532 | 25,408,862 | 27,392,545 | 29,714,894 | 32,273,423 | 34,542,785 | 37,780,992 |
| OPERATING SURPLUS | (54,388) | 34,431 | 30,054 | 56,455 | 123,313 | 276,312 | 256,609 | 177,781 | 148,058 | 264,300 | 191,202 | 175,080 | 172,043 | 305,431 | 226,767 | 322,830 | 232,751 |
| LONG TERM DEBT INTEREST | | | | | | | | | | | | | | | | | |
| FOREIGN | 0 | 50,435 | 50,435 | 50,435 | 50,435 | 69,699 | 68,595 | 67,400 | 66,108 | 64,608 | 103,627 | 101,530 | 99,261 | 96,808 | 93,939 | 90,171 | 86,097 |
| DOMESTIC | 0 | 2,934 | 2,453 | 1,907 | 1,287 | 2,685 | 1,755 | 1,364 | 921 | 419 | 4,445 | 3,716 | 2,888 | 1,950 | 886 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST EXPENSE | 0 | 53,369 | 52,888 | 52,342 | 51,722 | 72,384 | 70,350 | 68,765 | 67,030 | 65,027 | 108,072 | 105,246 | 102,150 | 98,758 | 94,825 | 90,171 | 86,097 |
| NET INCOME FOR YEAR | (54,388) | (18,939) | (22,834) | 4,114 | 71,591 | 203,928 | 186,259 | 109,016 | 81,028 | 199,274 | 83,130 | 69,835 | 69,893 | 206,673 | 131,943 | 232,659 | 146,654 |
| PROVISION FOR TAXES @ 42% | 0 | 0 | 0 | 1,728 | 30,068 | 85,650 | 78,229 | 45,787 | 34,032 | 83,695 | 34,915 | 29,331 | 29,355 | 86,802 | 55,416 | 97,717 | 61,595 |
| ADJUSTED NET INCOME | (54,388) | (18,939) | (22,834) | 2,386 | 41,523 | 118,278 | 108,030 | 63,230 | 46,996 | 115,579 | 48,216 | 40,504 | 40,538 | 119,870 | 76,527 | 134,942 | 85,059 |
| RETAINED EARNINGS, FIRST OF YEAR | 0 | (54,388) | (73,326) | (96,160) | (93,774) | (52,252) | 66,027 | 174,057 | 237,286 | 284,283 | 399,861 | 448,077 | 488,581 | 529,119 | 648,989 | 725,516 | 860,458 |
| RETAINED EARNINGS, END OF YEAR | (54,388) | (73,326) | (96,160) | (93,774) | (52,252) | 66,027 | 174,057 | 237,286 | 284,283 | 399,861 | 448,077 | 488,581 | 529,119 | 648,989 | 725,516 | 860,458 | 945,517 |



1083

# Exhibit 9-11
## Analysis of Cash & Cash Balances
## Sofia District Heating Company
## TPS Sofia - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING CASH BALANCES | 0 | 5,094 | 7,284 | 9,768 | 10,859 | 6,850 | 24,063 | 55,476 | 20,190 | 5,063 | 37,570 | 19,748 | 9,076 | 101 | 51,175 | 11,506 | 40,547 |
| PLUS FUNDS GENERATED: | | | | | | | | | | | | | | | | | |
| ADJ. NET INCOME | (54,368) | (16,939) | (22,834) | 2,366 | 41,523 | 116,278 | 108,030 | 63,230 | 46,996 | 115,579 | 48,216 | 40,504 | 40,538 | 119,870 | 76,527 | 134,942 | 85,059 |
| NON CASH ITEMS: | | | | | | | | | | | | | | | | | |
| DEPRECIATION | 74,323 | 95,128 | 90,371 | 85,853 | 83,191 | 90,445 | 85,923 | 81,627 | 77,546 | 77,090 | 97,186 | 92,329 | 87,712 | 83,326 | 79,160 | 75,202 | 71,442 |
| TOTAL FUNDS GENERATED | 19,936 | 78,189 | 67,537 | 88,239 | 124,713 | 206,724 | 193,953 | 144,856 | 124,542 | 192,669 | 145,403 | 132,833 | 128,250 | 203,197 | 155,687 | 210,144 | 156,501 |
| DEDUCT USES OF FUNDS: | | | | | | | | | | | | | | | | | |
| REDEMPTION – LOANS | 0 | 3,567 | 4,069 | 4,615 | 5,234 | 22,036 | 17,550 | 19,135 | 20,870 | 28,011 | 31,136 | 33,962 | 37,058 | 40,450 | 55,159 | 49,934 | 54,006 |
| FINANCING COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CHANGE IN WORKING CAPITAL | (14,842) | (70,411) | (60,964) | (82,534) | (123,466) | (169,453) | (145,011) | (161,006) | (118,798) | (132,151) | (132,091) | (109,541) | (100,166) | (111,673) | (140,197) | (131,169) | (136,900) |
| MAINTENANCE SPARES | (1,526) | (1,312) | (792) | (1,178) | (1,599) | 65 | (4,209) | 489 | (2,921) | (2,150) | 304 | (4,572) | 367 | (3,616) | (4,557) | 4,998 | (10,590) |
| ACCOUNTS RECEIVABLE | (27,924) | (75,046) | (67,650) | (90,501) | (132,022) | (179,909) | (152,082) | (172,699) | (127,509) | (141,391) | (143,076) | (114,232) | (110,592) | (118,639) | (147,344) | (148,792) | (141,926) |
| ACCOUNTS PAYABLE | 14,609 | 5,949 | 7,658 | 9,145 | 10,133 | 10,371 | 11,261 | 11,402 | 11,632 | 11,391 | 10,681 | 9,263 | 10,059 | 10,782 | 11,704 | 12,625 | 13,616 |
| CAPITAL EXPENDITURES | 653,678 | 0 | 0 | 0 | 260,894 | 0 | 0 | 0 | 0 | 547,483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUNDS USED | 666,720 | 73,999 | 65,053 | 87,149 | 369,616 | 191,491 | 162,560 | 160,143 | 139,668 | 707,645 | 163,227 | 143,503 | 137,224 | 152,123 | 195,356 | 181,103 | 192,906 |
| CASH RECEIPTS FROM FINANCING | 653,678 | 0 | 0 | 0 | 260,894 | 0 | 0 | 0 | 0 | 547,483 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENDING CASH BALANCES | 5,094 | 7,284 | 9,768 | 10,859 | 6,850 | 24,063 | 55,476 | 20,190 | 5,063 | 37,570 | 19,748 | 9,076 | 101 | 51,175 | 11,506 | 40,547 | 4,140 |



1081

# Exhibit 9-12
## Balance Sheet
## Sofia District Heating Company
## TPS Sofia - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASSETS:** | | | | | | | | | | | | | | | | | |
| PLANT IN SERVICE | 1,976,878 | 1,976,878 | 1,976,878 | 1,976,878 | 2,237,772 | 2,237,772 | 2,237,772 | 2,237,772 | 2,237,772 | 2,785,255 | 2,785,255 | 2,785,255 | 2,785,255 | 2,785,255 | 2,785,255 | 2,785,255 | 2,785,255 |
| C.W.I.P. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LESS: ACCUM. PROV. FOR DEPR. | 74,323 | 169,451 | 259,823 | 345,675 | 428,866 | 519,311 | 605,234 | 686,861 | 764,407 | 841,497 | 938,685 | 1,031,013 | 1,118,725 | 1,202,052 | 1,281,212 | 1,356,414 | 1,427,856 |
| NET PLANT | 1,902,554 | 1,807,427 | 1,717,055 | 1,631,203 | 1,808,906 | 1,718,460 | 1,632,537 | 1,550,910 | 1,473,365 | 1,943,758 | 1,846,570 | 1,754,242 | 1,666,530 | 1,583,203 | 1,504,043 | 1,428,841 | 1,357,399 |
| CURRENT ASSETS | | | | | | | | | | | | | | | | | |
| CASH | 5,094 | 7,284 | 9,768 | 10,659 | 6,850 | 24,083 | 55,476 | 20,190 | 5,063 | 37,570 | 19,746 | 9,076 | 101 | 51,175 | 11,506 | 40,547 | 4,140 |
| STORES & MATERIALS | 1,526 | 2,840 | 3,632 | 4,810 | 6,409 | 6,324 | 10,533 | 10,044 | 12,965 | 15,115 | 14,611 | 19,382 | 19,015 | 22,632 | 27,169 | 22,191 | 32,781 |
| ACCOUNTS RECEIVABLE | 27,924 | 102,972 | 170,822 | 261,323 | 393,345 | 573,254 | 725,336 | 898,235 | 1,025,744 | 1,167,135 | 1,310,212 | 1,424,444 | 1,535,037 | 1,653,875 | 1,601,219 | 1,950,011 | 2,091,937 |
| TOTAL CURRENT ASSETS | 34,545 | 113,096 | 184,223 | 276,992 | 406,603 | 603,660 | 791,344 | 928,468 | 1,043,772 | 1,219,820 | 1,344,769 | 1,452,902 | 1,554,153 | 1,727,682 | 1,639,914 | 2,012,749 | 2,128,858 |
| EXCHANGE RATE VARIANCES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNAMORTIZED FIN. COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL ASSETS | 1,937,100 | 1,920,523 | 1,901,278 | 1,908,194 | 2,215,509 | 2,322,120 | 2,423,882 | 2,479,379 | 2,517,137 | 3,163,579 | 3,191,339 | 3,207,144 | 3,220,683 | 3,310,885 | 3,343,957 | 3,441,590 | 3,486,257 |
| **LIABILITIES:** | | | | | | | | | | | | | | | | | |
| PAID IN CAPITAL | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 | 1,323,000 |
| RESERVE FUNDS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET INCOME FOR PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRANSFERS & CONTRIBUTIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE, END OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LOANS OUTSTANDING | | | | | | | | | | | | | | | | | |
| DOMESTIC LOANS | 19,854 | 15,786 | 11,171 | 5,937 | 14,206 | 11,295 | 7,993 | 4,246 | (0) | 30,074 | 23,911 | 16,921 | 8,993 | (0) | (0) | 0 | 0 |
| FOREIGN LOANS | 630,436 | 630,436 | 630,436 | 630,436 | 661,023 | 646,365 | 630,552 | 613,427 | 789,664 | 1,275,937 | 1,248,138 | 1,218,070 | 1,185,548 | 1,139,382 | 1,089,448 | 1,035,440 | 979,668 |
| TOTAL LONG-TERM DEBT | 650,291 | 646,222 | 641,607 | 636,373 | 675,229 | 657,660 | 638,545 | 617,675 | 789,664 | 1,306,011 | 1,272,049 | 1,234,991 | 1,194,541 | 1,139,382 | 1,089,448 | 1,035,440 | 979,668 |
| CURRENT LIABILITIES | | | | | | | | | | | | | | | | | |
| SHORT TERM LOANS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CURRENT PORTION-LONG-TERM DEBT | 3,567 | 4,069 | 4,615 | 5,234 | 22,036 | 17,550 | 19,135 | 20,870 | 28,011 | 31,136 | 33,962 | 37,058 | 40,450 | 55,159 | 49,934 | 54,008 | 55,772 |
| ACCOUNTS PAYABLE | 14,609 | 20,558 | 28,216 | 37,361 | 47,494 | 57,865 | 69,145 | 80,548 | 92,180 | 103,570 | 114,251 | 123,515 | 133,573 | 144,355 | 156,059 | 168,684 | 182,299 |
| TOTAL CURRENT LIABILITIES | 18,196 | 24,627 | 32,831 | 42,595 | 69,532 | 75,414 | 88,280 | 101,418 | 120,191 | 134,706 | 148,213 | 160,573 | 174,023 | 199,514 | 205,993 | 222,692 | 238,071 |
| TOTAL LIABILITIES | 1,991,487 | 1,993,849 | 1,997,438 | 2,001,968 | 2,267,761 | 2,256,094 | 2,249,825 | 2,242,092 | 2,232,854 | 2,763,717 | 2,743,262 | 2,718,563 | 2,691,564 | 2,661,896 | 2,618,441 | 2,581,132 | 2,540,739 |
| RETAINED EARNINGS | (54,386) | (73,326) | (96,160) | (93,774) | (52,252) | 66,027 | 174,057 | 237,286 | 284,283 | 399,861 | 448,077 | 488,581 | 529,119 | 648,989 | 725,516 | 860,458 | 945,517 |
| TOTAL LIABILITIES & CAPITAL | 1,937,100 | 1,920,523 | 1,901,278 | 1,908,194 | 2,215,508 | 2,322,120 | 2,423,882 | 2,479,379 | 2,517,137 | 3,163,579 | 3,191,339 | 3,207,144 | 3,220,683 | 3,310,885 | 3,343,957 | 3,441,590 | 3,486,257 |



1082

# ZEMLIANE TPS

## Baseline Case

### Exhibit 9-13 to 9-18

1083

# Exhibit 9-13
## General Data Development
## Sofia District Heating Company
## Zemliane - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GENERAL INFLATION | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.860% | 2.670% | 3.500% | 3.500% | 3.500% | 3.500% | 3.500% | 3.350% | 3.200% | 3.060% | 2.930% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% |
| DOMESTIC | 40.000% | 40.000% | 35.000% | 30.000% | 25.000% | 20.000% | 18.000% | 16.000% | 14.000% | 12.000% | 10.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% |
| COMPOUNDED: | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.0186 | 1.0458 | 1.0824 | 1.1203 | 1.1595 | 1.2001 | 1.2421 | 1.2837 | 1.3248 | 1.3653 | 1.4053 | 1.4447 | 1.4851 | 1.5267 | 1.5694 | 1.6134 | 1.6586 |
| DOMESTIC | 1.4000 | 1.9600 | 2.6460 | 3.4398 | 4.2998 | 5.1597 | 6.0884 | 7.0626 | 8.0514 | 9.0175 | 9.9193 | 10.7128 | 11.5698 | 12.4954 | 13.4951 | 14.5747 | 15.7406 |
| FOREX RATIO | 1.3744 | 1.8742 | 2.4446 | 3.0705 | 3.7083 | 4.2995 | 4.9018 | 5.5018 | 6.0776 | 6.6048 | 7.0584 | 7.4155 | 7.7906 | 8.1847 | 8.5987 | 9.0336 | 9.4906 |
| EXCHANGE RATE(LEVA/US) | 43.98 | 59.97 | 78.23 | 98.26 | 118.67 | 137.58 | 156.86 | 176.06 | 194.48 | 211.35 | 225.87 | 237.30 | 249.30 | 261.91 | 275.16 | 289.06 | 303.70 |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN (US 1993$) | $1,334 | $3,628 | $4,527 | $4,701 | $13,437 | $3,278 | $3,278 | $3,278 | $3,278 | $3,278 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| FOREIGN (CURRENT) | $1,359 | $3,794 | $4,900 | $5,266 | $15,580 | $3,934 | $4,072 | $4,206 | $4,343 | $4,475 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| FOREIGN (LEVA-CURRENT) | 59,763 | 227,546 | 383,310 | 517,456 | 1,848,624 | 541,232 | 638,654 | 740,838 | 844,556 | 945,902 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (US 1993) | $387 | $1,054 | $1,315 | $1,365 | $1,592 | $937 | $937 | $937 | $937 | $937 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOMESTIC (LEVA 1993) | 12,384 | 33,726 | 42,080 | 43,680 | 50,944 | 29,984 | 29,984 | 29,984 | 29,984 | 29,984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (LEVA-CURRENT) | 17,338 | 66,107 | 111,344 | 150,250 | 219,046 | 154,708 | 182,556 | 211,765 | 241,412 | 270,381 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (CURRENT US) | $394 | $1,102 | $1,423 | $1,529 | $1,846 | $1,124 | $1,164 | $1,203 | $1,241 | $1,279 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| OPERATING EXPENSES (US $1993) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 12,602 | 14,794 | 17,494 | 20,775 | 24,651 | 25,893 | 27,276 | 27,003 | 26,733 | 26,466 | 26,201 | 25,939 | 25,939 | 25,939 | 25,939 | 25,939 | 25,939 |
| FUEL COST-OIL | 740 | 791 | 865 | 914 | 965 | 1,014 | 1,069 | 1,058 | 1,046 | 1,037 | 1,026 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 | 1,016 |
| PURCHASED POWER (NET) | 1,075 | 1,149 | 1,257 | 1,328 | 1,402 | 1,479 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 | 1,560 |
| FIXED O & M | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| VARIABLE O & M | 1,100 | 1,103 | 1,131 | 1,164 | 1,198 | 1,232 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 | 1,265 |
| EMISSION PENALTIES | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| MAINTENANCE EXPENSES | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| TOTAL O & M EXPENSES | 17,666 | 19,821 | 23,791 | 26,204 | 30,410 | 31,712 | 34,422 | 33,023 | 32,929 | 32,542 | 33,532 | 32,042 | 32,245 | 32,125 | 33,509 | 32,177 | 32,400 |
| OPERATING EXPENSES (LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 573,530 | 927,880 | 1,481,252 | 2,286,779 | 3,391,760 | 4,275,204 | 5,314,190 | 6,102,762 | 6,887,565 | 7,637,050 | 8,316,639 | 8,892,154 | 9,603,526 | 10,371,808 | 11,201,553 | 12,097,677 | 13,065,491 |
| FUEL COST-OIL | 33,152 | 49,612 | 73,241 | 100,607 | 132,776 | 167,422 | 208,274 | 239,111 | 270,010 | 299,238 | 325,670 | 348,295 | 376,159 | 406,251 | 438,752 | 473,852 | 511,760 |
| PURCHASED POWER | 48,160 | 72,065 | 106,433 | 146,176 | 192,904 | 244,198 | 303,935 | 352,565 | 401,924 | 450,155 | 495,170 | 534,784 | 577,567 | 623,772 | 673,674 | 727,568 | 785,773 |
| FIXED O & M | 35,482 | 49,674 | 67,060 | 87,178 | 108,973 | 130,767 | 154,306 | 176,994 | 204,054 | 228,540 | 251,394 | 271,506 | 293,226 | 316,684 | 342,019 | 369,380 | 398,931 |
| VARIABLE O & M | 49,260 | 69,160 | 95,764 | 126,126 | 164,835 | 203,416 | 246,460 | 285,894 | 325,919 | 365,029 | 401,532 | 433,655 | 468,347 | 505,815 | 546,260 | 589,983 | 637,181 |
| EMISSION PENALTIES | 224 | 314 | 423 | 550 | 688 | 826 | 974 | 1,130 | 1,288 | 1,443 | 1,587 | 1,714 | 1,851 | 1,999 | 2,159 | 2,332 | 2,519 |
| MAINTENANCE EXPENSES | 51,610 | 74,449 | 190,258 | 134,950 | 192,216 | 214,146 | 478,306 | 302,644 | 393,164 | 408,891 | 851,629 | 502,217 | 617,552 | 618,974 | 1,266,161 | 746,223 | 918,246 |
| TOTAL O & M EXPENSES | 791,437 | 1,243,173 | 2,014,432 | 2,884,369 | 4,184,173 | 5,235,981 | 6,706,446 | 7,463,301 | 8,483,945 | 9,390,345 | 10,643,622 | 10,984,325 | 11,938,228 | 12,845,304 | 14,470,598 | 15,007,015 | 16,319,901 |



1084

# Exhibit 9-14
## Projected Investment Program - Municipal Ownership
## Sofia District Heating Company
## Zemliane - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPITAL EXPENDITURES (000'S LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FOREIGN | 59,763 | 227,548 | 383,310 | 517,456 | 1,848,824 | 541,232 | 638,654 | 740,838 | 844,556 | 945,902 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC | 17,338 | 66,107 | 111,344 | 150,250 | 219,046 | 154,708 | 182,556 | 211,765 | 241,412 | 270,381 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MUNICIPAL OWNERSHIP: | | | | | | | | | | | | | | | | | |
| INVESTMENT PROGRAM | | | | | | | | | | | | | | | | | |
| FOREIGN | | | | | | | | | | | | | | | | | |
| SERIES 94-98 | 3,208,086 | 3,145,933 | 2,894,397 | 2,482,006 | 1,932,021 | | | | | | | | | | | | |
| DRAWDOWN | 62,154 | 251,536 | 412,390 | 549,986 | 1,932,021 | | | | | | | | | | | | |
| UNDISBURED | 3,145,933 | 2,894,397 | 2,482,006 | 1,932,021 | 0 | | | | | | | | | | | | |
| SERIES 99-2003 | | | | | | 3,901,817 | 3,338,936 | 2,658,886 | 1,875,758 | 988,468 | | | | | | | |
| DRAWDOWN | | | | | | 562,881 | 680,050 | 783,128 | 887,290 | 988,468 | | | | | | | |
| UNDISBURED | | | | | | 3,338,936 | 2,658,886 | 1,875,758 | 988,468 | 0 | | | | | | | |
| DOMESTIC | | | | | | | | | | | | | | | | | |
| ANNUAL REQUIREMENT | 19,938 | 76,023 | 128,045 | 172,788 | 251,903 | 177,915 | 209,939 | 243,530 | 277,624 | 310,939 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

CAPITALIZATION SCHEDULE AND
APPLICATION OF CONSTRUCTION FUNDS
SOFIA DISTRICT HEATING COMPANY
ZEMLIANE - BASELINE CASE

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING BALANCE | | | | | | | | | | | | | | | | | |
| CAPITAL FUNDING | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 62,154 | 251,536 | 412,390 | 549,986 | 1,932,021 | 562,881 | 680,050 | 783,128 | 887,290 | 988,468 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC LOANS | 19,938 | 76,023 | 128,045 | 172,788 | 251,903 | 177,915 | 209,939 | 243,530 | 277,624 | 310,939 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL NEW CAPITAL | 82,092 | 327,559 | 540,436 | 722,774 | 2,183,924 | 740,796 | 889,989 | 1,026,658 | 1,164,914 | 1,299,406 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INTERNAL FUNDS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PROCEEDS AVAILABLE | 82,092 | 327,559 | 540,436 | 722,774 | 2,183,924 | 740,796 | 889,989 | 1,026,658 | 1,164,914 | 1,299,406 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UTILIZATION OF PROCEEDS | | | | | | | | | | | | | | | | | |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN COSTS | 59,763 | 227,548 | 383,310 | 517,456 | 1,848,824 | 541,232 | 638,654 | 740,838 | 844,556 | 945,902 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC COSTS | 17,338 | 66,107 | 111,344 | 150,250 | 219,046 | 154,708 | 182,556 | 211,765 | 241,412 | 270,381 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COMMITMENT FEES | 0 | 14,886 | 13,748 | 11,831 | 9,244 | 0 | 15,850 | 12,656 | 8,952 | 4,730 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOND DISCOUNT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RES. FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER EXPENSES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL UTILIZATION | 77,101 | 308,541 | 508,402 | 679,538 | 2,077,114 | 695,940 | 837,059 | 965,260 | 1,094,920 | 1,221,013 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE ON DEPOSIT | | | | | | | | | | | | | | | | | |
| INTEREST EARNED ON: | | | | | | | | | | | | | | | | | |
| CONSTRUCTION FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RESERVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE AVAILABLE | 4,991 | 19,018 | 32,034 | 43,236 | 106,810 | 44,856 | 52,930 | 61,398 | 69,994 | 78,393 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INTEREST CHARGES | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 2,391 | 9,102 | 15,332 | 20,698 | 73,953 | 21,649 | 25,546 | 29,634 | 33,782 | 37,836 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC LOANS | 2,601 | 9,916 | 16,702 | 22,538 | 32,857 | 23,206 | 27,383 | 31,765 | 36,212 | 40,557 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST | 4,991 | 19,018 | 32,034 | 43,236 | 106,810 | 44,856 | 52,930 | 61,398 | 69,994 | 78,393 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET END OF PERIOD | 0 | 0 | (0) | (0) | (0) | 0 | (0) | (0) | (0) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AMOUNT CLOSED TO PLANT | 82,092 | 327,559 | 540,436 | 722,774 | 2,183,924 | 740,796 | 889,989 | 1,026,658 | 1,164,914 | 1,299,406 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



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# Exhibit 9-15
## Debt Service Schedule
## Sofia District Heating Company
## Zemliane - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOREIGN LOANS: | | | | | | | | | | | | | | | | | |
| SERIES 94-98 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 62,154 | 313,690 | 726,080 | 1,276,066 | 3,208,086 | 3,139,215 | 3,064,725 | 2,984,155 | 2,897,012 | 2,802,757 | 2,700,811 | 2,590,547 | 2,471,284 | 2,342,291 | 2,202,771 | 2,051,866 |
| AMOUNT DRAWN DOWN | 62,154 | 251,536 | 412,390 | 549,986 | 1,932,021 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 4,972 | 25,095 | 58,086 | 102,085 | 255,297 | 249,677 | 243,598 | 237,024 | 229,913 | 222,222 | 213,903 | 204,905 | 195,173 | 184,648 | 173,263 | 160,949 |
| PRINCIPAL REPAYMENT | 0 | 0 | 0 | 0 | 0 | 68,871 | 74,491 | 80,569 | 87,144 | 94,255 | 101,946 | 110,265 | 119,262 | 128,994 | 139,520 | 150,905 | 163,219 |
| TOTAL DEBT SERVICE | 0 | 4,972 | 25,095 | 58,086 | 102,085 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 | 324,167 |
| SERIES 99-03 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | 0 | 562,681 | 1,242,931 | 2,026,059 | 2,913,349 | 3,901,817 | 3,818,053 | 3,727,454 | 3,629,462 | 3,523,474 | 3,408,837 | 3,284,846 |
| AMOUNT DRAWN DOWN | | | | | | 562,681 | 680,050 | 783,128 | 887,290 | 988,468 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | 0 | 45,030 | 99,434 | 162,085 | 0 | 310,503 | 303,668 | 296,275 | 288,279 | 279,630 | 270,276 | 260,158 |
| PRINCIPAL REPAYMENT | | | | | | 0 | 0 | 0 | 0 | 0 | 83,764 | 90,599 | 97,992 | 105,988 | 114,637 | 123,991 | 134,109 |
| TOTAL DEBT SERVICE | | | | | | 0 | 45,030 | 99,434 | 162,085 | 0 | 394,267 | 394,267 | 394,267 | 394,267 | 394,267 | 394,267 | 394,267 |
| BALANCE, END OF PERIOD | 62,154 | 313,690 | 726,080 | 1,276,066 | 3,208,086 | 3,702,097 | 4,307,855 | 5,010,214 | 5,810,361 | 6,704,574 | 6,518,864 | 6,318,001 | 6,100,747 | 5,865,765 | 5,611,608 | 5,336,712 | 5,039,385 |
| DOMESTIC LOANS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | | | | |
| SERIES 94 | 0 | 19,938 | 16,887 | 13,427 | 9,501 | 5,050 | | | | | | | | | | | |
| SERIES 95 | | 0 | 76,023 | 64,389 | 51,194 | 36,228 | 19,253 | | | | | | | | | | |
| SERIES 96 | | | | 128,045 | 108,451 | 86,227 | 61,019 | 32,428 | | | | | | | | | |
| SERIES 97 | | | | | 172,786 | 146,347 | 116,357 | 82,341 | 43,760 | | | | | | | | |
| SERIES 98 | | | | | | 251,903 | 213,356 | 169,634 | 120,043 | 63,796 | | | | | | | |
| SERIES 99 | | | | | | | 177,915 | 150,689 | 119,809 | 84,784 | 45,058 | | | | | | |
| SERIES 00 | | | | | | | | 209,939 | 177,813 | 141,375 | 100,045 | 53,169 | | | | | |
| SERIES 01 | | | | | | | | | 243,530 | 206,263 | 163,995 | 116,053 | 61,676 | | | | |
| SERIES 02 | | | | | | | | | | 277,624 | 235,140 | 186,954 | 132,300 | 70,310 | | | |
| SERIES 03 | | | | | | | | | | | 310,939 | 263,357 | 209,388 | 148,176 | 78,748 | | |
| SERIES 04 | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| SERIES 05 | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| SERIES 06 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| SERIES 07 | | | | | | | | | | | | | | | 0 | 0 | 0 |
| SERIES 08 | | | | | | | | | | | | | | | | 0 | 0 |
| SERIES 09 | | | | | | | | | | | | | | | | | 0 |
| SERIES 10 | | | | | | | | | | | | | | | | | |
| TOTAL OUTSTANDING | 0 | 19,938 | 92,910 | 205,861 | 341,935 | 525,755 | 587,900 | 645,032 | 704,955 | 773,843 | 855,177 | 619,532 | 403,364 | 218,487 | 78,748 | 0 | 0 |
| AMOUNT DRAWN DOWN | 19,938 | 76,023 | 128,045 | 172,786 | 251,903 | 177,915 | 209,939 | 243,530 | 277,624 | 310,939 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 2,496 | 11,603 | 25,606 | 42,308 | 64,704 | 71,617 | 78,075 | 85,074 | 93,372 | 103,758 | 73,735 | 46,618 | 24,005 | 7,758 | 0 | 0 |
| PRINCIPAL REPAYMENT | 0 | 3,051 | 15,094 | 36,714 | 68,083 | 115,770 | 152,607 | 183,606 | 208,736 | 229,604 | 235,645 | 216,168 | 184,876 | 139,739 | 78,748 | 0 | 0 |
| TOTAL DEBT SERVICE | 0 | 5,547 | 26,697 | 62,321 | 110,392 | 180,474 | 224,424 | 261,681 | 293,810 | 322,976 | 339,400 | 289,903 | 231,496 | 163,744 | 86,506 | 0 | 0 |
| BALANCE, END OF PERIOD | 19,938 | 92,910 | 205,861 | 341,935 | 525,755 | 587,900 | 645,032 | 704,955 | 773,843 | 855,177 | 619,532 | 403,364 | 218,487 | 78,748 | (0) | 0 | 0 |
| TOTALS ALL DEBT: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 82,092 | 406,600 | 931,941 | 1,618,001 | 3,733,841 | 4,289,996 | 4,952,687 | 5,715,169 | 6,584,203 | 7,559,751 | 7,138,397 | 6,721,365 | 6,319,233 | 5,944,512 | 5,611,608 | 5,336,712 |
| AMOUNT DRAWN DOWN | 82,092 | 327,559 | 540,436 | 722,774 | 2,183,924 | 740,796 | 889,989 | 1,026,658 | 1,164,914 | 1,299,406 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 7,468 | 36,698 | 83,693 | 144,394 | 320,001 | 366,324 | 421,107 | 484,162 | 323,285 | 636,480 | 591,306 | 547,798 | 507,457 | 472,036 | 443,539 | 421,107 |
| PRINCIPAL REPAYMENT | 0 | 3,051 | 15,094 | 36,714 | 68,083 | 184,641 | 227,298 | 264,176 | 295,680 | 323,859 | 421,355 | 417,032 | 402,132 | 374,721 | 332,904 | 274,896 | 297,327 |
| BALANCE, END OF PERIOD | 82,092 | 406,600 | 931,941 | 1,618,001 | 3,733,841 | 4,289,996 | 4,952,687 | 5,715,169 | 6,584,203 | 7,559,751 | 7,138,397 | 6,721,365 | 6,319,233 | 5,944,512 | 5,611,608 | 5,336,712 | 5,039,385 |
| TOTAL DEBT SERVICE | 0 | 10,519 | 51,792 | 120,407 | 212,477 | 504,641 | 593,622 | 685,283 | 780,062 | 647,144 | 1,057,835 | 1,008,337 | 949,930 | 882,178 | 804,940 | 718,434 | 718,434 |



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# Exhibit 9-16
## Statement of Income
## Sofia District Heating Company
## Zemliane - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING REVENUES: | | | | | | | | | | | | | | | | | |
| STEAM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HOT WATER | 695,467 | 1,299,029 | 2,096,455 | 3,063,786 | 4,480,920 | 5,900,016 | 7,481,969 | 8,347,098 | 9,438,085 | 10,235,467 | 11,931,562 | 12,259,458 | 13,075,649 | 13,930,209 | 15,475,627 | 15,918,968 | 17,188,649 |
| ELECTRICITY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL SALES REVENUE | 695,467 | 1,299,029 | 2,096,455 | 3,063,786 | 4,480,920 | 5,900,016 | 7,481,969 | 8,347,098 | 9,438,085 | 10,235,467 | 11,931,562 | 12,259,458 | 13,075,649 | 13,930,209 | 15,475,627 | 15,918,968 | 17,188,649 |
| OTHER OPER. REVENUES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING REVENUES | 695,467 | 1,299,029 | 2,096,455 | 3,063,786 | 4,480,920 | 5,900,016 | 7,481,969 | 8,347,098 | 9,438,085 | 10,235,467 | 11,931,562 | 12,259,458 | 13,075,649 | 13,930,209 | 15,475,627 | 15,918,968 | 17,188,649 |
| OPERATING EXPENSES: | | | | | | | | | | | | | | | | | |
| OPER. & MAIN. | | | | | | | | | | | | | | | | | |
| FUEL – GAS | 573,530 | 927,880 | 1,481,252 | 2,286,779 | 3,391,760 | 4,275,204 | 5,314,190 | 6,102,762 | 6,887,585 | 7,637,050 | 8,316,639 | 8,892,154 | 9,603,526 | 10,371,808 | 11,201,553 | 12,097,677 | 13,065,491 |
| OIL | 33,152 | 49,612 | 73,241 | 100,607 | 132,776 | 167,422 | 208,274 | 239,111 | 270,010 | 299,238 | 325,670 | 348,295 | 378,159 | 406,251 | 438,752 | 473,852 | 511,760 |
| LIGNITE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUEL COST | 606,682 | 977,491 | 1,554,493 | 2,387,386 | 3,524,557 | 4,442,626 | 5,522,464 | 6,341,873 | 7,157,596 | 7,936,287 | 8,642,309 | 9,240,449 | 9,979,685 | 10,778,060 | 11,640,305 | 12,571,529 | 13,577,251 |
| PURCHASED POWER | 48,160 | 72,065 | 106,433 | 146,178 | 192,904 | 244,198 | 303,935 | 352,565 | 401,924 | 450,155 | 495,170 | 534,784 | 577,567 | 623,772 | 673,674 | 727,568 | 785,773 |
| FIXED O & M | 35,482 | 49,674 | 67,060 | 87,178 | 108,973 | 130,767 | 154,306 | 178,994 | 204,054 | 228,540 | 251,394 | 271,506 | 293,226 | 316,684 | 342,019 | 369,380 | 398,931 |
| OTHER VAR. O & M | 49,260 | 69,180 | 95,764 | 128,126 | 164,835 | 203,416 | 246,460 | 285,894 | 325,919 | 365,029 | 401,532 | 433,655 | 468,347 | 505,815 | 546,260 | 589,983 | 637,181 |
| EMISSION PENALTIES | 224 | 314 | 423 | 550 | 688 | 826 | 974 | 1,130 | 1,288 | 1,443 | 1,587 | 1,714 | 1,851 | 1,999 | 2,159 | 2,332 | 2,519 |
| MAINTENACE EXPENSE | 51,610 | 74,449 | 190,258 | 134,950 | 192,216 | 214,148 | 478,308 | 302,844 | 393,164 | 408,891 | 651,629 | 502,217 | 617,552 | 618,974 | 1,266,161 | 746,223 | 918,246 |
| PLANT REMOVAL COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL O & M | 791,437 | 1,243,173 | 2,014,432 | 2,884,369 | 4,184,173 | 5,235,981 | 6,706,448 | 7,463,301 | 8,483,945 | 9,390,345 | 10,643,622 | 10,984,325 | 11,938,228 | 12,645,304 | 14,470,598 | 15,007,015 | 16,319,901 |
| DEPRECIATION EXPENSE | 27,696 | 33,484 | 50,849 | 77,608 | 128,130 | 212,881 | 241,141 | 275,292 | 314,589 | 358,786 | 389,575 | 370,096 | 351,591 | 334,011 | 317,311 | 301,445 | 286,373 |
| OTHER OPER. EXPENSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING EXPENSES | 819,133 | 1,276,657 | 2,065,281 | 2,961,976 | 4,312,303 | 5,448,862 | 6,947,589 | 7,738,593 | 8,798,533 | 9,749,131 | 11,033,197 | 11,354,420 | 12,289,819 | 13,179,316 | 14,787,909 | 15,308,460 | 16,606,274 |
| OPERATING SURPLUS | 76,334 | 22,372 | 31,175 | 101,810 | 168,617 | 451,154 | 534,380 | 608,505 | 639,552 | 486,336 | 898,365 | 905,038 | 785,830 | 750,893 | 687,718 | 610,508 | 582,375 |
| LONG TERM DEBT INTEREST | | | | | | | | | | | | | | | | | |
| FOREIGN | 0 | 4,972 | 25,095 | 58,086 | 102,085 | 255,297 | 294,707 | 343,033 | 399,108 | 229,913 | 532,725 | 517,571 | 501,180 | 483,452 | 464,276 | 443,539 | 421,107 |
| DOMESTIC | 0 | 2,496 | 11,603 | 25,606 | 42,308 | 64,704 | 71,617 | 78,075 | 85,074 | 93,372 | 103,756 | 73,735 | 46,618 | 24,005 | 7,758 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST EXPENSE | 0 | 7,468 | 36,698 | 83,693 | 144,394 | 320,001 | 366,324 | 421,107 | 484,182 | 323,285 | 636,480 | 591,306 | 547,798 | 507,457 | 472,036 | 443,539 | 421,107 |
| NET INCOME FOR YEAR | 76,334 | 14,904 | (5,524) | 18,118 | 24,223 | 131,153 | 168,056 | 187,398 | 155,370 | 163,051 | 261,885 | 313,733 | 238,032 | 243,437 | 215,682 | 166,969 | 161,267 |
| PROVISION FOR TAXES @ 42% | 32,060 | 6,260 | (2,320) | 7,609 | 10,174 | 55,084 | 70,583 | 78,707 | 65,255 | 68,481 | 109,992 | 131,768 | 99,973 | 102,243 | 90,587 | 70,127 | 67,732 |
| ADJUSTED NET INCOME | 44,274 | 8,644 | (3,204) | 10,508 | 14,049 | 76,069 | 97,472 | 108,691 | 90,115 | 94,570 | 151,893 | 181,965 | 138,059 | 141,193 | 125,096 | 96,842 | 93,535 |
| RETAINED EARNINGS, FIRST OF YEAR | 0 | 44,274 | 52,918 | 49,714 | 60,222 | 74,272 | 150,341 | 247,813 | 356,504 | 446,618 | 541,188 | 693,081 | 875,046 | 1,013,105 | 1,154,298 | 1,279,394 | 1,376,236 |
| RETAINED EARNINGS, END OF YEAR | 44,274 | 52,918 | 49,714 | 60,222 | 74,272 | 150,341 | 247,813 | 356,504 | 446,618 | 541,188 | 693,081 | 875,046 | 1,013,105 | 1,154,298 | 1,279,394 | 1,376,236 | 1,469,771 |



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# Exhibit 9-17
## Analysis of Cash & Cash Balances
## Sofia District Heating Company
## Zemliane - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING CASH BALANCES | 0 | 67,940 | 62,962 | 71,621 | 79,432 | 97,853 | 120,318 | 145,200 | 177,446 | 236,460 | 304,000 | 370,977 | 414,362 | 463,264 | 538,424 | 587,657 | 632,986 |
| PLUS FUNDS GENERATED: | | | | | | | | | | | | | | | | | |
| ADJUSTED NET INCOME | 44,274 | 8,644 | (3,204) | 10,508 | 14,049 | 76,069 | 97,472 | 108,691 | 90,115 | 94,570 | 151,693 | 181,965 | 136,059 | 141,193 | 125,096 | 98,842 | 93,535 |
| NON CASH ITEMS: | | | | | | | | | | | | | | | | | |
| DEPRECIATION | 27,696 | 33,484 | 50,849 | 77,608 | 128,130 | 212,881 | 241,141 | 275,292 | 314,589 | 358,786 | 389,575 | 370,096 | 351,591 | 334,011 | 317,311 | 301,445 | 286,373 |
| TOTAL FUNDS GENERATED | 71,970 | 42,128 | 47,645 | 88,116 | 142,180 | 288,950 | 338,614 | 383,983 | 404,703 | 453,356 | 541,468 | 552,061 | 489,650 | 475,205 | 442,407 | 398,287 | 379,908 |
| DEDUCT USES OF FUNDS: | | | | | | | | | | | | | | | | | |
| REDEMPTION – LOANS | 0 | 3,051 | 15,084 | 36,714 | 68,083 | 184,641 | 227,298 | 264,176 | 295,880 | 323,859 | 421,355 | 417,032 | 402,132 | 374,721 | 332,904 | 274,896 | 297,327 |
| FINANCING COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CHANGE IN WORKING CAPITAL | (4,030) | (44,055) | (23,692) | (43,591) | (55,875) | (81,844) | (56,434) | (87,561) | (49,809) | (61,958) | (53,136) | (91,643) | (18,596) | (45,344) | (60,269) | (78,062) | (25,436) |
| MAINTENANCE SPARES | (1,032) | (457) | (2,316) | 1,106 | (1,145) | (439) | (5,283) | 3,509 | (1,806) | (315) | (9,855) | 9,988 | (2,307) | (28) | (12,944) | 10,399 | (3,440) |
| ACCOUNTS RECEIVABLE | (9,084) | (45,844) | (24,214) | (47,848) | (58,040) | (85,028) | (85,146) | (94,917) | (51,908) | (65,459) | (47,843) | (101,786) | (19,674) | (48,971) | (51,274) | (92,725) | (28,600) |
| ACCOUNTS PAYABLE | 5,066 | 2,046 | 2,638 | 3,149 | 3,510 | 3,623 | 3,995 | 3,847 | 3,905 | 3,816 | 3,561 | 3,134 | 3,365 | 3,656 | 3,948 | 4,264 | 4,605 |
| CAPITAL EXPENDITURES | 82,092 | 327,559 | 540,436 | 722,774 | 2,183,924 | 740,796 | 889,989 | 1,026,658 | 1,164,914 | 1,299,406 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUNDS USED | 86,122 | 374,685 | 579,422 | 803,079 | 2,307,683 | 1,007,281 | 1,203,721 | 1,378,394 | 1,510,603 | 1,685,223 | 474,491 | 508,675 | 420,728 | 420,065 | 393,173 | 352,958 | 322,783 |
| CASH RECEIPTS FROM FINANCING | 82,092 | 327,559 | 540,436 | 722,774 | 2,183,924 | 740,796 | 889,989 | 1,026,658 | 1,164,914 | 1,299,406 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENDING CASH BALANCES | 67,940 | 62,962 | 71,621 | 79,432 | 97,853 | 120,318 | 145,200 | 177,446 | 236,460 | 304,000 | 370,977 | 414,362 | 463,264 | 538,424 | 587,657 | 632,986 | 690,131 |



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# Exhibit 9-18
## Balance Sheet
## Sofia District Heating Company
## Zemliane - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASSETS: | | | | | | | | | | | | | | | | | |
| PLANT IN SERVICE | 615,492 | 943,051 | 1,483,488 | 2,206,260 | 4,390,184 | 5,130,980 | 6,020,969 | 7,047,627 | 8,212,541 | 9,511,947 | 9,511,947 | 9,511,947 | 9,511,947 | 9,511,947 | 9,511,947 | 9,511,947 | 9,511,947 |
| C.W.I.P. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LESS: ACCUM. PROV. FOR DEPR. | 27,696 | 61,180 | 112,029 | 189,637 | 317,767 | 530,648 | 771,789 | 1,047,082 | 1,361,670 | 1,720,456 | 2,110,031 | 2,480,127 | 2,831,718 | 3,165,729 | 3,483,040 | 3,784,486 | 4,070,859 |
| NET PLANT | 587,796 | 881,870 | 1,371,457 | 2,016,623 | 4,072,417 | 4,600,332 | 5,249,180 | 6,000,545 | 6,850,870 | 7,791,491 | 7,401,916 | 7,031,821 | 6,680,229 | 6,346,218 | 6,028,907 | 5,727,462 | 5,441,089 |
| CURRENT ASSETS | | | | | | | | | | | | | | | | | |
| CASH | 67,940 | 62,962 | 71,621 | 79,432 | 97,853 | 120,318 | 145,200 | 177,446 | 236,460 | 304,000 | 370,977 | 414,382 | 483,284 | 538,424 | 587,657 | 632,986 | 690,131 |
| STORES & MATERIALS | 1,032 | 1,489 | 3,605 | 2,699 | 3,844 | 4,283 | 9,566 | 6,057 | 7,863 | 8,176 | 17,033 | 10,044 | 12,351 | 12,379 | 25,323 | 14,924 | 18,365 |
| ACCOUNTS RECEIVABLE | 8,084 | 53,728 | 77,942 | 125,767 | 183,827 | 268,855 | 354,001 | 448,918 | 500,626 | 566,285 | 614,128 | 715,894 | 735,566 | 784,539 | 835,613 | 928,538 | 955,138 |
| TOTAL CURRENT ASSETS | 77,056 | 118,179 | 153,368 | 207,918 | 285,524 | 393,456 | 508,767 | 632,421 | 745,150 | 878,463 | 1,002,137 | 1,140,300 | 1,231,203 | 1,335,342 | 1,448,793 | 1,576,448 | 1,663,634 |
| EXCHANGE RATE VARIANCES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNAMORTIZED FIN. COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL ASSETS | 664,851 | 1,000,049 | 1,524,825 | 2,224,541 | 4,357,942 | 4,993,788 | 5,757,946 | 6,632,967 | 7,596,020 | 8,669,953 | 8,404,054 | 8,172,121 | 7,911,432 | 7,681,560 | 7,477,700 | 7,303,910 | 7,104,723 |
| LIABILITIES: | | | | | | | | | | | | | | | | | |
| PAID IN CAPITAL | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 | 533,400 |
| RESERVE FUNDS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET INCOME FOR PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRANSFERS & CONTRIBUTIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE, END OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LOANS OUTSTANDING | | | | | | | | | | | | | | | | | |
| DOMESTIC LOANS | 16,887 | 77,816 | 169,147 | 273,851 | 409,985 | 435,092 | 461,425 | 496,219 | 544,239 | 619,532 | 403,384 | 216,487 | 78,748 | (0) | (0) | 0 | 0 |
| FOREIGN LOANS | 62,154 | 313,690 | 726,080 | 1,276,066 | 3,139,215 | 3,627,606 | 4,227,086 | 4,923,071 | 5,716,106 | 6,518,864 | 6,318,001 | 6,100,747 | 5,865,765 | 5,611,608 | 5,336,712 | 5,039,385 | 4,756,860 |
| TOTAL LONG-TERM DEBT | 79,041 | 391,505 | 895,227 | 1,549,917 | 3,549,201 | 4,062,698 | 4,688,512 | 5,419,289 | 6,260,345 | 7,138,397 | 6,721,385 | 6,319,233 | 5,944,512 | 5,611,608 | 5,336,712 | 5,039,385 | 4,756,860 |
| CURRENT LIABILITIES | | | | | | | | | | | | | | | | | |
| SHORT TERM LOANS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CURRENT PORTION-LONG-TERM DEBT | 3,051 | 15,094 | 36,714 | 68,083 | 184,641 | 227,298 | 264,176 | 295,880 | 323,859 | 421,355 | 417,032 | 402,132 | 374,721 | 332,904 | 274,896 | 297,327 | 282,525 |
| ACCOUNTS PAYABLE | 5,086 | 7,131 | 9,769 | 12,918 | 16,428 | 20,051 | 24,046 | 27,893 | 31,798 | 35,614 | 39,176 | 42,310 | 45,694 | 49,350 | 53,298 | 57,562 | 62,167 |
| TOTAL CURRENT LIABILITIES | 8,137 | 22,225 | 46,484 | 81,002 | 201,069 | 247,349 | 288,222 | 323,773 | 355,657 | 456,969 | 456,207 | 444,442 | 420,415 | 382,254 | 328,194 | 354,889 | 344,692 |
| TOTAL LIABILITIES | 87,178 | 413,731 | 941,711 | 1,630,919 | 3,750,270 | 4,310,047 | 4,976,733 | 5,743,063 | 6,616,002 | 7,595,365 | 7,177,572 | 6,763,675 | 6,364,927 | 5,993,862 | 5,664,906 | 5,394,274 | 5,101,552 |
| RETAINED EARNINGS | 44,274 | 52,918 | 49,714 | 60,222 | 74,272 | 150,341 | 247,613 | 356,504 | 446,618 | 541,188 | 693,081 | 875,046 | 1,013,105 | 1,154,298 | 1,279,394 | 1,376,236 | 1,469,771 |
| TOTAL LIABILITIES & CAPITAL | 664,851 | 1,000,049 | 1,524,825 | 2,224,541 | 4,357,942 | 4,993,788 | 5,757,946 | 6,632,967 | 7,596,020 | 8,669,953 | 8,404,054 | 8,172,121 | 7,911,432 | 7,681,560 | 7,477,700 | 7,303,910 | 7,104,723 |



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# LIULIN TPS

## Baseline Case

### Exhibit 9-19 to 9-24

1090

# Exhibit 9-19
## General Data Development
## Sofia District Heating Company
## Liulin - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GENERAL INFLATION | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.860% | 2.670% | 3.500% | 3.500% | 3.500% | 3.500% | 3.500% | 3.350% | 3.200% | 3.060% | 2.930% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% |
| DOMESTIC | 40.000% | 40.000% | 35.000% | 30.000% | 25.000% | 20.000% | 18.000% | 16.000% | 14.000% | 12.000% | 10.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% |
| COMPOUNDED: | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.0186 | 1.0458 | 1.0824 | 1.1203 | 1.1595 | 1.2001 | 1.2421 | 1.2837 | 1.3248 | 1.3653 | 1.4053 | 1.4447 | 1.4851 | 1.5267 | 1.5694 | 1.6134 | 1.6586 |
| DOMESTIC | 1.4000 | 1.9600 | 2.6460 | 3.4398 | 4.2998 | 5.1597 | 6.0884 | 7.0626 | 8.0514 | 9.0175 | 9.9193 | 10.7128 | 11.5698 | 12.4954 | 13.4951 | 14.5747 | 15.7406 |
| FOREX RATIO | 1.3744 | 1.8742 | 2.4446 | 3.0705 | 3.7063 | 4.2995 | 4.9018 | 5.5018 | 6.0776 | 6.6048 | 7.0584 | 7.4155 | 7.7906 | 8.1647 | 8.5987 | 9.0336 | 9.4906 |
| EXCHANGE RATE (LEVA/US) | 43.98 | 59.97 | 78.23 | 98.26 | 118.67 | 137.58 | 156.86 | 176.06 | 194.48 | 211.35 | 225.87 | 237.30 | 249.30 | 261.91 | 275.16 | 289.08 | 303.70 |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN (US 1993$) | $953 | $2,591 | $3,234 | $3,358 | $12,061 | $2,341 | $2,341 | $2,341 | $2,341 | $2,341 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| FOREIGN (CURRENT) | $971 | $2,710 | $3,500 | $3,762 | $13,985 | $2,809 | $2,908 | $3,005 | $3,101 | $3,196 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| FOREIGN (LEVA-CURRENT) | 42,694 | 162,508 | 273,829 | 369,627 | 1,659,497 | 386,523 | 456,098 | 529,073 | 603,144 | 675,521 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (US 1993) | $276 | $753 | $94 | $975 | $1,192 | $669 | $669 | $669 | $669 | $669 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| DOMESTIC (LEVA 1993) | 8,832 | 24,096 | 3,008 | 31,200 | 38,144 | 21,408 | 21,408 | 21,408 | 21,408 | 21,408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (LEVA-CURRENT) | 12,365 | 47,226 | 7,959 | 107,322 | 164,010 | 110,459 | 130,341 | 151,196 | 172,364 | 193,047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC (CURRENT US) | $281 | $787 | $102 | $1,092 | $1,362 | $803 | $831 | $859 | $886 | $913 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| OPERATING EXPENSES (US $1993) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 10,649 | 12,306 | 14,553 | 17,282 | 20,506 | 21,536 | 22,689 | 22,462 | 22,238 | 22,015 | 21,795 | 21,577 | 21,577 | 21,577 | 21,577 | 21,577 | 21,577 |
| FUEL COST-OIL | 615 | 658 | 719 | 760 | 803 | 844 | 890 | 880 | 871 | 862 | 854 | 845 | 845 | 845 | 845 | 845 | 845 |
| PURCHASED POWER (NET) | 850 | 909 | 994 | 1,050 | 1,109 | 1,170 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 | 1,233 |
| FIXED O & M | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 | 792 |
| VARIABLE O & M | 915 | 917 | 940 | 968 | 996 | 1,025 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 | 1,053 |
| EMISSION PENALTIES | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| MAINTENANCE EXPENSES | 1,152 | 1,187 | 2,247 | 1,226 | 1,397 | 1,297 | 2,455 | 1,340 | 1,526 | 1,417 | 2,683 | 1,465 | 1,668 | 1,548 | 2,932 | 1,600 | 1,823 |
| TOTAL O & M EXPENSES | 14,977 | 16,773 | 20,249 | 22,082 | 25,607 | 26,670 | 29,117 | 27,765 | 27,718 | 27,377 | 28,415 | 26,970 | 27,173 | 27,053 | 28,437 | 27,105 | 27,328 |
| OPERATING EXPENSES (LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 477,075 | 771,832 | 1,232,232 | 1,902,292 | 2,821,462 | 3,556,146 | 4,420,504 | 5,076,482 | 5,729,477 | 6,352,666 | 6,916,100 | 7,396,616 | 7,988,561 | 8,627,646 | 9,317,858 | 10,063,288 | 10,868,349 |
| FUEL COST-OIL | 27,552 | 41,270 | 60,879 | 83,656 | 110,486 | 139,353 | 173,399 | 198,883 | 224,408 | 248,739 | 271,074 | 289,675 | 312,849 | 337,876 | 364,907 | 394,099 | 425,627 |
| PURCHASED POWER | 38,080 | 57,012 | 84,164 | 115,577 | 152,590 | 193,179 | 240,226 | 278,662 | 317,674 | 355,795 | 391,375 | 422,685 | 456,500 | 493,020 | 532,461 | 575,058 | 621,063 |
| FIXED O & M | 35,482 | 49,674 | 67,060 | 87,178 | 108,973 | 130,767 | 154,306 | 178,994 | 204,054 | 228,540 | 251,394 | 271,506 | 293,226 | 316,684 | 342,019 | 369,380 | 398,931 |
| VARIABLE O & M | 40,992 | 57,514 | 79,592 | 106,551 | 137,042 | 169,238 | 205,158 | 237,981 | 271,299 | 303,854 | 334,240 | 360,979 | 389,857 | 421,046 | 454,730 | 491,108 | 530,397 |
| EMISSION PENALTIES | 179 | 251 | 339 | 440 | 550 | 660 | 974 | 1,130 | 1,286 | 1,443 | 1,587 | 1,714 | 1,851 | 1,999 | 2,159 | 2,332 | 2,519 |
| MAINTENANCE EXPENSES | 51,610 | 74,449 | 190,258 | 134,950 | 192,216 | 214,148 | 478,308 | 302,844 | 393,164 | 408,891 | 651,629 | 502,217 | 617,532 | 618,974 | 1,266,161 | 746,223 | 918,248 |
| TOTAL O & M EXPENSES | 670,970 | 1,052,003 | 1,714,523 | 2,430,645 | 3,523,318 | 4,403,494 | 5,672,873 | 6,274,977 | 7,141,364 | 7,899,928 | 9,019,400 | 9,245,591 | 10,060,396 | 10,817,245 | 12,280,295 | 12,641,487 | 13,765,132 |



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# Exhibit 9-20
## Projected Investment Program - Municipal Ownership
## Sofia District Heating Company
## Liulin - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPITAL EXPENDITURES (000'S LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FOREIGN | 42,694 | 162,508 | 273,829 | 369,627 | 1,659,497 | 366,523 | 456,098 | 529,073 | 603,144 | 675,521 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC | 12,365 | 47,228 | 7,959 | 107,322 | 164,010 | 110,459 | 130,341 | 151,196 | 172,364 | 193,047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MUNICIPAL OWNERSHIP: | | | | | | | | | | | | | | | | | |
| INVESTMENT PROGRAM | | | | | | | | | | | | | | | | | |
| FOREIGN | | | | | | | | | | | | | | | | | |
| SERIES 94-98 | 2,650,767 | 2,606,365 | 2,425,030 | 2,128,732 | 1,734,174 | | | | | | | | | | | | |
| DRAWDOWN | 44,402 | 181,335 | 296,297 | 394,558 | 1,734,174 | | | | | | | | | | | | |
| UNDISBURED | 2,606,365 | 2,425,030 | 2,128,732 | 1,734,174 | 0 | | | | | | | | | | | | |
| SERIES 99-2003 | | | | | | 2,786,502 | 2,384,517 | 1,898,857 | 1,339,582 | 705,919 | | | | | | | |
| DRAWDOWN | | | | | | 401,984 | 485,661 | 559,275 | 633,663 | 705,919 | | | | | | | |
| UNDISBURED | | | | | | 2,384,517 | 1,898,857 | 1,339,582 | 705,919 | 0 | | | | | | | |
| DOMESTIC | | | | | | | | | | | | | | | | | |
| ANNUAL REQUIREMENT | 14,220 | 54,312 | 9,153 | 123,420 | 188,611 | 127,028 | 149,893 | 173,875 | 198,218 | 222,004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

CAPITALIZATION SCHEDULE AND
APPLICATION OF CONSTRUCTION FUNDS
SOFIA DISTRICT HEATING COMPANY
LIULIN – BASELINE CASE

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING BALANCE | | | | | | | | | | | | | | | | | |
| CAPITAL FUNDING | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 44,402 | 181,335 | 296,297 | 394,558 | 1,734,174 | 401,984 | 485,661 | 559,275 | 633,663 | 705,919 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC LOANS | 14,220 | 54,312 | 9,153 | 123,420 | 188,611 | 127,028 | 149,893 | 173,875 | 198,218 | 222,004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL NEW CAPITAL | 58,622 | 235,648 | 305,450 | 517,978 | 1,922,786 | 529,012 | 635,553 | 733,150 | 831,881 | 927,923 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INTERNAL FUNDS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PROCEEDS AVAILABLE | 58,622 | 235,648 | 305,450 | 517,978 | 1,922,786 | 529,012 | 635,553 | 733,150 | 831,881 | 927,923 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UTILIZATION OF PROCEEDS | | | | | | | | | | | | | | | | | |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN COSTS | 42,694 | 162,508 | 273,829 | 369,627 | 1,659,497 | 366,523 | 456,098 | 529,073 | 603,144 | 675,521 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC COSTS | 12,365 | 47,228 | 7,959 | 107,322 | 164,010 | 110,459 | 130,341 | 151,196 | 172,364 | 193,047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COMMITMENT FEES | 0 | 12,327 | 11,515 | 10,146 | 8,297 | 0 | 11,319 | 9,039 | 6,393 | 3,378 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOND DISCOUNT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RES. FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER EXPENSES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL UTILIZATION | 55,059 | 222,063 | 293,303 | 487,095 | 1,831,804 | 496,982 | 597,758 | 689,308 | 781,900 | 871,946 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE ON DEPOSIT | | | | | | | | | | | | | | | | | |
| INTEREST EARNED ON: | | | | | | | | | | | | | | | | | |
| CONSTRUCTION FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RESERVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE AVAILABLE | 3,562 | 13,585 | 12,147 | 30,883 | 90,981 | 32,030 | 37,795 | 43,842 | 49,980 | 55,978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INTEREST CHARGES | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 1,708 | 6,500 | 10,953 | 14,785 | 66,380 | 15,461 | 18,244 | 21,163 | 24,126 | 27,021 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DOMESTIC LOANS | 1,855 | 7,084 | 1,194 | 16,098 | 24,601 | 16,569 | 19,551 | 22,679 | 25,855 | 28,957 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST | 3,562 | 13,585 | 12,147 | 30,883 | 90,981 | 32,030 | 37,795 | 43,842 | 49,980 | 55,978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET END OF PERIOD | 0 | 0 | (0) | (0) | 0 | 0 | 0 | (0) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AMOUNT CLOSED TO PLANT | 58,622 | 235,648 | 305,450 | 517,978 | 1,922,786 | 529,012 | 635,553 | 733,150 | 831,881 | 927,923 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



1092

# Exhibit 9-21
## Debt Service Schedule
## Sofia District Heating Company
## Liulin - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOREIGN LOANS: | | | | | | | | | | | | | | | | | |
| SERIES 94-98 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 44,402 | 225,737 | 522,034 | 916,592 | 2,650,767 | 2,593,860 | 2,532,310 | 2,465,738 | 2,393,733 | 2,315,853 | 2,231,617 | 2,140,508 | 2,041,965 | 1,935,380 | 1,820,098 | 1,695,409 |
| AMOUNT DRAWN DOWN | 44,402 | 181,335 | 296,297 | 394,558 | 1,734,174 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 3,552 | 18,059 | 41,763 | 73,327 | 210,946 | 206,302 | 201,279 | 195,847 | 189,972 | 183,617 | 176,743 | 169,308 | 161,267 | 152,570 | 143,163 | 132,988 |
| PRINCIPAL REPAYMENT | 0 | 0 | 0 | 0 | 0 | 56,906 | 61,550 | 66,572 | 72,005 | 77,880 | 84,235 | 91,109 | 98,544 | 106,585 | 115,282 | 124,689 | 134,864 |
| TOTAL DEBT SERVICE | 0 | 3,552 | 18,059 | 41,763 | 73,327 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 | 267,852 |
| SERIES 99-02 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | 0 | 401,984 | 887,645 | 1,446,920 | 2,080,583 | 2,786,502 | 2,726,681 | 2,661,980 | 2,591,998 | 2,516,306 | 2,434,438 | 2,345,889 |
| AMOUNT DRAWN DOWN | | | | | | 401,984 | 485,661 | 559,275 | 633,663 | 705,919 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | 0 | 32,159 | 71,012 | 115,754 | 166,447 | 221,747 | 216,866 | 211,566 | 205,876 | 199,699 | 193,019 | 185,793 |
| PRINCIPAL REPAYMENT | | | | | | 0 | 0 | 0 | 0 | 0 | 59,820 | 64,702 | 69,981 | 75,692 | 81,868 | 88,549 | 95,774 |
| TOTAL DEBT SERVICE | | | | | | 0 | 32,159 | 71,012 | 115,754 | 166,447 | 281,568 | 281,568 | 281,568 | 281,568 | 281,568 | 281,568 | 281,568 |
| BALANCE, END OF PERIOD | 44,402 | 225,737 | 522,034 | 916,592 | 2,650,767 | 2,995,845 | 3,419,956 | 3,912,658 | 4,474,316 | 5,102,355 | 4,958,299 | 4,802,488 | 4,633,963 | 4,451,686 | 4,254,536 | 4,041,298 | 3,810,660 |
| DOMESTIC LOANS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | | | | |
| SERIES 94 | 0 | 14,220 | 12,044 | 9,576 | 6,776 | 3,601 | | | | | | | | | | | |
| SERIES 95 | | 0 | 54,312 | 46,001 | 36,574 | 25,882 | 13,755 | | | | | | | | | | |
| SERIES 96 | | | | 9,153 | 7,752 | 6,164 | 4,362 | 2,318 | | | | | | | | | |
| SERIES 97 | | | | | 123,420 | 104,534 | 83,112 | 58,815 | 31,257 | | | | | | | | |
| SERIES 98 | | | | | | 188,611 | 159,749 | 127,012 | 89,682 | 47,767 | | | | | | | |
| SERIES 99 | | | | | | | 127,028 | 107,589 | 85,541 | 60,534 | 32,171 | | | | | | |
| SERIES 00 | | | | | | | | 149,893 | 126,955 | 100,939 | 71,431 | 37,961 | | | | | |
| SERIES 01 | | | | | | | | | 173,875 | 147,268 | 117,069 | 82,859 | 44,035 | | | | |
| SERIES 02 | | | | | | | | | | 198,218 | 167,888 | 133,482 | 94,460 | 50,200 | | | |
| SERIES 03 | | | | | | | | | | | 222,004 | 188,032 | 149,499 | 105,795 | 56,224 | | |
| SERIES 04 | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| SERIES 05 | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| SERIES 06 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| SERIES 07 | | | | | | | | | | | | | | | 0 | 0 | 0 |
| SERIES 08 | | | | | | | | | | | | | | | | 0 | 0 |
| SERIES 09 | | | | | | | | | | | | | | | | | 0 |
| SERIES 10 | | | | | | | | | | | | | | | | | 0 |
| TOTAL OUTSTANDING | 0 | 14,220 | 66,356 | 64,730 | 174,523 | 328,792 | 388,005 | 445,627 | 507,511 | 554,727 | 610,580 | 442,334 | 287,994 | 155,995 | 56,224 | 0 | 0 |
| AMOUNT DRAWN DOWN | 14,220 | 54,312 | 9,153 | 123,420 | 188,611 | 127,028 | 149,893 | 173,875 | 198,218 | 222,004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 1,760 | 8,287 | 7,966 | 21,607 | 40,608 | 47,536 | 54,406 | 61,223 | 66,685 | 74,080 | 52,645 | 33,284 | 17,139 | 5,539 | 0 | 0 |
| PRINCIPAL REPAYMENT | 0 | 2,176 | 10,779 | 13,627 | 34,342 | 67,814 | 92,271 | 111,992 | 151,002 | 166,151 | 168,246 | 154,340 | 131,999 | 99,771 | 56,224 | 0 | 0 |
| TOTAL DEBT SERVICE | 0 | 3,956 | 19,066 | 21,613 | 55,949 | 108,423 | 139,807 | 166,398 | 212,226 | 233,035 | 242,325 | 206,985 | 165,284 | 116,910 | 61,764 | 0 | 0 |
| BALANCE, END OF PERIOD | 14,220 | 66,356 | 64,730 | 174,523 | 328,792 | 388,005 | 445,627 | 507,511 | 554,727 | 610,580 | 442,334 | 287,994 | 155,995 | 56,224 | (0) | 0 | 0 |
| TOTALS ALL DEBT: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 58,622 | 292,093 | 586,764 | 1,091,115 | 2,979,559 | 3,383,850 | 3,865,583 | 4,420,169 | 5,029,042 | 5,712,935 | 5,400,633 | 5,090,482 | 4,789,958 | 4,507,911 | 4,254,536 | 4,041,298 |
| AMOUNT DRAWN DOWN | 58,622 | 235,648 | 305,450 | 517,978 | 1,922,786 | 529,012 | 635,553 | 733,150 | 831,881 | 927,923 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 5,332 | 26,346 | 49,749 | 94,934 | 251,554 | 285,997 | 326,697 | 372,824 | 423,303 | 479,443 | 446,254 | 414,179 | 384,282 | 357,809 | 336,182 | 318,782 |
| PRINCIPAL REPAYMENT | 0 | 2,176 | 10,779 | 13,627 | 34,342 | 124,721 | 153,821 | 178,564 | 223,007 | 244,031 | 312,302 | 310,151 | 300,524 | 282,047 | 253,375 | 213,238 | 230,638 |
| BALANCE, END OF PERIOD | 58,622 | 292,093 | 586,764 | 1,091,115 | 2,979,559 | 3,383,850 | 3,865,583 | 4,420,169 | 5,029,042 | 5,712,935 | 5,400,633 | 5,090,482 | 4,789,958 | 4,507,911 | 4,254,536 | 4,041,298 | 3,810,660 |
| TOTAL DEBT SERVICE | 0 | 7,508 | 37,125 | 63,375 | 129,277 | 376,275 | 439,818 | 505,262 | 595,831 | 667,334 | 791,745 | 756,405 | 714,703 | 666,329 | 611,183 | 549,420 | 549,420 |

# Exhibit 9-22
## Statement of Income
## Sofia District Heating Company
## Liulin - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING REVENUES: | | | | | | | | | | | | | | | | | |
| STEAM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HOT WATER | 676,110 | 1,106,215 | 1,785,974 | 2,566,015 | 3,840,167 | 4,947,122 | 6,260,565 | 6,991,391 | 7,901,665 | 8,818,208 | 9,999,910 | 10,179,692 | 10,885,140 | 11,600,396 | 12,993,219 | 13,374,521 | 14,420,717 |
| ELECTRICITY | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL SALES REVENUE | 676,110 | 1,106,215 | 1,785,974 | 2,566,015 | 3,840,167 | 4,947,122 | 6,260,565 | 6,991,391 | 7,901,665 | 8,818,208 | 9,999,910 | 10,179,692 | 10,885,140 | 11,600,396 | 12,993,219 | 13,374,521 | 14,420,717 |
| OTHER OPER. REVENUES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING REVENUES | 676,110 | 1,106,215 | 1,785,974 | 2,566,015 | 3,840,167 | 4,947,122 | 6,260,565 | 6,991,391 | 7,901,665 | 8,818,208 | 9,999,910 | 10,179,692 | 10,885,140 | 11,600,396 | 12,993,219 | 13,374,521 | 14,420,717 |
| OPERATING EXPENSES: | | | | | | | | | | | | | | | | | |
| OPER. & MAIN. | | | | | | | | | | | | | | | | | |
| FUEL – GAS | 477,075 | 771,832 | 1,232,232 | 1,902,292 | 2,821,462 | 3,556,148 | 4,420,504 | 5,076,462 | 5,729,477 | 6,352,666 | 6,916,100 | 7,396,816 | 7,988,561 | 8,627,646 | 9,317,858 | 10,063,286 | 10,868,349 |
| OIL | 27,552 | 41,270 | 60,879 | 83,656 | 110,486 | 139,353 | 173,399 | 198,883 | 224,408 | 248,739 | 271,074 | 289,675 | 312,849 | 337,876 | 364,907 | 394,099 | 425,627 |
| LIGNITE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUEL COST | 504,627 | 813,102 | 1,293,111 | 1,985,948 | 2,931,948 | 3,695,501 | 4,593,903 | 5,275,365 | 5,953,885 | 6,601,405 | 7,189,174 | 7,686,490 | 8,301,410 | 8,965,522 | 9,682,764 | 10,457,385 | 11,293,976 |
| PURCHASED POWER | 38,060 | 57,012 | 84,164 | 115,577 | 152,590 | 193,179 | 240,226 | 278,662 | 317,674 | 355,795 | 391,375 | 422,685 | 456,500 | 493,020 | 532,461 | 575,058 | 621,063 |
| FIXED O & M | 35,482 | 49,674 | 67,060 | 87,178 | 106,973 | 130,767 | 154,306 | 178,994 | 204,054 | 228,540 | 251,394 | 271,506 | 293,226 | 316,684 | 342,019 | 369,380 | 398,931 |
| OTHER VAR. O & M | 40,992 | 57,514 | 79,592 | 106,551 | 137,042 | 169,236 | 205,156 | 237,981 | 271,299 | 303,854 | 334,240 | 360,979 | 389,857 | 421,046 | 454,730 | 491,108 | 530,397 |
| EMISSION PENALTIES | 179 | 251 | 339 | 440 | 550 | 660 | 974 | 1,130 | 1,288 | 1,443 | 1,587 | 1,714 | 1,851 | 1,999 | 2,159 | 2,332 | 2,519 |
| MAINTENACE EXPENSE | 51,810 | 74,449 | 190,258 | 134,950 | 192,216 | 214,148 | 478,306 | 302,644 | 393,164 | 408,891 | 851,629 | 502,217 | 617,552 | 618,974 | 1,266,161 | 746,223 | 918,246 |
| PLANT REMOVAL COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL O & M | 670,970 | 1,052,003 | 1,714,523 | 2,430,645 | 3,523,318 | 4,403,494 | 5,672,873 | 6,274,977 | 7,141,364 | 7,899,928 | 9,019,400 | 9,245,591 | 10,060,396 | 10,817,245 | 12,280,295 | 12,641,487 | 13,765,132 |
| DEPRECIATION EXPENSE | 24,673 | 28,583 | 39,809 | 55,747 | 96,419 | 170,315 | 189,582 | 213,100 | 240,337 | 271,115 | 292,356 | 277,738 | 263,851 | 250,659 | 238,126 | 226,220 | 214,909 |
| OTHER OPER. EXPENSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING EXPENSES | 695,642 | 1,080,586 | 1,754,332 | 2,486,393 | 3,619,737 | 4,573,810 | 5,862,455 | 6,488,077 | 7,381,701 | 8,171,043 | 9,311,756 | 9,523,330 | 10,324,248 | 11,067,904 | 12,518,420 | 12,867,707 | 13,980,040 |
| OPERATING SURPLUS | (19,533) | 25,630 | 31,642 | 79,622 | 220,429 | 373,312 | 418,110 | 503,314 | 519,964 | 647,165 | 688,154 | 656,363 | 560,893 | 532,492 | 474,798 | 506,814 | 440,677 |
| LONG TERM DEBT INTEREST | | | | | | | | | | | | | | | | | |
| FOREIGN | 0 | 3,552 | 18,059 | 41,763 | 73,327 | 210,946 | 238,461 | 272,291 | 311,601 | 356,416 | 405,364 | 393,609 | 380,895 | 367,143 | 352,269 | 336,182 | 318,782 |
| DOMESTIC | 0 | 1,780 | 8,287 | 7,986 | 21,607 | 40,608 | 47,536 | 54,406 | 61,223 | 66,885 | 74,080 | 52,645 | 33,284 | 17,139 | 5,539 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST EXPENSE | 0 | 5,332 | 26,346 | 49,749 | 94,934 | 251,554 | 285,997 | 326,697 | 372,824 | 423,303 | 479,443 | 446,254 | 414,179 | 384,282 | 357,809 | 336,182 | 318,782 |
| NET INCOME FOR YEAR | (19,533) | 20,297 | 5,296 | 29,873 | 125,495 | 121,758 | 132,113 | 176,616 | 147,140 | 223,862 | 208,711 | 210,109 | 146,714 | 148,210 | 116,990 | 170,633 | 121,895 |
| PROVISION FOR TAXES @42% | (8,204) | 8,525 | 2,224 | 12,547 | 52,708 | 51,139 | 55,487 | 74,179 | 61,799 | 94,022 | 87,659 | 88,246 | 61,620 | 62,248 | 49,136 | 71,666 | 51,196 |
| ADJUSTED NET INCOME | (11,329) | 11,772 | 3,072 | 17,327 | 72,787 | 70,620 | 76,625 | 102,437 | 85,341 | 129,840 | 121,052 | 121,863 | 85,094 | 85,962 | 67,854 | 98,967 | 70,699 |
| RETAINED EARNINGS, FIRST OF YEAR | 0 | (11,329) | 444 | 3,515 | 20,842 | 93,629 | 164,249 | 240,874 | 343,312 | 428,653 | 558,493 | 679,545 | 801,408 | 886,502 | 972,464 | 1,040,318 | 1,139,285 |
| RETAINED EARNINGS, END OF YEAR | (11,329) | 444 | 3,515 | 20,842 | 93,629 | 164,249 | 240,874 | 343,312 | 428,653 | 558,493 | 679,545 | 801,408 | 886,502 | 972,464 | 1,040,318 | 1,139,285 | 1,209,984 |



1094

# Exhibit 9-23
## Analysis of Cash & Cash Balances
## Sofia District Heating Company
## Liulin - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING CASH BALANCES | 0 | 11,294 | 15,899 | 22,246 | 44,836 | 134,891 | 177,458 | 221,711 | 265,638 | 347,356 | 452,771 | 493,225 | 521,573 | 559,936 | 575,433 | 575,720 | 618,323 |
| PLUS FUNDS GENERATED: | | | | | | | | | | | | | | | | | |
| ADJUSTED NET INCOME | (11,329) | 11,772 | 3,072 | 17,327 | 72,787 | 70,620 | 76,625 | 102,437 | 85,341 | 129,840 | 121,052 | 121,863 | 85,094 | 85,962 | 67,854 | 96,967 | 70,699 |
| NON CASH ITEMS: | | | | | | | | | | | | | | | | | |
| DEPRECIATION | 24,673 | 28,583 | 39,809 | 55,747 | 96,419 | 170,315 | 189,582 | 213,100 | 240,337 | 271,115 | 292,356 | 277,738 | 263,851 | 250,659 | 238,126 | 226,220 | 214,909 |
| TOTAL FUNDS GENERATED | 13,344 | 40,356 | 42,880 | 73,074 | 169,206 | 240,935 | 266,207 | 315,538 | 325,678 | 400,955 | 413,408 | 399,601 | 348,945 | 336,620 | 305,980 | 325,187 | 285,608 |
| DEDUCT USES OF FUNDS: | | | | | | | | | | | | | | | | | |
| REDEMPTION – LOANS | 0 | 2,176 | 10,779 | 13,627 | 34,342 | 124,721 | 153,821 | 178,564 | 223,007 | 244,031 | 312,302 | 310,151 | 300,524 | 282,047 | 253,375 | 213,236 | 230,638 |
| FINANCING COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CHANGE IN WORKING CAPITAL | (2,050) | (33,574) | (25,755) | (36,855) | (44,611) | (73,648) | (88,133) | (73,046) | (40,853) | (51,506) | (60,653) | (61,103) | (10,058) | (39,077) | (52,318) | (69,346) | (22,188) |
| MAINTENANCE SPARES | (1,032) | (457) | (2,316) | 1,106 | (1,145) | (439) | (5,283) | 3,509 | (1,806) | (315) | (8,855) | 6,966 | (2,307) | (26) | (12,944) | 10,399 | (3,440) |
| ACCOUNTS RECEIVABLE | (5,607) | (34,960) | (25,806) | (40,786) | (46,802) | (78,449) | (88,417) | (90,007) | (42,650) | (54,616) | (54,993) | (70,902) | (10,787) | (42,327) | (42,915) | (83,569) | (22,878) |
| ACCOUNTS PAYABLE | 4,586 | 1,843 | 2,368 | 2,825 | 3,137 | 3,239 | 3,567 | 3,451 | 3,503 | 3,423 | 3,194 | 2,811 | 3,036 | 3,279 | 3,541 | 3,824 | 4,130 |
| CAPITAL EXPENDITURES | 58,622 | 235,648 | 305,450 | 517,978 | 1,922,786 | 529,012 | 635,553 | 733,150 | 831,861 | 927,923 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUNDS USED | 60,672 | 271,397 | 341,964 | 568,459 | 2,001,939 | 727,361 | 867,807 | 964,761 | 1,095,841 | 1,223,463 | 372,955 | 371,253 | 310,582 | 321,124 | 305,693 | 262,584 | 252,626 |
| CASH RECEIPTS FROM FINANCING | 58,622 | 235,648 | 305,450 | 517,978 | 1,922,786 | 529,012 | 635,553 | 733,150 | 831,861 | 927,923 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ENDING CASH BALANCES | 11,294 | 15,899 | 22,246 | 44,836 | 134,891 | 177,458 | 221,711 | 265,638 | 347,356 | 452,771 | 493,225 | 521,573 | 559,936 | 575,433 | 575,720 | 618,323 | 651,104 |



1095

# Exhibit 9-24
## Balance Sheet
## Sofia District Heating Company
## Liulin - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASSETS: | | | | | | | | | | | | | | | | | |
| PLANT IN SERVICE | 537,422 | 773,069 | 1,078,519 | 1,596,497 | 3,519,283 | 4,048,295 | 4,683,846 | 5,416,999 | 6,248,879 | 7,176,803 | 7,176,803 | 7,176,803 | 7,176,803 | 7,176,803 | 7,176,803 | 7,176,803 | 7,176,803 |
| C.W.I.P. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LESS: ACCUM. PROV. FOR DEPR. | 24,673 | 53,256 | 93,065 | 148,612 | 245,231 | 415,546 | 605,126 | 816,229 | 1,058,566 | 1,329,680 | 1,622,037 | 1,899,775 | 2,163,626 | 2,414,265 | 2,652,411 | 2,878,631 | 3,093,539 |
| NET PLANT | 512,749 | 719,813 | 985,455 | 1,447,885 | 3,274,052 | 3,632,749 | 4,078,720 | 4,598,770 | 5,190,314 | 5,847,123 | 5,554,766 | 5,277,028 | 5,013,177 | 4,762,518 | 4,524,392 | 4,298,172 | 4,083,264 |
| CURRENT ASSETS | | | | | | | | | | | | | | | | | |
| CASH | 11,294 | 15,899 | 22,246 | 44,838 | 134,891 | 177,456 | 221,711 | 285,638 | 347,356 | 452,771 | 493,225 | 521,573 | 559,936 | 575,433 | 575,720 | 618,323 | 651,104 |
| STORES & MATERIALS | 1,032 | 1,489 | 3,805 | 2,699 | 3,844 | 4,283 | 9,566 | 6,057 | 7,663 | 8,178 | 17,033 | 10,044 | 12,351 | 12,379 | 25,323 | 14,924 | 18,365 |
| ACCOUNTS RECEIVABLE | 5,607 | 40,567 | 68,373 | 107,158 | 153,961 | 230,410 | 296,827 | 376,834 | 419,483 | 474,100 | 529,092 | 599,995 | 610,762 | 653,108 | 696,024 | 779,593 | 802,471 |
| TOTAL CURRENT ASSETS | 17,932 | 57,955 | 92,424 | 154,696 | 292,697 | 412,151 | 528,104 | 668,529 | 774,703 | 935,049 | 1,039,350 | 1,131,612 | 1,183,069 | 1,240,921 | 1,297,067 | 1,412,840 | 1,471,940 |
| EXCHANGE RATE VARIANCES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNAMORTIZED FIN. COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL ASSETS | 530,681 | 777,768 | 1,077,879 | 1,602,381 | 3,566,748 | 4,044,899 | 4,606,825 | 5,267,299 | 5,965,016 | 6,782,171 | 6,594,116 | 6,408,640 | 6,196,246 | 6,003,438 | 5,821,459 | 5,711,013 | 5,555,204 |
| LIABILITIES: | | | | | | | | | | | | | | | | | |
| PAID IN CAPITAL | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 | 478,800 |
| RESERVE FUNDS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET INCOME FOR PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRANSFERS & CONTRIBUTIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE, END OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LOANS OUTSTANDING | | | | | | | | | | | | | | | | | |
| DOMESTIC LOANS | 12,044 | 55,577 | 51,103 | 140,181 | 260,978 | 295,735 | 333,635 | 356,508 | 368,576 | 442,334 | 287,994 | 155,995 | 56,224 | (0) | (0) | 0 | 0 |
| FOREIGN LOANS | 44,402 | 225,737 | 522,034 | 916,592 | 2,593,860 | 2,934,295 | 3,353,363 | 3,840,653 | 4,396,435 | 4,958,299 | 4,802,488 | 4,633,963 | 4,451,686 | 4,254,536 | 4,041,298 | 3,810,660 | 3,589,100 |
| TOTAL LONG-TERM DEBT | 56,446 | 281,314 | 573,137 | 1,056,773 | 2,854,838 | 3,230,029 | 3,687,018 | 4,197,162 | 4,765,011 | 5,400,633 | 5,090,482 | 4,789,958 | 4,507,911 | 4,254,536 | 4,041,298 | 3,810,660 | 3,589,100 |
| CURRENT LIABILITIES | | | | | | | | | | | | | | | | | |
| SHORT TERM LOANS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CURRENT PORTION-LONG-TERM DEBT | 2,176 | 10,779 | 13,627 | 34,342 | 124,721 | 153,821 | 178,564 | 223,007 | 244,031 | 312,302 | 310,151 | 300,524 | 282,047 | 253,375 | 213,236 | 230,636 | 221,560 |
| ACCOUNTS PAYABLE | 4,588 | 6,431 | 8,799 | 11,624 | 14,761 | 18,000 | 21,568 | 25,019 | 28,521 | 31,944 | 35,138 | 37,949 | 40,965 | 44,264 | 47,805 | 51,629 | 55,760 |
| TOTAL CURRENT LIABILITIES | 6,764 | 17,211 | 22,426 | 45,966 | 139,482 | 171,821 | 200,132 | 248,026 | 272,552 | 344,245 | 345,289 | 338,473 | 323,033 | 297,638 | 261,043 | 282,267 | 277,320 |
| TOTAL LIABILITIES | 63,210 | 298,525 | 595,563 | 1,102,739 | 2,994,320 | 3,401,850 | 3,887,150 | 4,445,187 | 5,037,563 | 5,744,878 | 5,435,771 | 5,128,431 | 4,830,943 | 4,552,174 | 4,302,341 | 4,092,926 | 3,866,420 |
| RETAINED EARNINGS | (11,329) | 444 | 3,515 | 20,842 | 93,629 | 164,249 | 240,874 | 343,312 | 428,653 | 556,493 | 679,545 | 801,408 | 866,502 | 972,464 | 1,040,318 | 1,139,285 | 1,209,984 |
| TOTAL LIABILITIES & CAPITAL | 530,681 | 777,768 | 1,077,879 | 1,602,381 | 3,566,748 | 4,044,899 | 4,606,825 | 5,267,299 | 5,965,016 | 6,782,171 | 6,594,116 | 6,408,640 | 6,196,246 | 6,003,438 | 5,821,459 | 5,711,013 | 5,555,204 |



1096

# KOSTOV TPS

## Baseline Case

### Exhibit 9-25 to 9-30

1097

# Exhibit 9-25
## General Data Development
## Sofia District Heating Company
## Kostov - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GENERAL INFLATION | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.860% | 2.670% | 3.500% | 3.500% | 3.500% | 3.500% | 3.500% | 3.350% | 3.200% | 3.060% | 2.930% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% | 2.800% |
| DOMESTIC | 40.000% | 40.000% | 35.000% | 30.000% | 25.000% | 20.000% | 18.000% | 16.000% | 14.000% | 12.000% | 10.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% | 8.000% |
| COMPOUNDED: | | | | | | | | | | | | | | | | | |
| FOREIGN | 1.0186 | 1.0458 | 1.0824 | 1.1203 | 1.1595 | 1.2001 | 1.2421 | 1.2837 | 1.3248 | 1.3653 | 1.4053 | 1.4447 | 1.4851 | 1.5267 | 1.5694 | 1.6134 | 1.6586 |
| DOMESTIC | 1.4000 | 1.9600 | 2.6460 | 3.4398 | 4.2998 | 5.1597 | 6.0884 | 7.0626 | 8.0514 | 9.0175 | 9.9193 | 10.7128 | 11.5698 | 12.4954 | 13.4951 | 14.5747 | 15.7406 |
| FOREX RATIO | 1.3744 | 1.8742 | 2.4446 | 3.0705 | 3.7083 | 4.2995 | 4.9018 | 5.5018 | 6.0776 | 6.6048 | 7.0584 | 7.4155 | 7.7906 | 8.1647 | 8.5987 | 9.0336 | 9.4906 |
| EXCHANGE RATE (LEVA/US) | 43.98 | 59.97 | 78.23 | 98.26 | 118.67 | 137.58 | 156.88 | 176.06 | 194.48 | 211.35 | 225.87 | 237.30 | 249.30 | 261.91 | 275.16 | 289.08 | 303.70 |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN (US 1993$) | $9,755 | $9,257 | $11,109 | $11,109 | $14,472 | $11,109 | $0 | $0 | $0 | $3,363 | $0 | $0 | $0 | $0 | $3,363 | $0 | $0 |
| FOREIGN (CURRENT) | $9,936 | $9,681 | $12,024 | $12,445 | $16,780 | $13,332 | $0 | $0 | $0 | $4,592 | $0 | $0 | $0 | $0 | $5,278 | $0 | $0 |
| FOREIGN (LEVA-CURRENT) | 437,024 | 580,599 | 940,621 | 1,222,608 | 1,991,231 | 1,834,211 | 0 | 0 | 0 | 970,430 | 0 | 0 | 0 | 0 | 1,452,265 | 0 | 0 |
| DOMESTIC (US 1993) | $314 | $1,362 | $1,634 | $1,634 | $1,705 | $1,634 | $0 | $0 | $0 | $71 | $0 | $0 | $0 | $0 | $71 | $0 | $0 |
| DOMESTIC (LEVA 1993) | 10,048 | 43,584 | 52,288 | 52,288 | 54,560 | 52,288 | 0 | 0 | 0 | 2,272 | 0 | 0 | 0 | 0 | 2,272 | 0 | 0 |
| DOMESTIC (LEVA-CURRENT) | 14,067 | 85,425 | 138,354 | 179,860 | 234,594 | 269,790 | 0 | 0 | 0 | 20,468 | 0 | 0 | 0 | 0 | 30,661 | 0 | 0 |
| DOMESTIC (CURRENT US) | $320 | $1,424 | $1,769 | $1,831 | $1,977 | $1,961 | $0 | $0 | $0 | $97 | $0 | $0 | $0 | $0 | $111 | $0 | $0 |
| OPERATING EXPENSES (US $1993) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 53,726 | 62,720 | 74,434 | 87,774 | 103,151 | 107,777 | 111,775 | 111,775 | 111,807 | 111,433 | 111,005 | 110,123 | 110,402 | 110,560 | 110,770 | 110,977 | 111,132 |
| FUEL COST-OIL | 3,105 | 3,352 | 3,679 | 3,661 | 4,037 | 4,222 | 4,383 | 4,381 | 4,381 | 4,365 | 4,347 | 4,311 | 4,322 | 4,328 | 4,337 | 4,345 | 4,351 |
| PURCHASED POWER (NET) | (38,977) | (42,109) | (46,037) | (47,820) | (49,495) | (51,380) | (52,992) | (53,227) | (53,586) | (53,679) | (53,769) | (53,799) | (53,834) | (53,845) | (53,857) | (53,869) | (53,877) |
| FIXED O & M | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 | 2,211 |
| VARIABLE O & M | 5,565 | 5,646 | 5,609 | 5,931 | 6,035 | 6,149 | 6,213 | 6,271 | 6,334 | 6,372 | 6,407 | 6,419 | 6,434 | 6,442 | 6,452 | 6,463 | 6,471 |
| EMISSION PENALTIES | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| MAINTENANCE EXPENSES | 5,683 | 7,246 | 6,544 | 6,438 | 6,419 | 8,104 | 7,090 | 7,044 | 7,048 | 8,559 | 7,743 | 7,651 | 7,639 | 9,353 | 8,275 | 8,254 | 8,196 |
| TOTAL O & M EXPENSES | 31,333 | 39,086 | 46,661 | 58,416 | 72,380 | 77,105 | 78,702 | 78,477 | 78,218 | 79,264 | 77,967 | 76,939 | 77,197 | 79,072 | 78,211 | 78,404 | 78,507 |
| OPERATING EXPENSES (LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FUEL COST-NATURAL GAS | 2,406,925 | 3,933,798 | 6,302,476 | 9,661,600 | 14,192,752 | 17,795,104 | 21,777,154 | 25,261,498 | 28,806,353 | 32,155,193 | 35,234,658 | 37,751,288 | 40,874,687 | 44,207,839 | 47,835,153 | 51,758,507 | 55,977,262 |
| FUEL COST-OIL | 139,104 | 210,237 | 311,508 | 424,994 | 555,459 | 697,096 | 853,941 | 990,120 | 1,128,736 | 1,259,568 | 1,379,611 | 1,477,855 | 1,600,156 | 1,730,567 | 1,872,899 | 2,026,462 | 2,191,602 |
| PURCHASED POWER | (1,746,170) | (2,641,076) | (3,898,045) | (5,263,720) | (6,810,116) | (8,483,372) | (10,324,446) | (12,029,468) | (13,806,087) | (15,489,654) | (17,067,187) | (18,442,846) | (19,931,232) | (21,530,129) | (23,257,721) | (25,123,936) | (27,137,880) |
| FIXED O & M | 99,053 | 138,674 | 187,210 | 243,373 | 304,216 | 365,059 | 430,770 | 499,693 | 569,650 | 638,008 | 701,809 | 757,953 | 818,590 | 884,077 | 954,603 | 1,031,167 | 1,113,682 |
| VARIABLE O & M | 249,312 | 354,117 | 491,860 | 652,847 | 830,368 | 1,015,264 | 1,210,480 | 1,417,266 | 1,631,914 | 1,838,709 | 2,033,890 | 2,200,499 | 2,382,092 | 2,575,858 | 2,786,245 | 3,014,275 | 3,259,447 |
| EMISSION PENALTIES | 896 | 1,254 | 1,778 | 2,312 | 3,027 | 3,632 | 4,286 | 4,972 | 5,926 | 6,637 | 7,301 | 7,885 | 8,515 | 9,197 | 9,932 | 10,727 | 11,585 |
| MAINTENANCE EXPENSES | 254,598 | 454,469 | 554,094 | 706,654 | 883,203 | 1,338,055 | 1,381,347 | 1,591,966 | 1,815,872 | 2,469,792 | 2,457,759 | 2,622,841 | 2,828,225 | 3,739,833 | 3,573,494 | 3,849,579 | 4,128,331 |
| TOTAL O & M EXPENSES | 1,403,718 | 2,451,474 | 3,950,880 | 6,430,059 | 9,958,909 | 12,730,837 | 15,333,532 | 17,736,046 | 20,152,363 | 22,878,253 | 24,748,040 | 26,375,474 | 28,561,033 | 31,617,241 | 33,774,805 | 36,566,802 | 39,544,028 |



1098

# Exhibit 9-26
## Projected Investment Program - Municipal Ownership
## Sofia District Heating Company
## Kostov - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAPITAL EXPENDITURES (000'S LEVA-CURRENT) | | | | | | | | | | | | | | | | | |
| FOREIGN | 437,024 | 580,599 | 940,621 | 1,222,808 | 1,991,231 | 1,834,211 | 0 | 0 | 0 | 970,430 | 0 | 0 | 0 | 0 | 1,452,285 | 0 | 0 |
| DOMESTIC | 14,067 | 85,425 | 138,354 | 179,860 | 234,594 | 269,790 | 0 | 0 | 0 | 20,488 | 0 | 0 | 0 | 0 | 30,661 | 0 | 0 |
| MUNICIPAL OWNERSHIP: | | | | | | | | | | | | | | | | | |
| INVESTMENT PROGRAM | | | | | | | | | | | | | | | | | |
| FOREIGN | | | | | | | | | | | | | | | | | |
| SERIES 94-96 | 2,048,883 | 1,594,378 | 982,949 | | | | | | | | | | | | | | |
| DRAWDOWN | 454,505 | 611,429 | 982,949 | | | | | | | | | | | | | | |
| UNDISBURED | 1,594,378 | 982,949 | 0 | | | | | | | | | | | | | | |
| SERIES 97-99 | | | | 5,276,479 | 4,005,759 | 1,916,751 | | | | | | | | | | | |
| DRAWDOWN | | | | 1,271,720 | 2,090,008 | 1,916,751 | | | | | | | | | | | |
| UNDISBURED | | | | 4,005,759 | 1,916,751 | 0 | | | | | | | | | | | |
| SERIES 03 | | | | | | | | | | 1,009,247 | | | | | | | |
| DRAWDOWN | | | | | | | | | | 1,009,247 | | | | | | | |
| UNDISBURED | | | | | | | | | | 0 | | | | | | | |
| SERIES 06 | | | | | | | | | | | | | | | 1,510,376 | | |
| DRAWDOWN | | | | | | | | | | | | | | | 1,510,376 | | |
| UNDISBURED | | | | | | | | | | | | | | | 0 | | |
| DOMESTIC | | | | | | | | | | | | | | | | | |
| ANNUAL REQUIREMENT | 16,177 | 98,238 | 159,107 | 206,839 | 269,784 | 310,259 | 0 | 0 | 0 | 23,561 | 0 | 0 | 0 | 0 | 35,260 | 0 | 0 |

CAPITALIZATION SCHEDULE AND
APPLICATION OF CONSTRUCTION FUNDS
SOFIA DISTRICT HEATING COMPANY
KOSTOV - BASELINE CASE

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING BALANCE | | | | | | | | | | | | | | | | | |
| CAPITAL FUNDING | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 454,505 | 611,429 | 982,949 | 1,271,720 | 2,090,008 | 1,916,751 | 0 | 0 | 0 | 1,009,247 | 0 | 0 | 0 | 0 | 1,510,376 | 0 | 0 |
| DOMESTIC LOANS | 16,177 | 98,238 | 159,107 | 206,839 | 269,784 | 310,259 | 0 | 0 | 0 | 23,561 | 0 | 0 | 0 | 0 | 35,260 | 0 | 0 |
| TOTAL NEW CAPITAL | 470,682 | 709,667 | 1,142,056 | 1,478,559 | 2,359,791 | 2,227,010 | 0 | 0 | 0 | 1,032,808 | 0 | 0 | 0 | 0 | 1,545,636 | 0 | 0 |
| INTERNAL FUNDS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PROCEEDS AVAILABLE | 470,682 | 709,667 | 1,142,056 | 1,478,559 | 2,359,791 | 2,227,010 | 0 | 0 | 0 | 1,032,808 | 0 | 0 | 0 | 0 | 1,545,636 | 0 | 0 |
| UTILIZATION OF PROCEEDS | | | | | | | | | | | | | | | | | |
| CAPITAL EXPENDITURES | | | | | | | | | | | | | | | | | |
| FOREIGN COSTS | 437,024 | 580,599 | 940,621 | 1,222,808 | 1,991,231 | 1,834,211 | 0 | 0 | 0 | 970,430 | 0 | 0 | 0 | 0 | 1,452,285 | 0 | 0 |
| DOMESTIC COSTS | 14,067 | 85,425 | 138,354 | 179,860 | 234,594 | 269,790 | 0 | 0 | 0 | 20,488 | 0 | 0 | 0 | 0 | 30,661 | 0 | 0 |
| COMMITMENT FEES | 0 | 7,606 | 4,703 | 0 | 19,127 | 9,171 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BOND DISCOUNT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RES. FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER EXPENSES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL UTILIZATION | 451,091 | 673,630 | 1,083,678 | 1,402,668 | 2,244,953 | 2,113,173 | 0 | 0 | 0 | 990,918 | 0 | 0 | 0 | 0 | 1,482,946 | 0 | 0 |
| BALANCE ON DEPOSIT | | | | | | | | | | | | | | | | | |
| INTEREST EARNED ON: | | | | | | | | | | | | | | | | | |
| CONSTRUCTION FUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE RESERVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE AVAILABLE | 19,591 | 36,038 | 58,378 | 75,891 | 114,838 | 113,837 | 0 | 0 | 0 | 41,890 | 0 | 0 | 0 | 0 | 62,691 | 0 | 0 |
| INTEREST CHARGES | | | | | | | | | | | | | | | | | |
| FOREIGN LOANS | 17,481 | 23,224 | 37,625 | 49,912 | 79,649 | 73,368 | 0 | 0 | 0 | 38,817 | 0 | 0 | 0 | 0 | 58,091 | 0 | 0 |
| DOMESTIC LOANS | 2,110 | 12,814 | 20,753 | 26,979 | 35,189 | 40,489 | 0 | 0 | 0 | 3,073 | 0 | 0 | 0 | 0 | 4,599 | 0 | 0 |
| TOTAL INTEREST | 19,591 | 36,038 | 58,378 | 75,891 | 114,838 | 113,837 | 0 | 0 | 0 | 41,890 | 0 | 0 | 0 | 0 | 62,691 | 0 | 0 |
| NET END OF PERIOD | (0) | 0 | 0 | (0) | (0) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AMOUNT CLOSED TO PLANT | 470,682 | 709,667 | 1,142,056 | 1,478,559 | 2,359,791 | 2,227,010 | 0 | 0 | 0 | 1,032,808 | 0 | 0 | 0 | 0 | 1,545,636 | 0 | 0 |



1099

# Exhibit 9-27
## Debt Service Schedule
## Sofia District Heating Company
## Kostov - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOREIGN LOANS: | | | | | | | | | | | | | | | | | |
| SERIES 94-96 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 454,505 | 1,065,934 | 2,048,883 | 2,048,883 | 2,048,883 | 2,004,898 | 1,957,324 | 1,905,867 | 1,850,212 | 1,790,015 | 1,724,906 | 1,654,484 | 1,578,316 | 1,495,932 | 1,406,826 | 1,310,449 |
| AMOUNT DRAWN DOWN | 454,505 | 611,429 | 982,949 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 36,360 | 85,275 | 163,911 | 163,911 | 163,048 | 159,459 | 155,577 | 151,376 | 146,837 | 141,925 | 136,612 | 130,865 | 124,650 | 117,927 | 110,656 | 102,792 |
| PRINCIPAL REPAYMENT | 0 | 0 | 0 | 0 | 0 | 43,985 | 47,574 | 51,457 | 55,655 | 60,197 | 65,109 | 70,422 | 76,168 | 82,384 | 89,106 | 96,377 | 104,241 |
| TOTAL DEBT SERVICE | 0 | 36,360 | 85,275 | 163,911 | 163,911 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 | 207,033 |
| SERIES 97-99 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | 0 | 1,271,720 | 3,361,728 | 5,278,479 | 5,278,479 | 5,278,479 | 5,165,161 | 5,042,596 | 4,910,030 | 4,766,647 | 4,611,563 | 4,443,825 | 4,262,399 | 4,066,169 |
| AMOUNT DRAWN DOWN | | | | 1,271,720 | 2,090,008 | 1,916,751 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | 0 | 101,738 | 268,938 | 422,278 | 422,278 | 420,056 | 410,810 | 400,808 | 389,991 | 378,291 | 365,636 | 351,949 | 337,144 | 321,132 |
| PRINCIPAL REPAYMENT | | | | 0 | 0 | 0 | 0 | 0 | 113,318 | 122,565 | 132,566 | 143,383 | 155,083 | 167,738 | 181,426 | 196,230 | 212,242 |
| TOTAL DEBT SERVICE | | | | 0 | 101,738 | 268,938 | 422,278 | 422,278 | 533,374 | 533,374 | 533,374 | 533,374 | 533,374 | 533,374 | 533,374 | 533,374 | 533,374 |
| SERIES 03 | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | 0 | 1,009,247 | 987,581 | 964,146 | 938,800 | 911,385 | 881,733 | 849,661 |
| AMOUNT DRAWN DOWN | | | | | | | | | | 1,009,247 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | | | | | 0 | 80,315 | 78,547 | 76,635 | 74,566 | 72,329 | 69,910 | 67,293 |
| PRINCIPAL REPAYMENT | | | | | | | | | | 0 | 21,666 | 23,434 | 25,347 | 27,415 | 29,652 | 32,072 | 34,689 |
| TOTAL DEBT SERVICE | | | | | | | | | | | 101,981 | 101,981 | 101,981 | 101,981 | 101,981 | 101,981 | 101,981 |
| SERIES 08 | | | | | | | | | | | | | | | 0 | 1,510,376 | 1,477,952 |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | | 1,510,376 | 0 | 0 |
| AMOUNT DRAWN DOWN | | | | | | | | | | | | | | | 0 | 120,194 | 117,548 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | | | | | | | | | | | | | | | 0 | 32,425 | 35,070 |
| PRINCIPAL REPAYMENT | | | | | | | | | | | | | | | 0 | 152,619 | 152,619 |
| TOTAL DEBT SERVICE | | | | | | | | | | | | | | | | | |
| BALANCE, END OF PERIOD | 454,505 | 1,065,934 | 2,048,883 | 3,320,603 | 5,410,611 | 7,283,377 | 7,235,802 | 7,184,346 | 7,015,372 | 6,841,858 | 7,622,517 | 7,385,277 | 7,128,879 | 6,851,142 | 8,061,335 | 7,704,231 | 7,317,968 |
| DOMESTIC LOANS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | | | | | | | | | | | | | | | | | |
| SERIES 94 | 0 | 16,177 | 13,702 | 10,894 | 7,709 | 4,097 | | | | | | | | | | | |
| SERIES 95 | | 0 | 98,238 | 83,205 | 66,154 | 46,815 | 24,880 | | | | | | | | | | |
| SERIES 96 | | | | 159,107 | 134,760 | 107,144 | 75,822 | 40,295 | | | | | | | | | |
| SERIES 97 | | | | | 206,839 | 175,187 | 139,287 | 98,568 | 52,384 | | | | | | | | |
| SERIES 98 | | | | | | 269,784 | 228,500 | 181,674 | 128,564 | 68,325 | | | | | | | |
| SERIES 99 | | | | | | | 310,259 | 262,781 | 208,931 | 147,852 | 78,575 | | | | | | |
| SERIES 00 | | | | | | | | 0 | 0 | 0 | 0 | 0 | | | | | |
| SERIES 01 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | | | | |
| SERIES 02 | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | | | |
| SERIES 03 | | | | | | | | | | | 23,561 | 19,956 | 15,866 | 11,228 | 5,967 | | |
| SERIES 04 | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | |
| SERIES 05 | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 |
| SERIES 06 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| SERIES 07 | | | | | | | | | | | | | | | 0 | 0 | 0 |
| SERIES 08 | | | | | | | | | | | | | | | | 35,260 | 29,864 |
| SERIES 09 | | | | | | | | | | | | | | | | | 0 |
| SERIES 10 | | | | | | | | | | | | | | | | | |
| TOTAL OUTSTANDING | 0 | 16,177 | 111,940 | 253,206 | 415,463 | 603,027 | 778,747 | 583,319 | 389,878 | 216,177 | 102,136 | 19,956 | 15,866 | 11,228 | 5,967 | 35,260 | 29,864 |
| AMOUNT DRAWN DOWN | 16,177 | 98,238 | 159,107 | 206,839 | 269,784 | 310,259 | 0 | 0 | 0 | 23,561 | 0 | 0 | 0 | 0 | 35,260 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 2,025 | 13,991 | 31,513 | 51,422 | 74,159 | 95,086 | 69,743 | 45,217 | 23,772 | 10,691 | 2,465 | 1,917 | 1,294 | 588 | 4,414 | 3,690 |
| PRINCIPAL REPAYMENT | 0 | 2,476 | 17,841 | 44,583 | 82,219 | 134,539 | 195,428 | 193,440 | 173,701 | 137,602 | 82,181 | 4,089 | 4,638 | 5,261 | 5,967 | 5,396 | 6,120 |
| TOTAL DEBT SERVICE | 0 | 4,501 | 31,831 | 76,097 | 133,641 | 208,698 | 290,514 | 263,183 | 218,918 | 161,373 | 92,872 | 6,555 | 6,555 | 6,555 | 6,555 | 9,810 | 9,810 |
| BALANCE, END OF PERIOD | 16,177 | 111,940 | 253,206 | 415,463 | 603,027 | 778,747 | 583,319 | 389,878 | 216,177 | 102,136 | 19,956 | 15,866 | 11,228 | 5,967 | 35,260 | 29,864 | 23,744 |
| TOTALS ALL DEBT: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 470,682 | 1,177,874 | 2,302,090 | 3,736,066 | 6,013,638 | 8,062,124 | 7,819,121 | 7,574,224 | 7,231,549 | 7,943,994 | 7,642,472 | 7,401,143 | 7,139,907 | 8,857,109 | 8,096,595 | 7,734,096 |
| AMOUNT DRAWN DOWN | 470,682 | 709,667 | 1,142,056 | 1,476,559 | 2,359,791 | 2,227,010 | 0 | 0 | 0 | 1,032,808 | 0 | 0 | 0 | 0 | 1,545,636 | 0 | 0 |
| DEBT SERVICE | | | | | | | | | | | | | | | | | |
| INTEREST CHARGES | 0 | 38,386 | 99,265 | 195,424 | 317,070 | 506,145 | 676,823 | 647,598 | 616,651 | 581,418 | 633,739 | 607,615 | 587,707 | 566,146 | 542,793 | 542,319 | 612,455 |
| PRINCIPAL REPAYMENT | 0 | 2,476 | 17,841 | 44,583 | 82,219 | 178,524 | 243,003 | 244,897 | 342,675 | 320,363 | 301,522 | 241,329 | 261,237 | 282,798 | 306,151 | 362,499 | 392,363 |
| BALANCE, END OF PERIOD | 470,682 | 1,177,874 | 2,302,090 | 3,736,066 | 6,013,638 | 8,062,124 | 7,819,121 | 7,574,224 | 7,231,549 | 7,943,994 | 7,642,472 | 7,401,143 | 7,139,907 | 6,857,109 | 8,096,595 | 7,734,096 | 7,341,733 |
| TOTAL DEBT SERVICE | 0 | 40,861 | 117,106 | 240,007 | 399,289 | 684,669 | 919,826 | 892,495 | 959,326 | 901,781 | 935,261 | 848,944 | 848,944 | 848,944 | 848,944 | 1,004,818 | 1,004,818 |



1100

# Exhibit 9-28
## Statement of Income
## Sofia District Heating Company
## Kostov - Baseline Case

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING REVENUES: | | | | | | | | | | | | | | | | | |
| STEAM | 125,798 | 219,703 | 347,713 | 551,115 | 835,050 | 1,051,409 | 1,234,015 | 1,416,800 | 1,588,034 | 1,763,070 | 1,919,292 | 2,037,400 | 2,198,658 | 2,421,039 | 2,583,708 | 2,802,048 | 3,009,943 |
| HOT WATER | 1,380,580 | 2,416,180 | 3,921,283 | 6,400,194 | 9,977,998 | 12,918,353 | 15,574,036 | 17,880,888 | 20,041,970 | 22,503,443 | 24,222,650 | 25,713,248 | 27,748,427 | 30,555,016 | 32,607,998 | 35,363,579 | 37,987,347 |
| ELECTRICITY | 1,746,170 | 2,641,076 | 3,898,045 | 5,263,720 | 6,810,116 | 8,483,372 | 10,324,446 | 12,029,468 | 13,806,087 | 15,489,654 | 17,067,187 | 18,442,848 | 19,931,232 | 21,530,129 | 23,257,721 | 25,123,936 | 27,137,880 |
| TOTAL SALES REVENUE | 3,252,527 | 5,276,959 | 8,167,041 | 12,215,029 | 17,623,164 | 22,451,134 | 27,132,497 | 31,327,156 | 35,436,091 | 39,776,166 | 43,209,129 | 46,193,494 | 49,878,317 | 54,506,185 | 58,449,426 | 63,289,563 | 68,135,170 |
| OTHER OPER. REVENUES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING REVENUES | 3,252,527 | 5,276,959 | 8,167,041 | 12,215,029 | 17,623,164 | 22,451,134 | 27,132,497 | 31,327,156 | 35,436,091 | 39,776,166 | 43,209,129 | 46,193,494 | 49,878,317 | 54,506,185 | 58,449,426 | 63,289,563 | 68,135,170 |
| OPERATING EXPENSES: | | | | | | | | | | | | | | | | | |
| OPER. & MAIN. | | | | | | | | | | | | | | | | | |
| FUEL - GAS | 2,406,925 | 3,933,798 | 6,302,476 | 9,661,600 | 14,192,752 | 17,795,104 | 21,777,154 | 25,261,496 | 28,806,353 | 32,155,193 | 35,234,858 | 37,751,288 | 40,874,687 | 44,207,839 | 47,835,153 | 51,758,507 | 55,977,262 |
| OIL | 139,104 | 210,237 | 311,508 | 424,994 | 555,459 | 697,096 | 853,941 | 990,120 | 1,128,736 | 1,259,568 | 1,379,811 | 1,477,855 | 1,600,158 | 1,730,567 | 1,872,899 | 2,026,462 | 2,191,602 |
| LIGNITE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUEL COST | 2,546,029 | 4,144,036 | 6,613,984 | 10,086,594 | 14,748,211 | 18,492,200 | 22,631,095 | 26,251,616 | 29,935,089 | 33,414,761 | 36,614,669 | 39,229,143 | 42,474,842 | 45,938,406 | 49,708,052 | 53,784,970 | 58,168,863 |
| PURCHASED POWER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FIXED O & M | 99,053 | 138,674 | 187,210 | 243,373 | 304,216 | 365,059 | 430,770 | 499,693 | 569,650 | 638,008 | 701,609 | 757,953 | 818,590 | 884,077 | 954,803 | 1,031,187 | 1,113,682 |
| OTHER VAR. O & M | 249,312 | 354,117 | 491,860 | 652,847 | 830,368 | 1,015,264 | 1,210,480 | 1,417,266 | 1,631,914 | 1,838,709 | 2,033,690 | 2,200,499 | 2,382,092 | 2,575,658 | 2,786,245 | 3,014,275 | 3,259,447 |
| EMISSION PENALTIES | 896 | 1,254 | 1,778 | 2,312 | 3,027 | 3,632 | 4,286 | 4,972 | 5,926 | 6,637 | 7,301 | 7,885 | 8,515 | 9,197 | 9,932 | 10,727 | 11,585 |
| MAINTENACE EXPENSE | 254,596 | 454,469 | 554,094 | 708,654 | 883,203 | 1,338,055 | 1,361,347 | 1,591,966 | 1,815,872 | 2,469,792 | 2,457,759 | 2,622,841 | 2,828,225 | 3,739,833 | 3,573,494 | 3,849,579 | 4,128,331 |
| PLANT REMOVAL COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL O & M | 3,149,888 | 5,092,550 | 7,848,925 | 11,693,779 | 16,769,025 | 21,214,210 | 25,657,978 | 29,765,514 | 33,958,451 | 38,367,907 | 41,815,227 | 44,818,320 | 48,512,265 | 53,147,370 | 57,032,526 | 61,690,738 | 66,681,906 |
| DEPRECIATION EXPENSE | 99,124 | 120,689 | 155,543 | 209,075 | 283,564 | 385,716 | 449,943 | 427,446 | 406,073 | 398,660 | 417,476 | 396,602 | 376,772 | 357,934 | 359,357 | 399,351 | 379,383 |
| OTHER OPER. EXPENSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL OPERATING EXPENSES | 3,249,012 | 5,213,239 | 8,004,468 | 11,902,854 | 17,052,589 | 21,599,926 | 26,107,921 | 30,192,960 | 34,364,524 | 38,766,567 | 42,232,703 | 45,214,923 | 48,889,037 | 53,505,304 | 57,391,884 | 62,090,089 | 67,061,291 |
| OPERATING SURPLUS | 3,515 | 63,720 | 162,573 | 312,175 | 570,575 | 851,209 | 1,024,577 | 1,134,196 | 1,071,567 | 1,009,580 | 976,426 | 978,571 | 989,280 | 1,000,881 | 1,057,542 | 1,199,474 | 1,073,879 |
| LONG TERM DEBT INTEREST | | | | | | | | | | | | | | | | | |
| FOREIGN | 0 | 36,360 | 85,275 | 183,911 | 265,648 | 431,986 | 581,737 | 577,855 | 571,434 | 557,646 | 623,048 | 605,150 | 585,791 | 564,852 | 542,205 | 637,905 | 608,765 |
| DOMESTIC | 0 | 2,025 | 13,991 | 31,513 | 51,422 | 74,159 | 95,066 | 69,743 | 45,217 | 23,772 | 10,691 | 2,465 | 1,917 | 1,294 | 588 | 4,414 | 3,690 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL INTEREST EXPENSE | 0 | 38,386 | 99,265 | 195,424 | 317,070 | 506,145 | 676,823 | 647,598 | 616,651 | 581,418 | 633,739 | 607,615 | 587,707 | 566,146 | 542,793 | 642,319 | 612,455 |
| NET INCOME FOR YEAR | 3,515 | 25,334 | 63,308 | 116,751 | 253,504 | 345,064 | 347,754 | 486,598 | 454,916 | 428,162 | 342,687 | 370,956 | 401,573 | 434,734 | 514,749 | 557,155 | 461,424 |
| PROVISION FOR TAXES @ 42% | 1,476 | 10,640 | 26,589 | 49,035 | 106,472 | 144,927 | 146,057 | 204,371 | 191,065 | 179,828 | 143,929 | 155,802 | 168,661 | 182,588 | 216,194 | 234,005 | 193,798 |
| ADJUSTED NET INCOME | 2,039 | 14,694 | 36,719 | 67,716 | 147,033 | 200,137 | 201,697 | 282,227 | 263,851 | 248,334 | 198,759 | 215,154 | 232,912 | 252,146 | 298,554 | 323,150 | 267,626 |
| RETAINED EARNINGS, FIRST OF YEAR | 0 | 2,039 | 16,733 | 53,451 | 121,167 | 268,199 | 468,336 | 670,034 | 952,260 | 1,216,111 | 1,464,445 | 1,663,204 | 1,878,358 | 2,111,270 | 2,363,416 | 2,661,970 | 2,985,121 |
| RETAINED EARNINGS, END OF YEAR | 2,039 | 16,733 | 53,451 | 121,167 | 268,199 | 468,336 | 670,034 | 952,260 | 1,216,111 | 1,464,445 | 1,663,204 | 1,878,358 | 2,111,270 | 2,363,416 | 2,661,970 | 2,985,121 | 3,252,746 |



101

# Exhibit 9-29
## Analysis of Cash & Cash Balances
## Sofia District Heating Company
## Kostov - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BEGINNING CASH BALANCES | 0 | 89,239 | 59,396 | 121,534 | 190,274 | 306,584 | 395,071 | 528,820 | 725,044 | 813,213 | 896,758 | 966,833 | 1,141,359 | 1,321,171 | 1,424,687 | 1,518,969 | 1,655,120 |
| PLUS FUNDS GENERATED: | | | | | | | | | | | | | | | | | |
| ADJUSTED NET INCOME | 2,039 | 14,694 | 36,719 | 67,716 | 147,033 | 200,137 | 201,697 | 282,227 | 263,851 | 248,334 | 198,759 | 215,154 | 232,912 | 252,146 | 298,554 | 323,150 | 267,626 |
| NON CASH ITEMS: | | | | | | | | | | | | | | | | | |
| DEPRECIATION | 99,124 | 120,689 | 155,543 | 209,075 | 283,564 | 385,716 | 449,943 | 427,446 | 406,073 | 398,680 | 417,476 | 396,602 | 376,772 | 357,934 | 359,357 | 399,351 | 379,383 |
| TOTAL FUNDS GENERATED | 101,162 | 135,383 | 192,261 | 276,790 | 430,597 | 585,853 | 651,640 | 709,673 | 669,924 | 647,014 | 616,235 | 611,757 | 609,684 | 610,079 | 657,912 | 722,501 | 647,009 |
| DEDUCT USES OF FUNDS: | | | | | | | | | | | | | | | | | |
| REDEMPTION – LOANS | 0 | 2,476 | 17,641 | 44,583 | 82,219 | 178,524 | 243,003 | 244,697 | 342,675 | 320,363 | 301,522 | 241,329 | 261,237 | 282,798 | 306,151 | 362,499 | 392,363 |
| FINANCING COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CHANGE IN WORKING CAPITAL | (11,923) | (162,750) | (112,282) | (163,467) | (232,068) | (318,641) | (274,666) | (268,552) | (239,061) | (243,105) | (244,637) | (195,902) | (168,636) | (223,766) | (257,478) | (223,851) | (276,323) |
| MAINTENANCE SPARES | (5,092) | (3,997) | (1,992) | (3,091) | (3,491) | (9,097) | (666) | (4,212) | (4,478) | (13,078) | 241 | (3,302) | (4,106) | (16,232) | 3,327 | (5,522) | (5,575) |
| ACCOUNTS RECEIVABLE | (27,733) | (167,419) | (121,466) | (173,405) | (242,679) | (324,488) | (269,678) | (260,882) | (251,660) | (246,536) | (260,405) | (205,978) | (179,062) | (221,089) | (277,672) | (236,594) | (290,408) |
| ACCOUNTS PAYABLE | 20,902 | 8,666 | 11,177 | 13,029 | 14,302 | 14,744 | 15,656 | 16,542 | 17,076 | 16,509 | 15,527 | 13,377 | 14,534 | 15,555 | 16,667 | 18,265 | 19,660 |
| CAPITAL EXPENDITURES | 470,662 | 709,667 | 1,142,056 | 1,478,559 | 2,359,791 | 2,227,010 | 0 | 0 | 0 | 1,032,808 | 0 | 0 | 0 | 0 | 1,545,636 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EXCHANGE RATE VARIANCE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL FUNDS USED | 482,605 | 674,893 | 1,272,179 | 1,656,609 | 2,674,079 | 2,724,375 | 517,891 | 513,449 | 561,756 | 1,596,276 | 546,159 | 437,231 | 429,872 | 506,564 | 2,109,266 | 586,350 | 668,686 |
| CASH RECEIPTS FROM FINANCING | 470,662 | 709,667 | 1,142,056 | 1,478,559 | 2,359,791 | 2,227,010 | 0 | 0 | 0 | 1,032,808 | 0 | 0 | 0 | 0 | 1,545,636 | 0 | 0 |
| ENDING CASH BALANCES | 89,239 | 59,396 | 121,534 | 190,274 | 306,584 | 395,071 | 528,820 | 725,044 | 813,213 | 896,758 | 966,833 | 1,141,359 | 1,321,171 | 1,424,687 | 1,518,969 | 1,655,120 | 1,633,443 |



1102

# Exhibit 9-30
## Balance Sheet
## Sofia District Heating Company
## Kostov - Baseline Case

| ITEMS | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASSETS: | | | | | | | | | | | | | | | | | |
| PLANT IN SERVICE | 2,335,482 | 3,045,150 | 4,187,208 | 5,665,765 | 8,025,557 | 10,252,567 | 10,252,567 | 10,252,567 | 10,252,567 | 11,285,375 | 11,285,375 | 11,285,375 | 11,285,375 | 11,285,375 | 12,831,011 | 12,831,011 | 12,831,011 |
| C.W.I.P. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LESS: ACCUM. PROV. FOR DEPR. | 99,124 | 219,812 | 375,355 | 584,429 | 867,994 | 1,253,709 | 1,703,652 | 2,131,098 | 2,537,171 | 2,935,851 | 3,353,327 | 3,749,930 | 4,126,702 | 4,484,636 | 4,843,993 | 5,243,344 | 5,622,727 |
| NET PLANT | 2,236,359 | 2,825,337 | 3,811,851 | 5,081,336 | 7,157,563 | 8,998,857 | 8,548,914 | 8,121,469 | 7,715,395 | 8,349,523 | 7,932,047 | 7,535,445 | 7,158,673 | 6,800,739 | 7,987,018 | 7,587,667 | 7,208,284 |
| CURRENT ASSETS | | | | | | | | | | | | | | | | | |
| CASH | 89,239 | 59,396 | 121,534 | 190,274 | 306,564 | 395,071 | 528,820 | 725,044 | 813,213 | 896,758 | 966,833 | 1,141,359 | 1,321,171 | 1,424,687 | 1,518,969 | 1,655,120 | 1,633,443 |
| STORES & MATERIALS | 5,092 | 9,069 | 11,082 | 14,173 | 17,664 | 26,761 | 27,627 | 31,839 | 36,317 | 49,396 | 49,155 | 52,457 | 56,565 | 74,797 | 71,470 | 76,992 | 82,567 |
| ACCOUNTS RECEIVABLE | 27,733 | 195,152 | 316,618 | 490,022 | 732,902 | 1,057,390 | 1,347,068 | 1,627,950 | 1,879,629 | 2,126,165 | 2,386,570 | 2,592,546 | 2,771,610 | 2,992,699 | 3,270,371 | 3,506,966 | 3,797,374 |
| TOTAL CURRENT ASSETS | 122,064 | 263,637 | 449,234 | 694,470 | 1,057,149 | 1,479,222 | 1,903,515 | 2,384,833 | 2,729,160 | 3,072,319 | 3,402,559 | 3,786,364 | 4,149,345 | 4,492,182 | 4,860,810 | 5,239,077 | 5,513,383 |
| EXCHANGE RATE VARIANCES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| UNAMORTIZED FIN. COSTS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL ASSETS | 2,358,423 | 3,088,974 | 4,261,085 | 5,775,806 | 8,214,712 | 10,478,080 | 10,452,430 | 10,506,302 | 10,444,555 | 11,421,843 | 11,334,606 | 11,321,809 | 11,308,018 | 11,292,921 | 12,847,828 | 12,826,744 | 12,721,667 |
| LIABILITIES: | | | | | | | | | | | | | | | | | |
| PAID IN CAPITAL | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 | 1,864,600 |
| RESERVE FUNDS: | | | | | | | | | | | | | | | | | |
| BALANCE, START OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NET INCOME FOR PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRANSFERS & CONTRIBUTIONS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BALANCE, END OF PERIOD | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LOANS OUTSTANDING | | | | | | | | | | | | | | | | | |
| DOMESTIC LOANS | 13,702 | 94,099 | 208,623 | 333,243 | 468,488 | 583,319 | 389,878 | 216,177 | 78,575 | 19,956 | 15,866 | 11,228 | 5,967 | (0) | 29,864 | 23,744 | 16,603 |
| FOREIGN LOANS | 454,505 | 1,065,934 | 2,048,883 | 3,320,603 | 5,366,626 | 7,235,802 | 7,184,346 | 7,015,372 | 6,832,611 | 7,622,517 | 7,385,277 | 7,128,679 | 6,851,142 | 6,550,958 | 7,704,231 | 7,317,988 | 6,999,983 |
| TOTAL LONG-TERM DEBT | 468,207 | 1,160,033 | 2,257,507 | 3,653,847 | 5,835,114 | 7,819,121 | 7,574,224 | 7,231,549 | 6,911,186 | 7,642,472 | 7,401,143 | 7,139,907 | 6,857,109 | 6,550,958 | 7,734,096 | 7,341,733 | 7,016,786 |
| CURRENT LIABILITIES | | | | | | | | | | | | | | | | | |
| SHORT TERM LOANS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CURRENT PORTION-LONG-TERM DEBT | 2,476 | 17,841 | 44,583 | 82,219 | 178,524 | 243,003 | 244,897 | 342,675 | 320,363 | 301,522 | 241,329 | 261,237 | 282,798 | 306,151 | 362,499 | 392,363 | 324,946 |
| ACCOUNTS PAYABLE | 20,902 | 29,567 | 40,744 | 53,773 | 68,075 | 82,819 | 98,475 | 115,018 | 132,094 | 148,603 | 164,130 | 177,507 | 192,041 | 207,596 | 224,463 | 242,728 | 262,388 |
| TOTAL CURRENT LIABILITIES | 23,377 | 47,408 | 85,327 | 135,992 | 246,599 | 325,822 | 343,372 | 457,692 | 452,457 | 450,125 | 405,459 | 438,744 | 474,839 | 513,747 | 586,962 | 635,091 | 587,334 |
| TOTAL LIABILITIES | 491,584 | 1,207,442 | 2,342,834 | 3,789,839 | 6,081,713 | 8,144,943 | 7,917,596 | 7,689,242 | 7,363,643 | 8,092,597 | 7,806,602 | 7,578,650 | 7,331,947 | 7,064,705 | 8,321,057 | 7,976,823 | 7,604,120 |
| RETAINED EARNINGS | 2,039 | 16,733 | 53,451 | 121,167 | 268,199 | 468,336 | 670,034 | 952,260 | 1,216,111 | 1,464,445 | 1,663,204 | 1,878,358 | 2,111,270 | 2,363,416 | 2,661,970 | 2,985,121 | 3,252,746 |
| TOTAL LIABILITIES & CAPITAL | 2,358,423 | 3,088,974 | 4,261,085 | 5,775,806 | 8,214,712 | 10,478,080 | 10,452,430 | 10,506,302 | 10,444,555 | 11,421,843 | 11,334,606 | 11,321,809 | 11,308,018 | 11,292,921 | 12,847,828 | 12,826,744 | 12,721,667 |



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**SECTION 10**

**Training Program Support**

Vol. 11

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# Bulgarian District Heating System Feasibility Study

*Gilbert/Commonwealth International, Inc.*

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# LIST OF EXHIBITS
# SECTION 10

# LIST OF EXHIBITS


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# 10.0 TRAINING PROGRAM SUPPORT

This training program has been developed to support the Ministry of Regional Development, Housing and Buildings in its' stated objective to improve the operation and efficiency of the Sofia and Pernik District Heating systems.

## 10.1 BACKGROUND

Reform of the Sofia and Pernik District Heating energy supply and demand management process is a focal point for the Governments plan for energy policy development and implementation in the buildings sector. this reform program will result in a transition from the current operation to one that will support increasing building sector energy efficiency. The implementation needed to support the development of the transition policy will occur at the local level.

Transition to a competitive business environment is based on the ability to identify issues that will affect operation in the future. This future operation will be impacted by the business and economic pressures that are driving changes in the country and, specifically, the need for change in the operation of the district heating systems. To address those changes, fundamental questions must be asked and answered . Specifically, "How must the business processes change?" and, "How must the organization change?"

Answers to these questions will require the identification of business strategies and practices that are needed to provide clear organizational direction. In addition, it is necessary to look at the business processes that are essential to managing the business in a changed environment. Skills needed to institute and then manage organizational changes are a fundamental part of the proposed training program. The second area of the planned training will address the need to equip the district heating staff members with the skills needed to perform in the planned organization.

Developing the administrative skills needed to perform in a market driven economy will be an integral part of the planned training program. The administration skills will address the need to operate in a market economy with an emphasis on the management of the financial and cost data. In addition, the skills needed to: develop revenue requirements, identify and establish rates for



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supplying service, and effectively collecting revenues will be a significant part of the training effort.

## 10.2 ISSUES THAT IMPACT THE DELIVERY OF TRAINING

Operation of the district heating systems in Sofia and Pernik follow the management and economic philosophy that was established in support of the Bulgarian planned economy. This management approach is used to provide hot water and electric service utilizing an organization and an operations approach that has an established performance history. The establishment of a new method for the delivery of service will require the evaluation and possible reorganization of the current program. Reorganization can be a powerful tool in the development of new and more efficient means of services delivery.

This training program has been developed using the premise that the Government and the local municipalities will be supportive of the establishment of the organization and management programs that are needed to operate the district heating system in a market driven economy. A key element of the proposed operational improvement is the need to develop a high performance operating organization for the District Heating program.

It has been said that all organizations are perfectly designed for the results they get. To get better results from the District Heating organization, it may be necessary to improve the design and develop a high performance organization. However, when the organization design is changed, it is essential that those activities that are working well are retained. The organization needs to identify areas for change and balance those areas against the strengths of the current organization.

For the appropriate changes to be made it is essential that the management team have a clear understanding of the functions that must be considered in the design of the organization. In a high performance organization, there is an ability to evaluate the current business situation and, as required, modify the approach to the delivery of service. Flexibility of the organization to rearrange and manage its operation when the business climate is changing is also an essential part of the high performance organization.

To develop a high performance organization for the District Heating organization, it is suggested that the current organization be broken down into a number of self sufficient operating units that can be operated such that they specialize and produce and/or distribute heat and electricity.



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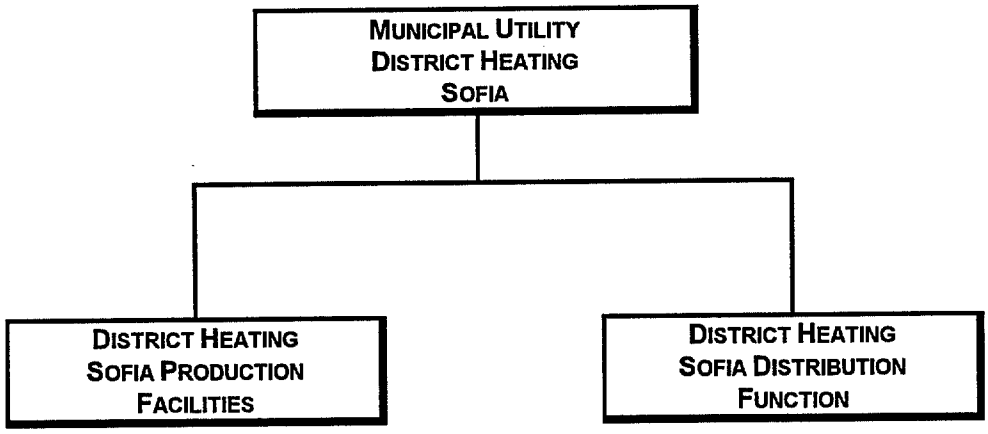
The suggested realignment of the system, shown in Exhibit 10-1, is predicated on the need to group together those elements of the program that are natural operating units based on the current design of the system. This natural alignment would result in the generating stations being assembled as operating units with the distribution network organized as a separate operating company. This organization would allow the groups to specialize and enhance their operations such that the cost elements of the program can be managed and controlled.

## Exhibit 10-1

## District Heating Organization Alignment




The Sofia production facilities could be broken down into four independent power districts. These districts would be responsible for the economic production and distribution of hot water and electricity. The four producers would each sell their generators output to the distribution company. The distributors would act as the retailing organization and would market the power and hot water to the end users, the apartment house operators for example.

The Sofia power districts could be organized according to geographic areas dividing the city into four quarters. These could include:

- Sofia
- Sofia East
- Liulin
- Zemliane

The transmission and distribution system should remain a single company responsible for the quality delivery of heat and electricity to the customers and, the distributors would be responsible for the collection of revenues generated by the sale of the heat and electricity.

The existing maintenance organization should be streamlined to address the basic planning and management functions. The construction and maintenance activities



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should be evaluated and may be candidates for subcontracting to specialized support organizations.

## 10.3 TRAINING PROGRAM OBJECTIVES

The district heating training program objectives will focus on the development of the skills needed to address the development and implementation of a high performance organization for the District Heating system. A key part of the training will be to provide the skills needed to identify and reduce operational risks through the establishment of an enhanced management process, improved operation, and enhanced administrative controls.

The District Heating Training Program will be structured to provide:

- Training that will effectively enhance the operation of the Sofia and Pernik District Heating facilities.
- Training directed at improving the management teams ability to operate the District Heating facilities in a competitive economy versus a planned economy.
- An understanding of the issues that are critical to the privatization of the district heating system.

Organizational training will concentrate on developing the understanding that is needed to support the transition from a planned to a market driven operation of the district heating program. The training program will assist the management and supervisory team in identifying those things that are in the way of improving organizational performance. A critical part of the training will be the identification of the skills needed to design and then implement organizational change. The management techniques that are presented in the training program will support the managers in their efforts to remove obstacles to productivity.

The initial organizational part of the training program will be driven through a series of management and supervisory work shops that will support the need to restructure the organization. The skills needed to redesign the organization and to provide the individuals in the newly defined organization with the skills needed to manage in a competitive economic market environment are a planned part of the training. The program will provide the skills that are needed to help managers make employees more responsible for their own activities. In addition, the employees will be provided with an in depth understanding of the organizational objectives that will directly support increased performance.

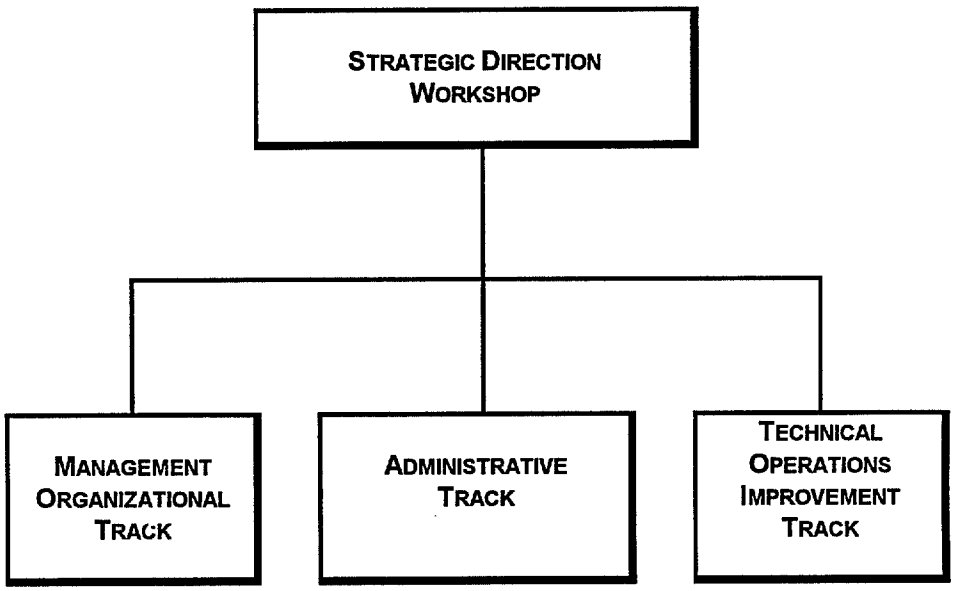
As a part of the training program development, an organizational review will be used to identify the current performance levels and to identify areas where improved organizational performance can contribute to enhanced service. The need to link the organizational performance to the future direction of the organization should be linked in the District Heating planning programs. If, for example, the plan is to privatize all or part of the system, the training program should support that objective. In addition, the individuals selected for the training program should be those individuals who are expected to be key members of the organization in the year 2000.

Organizational positions that are critical to the future operation are those middle and upper management levels that will be responsible for the implementation of the programs that are needed to improve system efficiency. Training will be directed at changing the behavior of the management team in addition to ensuring that the management team has the applicable technical skill base.

Training for the management and first level supervisors will be designed to coordinate the technical, business, and financial elements that impact the overall business performance. As a part of the training process, the program will be adjusted to ensure those areas that are most critical to achieve the organizations strategic mission are a critical part of the training program.

The overview of the proposed training program is shown in Exhibit 10-2.

**Exhibit 10-2**




### 10.3.1 DETAILED TRAINING ACTIVITIES

The proposed training program will be performance based. The identification of learning objectives is the foundation of a performance based training program. The learning objectives are stated as observable trainee behaviors and serve as the design basis for the training program. For the strategic direction workshop and for each of the training tracks, the program design will include affective and cognitive learning objectives.

Affective learning objectives define the attitudes and values associated with effective job performance. The cognitive learning objectives identify what the employee must know and be able to apply while performing the job tasks.

The training program will be subdivided to address the production/supply side activities and the transmission and distribution activities that are required to operate the District Heating System. For each of the performance areas, the planned training will be structured to provide the management, administrative, and



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technical personnel with the detailed information to deal with the changing conditions that will be impacting the operation of the system.

### 10.3.2 Strategic Direction Workshop

The Strategic Direction Planning Workshop will be used to provide a framework for management to establish a consistent direction for the future of the program. the specific areas that will be addressed in the planning workshops include:

- District heating strategic analysis
- Strategy definition
- Identification of long term objectives
- Development of integrated management programs
- Establishment of the financial projections

### 10.3.3 Management and Organizational Training

The Management and Organizational Training will be used to provide a back ground for management to implement a consistent management approach that is essential for the future direction of the program. Areas that may be addressed in the training session include:

- Management Issues
- Managing Change
- Managing to Achieve Organizational Effectiveness
- Supervisory Skills
- Project Management
- Organizational Planning for Production and Distribution
- Customer Service Training
- Human Resource Management
- Regulatory Management

It should be noted, the final training will be defined following the organization assessment.



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### 10.3.4 ADMINISTRATIVE TRAINING

The Administrative Training will be used to provide the skills needed for administering the program. The specific areas that will be addressed in the Administrative Training include:

- Accounting
- Financial Management
- Cost Collection
- Billing and Revenue Collection
- Project Control
- Project and Work Activity Planning
- Cost Management
- Project Administration
- Performance Measurement

### 10.3.5 TECHNICAL TRAINING

The Technical Training will be used to enhance the operation of the system and will focus on the need to combine sound technical operations in an economic framework. The specific areas that will be addressed in the Technical training include:

- Operations training as related to production and distribution
- Maintenance training with a concentration on:
  - Electrical
  - Mechanical
  - Instrumentation and Control; Civil
- Environmental Protection

Training Program Focus and Format

The following section identifies a number of training areas that are believed to be fundamental to the future success of the organizational. This area will serve as the basis for the design of the final training program.

### 10.3.6 MANAGEMENT AND ORGANIZATIONAL TRAINING

The program is designed for the Bulgaria District Heating personnel who hold positions of management responsibility or who have been identified as having the



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potential for assuming management roles. To meet the training goals of expanding managerial strengths, the training will focus on four objectives:

- To improve the managers' understanding of the changing, hybrid regulated - competitive District Heating operating environment.
- To increase knowledge of the roles and responsibilities that will be required to operate in the changing environment.
- To develop a general management, multi-functional perspective for leadership and decision making.
- To enhance personal effectiveness.

These objectives will be met through a demand, interactive cirriculum, delivered by personnel with experience and a firm commitment to assist the students in developing the skills needed to function in a changing environment. The programs will be used to challenge the student and to broaden his or her perspective and knowledge base through active participation with others in problem solving exercises, lectures, and reading assignments. The courses will be designed to maintain a balance between relevant regulatory issues and emerging issues related to competition.

The following areas of study are considered to be typical of the type of courses that will be developed for the program.

### 10.3.7 MANAGEMENT ISSUES

This course will deal with the perspective, skills, and responsibilities of the general manager in formulating strategy for the organization and integrating the organization's structure, systems, and resources to implement the strategy. Specific attention will be paid to both formal and informal planning processes. The need for implementing marking and customer service approaches will be addressed. This section of the training will be used to provide a framework for the various functional subject areas of the program such as project management and leadership, and change management.

### 10.3.8 MANAGING CHANGE

This area of training will focus on leadership and change in the organization. Students will be asked to evaluate specific issues within the District Heating organization and to look at the impact that may result from change. Fundamentals will be expanded to look at the processes that are used to implement improvements. Four areas of improvement will be considered: productivity, cohesion, innovation, and structure. Emphasis will be placed on managing in a changed environment.

### 10.3.9 SUPERVISORY SKILLS

Mastering the roles and responsibilities of supervision is an ongoing process. This course will address fundamentals that impact supervisory performance. In this element of the training program, the differences between supervisory and technical responsibility will be defined. The need to communicate and respond to



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the external and internal forces that impact the organization will be discussed. Skill areas that include time management, establishing priorities, and performing such that critical situations and potential problems are addressed will be included in the training program.

### 10.3.10 Project Management

The effective management of a project is the first line of control in the overall management of the organization. This training covers the essential knowledge and skills required to organize, plan, and control projects of all sizes. It serves as an introduction to the leadership or the management of any type of project. Emphasis will be placed on the practical approaches and techniques that will work within the existing organizational environment of any organization. This training will balance the skills needed to plan and estimate the project with the need to develop the people skills that are essential to the total success of the activity.

### 10.3.11 Organizational Planning for Production and Distribution

Directing, motivating, appraising, coaching and disciplining employees are the defining characteristics of effective management practice. This training will address the need to link the District Heating goals to the individual's goals. The planning that is an integral part of this effort will be addressed in the training program.

### 10.3.12 Customer Service Training

Customer service is an essential part of the business management process however, many organizations have difficulty implementing an effective customer service program. This training will provide the basics for effective customer service and will provide a model for developing a continuous improvement program focused on customer satisfaction. The training will address the need to understand the customer service function, establish effective communications, and establish a method to deal effectively with the customer.

### 10.3.13 Human Resource Management

This element of the training will focus on the formulation and implementation of human resource planning strategies for the District Heating organization. The training is concerned with such issues as the changing demographics of the labor force, for casting manpower needs, the development of managerial succession systems, career management, performance appraisal and compensation systems. The needs of the organization will be linked to the processes that are used to define jobs and will be presented in framework that could be used to develop a management for performance program.

### 10.3.14 Regulatory Management

This training will examine the legal responsibilities of management and the framework that is evolving for the District Heating operation. Among the areas that will be covered are the relationship between legal and ethical responsibilities, the impact of private ownership on the management of District Heating and the development of the skills needed to prevent and resolve legal disputes.



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### 10.3.15 ADMINISTRATIVE TRAINING

The program will be designed for the Bulgaria District Heating personnel who have significant administrative responsibilities or who have been identified as having the potential for assuming greater roles. To meet the training goals of expanding administrative strengths, the training will focus on four objectives:

- To improve the managers' understanding of the changing, administrative requirements that are impacting the District Heating operating environment.
- To increase the process knowledge that is needed to implement the administrative processes in an organizational environment.
- To develop a multi discipline perspective for the role that the administrative area plays in the management of the total District Heating organization.
- To provide the individual managers with the specific technical training and experience that is needed to implement the administrative program.

As with the Management and Organizational training area, these objectives will be met through a demanding, interactive curriculum that is led by an experienced staff.

The following areas of study are considered to be typical of the type of courses that will be provided for the program.

### 10.3.16 ACCOUNTING

This training will begin with an overview of the accounting concepts and terminology, with special emphasis on the development and understanding of financial reports used both internally and externally. The focus will include the role the financial reporting process has in the management of the organization. Specific topics include accounting for income vs cash flow, the relationship between costs and the rates assessed to the customers. The tie between the accounting performance and establishment of the rate structure will be discussed.

### 10.3.17 FINANCIAL MANAGEMENT

Building on concepts that are introduced in the accounting portion of the program, this training will deal with the District Heating's financial management policies and procedures as well as the relationships with the financial markets. Topics will include time value of money, valuation, risk and rate of return, cost of capital, capital budgeting, capital structure, and earnings policies.

### 10.3.18 COST COLLECTION

The methods that are used to effectively collect costs in the organizational will be the subject of this training. The costs associated with labor, material, contracting, and capital improvement will be evaluated and the methods that can be used to manage those costs will be defined. The use of automated systems and processes will be evaluated.



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### 103.19 Billing and Revenue Collection

An examination of the role that the revenue function plays in the operation of the organization will be addressed in this element. Decision making as it related to revenue collection will be stressed and the methods used for motivation, coordination, and control of the billing and revenue collection process will be discussed. This section will emphasis the relationship between the cost of the operation, the volume of revenue and the generation of the profit.

### 10.3.20 Project and Work Activity Planning

This course concentrates on the management of two critical resources, time and money. Participants learn the multifaceted activity that is time management: identifying project tasks and their logical sequence, estimating their duration, scheduling them using applicable planning tools and developing an understanding as to how to control variances.

### 10.3.21 Cost Management

Over the past decade, cost impacts associated with projects have had more impact on the bottom line than ever before. This training will provide managers with the information needed to estimate, monitor, and control costs. The ability to control costs can mean the difference between realizing significant advantages and lost profitability.

### 10.3.22 Project Administration

The need to anticipate and address the key issues and conflicts that arise during the administration of a project is critical to the success of the project. This course will equip the project manager with the business knowledge needed to administer any contract.

### 10.3.23 Technical Training

The program is designed for the Bulgaria District Heating personnel who hold technical management positions or who have been identified as having the potential for assuming greater roles. To meet the training goals of expanding technical strengths, the training will focus on four objectives:

- To improve the managers' understanding of the changing, technical issues and/or requirements that are impacting the District Heating operating environment.
- To increase the technical knowledge that is needed to implement the technical programs and processes in an organizational environment.
- To develop a multi discipline perspective for the role that the technical area plays in the management and ultimate profitability of the District Heating operation.
- To provide the individual managers with the specific technical training and experience that is needed to implement the technical program.



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The technical training objectives will be met through a demanding, interactive curriculum that is led by an experienced staff.

The following areas of study are considered to be typical of the type of courses that will be provided for the program.

### 10.3.24 Operations Training that is Related to Production and Distribution

The training program will address the need to effectively operate the District Heating system such that the system can function in a competitive business environment. Training will stress the need to implement a systematic management program that stresses energy conservation. The operations training program will address separately the steam and power production portion of the system and the distribution portion of the system. Training will include a background in the need for energy conservation and a grounding in the factors that affect boiler and distribution system efficiency. The operational considerations that will improve efficiency will be addressed and the need for close coordination between the operations and maintenance functions will be defined.

### 10.3.25 Maintenance Training

Maintenance of the systems and equipment is a critical part of the total management program. This training will highlight the role the maintenance organization plays in asset preservation and cost control. Training will discuss the establishment of maintenance information systems, maintenance material and parts management, and organizational approaches that could result in enhancing the maintenance organization. Types of maintenance programs to include preventive and predictive will be evaluated. Other areas that may be part of the training program include: use of maintenance improvement techniques, development of work standards, and the use of budget data in the maintenance planning function. Each of the maintenance areas will be evaluated to determine specific technical training that would be needed.

### 10.3.26 Environmental Protection

Perhaps the most fundamental trend in the decade to come will be the ever expanding growth of environmental law on the business community. On a world basis, increased emphasis on the need to address the environmental issue is being seen as a major requirement for future operation. The environmental issues may reach back and address the need for cleanup for past practice and will be a factor in defining how we work in the future. This training will address the environmental issues that are impacting the operation of District Heating.

### 10.3.27 TRAINING MATERIAL

In the attached Appendix, G/C has provided sample training material which includes:

- Foundations of Management Review
- Project Management Basics
- Planning and Scheduling
- Cost Engineering and Estimating



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- Construction Contracting Methods and Administration
- Teaching Outline - Time Management
- Teaching Outline - Conducting
- Teaching Outline - Performance Appraisal
- Procurement Review Engineer Tasks
- Lead Auditor Training Program



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# FOUNDATIONS OF MANAGEMENT REVIEW

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# FOUNDATIONS OF MANAGEMENT REVIEW

## INTRODUCTION

Foundations of Management is a G/C course presented to provide a broad foundation of understanding management by utilizing a self-teaching text entitled Management 18 and films from Roundtable Films, Inc. This module, Foundations of Management Review, is a two-session review of the principles previously learned in Foundations of Management.

### Objectives

Upon completion of this module, the participant should be able to:

- List and define the five functions of a manager.
- Describe four essential steps used in problem analysis that can be applied to the decision making process.
- Describe six principles applied to properly managing time.
- Describe the principles and concepts applied to motivating, directing, and controlling subordinates.
- Characterize the major elements of responsibility, accountability, authority, and controlling as they contribute to effective delegation.
- Describe the barriers of effective team building and suggestions for effectively managing these barriers.

I. MY RESPONSIBILITIES AS A PROJECT/MANAGER AND/OR SUPERVISOR

1. Management: An Overview

   - Doing Versus Managing
   - Five Functions of a Manager
   - How Managers at Different Levels Perform the Five Functions

2. Planning

   - Systems Approach to Planning
   - Phase 1: Establishing Objectives
   - Phase 2: Formulating Policies
   - Phase 3: Developing Plans
   - Phase 4: Stating Procedures

3. Decision Making

   - Decision Making - Four Essential Steps:
   - Step 1: Analyzing the Problem
   - Step 2: Developing Alternative Solutions
   - Step 3: Analyzing Alternative Solutions
   - Step 4: Implementing the Decision

4. Organizing

   - Authority - Repsonsibility - Accountability
   - Elements in Organizing
   - The Steps in Organizing
   - Power and Authority

5. Leading and,Directing

   - Directing, Motivation, and Productivity
   - Theories X and Y

6. Controlling

- Controlling and Control Systems
- Essential Elements of Controlling
- Fundamental Principles of a Good Control System
- Human Aspects of Control Systems
- Four Guidelines for Administering Control Systems

* F. O. M. Review Definitions
* The Functions of Management
* Functions of Management Note Sheet
* Worksheet 3-1: Problem Analysis
* Worksheet 3-2: Analysis of Alternatives
* Worksheet 3-3: Analysis of Alternatives (Cont.)

# F. O. M. REVIEW

## DEFINITIONS

| | | |
|---|---|---|
| COMMUNICATIONS | - | The process of passing information and understanding from one person to another. |
| DELEGATION | - | Getting work done through others |
| GOAL | - | A known objective toward which an action is directed with the purpose of achieving that end. |
| | - | Long range attainment |
| MANAGEMENT | - | Getting desired results through the willing cooperation of others. |
| Theory X Mgm't Style | - | a. Average person dislikes work and will avoid it whenever possible<br>b. Promise of award is not enough to motivate them; the only way to get them to make an adequate effort is through coercian, tight controls, constant direction, threats, and punishment.<br>c. Average person prefers to be directed, wishes to avoid responsibility, has little ambition, and wants security above all. |
| Theory Y Mgm't Style | - | a. Average person likes work and the expenditure of physical and mental effort is as natural as play or rest.<br>b. Man will exercise self-direction and self-control in the service of objectives to which he is committed.<br>c. Commitment is a function of the rewards associated with their achievement.<br>d. Under proper conditions people will not only accept but seek responsibility.<br>e. Capacity to exercise imagination, ingenuity,and creativity is widely distributed.<br>f. Intellectual potential of the average person is only partially utilized. |
| PURPOSE | - | The route chosen by an individual in the accomplishment of a goal |
| | - | Lesser goal applying to specific activities and subjects |

# MANAGEMENT

"Getting Desired Results Through the Willing Cooperation of Others"

THE FUNCTIONS OF MANAGEMENT

| PLANNING | DECISION MAKING | ORGANIZING | LEADING AND DIRECTING | CONTROLLING |
|---|---|---|---|---|
| • Forecasting<br>• Establishing Objectives<br>• Formulating Policies<br>• Developing Plans<br>• Scheduling<br>• Budgeting<br>• Stating Procedures | • Identifying & Analyzing Problems<br>• Developing Alternative Solutions<br>• Analyzing Alternative Solutions<br>• Implementing Decisions | • Defining & Separating Work<br>• Establishing Structures & Relationships<br>• Organizing the people & work place<br>• Assigning & Delegating Responsibilities, Authorities, & Accountabilities | • Selecting Personnel<br>• Developing Subordinates<br>• Communicating<br>• Motivating | • Setting Standards<br>• Establishing Reporting Systems<br>• Measuring & Evaluating<br>• Taking Corrective Action |

# MANAGEMENT

**"Getting Desired Results Through the Willing Cooperation of Others"**

**THE FUNCTIONS OF MANAGEMENT**

**NOTE SHEET**

| PLANNING | DECISION MAKING | ORGANIZING | LEADING AND DIRECTING | CONTROLLING |
|---|---|---|---|---|
| | | | | |

Worksheet 3-1. Problem Analysis

| 1. Symptoms: what is wrong or needing improvement | 2. Specific facts: What? Where? When? | 3. Possible causes. | The real problem. | 4. Requirements of a satisfactory solution stated as objectives. | 5. Restrictions on a possible solution. |
|---|---|---|---|---|---|
| | | | | | |

Worksheet 3-2. Analysis of Alternatives

| Results Expected or Objectives in Order of Importance<br>1.<br>2.<br>3. | | | | | Restrictions on Acceptable Solutions<br>1.<br>2.<br>3. | |
|---|---|---|---|---|---|---|
| Alternative | Disadvantages | | Advantages | | Areas of Difficulty in Implementing Alternative | Specific Action Needed to Remove Difficulty |
| | Very Important | Moderately Important | Very Important | Moderately Important | | |
| 1. | | | | | | |
| 2. | | | | | | |
| 3. | | | | | | |

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Worksheet 3-3. Analysis of Alternatives

| | Objective One | | | Objective Two | | | Objective Three | | | Restriction(s) Violated |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fully Acceptable | Partially Accepted | Inade-quate | Fully Acceptable | Partially Accepted | Inade-quate | Fully Acceptable | Partially Accepted | Inade-quate | |
| 1. Alternative | | | | | | | | | | |
| 2. Alternative | | | | | | | | | | |
| 3. Alternative | | | | | | | | | | |

# GOOD CONTROL SYSTEM - FUNDAMENTAL PRINCIPLES

- BE CURRENT
- DEVELOP RECORDS ON ALL OBJECTIVES
- FOCUS ON DEVIATIONS FROM OBJECTIVES
- REPORT DEVIATIONS DIRECTLY TO THE EMPLOYEE RESPONSIBLE
- REFLECT INDIVIDUAL RESPONSIBILITIES AS WELL AS OVERALL RESULTS

# CONTROL SYSTEM -

# HUMAN ASPECTS TO CONSIDER

- ANTAGONISM
- RESISTANCE AND NONCOMPLIANCE
- UNRELIABLE PERFORMANCE INFORMATION
- NECESSITY FOR CLOSE SURVEILLANCE
- HIGH ADMINISTRATIVE COST

# COMMON WEAKNESSES OF CONTROL:

1. TOO MUCH EMPHASIS ON THE PAST

2. MISTAKE CENTERED - RATHER THAN CAUSE AND CORRECTION CENTERED

3. BECOME TOO INVOLVED WITH THE CONTROLLING FUNCTION AND NOT FINDING THE PROBLEM CAUSE

4. NOT BASED ON KEY FACTORS

## II. TIME MANAGEMENT

The six points to remember for better Time Management

* "Work Smarter - Not Harder"
* Managing Your Time (How Do You Rate?)
* Principles of Effective Time Utilization
* Time Wasters: Possible Causes and Solutions
* Saving Time With: Paperwork, Office Callers, and Writing
* Saving Time With: Telephone, Gadgetry, and Filing
* Saving Time Through: Delegation
* Little Known, But Possibly Useful, "Time Savers"
* Time Planner
* Detail of Charges Record Sheet

## "MANAGING YOUR TIME"

## (HOW DO YOU RATE?)

(Circle one)

| | | | |
|---|---|---|---|
| (yes) | (no) | 1. | Start a job before thinking it through? |
| (yes) | (no) | 2. | Leave jobs before completion? |
| (yes) | (no) | 3. | Schedule less important work before more important (and possibly more unattractive) work? |
| (yes) | (no) | 4. | Oversupervise subordinates? |
| (yes) | (no) | 5. | Undersupervise subordinates, with consequent crises? |
| (yes) | (no) | 6. | Spend too much time on problems brought to you by subordinates? |
| (yes) | (no) | 7. | Do things that can be delegated to others? |
| (yes) | (no) | 8. | Do things that can be delegated to modern machines? |
| (yes) | (no) | 9. | Do things that actually aren't part of your real job? |
| (yes) | (no) | 10. | Spend too much time on your previous area of interest or competence? |
| (yes) | (no) | 11. | Do unproductive things from sheer habit? |
| (yes) | (no) | 12. | Keep too many, too complicated, or overlapping records? |
| (yes) | (no) | 13. | Pursue projects you probably can't achieve? |
| (yes) | (no) | 14. | Pay too much attention to low yield projects? |
| (yes) | (no) | 15. | Fail to anticipate crises? |
| (yes) | (no) | 16. | Handle too wide a variety of duties? |
| (yes) | (no) | 17. | Shrink from unfamiliar duties? |
| (yes) | (no) | 18. | Fail to build barriers against interruptions? |
| (yes) | (no) | 19. | Allow conferences and discussions to wander? |
| (yes) | (no) | 20. | Allow conferences and discussions to continue after their purpose is fulfilled? |
| (yes) | (no) | 21. | Conduct unnecessary meetings, visits, and phone calls? |
| (yes) | (no) | 22. | Chase trivial data after the main facts are in? |
| (yes) | (no) | 23. | Engage in personal work or conversations before starting business work? |
| (yes) | (no) | 24. | Socialize at great length between tasks? |
| (yes) | (no) | 25. | Read trade journals, newspapers, and unimportant documents and reports during most productive time each day? |

Reference: "Manage More By Doing Less," Raymond Leon

## "Time Wasters," Possible Causes and Solutions*

The following "time wasters" have been found to be the most commonly encountered by management personnel. In addition to these time wasters, possible causes and solutions are listed as ways of correcting the problems. This list is not complete but rather a list of those more frequently encountered:

| Time Waster | Possible Causes | Solutions |
|---|---|---|
| 1. Lack of planning | Failure to see the benefit | Recognize that planning takes time but saves time in the end. |
| | Action orientation | Emphasize results, not activity. |
| | Success without it | Recognize that success is often in spite of, not because of, methods. |
| 2. Lack of priorities | Lack of goals and objectives | Write down goals and objectives. Discuss priorities with subordinates. |
| 3. Overcommitment | Broad interests | Say no. |
| | Confusion in priorities | Put first things first. |
| | Failure to set priorities | Develop a personal philosophy of time. Relate priorities to a schedule of events. |
| 4. Management by crisis | Lack of planning | Apply the same solutions as for lack of planning. |
| | Unrealistic time estimates | Allow more time. Allow for interruptions. |
| | Problem orientation | Be opportunity oriented. |
| | Reluctance of subordinates to break bad news | Encourage fast transmission of information as essential for timely corrective action. |
| 5. Haste | Impatience with detail | Take time to get it right. Save the time of doing it over. |
| | Responding to the urgent | Distinguish between the important. |

| Time Waster | Possible Causes | Solutions |
|---|---|---|
| | Lack of planning ahead | Take time to plan. It repays itself many times over. |
| | Attempting too much in too little time | Attempt less. Delegate more. |
| 6. Paperwork and reading | Knowledge explosion | Read selectively. Learn speed reading. |
| | Computeritis | Manage computer date by exception. |
| | Failure to screen | Remember the Pareto principle. Delegate reading to subordinates. |
| 7. Routine and trivia | Lack of priorities | Set and concentrate on goals. Delegate nonessentials. |
| | Over-surveillance of subordinates | Delegate; then give subordinates their head. Look to results, not details or methods. |
| | Refusal to delegate; feeling of greater security dealing with operating detail | Recognize that without delegation it is impossible to get anything done through others. |
| 8. Visitors | Enjoyment of socializing | Do it elsewhere. Meet visitors outside. Suggest lunch if necessary. Hold standup conferences. |
| | Inability to say no | Screen. Say no. Be unavailable. Modify the open-door policy. |
| 9. Telephone | Lack of self-discipline | Screen and group calls. Be brief. |
| | Desire to be informed and involved | Stay uninvolved with all but essentials. Manage by exception. |
| 10. Meetings | Fear of responsibility for decisions | Make decisions without meetings. |

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| Time Waster | Possible Causes | Solutions |
|---|---|---|
| | Indecision | Make decisions even when some facts are missing. |
| | Overcommunication | Discourage unnecessary meetings. Convene only those needed. |
| | Poor leadership | Use agendas. Stick to the subject. Prepare concise minutes as soon as possible. |
| 11. Indecision | Lack of confidence in the facts | Improve fact-finding and validating procedures. |
| | Insistence on all the facts - paralysis of analysis | Accept risks as inevitable. Decide without all facts. |
| | Fear of the consequences of a mistake | Delegate the right to be wrong. Use mistakes as a learning process. |
| | Lack of a rational decision-making process | Get facts, set goals, investigate alternatives, and negative consequences make the decision, and implement it. |
| 12. Lack of delegation | Fear of subordinates' inadequacy | Train. Allow mistakes. Replace if necessary. |
| | Fear of subordinates' competence | Delegate fully. Give credit. Insure corporate growth to maintain challenge. |
| | Work overload on subordinates | Balance the workload. Staff up. Reorder priorities. |

*Source: Adapted from The Time Trap, McKenzie, 1972
C. W. Lifer - Ohio

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## Saving Time With: PAPERWORK, OFFICE CALLERS, AND WRITING

### I. READING AND PAPERWORK:

| | Yes | No |
|---|---|---|
| 1. Screen for a purpose (ask) | | |
| - Is it required? | ___ | ___ |
| - Is it pertinent? | ___ | ___ |
| - Is it of interest? | ___ | ___ |
| ** If not, toss it! | | |

| 2. In reading, do you? | Yes | No |
|---|---|---|
| - Screen your reading materials to weed out unnecessary or unproductive matter? | ___ | ___ |
| - Skim the surface of the reading matter for main ideas? | ___ | ___ |
| - Practice rapid reading techniques to improve speed and comprehension? | ___ | ___ |

3. Don't be a paper shuffler! Pick it up and act on it and eliminate that continuous shuffling.

### II. OFFICE CALLERS:

Office callers are among the greatest consumers of your time. Whatever the priority, you must carefully budget your time if you are to be totally effective.

| Do You: | Yes | No |
|---|---|---|
| 1. Set up regular conference periods with your co-workers and accumulate items for discussion at that time? | ___ | ___ |
| 2. Hold regular staff meetings and take up matters of common concern from all sides (accumulate between meetings). | ___ | ___ |
| 3. Hold occasional luncheon meetings to remove pressure of social visits by various publics? | ___ | ___ |
| 4. Encourage use of other media-telephone, office mail system, etc., when personal visits are not necessary. | ___ | ___ |

### III. WRITING:

| Do You: | Yes | No |
|---|---|---|
| - Make simple outlines for letters, memoranda, reports and more detailed outline for major writing tasks? | ___ | ___ |
| - Use a simple, direct style communication, getting right to the point? | ___ | ___ |
| - Make use of form letters and form paragraphs for routine correspondence? | ___ | ___ |

C. W. Lifer - Ohio

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## Saving Time With: TELEPHONE, GADGETRY, FILING

### TELEPHONE:

| Do You: | Yes | No |
|---|---|---|
| - Have your secretary place and answer most calls? (saves time both ways) | ___ | ___ |
| - Know ahead of time what you want to discuss and the types of references you might need? | ___ | ___ |
| - Bring the conversation to a prompt close when the business of the telephone conversation is finished? | ___ | ___ |

NOTE: Although some indicate the professional should do his own direct dialing and receive his own calls it generally is not the most efficient use of professional time.

### GADGETRY:

| | Yes | No |
|---|---|---|
| (Photocopier, telephone devices, dictating units, carbonless paper, etc) Usually multiplies human effort and eliminates drudgery. Do you use them? | ___ | ___ |

| Does It: | | |
|---|---|---|
| - Have benefits which exceed the cost or burdens? | ___ | ___ |
| - Replace something else? | ___ | ___ |
| - Fit into the operating style of you and your unit? | ___ | ___ |
| - Provide simplicity? | ___ | ___ |
| - Increase flexibility? | ___ | ___ |
| - Reduce storage or inventory problems? | ___ | ___ |

### FILING:

| Do You: | Yes | No |
|---|---|---|
| - Have a well defined system so you, your secretary, and others know and can use it? | ___ | ___ |
| - Save only the essentials (those "just in case" items should not be saved and will merely clutter files)? | ___ | ___ |
| - Have a systematic way for disposing file materials? | ___ | ___ |
| - Have your secretary do the filing? | ___ | ___ |
| - File responses to letters with the original letter? | ___ | ___ |
| - Use a system of reminders for future events (e.g. "hold file" by day or week)? | ___ | ___ |

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## Saving Time Through: DELEGATION

A. Items that can be delegated: (Do you delegate the following)?

| | How Do you Rate? Yes | No |
|---|---|---|
| 1. Fact finding and analysis | ___ | ___ |
| 2. Formulation of goals - not final determination | ___ | ___ |
| 3. Preparation of first drafts | ___ | ___ |
| 4. Performance of routines and carrying out details | ___ | ___ |
| 5. Tasks others can do better, sooner, cheaper | ___ | ___ |
| 6. Representing you at meetings, conferences, etc., where your points of view can be exposed | ___ | ___ |
| 7. Tasks which will help subordinates to develop through exposure | ___ | ___ |
| 8. Tasks after decisions are made | ___ | ___ |

NOTE: A key point in delegation is to hold your people more accountable for results instead of methods.

B. Items that can't be delegated: (Do you handle yourself)?

| | | |
|---|---|---|
| 1. Making final decisions - deciding on goals, etc. | ___ | ___ |
| 2. Executing tasks where goals are not clear | ___ | ___ |
| 3. Hiring, discipline, firing of immediate staff | ___ | ___ |
| 4. Unique or highly personalized tasks that will not come up again | ___ | ___ |
| 5. Things that must be kept absolutely secret | ___ | ___ |
| 6. Personal representation where your presence is important | ___ | ___ |
| 7. Emergency, short term tasks where there is not time to explain | ___ | ___ |

C. W. Lifer - Ohio

# TIME PLANNER

Date_____

## Appointments

| | Time | Place | Topic |
|---|---|---|---|
| AM | | | |
| PM | | | |
| NITE | | | |

## To Be Done Today
(prioritize each item)

## Phone Record

Outgoing

| To | Topic | Consequence |
|---|---|---|
| | | |

Incoming

| From | Topic | Consequence |
|---|---|---|
| | | |

| | Description | Pl/Unpl |
|---|---|---|
| 8:00 | | |
| 30 | | |
| 9:00 | | |
| 30 | | |
| 10:00 | | |
| 30 | | |
| 11:00 | | |
| 30 | | |
| 12:00 | | |
| 30 | | |
| 1:00 | | |
| 30 | | |
| 2:00 | | |
| 30 | | |
| 3:00 | | |
| 30 | | |
| 4:00 | | |
| 30 | | |
| 5:00 | | |
| 30 | | |

NITE

## Calls to be made

| W | Time | Number |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

| Time Wasters | Planned Actions |
|---|---|
| | |

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## III. MOTIVATION AND HUMAN RELATIONS

Human Motivation: An Overview

- The Mainsprings of Motivation
- The Need Hierarchy
- Motivation-Hygiene Concept
- Theory of Expectancy and Path Goal Relationships
- A Word of Praise Goes A Long Way

* Supervisory Performance Priority Scale
* Recognition - Self Test
* There Is Magic In A Word of Praise

SUPERVISORY PERFORMANCE PRIORITY SCALE*

| | WHEN THINGS ARE DONE | WHY THINGS ARE DONE |
|---|---|---|
| THINGS THAT GET DONE | 1. Immediately | 1. Told to do them |
| | 2. Routinely | 2. Like to do them |
| THINGS THAT DON'T GET DONE | 3. Put off | 1. Not told to do |
| | 4. Delayed indefinitely | 2. Don't like doing |
| | 5. Not perceived as needing to be done | 3. Feels no opportunity to do |

*Adapted from Clark C. Caskey, Balance in Management (Ann Arbor, Mich.: Masterco Press Inc., 1968) pp. 83-85

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## RECOGNITION SELF TEST

During the past three weeks, have you received and/or given any recognition from/to those individuals listed, which meet the following qualifications?

- It was sincere
- It was timely (soon after the task)
- It was a proper reward/recognition for the task performed

| | HAVE (1 point) | HAVE NOT (0 points) |
|---|---|---|
| **RECOGNITION RECEIVED** | | |
| A. Received from boss or superiors | | |
| B. Received from peers, colleagues | | |
| C. Received from subordinates | | |
| D. Received from elsewhere in organization | | |
| E. Received from spouse, relatives, neighbor | | |

SCORE _____

| | HAVE (1 point) | HAVE NOT (0 points) |
|---|---|---|
| **RECOGNITION GIVEN** | | |
| A. Given to boss or superiors | | |
| B. Given to peers, colleagues | | |
| C. Given to subordinates | | |
| D. Given to someone else in the organization | | |
| E. Given to spouse, relatives, or a neighbor | | |

SCORE _____

How does recognition received compare with recognition given?

# There is Magic in a Word of Praise

A Broadway comedian once had an excruciating nightmare: he dreamed he was telling stories and singing songs in a crowded theater, with thousands of people watching him; but no one laughed or clapped.

"Even at $100,000 a week," he says, "that would be hell on earth."

It is not only the actor who has a deep, primal need for applause. Without praise and encouragement any one of us can lose self-confidence. Thus, we all have a double necessity: to be commended and to know how to commend.

There is a technique in giving a compliment, a right way to go about it. It is no real compliment, for instance, to praise a man for some obvious attainment. Use discernment and originality. "That was a wonderfully convincing speech you made tonight," a gracious woman once said to a businessman. "I could not help thinking what a fine lawyer you would have made." The merchant flushed like a schoolboy at the unexpected character of the tribute. As André Maurois once remarked: "The general did not thank me when I talked to him of his victories, but his gratitude was unbounded when a lady mentioned the twinkle in his eye."

No one, great or obscure, is untouched by genuine appreciation. Yale's renowned English professor, the late William Lyon Phelps, relates: "One hot summer day I went into a crowded railroad dining car for lunch. When the steward handed me the menu, I said, 'The boys in the kitchen certainly must be suffering today!' The steward looked at me in surprise. 'People come in here and complain about the food, kick about the service and growl about the heat. In 19 years you are the first person who has ever expressed any sympathy for the cooks back there in the kitchen.' What people want," Mr. Phelps concluded, "is a little attention as human beings."

In that attention, sincerity is essential. For it is sincerity, unmixed with the possibility of flattery which gives potency to a compliment. The man coming home after a hard day's work, who sees the faces of his children pressed against the windowpane, waiting and watching for him, may water his soul with their silent but golden opinion.

The simple principles of the art of praise - to realize the human need for it, to compliment sincerely, and to train ourselves to look for the praiseworthy - help rub off the sharp edges of daily contact. And nowhere is this more true than in marriage. The wife or husband who is alert to say the heartening thing at the right moment has taken out valuable marriage insurance.

Women seem to have an instinct for such things; they look at life, so to speak, through their hearts. Lyon Mearson, the author, and Rose, his wife, were married on February 23. "Well," remarked Lyon, "I will never forget our wedding anniversary. It will always be the day after Washington's birthday." "And I," his bride answered, "will never forget Washington's birthday. It will always be the day before we were married."

One night Sir Max Beerbohm went with his aging wife to a theatrical party in London. As they entered the room he was ambushed by a horde of stage and film beauties, all eager to impress the great critic and caricaturist. Beerbohm turned to the lady on his arm: "My dear, let's find a quiet corner. You are looking so charming tonight that I want to talk to you alone."

Children especially are hungry for reassurance, and the want of kindly appreciation in childhood can endanger the growth of character; it can even be a lifetime calamity. A young mother told the Rev. A. W. Beaven of a heartaching incident:

"My little daughter often misbehaves, and I have to rebuke her. But one day she had been an especially good girl, hadn't done a single thing that called for reprimand. That night, after I tucked her in bed and started down the stairs, I heard her sobbing. Turning back, I found her head buried in the pillow. Between sobs she asked 'Haven't I been a pretty good girl today?'

"That question," said the mother, "went through me like a knife. I had been quick enough to correct her when she did wrong, but when she had tried to behave I had not noticed it. I had put her to bed without one word of appreciation."

The same principle -- using the kind word -- is potent in all human relationships. In my boyhood in Baltimore, a new drugstore opened in the neighborhood, and old Pyke Barlow, our skilled and long-established pharmacist, was outraged. He accused his young rival of selling cheap drugs and of being inexperienced in compounding prescriptions. Finally, the injured newcomer, contemplating a suit for slander, consulted a wise lawyer, Thomas G. Hays. "Don't make an issue of it," Hays advised. "Try kindness."

Next day, when customers reported his rival's attacks, the new druggist said there must be a mistake somewhere. "Pyke Barlow," he told them, "is one of the finest pharmacists in this town. He'll mix an emergency prescription any hour, day or night, and the care he takes with them sets an example for all of us. This neighborhood has grown -- there's plenty of room for both of us. I'm taking Doc's store as the pattern for mine."

When the older man heard these remarks -- because compliments fly on the wings of gossip quite as fast as scandal -- he could not wait to meet the young fellow face to face and give him some helpful advice. The feud had been wiped out by sincere and truthful praise.

Wherever human beings gather, thoughtfulness is needed. In a group conversation the kind person will help everyone to feel a part of the discussion. A friend once paid this tribute to Prime Minister Balfour as a dinner host: "He would take the hesitating remark of a shy man and discover in it unexpected possibilities, would expand it until its author felt he had really made some contribution to human wisdom. Guests would leave, walking on air, convinced that they were bigger men than they had thought."

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Why must most of us leave unuttered some pleasant truths that would make others happy? It would help if we remembered more often that "a rose to the living is more than sumptuous wreaths to the dead." A charming old gentleman used to drop in occasionally at an antique shop near Conway, New Hampshire, to sell merchandise. One day after he left, the antique dealer's wife said she wished they had told him how much they enjoyed his visits. The husband replied, "Next time let's tell him so." The following summer a young woman came in and introduced herself as the daughter of the salesman. Her father, she said, had died. Then the wife told her of the conversation she and her husband had had after her father's last visit. The visitor's eyes filled with tears. "How much good that would have done my father!" she exclaimed. "He was a man who needed to be reassured that he was liked."

"Since that day," says the shopowner, "whenever I think something particularly nice about a person, I tell him. I might never have another chance."

As the painter, the musician and all other artists find joy in giving beauty to others, so anyone who masters the art of praising will find that it blesses the giver quite as much as the receiver. It brings warmth and pleasure into common places and turns the noisy rattle of the world into music.

Something good can be said about everyone. We have only to say it.

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## IV. COMMUNICATING JOB ASSIGNMENTS CLEARLY

1. Organizational and Interpersonal Communications
   - The Role of Communications
   - What Is Effective Communication?
   - Communications and the Manager
   - How to Overcome Barriers to Understanding
     1. Organizational Barriers
     2. Human Barriers

2. "If You Want IT Done Right"

   Checkpoints for Planning and Making a Job Assignment

* Technical Steps In Assigning Jobs - Checklist

# EFFECTIVE COMMUNICATION

INFORMATION &
UNDERSTANDING

- COMMUNICATOR MUST CONSIDER RECEIVER
- ELICIT POSITIVE ACTION OR RESPONSE

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## *"If You Want it Done Right"*

## Checkpoints for Planning and Making a Job Assignment

1. Have I made clear the ACTUAL RESULTS I expect at job completion?
2. Have I indicated how this job fits into the scheme of other jobs and goals?
3. Have I described how this job resembles or differs from similar or past jobs?
4. Have I covered all information needed to do this job effectively?
   - who, what, why, when, where and how
   - pitfalls to avoid
   - limitations (time, cost, policy restriction)
   - alternative plans if difficulties arise
5. Did I encourage suggestions?
6. Did I ask the employee to restate the critical parts of job?
7. Have I set controls to check progress (what and when)?

TECHNICAL STEPS IN ASSIGNING JOBS

- CHECK LIST -

_____ 1. Do my subordinates know what terminal behavior (Actual results) I expect following completion of job assignment - in each case?

_____ 2. Have I covered the main purpose of the job?

_____ 3. Do subordinates know how each job assigned fits into the scheme of other jobs and goals involved?

_____ 4. Have I covered how the present job assignment differs from or resembles similar, past job assignments?

_____ 5. Have I provided as much information as the subordinate really needs to carry out the assignment effectively? (Including pitfalls to be avoided).

_____ 6. Does my assignment include answers to the old favorites - What? When? Where? Who? How? and Why?

_____ 7. Have I covered important limitations - such as time, cost, or policy restrictions that apply to the job?

_____ 8. Have I reinforced critical parts of the job assignment?

_____ 9. What controls have I established to insure adequate checks on progress?

_____ 10. What coordination has been effected with other departments/ individuals who may be affected by this job assignment?

_____ 11. Are there contingencies or alternative plans should difficulties arise?

## V. CONDUCTING MEETINGS

1. Preparing For A Meeting
2. The Functions Of A Group Leader
3. The Two Major Types Of Functions:
   - Task Functions
   - Group Relations Functions

* Conference Leadership: The Critical Functions

# CONFERENCE LEADERSHIP:
# THE CRITICAL FUNCTIONS

A great deal of today's problem solving and desision making in business, industry, government, and other organizations is done through people acting together in conferences and staff meetings. Similarly, off the job, in various community and social activities, conferences and meetings are common ways of formulating plans of action and achieving objectives. It is important, therefore, to be able to conduct a conference effectively when you are called upon to do so.

These principles apply not only to leading a group, but also to participating more effectively as a member. By understanding the group processes better, you will be able to make greater contributions toward the team effort, since at times each member of a smoothly working group performs the same functions as the leader.

## PREPARING FOR A MEETING

If you are to lead a conference, some initial preparation on your part will start things off smoothly. Briefly:

1. ARRANGE A SUITABLE PLACE FOR THE MEETING

   If it is necessary to reserve a conference room ahead of time, make sure it is available to you for the use of your group exclusively. The room should be of appropriate size with adequate seating arrangements and should be well lighted and ventilated. It should be quiet and free from distracting intrusions.

2. SELECT AND NOTIFY THE PARTICIPANTS

   They should be informed of the general purpose of the meeting with sufficient advance notice so that they can gather any information they may need for the meeting, as well as adjust their work or personal schedules to the time set for the meeting.

3. PREPARE ANY VISUAL AIDS YOU MAY NEED

   These may range from simple things, such as a blackboard, chalk, and eraser, to charts and graphs, slides, or other material. Make sure that these aids are on hand in order to avoid wasteful delays after the meeting has started.

4. PREPARE YOURSELF FOR THE MEETING

Gather all the information you will need ahead of time. Do your homework by thinking through the problem and what you hope to accomplish with the meeting. Consider what each member of the group might have in the way of knowledge, experience, or information to contribute to the meeting. Above all, have a definite purpose of objective for the meeting, even though this may change in the course of the meeting. Unnecessary or purposeless meetings should be avoided.

## THE FUNCTIONS DF A GROUP LEADER

There are a number of functions which an effective group leader performs during the course of a meeting. It is the main purpose of this discussion to acquaint you with these functions and the situations in which they apply, and to help you prepare to use them appropriately. In actual practice, leaders' functions overlap each other and are difficult to distinguish.

Your own personality and value system will, of course, affect to some extent the way you actually conduct any meeting. You will not use exactly the same words that another person would in the same situation, and you may use different techniques, some of which have developed out of your own experience and habits. However, a knowledge of the basic functions which are available for a group leader to use will tend to make you more flexible and adaptable as a leader in meeting new situations, and you will develop more skill as a leader as these become second nature to you through using them.

## THE TWO MAJOR TYPES OF FUNCTIONS

Every group leader has two major functions. They are: (1) TASK functions and (2) GROUP RELATIONS functions.

The purpose of the TASK functions is to keep the group working on the task or project at hand, i.e., getting the group work done.

The purpose of the GROUP RELATIONS functions is to maintain constructive group relations among the members and to keep diverse individuals working together as a team. This means dealing with individual and group feelings and attitudes which may prevent the progress of the group towards its goals.

There are six TASK functions and six GROUP RELATIONS functions:

TASK FUNCTIONS

1. INITIATING: Proposing tasks or goals; defining a group problem; suggesting a procedure or ideas for solving a problem.

2. INFORMATION OR OPINION SEEKING: Requesting facts; seeking relevant information about group concern; asking for suggestions or ideas.

3. INFORMATION OR OPINION GIVING: Stating a belief; providing relevant information about group concern; giving suggestions or ideas.

4. CLARIFYING: Elaborating, interpreting, or reflecting ideas and suggestions; clearing up confusion; indicating alternatives and issues before the group; giving examples.

5. SUMMARIZING: Pulling together related ideas; restating suggestions after the group has discussed them; offering a decision or conclusion for the group to accept or reject.

6. CONSENSUS TESTING: Sending up "trial balloons" to see if the group is nearing a conclusion; checking with the group to see how much agreement has been reached.

GROUP RELATIONS FUNCTIONS

1. ENCOURAGING: Being friendly, warm, and responsive to others; accepting others and their contributions; regarding others by giving them an opportunity for recognition.

2. EXPRESSING GROUP FEELINGS: Sensing feeling, mood, relationships within the group; sharing one's feelings with other members.

3. HARMONIZING: Attempting to reconcile disagreements; reducing tension; getting people to explore their differences.

4. MODIFYING: When one's own idea or status is involved in a conflict, offering to modify one's own position; admitting error; disciplining oneself to maintain group cohesion.

5. GATE-KEEPING: Attempting to keep communication channels open; facilitating the participation of others; suggesting procedures for sharing opportunities to discuss group problems.

6. EVALUATING: Evaluating group functioning and production; expressing standards for group to achieve; measuring results; evaluating degree of group commitment.

## VI. DELEGATION

1. Delegating
   - The Approach to Effective Delegation
   - The Role of Delegation
   - The Delegation Process
   - What Delegation Is Not
   - Why Managers Do Not Always Delegate
   - Why Subordinates Do Not Always Accept Delegation
   - Some More Tips on Delegating

2. Designing Jobs
   - Job Enlargement Versus Job Enrichment

* Delegation: Getting Results Through Others
* How to Delegate Work Sheet
* Self Quiz #1: "How Well Does My Boss Delegate?"
* Self Quiz #2: "How Well Do I Delegate?"

# *"You CAN Delegate"*

## The Step-By-Step Process of Delegation

1. Periodically Analyze Your Job.
2. Decide What To Delegate.
   - delegate to make the time available for important jobs
   - delegate to develop your subordinates
3. Plan The Job To Be Delegated.
   - establish standards
   - what, why, when, where and how
   - feedback/control features
4. Select The Right Person.
5. Make The Delegation
   - see checkpoints for planning and making a job assignment
6. Follow-Up

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# SOME MORE TIPS ON DELEGATING

- ENCOURAGE INDEPENDENCE
- DON'T SHORT CIRCUIT
- LIVE WITH DIFFERENCES
- DON'T SNATCH IT BACK
- REWARD GOOD PERFORMANCE

SUBORDINATE'S NAME

## HOW TO DELEGATE

- WORK SHEET -

1. RESPONSIBILITY

   a. List and describe the area of responsibility (function/task) where the subordinate is responsible to achieve specific end results.

2. ACCOUNTABILITY

   a. *Discuss the expected end results the subordinate is accountable for achieving in this area, i.e., What conditions will exist when this area is performed successfully?

   b. *Discuss the minimum performance standards to be used to measure (determine) if responsibility has been successfully performed.

   c. Discuss the limits of the subordinate's authorities.

3. GRANTING AUTHORITY

a. *Ask subordinate to present his ideas and plans as to how the desired results can best be achieved in this area, (including tasks/activites to be performed, schedule of events, target dates, How? By whom? etc.).

— b. By raising questions, suggest possible alternative and help the subordinate to explore all aspects of the situation.

c. *Arrive at mutual agreement on proposed course of action to be followed.

d. Transfer the authority (the power, freedom, right to act) to accomplish the agreed upon plan of action.

4. FOLLOW UP AND CONTROL

a. Establish what feedback information is needed, (how often, and in what form) to allow you to effectively control the delegated responsibility

b. Communicate to others who will be involved/affected that the subordinate has both the authority and your support to do the job.

*These items should be developed with the subordinate through mutual exchange in which the delegate has the widest possible latitude to recommend personal accountability.

# Moving Up

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## How to Make Teamwork Work for You

*Joanna J. Johnson*

The nature of the business of consulting engineering means that staff members often are assigned to teams. Since design effectiveness is the criterion by which most people measure success in engineering, a team effort contributes to the best possible product by incorporating the ideas of several competent people into one body of work. Usually a project is assigned a team consisting of a project manager, project engineers, drafters, and necessary subconsultants. Because success can be dependent on the continuity of personnel, on a large project a consulting engineer may work with one small group of people for a year or more.

Engineers are dedicated to their art, but most also are ambitious and eager to promote their careers. Just how can you turn opportunities offered within a team framework to your own advantage?

### Understanding Teams

Characteristics inherent in a successful team system, no matter what the industry or organization, are:

- A team's efforts are recognized through group rewards and incentives. Since the ultimate goal is to do the best possible job and do it on time, accomplishing it may require team members to help one another, attending to responsibilities not specifically theirs. Group rewards encourage this generosity.
- Since team meetings are scheduled, members come prepared to contribute and to question, fewer interruptions occur, and fewer excuses or cancellations are accepted.
- Clearly defining *team* responsibilities often is a problem, but on engineering teams the scope of the project defines responsibilities.
- The responsibilities of *individual* team members, however, may not be defined clearly.
- A strong team is composed of people with appropriate skills and personalities — skills to match assignments and personalities to complement one another.
- Horizontal and vertical communication are encouraged. The team system alleviates some of the liabilities connected with speaking up. The speaker usually is spokesman for the group and no one person has to assume individual responsibility. However, extra effort may be necessary to elicit the open communication that makes for a successful team.

### Benefits of Teamwork

Most team characteristics reinforce the concept of a project as a group effort. But there are methods to use them to your advantage. Since engineering firms usually structure teams so that the individual member has an opportunity to be upwardly mobile, the hierarchy is not absolute from project conception to end. A member knows that he can assume more responsibility within the team, but he sometimes overlooks the fact that the team framework offers opportunities to enhance personal skills in ways that can broaden career horizons. For example, you can:

- Improve communication skills. This is the number one benefit of the team environment. Engineering education offers little opportunity to develop either oral or written communication skills; such development is left to the individual. Yet engineers who move to the top of the profession are always good communicators. Even if communication skills don't come naturally to you, they can be learned and team meetings provide a nonthreatening opportunity to develop poise and self-confidence in front of a group.

On an interpersonal level, teams are composed of a range of personalities, not all of whom communicate in the same way. You will be with your team long enough to recognize the differences and to practice techniques of dealing with different types of people. If you are observant and careful you can begin to express yourself in terms the other person understands. You can practice until barriers to understanding are overcome and the skill becomes second nature.

- Develop self-confidence. Due to the creative atmosphere that team work encourages, it offers an opportunity to develop self-confidence. Here is the place to suggest new ideas without fear of failure. Use the team as a sounding board. Since all members have a stake in any action taken, they will help to develop and implement any good ideas that make success more likely. Success, if it comes, is the most powerful confidence builder.
- Continue your technical education. Even if you feel you have a strong engineering education, expanded by experience, there always is some new technical twist to be learned. I recently read an article that stated that young engineers fresh from the university are more valuable than 40-year-olds with 15 years of experience. True or not, this is evidence that you must continue to expand your technical horizons.

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Use all the knowledge the team has and add it to your own expertise.

- Broaden your base of knowledge. By definition, a team is made up of members who play different positions. As you move from one team to another, move from one position to another. Learn where your natural strengths lie, as well as any deficiencies you may need to overcome. Try a position that is difficult for you while you have help from knowledgeable people. By all means, take advantage of your strong points, but don't allow yourself to be pigeonholed. Broaden your experience so that you are familiar with the responsibilities of the entire team. This will make you more valuable to your firm and also will give you a base of experience that will enable you to start your own firm, if you desire.
- Sharpen cooperative skills. Another benefit that team work offers is an opportunity to practice cooperation. This may sound elementary, but the knowledge of when and when not to compromise is a subtle and sophisticated skill. Compromise often is required in emotional or personal areas. For example, when one person criticizes the work of another, the usual response is anger, which sometimes is appropriate but more often is counter-productive. The ability to separate personal reactions from business goals is gained only through effort and experience. The team environment is conducive to trial and error, and imposes limited liability if you err.

### Rewards of Good Teamwork

From management's point of view, your performance as a member of a team is indicative of your value to the firm. Your ability to get along well with team members, manage difficulties which inhibit productivity, and use technical expertise in providing good design will be recognized. Thus there are opportunities for growth in a team environment. The secret is to recognize the opening; then exploiting the opportunity should be easy. ΔΔ



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# How Well Does My Boss Delegate?

For each question check the box of the most appropriate answer.

**1. In projects that my boss delegates to me, he overrules or reverses my decisions.**

- ☐ a. Never or very seldom.
- ☐ b. Occasionally.
- ☐ c. Often.
- ☐ d. Almost always.

**2. My boss deserts me or revokes my authority before I finish a delegated project.**

- ☐ a. Never or very seldom.
- ☐ b. Occasionally.
- ☐ c. Often.
- ☐ d. Almost always.

**3. When I'm not there, my boss makes decisions without my approval (on projects already delegated to me).**

- ☐ a. Never or very seldom.
- ☐ b. Occasionally.
- ☐ c. Often.
- ☐ d. Almost always.

**4. I can feel my boss, or somebody spying for my boss, looking over my shoulder on projects delegated to me.**

- ☐ a. Never or very seldom.
- ☐ b. Occasionally.
- ☐ c. Often.
- ☐ d. Almost always.

**5. When a subject falls in my area of competence, how much does my boss encourage me to participate in meetings and contacts at higher levels?**

- ☐ a. He almost always encourages my participation.
- ☐ b. He often permits my participation, but doesn't strongly encourage it.
- ☐ c. More often than not he'll carry the ball.
- ☐ d. Almost always he'll carry the ball.

**6. Does my boss specify the results he expects from delegated projects or does he specify the tasks to be done?**

- ☐ a. Almost always he just asks for results.
- ☐ b. More often than not he asks for results.
- ☐ c. More often than not he also specifies the tasks to be done
- ☐ d. Almost always he specifies only the tasks to be done.

**7. On projects delegated to me, my boss has done the long range planning.**

- ☐ a. Almost always.
- ☐ b. Quite a bit.
- ☐ c. Occasionally.
- ☐ d. Never or very seldom.

**8. Does my boss delegate increasingly difficult projects to me?**

- ☐ a. Yes, when I'm ready to tackle them.
- ☐ b. Sometimes before I feel ready.
- ☐ c. No, unless I ask for them.
- ☐ d. No, or very rarely.

**9. My boss provides me with the amount and type of information I need to carry out a delegated assignment.**

- ☐ a. Almost always.
- ☐ b. More often than not.
- ☐ c. Occasionally.
- ☐ d. Almost never.

**10. When problems arise in a project delegated to me, my boss authorizes me to work them out my way.**

- ☐ a. Almost always.
- ☐ b. More often than not, although occasionally my boss will handle problems without seeking my ideas.
- ☐ c. Occasionally, although more often than not my boss will handle problems without seeking my ideas.
- ☐ d. Almost never.

How does your boss rate as a delegator? Before grading let's **Go Directly to Self-Quiz #2.** Here the focus shifts from your boss to yourself. Let's see how you stack up as a delegator.

# How Well Do I Delegate?

For each question check the box of the most appropriate answer. Do NOT check back to your answers from Self-Quiz #1.

**1. I have to take work home or work late.**

- ☐ a. Almost every night.
- ☐ b. More often than not.
- ☐ c. Occasionally.
- ☐ d. Almost never.

**2. Do I spend more time working on details than on planning and supervising?**

- ☐ a. I spend almost all my time working on details.
- ☐ b. Working on details takes up somewhat more time than planning and supervising.
- ☐ c. I spend relatively less time working on details than on planning and supervising.
- ☐ d. I spend almost all my time planning and supervising.

**3. In projects that I delegate, I overrule or reverse decisions made by my subordinates.**

- ☐ a. Almost never.
- ☐ b. Occasionally.
- ☐ c. Quite a bit.
- ☐ d. Almost always.

**4. I desert subordinates or revoke their authority before they finish a project.**

- ☐ a. Almost never.
- ☐ b. Occasionally.
- ☐ c. Quite a bit.
- ☐ d. Almost always.

**5. Am I interrupted by subordinates who come to me for advice, for decisions, or with questions?**

- ☐ a. Very frequently.
- ☐ b. Quite often.
- ☐ c. Occasionally.
- ☐ d. Almost never.

**6. Do I have unfinished jobs accumulating, difficulty meeting deadlines?**

- ☐ a. Yes - an overwhelming problem.
- ☐ b. A significant problem but not overwhelming.
- ☐ c. Moderately true.
- ☐ d. No problem here.

**7. Do I specify the results I expect from a delegated project or do I specify the tasks to be done?**

- ☐ a. Almost always I ask for a result.
- ☐ b. More often than not I ask for a result.
- ☐ c. More often than not I specify the tasks to be done.
- ☐ d. Almost always I specify the tasks to be done.

**8. Do my subordinates take the initiative in expanding their authority with delegated projects or do they wait for me to initiate all assignments?**

- ☐ a. Subordinates constantly seek ways to expand their authority.
- ☐ b. Subordinates are relatively aggressive in expanding their authority.
- ☐ c. Subordinates self-initiate occasionally but more often than not they wait for me to initiate delegations.
- ☐ d. Subordinates wait for me to initiate all assignments.

**9. I am irritable, tired or worried because of job pressure.**

- ☐ a. Never or very seldom.
- ☐ b. Occasionally.
- ☐ c. Quite a bit.
- ☐ d. Almost always.

**10. When problems arise in a project I have delegated, I ask for my subordinates' ideas.**

- ☐ a. Almost always.
- ☐ b. More often than not although occasionally I'll handle problems my own way without seeking subordinates' ideas.
- ☐ c. Occasionally, although more often than not I'll handle problems my own way without seeking subordinates' ideas.
- ☐ d. Almost never.

How do you rate as a delegator? Would you rather receive delegations from your boss or yourself? For scoring of both self-quizzes:

## Scoring Key For Self-Quizzes 1 & 2

For Self-Quiz #1 give yourself 2 points for each "a" box you checked, 4 points for each "b" box you checked, 6 points for each "c" box and 8 points for each "d" box.

For Self-Quiz #2 follow this same scoring procedure for all questions **Except** #1, 2, 5 and 6. For questions #1, 2, 5 and 6, the scoring is reversed - that is, give yourself 8 points for each "a" box you checked, 6 points for each "b" box, 4 points for each "c" box and 2 points for each "d" box.

For both quizzes, a score total of 20-38 indicates healthy delegation; 40-58 should give a clue about some areas in need of improvement; 60-80 probably indicates some serious delegation problems.

## VII. CONSTRUCTIVELY CORRECTING ERRORS

Role Play

The Five P's of the Positive Approach to Correcting

* Work Improvement Survey

# POSITIVE APPROACH TO CORRECTING: "THE FIVE P's"

- PREPARE
- PROMPT
- PRIVATE
- PROBLEM SOLVING
- POINT THE WAY

# WORK IMPROVEMENT SURVEY

| ITEM | FREQUENTLY | SOMETIMES | RARELY | NEVER |
|---|---|---|---|---|
| 1. I correct mistakes in front of others. | | | | |
| 2. When issuing corrections or discipline, I don't ask for their point of view. | | | | |
| 3. I assume that people make errors on purpose. | | | | |
| 4. I sometime dwell on aspects of personality more than on the mistake or problem. | | | | |
| 5. I seem to be interested in letting employees know who's in charge around here. | | | | |
| 6. I use mistakes to grind employees into the ground. | | | | |
| 7. I bring up past errors and history, when correcting a simple error that just happened. | | | | |
| 8. My boss is just like me; autocratic, hard, and unbending. | | | | |
| 9. Our work force around here shows signs of fatigue, distress. | | | | |
| 10. I would judge our work group as one requiring strong discipline, to keep things in order. | | | | |
| 11. My disciplinary measures seem to come into play after errors have been made, rather than serving as before-the-fact, preventative guidelines. | | | | |
| 12. I make judgements based on inferences rather than what I observe in fact. | | | | |
| 13. I see myself more as a paternal advice-giver than as a partner with whom my employees share experiences. | | | | |
| 14. I give my employees all the advice or correcting I want, rather than considering how much they can take at a given point in time. | | | | |
| 15. I call my employees ill-chosen names when berating them, from time to time. | | | | |

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## THE APPRAISAL REVIEW CONFERENCE

The most important part of the performance review is the appraisal review conference itself, when the supervisor and the subordinate meet to discuss the supervisor's rating of the subordinate. Many supervisors and managers would prefer to eliminate this conference entirely so they could rate the employee without discussion. However, since this cannot be done, the following suggestions will help to make this meeting proceed more smoothly:*

1. Use the "sandwich" technique. That means simply sandwiching unfavorable remarks between favorable remarks. Compliment the employee at the beginning and at the end of the discussion.

2. Emphasize the reason why the rating was given. Cite specific instances of performance, so the ratings become grounded in fact. They are then far more acceptable to the employee and leave him knowing they are fair.

3. Allow the employee to express his reactions to the ratings. Here one may find the underlying cause for unsatisfactory performance or obstacles hindering continued good performance. Listen.

4. Do not show anger or hostility, regardless of the remarks the employee may make. You must be prepared to accept criticism as well as to give it.

5. Do not be too anxious to prove the employee wrong. Help the employee save face and leave his self-respect intact.

6. Take your time. Acceptance of criticisms or suggestions may not come immediately.

7. Do not expect to convince him of anything while he is angry.

8. If the employee wants to talk, do not interrupt. Let him talk.

9. Do not be vague about personality shortcomings. Such faults are hard to tie in with ability and skill. They have much more meaning when they can be related to production efficiency -- either in the employee or in the effect on others.

10. Show a sincere interest in the employee's work and his problems.

11. Be sure criticism is positive. When you point out weaknesses be prepared to offer means of correcting them.

## VIII. PERFORMANCE APPRAISAL

1. The Basics

2. Doing the Review

3. The G/C Appraisal Forms ("Performance Appraisal and Development Plan")

* The Appraisal Review Conference

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# TEAM BUILDING IN PROJECT MANAGEMENT

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## INTRODUCTION

One of the most important developments in management during the 1970's has been the widespread application of project teams to a variety of complex tasks. Project managers quickly learn the critical significance of the effective project team and the role of team building activities in facilitating project management performance. In fact, the difference between successful and unsuccessful performance can often be linked to the effectiveness of the project team. We expect that the 1980's will surely witness an increased emphasis on team building.

Varney* notes that the importance of developing effective teams comes from three major forces. First, there are more specialists/experts within organizations whose talents need to be focused and integrated into a larger task. Second, more organizational members want to become increasingly involved in their total work environment. Third, the benefits of people working together can result in important synergy and creativity. Increasing task complexity and complicated environmental interfaces also encourage the development of effective teams. Effective team building also leads to higher levels of job satisfaction.

## TEAM BUILDING DEFINED

Team building is a process of taking a collection of individuals with different needs, backgrounds and expertise and transforming them by various methods into an integrated, effective work unit. In this transformation process, the goals and energies of individual contributors merge and support the objectives of the team.

The concept of team building becomes critically important as bureaucratic hierarchies decline and horizontally-oriented teams and work units become increasingly important. In most cases, team building involves relationships among peers with a wide diversity of expertise.

## MAJOR BARRIERS TO PROJECT TEAM DEVELOPMENT

In a recent exploratory field probe with over 90 project leaders, we attempted to identify some of the major barriers project leaders experience in building effective teams. The project leaders represented several types of organizations and technologies. Most of the respondents to our probe, however, were in research and development, construction and engineering projects and computer information system implementors. A more comprehensive study is planned to develop detailed data on team-building barriers. Our purpose here is to illustrate some of the most common major barriers to team-building efforts and suggest alternative approaches for handling these problems.

### Differing Outlooks, Priorities, Interests and Judgments of Team Members

A major barrier is that team members often have different professional objectives and interests. Yet project accomplishment often requires team members to place "what's good for the project" above their own interest areas. When team members are reluctant to do so, severe problems develop in building an effective team. This problem is compounded when the team relies on support groups which have different interests and priorities.

### Role Conflicts

Team development efforts also can be thwarted when role conflicts exist among the team members. Role conflicts are most likely to occur when there is ambiguity over who does what within the project team and between the team and external team support groups. Overlapping and ambiguous role responsibilities are also major contributors to role conflicts.

### Project Objectives/Outcomes Not Clear

One of the most frequently cited team-building barriers is unclear project objectives. As one project leader remarked:

> How can you implement a team building program if you're not clear on what the objectives for the project really are? Let's face it, many teams are muddling along on fifty percent of their potential because no one is really clear on where the project should be headed.

In R&D and computer systems projects, objectives may be formulated by managers or clients external to the team. Moreover, if objectives are not explicit, it becomes difficult, if not impossible, to clearly define roles and responsibilities.

*G.H. Varney, Organization Development for Managers (Reading, Mass.: Addison-Wesley Publishing Company, 1977), pp. 151-152.



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### Dynamic Project Environments

A characteristic of many projects is that the environments in which they operate are in a continual state of change. For example, senior management may keep changing the project scope, objectives and resource base. In other situations, regulatory changes or client demands for new and different specifications can drastically affect the internal operations of a project team. Disruptive environments are frequently a characteristic of project teams. Finally, the rate by which a team "builds up" to its full manpower base may present team-building barriers.

### Competition Over Team Leadership

Initially we were somewhat surprised at the number of project leaders who mentioned this issue. They indicated that this barrier was most likely to occur in the early phases of a project or if the project ran into severe problems and the quality of team leadership came into question. Obviously, both cases of leadership challenge can result in barriers (if only temporary) to team building. Frequently these challenges were covert challenges to the project leader's ability.

### Lack of Team Definition and Structure

One of the most frequently mentioned barriers of all was the lack of a clearly delineated team to undertake a project. We found this barrier to be most likely to occur among computer system managers and R&D project leaders. A common pattern was that a work unit (not a project team) would be charged with a task but no one leader or team member was clearly delegated the responsibility. As a consequence, some work-unit members would be working on the project but not be entirely clear on the extent of their responsibilities.

In other cases, a poorly defined team will result when a project is supported by several departments but no one person in these departments is designated as a team member and departmental coordinator. Such an approach results in the project leader being unclear on whom to count for support. This often occurs, for example, when a computer systems project leader must rely on a "programming pool."

### Team Personnel Selection

This barrier centered on how team members were selected. In some cases, project personnel are assigned to the teams by functional managers, and the project manager has little or no input into the selection process. This, of course, can impede team development efforts especially when the project leader is given available personnel versus the best, hand-picked team members. The assignment of "available personnel" can result in several problems, e.g., low motivation levels, discontentment and uncommitted team members. We've found, as a rule, that the more power the project leader has over the selection of his/her team members, the more likely team-building efforts will be fruitful.

### Credibility of Project Leader

Team-building efforts were hampered when the project leader suffered from poor credibility within the team or from important managers external to the team. In such cases, team members are often reluctant to make a commitment to the project or the leader. Credibility problems may come from poor managerial skills, poor technical judgments or lack of experience relevant to the project.

### Lack of Team Member Commitment

Lack of commitment to the project was cited as one of the most common barriers. Lack of commitment can come from several sources, such as: the team members' professional interests lie elsewhere; the feeling of insecurity being associated with projects; the unclear nature of the rewards which may be forthcoming upon successful project completion; and from intense interpersonal conflicts within the team. One project leader made this comment to us:

> Let's face it – some personnel are not suited for project work. Some can't stand the ambiguous, fluid nature of projects while others simply rather work alone or with a small group of colleagues they've developed close working relationships with over a period of years.

As we suggested earlier, the nature of many projects requires the disruption of valued, existing routine work relationships of team members. As a consequence, they may not feel commitment to the project.

Other issues which can result in uncommitted team members is suspicious attitudes which may exist between the project leader and a functional support manager or between two team members from two warring functional departments. Finally, we found that low commitment levels were likely to occur when a "star" on a team "demanded" too much deference from other team members or too much pampering from the team leader. One team leader put it this way:

> A lot of teams have their prima donnas and you learn to live and function with them. They can be critical to overall project success. But some stars can be so demanding on everyone that they'll kill the team's motivation.

### Communication Problems

Not surprisingly, we found that poor communication was a major enemy to effective team development efforts. Poor communication existed on three major levels. First, several mentioned the problems of communication among team members and between the project leader and the team members. Often the problem was caused by team members simply not keeping others informed on key project developments. Yet the "whys" of poor communication patterns were far more difficult



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to determine. It can result from low motivation levels, poor morale, or carelessness. We also discovered that poor communication patterns between the team and support groups could result in severe team-building problems, as did poor communication with the client. Poor communication practices often led to unclear objectives and poor project control, coordination, and work flow.

### Lack of Senior Management Support

Many of the project leaders indicated that senior management support and commitment often was unclear and subject to waxing and waning over the project life cycle. This behavior can result in an uneasy feeling among team members and lead to low levels of enthusiasm and project commitment. Two other common problems frequently noted were that senior management would not help set the right environment for the project team at the outset, nor would they give the team timely feedback on their performance and activities during the life of the project.

## OVERCOMING TEAM BUILDING BARRIERS

For each of the major team-building barriers identified, several suggestions can be advanced for either minimizing or eliminating them. Table I lists the barriers and the suggested handling approaches.

## SUGGESTIONS FOR HANDLING THE NEWLY FORMED TEAM

A major problem faced by many project leaders is managing the anxiety which usually develops when a new team is first formed. This anxiety experienced by team members is normal and predictable. It is a barrier, however, to getting the team quickly focused on the task. In other words, if team members are suffering from anxiety, their attention consciously or subconsciously will be focused on the resolution of their own anxieties rather than on the needs of the project.

This anxiety may come from several sources. For example, if the team members have never worked with the project leader, the team members may be concerned about his leadership style and its affect on them. In a different vein, some team members may be concerned about the nature of the project and whether it will match their professional interests and capabilities. Other team members may be concerned whether the project will be helpful or a hindrance to their career aspirations. Our experience indicates that team members can also be highly anxious about life-style/work-style disruptions which the project may bring. As one project manager recently remarked to one of the authors:

> Moving a team member's desk from one side of the room to the other can sometimes be just about as traumatic as moving someone from Chicago to Manila to build a power plant.

As the quote suggests, seemingly minor changes can result in unanticipated anxiety among team members.

Another common concern among newly formed teams is whether or not there will be an equitable distribution of the work load among team members and whether each member is capable of pulling his/her weight. In some newly formed teams, team members not only might have to do their own work but they also must train other team members. Within reason this is bearable, necessary and often expected. However, when it becomes excessive, anxiety increases and morale can fall.

We've found that certain steps taken early in the life of a team can pay handsome dividends in terms of handling the above problems. First, we recommend that the project leader at the start of the project talk with each team member on a one-to-one basis about the following:

1. What the objectives are for the project.
2. Who will be involved and why.
3. Importance of the project to the overall organization or work unit.
4. Why the team member was selected and assigned to the project. What role will he/she perform.
5. What rewards might be forthcoming if the project is successfully completed.
6. A candid appraisal of the problems and constraints which are likely to be encountered.
7. What are the rules-of-the-road which will be followed in managing the project, e.g., regular status review meetings.
8. What suggestions does the team member have for achieving success.
9. What are the professional interests of the team member.
10. The challenge the project is likely to provide to individual members and the entire team.
11. Why the team concept is so important to project management success and how it should work.

A frank, open discussion with each team member on the above is likely to reduce his/her initial anxiety. As a consequence, the team member is likely to be more attentive to the needs of the project. Of course, the opposite reaction is possible, too. A frank discussion, for example, may actually increase a team member's anxiety level. Often, however, the source of the anxiety can be identified and dealt with in a timely manner.

The importance of dealing with these anxieties and helping team members feel that they are an integral part of the team can result in rich dividends. First, as noted in Figure I, the more effective the project leader is in developing a feeling of team membership, the higher the quality of information which is likely to be contributed by team members. Team members will not be reluctant to openly share their ideas and approaches. By contrast, when a team member does not feel like part of the team and does not believe he/she can trust others in team deliberations, information will not be



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## TABLE I
## BARRIERS TO EFFECTIVE TEAM BUILDING AND SUGGESTED HANDLING APPROACHES

| Barrier | Suggestions for Effectively Managing Barriers (How to Minimize or Eliminate Barriers) |
|---|---|
| Differing Outlooks, Priorities, Interests, and Judments of Team Members | Make effort early in the project life cycle to discover these conflicting differences. Fully explain the scope of the project and the rewards which may be forthcoming upon successful project completion. Sell "team" concept and explain responsibilities. Try to blend individual interests with the overall project objectives. |
| Role Conflicts | As early in a project as feasible, ask team members where they see themselves fitting into the project. Determine how the overall project can best be divided into subsystems and subtasks (e.g., the work breakdown structure). Assign/negotiate roles. Conduct regular status review meetings to keep team informed on progress and watch for unanticipated role conflicts over the project's life. |
| Project Objectives/Outcomes Not Clear | Assure that all parties understand the overall and interdisciplinary project objectives. Clear and frequent communication with senior management and the client becomes critically important. Status review meetings can be used for feedback. Finally, a proper team name can help to reinforce the project objectives. |
| Dynamic Project Environments | The major challenge is to stabilize external influences. First, key project personnel must work out an agreement on the principal project direction and "sell" this direction to the total team. Also educate senior management and the customer on the detrimental consequences of unwarranted change. It is critically important to forecast the "environment" within which the project will be developed. Develop contingency plans. |
| Competition Over Team Leadership | Senior management must help establish the project manager's leadership role. On the other hand, the project manager needs to fulfill the leadership expectations of team members. Clear role and responsibility definition often minimizes competition over leadership. |
| Lack of Team Definition and Structure | Project leaders need to sell the team concept to senior management as well as to their team members. Regular meetings with the team will reinforce the team notion as will clearly defined tasks, roles and responsibilities. Also, visibility in memos and other forms of written media as well as senior management and client participation can unify the team. |
| Project Personnel Selection | Attempt to negotiate the project assignments with potential team members. Clearly discuss with potential team members the importance of the project, their role in it, what rewards might result upon completion, and the general "rules-of-the-road" of project management. Finally, if team members remain uninterested in the project, then replacement should be considered. |
| Credibility of Project Leader | Credibility of the project leader among team members is crucial. It grows with the image of a sound decision maker in both general management and relevant technical expertise. Credibility can be enhanced by the project leaders' relationship to other key managers who support the team's efforts. |
| Lack of Team Member Commitment | Try to determine lack of team member commitment early in the life of his project and attempt to change possible negative views toward the project. Often, insecurity is a major reason for the lack of commitment; try to determine why insecurity exists, then work on reducing the team members' fears. Conflicts with other team members may be another reason for lack of commitment. It is important for the project leader to intervene and mediate the conflict quickly. Finally, if a team member's professional interests lie elsewhere, the project leader should examine ways to satisfy part of the team member's interests or consider replacement. |
| Communication Problems | The project leader should devote considerable time communicating with individual team members about their needs and concerns. In addition, the leader should provide a vehicle for timely sessions to encourage communications among the individual team contributors. Tools for enhancing communications are status meetings, reviews, schedules, reporting system, and colocation. Similarly, the project leader should establish regular and thorough communications with the client and senior management. Emphasis is placed on written and oral communications with key issues and agreements in writing. |
| Lack of Senior Management Support | Senior management support is an absolute necessity for dealing effectively with interface groups and proper resource commitment. Therefore, a major goal for project leaders is to maintain the continued interest and commitment of senior management in their projects. We suggest that senior management become an integral part of project reviews. Equally important, it is critical for senior management to provide the proper environment for the project to function effectively. Here the project leader needs to tell management at the onset of the program what resources are needed. The project manager's relationship with senior management and ability to develop senior management support is critically affected by his own credibility and the visibility and priority of his project. |

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shared willingly or openly. One project leader emphasized this point this way:

> There's nothing worse than being on a team when no one trusts anyone else . . . Such situations lead to gamesmanship and a lot of watching what you say because you don't want your own words to bounce back in your face . . .

Second, the greater the feeling of team membership and the better the information exchange (flow) among team members, the more likely the team will be able to develop effective decision-making processes. The reason is that the team members feel committed to the project and they feel free to share their information and develop effective problem-solving approaches. Third, the team is likely to develop more effective project control procedures. Project control procedures can be divided into two basic areas. The first is the quantitative control procedures traditionally used to monitor project performance, e.g., PERT/CPM, networking, workbreakdown structures, etc. The second "control procedure" (and perhaps the most important) is the willingness and ability of project team members to give feedback to each other regarding performance. Again, trust among the project team members makes the feedback process easier and more effective. Without a high level of trust, project personnel are often reluctant to give negative or constructive feedback to fellow team members.

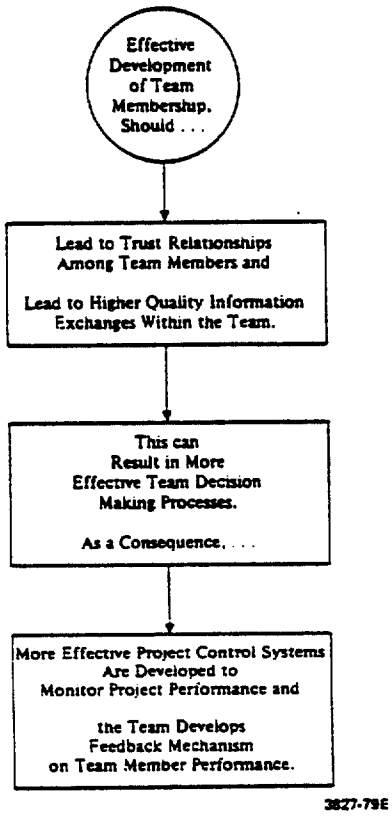


Figure I – Team Building Outcomes

## TEAM BUILDING AS AN ON-GOING PROCESS

While we've spent considerable attention on the role of team building in the critical early phases of a project, it is a never-ending process. The project manager is continually monitoring team functioning and performance to see what corrective action may be needed to prevent or correct various team problems. We've found several barometers to be good clues of potential team dysfunctioning. First, noticeable changes in performance levels for the team and/or for individual team members should always be followed up. Such changes can be symptomatic of more serious problems, e.g., conflict, lack of work integration, communication problems and unclear objectives. Second, the project leader and team members want to be aware of the changing energy levels of team members. This, too, may signal more serious problems or that the team is tired and stressed. Sometimes changing the work pace, taking time off, or selling near-term, more easily reached targets can serve as a means to reenergize team members. More serious cases, however, can call for more drastic action, e.g., reappraising project objectives and/or the means to achieve them. Third, verbal and nonverbal clues from team members may be a source of information on team functioning. It is important to hear the needs and concerns of team members (verbal clues) and to observe how they act in carrying out their responsibilities (nonverbal clues). Finally, detrimental behavior of one team member toward another can be a signal that a problem within the team warrants attention.

We highly recommend that project leaders hold regular team building meetings to evaluate overall team performance and deal with team functioning problems.

The focus of these meetings can be directed toward "what are we doing well as a team" and "what areas need our team's attention." This approach often brings positive surprises in that the total team will be informed on progress in diverse project areas, e.g., a breakthrough in technology development, a subsystem schedule met ahead of the original target, or a positive change in the client's behavior toward the project. After the positive issues have been discussed, attention should be devoted toward "areas needing team attention." The purpose of this part of the review session is to focus on actual or potential problem areas. The meeting leader should ask each team member for his observations on these issues. Then, an open discussion should be held to ascertain how significant the problems really are. Assumptions should, of course, be separated from the facts of each situation. Next, assignments should be agreed upon on how best to handle these problems. Finally, a plan for problem follow-up should be developed. The process should result in better overall performance and promote a feeling of team participation and high morale.

Over the life of a project, the problems encountered by the project team are likely to change and as old problems are identified and solved, new ones will emerge. We recommend that a high degree of effort be focused on problem avoidance in the entire process.



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## TEAM BUILDING WITH OTHER DEPARTMENTS – A CASE STUDY

A variation of the team-building approach occurs when two separate departments or work units are dependent upon each other for support but have intense conflicts which slow or even stop intradepartmental coordination attempts. Consider the following situation which recently occurred in a division of a large, high technology company. One of the authors served as a consultant to the firm.

The case involved an R&D group and a marketing-directed project team. R&D's role was to develop new technology and support the project team in its new product development efforts. Over a period of several months relationships between the two groups deteriorated to such a level that the division manager decided that an intervention into the situation was critical. One of the authors entered the picture at this point. After reviewing several problems with the division manager a recommendation was made to take both groups to a "neutral" site for a two-day meeting. The R&D manager and the project leader fully concurred with this decision. The meeting opened with a talk by the division manager on the overall status of the division, the role and importance of new product development to the division, and the importance of R&D and the new product project team in effectively integrating their efforts. The division manager left the meeting after the first short coffee break.

After reconvening the R&D and the project team members, the consultant asked each group to go to nearby conference rooms and clearly establish how they perceived the other group. These perceptions were to be limited to short statements and a general agreement reached on their validity. The consultant noted that if 50 percent or more of the members of a group believed that a statement was an accurate reflection of the other group's behavior, then it would constitute a general agreement. Complaints or perceptions about personalities were not allowed. The intent here was to keep the two teams focused on detrimental behaviors rather than specific individuals.

After several hours the two groups were reassembled and each group was asked to give their perceptions of the other. An abbreviated version of the results is presented in Table II. This process did produce an occasional emotional outburst but was handled by the consultant stressing that these were perceptions and part of an overall problem-solving process.

Upon completion of the "mirroring" process, each group had a chance to respond to the perceptions of the other group. This proved helpful in cooling down emotions.

The next morning, the two groups were reassembled and given this assignment: "What Can We Do Together to Solve the Problems We've Identified." The two teams were again asked to retire to their separate conference rooms to work on the assignment. After a couple of hours, the groups were brought together again to see what kind of suggestions had been developed and if an agreement could be reached. The results of this phase are presented in Table III. Overall, the session was a success and it set the tone for regular meetings between the R&D group and the New Product Project Team. In this situation, the "team" was the two interdependent groups working together.

**TABLE II**
**TEAM PERCEPTIONS REGARDING EACH OTHER'S BEHAVIORS: R&D vs NEW PRODUCT PROJECT TEAM**

| R&D's Perception of New Product Project Team | ⟺ | New Product Project Team's Perception of R&D |
|---|---|---|
| • Keeps Changing Requirements | ⟺ | R&D Not Responding to Market Needs |
| • Moves Too Quickly, Unilaterally and is Careless | ⟺ | Moves Too Slowly – Doesn't Realize How Aggressive Competitors Are |
| • Promises Too Much to Customers and Expects Us to Bail Them Out | ⟺ | Doesn't Respect Marketing's Priorities |
| • New Product Development Goals Not Clearly Defined | ⟺ | Hard to Get Straight Answers – Won't Turn Projects/Technology Loose |
| • Has Too Much Power and Clout | ⟺ | Resistant to Suggestions/Can't Do Attitude |
| • Doesn't Understand or Respect Creative Process | ⟺ | • Doesn't Understand Importance of Aggressive New Product Development Program |



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TABLE III
RESOLUTION PLAN: OUTCOME FROM INTERDISCIPLINARY PROBLEM-SOLVING SESSION

- Conduct Regular Status Review Meetings to Monitor Progress for All On-going Projects
- Hold Regular Product Concept Sessions to Screen New Product Ideas
- Establish Priority System for New Product Development Projects
- Project Team Members Will be Responsible for Facilitating R&D/Customer Contact
- Develop Team Concept to Facilitate R/D/Project Group Interaction (Matrix Approach)
- Continue These Sessions!

## CONCLUSIONS

Effective team building can be a critical determinant of project success. While the process of team building can entail frustrations and energy on the part of all concerned, the rewards can be great.

Social scientists generally agree that there are several indicators of effective and ineffective teams. At any point in the life of a team, the project manager should be aware of certain effectiveness/ineffectiveness indicators. Several such indicators appear in Table IV.

As we enter the 1980's, we anticipate important developments in team building. These developments should not only lead to higher performance levels but also to increased morale. We have noted on many occasions that the well developed, highly committed team can withstand almost any kind of adversity. It is the poorly developed team which is likely to run aground when storms appear.

TABLE IV
PROJECT TEAM CHARACTERISTICS: EFFECTIVE vs INEFFECTIVE

| The Effective Team Likely Characteristics | The Ineffective Team Likely Characteristics |
|---|---|
| • High Performance | • Low Performance |
| • Professional Objectives of Team Members Coincides with Project Requirements | • Low Commitment to Project Objectives |
| • Clearly Defined Project Objectives Which Are Accepted by Team Members | • Unclear Project Objectives and Fluid Commitment Levels from Key Participants |
| • Team Members Highly Interdependent | • Team Members Operate Independently/ Lack of Coordination |
| • Conflict Encouraged When It Can Lead to Beneficial Results | • Conflict Avoided at All Costs |
| • High Trust Levels | • Subtle Sabotage, Fear, Disinterest or Footdragging |
| • High Interest in the Team and Team Processes | • Unproductive Gamesmanship, Manipulation of Others, Hidden Feelings |
| • High Energy Levels and Enthusiasm | • Lethargic/Unresponsive |

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# memorandum

Gilbert/Commonwealth

**To:** Course Participants

**From:** Training and Development

**Subject:** Course Evaluation - Foundations of Management Review

The intent of the Project Management and Supervisory Training Course is to emphasize the importance of team work to project success and to review methods to enhance effective project management and control. Please evaluate the merits/shortcomings of this module as indicated below. Criticisms should be accompanied by suggestions for improvement.

1. Adequacy in meeting the overall course objectives

2. Success in meeting the module's stated objectives

3. Instruction methods, including presentation, selection of visual aids, and information presented in the training manual.

# PROJECT

# MANAGEMENT

# BASICS

# PROJECT MANAGEMENT BASICS

## INTRODUCTION

### PURPOSE

To present a basic training course for Project Managers to enable them to be more effective in their duties which are to ensure:

> that **QUALITY** projects are completed within the required **BUDGET** and **SCHEDULE** to meet **CLIENT NEEDS** and support **CORPORATE OBJECTIVES.**

### OBJECTIVES

Upon completion of this module, the participant should be able to:

- Identify the internal and external responsibilities of the Project Manager.
- Describe the role of the Project Manager in organizing, leading, and controlling project implementation.
- Discuss the Division's approach towards project management and the importance of effective project controls.

## I. APPROACH

To define the:

- **ORGANIZATION** of the Company, Division, and Project
- **POLICIES AND PROCEDURES** which control the performance and quality of project work
- **PROJECTS:** Their type and organization
- **RESPONSIBILITIES, AUTHORITY, ACCOUNTABILITIES AND QUALIFICATIONS** of major parties associated with projects
- **PROJECT CONTROLS** to maintain target budgets and schedules, and to monitor performance
- **MANAGEMENT OF A PROJECT** by scope definition, project manuals and team effort
- **INTERFACES** between G/C and client for project work and developing new business

## II. ORGANIZATION

A. Corporate

B. Division

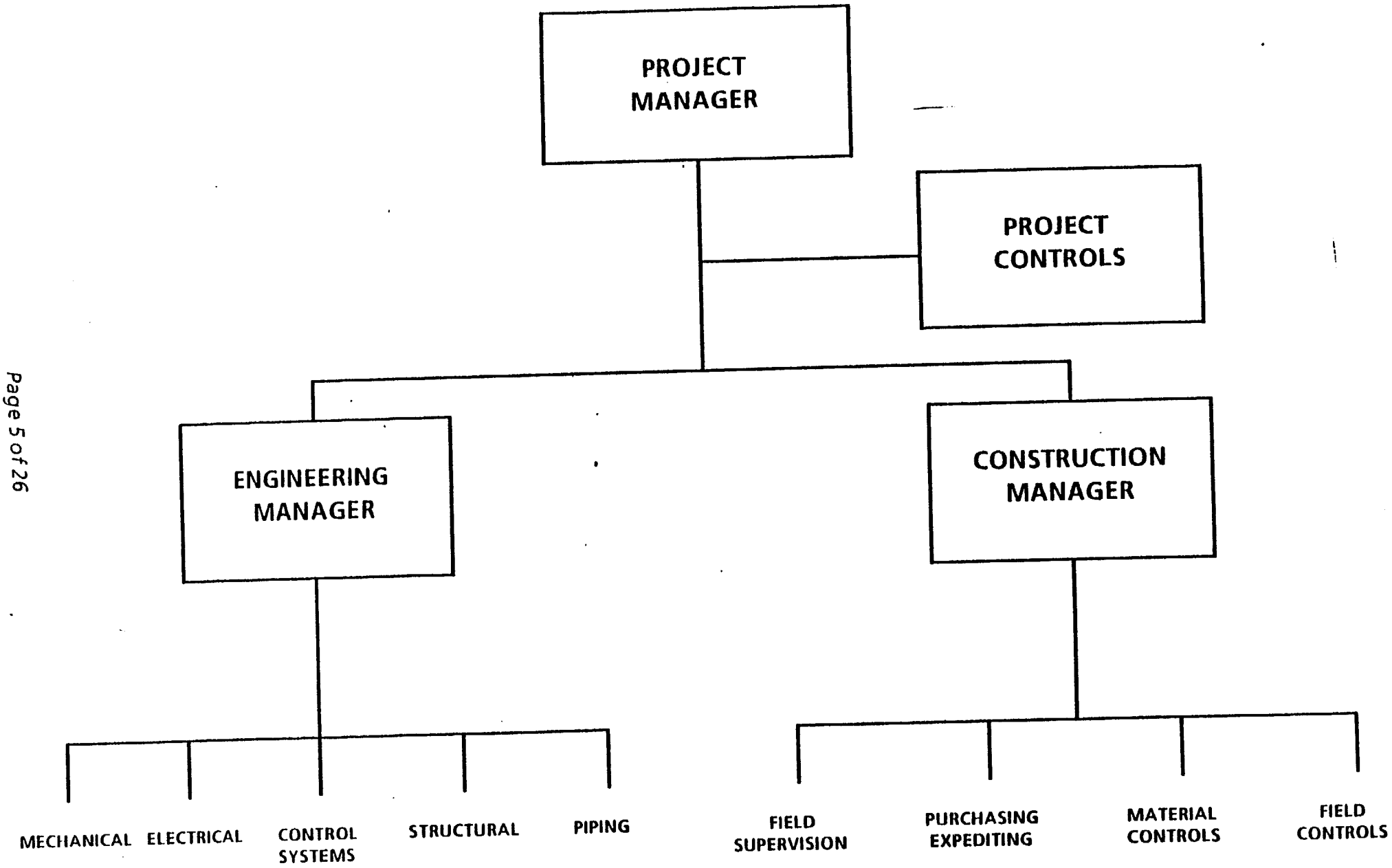
C. Projects

## III. POLICIES AND PROCEDURES

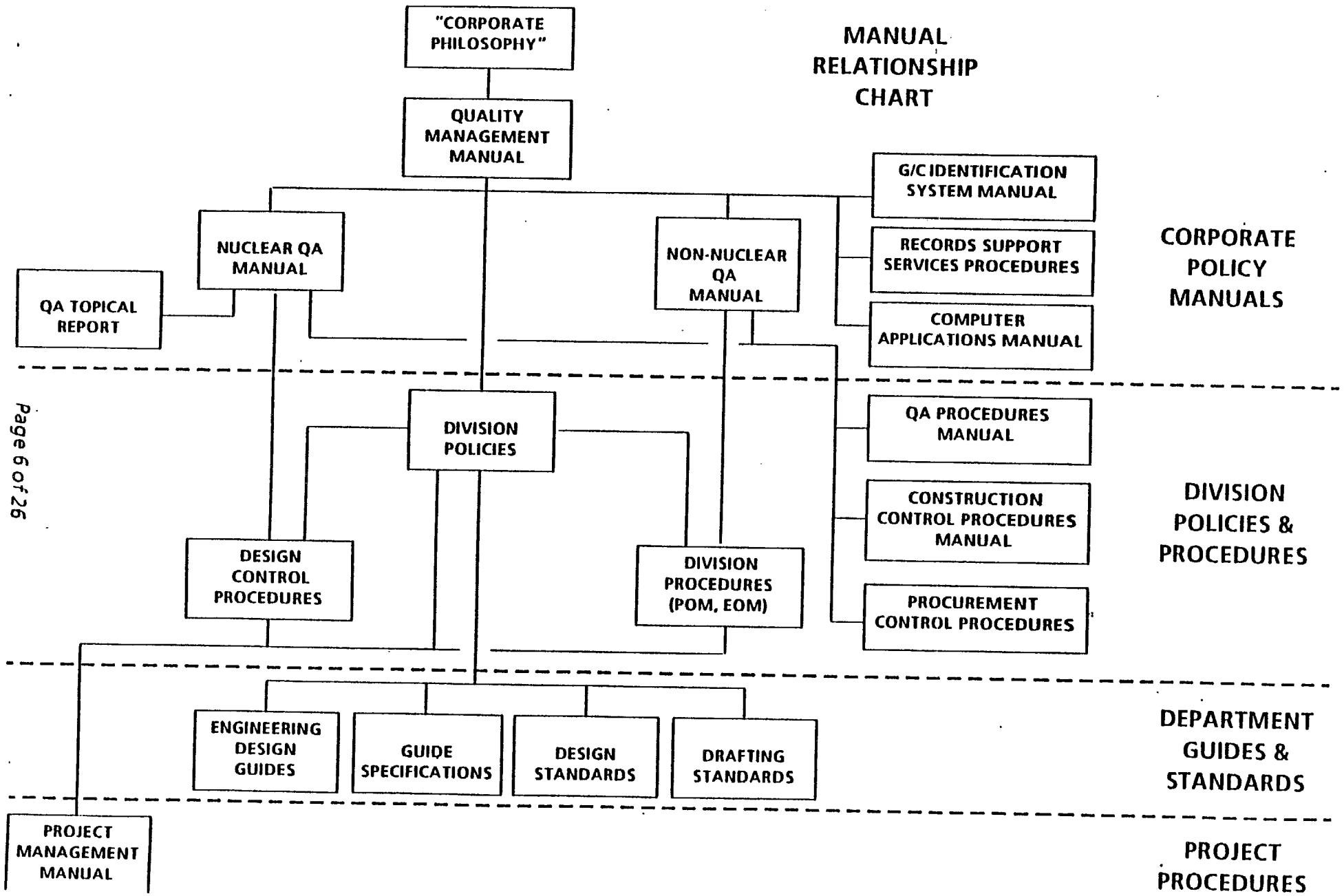
A. Corporate Philosophy

- To consistently provide professional services of the highest quality in all areas of our competence.
- To always serve with integrity the best interests of our clients and society.
- To seek fair compensation for services rendered but in no way permit profit or loss to influence the character or adequacy of the work performed.
- To foster an atmosphere which permits employees to attain the highest degree of fulfillment consistent with their talents.
- To merit and award the confidence of our shareholders to the fullest extent possible within the framework of the preceding tenets of corporate philosophy.

# HYPOTHETICAL PROJECT ORGANIZATION



# MANUAL RELATIONSHIP CHART



# MANUAL DISTRIBUTION

| | Controlled No | Controlled Yes | Distribution Criteria |
|---|---|---|---|
| **Corporate** | | | |
| Quality Management | X | | Managers |
| Nuclear QA | | X | Management personnel involved in nuclear work |
| QA Topical Report | | X | Management personnel involved in nuclear work |
| Non-Nuclear QA | X | | Managers |
| G/C IDS | | X | Managers |
| Records Support Services Procedures | | X | Limited distribution on an as needed basis |
| Computer Applications | | X | SM's |
| **Division** | | | |
| Design Control Procedures | | X | Managers involved with nuclear work, PE's, and lead personnel |
| Project Operations | | X | PM's, DM's, SM's |
| Engineering Operations | | X | PM's and Engineering personnel |
| QA Procedures | | X | QA personnel |
| Construction Control Procedures | | X | Managers involved in construction |
| Procurement Control Procedures | | X | Managers involved in procurement |



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# MANUAL DISTRIBUTION

| | Controlled No | Controlled Yes | Distribution Criteria |
|---|---|---|---|
| **Department** | | | |
| Engineering Design Guides and Standards | | X | Engineers and Managers associated with the applicable Department |
| Guide Specifications | | X | Engineers and Managers associated with the applicable Department |
| Drafting Standards | | X | Designers and Drafters associated with the applicable Department |



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B. Policies and Procedures Manuals

1. Corporate Level:

- Quality Management Manual
- Nuclear QA Manual
- QA Topical Report
- Non-Nuclear QA Manual
- G/C Identification System Manual
- Records Support Services Procedures
- Computer Applications Manual

2. Division Level

- Design Control Procedures
- Engineering Operations Manual
- Project Operations Manual
- QA Procedures Manual
- Construction Control Procedures Manual
- Procurement Control Procedures Manual

3. Department Level

- Engineering Design Guides
- Guide Specifications
- Drafting (and Design) Standards

4. Project Level

- Project Management Manual



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C. Availability

## IV. PROJECT MANAGER'S GUIDE

### A. Purpose and Function

In general, the Project Manager's primary function is to coordinate the work between engineering, construction, procurement, and supporting groups within Gilbert/Commonwealth, and serve as a primary interface with the Client, major suppliers, consultants, and field personnel.

- The purpose of this guide is to define the basic functions and responsibilities of a Project Manager.
- It is recognized that the size of a given project or specific Client concerns may dictate variations or additions to these basic responsibilities.

### B. Project Development

Develop Contract Information File:

1. Proposal Development File
2. Contract File (Contract Documents and Agreements)
3. Work Order Plan
4. Scope Document
5. Project Schedule
6. Man-hour Requirements
7. Organizational Charts
8. Areas of Authority and Limitations



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Develop the Following Additional Information:

1. Correspondence File Index System
2. Drawing Numbering System and Lists
3. Schedule for Development of Project Documents
4. Procedures for Review of Documents
5. Communication and Monitoring Requirements
6. Establish Special Client Requirements for Design Control
7. Establish Requirements for Record Keeping
8. Develop and Issue Project Management Manual
9. Develop Design Input
10. Develop and maintain schedule, estimate, and cost control program; include controls for:
    - Proper feedback and interface.
    - Require discipline engineers to develop the details in their portion of the plans.
    - Require discipline engineers to track and monitor their schedules and estimates.
    - Utilize project service departments for establishing and monitoring their services.
11. Establish team review meetings.
12. Establish procedures for reporting progress to Client and to Division Management.
13. Assist Department Managers in resolving any problems with discipline engineers.
14. Ensure that proper staff is maintained.

    Reference: Project Operations Manual, Instruction 1, Project Responsibility Matrix (enclosed)



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C. Type of Projects

STUDIES - Varying from single-discipline to multi-discipline.

SINGLE-DISCIPLINE PROJECTS - Upgrade of electrical system or piping modification.

MULTI-DISCIPLINE PROJECTS - Retrofit boiler from pressurized to balanced draft.

MULTI-DIVISION PROJECTS - Power plant including construction management and substation.

D. Type of Contracts

1. Cost plus established mark-up.
2. Cost plus a fixed fee.
3. Cost plus established mark-up with a ceiling.
4. Cost plus established mark-up with certain incentives.
5. Fixed Price
   a. Engineering only
   b. Engineering and Construction Management
6. Turnkey - Fixed-Price for Engineering and Construction.

V. RESPONSIBILITIES, AUTHORITY, ACCOUNTABILITY, AND QUALIFICATIONS

A. Responsibilities

RESPONSIBILITIES TO CLIENT

As the primary Client interface on his assigned project, the Project Manager provides liaison with the Client in order to:

1. Interpret Client's policies, special requirements, operating procedures, and other criteria and ensure that the project conforms with these requirements.
2. Ensure adequate communication, technical support, and other activities as covered in the Contract.
3. Monitor the Client's current plans and needs that pertain to the project and communicate these to the Project Team.



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4. Monitor travel expenses and other ancillary costs to ensure reasonableness.

5. Resolve problems that occur between the project and Client's personnel.

6. Inform and record those areas where action is required of the Client.

## RESPONSIBILITIES TO COMPANY

The Project Manager is the principal person responsible for coordinating the project's efforts. Among the major responsibilities in this respect are:

1. Establish and mointor the Contract to ensure that any changes are properly recorded and adequately processed.

2. Establish controls for design, purchasing, expediting, quality assurance, manufacturing surveillance, and other appropriate activities.

3. In cooperation with Department Managers, establish man-hour requirements and select key discipline personnel for the Project.

4. Review and develop detailed man-power requirements and schedules with selected discipline engineers and other service groups.

5. Establish reporting procedures and monitoring activities to keep Division Management properly informed.

6. Periodically report progress to Division Management.

7. Assist Department Managers in resolving any problems regarding performance of discipline personnel assigned to the Project.

8. Keep Management informed of problem areas that require resolution.

9. Anticipate, monitor, and report on new business opportunities.

## RESPONSIBILITIES TO PROJECTS

The Project Manager is responsible for the development of a Contract Informational File to meet Project as well as Corporate requirements. Such files should include the following:

1. Proposal Development File, including original pricing sheets and correspondence associated with the establishment of the Contract.

2. Contract File, including all contract documents and subsequent agreements which pertain to the project.

3. Establish Work Order plan in accordance with the level of accounting detail required by the Client and consistent with G/C's reporting requirements.

4. Develop Scope of Work document to track work and define limitations to the Contract Agreement.

5. Develop Project Schedule incorporating milestone dates to meet Client and Corporate targeted end dates.

6. Develop Project Organizational charts, both Client and Internal.

## OTHER RESPONSIBILITIES

The Project Manager is responsible for developing and monitoring the following:

1. Correspondence File Index System

2. Engineering Man-Hour Cost and Schedule

3. Project Estimated Cost and Schedule

4. Drawing Numbering System and Drawing Lists by Discipline

5. Schedules for documents such as: System Descriptions, Electrical One-Lines, Valve and Instrument Lists, Design Inputs and others.

6. The Manager should review the plans for processing all the documents established.

7. The Manager should establish and incorporate special Client requirements for design control, purchasing, expediting, quality assurance, or other similar requirements.

8. He must ensure that these requirements are defined in the scope of work.

9. He should determine and establish Client, Corporate, and Project requirements for record keeping.

10. Develop and issue Project Management Manual. Utilize DCP's or engineering instructions and incorporate special Client requirements.

    a. Manual to be based on the POM format and each item in that outline reconciled.

    b. Any deviation from established procedures to be formally resolved by a variance.

11. Initiate development and compilation of Design Input Records to be prepared by the Project Engineers with appropriate Client and G/C department reviews.

12. Develop and maintain a schedule, estimating, and cost control program ensuring that:

    a. The proper feedback, interface, and dialogue is taking place between all project members.

    b. Discipline engineers plan, schedule, and complete their work in accordance with the established milestone schedule and target dates.

    c. The control system requires each discipline to track closely with the same plan and to be accountable for any obvious deviations.

13. Establish team review meetings to ensure proper interface between various disciplines and service groups associated with the project.

14. Disseminate information to all project personnel via formal and informal plans or procedures.

15. Report progress to the Client and G/C management.

16. Assist Department Managers in resolving problems which may arise regarding performance of discipline personnel assigned to the project.

17. Ensure that proper staff is maintained to meet project commitments.



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B. Qualifications

The minimun experience requirements for a Project Manager are:

1. An Engineering Degree plus 8 years of successful engineering experience, including interface experience with numerous different engineering disciplines.

2. The higher levels of project management where projects consist of several hundred people, requires 7 years of experience and at least 3 years successful experience at lower project levels.

3. At all levels of management it is paramount that the Project Manager have an interest and aptitude for meeting schedules and budgets, and for managing a group of multi-discipline employees as an entire team.

4. The Project Manager should be perceptive of the Client's needs and see that they are met without unnecessarily sacrificing the Company's needs.

5. Should be fair and unbiased in handling the various disciplines and service groups that make up the team effort.

6. Should follow the Company's guidelines prescribed, yet maintain a sense of proportion as to what is most important.

POSITION DESCRIPTION - PROJECT MANAGER

Primary Function:

The Project Manager plans, directs, coordinates, and controls all activities on his assigned project so that Corporate commitments are met on schedule and within budget. He serves as a primary interface between the Client and the project to satisfy that Client requirements are met while ensuring that Corporate interests are fully protected.

NATURE AND SCOPE OF WORK

Reporting Relationships:

1. Reports to a higher level Project Manager or directly to a Manager of Projects, depending on the established organizational requirements for the specific project.

2. For special smaller projects utilizing the services of only one department, he may report directly to his Department Manager.

3. Reporting to the Project Manager for project direction are Deputy Project Manager (if required), Project Engineers, and Discipline and Service Group Supervisors.



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## C. Classification of Project Managers

There are currently five levels of Project Managers within Gilbert/Commonwealth. The general criteria utilized to establish these levels, consistent with individual experience and capabilities, are as follows:

### PROJECT MANAGER V

Full scope nuclear project (licensing, design, procurement, QA, construction management, startup) - peak man-power required could exceed 600 G/C employees. Approximately 17 years of engineering experience and 3 years at the Project Manager IV level.

### PROJECT MANAGER IV

Full scope fossil project or major scope nuclear project - peak man-power required could be 100 to 500 G/C employees. Approximately 14 years of engineering experience and 2 years at the Project Manager III level.

### PROJECT MANAGER III

Full scope, moderate size, fossil project - peak man-power required could be 50 to 200 G/C employees. Approximately 12 years of engineering experience and 2 years at the Project Manager II level.

### PROJECT MANAGER II

Partial scope fossil project or full scope continuing services - peak man-power required could be up to 100 G/C employees. Approximately 10 years of engineering experience and 2 years at the Project Manager I level.

### PROJECT MANAGER I

Partial scope continuing services - limited staff. Engineering degree plus approximately 8 years of engineering experience with exposure to various disciplines.

### PRINCIPAL FUNCTIONS

1. Manages the activities on his assigned project, ensuring that adequate controls are in place and being used so that Gilbert/Commonwealth's contractual commitments will be met.



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2. Is responsible for the direction and coordination of project team members in the execution of Gilbert/Commonwealth's responsibilities.

3. Is responsible for reporting to appropriate management levels anything which threatens or jeopardizes attainment of project goals.

## D. Authority

- Authority commensurate with the responsibilities stipulated is vested in the Project Manager's position consistent with Gilbert/Commonwealth's operating procedures, manuals, and related documents.

- The Project Manager is responsible for all contractual and administrative matters and monitoring of work progress on the project.

- The departments are responsible for all technical decisions and quality aspects of the work.

1. Internal Relationships

   a. Communication is maintained with department and service managers or their designated representative to ensure effective integration of discipline efforts and to preclude future budget or schedule problems. This applies equally within all divisions contributing to the project.

   b. Statistical results of man-hour expenditures versus budgeted man-hours are important for future estimates developed by Department Managers.

   c. Contacts with other projects of a similar nature should be made periodically to ensure that common problems and solutions are communicated.

   d. Reviews of project progress and problems should be presented to the appropriate levels of G/C and Client Management, including the division managers involved and corporate staff, as required.

2. External Relationships

   Since this position encompasses being both the Client's representative to G/C and the G/C Management representative to the Client, it entails very frequent communication with the Client in accordance with project needs and carries with it the responsibility to maintain a satisfactory relationship.

## VI. PROJECT CONTROLS

A. Introduction

B. Managing the Project

C. Client/Company Interfaces

## VII. PROJECT IMPLEMENTATION

### A. Managing the Project

1. As Project Manager, you are responsible for the preparation and implementation of sufficient documentation, controls, procedures, and guidelines to ensure that the project meets all the requirements of the Contract.

2. This material should be completed and approved prior to assigning discipline personnel.

### B. Scope Definition

1. The scope is a quantifiable description of the work or service to be performed. (Reference: POM, Instruction No. 2, "Project Initiation")

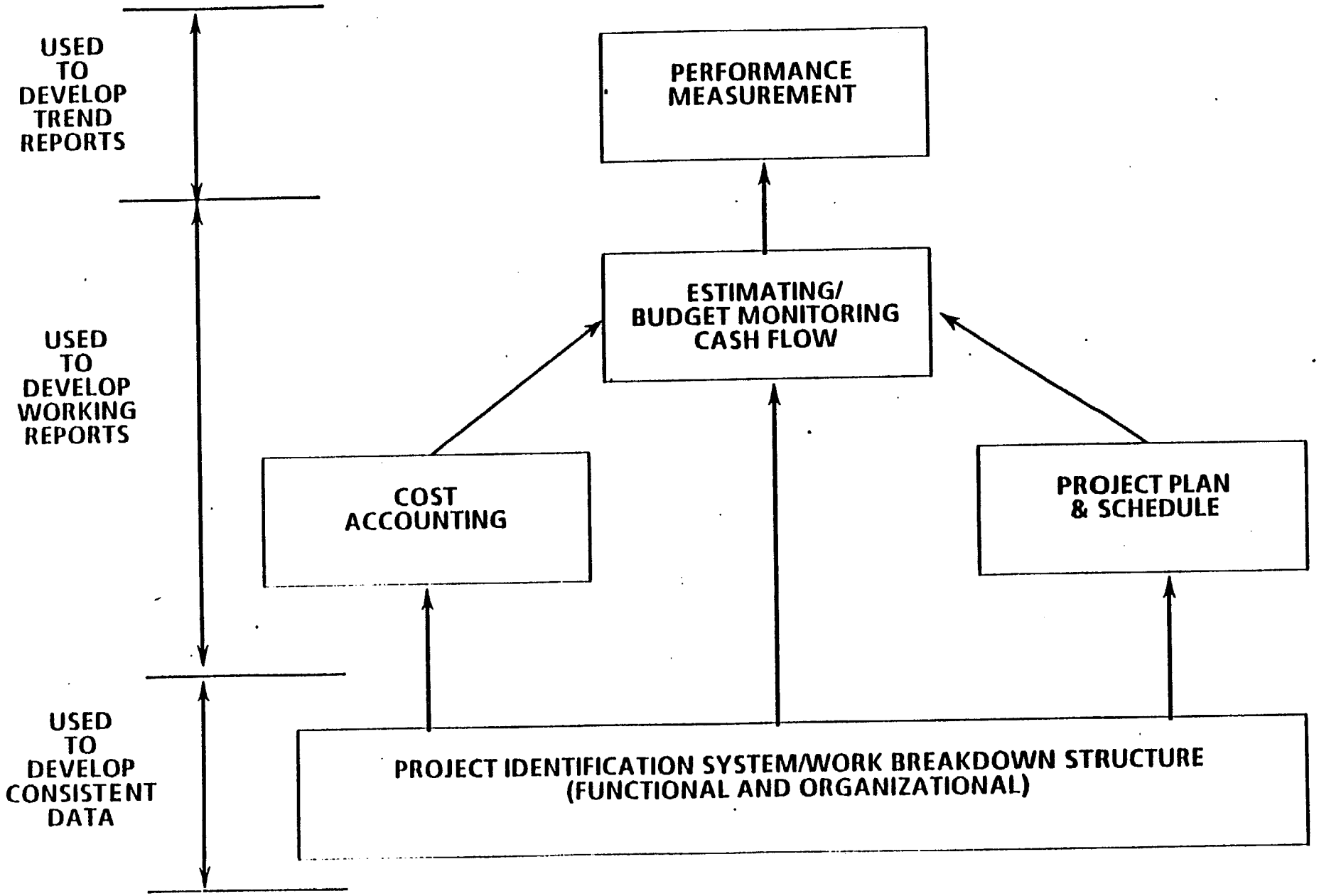
2. The scope generally results from a proposal (either a letter or formal one) and any subsequent negotiations.

3. The scope is documented in the PMM.

4. Internal and external correspondence should be constantly monitored against the scope of the work to ensure conformance.

5. The scope incorporates, by reference, such other things as a project schedule, budget, specific client documents, standards, etc.

# PROJECT CONTROL SYSTEM



C. Scope Changes

1. Scope changes are usually (and preferably) a mutually agreed upon written instruction from the Client changing the original scope of work. This is important for legal reasons in case of controversy. (Reference: POM Instruction No. 5, "Scope Change Control")

2. Scope changes should be reviewed and mutually agreed to internally for any possible impact they may have on cost and/or schedule prior to Client approval.

3. Generally should not proceed with changes prior to Client agreement. Should not proceed without Management approval.

4. Scope changes require revision to the PMM upon formal approval of the change.

D. Project Schedule

1. A bar chart and/or CPM schedule document, depending on size of Project, should be developed in sufficient detail to ensure that the total scope of work is represented.

2. The inital schedule and any subsequent revisions shall have the necessary internal and Client approval.

3. It shall be updated regularly to reflect progress as mutually agreed upon, and reports shall be issued internally and externally as required.

4. It shall include all Client and third party interfaces.

5. It shall be monitored for impact of scope change and the necessary persons notified of these changes.

6. All work should be performed in strict accordance with the established priorities, unless otherwise approved.

E. Project Schedule Changes

1. Project Schedule Milestone date should be changed only if mutually agreed upon with Client.

2. Project Schedule changes should be documented in writing. The procedure should be spelled out in the PMM.

3. Proposed changes should be reviewed and approved by the Project Engineer and the Project Manager.

4. Changes affecting date of completion or milestone incentives should be approved by the Client and G/C MOP.

## F. PMM Preparation

General Requirements:

1. There shall be a PMM for all projects, regardless of size.

2. It shall be prepared in accordance with the POM.

3. The PMM shall be reviewed and updated as required by the POM.

4. For large projects, the Project Manager should review the Guide PMM in detail. Any variations to the Guide PMM should be done with approval of the MOP.

5. For small projects, the Manager should review the Guide PMM in detail. Any variation to the Guide Format and content should be done with approval of the MOP.

## G. Reports - Project Originated

1. Progress Reports are issued internally and to the Client based upon a mutually agreed format.

2. Quarterly Project Review Status Reports for Management

3. Quarterly Man-hour Reviews

4. Meeting Reports

5. Trip Reports

6. Technical Reports/Studies

7. Expediting Reports

8. Manufacturer's Surveillance Reports

9. Quality Assurance Reports

H. Quality Reviews

1. Design Input (Reference: DCP 1.10/EI No. 1)

2. Design Reviews (Reference: DCP 2.10/EI No. 9)

3. Production Computer Program Documentation and Certification (Reference: CAM)

I. Project Indoctrination

1. All project personnel, regardless of type or size of project, shall be apprised of those procedures and guidelines which are applicable to their respective assignments.

2. The Project Manager shall ensure that a review is made to determine that all new project personnel are indoctrinated.

3. Revisions to these procedures and guidelines shall receive similar disposition.

4. All indoctrination shall be properly documented (Reference: DCP-5.15/EI No. 14).

5. The Project Manager should ensure through monitoring or auditing processes that all project personnel are up-to-date on the use of procedures and guidelines.

J. Project Team Building

1. As Project Manager, you are responsible for creating an atmosphere within the project which allows each member to participate to his or her maximum capability.

2. Adequate feedback must be provided to allow each member to understand that his or her participation has been recognized. Methods for achieving this include:

   a. Participation in the decisions to be made at their respective level.

   b. Project Coordination Meetings.

   c. Distribution to project personnel of material such as progress reports.

   d. Information regarding Client activities related to the project.

   e. Positive feedback to employee for work well done and correction where work is not well done.



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K. Directing and Leadership

Coaching:

1. As Project Manager you are responsible for the proper supervision of your immediate subordinates and to ensure that they are also performing this task with their subordinates.

2. In order to perform this task, you must provide or achieve the following:

   a. A project organizational structure that meets the needs of the scope of work to be performed.

   b. Position descriptions for the necessary positions in the project and agreement of work to be performed.

   c. A positive attitude and a program for effective coaching and an opportunity for employees to perform.

   d. A sincere interest and willingness to spend time in helping the subordinate to improve. Provide assistance and support.

   e. A thorough knowledge of job procedures, requirements, and the results expected.

   f. A project schedule to monitor the requirements.

   g. Recommended rewards to Department Managers.

L. Other Interfaces

1. As Project Manager you are responsible for coordinating and controlling all project-related interfaces.

2. You must function as the primary interface with the Client for your project.

3. In addition to those interfaces previously mentioned, the Manager should provide an interface with Accounting in order to:

   a. Provide Client input to and assist in determining method of billing.

   b. Provide time charging information and approve time sheets and expense accounts.

c. Provide proper instructions regarding billable and nonbillable labor and out-of-pocket expenses.



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4. Personnel:

   a. Coordinate with the Human Resources Department and the involved Department/Section Managers regarding the disposition of Corporate Policy and in the resolution of disciplinary problems.

   b. Participate in the performance appraisal of discipline supervisors.

   c. In conjunction with Human Resources Department, establish and inform project personnel of holiday schedules, field benefits, etc.

**M. Marketing Responsibilities**

1. Keep the client apprised of the services provided by G/C and explore potential new areas of work which may be either project-specific or associated with other group activities within the Company.

2. Apprise the Regional Marketing Managers of the potential identified so that they may follow up on any leads.

3. The Project Manager must work closely with the Marketing Team for his Client.

4. Schedule and arrange for presentations to your Client by other groups within G/C.

**N. Expenses**

1. The Project Manager is ultimately responsible for the expenses that are incurred against his project. It is essential, therefore, that he keep track of the status and legitimacy of these charges. He should periodically review and ensure that the following costs are reasonable.

   a. Travel Expense - make sure the expense reports are reasonable, and approve same.

   b. Periodically review Reproduction Services, CAD, and other service-type costs to ensure they are not out of line.

   c. Be cognizant of expenses that G/C may incur that are not job chargeable, and look after the Client's interest in such cases.

d. Establish the reasonableness of expediting and inspection trips to the project.

e. Instruct key project personnel and support groups of this policy.

**O. Entertainment Guidelines**

In the present business climate, there is a reluctance on the part of utility personnel to accept significant entertainment, and certainly expensive outright gifts are not in order.

1. In the event it is considered desirable to entertain a specific Client that involves a considerable expense, the plan should be developed primarily by the Regional Marketing Manager and should be discussed and approved by the General Manager of the Power Division.

2. Christmas parties should also be planned by the Regional Marketing Manager, and participation of employees and their accompanying expenses are subject to approval by the Director of Marketing.

3. Entertainment involving smaller expenses, such as occasionally taking a Client to dinner or lunch, is left up to the discretion of the individual Project Manager.



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# memorandum

Gilbert/Commonwealth

**To:** Course Participants

**From:** Training and Development

**Subject:** Course Evaluation - Project Management Basics

The intent of the Project Management and Supervisory Training Course is to emphasize the importance of team work to project success and to review methods to enhance effective project management and control. Please evaluate the merits/shortcomings of this module as indicated below. Criticisms should be accompanied by suggestions for improvement.

1. Adequacy in meeting the overall course objectives

2. Success in meeting the module's stated objectives

3. Instruction methods, including presentation, selection of visual aids, and information presented in the training manual.

# PLANNING

# AND

# SCHEDULING

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# PLANNING AND SCHEDULING

## PURPOSE

To provide an understanding of the role of Planning and Scheduling in the Project Control System and of how Management and project personnel should utilize and benefit from the support provided.

## OBJECTIVES

Upon completion of this module, the participant should be able to:

- Describe the approaches and techniques used by the Planning and Scheduling Department.
- Discuss the practical application of these approaches and techniques to actual projects.
- Participate in the implementation of the Planning, Scheduling and Control functions on the projects.



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## I. INTRODUCTION

### A. Purpose and Objectives

### B. P&S Quiz

### C. Department Information

### D. Department Functions

### E. Project Control System

The Gilbert/Commonwealth Project Control System (PCS) is a modular, integrated system which can be applied in total or in part as required to meet the needs of the project. PCS can be manual or computerized depending upon the specific needs of the client and the volume of information to be processed. The specific computer programs and data processing techniques may vary; the basic approach, implementation and results are the same.

The Gilbert/Commonwealth philosophy of project control is to establish a project engineering and capital cost budget estimate and schedule based upon a definitive description of the project and detailed Gilbert/Commonwealth scope of services, and then to monitor and control the project to achieve project schedule and budget objectives. It is intended that this basis for project control be prepared as early in the project as practical and that this technique be utilized by the client and Gilbert/Commonwealth as a tool in achieving project control.

The objective of PCS is to provide the total project team with integrated cost and schedule information so that timely decisions can be made and so that the project can be properly monitored and controlled.

The basic PCS consists of three main elements: Project Identification (numbering), Project Plan and Schedule, and Project Cost. The System can be further enhanced by the implementation of a fourth element, Performance Measurement. Implementation of Performance Measurement depends upon the scope and nature of each specific project and the degree of control desired by the client. The system is supported by a cost/schedule change control element.



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## F. Planning and Scheduling Concepts

1. Why Schedule

   - Client Requirements
   - Complexity (and Logistics)
   - Multiple Parties
   - Fast Tracking
   - Computerization
   - Inflationary Trends (and Contracts)
   - Construction Management
   - Claim Management
   - Legal Decision
   - Socio/Political Influences
   - International Projects

2. Benefits

   - A Control Base
   - Visibility
   - Early Warning System
   - Coordinated Priorities
   - Timely Information
   - Planned Approach to Project
   - Active Participation by All
   - A Positive Approach to Correct Deviation

3. Unified Project Plan

## P&S DEPARTMENT FUNCTIONS

### PROPOSALS

- Proposed Project Schedule Development
- RFP Schedule Analysis
- Proposed P&S Control
- Manpower Curves
- Schedule Comparison of Contracting Strategies

### PROJECTS

- Front End Planning
- Master Summary Level Schedule Development
- Detailed CPM Schedule Development
- Progress Monitoring, Reporting and Forecasting
- Contractor Schedule Assessment and Analysis
- Schedule Change Control
- Field Support
- Performance Measurement

### STAFF P&S

- Technical Guidance and Support
- Computer Application
- P&S Procedures, Standards and Historical Data Base
- P&S Orientation
- Training Seminars
- Recruiting
- Specialized P&S Activities (Claims Evaluation, Schedule Assessment, etc.)

## II. CPM FUNDAMENTALS

### A. Evolution of Scheduling Methods

1. Gantt
2. Time Scaled Barcharts
3. CPM
   - I-J Approach
   - Precedence Approach

### B. Disadvantages of Barchart Technique

1. Often Reflects Wishful Thinking
2. Cannot Show Interfaces
3. Often a Juggling Act
4. Does not Lend Itself to Planning Revisions
5. Size Limitation
6. Technologically Outdated

### C. Advantages of Network Based System

1. A Disciplined Basis for P&S and Monitoring & Controlling
2. A Vehicle for Commitment
3. A Central Source of Information
4. A Clear Picture of Project
5. Realistic Projections of Activity Accomplishments
6. Identification of Activities Requiring Management Decisions
7. Approach to Corrective Action
8. A Vehicle for MBO
9. Improved Coordination and Cooperation Necessary to Make Things Happen
10. An Effective Way for Demonstrating or Refuting Claims



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## D. Developing the Network Plan

1. Scope
   - Licensing
   - Design
   - Procurement
   - Construction
   - Startup

2. Participants
   - Owner
   - Engineer
   - Vendors
   - Contractors

3. Types of Activities
   - Discrete
   - Single Responsibility

4. Activity Relationships
   - FS (Finish to Start) - FS<u>n</u>

     Relationship between two activities. The second activity cannot start until <u>n</u> days after the first activity is complete.

   - SS (Start to Start) - SS<u>n</u>

     This indicates that the second activity will start <u>n</u> days after the first activity starts.

   - FF (Finish to Finish) - FF<u>n</u>

     This indicates that the second activity will finish <u>n</u> days fter the first activity finsihes.

5. Logic Format/Reference Logics



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6. Guidelines for Preparing Schedule Logic
   - Define the Work Breakdown within Known Scope
   - Identify the Deliverables
     - Milestones
     - Contract Awards
     - Deliveries
     - Mobilizations
     - Completions
   - Identify the Sequence of Measurable Interim Steps to Accomplish Each Deliverable
   - Assign Responsibilities
   - Identify Interdependencies
     - Design /Construction
     - Client /Engineer
     - Vendor/Design
     - System/Area
     - Delivery/Installation Early Start
   - Identify Manpower/ Resource Restrictions

**E. Scheduling the Network Plan**

1. Estimating Activity Durations
   - Consider Each Activity Separately
   - Base Duration on the Normal Work Day (No Overtime)
   - Consider Desired Manpower, Equipment, and Material
   - Consider Physical Conditions
   - Have Person/Group Responsible for Activity Establish Duration
   - Use Other Sources
     - Project Estimate
     - Lead Time Report
     - Past Data
     - Suppliers
     - Productivity Standards
     - Consultants



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2. Basic Scheduling Computations

a. Definitions

- CPM = Critical Path Method
- ADM/PDM = Diagramming Methods:
  - Arrow Diagram Method
  - Precedence Diagram Method
- EARLY START = Also called forecast start. The earliest date the activity can start.
- EARLY FINISH = Early (or Forecast) Start + Activity Duration
- LATE FINISH = Also called required finish. The latest date the activity can finish.
- LATE START = Late (or Required) Finish - Activity Duration
- CRITICAL PATH = The Longest Path of Activities with the Least Float (Results in the Shortest Project Duration)

b. Forward Pass

c. Backward Pass

d. Total Float/Critical Path

"Float" or "Total Float" is defined as the difference between Required (or Late) Finish and Expected (or Early) Finish. Float is not a function of individual activites. Float is a function of the separate logic path of which an individual activity is a part. Although a logic path may consist of just one activity, float must be considered in terms of logic paths, whether they consist of one activity or one hundred activities. Float is more correctly defined as the difference between the required finish of a logic path and its expected finish. The float of each individual activity in a logic path is equal to the float of the entire logic path. However, the logic path's float is a finite quantity that can be used only once. If the first activity in a logic path uses all of its available float, which is equal to the float of the entire path, then there is no remaining float to be used by succeeding activities in the path.

e. Constraints

These are restrictions on activity start or finish dates, which may be used to control or override the logical calculation of dates.



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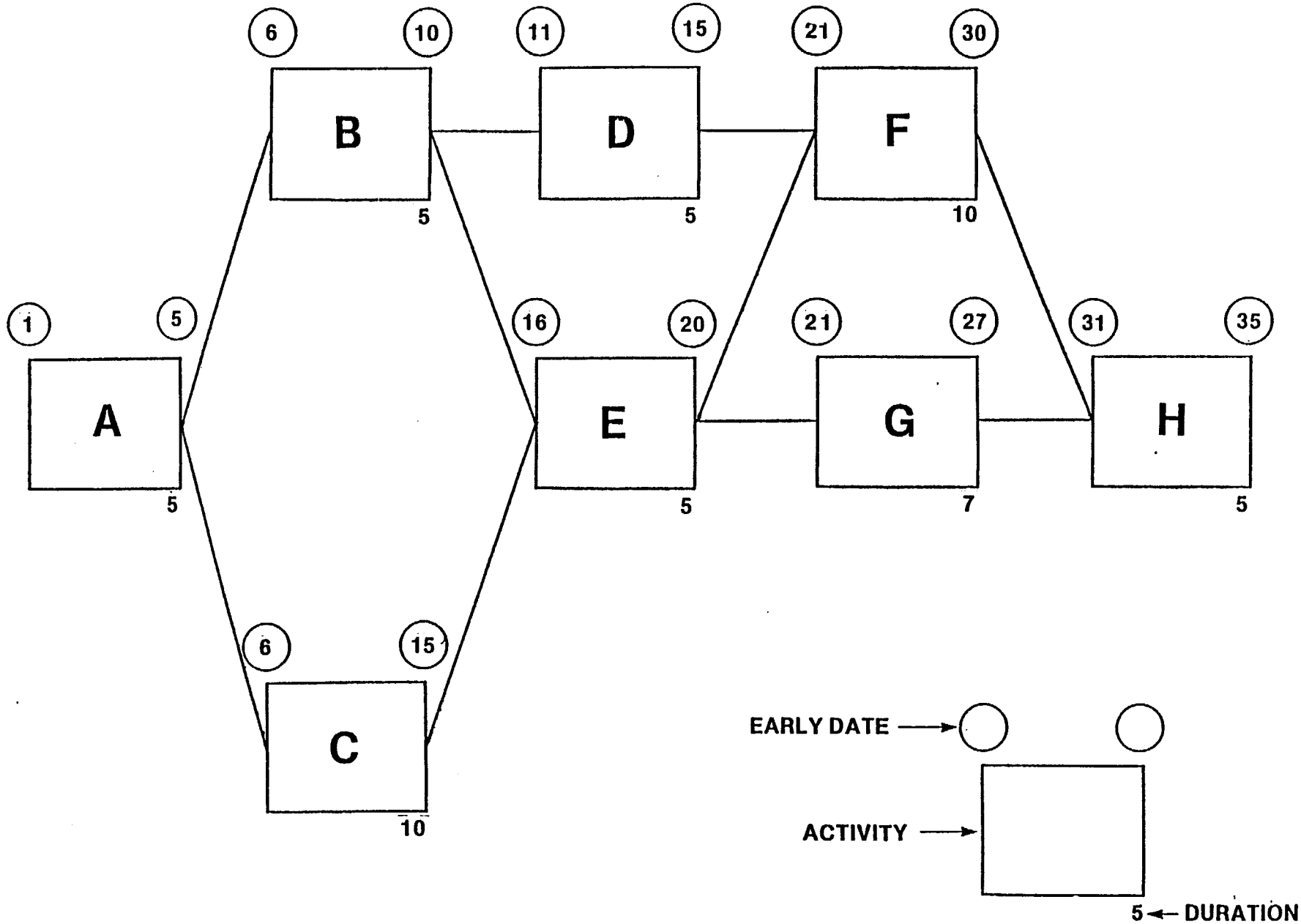
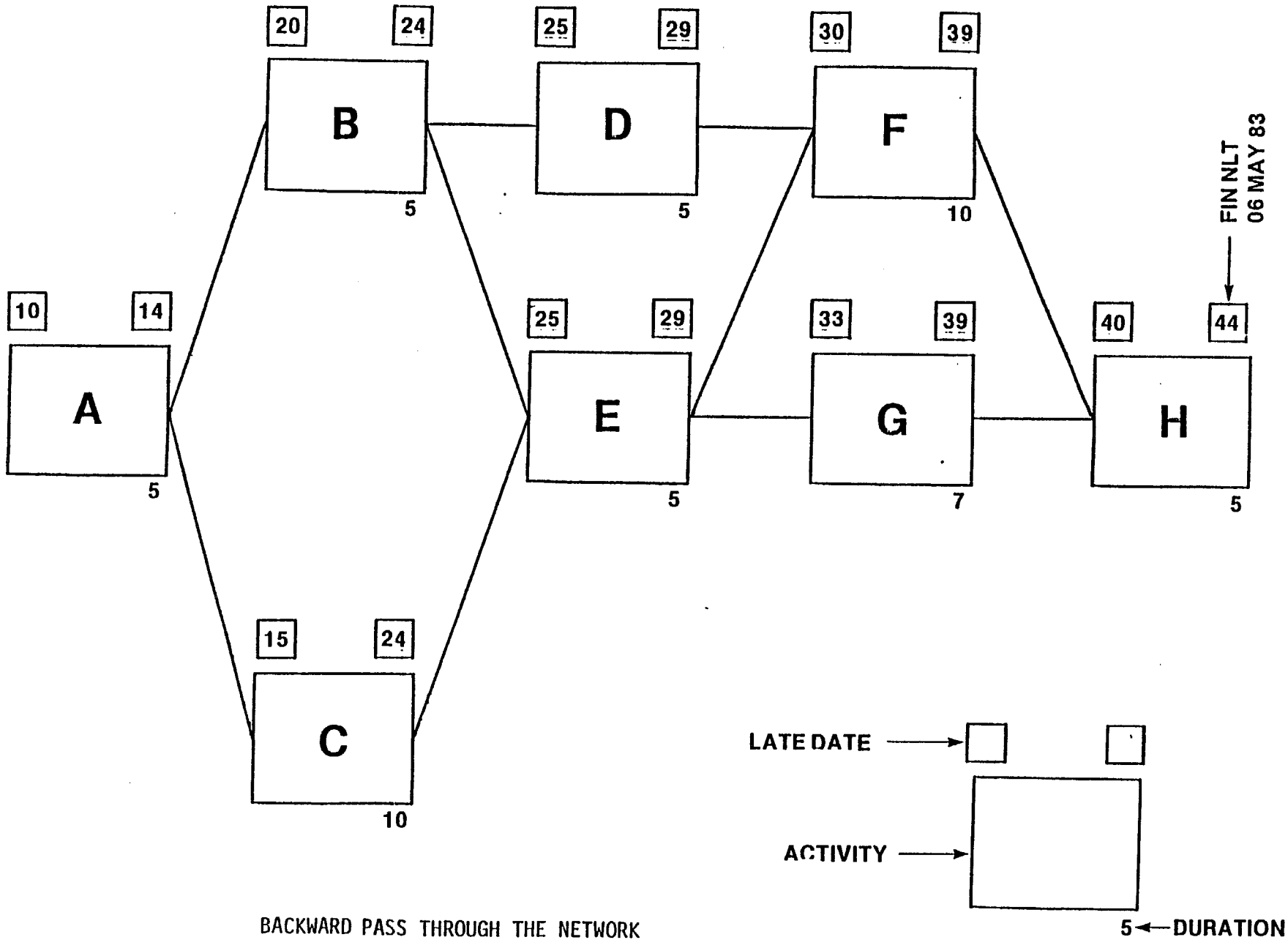



FORWARD PASS THROUGH THE NETWORK

ESTABLISHES THE EARLY EVENT TIMES




BACKWARD PASS THROUGH THE NETWORK

ESTABLISHES THE EARLY EVENT TIMES



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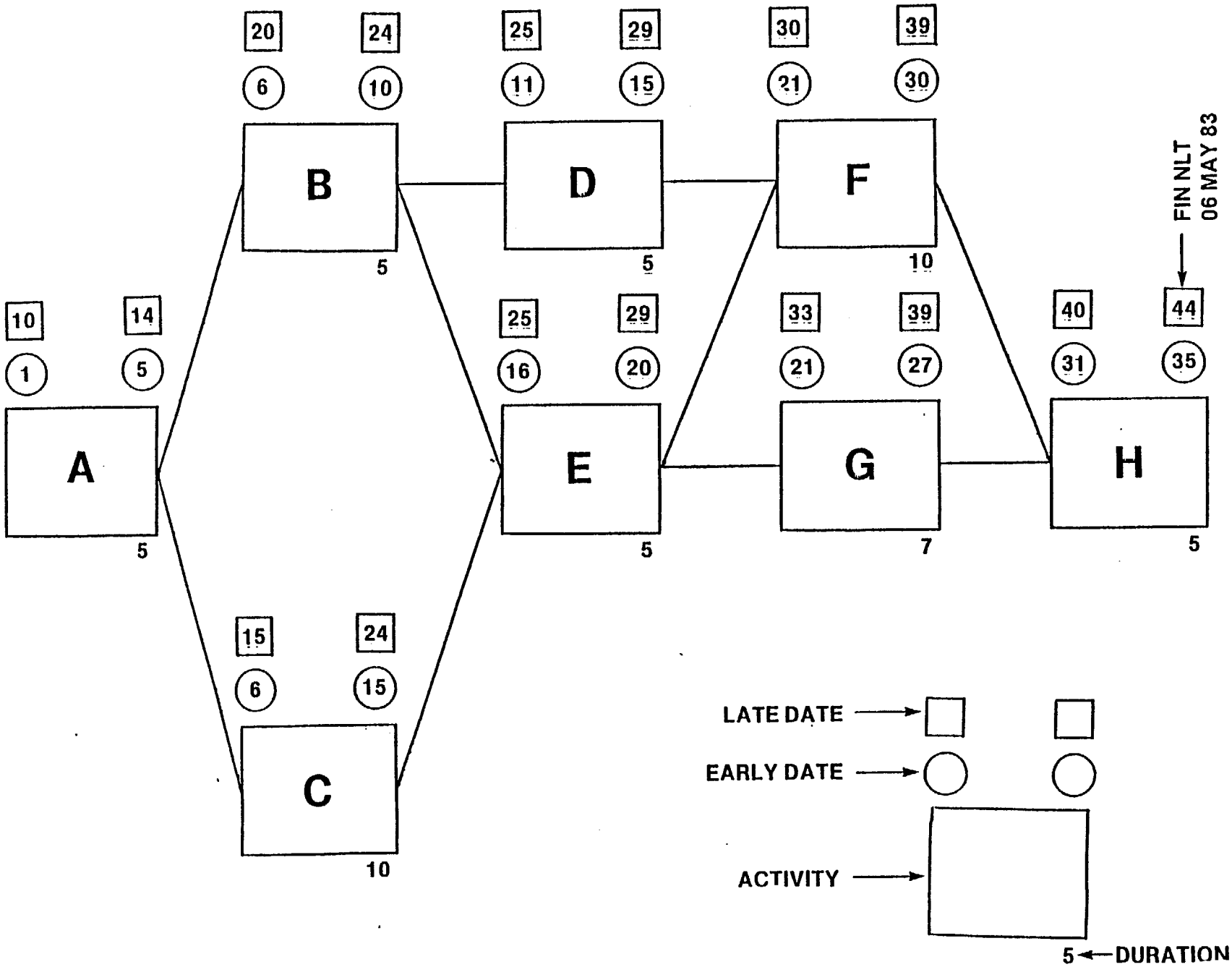


NETWORK DIAGRAM SHOWING EARLY AND LATE DATES TOGETHER



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PROJECT CALENDAR

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| | 01 MAR 83 | 02 MAR 83 | 03 MAR 83 | 04 MAR 83 |
| 07 MAR 83<br>1 | 08 MAR 83<br>2 | 09 MAR 83<br>3 | 10 MAR 83<br>4 | 11 MAR 83<br>5 |
| 14 MAR 83<br>6 | 15 MAR 83<br>7 | 16 MAR 83<br>8 | 17 MAR 83<br>9 | 18 MAR 83<br>10 |
| 21 MAR 83<br>11 | 22 MAR 83<br>12 | 23 MAR 83<br>13 | 24 MAR 83<br>14 | 25 MAR 83<br>15 |
| 28 MAR 83<br>16 | 29 MAR 83<br>17 | 30 MAR 83<br>18 | 31 MAR 83<br>19 | 01 APR 83<br>Holiday |
| 04 APR 83<br>20 | 05 APR 83<br>21 | 06 APR 83<br>22 | 07 APR 83<br>23 | 08 APR 83<br>24 |
| 11 APR 83<br>25 | 12 APR 83<br>26 | 13 APR 83<br>27 | 14 APR 83<br>28 | 15 APR 83<br>29 |
| 18 APR 83<br>30 | 19 APR 83<br>31 | 20 APR 83<br>32 | 21 APR 83<br>33 | 22 APR 83<br>34 |
| 25 APR 83<br>35 | 26 APR 83<br>36 | 27 APR 83<br>37 | 28 APR 83<br>38 | 29 APR 83<br>39 |
| 02 MAY 83<br>40 | 03 MAY 83<br>41 | 04 MAY 83<br>42 | 05 MAY 83<br>43 | 06 MAY 83<br>44 |
| 09 MAY 83<br>45 | 10 MAY 83<br>46 | 11 MAY 83<br>47 | 12 MAY 83<br>48 | 13 MAY 83<br>49 |
| 16 MAY 83<br>50 | 17 MAY 83<br>51 | 18 MAY 83<br>52 | 19 MAY 83<br>53 | 20 MAY 83<br>54 |
| 23 MAY 83<br>55 | 24 MAY 83<br>56 | 25 MAY 83<br>57 | 26 MAY 83<br>58 | 27 MAY 83<br>59 |



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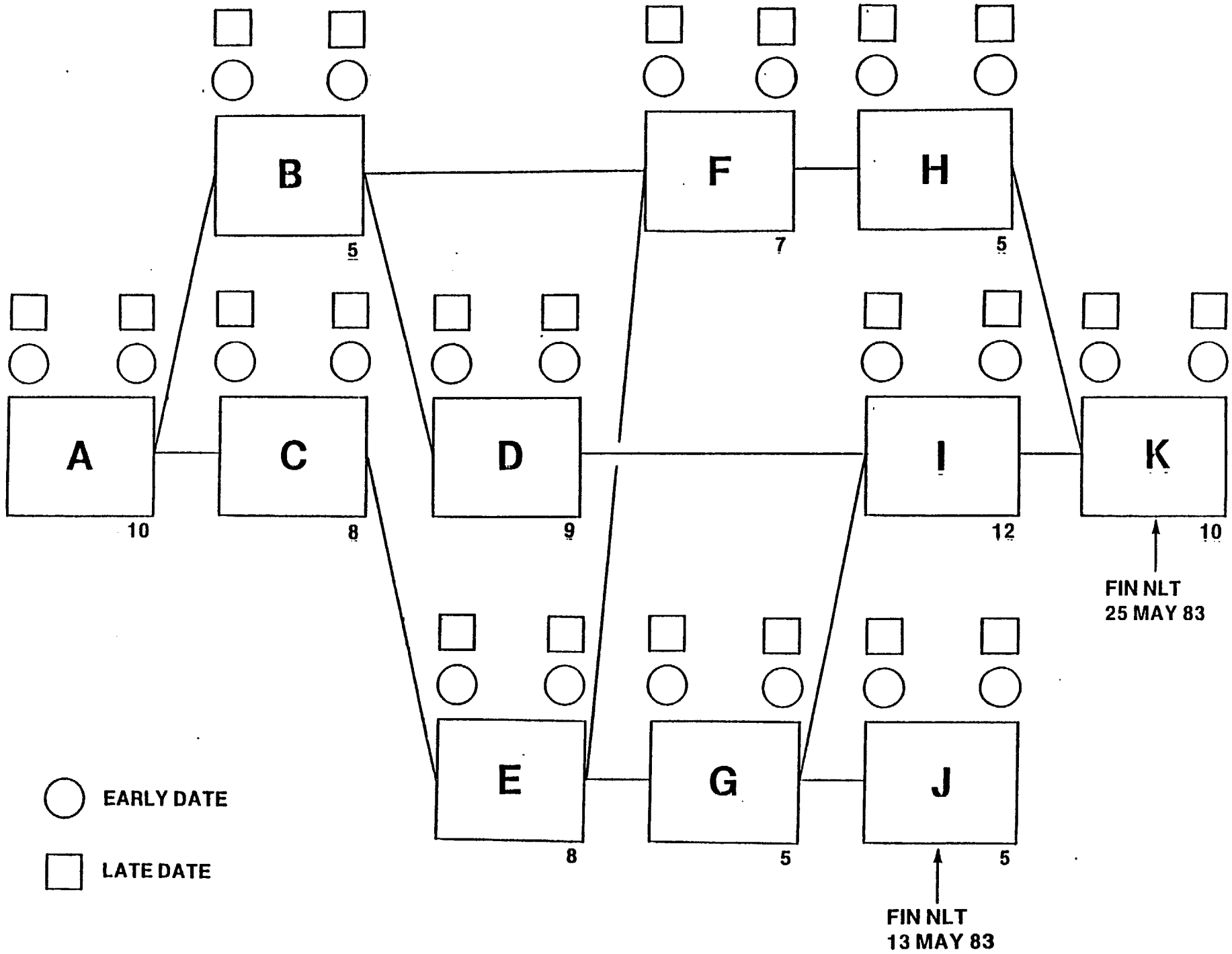
PLANNING SCHEDULE

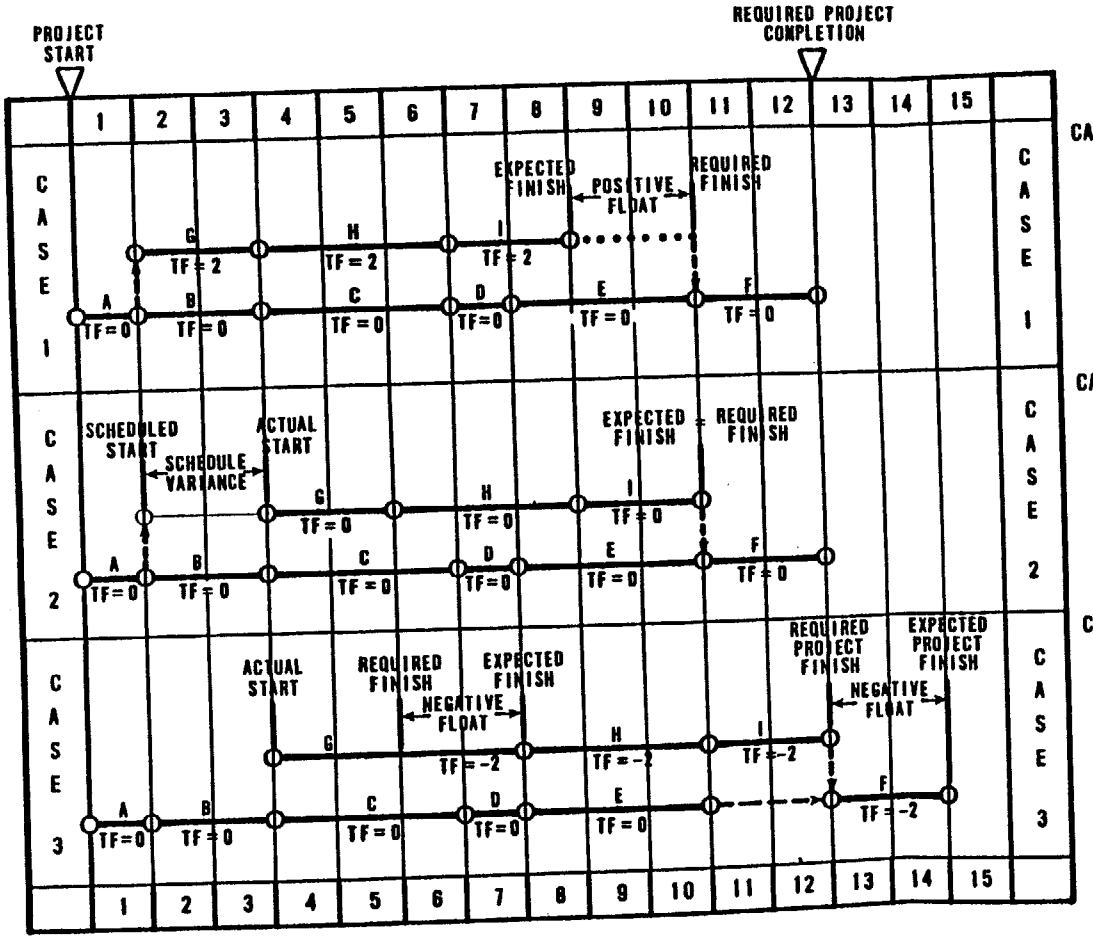
| Activity | Duration | E. Start | L. Start | E. Finish | L. Finish | TF |
|---|---|---|---|---|---|---|
| A | 5 | 07 MAR 83 (1) | 18 MAR 83 (10) | 11 MAR 83 (5) | 24 MAR 83 (14) | 9 |
| B | 5 | 14 MAR 83 (6) | 04 APR 83 (20) | 18 MAR 83 (10) | 08 APR 83 (24) | 14 |
| C | 10 | 14 MAR 83 (6) | 25 MAR 83 (15) | 25 MAR 83 (15) | 08 APR 83 (24) | 9 |
| D | 5 | 21 MAR 83 (11) | 25 MAR 83 (15) | 11 APR 83 (25) | 15 APR 83 (29) | 14 |
| E | 5 | 28 MAR 83 (16) | 11 APR 83 (25) | 04 APR 83 (20) | 15 APR 83 (29) | 9 |
| F | 10 | 05 APR 83 (21) | 18 APR 83 (30) | 18 APR 83 (30) | 29 APR 83 (39) | 9 |
| G | 7 | 05 APR 83 (21) | 21 APR 83 (33) | 13 APR 83 (27) | 29 APR 83 (39) | 12 |
| H | 5 | 19 APR 83 (31) | 02 MAY 83 (40) | 25 APR 83 (35) | 06 MAY 83 (44) | 9 |




CPM EXERCISE

# FLOAT

FLOAT = DIFFERENCE BETWEEN REQUIRED FINISH AND EXPECTED FINISH.
POSITIVE FLOAT = EXPECTED FINISH EARLIER THAN REQUIRED FINISH.
ZERO FLOAT = EXPECTED FINISH EQUALS REQUIRED FINISH.
NEGATIVE FLOAT = EXPECTED FINISH LATER THAN REQUIRED FINISH.




CASE 1: POSITIVE FLOAT

IN THIS EXAMPLE, THE LOGIC PATH CONSISTING OF ACTIVITIES G, H AND I HAS A REQUIRED FINISH OF DAY 11 AND AN EXPECTED FINISH OF DAY 9, RESULTING IN 2 DAYS OF POSITIVE FLOAT.

RF – EF = FLOAT (11 – 9 = +2)

CASE 2: ZERO FLOAT

IN THIS EXAMPLE, ACTIVITY G FAILED TO START ON DAY 2 AS SCHEDULED AND DID NOT START UNTIL DAY 4. THIS RESULTED IN A 2 DAY NEGATIVE SCHEDULE VARIANCE FOR LOGIC PATH G, H AND I. THE 2 DAYS POSITIVE FLOAT ON THE PATH SHOWN IN CASE 1 WAS CONSUMED BY THE DELAY. AS A RESULT, PATH G, H AND I NOW HAVE ZERO FLOAT AS DO EACH OF ITS CONSTITUENT ACTIVITIES.

CASE 3: NEGATIVE FLOAT

IN THIS EXAMPLE, ACTIVITY G FAILED TO COMPLETE ON DAY 6 AS REQUIRED AND ITS EXPECTED FINISH HAS EXTENDED TO DAY 8. AS A RESULT, LOGIC PATH G, H AND I HAS NOW DELAYED ACTIVITY F AND HAS FORMED A NEW LOGIC PATH CONSISTING OF ACTIVITIES G, H, I AND F.

NOTE THAT THIS PATH HAS A REQUIRED FINISH OF DAY 13 AND AN EXPECTED FINISH OF DAY 15 RESULTING IN 2 DAYS OF NEGATIVE FLOAT.

RF – EF = FLOAT (13 – 15 = -2)

ALSO NOTE THAT THIS PATH HAS DELAYED THE OVERALL PROJECT COMPLETION BY 2 DAYS RESULTING IN THE PROJECT COMPLETION HAVING 2 DAYS NEGATIVE FLOAT.

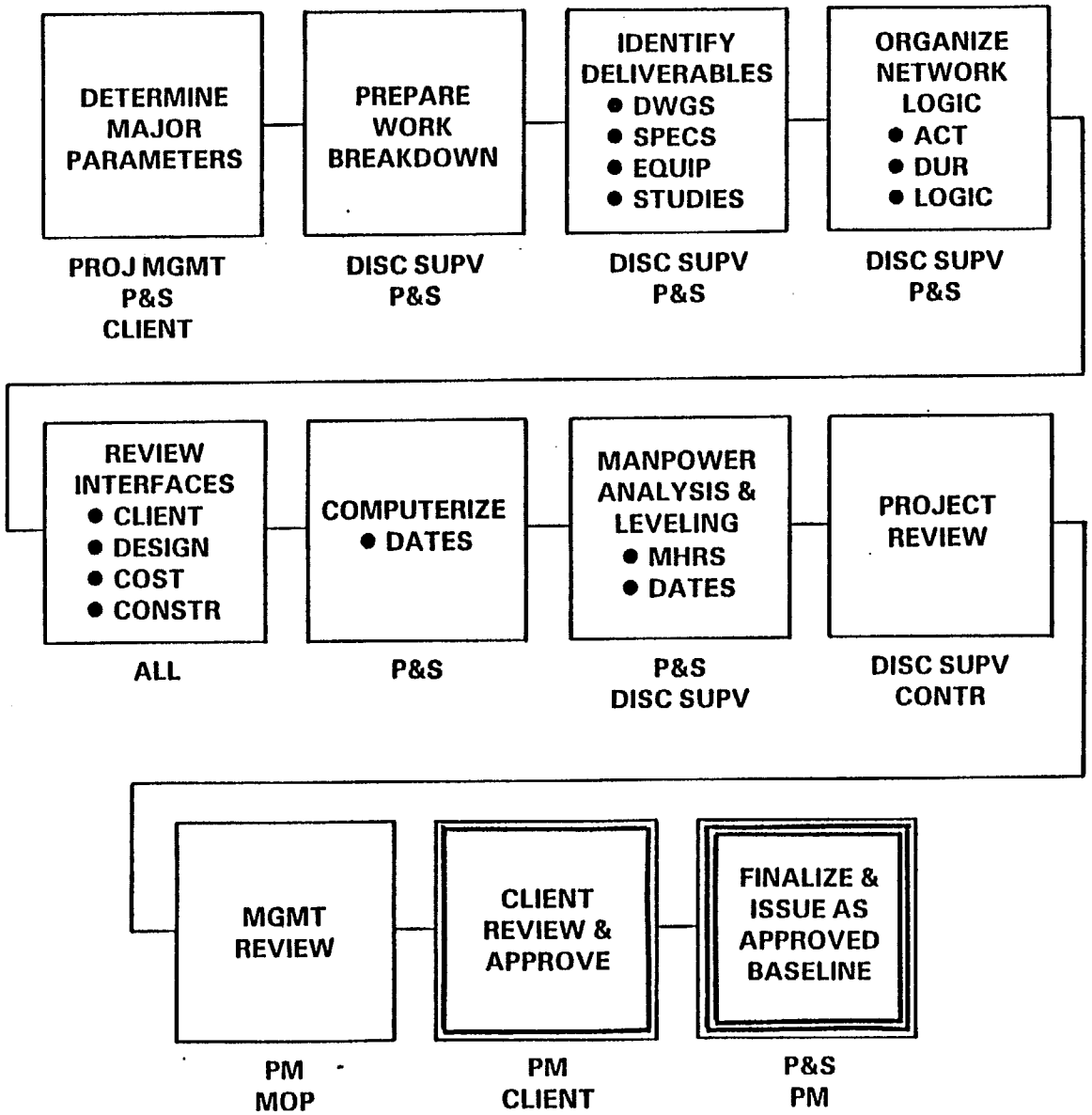
## F. Resource Scheduling

1. Time Constrained
   - Must be completed within time frame
   - Available Resources can be exceeded
2. Resource Constrained
   - Resource limits cannot be exceeded
   - Timeframe may be extended
3. Time and Resource Constrained
   - Resource limits are established
   - Secondary resource limits cannot be exceeded
   - Timeframe extended only when secondary resource limits are reached
4. Resource Levelling
   - Time Constrained
   - Resource Constrained
   - Time and Resource Constrained

## G. Schedule Development

## H. Discipline Supervisor Time Involvement

# SCHEDULE DEVELOPMENT



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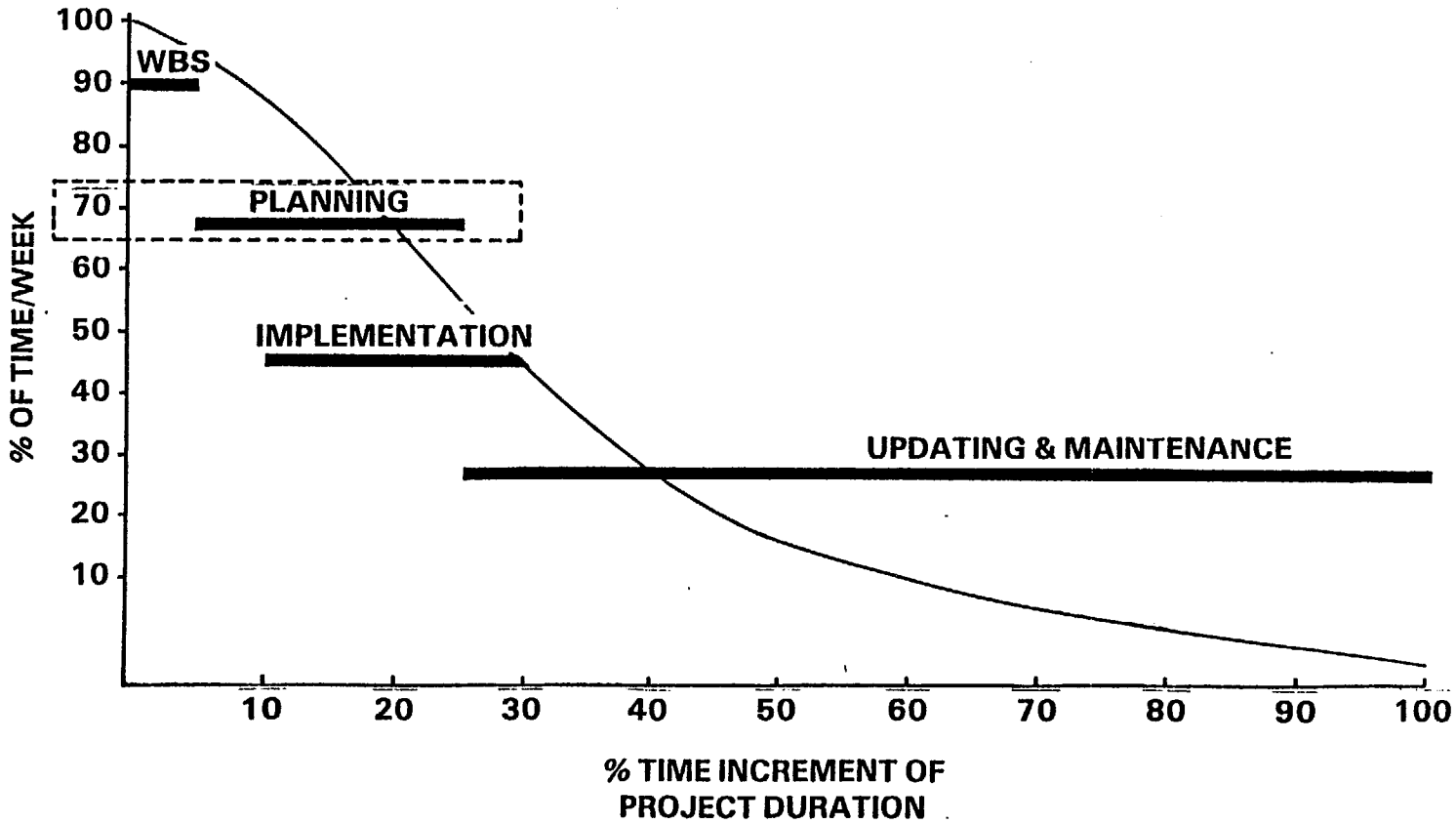
# DISCIPLINE SUPERVISOR TIME INVOLVEMENT IN PLANNING & SCHEDULING



## III. APPLICATION ON PROJECTS

### A. Types of Projects

1. CEI - Perry
2. Penelec - Continuing Services
3. FPC - Crystal River 3 Continuing Services
4. SCE&G - Virgil C. Summer Continuing Services
5. TECO - Big Bend 4, Construction Management
6. USAF - Deep Base
7. BG&E - Brandon Shores
8. Eastman Kodak - #44 Boiler and T/G
9. PECo - Peach Bottom
10. GPU - Three Mile Island Continuing Services
11. VEPCO - Continuing Services
12. RG&E - Ginna Continuing Services

### B. Progress Updating and Data Accumulation

1. Actual Starts and Completions
2. Expected Completion
3. Actual Manhours
4. Actual Costs
5. Physical Completions (Dwgs., Specs., etc.)

### C. Performance Schedule Update

1. Critical Path Identification/Analysis
2. Impact on Milestones
3. Run Performance Measurement



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D. **Prepare Reports and Analyses**

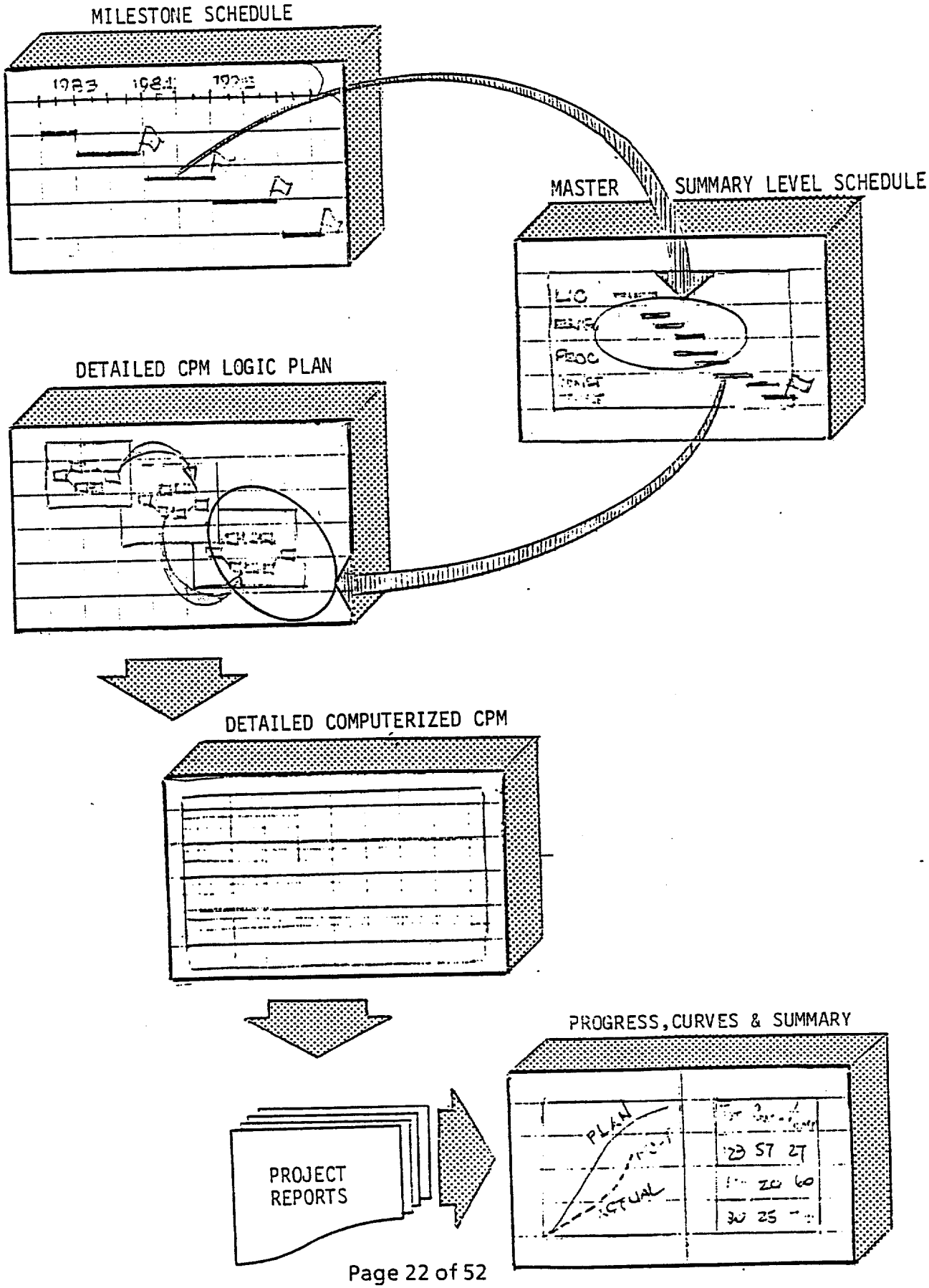
1. Get Information to All Participants
2. Large Project
   a. Levels of Schedule Implementation
   b. Levels of Reporting
   c. Management Summary
   d. Milestone Report
   e. Milestone Impact Summary
   f. Critical Path Analysis
   g. Target Exception Report
   h. Work Action Report
   i. Procurement Status Schedule
   j. Drawing Schedule
   k. Barcharts
3. Small Projects
   a. Levels of Schedule Implementation
   b. Levels of Reporting
   c. Project Overview/Summary Statistics
   d. Critical Path Analysis
   e. Barcharts

E. **Application on Actual Projects**

1. Penelec - Continuing Services
2. FPC - Crystal River 3 Continuing Services
3. USAF - Deep Base

F. **Common Causes for Limited Success with Planning and Scheduling**

LEVELS OF SCHEDULE IMPLEMENTATION
-LARGE PROJECT-



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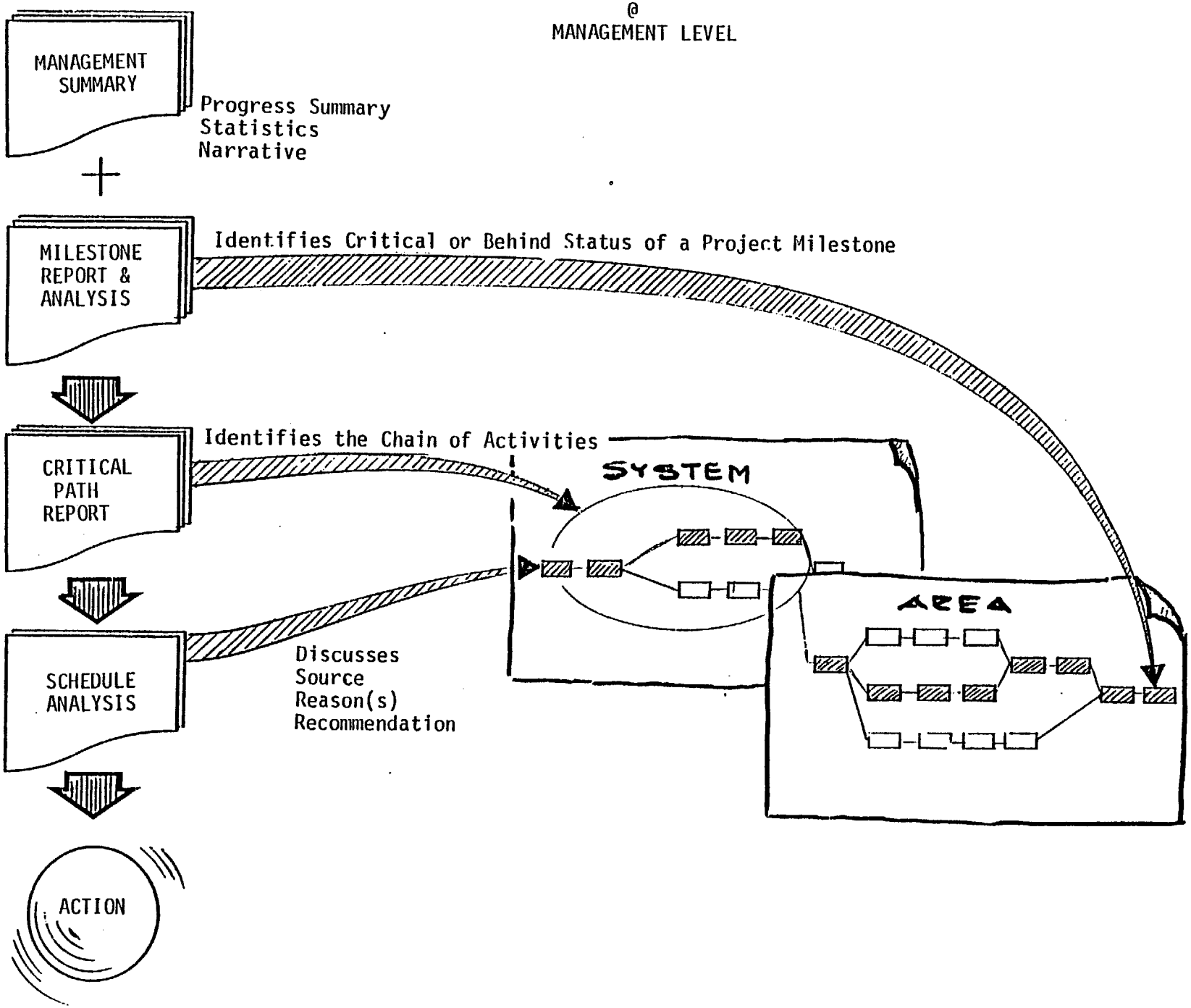
LEVEL OF SCHEDULING REPORTING
@
MANAGEMENT LEVEL



LEVEL OF SCHEDULE CONTROL
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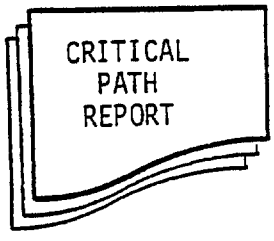
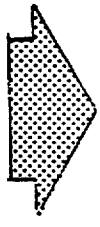
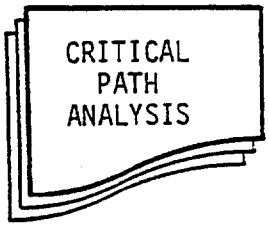
SUPERVISORY LEVEL

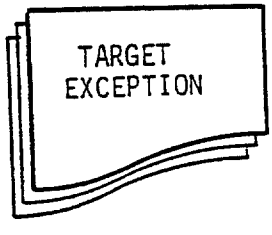


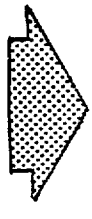



IDENTIFIES

CURRENT CRITICAL ACTIVITIES AND PROJECTED IMPACT ON PROJECT COMPLETION.



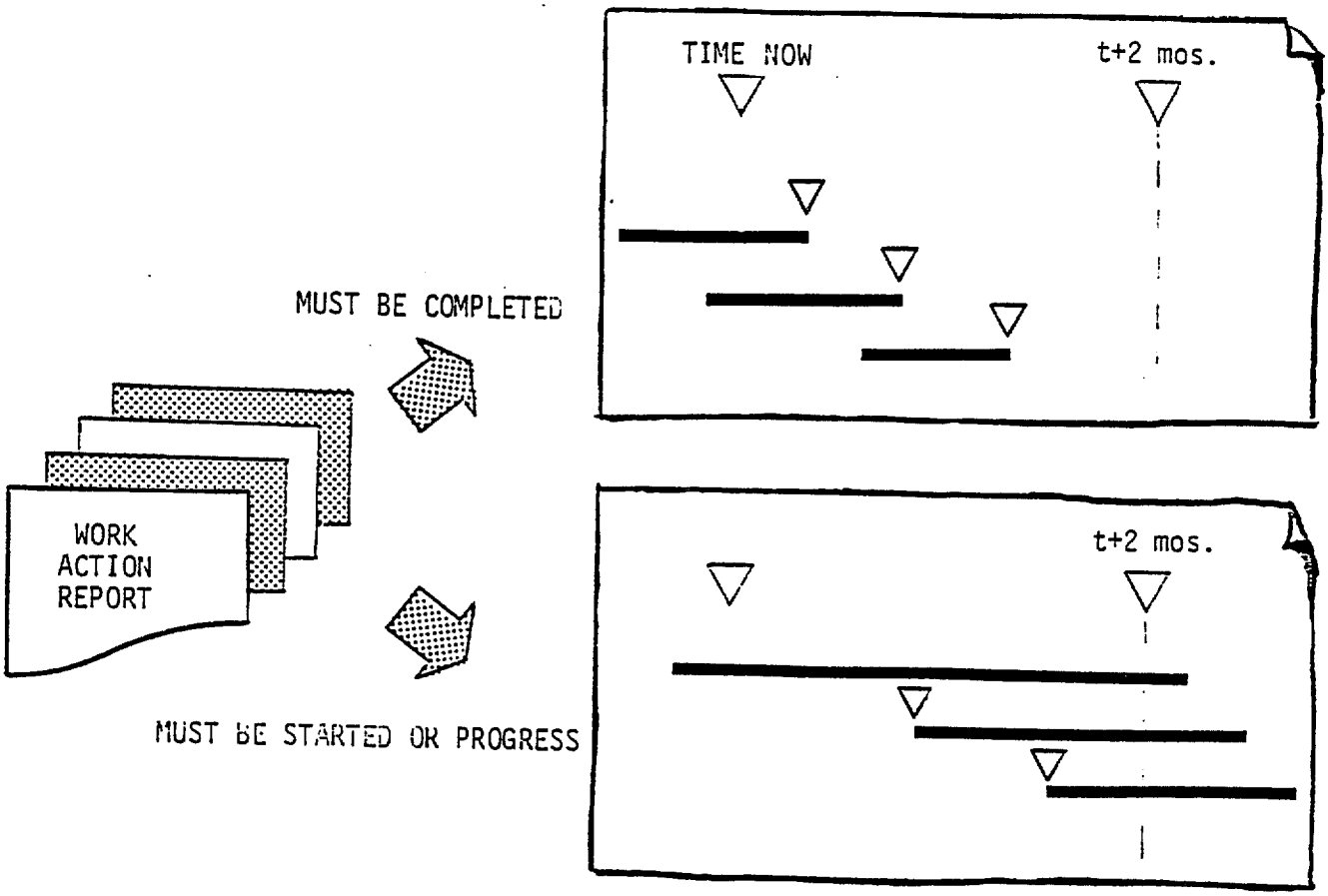
IDENTIFIES

BACKLOG OF ACTIVITIES WITH DEVIATIONS WITHIN THE PROJECT PLAN

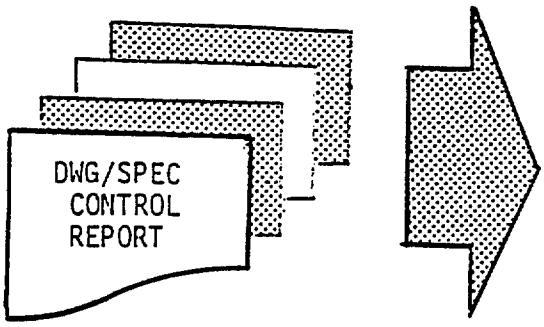


1237

LEVEL OF SCHEDULE CONTROL
@
"FIRING LINE" LEVEL




IDENTIFIES CURRENT & NEAR WORK LOAD




SCHEDULES AND TRACKS
DELIVERABLES



1238

MILESTONE SCHEDULE

SORT CODES 1 TARG E DATA DATE 30JUL82 PAGE 2

MODE=T/FE

| ACTIVITY | DESCRIPTION | FINISH E.TARG | FINISH CURRENT | TRF | STATUS |
|---|---|---|---|---|---|
| C 426029009 | START UNIT-4 TIE-IN | 29OCT82 | 29OCT82 | 0 | CRITICAL |
| C 526029009 | START UNIT-5 TIE-IN | 30APR84 | 30APR84 | 0 | CRITICAL |
| C 626029009 | START UNIT-6 TIE-IN | 31AUG84 | 5NOV84 | -45 | BEHIND |
| C 726029999 | ACHIEVE A/Q COMPLIANCE (START UNIT-7 OUTAGE) EPA | 30DEC82 | 30DEC82 | 0 | CRITICAL |
| C 726029009 | START UNIT-7 TIE-IN | 30DEC82 | 4APR83 | -64 | BEHIND |
| 726227638 | E.S.P. EXCAVATE.DRIVE PILES IN BRCHG AREA UT7 | AUG84 | 5NOV84 | -45 | BEHIND |
| 726227018 | E.S.P. ERECT SUPPORT STEEL BOX A UNIT 7 | 9FEB81 A | 9FEB81 | 0 | COMPLETE |
| 726227058 | E.S.P. INSTALL HOPPERS BOX A UNIT 7 | 19JUN81 A | 19JUN81 | 0 | COMPLETE |
| 3338 | E.S.P. INSTALL PREASSEMBLED INTERNALS-BOX C U7 | 14AUG81 A | 14AUG81 | 0 | COMPLETE |
| | IANCE (START UNIT-7 OUTAGE) EPA | 26MAR82 A | 13APR82 | -11 | COMPLETE |
| | | 30DEC82 | 30DEC82 | 0 | CRITICAL |
| | | 30DEC82 | 4APR83 | -64 | BEHIND |

MAJOR MILESTONE

MILESTONE DATE

CURRENT PROJECTION

STATUS CRITICAL/BEHIND



1239

MILESTONE IMPACT SUMMARY

| MILESTONE | DELAY | REASON/SOURCE | IMPACT ON SUCCEEDING ACTIVITIES | RECOVERY PLAN |
|---|---|---|---|---|
| 626227498<br>626227938<br>626029009 | - 2<br>- 2<br>-45 | Late completion of construction for the Unit 7 13.8 KV power system is delaying Unit 7 outage work which precedes these Unit 6 milestones. | Completion of the Unit 6 tie-in outage is delayed by 45 days. | The contractor is reassigning electricians to accelerate the completion of the Unit 7 13.8 KV power system. |
| 726029009 | -64 | Delivery of the microprocessor and CRT for the precipitator has been delayed by vendor testing. This has delayed the start of precipitator checkout. | The Unit 7 tie-in outage is delayed by 64 days. | Precipitator testing and checkout is planned to begin without this equipment. In addition, COM expediters will monitor the testing and delivery of the equipment. |

CRITICAL PATH REPORT

GILBERT/COMMONWEALTH

RUN DATE 16AUG82 0959HRS

PROJECT START 9JAN78

CURRENT COMPL. 24NOV86

PROJECT

CURRENT SOURCE OF THE PROBLEM

SORT TOT FLT E START

DATA DATE 30JUL82 PAGE 1

| ACTIVITY | DESCRIPTION | MODE=C/B | CODE | DURA-TION | START EARLY | START LATE | FINISH EARLY | FINISH LATE | FF | TF |
|---|---|---|---|---|---|---|---|---|---|---|
| C726255326 | E.S.P. L-C FAB & SHIP MICROPRCSR & CRT | U7 | 726255326 | 120 | 14JUN82 1121 | 12MAR82 A 1057 | 1DEC82 1240 | 31AUG82 E 1176 | 0 | -64 |
| C726255325 | E.S.P. L-C RCV MICROPRCSR & CRT CERT DWG | U7 | 726255325 | | EVENT | | 30JUL82 1154 | 29APR82 A 1090 | | -64 |
| C726257327 | E.S.P. REC MICROPRCSR & CRT | U7 | 726255327 | 5 | 2DEC82 1241 | 1SEP82 1177 | 8DEC82 1245 | 8SEP82 1181 | 0 | -64 |
| C726257328 | E.S.P. MOUNT MICROPRCSR & CRT IN EXIST PANEL | U7 | 726257328 | 10 | 9DEC82 1246 | 9SEP82 1182 | 22DEC82 1255 | 22SEP82 1191 | 0 | -64 |
| C726257298 | ESP P&T CBL TO MICROPROC & CRT IN [illegible] RM UNIT 7 | | 726257298 | 10 | 27DEC82 1256 | 23SEP82 [illegible] | 10JAN82 [illegible] | 6OCT82 1201 | 0 | -64 |
| C726237488 | E.S.P. TEST & CHECKOUT-BO[illegible] | | [illegible]26237488 | 58 | 11JAN83 1266 | [illegible] | [illegible] | [illegible]82 | 0 | -64 |
| C726237038 | E.S.P. TEST & CHECKOUT-BOX A | | 726237208 | 58 | 11JAN83 1266 | [illegible] 1202 | [illegible] 1323 | [illegible]DEC82 1259 | 0 | -64 |
| C726029009 | START UNIT-7 TIE-IN | | 726029009 | | EVENT | | 4APR83 1323 | 30DEC82 1259 | | -64 |
| [illegible]27247048 | FD FAN BOILER COOL DOWN PRECEDES 727227018 -64/ | UT7 | 727247048 | 1 | 5APR83 1324 | 3JAN83 1260 | 5APR83 1324 | 3JAN83 1260 | 0 | -64 |
| | FD FAN DISASSEMBLE FAN MECH [illegible] 727227028 -64/ 727237048 -64/ | UT7 | 727227018 | 6 | 6APR83 1325 | 4JAN83 1261 | 13APR83 1330 | 11JAN83 1266 | 0 | -64 |
| | [illegible] FAN MOTOR [illegible]38 -64/ | UT7 | 727227028 | 11 | 13APR83 1330 | 11JAN83 1266 | 27APR83 1340 | 25JAN83 1276 | 0 | -64 |
| | [illegible] | | 727237048 | 11 | 13APR83 1330 | 11JAN83 1266 | 27APR83 1340 | 25JAN83 1276 | 0 | -64 |

MAJOR MILESTONE

IMPACT ON MILESTONE



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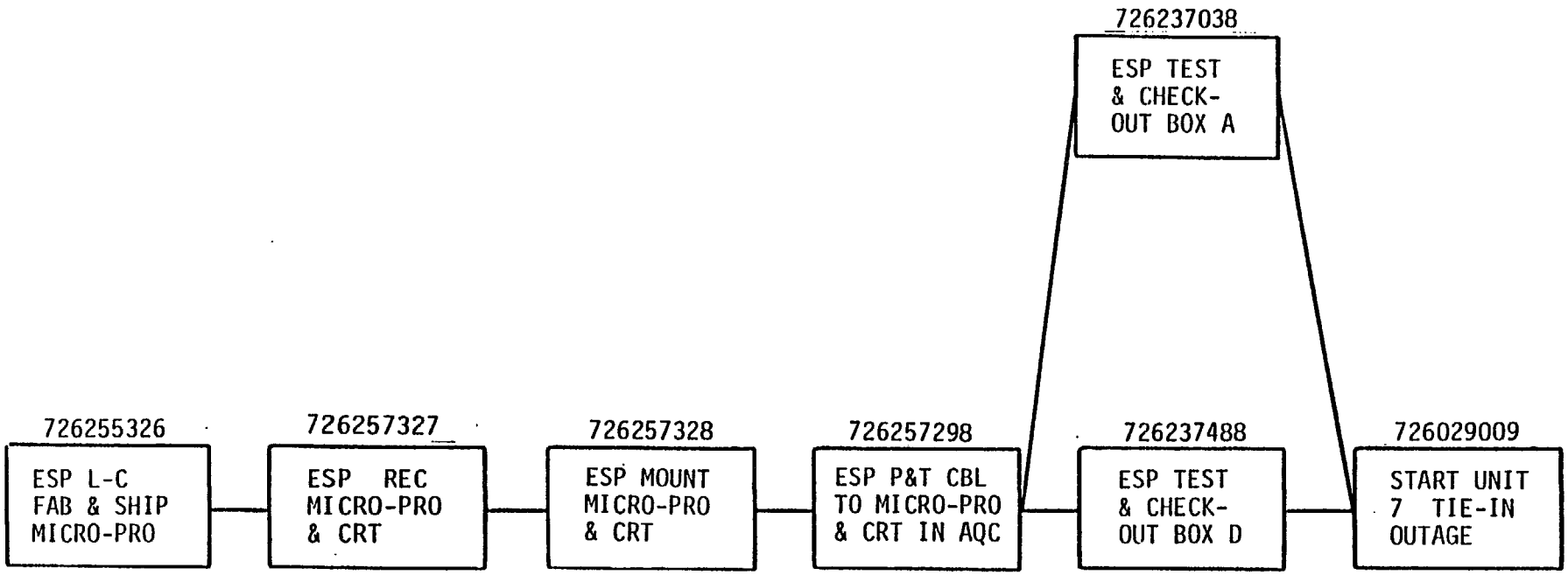
CRITICAL PATH LOGIC



Gilbert/Commonwealth
ENGINEERS/CONSULTANTS Reading,PA/Jackson,MI

| JOB: PROJECT |
|---|
| ISSUE DATE: August 24, 1982 |
| RESPONSE DATE September 10, 1982 |
| DATA DATE: July 30, 1982 |
| PAGE 1 OF 15 |

# CRITICAL PATH REPORT ANALYSIS

ACTIVITY OF CONCERN

TIES OF CONCERN

| ACTIVI | DESCRIPTION | FLOAT REPORTED |
|---|---|---|

| | | TF |
|---|---|---|
| 726255326: | ESP Fabricate and Ship Microprocessor and CRT | -64 |

FORECAST OF IMPACT

DESCRIPTION: This path extends through delivery and installation of the microprocessor and CRT, pulling and terminating cable, Unit 7 precipitator Boxes A and D check out, to the start of the Unit 7 tie-in outage.

REASONS FOR DELAY: In the first week of October, the vendor plans to test this equipment at another power plant with a similar precipitator to determine how the equipment functions in operating conditions. However, outages at the other plant are interfering with performing the tests.

The latest report from the vendor indicates that tests will be concluded in October so that the equipment can be shipped by December 1, 1982.

ACTION REQUIRED: Client Operation Supervisor has indicated that it is preferable to have the microprocessor and CRT installed prior to checking out Boxes A and D, but operations will revise the plan to proceed with Boxes A and D checkout without this equipment. The equipment should then be installed prior to Boxes B and C checkout. An SCR will be necessary to change the logic and retarget this work. COM expeditor will monitor the status of this item.

RECOMMENDED ACTION

NOTE: This path also affects all tie-in work occurring during the tie-in outage, which is not shown on the sketch.



1243

TARGET DATA DATE 30OCT81 TARGET EXCEPTION REPORT GILBERT/COMMONWEALTH

RUN DATE 16AUG82 1003HRS PROJECT START 9JAN78

PROJECT TARGET 43 COMPL 29SEP86 CURRENT COMPL. 24NOV86

CODE 31 ELECTRICAL SORT EJECT CODES 56 TARG EF DATA DATE 30JUL82 PAGE 1

DISCIPLINE OR CRAFT

MODE=T/BE

| ACTIVITY | DESCRIPTION | PCT COM | REMDUR | START E.TARG | START CURRENT | FINISH E.TARG | FINISH CURRENT | TRF | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| 82131030 | 480V PWR SYS PREP OPER & MAINT INST U1-7 | 80 | 5 | 11FEB82 A | 7JUN82 | 25MAR82 | 6AUG82 | -93 | BEHIND |
| 782631012 | 120V AC PWR DISTRIBUTION PANEL LAYOUT U7 | 82 | 11 | 7APR82 A | 17MAY82 | 21APR82 E | 16AUG82 | -81 | BEHIND |
| 582631032 | 120V AC PWR SYS DSN&DFT UPS DIST PNL U5 | 0 | 5 | 20APR82 | 2AUG82 | 26APR82 | 6AUG82 | -72 | BEHIND |
| 682631032 | 120V AC PWR SYS DSN&DFT UPS DIST PNL U6 | 0 | 5 | 21APR82 | 2AUG82 | 27APR82 | 6AUG82 | -71 | BEHIND |
| 500431072 | 480V PWR SYSTEM UT5 FINAL ONE-LINE DIAGRAMS | 0 | 20 | 7APR82 | 2AUG82 | 5MAY82 | 27AUG82 | -80 | BEHIND |
| 681131012 | 13.8 KV PWR SYS SWITCHGEAR RELAY SETTINGS UT6 | 77 | 10 | 12APR82 A | 17MAY82 | 7MAY82 | 13AUG82 | -68 | BEHIND |
| 82131040 | 480V PWR SYSTEM RSLV COMMENTS & ISSUE OP | 0 | 15 | 26APR82 | 10AUG82 | 14MAY82 | 30AUG82 | -74 | BEHIND |
| 26731112 | FABRIC FLTR PREP SCHEMATIC & WIRING D | | 5 | 6JUL81 | | E | 13AUG82 | -63 | BEHIND |
| 0431072 | 480V PWR SYSTEM UT6 FINAL ONE-LINE DI | | 20 | 21APR82 | | | 27AUG82 | -71 | BEHIND |
| | AC PWR SYS PREP CONDUIT LAYOUTS | 54 | 10 | 20MAY82 | | | 13AUG82 | -55 | BEHIND |
| | WR SYS PREP CIR.J.ISTSCTERM SHTS U7 | 0 | 5 | 27MAY82 | | | 20AUG82 | -55 | BEHIND |
| | DIAGRAMS U7 | 66 | 10 | 23APR82 A | 2JUN82 | 4JUN82 | 13AUG82 | -49 | BEHIND |
| | U7 | 66 | 10 | 23APR82 A | 23APR82 | 4JUN82 | 13AUG82 | -49 | BEHIND |
| | | 68 | 18 | 1JUN82 A | 3MAY82 | 28JUN82 | 25AUG82 | -41 | BEHIND |
| | | 0 | 20 | 1JUN82 | 2AUG82 | 28JUN82 | 27AUG82 | -43 | BEHIND |
| | | | | 30MAY82 A | 3MAY82 | 6JUL82 | 6AUG82 | -23 | BEHIND |
| | | | | A | 25JUN82 | 14JUL82 | 19AUG82 | -26 | BEHIND |
| | | | | | 2AUG82 | 16JUL82 | 27AUG82 | -30 | BEHIND |
| | | | | | | | | -19 | BEHIND |
| | | | | | | | | | BEHIND |

PLAN VS. ACTUAL

No. OF DAYS BEHIND

MUST BE COMPLETED CRIT

WORK ACTION REPORT

Project Start 29MAR76

RUN DATE 8SEP81

TARGET 1 COMPL 2APR88 CURRENT COMPLETION 1APR88

ENP 1 & 2

THE ACTIVITIES THAT

BEFORE 3 MONTHS AFTER THE DATA DATE.

CODE 3 *** ELECTRICAL ENGINEERING *** SORT CODES 923478 DATA D

RESPONSIBLE DISCIPLINE

| ACTIVITY | DESCRIPTION | MODE-T | | | | CURRENT | E.TARG | FINISH CURRENT | TRF | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|
| 231360 | 480 MCC's LOAD | | | | A | 6AUG76 | 6SEP78 | 6SEP78 | 0 | CRITICAL |
| 82113303 | OEC RVW SPEC 480V U SUBST NO | | | G78 | A | 2AUG78 | 25AUG78 | 1SEP78 | -5 | BEHIND |
| 82113313 | OEC RVW SPEC 480V MCC NON-1E | 44 | 5 | 23JUN78 | A | 22AUG78 | 14JUL78 | 1SEP78 | -35 | BEHIND |
| 8322 | TRAY & ACCESSORIES | 0 | 15 | 22SEP78 | | 28AUG78 | 12OCT78 | 18SEP78 | 18 | |

WORK ACTION REPORT

Project Start 29MAR76

TARGET 1 COMPL 1APR88 CURRENT COMPL

RUN DATE 08SEP78 2236HRS

THE ACTIVITIES THAT MUST BE STARTED OR

IN PROGRESS BEFORE 3 MONTHS AFTER THE DATA

MUST BE IN PROGRESS

STATUS CRITICAL/BEHIND

CODE 3 *** ELECTRICAL ENGINEERING *** CODES 923478

| ACTIVITY | DESCRIPTION | MODE-T/BE | | PCT COM | REMDUR | START E. TARG | CURRENT | FINISH E.TARG | CURRENT | TRF | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 331100 | 480V D-C Sizing | | | 76 | 120 | 1FEB77 A | 1FEB77 | 15FEB79 | 15FEB79 | 0 | CRITICAL |
| 114331062 | Cable Tray Final | | 10 | 48 | 275 | 27DEC76 A | 27DEC76 | 11MAR80 | 27SEP79 | 113 | |
| 77231102 | LP & VIB Monitoring | | | 0 | 60 | 15NOV78 | 28AUG78 | 9FEB79 | 20NOV78 | 56 | |
| C 8323130 | Cable Tray & Conduit L/O | | | 10 | 130 | 21JUL78 A | 15JUN78 | 14FEB79 | 2MAR79 | -11 | BEHIND |

ORIGINAL TARGET START

ACTUAL PERFORMANCE DATE



1245

# PROCUREMENT STATUS SCHEDULE

| | START ROUGH DRAFT | COMPLETE CCM REVIEW & CECO REVIEW | RECEIVE CECC APVL. SIGN ATTEST SHEET. & ISSUE | RECEIVE BIDS | EVALUATE BIDS AND MAKE [illegible] | ISSUE PO | RECEIVE VENDOR DRAWINGS | APPROVE VENDOR DRAWINGS | DELIVERY DATE | EXP. DATE CECO PL NO. CECO ACCT NO. VENDOR NAME |
|---|---|---|---|---|---|---|---|---|---|---|
| C 081431303 +CRITICAL+ 2400 V SWITCHGEAR | | | | | | | | | | |
| TAR | 14FEB79 | 10MAY79 | 18JUL79 | 08AUG79 | 29AUG79 | 27SEP79 | 21DEC79 | 14JAN80 | 03MAR81 | |
| CUR | 05DEC78 | 06MAR79 | 30JUL79 | 15AUG79 | 25SEP79 | 31DEC79 | 30JUL80 | 20AUG80 | 14NOV80 | D-61605 |
| ACT | 05DEC78 | 06MAR79 | 30JUL79 | 15AUG79 | 25SEP79 | 31DEC79 | | | | U1 X8249-42 |
| | | | | | | | | | | U2 X7471-42 |
| | | | | | | | | | | SIEMENS-ALLIS |

INTERNAL REVIEW

| A | C | E | M | I | S | C |
|---|---|---|---|---|---|---|

082131303 2400/480 V POWER TRANSFORMER

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TAR | 17JUL78 | 21FEB79 | 23APR79 | 07MAY79 | 21MAY79 | 19JUN79 | 28AUG79 | 11SEP79 | 20OCT80 | |
| CUR | 17JUL78 | 06MAR79 | 08JUN79 | 02JUL79 | 07AUG79 | 11OCT79 | 20DEC79 | 09JAN80 | 01MAY80 | C-59428 |
| ACT | 17JUL78 | 06MAR79 | 08JUN79 | 02JUL79 | 07AUG79 | 11OCT79 | 20DEC79 | 09JAN80 | 01MAY80 | U1 X8249-42 |
| | | | | | | | | | | U2 X7471-42 |
| | | | | | | | | | | WESTINGHOUSE |

INTERNAL REVIEW

| A | C | E | M | I | S | O |
|---|---|---|---|---|---|---|
| | P | X | P | | | X |

[illegible] SWITCH[illegible]

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 01AUG79 | [illegible] | [illegible]79 | 30SEP80 | |
| | | | | | | [illegible] | [illegible] | [illegible] | 30SEP80 | C-59424 |
| | | | | | | | | | | U1 X8249-35 |
| | | | | | | | | | | U2 X7471-35 |
| | | | | | | | | | | GENERAL ELEC[illegible] |

START SPEC DRAFT

REVIEWS

BIDS FROM VENDORS

SCHEDULE VS ACTUAL/CURRENT

# DRAWING SCHEDULE

DATA DATE 2/1/83

| DRAWING NUMBER AND SHEET | REV | DRAWING TITLE | | DESIGN & DRAFT START | DESIGN & DRAFT COMP. | CHECKING START | CHECKING COMP. | ISSUED FOR REVIEW | ISSUED FOR FAB | ISSUED FOR CONST | % COMP. | CAD | PIPE | STRESS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J0-P63-AE01 | | Feedwater | S | 01/10/83 | 01/15/83 | 01/17/83 | 01/21/83 | 01/24/83 | 02/03/83 | 03/03/83 | | | | | |
| | | | A | 01/10/83 | 01/28/83 | 2/21/83 | | | | | 72 | | | | |
| J0-P63-AE02 | | Feedwater | S | 01/10/83 | 01/28/83 | 02/01/83 | 02/07/83 | 02/11/83 | 02/18/83 | 03/21/83 | | | | | |
| | | | A | 01/10/83 | 01/28/83 | 02/01/83 | | | | | 82 | | | | |
| J0-P63-AE03 | | Feedwater | S | 01/10/83 | 01/15/83 | 01/21/83 | 01/28/83 | 02/03/83 | 02/10/83 | 03/15/83 | — | | | | |
| | | | A | 01/10/83 | 01/28/83 | | | | | | 62 | | | | |
| J0-P63-AE04 | | Feedwater | S | 01/15/83 | 02/01/83 | 02/03/83 | 02/10/83 | 02/17/83 | 01/28/83 | 04/03/83 | | | | | |
| | | | A | 01/10/83 | 01/28/83 | | | | | | 35 | | | | |
| | | | S | | | | | | | | | | | | |
| | | | A | | | | | | | | | | | | |
| | | | S | | | | | | | | | | | | |
| | | | A | | | | | | | | | | | | |
| | | | S | | | | | | | | | | | | |
| | | | A | | | | | | | | | | | | |
| | | | S | | | | | | | | | | | | |
| | | | A | | | | | | | | | | | | |
| | | | S | | | | | | | | | | | | |
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| | | | S | | | | | | | | | | | | |
| | | | A | | | | | | | | | | | | |
| | | | S | | | | | | | | | | | | |
| | | | A | | | | | | | | | | | | |

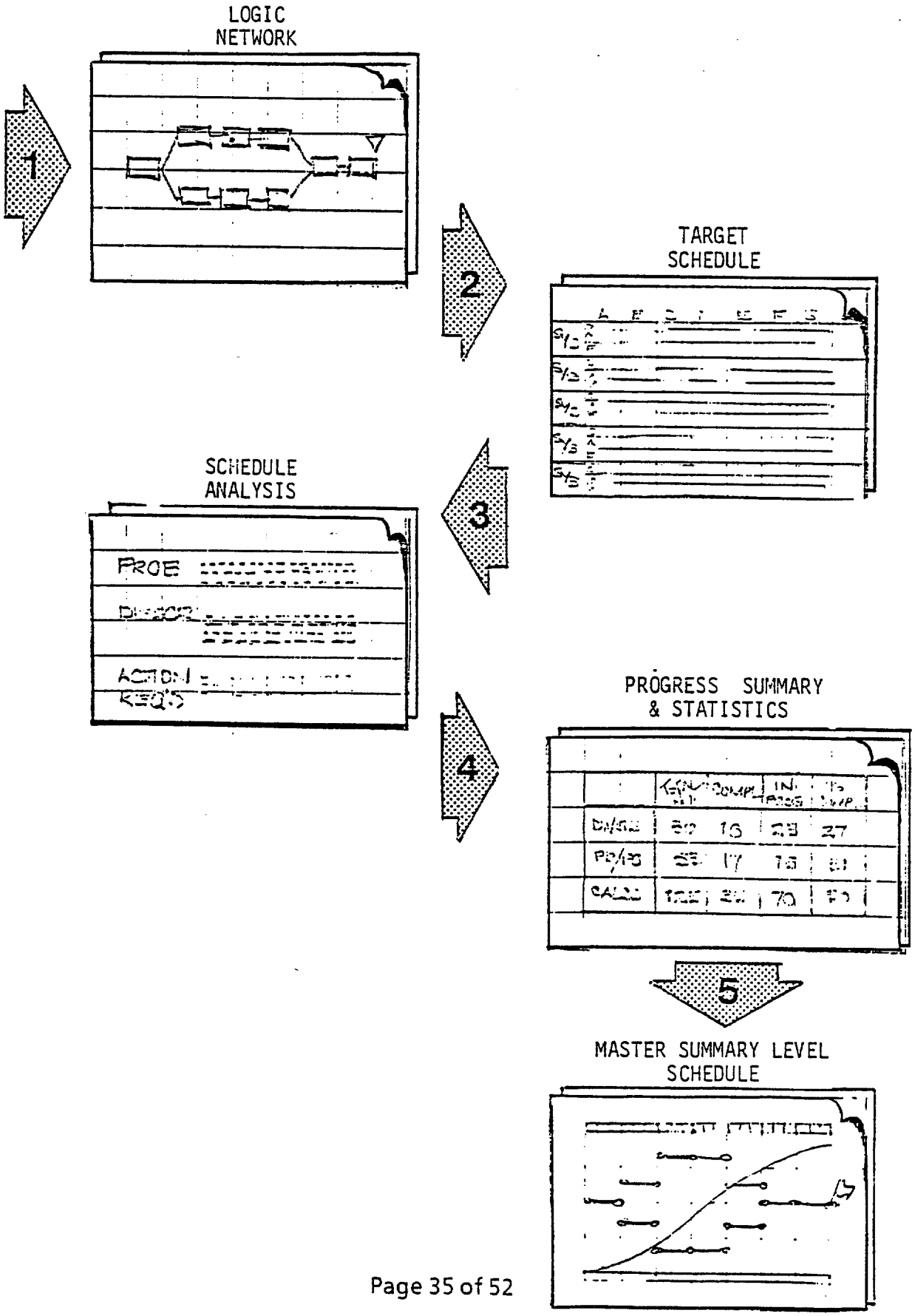
N - No
Y - Yes

% Complete
30% Drafting Started

80% Checking in Progress

95% Backcheck/Completion

LEVELS OF SCHEDULE IMPLEMENTATION
-SMALL PROJECT-






1248

LEVELS OF SCHEDULE CONTROL
@
-SMALL PROJECTS-

MGMT LEVEL

TIME-SCALED SUMMARY BAR CHART → PROVIDES AN OVERVIEW OF PROJECT STATUS

PROGRESS SUMMARY STATISTICS → OFFERS PROGRESS QUANTITY PICTURE

SUPERVISOR LEVEL

LOGIC NETWORK → ESTABLISHES LOGIC PLAN

ACTIVITY TARGET REPORT → PROVIDES SCHEDULING AND MONITORING OF DETAILED ACTIVITIES

CRITICAL PATH ANALYSIS REPORT → RELATES CRITICAL MILESTONES AND OVERALL ACTIVITY DEVIATIONS

WORKING LEVEL

DWG/SPEC STATUS REPORT → PROVIDES SCHEDULING AND TRACKING OF PRODUCTION OF DELIVERABLES



1249

# SYSTEMS SCHEDULE

| JAJ PRIORITY | STATUS | SYSTEM | | STARTED CHECKING @ P&ID | COMPLETE COMPOSITES INPUT INTO CAD (B) | COMPLETE CHECKING OF COMPOSITES WRT P&ID (C) | ISO'S START (D) | ISO'S FINISH (E) | SPOOL PIECES START (F) | SPOOL PIECES FINISH (G) | STRESS ANALYSIS START (H) | STRESS ANALYSIS FINISH (I) | FAB NEED DATE* * BASED ON 4 MO WINDOW (J) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | 1 CRITICAL | MAIN & REHEAT STEAM (AB) | S | DEC 20, '82 | 12/21 | 12/29 | 12/20 | 01/05 | 12/22 | 01/07 | 12/22 | 01/17 | 12/20/82 | SUPER-CRITICAL BASED ON CONST STA OF 4/20/83. WITH 4 MO LEAD TIME FOR FAB & SHIP. SHOULD BE RELEASED BY 12/20/82. |
| | | | A | 01/14 | 01/16 | | | | | | | | | |
| | | | F | | | 02/02 | | | | | | | | |
| | | | | COMPLETE | COMPLETE | BEHIND | | | | | | | | |
| (1) | 2 CRITICAL | FEEDWATER (AE) | S | DEC 20, '82 | 12/27 | 01/07 | 12/20 | 01/27 | 12/22 | 02/02 | 12/22 | 02/08 | 12/20/92 | SAME AS SYS "AB" THIS SYS SHOULD HAVE BEEN RELEASED 12/20/82 TO MEET THE CONST STA DATE OF 4/20/83. |
| | | | A | 01/10 | 01/29 | | | | | | | | | |
| | | | F | | | 03/10 | | | | | | | | |
| | | | | COMPLETE | COMPLETE | BEHIND | | | | | | | | |
| | 3 CRIT | CLOSED COOLING WATER (EB) | S | | | | | | | | | | | |
| | | | A | | | | | | | | | | | |
| | | | F | | | | | | | | | | | |

GILBERT/COMMONWEALTH

90 DAY/DAILY ENGINEERING SCHEDULE

PROJECT NO XX-XXXX-XXX
DATE JAN 10, 1983
REVISION Ø

| JAJ PRIORITY | ITEM NO | SYSTEM | 1982 DECEMBER | 1983 JANUARY | 1983 FEBRUARY | 1983 MARCH | 1983 APRIL |
|---|---|---|---|---|---|---|---|
| 1 | 1 CRITICAL | MAIN & REHEAT STEAM (AB) | COMPOSITE INPUT & UPDATE<br>REVIEW W/P&ID, INTERFERENCE CHECK,<br>ISO'S<br>THERMAL STRESS ANALYSIS | POSSIBLE REDESIGN | | | |
| 1 | 2 CRITICAL | FEEDWATER (AE) | COMPOSITE INPUT & UPDATE<br>REVIEW W/P&ID, INTERFERENCE CHECK,<br>ISO'S<br>THERMAL STRESS ANALYSIS | POSSIBLE REDESIGN | | | |
| | 3 C | [illegible] | COMPOSITE INPUT & UPDATE<br>REVIEW W/P&ID, INTERFERENCE CHECK,<br>ISO'S | POSSIBLE REDESIGN | | | |
| | | | | [illegible]DESIGN | | | |



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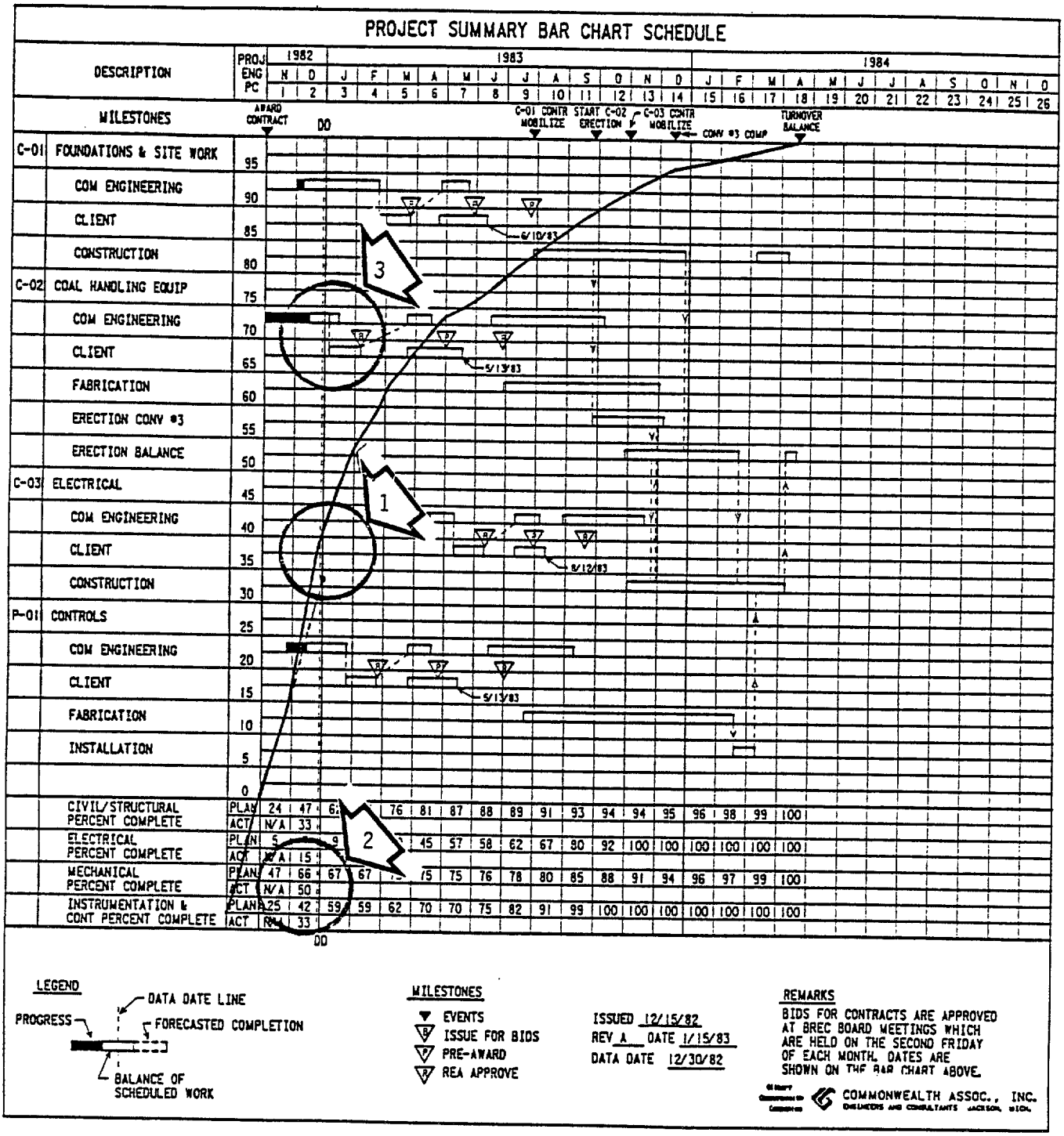
# THREE-STEP PROJECT OVERVIEW
## (TYPICAL SMALL PROJECT)




LEGEND

PROGRESS — DATA DATE LINE — FORECASTED COMPLETION — BALANCE OF SCHEDULED WORK

MILESTONES

- EVENTS
- ISSUE FOR BIDS
- PRE-AWARD
- REA APPROVE

ISSUED 12/15/82
REV A DATE 1/15/83
DATA DATE 12/30/82

REMARKS

BIDS FOR CONTRACTS ARE APPROVED AT BREC BOARD MEETINGS WHICH ARE HELD ON THE SECOND FRIDAY OF EACH MONTH. DATES ARE SHOWN ON THE BAR CHART ABOVE.

COMMONWEALTH ASSOC., INC.
ENGINEERS AND CONSULTANTS JACKSON, MICH.



1252

CRITICAL PATH REPORT ANALYSIS

DATA DATE FOR CURRENT UPDATE 11/26/82

DATA DATE FOR LAST UPDATE 10/29/82

| ACTIVITY/CODE DESCRIPTION | REQUIRED START / FCST. START | REQ. FINISH / FCST. FINISH. | DAYS BEHIND REQ. DATE: LAST UPDATE | DAYS BEHIND REQ. DATE: CURR. UPDATE | REASON FOR THE DELAY | SUCCEEDING ACTIVITIES AFFECTED BY THE DELAY | REMARKS/IMPACT ON COMMITMENT DATES | PLAN TO RECOVER LOST TIME |
|---|---|---|---|---|---|---|---|---|
| (260413350) Vendor Prepare Aeration Blower Drawings | 3/09/82<br>3/12/82<br>(A) | 9/20/82<br>12/30/82 | -71 | -71 | Vendor slippages | 1. Review drawings and issue Major Mechanical package to JELCO<br>2. Fabrication and delivery. | 1. These drawings must be reviewed and included in with Major Mechanical.<br>2. Delivery is forecasted for 5/20/83, 58 days after the required date of 2/28/83. | Continue to expedite Allen-Sherman-Hoff |
| (260413550) Vendor Prepare Vacuum Producer Drawings | 3/09/82<br>3/12/82 | 9/20/82<br>12/30/82 | -71 | -71 | | | | |
| | | | | | 1 Given low priority<br>2 CAI engineering has discussed with T&B the possibility of [illegible]cting these [illegible] in the [illegible]83 and [illegible] | In-House and JELCO review, issue to EG&G for info, issue package to JELCO, JELCO procure pre-engineered building contractor, vendor prepare drawings, review drawings design and draft thaw [illegible] guard house, [illegible] foundations [illegible]re | 1 This sequence of activities is on a negative 62 day critical path | None |



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# PROGRESS SUMMARY STATISTICS

| | TOTAL DRAWINGS | QUANTITY COMPLETE | QTY. IN PROGRESS | % COMPLETE | REMARKS |
|---|---|---|---|---|---|
| COMPOSITES | 55 | Ø | 51 | 50% | |
| ISO'S | 330 | Ø | 35 | 32% | |
| SPOOLS | 1327 | Ø | Ø | Ø | Spool status uncertain at this time. |

| | NO. OF SYSTEMS | QUANTITY COMPLETE | QTY. IN PROGRESS | % COMPLETE | REMARKS |
|---|---|---|---|---|---|
| STRESS ANALYSIS (THERMAL) | 16 | Ø | Ø | Ø | Cannot begin stress analysis until vendor information is rec'vd so that ISO's can be completed. |
| SYSTEMS (AA thru RC) | 33 | 5 | 14 | Ø | |
| ADDITIONAL WORK SCOPE SYSTEMS | 5 | Ø | 1 | Ø | "Cable tray supports" in progress. |

## IV. SCHEDULE CHANGE CONTROL

### A. Purpose

- Provides a Controlled Approach to Scheduling Revisions
- Scope
- Sequencing
- Missing Logic -- Additional Definition
- Unexpected

### B. Factors

- Visibility
- Schedule Credibility
- Documentation and Retaining
- Claims
- Trend Register

### C. Types of Changes

- Class I

  The Schedule change which affects the schedule dates of the work activities of the parties other than the one originating the change.

- Class II

  The schedule change which does not affect the schedule dates of work activities of the parties other than the one originating the change.

### D. Schedule Change Request Procedure

### E. Addition of New Work



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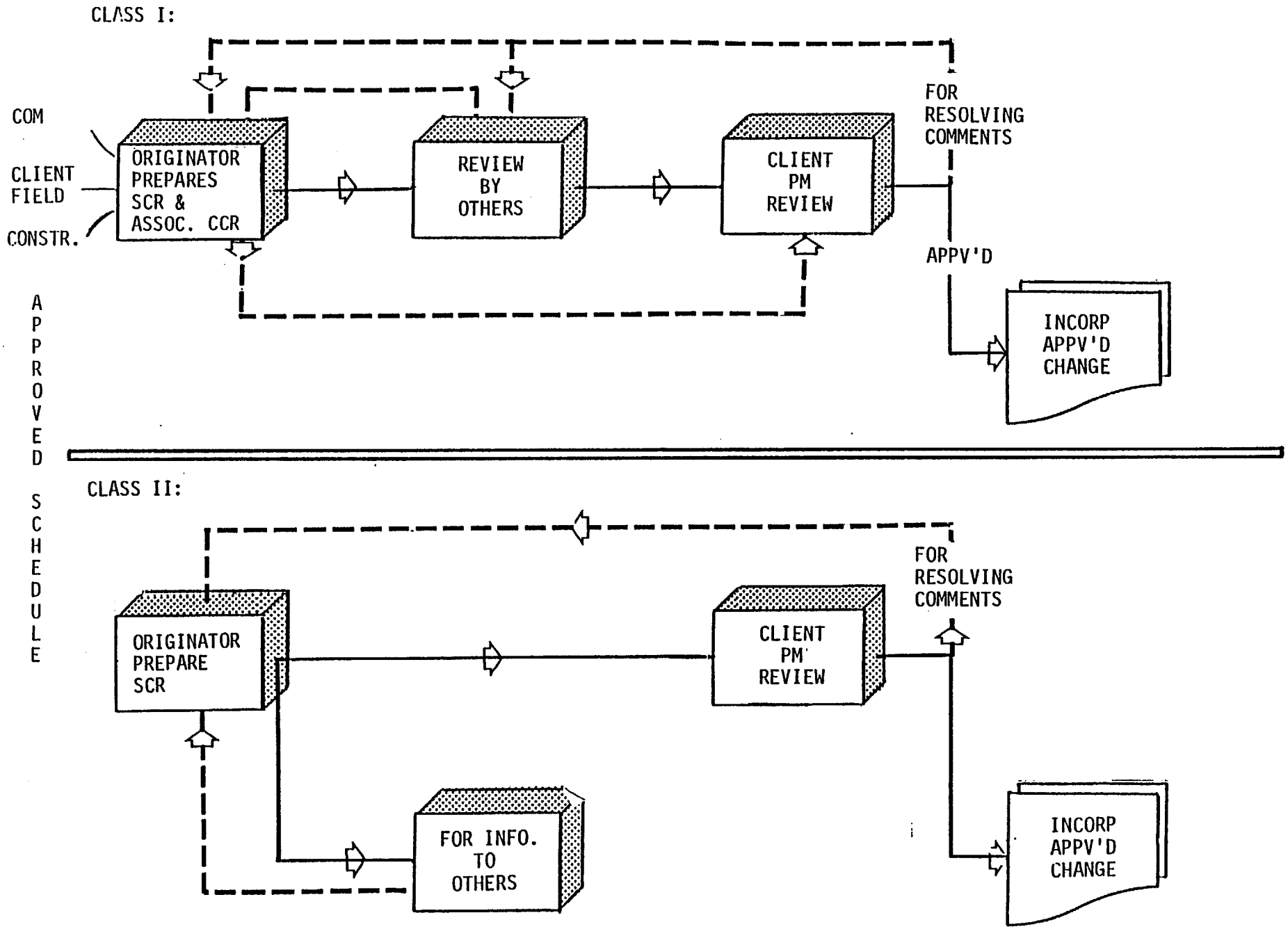
# SCHEDULE CHANGE REQUEST PROCEDURE




APPROVED SCHEDULE

CLASS I SCHEDULE CHANGE REQUEST FORM

Date: April 7, 1983

Serial No: COM-126

Revision:

1.0 Originator and Organization: J. A. Ludwig/COM and M. D. Hayes/COM

2.0 Description of Change and Account Number: Remove design, procurement and installation activities for the Silo #3 Unloader Permanent Electrical Equipment. Remove activities: 326331303, 326331012, 326313304, 326337307, 026337018.

No Comment RJH. 4/18/83

3.0 Reason for Change: After temporary electrical equipment had been installed, COM was informed by OEC that permanent electrical equipment would not be required.

4.0 Estimated Impact of Change: No construction target dates are delayed.

5.0 Additional Remarks by Reviewer:

Issuer for I.W.F. — Date April 11, 83

Reviewer/Organization — Date 4-15-83 — Concurrence / Nonconcurrence

OEC Project Manager — Date 4-22-83 — Approved / Disapproved

4-20-83

4/21



1257

# CLASS I COST CHANGE REQUEST FORM

Date: September 15, 1982

Serial No.: SA-74

Revision:

1.0 Originator and Organization: J.T.Peace, Commonwealth Associates, Inc.

2.0 Description of Change and Account Number: Please refer to Schedule Change Request OEC-003.

Account Numbers

| | | |
|---|---|---|
| 66076600 - $21,904 ; | 68018999 - $116,026; | 68011501 - $17,475; |
| 68013702 - $29,529 ; | 68018602 - $347,514; | 68011018 - $56,805 |

3.0 Reason for Change: Please refer to Schedule Change Request OEC-003.

4.0 Estimated Impact of Change:

| | | |
|---|---|---|
| Material | Engineering | |
| Labor | Client Cost | |
| Distributables | AFDC | |
| Contingency | Total Capital Cost | $ 555,302 |
| Escalation | | |

5.0 Additional Remarks by Reviewer: These dollars will be expended in 1982 rather than in 1983 or 1984.

Change by Year
1982 - $555,302
1983 -($369,418)
1984 -($185,884)

| | | |
|---|---|---|
| Issuer | September 16, 1982<br>Date | |
| Reviewer/Organization | Date | Concurrence<br>Nonconcurrence |
| OEC Project Manager | 9-30-82<br>Date | Approved<br>Disapproved |

9-30-82 9/30



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# CLASS II SCHEDULE CHANGE REQUEST FORM

Date: August 30, 1982

Serial No.: COM-028

Revision:

1.0 Originator and Organization:

P. E. McCool/COM for L. P. Rinck/COM

2.0 Description of Change:

Remove Activities:

063041053

063014054

063047057

3.0 Reason for Change:

No vent fans will be procured for the toilet facility. Ventilation will be supplied from the elevator HVAC.

9-27-82

Approved

Disapproved

OEC Project Manager

9-20-82

9/21



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CLASS II COST CHANGE REQUEST FORM

Date: September 10, 1982

Serial No : SA-0

Revision: 13

1.0 Originator and Organization:

J. T. Peace - Commonwealth Associates Inc.

2.0. Description of Change and Account Number:

Please refer to Schedule Change Request Numbers COM-103, COM-107 and COM-028.

3.0 Reason for Change:

No Cost Impact

9-27-82
Approved

OEC Project Manager

Disapproved

9-20-82

9/21



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## V. ADVANCED APPLICATIONS OF THE PROJECT SCHEDULE

### A. Delay Claims

1. Evidence
   - Burden of Proof
   - Court Requirements for Formal Documentation
   - Records in Support of Claim
     - CPM Schedule
     - Progress Charts
     - Daily/Weekly Reports

2. Time Impact Analysis
   a. Prepare and Document T.I. Analysis for:
     - Change Notice
     - Strike
     - Act of God
     - Other Upset Condition

   b. Base the Analysis on:
     - Current Schedule Data
     - Job Conditions
     - Progress Achieved at the Time
     - Plans and Specifications
     - Contract Files
     - Daily Inspection Logs
     - Experience and Knowledge of Work Methods vs. What Was Used

   c. Document the Details of Each Item with:
     - Proper ID
     - References
     - Adequate Description
     - CPM Network Calculations and Fragments
     - Final Conclusions



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3. Impact Evaluation Process
   a. Study the Scope of the Change or Delay
   b. Review All Material (Dwgs., Sketches, etc.)
   c. Determine Parties Affected
   d. Identify Activities Affected
   e. Review and Determine the Event Time Computations (*CAUTION: Compute Accurately*)
   f. Review Daily Logs, Progress Report, etc., to Determine Actual Status of Activities
   g. Prepare a CPM Network
   h. Prepare an Independent Schedule Analysis (*NOTE: Weekends, Holidays, Lost Time, etc.*)
   i. Check to Ensure that any Resulting Extension Is the Product of the Change
   j. Document the Situation by a Written Report
4. Guidelines for Negotiating Claims
   a. Determine and Document the Time Impact (as discussed earlier)
   b. Identify Significant Items Such As:
      - Delayed Start
      - Float Before the Delayed Start
      - Actual Versus New Critical Path
      - Estimate of Additional Work
      - Inconsistency of Data
      - Errors and Omissions
      - Nonconformance to the Approved Schedule
      - Inefficiency
      - Noncompliance
      - Recommendations



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- During Negotiations:
    - Maximum and Minimum Position
    - Positive and Professional Conduct
    - Simplify the Facts to Clarify Your Position
    - Use Summary Time-Scaled Networks as Visual Aids
    - Keep Negotiations Moving
    - Be Ready to Furnish More Detail if Asked
    - Strive for a Settlement
    - Abide by the Adjusted Schedule While Negotiations Are in Process
    - Document Negotiation Sessions
    - Go on Record with Your Disagreement
    - Present as Convincing a Case as Possible

5. Examples
    a. Angra
    b. Krsko

B. **Schedule and Control Specifications**

1. Small Project

2. Large Project

C. **Evaluation of the Contractor**

1. Proposal Phase
    a. Scheduling Technique
    b. Who is Responsible for Preparing the Schedule
    c. The Factoring of Schedule Detail Requirements
    d. Important Deliverable - and Interim Milestones
    e. Submittals (Initial, Updated)
    f. Review and Approval Procedure
    g. Remedies for Noncompliance
    h. Progress Report
    i. Use for Progress Payments
    j. Float Utilization

2. Contract Award Phase
   a. Before Award, Review Contractor's General P&S Techniques
   b. After Award, Review Contractor's General P&S Techniques
      - Become Familiar with the Details and Mechanics of the System and the People Who Will be Executing it
      - Good Understanding of Contractor's Terminology Is Essential
      - Review the Contractor's P&S Organization and Plans for Staffing
      - Review Critically the Contractor's Schedule for:
        - Conformance to Requirements
        - Level of Detail
        - Need for Logic Network (CP, DUR Sampling)
        - Optimum Cost-Based Schedule (No O.T., Premium)
        - Viability
        - Validity of Assumptions
        - Consistency of Milestones with Those Established by the Project
        - Critical and Subcritical Paths
        - Resolve Differences and Approve the Schedule as Early as Possible

3. Project Execution Phase
   a. Monitoring the Contractor's Schedule
      - Regular Evaluation of the Physical Completion of Each Project Segment
      - A Copy of the CPM Network of Showing the Current Critical Path and theWeighted Percent Complete Should be Submitted
      - Compile Contractor's Status Data and Schedule of Problems and Proposed Solutions Prior to Regular Schedule Status Meeting (Verify the Reported Information)
   b. Contractor Progress Report
      - Schedule Anal;ysis with Particular Emphasis on the Critical/Subcritical Paths
      - Separate Progress Curves - Plan versus Actual - for Engineering, Procurement, and Construction
      - Estimated Manpower Requirements to Meet the Progress
      - Narrative Highlights of Any Changes Over the Previous Status and Special Actions Recommended or Being Implemented to Maintain or Improve Schedule



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## VI. SOFTWARE CONSIDERATIONS

### A. Computerization Considerations

### B. Available Packages



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# memorandum

Gilbert/Commonwealth

**To:** Course Participants

**From:** Training and Development

**Subject:** Course Evaluation - Planning and Scheduling

The intent of the Project Management and Supervisory Training Course is to emphasize the importance of team work to project success and to review methods to enhance effective project management and control. Please evaluate the merits/shortcomings of this module as indicated below. Criticisms should be accompanied by suggestions for improvement.

1. Adequacy in meeting the overall course objectives

2. Success in meeting the module's stated objectives

3. Instruction methods, including presentation, selection of visual aids, and information presented in the training manual.

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# COST ENGINEERING

# AND

# ESTIMATING

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# COST ENGINEERING AND ESTIMATING

## INTRODUCTION

Every Project Manager has multiple responsibilities on his project. One of those responsibilities is cost control. Cost control is an essential element of project management from both the perspective of the company and the client. Comprehensive cost control is critical for the company to maximize profit, develop client satisfaction and confidence, and promote future work. Our clients require cost-related information to develop, evaluate, and monitor a financial plan and cash flow.

Cost Engineering focuses on cost management, which includes estimating costs, evaluating economics, and providing cost control.

**Objectives**

Upon completion of this module, the participant should be able to:

- Understand CE Services and Responsibilities.
- Describe the Project Control Philosophy and Goals.
- State the Scope of Cost Management.
- Detail the Estimating Process and Relate to Project Phases.
- Describe the Engineering and Construction Cost Control Program.
- Discuss the Concept of Cash Flow.
- Describe the Relationship of Cost Accounting.
- Summarize the Role of the Cost Engineer on Large and Small Projects.



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## I. INTRODUCTION

### A. What is the role of the Cost Engineer?

- Estimate Costs
- Evaluate Economics
- Provide Control

### B. Why is the Cost Engineering role important?

- Track Record
- Client Needs
- Company Survival
- Industry Demand
- Project Benefits

### C. Overview of Sessions



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## II. COST ENGINEERING DEPARTMENT

### A. Organization

### B. Structure

### C. Qualifications

1. A typical Cost Engineering Department includes personnel with experience and expertise in one or more of the following areas:
   - Nuclear Power Plants
   - Fossil Power Plants
   - Industrial
   - Residential
   - Construction Management
   - New Technology
   - Retrofit
   - Domestic
   - International.

2. The Cost Engineering staff qualifications include:
   - Graduate Engineers
   - Registered Professional Engineers
   - Certified Cost Engineers
   - Value Engineers

### D. Responsibilities/Accountability

The Cost Engineer's role must fulfill certain basic needs of both the client and Project Manager.

Responsibilities include:

- Estimating the total cost of a project
- Keeping track of costs on a daily basis
- Making timely evaluations of cost and schedule status
- Developing trends of cost and progress
- Forecasting cost at completion.

### E. Scope of Services

G/C Cost Engineering services encompass the full spectrum of cost management activities including:

- Cost Estimating
- Risk Analysis



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- Value Engineering Analysis
- Cash Flow Forecasting
- Engineering Cost Control
- Construction Cost Control
- Project Control Development
- Bid Evaluation
- Life Cycle Cost Evaluation
- Claims Analysis



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## III. PROJECT CONTROL

### A. Overview of Project Control Program

### B. Components of Project Control System

1. Estimates
   - Proposal Estimates
   - Original Budget Estimates
   - Revised Budget Estimates
   - Forecast of Estimate at Completion
2. Schedules
3. Cash Flows
   - Original
   - Updated
   - Reconciliation
4. Actual Expenditures and Installed Quantities
5. Material Control
6. Document Control
7. Reports
   - Progress
   - Performance

### C. Overview of Cost Management

1. Objectives

   Because of its contributions at all project levels leading to profit maximizing, project direction, and coordination, Cost Engineering can be seen as a management function.

   The Project Manager must know precisely what the project status is and what lies ahead at all times. In order to accomplish this, the Cost Engineer must know exactly the scope of the job, all its conditions, and its present status. The Cost Engineer is one of the first to recognize when the project is "off" course and has the responsibility for suggesting corrective action.

   The objectives of a cost management program are to:
   - Determine total project scope and monitor changes.
   - Develop and monitor a financial plan, including budget estimates and cash flow forecasts.
   - Monitor and analyze progress and deviations from the plan.
   - Provide effective project management reports in a timely manner
   - Provide analysis of deviations, including probable results and workable solutions.



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2. Effect of Viewpoint
   Because of different contract types, the owner, architect/engineer, construction manager, and contractor have different types of relationships with respect to a project. On any one project each is responsible for his own costs, and some may be responsible for the costs of others.

   The type of contracts, together with all other elements in the project, determines the cost control method used on a project.

   The Cost Engineer has the major responsibility of controlling costs on various types of contracts and must understand all viewpoints.

3. Implementation
   Three basic questions should be answered before implementing the cost management program:
   - What do we want?
   - How will we get it?
   - What will we do with it?

   In order to effectively implement and manage the cost management plan, it should first be defined and documented.
   - Project Management Manual
   - Construction Management Manual
   - Department Guidelines
   - Procurement/Contract Terms and Conditions

   An effort should be made to develop plan awareness with all project members.



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Cost management program implementation includes:

- Detailed studies of design alternatives
- Detailed budget estimate
- Competitively bid fixed price procurement
- Cost monitoring plan and system
  - o Guidelines and procedures
  - o "How to" instructions
  - o Computer utilization specifications
  - o Integration plan

Cost management program implementation requires:

- Early involvement
- Code/information requirements
- Management report requirements
- Reporting and recording measurement methods and procedures
- Change control procedures
- Performance and progress measurement methods and procedures
- Budget monitoring requirements

The Cost Engineer should be involved in the project from the beginning to help interpret and implement cost management program requirements.

## D. Cost Engineering Involvement in the Phases of a Project

1. Proposal for Services
   - Scope Definition
   - Schedule
   - Estimates of Services
   - Funds Requirement Plan
   - Escalation Analysis
   - Change Control Procedures
   - Determination/Implementation of Identification/Numbering System
   - Report Requirements
   - Integration Requirements



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2. Engineering Phase
   - Refine Scope
   - Approve Schedule
   - Develop Preliminary Estimate
   - Develop Project Cash Flow Requirements and Analysis
   - Develop Change Control Procedures
   - Implement Integration
   - Finalize Report Requirements

3. Construction Phase
   - Refine Scope
   - Define Budget/Definitive Estimate
   - Implement Budget Control/Monitoring
   - Implement Progress and Performance Measurement
   - Implement Change Control Procedures

4. Continuing Services



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## IV. CAPITAL COST ESTIMATING

### A. Definition

1. Direct Capital Cost

   Interpretation of direct cost is dependent on viewpoint.

   - Contractor

     The contractor may interpret direct cost as the cost of labor, materials, and equipment before adding field costs, overheads, and profits.

   - Engineer or Construction Manager

     The engineer or construction manager may consider the contractor's total cost and purchase materials/equipment as direct cost. From their viewpoint, direct capital cost includes the total cost of all materials and improvements forming a permanent part of the furnished plant, and all of the constructor and subcontractor labor engaged in installing or erecting such materials or performing such improvements.

   - Owner

     The owner generally shares the same viewpoint as the engineer and construction manager. However, additional items may be included which were performed independently by the owner.

2. Indirect Capital Costs

   Indirect costs are generally considered as the cost of items which do not become a permanent part of the project/property being constructed. Indirect costs are often synonymous with distributable costs.

   Interpretation of indirect costs are also dependent on the viewpoint of the contractor, engineer/construction manager, or owner.

3. Estimate

   An estimate is a judgment or opinion applied to the value, size, weight, degree, extent, or quantity relating to a specified scope.

   An estimate is usually considered as an approximate value when developed but is often interpreted as an exact value at completion.

A capital cost estimate is usually based on some degree of quantity development and unit price evaluation and includes the following major categories of cost:

- Procured Equipment
- Field Purchased Material
- Erection of Structures and Systems
- Field Indirect Costs
- Engineering Services
- Construction Management Services
- Owner's Costs
- Pre-Operational Testing and Startup
- Contingency
- Escalation

Within the body of the estimate all costs are expressed in terms of present-day dollars, and anticipated escalation is shown separately.

## B. Purpose

Estimates serve three general functions:

- Provide information for financial analysis and economic evaluation
- Serve as a benchmark for evaluating the value of specific packages and measuring changes
- Serve as a benchmark for measuring actual performance and expenditures

This is accomplished with the following considerations.

1. Scope Definition

Project scope definition consists of two basic tasks:

- Determining the component parts of systems and facilities
- Determining the services to be provided

The Cost Engineer must:

- Provide for a complete project whether or not design information is available
- Continually conceptualize portions until project completion
- Develop quantities through takeoff, conceptualization, and historical data



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2. Cost Budget

An estimate is developed for determining the total cost of an item or project, and answers the following questions:

- Is the project worth the investment?
- How will funds be appropriated?
- What is "the budget"?
- How will cost be monitored and updated?

3. Cash Flow/Financial Plan

The cash flow utilizes a time-phased cost estimate to determine the projected rate of cash expenditures.

Increased project definition improves cash flow accuracy when utilizing estimates for engineering services and construction management services, contracts and purchase orders, and operations and maintenance.

4. Schedule Basis

The estimate provides resource data such as quantities, manhours and costs for schedule development and analysis.

Schedule resource loading provides for schedule analysis, resource leveling, progress evaluation, and earned value analysis.

5. Manpower Requirements

Estimate development incorporates manpower availability, labor agreements, and contracts. Results in manpower requirements are:

- Project
- Contract
- Area
- Department
- Discipline
- Crew
- Craft
- Task



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6. Procurement Requirements

Estimate development identifies and quantifies bulk commodity items for procurement.

7. Contract Package Values

Estimates of contract package values are used for:

- Budgeting
- Cash Flow Projections
- Determination of Bidders List
- Bid Evaluation
- Budget Monitoring
- Progress Payments

8. Progress Yardstick

Estimates are used as a yardstick to measure progress. The estimate represents the total project including anticipated changes. Physical progress is measured using costs, quantities, manhours or deliverables.

## C. Estimate Types

1. Conceptual/Study

A conceptual/study estimate is an estimate prepared without the benefit of detailed engineering data and with limited information.

- Usually less than 10% engineering
- Utilizes similar projects
- Parametrics utilizing historic data
- Identification of major components and commodities

Typical available information includes:

- Project Scope Document
- Process Characteristics
- Size
- General Location



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- General Layout
- Milestone Schedule
- Anticipated Packages

For the Conceptual Estimate, maximum use is made of the Project Scope information. Plant area and volume and relationships are used to develop quantities. Current pricing and wage levels, anticipated labor productivity, and schedule requirements are reflected in the estimate. Depending upon the degree of project definition, the Conceptual Estimate may be used as a basis for early cost management.

2. Preliminary

The preliminary estimate is generally prepared prior to the start of construction and with minimal detailed engineering:

- Engineering and drafting are 10-15% complete
- Utilizes other project data in many areas

Typical available information includes:

- Approved Site
- Approved General Arrangement
- Preliminary Equipment Lists
- Preliminary Flow and Single-Line Diagrams
- Planned Packages
- Major Equipment Quotations or Orders

At the time of this estimate, major equipment has been defined. Some equipment is committed or quoted, and other equipment and materials are prices from historical cost data or vendor catalog data and price lists.

Some specific quantities, representing significant dollar values, are developed on the basis of design data. Other quantities are evaluated or estimated based on information obtained from previous projects. These quantity evaluations will be directed primarily at major commodities. Labor manhours for all specific work operations are included. Evaluations of labor productivity are made and factored into the labor manhour estimates.

3. Definitive

The definitive estimate is the most extensive estimating effort performed on the project.

- Engineering is greater than 50% complete



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- No major changes are expected
- Scope definition exists for virtually all significant items of work

Typical available information includes:

- Commitments for all major equipment
- Quotations or commitments for many bulk commodities and other equipment
- Detailed drawings including composites and physicals
- Developed construction packages
- Approved equipment lists and delivery dates
- Construction Schedule

The definitive estimate is utilized for project monitoring and control, and is the basis for measuring, quantifying, and reporting cost variances.

The definitive estimate incorporates all available updated information concerning the project. The sketches, assumed typical foundations, conceptual arrangements, and other non-engineered scope and quantity data which were important in the development of the preliminary estimate are replaced in part by firm design information.

In final form, the Definitive Estimate presents the comprehensive evaluation of project cost, which is necessary for project financial planning, monitoring and control. The detail and documentation in the definitive estimate establish the basis for measuring and quantifying cost variances. If major design changes occur, or if the scope of the estimate is issued, documentation is prepared stating the reason for such changes, and the associated costs are estimated. By this method all major design and scope changes are identified and the client is provided with a complete history of the cost evolution of the project.

4. Contract Fair Price

The contract fair price estimate is an estimate prepared from the perspective of a bidding contractor utilizing the plans and specifications transmitted in the form of a proposal.

The purpose of this estimate is to:

- Provide an independent, objective analysis of the proposal package value
- Provide a detailed cost basis for bid evaluation
- Provide a check on bid package completeness and clarity



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In making a Fair Price Estimate, a complete takeoff is made; specific wage rates are determined; crew size and composite wage rates are established; work activities are priced; equipment and material are priced; and construction equipment, overheads, profits, and a contingency, when applicable, are established.

5. Change/Trend

6. Life Cycle Cost

Life cycle cost analysis is a forecasting tool used to compare or evaluate alternative project proposals by converting estimated future costs to present value dollars. The concept of money having a time dimension forms the basis for cost comparison.

The present worth is obtained for the total cost to the owner including:

- Capital Cost
- Operational Cost
- Maintenance Cost
- Replacement Cost

The concept underlying life cycle cost analysis is that the owner should have perpetual use of the facility, replacing its parts or the whole of it whenever necessary.

Life cycle cost analysis is not a deterministic approach, but a method of forecasting likely results that depend on many variables.

7. Claim

8. Fair Market Price

## D. Estimating Disciplines

Development of capital cost estimates for large projects is performed by specialized disciplines, particularly for estimates requiring detailed analysis of components. The estimating disciplines are the Civil/Structural, Mechanical/Piping, and the Electrical/Instrumentation.



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## E. Estimate Development

1. Estimate Structure and Numbering System

   The identification/numbering system is a form of communication for the entire project. Utilization of common terminology which is readily understood by all parties helps to provide effective communications between dissimilar organizations.

   The identification system is based on a Work Breakdown Structure (WBS), which is a numbering system built on sets (types) of codes. Codes are developed to identify and segregate information into groups such as physical and functional items, and are used to identify project information such as unit number, area, and system.

   Work Breakdown Structure (WBS) codes are used for:

   - Scope Identification
   - Estimate Development
   - Sort and Select Capabilities
   - Recording of Expenditures
   - Budget Monitoring
   - Progress and Payment Determination
   - Providing a Base for Future Estimates
   - Records Development

   The basic objective of developing an identification/numbering system is to subdivide the total project into manageable units of work.

2. Approach
   a. Scope Review
   b. Level of Detail
   c. WBS
   d. End Use
   e. Deliverables

3. Surveys
   a. Market Conditions
   b. Area Labor Conditions
      - Union Versus Non-Union



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- Labor Availability
- Travel Requirements
- Project Agreement
- Wage Agreements
- Camp Requirements

c. Delivery Lead Times
d. Area Climate/Weather
e. Taxes
f. Escalation/Inflation
g. Site Visit
h. Client Preferences

4. Data/Information Collection

Most data prepared by design engineering is transmitted to Cost Engineering for the preparation of the capital cost estimate. There must be constant communication between the two groups so that only the required information is developed and produced efficiently, and all available information is incorporated into the estimate.

a. For Capital Cost Estimates
   - Project Scope Document
   - Project Schedule
   - Contract including Proposals and Specifications
   - Purchase Orders including Letters of Intent and Specifications
   - Progress Report (if available)
   - Drawing Schedules and Drawings
   - Contract Schedule
   - Purchase Schedule
   - Material and Schedule List
   - Project Labor Agreement
   - Wage Agreement

b. For Services Estimates

c. For Operations and Maintenance Estimates



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5. Techniques and Methodology

   a. Estimating Techniques
      - Take-off
      - Parametric
      - Scaling
      - Historical
      - Factoring

   b. Estimating Methodology
      - Select a data cut-off date
      - Select an estimate base date
      - Accumulate information
      - Determine scope
      - Establish quantitites
      - Apply/Establish installation manhour rates
      - Establish composite crew labor rates
      - Obtain material/equipment price quotations
      - Price bulk commodities and miscellaneous equipment
      - Incorporate commitments
      - Determine and estimate distributables
      - Estimate/Incorporate engineering services
      - Estimate/Incorporate construction management services
      - Estimate AFDC
      - Determine expenditure periods
      - Establish and apply escalation rates
      - Analyze and determine contingency amounts
      - Prepare report

6. Documentation and Reports

   Estimate development may be as simple as a few calculations or as complex as estimating thousands of items for a nuclear project. Estimate documentation includes items such as:

   - List of source documents
   - Scope data
   - Estimate qualifications such as assumptions and exclusions



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- Estimate summaries by system, facility, etc.
- Estimate details by WBS number, commodity, etc.
- Drawing take-off sheets by commodities such as pipe, rebar, etc.
- Sketches and calculations

## F. Estimating Procedures

1. Guidelines and Procedures
2. Reviews
3. Rules for Describing
4. Practices to Avoid

## G. Risk Analysis

1. Overview

Determination of cost overrun probability, or risk, is highly dependent on:

- The State of Technology Development
- Scope Definition
- Design Progress
- Amount of Commitment
- Schedule

Those items can be assessed based on judgment or with the aid of computer program utilizing Monte Carlo simulation methods.

After the estimate is prepared and prior to final approval, certain questions must be addressed:

- How good is the estimate?
- What is the accuracy of the estimate?
- What are the areas of risk?
- How much contingency should be added to the estimate to minimize risk?

Factors to be considered:

- Completeness of Documentation
- One of a Kind

- Research and Development Type
- Familiarity with the Client
- State of the Economy
- Work Backlog
- Labor Environment
- First -Time Venture
- Schedule

2. Risk Analysis Methodology
   - Determine Risk Areas
   - Define Components of Risk Areas
   - Rate Components
   - Construct a Mathematical Model
3. Results
   - Analysis
   - Confidence
   - Probability Curve

The product of a Risk Analysis is a probability distribution which describes the capital cost in terms of probability of overrun. This curve enables the estimator to select the proper contingency required to arrive at 50% or mid-point of accuracy and the client to select management reserve to achieve a level of confidence which suits the particular needs.

## H. Contingency

1. Definitions

Contingency is an estimated amount to cover unknowns, uncertainties, and expenses which are likely to occur. It is not padding or additional expected fee.

The cost estimate for a project is best viewed as a mid-point value bounded by upper and lower cost limits, and the addition of contingency to the base cost adjusts the estimate to the mid-point of the expected cost range.

The purpose of contingency is to reduce financial risk and exposure due to unforeseeable conditions and circumstances.

a. Project Contingency

Project Contingency is:

"Specific provision for unforeseeable elements of cost within the defined project scope, particularly important where previous



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experience relating estimates and actual cost has shown that unforeseeable events which will increase costs are likely to occur."

OR

"Incremental resources included in estimates to cover indeterminate but substantially inferred requirements for a capital project."

b. Process Contingency

Process Contingency is:

"Specific provision for uncertainties in the design and cost of equipment or projects utilizing or based on new technology."

c. Management Reserve

Management Reserve is:

"An additional contingency sometimes required by a client to provide a higher level of confidence in an estimate and reduce the probability of cost overrun."

Management reserve may also be a collecting pot for unused contingency on items such as contracts, which were complete before project completion. Monies from this reserve are then used for cost overruns to reduce the probability of a budget overrun.

2. Development

The method of contingency development is dependent on the type of project and the type of estimate.

Contingency percentages or amounts may be prescribed by a client but more often are determined by Cost Engineering.

Two partial examples of development methods, other than risk analysis, are:

- A matrix of information and cost status

| INFORMATION STATUS | MATERIAL COST | LABOR COST | CONTINGENCY PERCENT |
|---|---|---|---|
| Approved | Committed | Committed | 3% |
| Approved | Committed | Estimated | 5% |
| Preliminary | Estimated | Estimated | 15% |
| Conceptual | Allowance | Allowance | 35% |

- Historical Experience



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Initial contingency assessment is the responsibility of the Cost Engineer. However, contingency review and approval is the responsibility of management.

- Engineer Manager
- Construction Manager
- Project Manager
- Client



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## VI. COST CONTROL

### A. Objectives

### B. Engineering Cost Control

1. Cost Control Functions
   - Scope
   - Schedule
   - Disciplines
   - Deliverables
   - Manhours
   - Expenses
   - Overhead and Profit
   - Project Controls

2. Performance Measurement

   a. Purpose
   The purpose of performance measurement is to provide a method for joining cost and scheduling information to monitor and report project performance.

   It is intended to answer the following questions:
   - Is the project on schedule?
   - Is the project within budget?
   - How much overrun/underrun?

   b. Concept
   Performance measurement is a technique that forces both cost and schedule to be integrated for analysis and reporting.
   - Schedule variance
   - Cost Variance
   - Budget Variance

   When cost and scheduling are fully integrated, the performance measurement system will:
   - Measure manhour performance at various levels
   - Compare manhour performance with the schedule percentage complete



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- Indicate relative worth of manhours toward progress
- Indicate productivity trends
- Provide "earned value" basis for progress payment

## C. Construction Cost Control

### 1. General Overview

a. Types of Projects

Construction projects are generally divided into two general types:

- Heavy Construction
- Building Construction

Our viewpoint is based on power plants, which are considered as heavy construction.

b. Size of Projects

c. Contract Types

Contracts are generally awarded separately for design and construction. However, sometimes a contract is let for design, construction, and commissioning; this is called a "turn-key contract".

Whether it is a turn-key or a contract for construction work only, contracts are generally of three types:

- Stipulated Lump Sum/Unit Price
- Cost Plus
- Management

d. Effect of Viewpoint

The overall objectives of the cost management program do not change with different contract types. However, the type and level of effort are dependent on the type(s) of contracts.

e. The Cost Engineer's Role

The Cost Engineer occupies a key position on any large project. There is an exchange of information between this individual and all other departments involved in the project.

The Cost Engineer analyzes and summarizes information so that the Project Manager can:

- Know the status of the project at all times
- Implement corrective action



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The Cost Engineer interfaces directly with the:

- Project Manager
- Project Engineers
- Procurement
- Estimators
- Contract Administrator
- Specification Writers
- Schedulers
- Start-Up Team
- Accountants

The Cost Engineer must strive to make everyone involved with the project as cost conscious as possible.

The Cost Engineer is in the key position to:

- Provide for Cost Reduction
- Provide Cost Optimization
- Forecast Anticipated Cost
- Control Cost

2. The Cost Control Plan

For control of project cost, there must be a cost plan against which cost performance is measured.

The cost plan may be considered to consist of two major areas or functions:

- Estimate
- Schedule

The cost control plan consists of two phases:

- Building the Plan
- Monitoring the Plan



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Building the cost plan is essentially completed prior to start of construction and includes:

- Defining scope
- Establishing the WBS
- Developing the Estimate and Cash Flow

Modification of the plan and monitoring of the plan continue throughout construction. Monitoring of the plan includes analysis of:

- Time
- Resources
- Physical Accomplishments
- Change
- Cost

3. Components of Cost Control
   a. Schedule
   b. Installed Quantities
      Installed quantities are reported and recorded weekly for major bulk commodities. Various methods of reporting installed quantitites are utilized such as pour tickets, pull slips (wire and cable), drawing take-off, and submittal of standard forms.This data issued for both weekly contractor meetings and monthly progress reporting.
   c. Productivity

      Craft manhours are reported and recorded daily by:

      - Contract Package
      - Craft
      - Work Item

      Productivity is:

      "A measure of the relative effectiveness of labor in its performance of similar and comparable work operations when compared to an established base or to a particular job."

      Measurement of productivity begins with recorded manhours and installed quantities for a given work operation.

      Actual manhours or time required to install a given unit of work are compared to the established base estimates to determine performance or productivity.



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Productivity is generally measured only for key bulk commodities such as concrete, structural steel, and pipe.

Productivity data is used to determine both specific problem areas regarding progress and schedule, and manpower efficiency.

Productivity analysis may include a time study of a given operation.

d. Commitments

Commitments may be reported and recorded:

- At summary package levels and detailed account codes such as service agreements, contracts, and purchase orders.
- As estimated amounts based on committed unit prices.
- By types such as base amount, change/supplement amount, pending changes and material, or labor.

e. Actual Costs

Actual costs must be recorded in conformance with standard accounting procedures and at a level consistent with analysis and reporting requirements such as:

- General Ledger
- Property Records
- Budget Monitoring
- Performance Measurement
- Cash Flow
- Other Client Requirements

The levels of detail and interfaces are initially determined during the cost plan building phase.

f. Changes

Changes and potential changes to a project are brought to the attention of the Cost Engineer in forms such as:

- Drawings
- Change Orders
- Claims
- Delays/Interferences
- Schedule Modification

Change order status reports are used to record changes to monitor trends and types of changes, and to provide cost information for budget updates.



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When revised drawings/specifications or a request for a proposal are transmitted to a contractor, the Cost Engineer will concurrently prepare a cost estimate for comparison with the contractor's bid.

g. Progress

Physical Progress

The project percentage of completion may be based on physical progress, which is determined by utilizing:

- Manhours Expended
- Quantities Installed
- Judgment

Following is an example of an analysis of project completion based on physical completion of individual packages:

| Package | Weighted Percent | Physical Completion | Composite Percent |
|---|---|---|---|
| CO1 | 14.2% | 74% | 10.5% |
| CO2 | 27.0 | - | - |
| CO3 | 36.4% | 100 | 36.4% |
| CO4 | 22.4 | 35 | 7.8% |
| | 100.0% | | 54.7% |

Earned progress

Earned costs may be used to determine progress if a detailed progress payment estimate, based on physical completion, is being utilized.

This method assumes that individual, detailed cost items are being monitored and statused for each payment period. Therefore, earned cost compared to total cost can be used to determine progress.

h. Comparisons

- Progress - Planned versus Actual
- Commitments versus Estimates
- Cost-To-Date versus Commitments and Estimates
- Actual Expenditures versus Cash Flow Projections
- Change versus Contingency



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i. Variances and Trends

Variances and trends are analyzed to determine their effect on the estimate and cash flow. They are used for determining:

- Level of Confidence
- Areas of Risk
- Distribution of Expenditures



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VII. COST ACCOUNTING

A. Record of Actual Costs
B. Purchase Orders
C. Commitments
D. Payments
E. Retention
F. Taxes
G. Property records



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VIII. COST ENGINEERING ON SMALL AND LARGE PROJECTS

A. Review of Project Control Responsibilities

Cost Replacement

Scheduling

B. Characteristics of Large and Small Projects

Large Project

Small Project

C. Typical Project Control Effort

Large Project

Small Project

D. Examples of Various Levels of Effort of Project Control



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# CONSTRUCTION CONTRACTING METHODS AND ADMINISTRATION

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# CONSTRUCTION CONTRACTING METHODS AND ADMINISTRATION

## TOPICS

- Organizational Structures of Construction Projects
- Types of Construction Contracts
- Individual Construction Responsibilities
- Risk in Construction
- Elements of a Construction Management Program
- Elements of a Construction Contract
- Construction Considerations during Design

## OBJECTIVES

Upon completion of this module, the participant should be able to:

- Name, define, and contrast concepts of construction organizational structures.
- Identify and discuss the different types of construction contracts and their unique characteristics.
- Define the responsibilities of various construction functional positions within a project organization.
- Implement the principles and action plan of risk management as they relate to construction management.
- Explain roles and benefits of the elements of a construction management program.
- Identify and define the elements of a construction contract.
- Monitor and input construction viewpoints during the design phase to increase cost savings.



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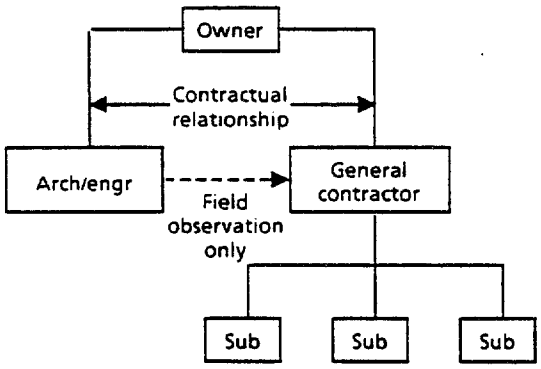
## ORGANIZATIONAL STRUCTURES OF CONSTRUCTION PROJECTS

Session Objective:

Introduce and discuss the four basic organizational structures

* Traditional A/E
* Design/Construction Management
* Professional Construction Management
* Design/Build

TRADITIONAL A/E CONCEPT




* Complete design services by A/E
* A/E assistance with Bid and Award
* Limited services during construction
* Construction by General Contractor



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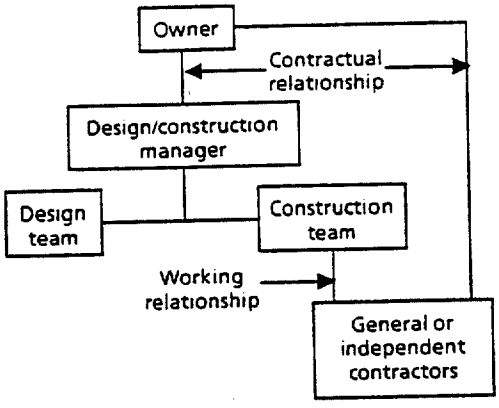
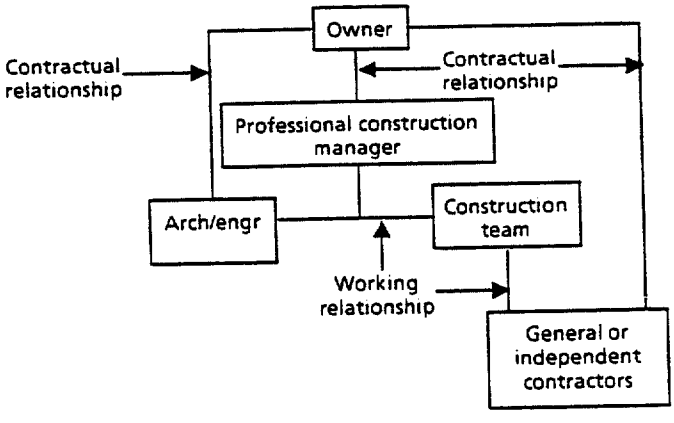
## DESIGN/CONSTRUCTION MANAGEMENT CONCEPT




* A/E Firm provides both design and C. M. services
* Single Project Manager responsible for all A/E services
* Construction by one general or several independent contractors
* Fast Track, Lump Sum construction contracts probable

## PROFESSIONAL CONSTRUCTION MANAGEMENT CONCEPTS

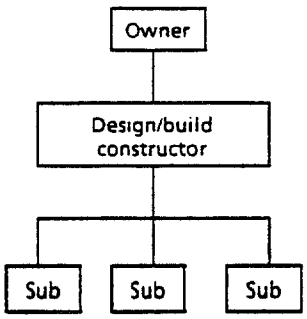



* Separate Contract for Construction Management
* A/E provides TRADITIONAL DESIGN SERVICES
* C.M. administers entire project
* Construction usually by several independent contractors
* Fast Track, Lump Sum Construction Contracts probable



1302

## DESIGN/BUILD CONCEPT




* Single contract for entire package
* Design and construction with contractor's in-house capabilities
* Fast Track construction
* Lump Sum requires detailed scope of project
* Cost Plus Fixed Fee is alternative to Lump Sum
* Can result in lowest cost and fastest delivery



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## TYPES OF CONSTRUCTION CONTRACTS

Session Objectives:

Identify various forms of contracts used in construction

Discuss the relationships formed by the various types of contracts

Discuss the unique qualities of the various forms of contracts

## COMMON TERMS USED IN CONTRACTING

* Prime Contractor

  Has direct construction contract with Owner

* Independent Contractor

  One of several contractors to have direct contract with Owner

* Subcontractor

  Contract is with other than the Owner

* Broker

  Employs supervisor to oversee several subcontractors

* Fast Track

  Overlap of design and construction activities

* Lump Sum

  Guarantees price for specified scope

* Unit Price

  Guarantees price for each unit of work

* Time and Material

  Guarantees amount of mark-up on labor and materials

* Fixed Fee

  Guarantees a fixed fee to cover overhead and profit



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## COMMON TERMS USED IN CONTRACTING
(Continue)

* Target Manhour

  Guarantees decreased mark-up when manhours are exceeded

* Variations on all the above

## GENERAL CONTRACT

* Contractor responsible for work of all trades
* Contractor performs work of several trades
* Subcontractors may perform specialty work
* Contractor furnishes and installs normal building material and equipment
* Contractor has overall responsibility for construction of project and controls site facilities
* Payments generally based on percentage of work complete and acceptable

## SUBCONTRACT

* Agreement between General Contractor and Specialty Contractor
* Subcontractor performs work of single trade or specialty
* Furnishes and installs items of single trade or specialty
* Bound to same terms and conditions as General Contractor
* Payments are made by General Contractor to Subcontractor



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## DESIGN/BUILD CONTRACT

* Agreement for all design, furnish and construction services
* Contractor is single source for complete package
* Contractor generally has in-house capabilities for all services
* Financing alternatives may be a part of overall services

## TECHNICAL SERVICES CONTRACT

* Agreement for a specific service
* Generally a specialty service to support Design or Construction
* Agreement may be with Contractor or Owner
* May be selected by reputation or capabilities rather than price

## PROFESSIONAL CONSTRUCTION MANAGEMENT CONTRACT

* Agreement directly with Owner for Professional Management Services
* Agreement may include administration of Architect/Engineer
* Cost of actual construction is not guaranteed
* Administers all phases of construction as Owner's Representative
* Agreement generally calls for planning, constructibility reviews and many times value engineering
* Construction performed by independent contractors



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## CONSTRUCTION MANAGEMENT CONTRACT

* Agreement directly with Owner
* May include construction as well as management
* May guarantee final construction price
* Agreement may include administration of Architect/Engineer
* This type of Construction Management usually performed by a General Contractor
* Construction Manager subcontracts for remainder of construction

## INDIVIDUAL CONSTRUCTION RESPONSIBILITIES

Session Objectives:

Introduce and discuss the various functional positions

Describe typical responsibilities for these positions

## DEFINITIONS OF RESPONSIBILITY VARY WITH PROJECT NEEDS

*There is no single "correct" assignment of responsibility

*Positions and functions must be responsive to needs of project



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## PROJECT ORGANIZATION DIRECTLY AFFECTS INDIVIDUAL RESPONSIBILITIES

*Important that project requirements be understood

*Project organization must be well defined

*Functions of positions within organization are assigned

*Authority to carry out responsibilities is essential

*Experience and capabilities of people can be matched to position functions, authority and responsibility.

## RISK IN CONSTRUCTION

Session Objectives:

Define risk as it relates to construction

Discuss risk management principles

Describe the principles of allocating risk

Suggest an effective risk management program

Suggest actions to take when risk results in dispute

## WE ALL MANAGE RISK TO SOME DEGREE

* Risk exists wherever the future is unknown

* If there is potential for variation in the possible outcome in a given situation there is risk

The foundation for a sound claims management program is composed of proper risk allocation and competent risk management

## RISK MANAGEMENT

* Recognize that risks exist
* Define all known potential risks
* Share risk equitably
* Minimize risk by assigning limits of exposure
* Important issues to decide:
    - What levels of risk are realistic to assume?
    - Who can best assume each risk?
    - What levels and kinds of risk are properly and most economically passed on to insurance carriers?



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## ENGINEERING RELATED RISK

### DESIGN OR PERFORMANCE FAILURE

System may fail when subjected to design conditions

### INCORRECT PRESENTATION

Missing information and discrepancies

### WORK NOT PROPERLY SCHEDULED

Schedule delays affect engineering and construction cost

### IMPROPER ESTIMATES

Engineering rework to protect budget may result

### EXCEEDING AUTHORITY

Directions given to vendor or contractor without Owner's approval may result in cost



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## CONSTRUCTION RELATED RISKS

* Physical

  (subsurface conditions)

* Contractual and Legal

  (flaw in contract - lawsuit due to injury)

* Performance

  (Capability of subcontractors - weather)

* Economic

  (correct bid prices - inflation)

* Political and Public

  (permits - withdraw funding)

## ALLOCATION OF RISK

* All risks are lawfully the Owner's unless contractually transferred or assumed by others for fair compensation

* Principal guidelines for transferring risk are whether receiving party has competence to assess the risk and expertise to control or minimize it

* Risks are normally allocated by the following:

  - Owner's legal department
  - Preparations of terms and conditions
  - Plans and specification
  - Negotiation
  - Courts



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* Courts generally observe these traditional legal principles:
    - Which party can best control the risk?
    - Which party can best foresee the risk?
    - Which party can best bear the risk?
    - Which party benefits/suffers if the risk materializes?
* "Risk Dumping" by Owners and A/E's is unwarranted:
    - Owner may pay twice - in bid price and secondary claims
    - Owner may be lulled into false sense of security
    - Owner always retains greatest amount of risk
* Reputations on risk allocation influence contractors

## SUGGESTIONS FOR AN EFFECTIVE RISK MANAGEMENT PROGRAM

1. Through engineering with competent advance planning
2. Adequate site and subsurface examination
3. Disclosure of all available design information
4. Permits and right-of-way obtained in advance by Owner
5. Strong competent management by all parties
6. On-site decision making ability
7. Adequate financial security of all parties
8. Adequate management procedures
9. Construction input during design
10. Good labor contracts and conditions

## SUGGESTIONS WHEN RISK RESULTS IN DISPUTE

1. Negotiate and settle as soon as possible
2. Discover all possible evidence
3. Try to understand the opposing viewpoint
4. Attempt to be fair
5. Keep lines of communication open
6. Avoid litigation if possible



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## ELEMENTS OF A CONSTRUCTION MANAGEMENT PROGRAM

Session Objectives:

*Define Construction Management

*Identify elements of Construction Management

*Discuss the role of each element

*Discuss the benefits of implementing each element

### CONSTRUCTION MANAGEMENT

* The planning, development and implementation of a construction program
* Part of an overall team effort which includes the Owner, Designers, Vendors and Contractors
* The construction management tool box contains proven methods and procedures for implementing the elements of a Construction Management program



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## LISTING OF BASIC PROGRAM ELEMENTS

*Construction Planning

*Constructibility Reviews

*Bid and Award

*Contract Administration

*Site Coordination

*Cost and Schedule Control

*Quality Control

*Material Control

*Construction Records

*Site Services

## CONSTRUCTION PLANNING

* Determine organizational structure at concept
* Develop scope of construction contracts and milestone schedules
* Integrate design plan with construction plan
* Identify and assign responsibility for interface points

## CONSTRUCTIBILITY REVIEWS

* Aid Designer in economic choice of methods and materials
* Assist Designer - obtain competitive pricing
* Input must be very early to be easily incorporated
* Value engineering can be provided



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## BID AND AWARD

* Commercial sections are developed early and finalized as technical sections are completed
* Bidders are pre-qualified
* Bids must be solicited and questions answered in a uniform manner
* Evaluation must be confidential and uniform
* Important to document each step of process
* Conforming documents prior to award minimizes confusion

## CONTRACT ADMINISTRATION

* Administration of all commercial matters
* Published methods and procedures clarify everyone's role
* Process all scope changes
* Provide communication link between Owner and Designer
* Source of documentation
* Interpret intent of terms and conditions

## SITE COORDINATION

* Enforce integrated construction work plan
* Administer use of common facilities
* Administer safety and security programs
* Provide labor relations program when required
* Preside at job meetings



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## COST AND SCHEDULE CONTROL

* Monitor value of work complete
* Report on financial status of project and cash flow
* Provide estimates for new work, changed conditions and studies
* Provide the accounting and financial documentation
* Monitor progress and report
* Provide "work-around" solutions to problem areas
* Develop workable formats for the field
* Assure integration with design and procurement

## QUALITY CONTROL

* Assure that the latest revision of documents is in use
* Inspect for conformance with technical requirements
* Witness tests and critical construction procedures
* Document the acceptability of the work

## MATERIAL CONTROL

* Maintain current delivery status reports
* Receive and inspect incoming shipments
* Administer necessary repairs and corrections
* Protect warranty with proper storage procedures
* Administer and inventory and turn over procedure

## CONSTRUCTION RECORDS

* Develop and maintain a retrievable filing system
* All revisions of all construction related documents must be on file
* Provide documentation for all contractual and construction related activities

## SITE SERVICES

* Provide services common to all site contractors
* Eliminate multiple overhead (general conditions) items
* Assure that services are adequate
* Available to take over special or troubled construction activities



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## ELEMENTS OF A CONSTRUCTION CONTRACT

Session Objectives:

* Explain why a contract is necessary
* Discuss the differences between a material purchase and construction contract
* Define and discuss the elements of a construction contract

### THE CONTRACT IS THE BASIS FOR ACCOMPLISHING CONSTRUCTION

* A Contract must exist in some form
* The Contract is the starting point and remains as the basis for all changes
* The Contract sets forth the requirements and responsibilities of all parties
* The Contract must be legal and binding



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## DIFFERENCES BETWEEN

## MATERIAL/EQUIPMENT PURCHASE AND CONSTRUCTION CONTRACT

### MATERIAL/EQUIPMENT PURCHASE

*Well-defined Scope

*Work in Vendor's Shop Minimizes Risk

*Independence of Working Conditions

*No Work by Craftsmen on Owner's Site

### CONSTRUCTION CONTRACT

*Work by Craftsmen on Owner's Site

*Labor Relations, Safety, Security

*Coordination of Several Participants

*Administrative Process of Changing Scope

*Acceptance and Payment for Work

### ELEMENTS OF A CONSTRUCTION CONTRACT

*Agreement

*Bonds

*General Conditions

*Special Conditions

*Scope of Work

*Technical Sections

*Drawings



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## AGREEMENT

*Project description

*Description of the work

*Legal names and addresses

*Clause binding each party to the contract

*Description of what each party agrees to (references)

*Schedule of prices and contract amount

*Signatures

## BONDS

Protection for Owner when contractor fails to perform does not guarantee trouble free jobs

*Bid Bond

*Performance Bond

*Payment Bond

*Combination Bond

*Warranty Bond

## GENERAL CONDITIONS

* Conditions under which work is done
* Apply to all contractors and provide a common language
* Reference general conditions are available
* Recommend that the legality of General Conditions be reviewed by legal counsel
* Discussion of the elements of General Conditions

## SPECIAL CONDITIONS

* Conditions under which the work is to be done for each specific contract
* Owner-provided site services and facilities
* Special instructions are given to contractor
* Methods of measurement and payment
* Safety program
* Quality control requirements
* Reports and submittals
* Project control program
* Job rules are given or referred to

## SCOPE OF WORK

* Detailed scope of work
* Items furnished by owner
* Statement of intention of documents
* List of technical sections



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## TECHNICAL SECTIONS OF CONTRACT DOCUMENTS

* Prepared by the Designer
* Set forth the technical requirements for the work
* Describe acceptable materials
* Describe acceptable methods of installation
* Acceptance criteria for finished work
* Specifications may contain a "General Requirements" section
* CSI 16 part format popular for building construction
* A/E developed format popular for heavy or special construction

## CONTRACT DRAWINGS

* Prepared by the Designer
* Show locations, quantities and configurations of the work
* May include vendor drawings showing product data
* Identification is by drawing number and revision
* Drawings should indicate Released for Construction
* Important that all participants are working to latest revision of drawings
* The contract drawing list must be complete to legally bind the contractor to the entire scope



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## CONSTRUCTION CONSIDERATIONS DURING DESIGN

Session Objectives

* To stress the importance of including input from a construction viewpoint during design
* To review the findings of Business Roundtable's cost effectiveness report on this subject
* To suggest meaningful methods for incorporating the construction viewpoint

### IMPORTANCE OF THE CONSTRUCTION VIEWPOINT

* Development of the overall project approach
* Development of contracting strategies
* Presentation of the design
* Layouts that lend themselves well to construction and maintainability
* Administration of the work especially at interface points
* Integration of the construction schedule with the design schedule to assure a smooth flow of work



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## FINDINGS OF THE BUSINESS ROUNDTABLE

Significant savings can result with the interaction of engineering and construction considerations during design

*Improved project economics

*Effective use of field labor

*Work simplification

*Shorter schedule

*Application of advanced technologies

Studies by Business Roundtable show that typical savings on a project are 10 to 20 times the cost of additional personnel

## INCORPORATION OF THE CONSTRUCTION VIEWPOINT

* Owner and Management must be committed to this concept
* Input must be in early stages as most project results are fixed during the first 25% of design
* Engineering must be receptive to considering construction input
* Experienced construction personnel with good communication skills are required to participate in:

  *Conceptual development and planning

  *Decision making

  *Design reviews, Scheduling and Cost Estimating

  *Consultation on construction related problems

# GENERAL CONDITIONS
# FOR
# CONSTRUCTION CONTRACTS


DEFINITIONS

2:01 DEFINITIONS

CONSTRUCTION MANAGER'S ROLE

2:02 CONTRACT PARTS AND CONSTRUCTION MANAGER'S DECISIONS

2:03 NO WAIVER OF OBLIGATIONS

CONTRACTOR'S ROLE

2:04 INDEPENDENT CONTRACTOR

2:05 COLLATERAL WORK

2:06 WORK PERFORMED AT CONTRACTOR'S RISK

2:07 CONTRACTOR INFORMED AS TO CONDITIONS

2:08 REMOVAL OF EMPLOYEES

2:09 EMERGENCY ORDERS

2:10 SKILLED WORKERS

2:11 CONTRACTOR'S ADDRESS

2:12 PERSONAL ATTENTION OF CONTRACTOR

2:13 REMOVAL OF EQUIPMENT

2:14 ASSIGNMENT OF CONTRACT

2:15 SUBCONTRACTS

SCHEDULE

2:16 TIME AND ORDER OF COMPLETION

2:17 INCREASE OF WORKING FORCE AND EQUIPMENT

2:18 DISCONTINUANCE FOR CAUSES BEYOND THE CONTROL OF THE PARTIES

PAYMENT

2:19 PROGRESS ESTIMATES AND PAYMENTS

2:20 FINAL PAYMENT

2:21 PROVISIONAL ACCEPTANCE

2:22 INDEBTEDNESS AND LIENS

CHANGES

2:23 CHANGES IN THE WORK

2:24 NO CLAIM BECAUSE ACTUAL QUANTITIES DIFFER FROM ESTIMATES

QUALITY

2:25 INSPECTION AND RIGHT OF ACCESS

2:26 MATERIALS AND EQUIPMENT

2:27 GUARANTY


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# GENERAL CONDITIONS
# FOR
# CONSTRUCTION CONTRACTS


PROJECT REQUIREMENTS

2:28 LAYOUT AND MEASUREMENT

2:29 PROTECTION OF PROPERTY

2:30 LANDS FOR CONSTRUCTION PURPOSES

2:31 WORK WEEK

2:32 USE OF EXPLOSIVES

2:33 CLEANING UP

SUSPENSION AND TERMINATION

2:34 CONSTRUCTION MANAGER'S RIGHT TO STOP WORK

2:35 RIGHT TO TEMPORARILY SUSPEND WORK BY THE CONSTRUCTION MANAGER

2:36 SUSPENSION OF WORK IF CONTRACT IS VIOLATED

2:37 OPTION OF TERMINATION BY THE CONSTRUCTION MANAGER

INDEMNIFICATION

2:38 INDEMNIFICATION

2:39 INFRINGEMENT OF PATENTS

2:40 CONSEQUENTIAL DAMAGES

LAWS AND REGULATIONS

2:41 LAWS, REGULATIONS, AND PERMITS

2:42 TAXES AND WITHHOLDINGS

2:43 REQUIREMENTS FOR HEALTH AND SAFETY

2:44 EQUAL OPPORTUNITY CLAUSE

APPENDIX A - Equal Opportunity Compliance Certificate


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# memorandum

Gilbert/Commonwealth

**To:** Course Participants

**From:** Training and Development

**Subject:** Course Evaluation - Construction Contracting

The intent of the Project Management and Supervisory Training Course is to emphasize the importance of team work to project success and to review methods to enhance effective project management and control. Please evaluate the merits/shortcomings of this module as indicated below. Criticisms should be accompanied by suggestions for improvement.

1. Adequacy in meeting the overall course objectives

2. Success in meeting the module's stated objectives

3. Instruction methods, including presentation, selection of visual aids, and information presented in the training manual

# TEACHING OUTLINE

# TIME MANAGEMENT

# TEACHING OUTLINE

## TIME MANAGEMENT

## I. OBJECTIVES

Participants will be able to:

1. Explain the principles of good time management, as explained in the reading assignment below in items II, 2 and 3.

2. Identify areas where they are and are not using time wisely on their job. Determine what things they can do to use time more wisely.

3. Develop a personal plan of action, with the assistance of the instructor and fellow participants, to most effectively use their time through:

   - Working smarter.
   - Delegating more.
   - Eliminating work tasks.

## II. INSTRUCTOR PREPARATION

1. Complete the "Time Use Log" for three days.

2. Read - "Getting the Monkey Off Your Back."

3. Read - "Time wasters: Possible Causes and Solutions."

4. Study and complete on yourself the following participants handouts:

   - Managing your time.
   - Gaining time by knowing yourself.
   - Saving time with paperwork, office callers, and writing.
   - Saving time with telephone, gadgetry, and filing.
   - Working with your secretary or assistant.
   - Saving time through delegation.
   - My plan of action for more effective time use.

5. Preview the film - The Time Of Your Life.

   - Determine what trigger questions you will ask.

6. Preview the participants' assignment sheet.

## III. SCHEDULE OF EVENTS

1. As a humorous start, distribute copies of the Scheduling Calendar to all participants. - 2 min.

   A. Then assure participants this is going to be a very short session. "We've done a lot of research on Time Management and have discovered the seven key elements to mastering the use of time." - Read the seven items from the calendar.

2. Lead a discussion on how well we are currently using our time (make sure you include yourself).



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A. Time Use Log - 20 min.

Discuss with participants the results of their three day time analyses.

- o What did they learn about how to manage their time?
- o What percentage of their time was spent on high priority items? Low priority?
- o How much wasted?
- o How much time could have been gained through delegation?

B. Ask participants to identify their time management problems as discovered from the following sheets. (Do not review each sheet individually.) - 10 min.

- o Gaining time by knowing yourself.
- o Managing your time.
- o Saving time with paperwork, office callers, and writing.
- o Saving time through delegation.
- o Saving time with telephone, gadgetry, and filing.
- o Working with your secretary or assistant.

C. Write these on left side of chalkboard. Select five or six of the most frequently mentioned ones.

D. Using the booklet - "Time Wasters: Possible Causes and Solutions," as a reference, lead a discussion concerning the - 20 min.

causes and possible solutions to these five or six major "Time Wasters" identified by the participants above.

Help the participants to come up with the causes and solutions.

Write the "solutions" on the chalkboard opposite each "waster."

3. The Time of Your Life film - 55 min.

- Ask: "Why should we get better control of our time and life?"
- "The film we are about to see will present ideas that will help us to better deal with interruptions, procrastination, unpleasant tasks, paper work and telephone problems."
- Introduce the film
  - "The film is based on a book written by Alan Lakein titled, How to Get Control of Your time and Your Life. It is designed to give us a clear understanding of the basic principles and practices of good time management. It presents ideas on how to become a better decision maker about the use of time, on how to be more analytical about the way we think about time, and on how to develop some intuitive skills about time use."
  - Ask participants to take notes of the main points in the film.
  - Show the film - stopping at 1 or 2 critical points for class discussion. Ask the trigger question you selected during your preparation.

- Hold a post film discussion. Help the participants to summarize the main learning points, i.e.:

  - List goals and set priorities
  - Make a daily "TO DO" list
  - Start with A's, not C's
  - Ask, "What is the best use of my time right now?" often
  - Handle each piece of paper only once
  - Do it now

4. Workshop - 30 min.

- Group participants into discussion teams used in session one.

- Making use of the principles presented in the film, ask each participant to prepare a plan of action for more effective time use. They are to follow the instructions listed on the "My Plan of Action For More Effective Time Use" sheet found in their participants' notebook.

- After the above exercise is completed, explain they have started to get control of their time. They now are prepared to concentrate their time on important priorities. They have a positive direction in which to move, and continue to develop their time management skills on their own.

5. Application and Summary - 10 min.

- Ask participants to write on their application sheets the major things they learned from this session.

- Ask three or four people to share these with the class. Use these to summarize the main points taught in the session and give recognition to sharers.

- Inspire participants to transfer their learnings to back-on-the-job situations.

6. **Assignment** - 5 min.

- Preview participants' assignment for the next session.

Total Scheduled Time:
2 Hours 32 minutes



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# TIME MANAGEMENT

## Participant's Assignment

**OBJECTIVES**

Participants will be able to:

1. Explain the principles of good time management.

2. Identify areas where time is or is not used wisely on the job.

3. Develop a personal plan of action to more effectively use time through:

   - Careful Planning
   - Delegating
   - Setting Priorities

**READING**

1. Getting the Monkey Off Your Back

2. Time Wasters: Possible Causes and Solutions

   (NOTE: Both are found in this notebook.)

**HOMEWORK**

1. Complete the time use log - for at least three days prior to this session. Analyze how your time was used these three days. Determine the amount of time wasted, used for non-priority activities, and how much could have been gained through delegation.



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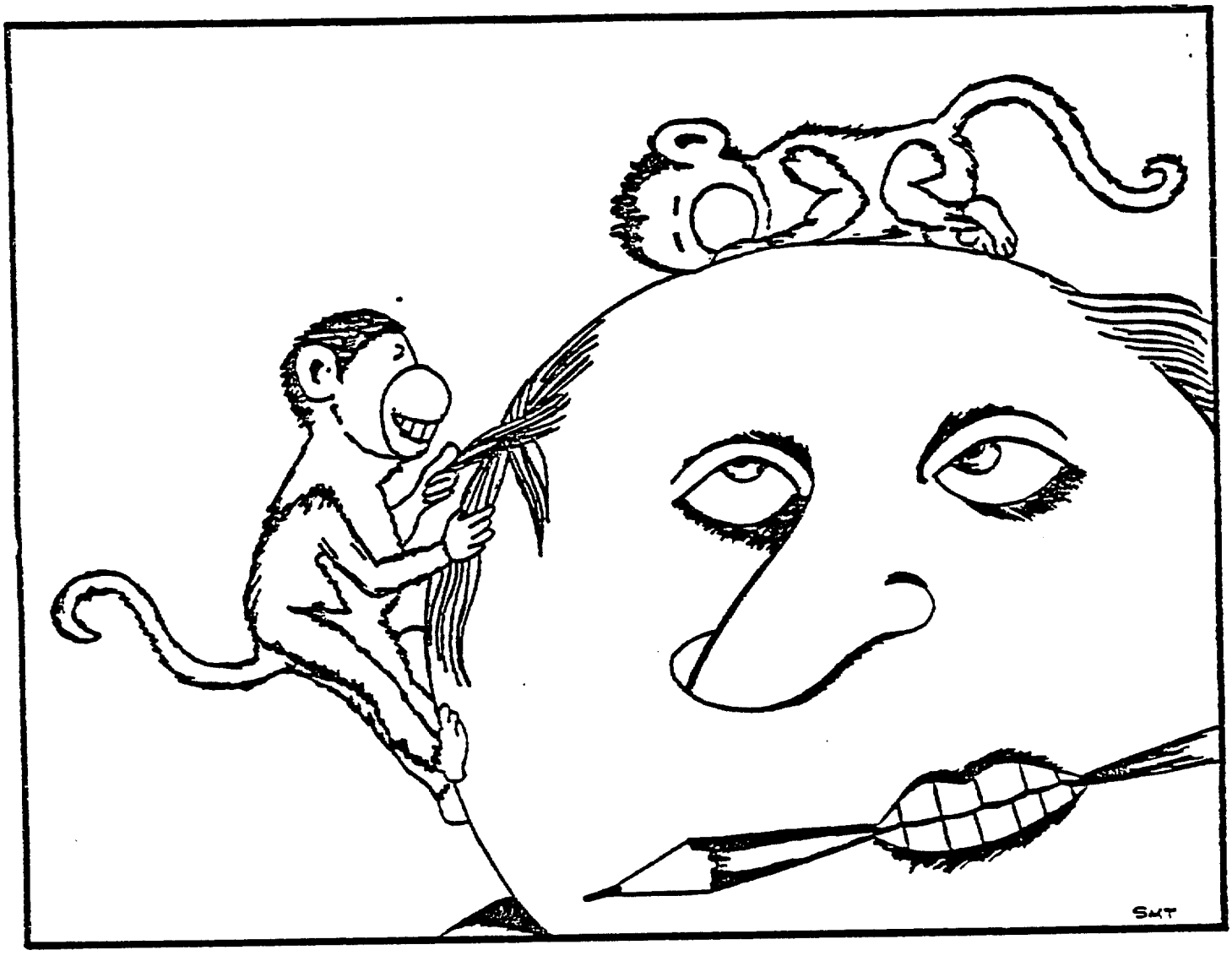
2. Complete the following time use check sheets, and be prepared to discuss in class what you discovered.

- Gaining Time By Knowing Yourself
- Managing Your Time
- Saving Time With Paperwork, Office Callers and Writing
- Saving Time With Telephone Gadgetry and Filing
- Saving Time Through Delegation
- Working With Your Secretary or Assistant

# Getting the Monkey off Your Back




by Samuel C. DeWald

*"When you're up to your waist in alligators, it's often difficult to remember your initial objective was to drain the swamp." -Anonymous*

Does the above sound like an early participant in EAMS, the Eastern Area's Management System?

Finding "the time" to manage by objectives is one of the most frequently expressed concerns of managers involved in objective-setting systems, and for good reason. Those hungry alligators continue to nip at your heels relentlessly while more noble goals beckon. Some of the day-to-day demands of the job must give way if additional hours are to be found to set objectives, develop action plans, define standards of evaluation, maintain records and counsel with employees. It often boils down to a choice between a longer working day or a better run one.

A swamp manager who tries to

*Mr. DeWald is assistant professor of management development at the Pennsylvania State University.*



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## "Time Wasters," Possible Causes and Solutions*

The following "time wasters" have been found to be the most commonly encountered by management personnel. In addition to these time wasters, possible causes and solutions are listed as ways of correcting the problems. This list is not complete but rather a list of those more frequently encountered:

| Time Waster | Possible Causes | Solutions |
|---|---|---|
| 1. Lack of planning | Failure to see the benefit | Recognize that planning takes time but saves time in the end. |
| | Action orientation | Emphasize results, not activity. |
| | Success without it | Recognize that success is often in spite of, not because of, methods. |
| 2. Lack of priorities | Lack of goals and objectives | Write down goals and objectives. Discuss priorities with subordinates. |
| 3. Overcommitment | Broad interests | Say no. |
| | Confusion in priorities | Put first things first. |
| | Failure to set priorities | Develop a personal philosophy of time. Relate priorities to a schedule of events. |
| 4. Management by crisis | Lack of planning | Apply the same solutions as for lack of planning. |
| | Unrealistic time estimates | Allow more time. Allow for interruptions. |
| | Problem orientation | Be opportunity oriented. |
| | Reluctance of subordinates to break bad news | Encourage fast transmission of information as essential for timely corrective action. |



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| Time Waster | Possible Causes | Solutions |
|---|---|---|
| 5. Haste | Impatience with detail | Take time to get it right. Save the time of doing it over. |
| | Responding to the urgent | Distinguish between the important. |
| | Lack of planning ahead | Take time to plan. It repays itself many times over. |
| | Attempting too much in too little time. | Attempt less. Delegate more. |
| 6. Paperwork and reading | Knowledge explosion | Read selectively. Learn speed reading. |
| | Computeritis | Manage computer date by exception. |
| | Failure to screen | Remember the Pareto principle. Delegate reading to subordinates. |
| 7. Routine and trivia | Lack of priorities | Set and concentrate on goals. Delegate nonessentials. |
| | Over-surveillance of subordinates | Delegate; then give subordinates their head. Look to results, not details or methods. |
| | Refusal to delegate; feeling of greater security dealing with operating detail | Recognize that without delegation it is impossible to get anything done through others. |
| 8. Visitors | Enjoyment of socializing | Do it elsewhere. Meet visitors outside. Suggest lunch if necessary. Hold standup conferences. |
| | Inability to say no | Screen. Say no. Be unavailable. Modify the open-door policy. |



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| Time Waster | Possible Causes | Solutions |
|---|---|---|
| 9. Telephone | Lack of self-discipline | Screen and group calls. Be brief. |
| | Desire to be informed and involved | Stay uninvolved with all but essentials. Manage by exception. |
| 10. Meetings | Fear of responsibility for decisions | Make decisions without meetings. |
| | Indecision | Make decisions even when some facts are missing. |
| | Overcommunication | Discourage unnecessary meetings. Convene only those needed. |
| | Poor leadership | Use agendas. Stick to the subject. Prepare concise minutes as soon as possible. |
| 11. Indecision | Lack of confidence in the facts | Improve fact-finding and and validating procedures. |
| | Insistence on all the facts - paralysis of analysis | Accept risks as inevitable. Decide without all facts. |
| | Fear of the consequences of a mistake | Delegate the right to be wrong. Use mistakes as a learning process. |
| | Lack of a rational decision-making process | Get facts, set goals, investigate alternatives and negative consequences, make the decision, and implement it. |



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| Time Waster | Possible Causes | Solutions |
|---|---|---|
| 12. Lack of delegation | Fear of subordinates' inadequacy | Train. Allow mistakes. Replace if necessary. |
| | Fear of subordinates' competence | Delegate fully. Give credit. Insure corporate growth to maintain challenge. |
| | Work overload on subordinates | Balance the workload. Staff up. Reorder priorities. |

*Source: Adapted from The Time Trap, McKenzie, 1972
C. W. Lifer - Ohio



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TIME USE LOG

Date: _____

| Time | Actual Use | Comments |
|---|---|---|
| 7:30 | | |
| 8:00 | | |
| 8:30 | | |
| 9:00 | | |
| 9:30 | | |
| 10:00 | | |
| 10:30 | | |
| 11:00 | | |
| 11:30 | | |
| 12:00 | | |
| 12:30 | | |
| 1:00 | | |
| 1:30 | | |
| 2:00 | | |



1344

| Time | Actual Use | Comments |
|---|---|---|
| 2:30 | | |
| 3:00 | | |
| 3:30 | | |
| 4:00 | | |
| 4:30 | | |
| 5:00 | | |

Please answer these questions:

1. Did I accomplish the things that were most important for today? Why?

2. How much time did I spend on low priority things?

3. Did I take time to think today?

4. Do I have my top priorities planned for tomorrow?



1345

TIME USE LOG

Date: _____

| Time | Actual Use | Comments |
|---|---|---|
| 7:30 | | |
| 8:00 | | |
| 8:30 | | |
| 9:00 | | |
| 9:30 | | |
| 10:00 | | |
| 10:30 | | |
| 11:00 | | |
| 11:30 | | |
| 12:00 | | |
| 12:30 | | |
| 1:00 | | |
| 1:30 | | |
| 2:00 | | |



1346

| Time | Actual Use | Comments |
|---|---|---|
| 2:30 | | |
| 3:00 | | |
| 3:30 | | |
| 4:00 | | |
| 4:30 | | |
| 5:00 | | |

Please answer these questions:

1. Did I accomplish the things that were most important for today? Why?

2. How much time did I spend on low priority things?

3. Did I take time to think today?

4. Do I have my top priorities planned for tomorrow?



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# TIME USE LOG

Date: _____

| Time | Actual Use | Comments |
|---|---|---|
| 7:30 | | |
| 8:00 | | |
| 8:30 | | |
| 9:00 | | |
| 9:30 | | |
| 10:00 | | |
| 10:30 | | |
| 11:00 | | |
| 11:30 | | |
| 12:00 | | |
| 12:30 | | |
| 1:00 | | |
| 1:30 | | |
| 2:00 | | |



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| Time | Actual Use | Comments |
|---|---|---|
| 2:30 | | |
| 3:00 | | |
| 3:30 | | |
| 4:00 | | |
| 4:30 | | |
| 5:00 | | |

Please answer these questions:

1. Did I accomplish the things that were most important for today? Why?

2. How much time did I spend on low priority things?

3. Did I take time to think today?

4. Do I have my top priorities planned for tomorrow?



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## GAINING TIME BY KNOWING YOURSELF

Questions to ask about yourself

1. Have you identified the most important tasks and responsibilities of your job? _____

   _____

   _____

2. List those things which should be done daily.

3. Determine those things that contribute most to success.

4. What do you get paid to do?

5. What things do you really like to do?

6. Should you be doing them?

7. Do you drag them out to fill time because you enjoy them and because they make you feel secure?

8. What can you delegate?

9. What can you do smarter?

10. What tasks do you dislike the most?

11. How much time do you spend planning --

    A. The day

    B. The week

    C. The month

    D. Long-range planning

12. When do you work best:

    Prime time

13. Do you know how to catch your momentum?

14. How do you use miscellaneous time?

15. How do you use leisure time?

S. C. DeWald



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## "MANAGING YOUR TIME"

## (HOW DO YOU RATE?)

(Circle one)

| | | | |
|---|---|---|---|
| (yes) | (no) | 1. | Start a job before thinking it through? |
| (yes) | (no) | 2. | Leave jobs before completion? |
| (yes) | (no) | 3. | Schedule less important work before more important (and possibly more unattractive) work? |
| (yes) | (no) | 4. | Oversupervise subordinates? |
| (yes) | (no) | 5. | Undersupervise subordinates, with consequent crises? |
| (yes) | (no) | 6. | Spend too much time on problems brought to you by subordinates? |
| (yes) | (no) | 7. | Do things that can be delegated to others? |
| (yes) | (no) | 8. | Do things that can be delegated to modern machines? |
| (yes) | (no) | 9. | Do things that actually aren't part of your real job? |
| (yes) | (no) | 10. | Spend too much time on your previous area of interest or competence? |
| (yes) | (no) | 11. | Do unproductive things from sheer habit? |
| (yes) | (no) | 12. | Keep too many, too complicated, or overlapping records? |
| (yes) | (no) | 13. | Pursue projects you probably can't achieve? |
| (yes) | (no) | 14. | Pay too much attention to low yield projects? |
| (yes) | (no) | 15. | Fail to anticipate crises? |
| (yes) | (no) | 16. | Handle too wide a variety of duties? |
| (yes) | (no) | 17. | Shrink from unfamiliar duties? |
| (yes) | (no) | 18. | Fail to build barriers against interruptions? |
| (yes) | (no) | 19. | Allow conferences and discussions to wander? |
| (yes) | (no) | 20. | Allow conferences and discussions to continue after their purpose if fulfilled? |
| (yes) | (no) | 21. | Conduct unnecessary meetings, visits, and phone calls? |
| (yes) | (no) | 22. | Chase trivial data after the main facts are in? |
| (yes) | (no) | 23. | Engage in personal work or conversations before starting business work? |
| (yes) | (no) | 24. | Socialize at great length between tasks? |
| (yes) | (no) | 25. | Read trade journals, newspapers, and unimportant documents and reports during most productive time each day? |

Reference: "Manage More By Doing Less," Raymond Leon



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## Saving Time With: PAPERWORK, OFFICE CALLERS AND WRITING

### I. READING AND PAPERWORK:

| | Yes | No |
|---|---|---|
| 1. Screen for a purpose (ask) | | |
| - Is it required? | ____ | ____ |
| - Is it pertinent? | ____ | ____ |
| - Is it of interest? | ____ | ____ |
| ** If not, toss it! | | |
| 2. In reading do you? | | |
| - Screen your reading materials to weed out unnecessary or unproductive matter? | ____ | ____ |
| - Skim the surface of the reading matter for main ideas? | ____ | ____ |
| - Practice rapid reading techniques to improve speed and comprehension? | ____ | ____ |
| 3. Don't be a paper shuffler! Pick it up and act on it and eliminate that continuous shuffling. | | |

### II. OFFICE CALLERS

Office callers are among the greatest consumers of your time. Whatever the priority, you must carefully budget your time if you are to be totally effective.

| Do You: | Yes | No |
|---|---|---|
| 1. Set up regular conference periods with your co-workers and accumulate items for discussion at that time? | ____ | ____ |
| 2. Hold regular staff meetings and take up matters of common concern from all sides (accumulate between meetings). | | |
| 3. Hold occasional luncheon meetings to remove pressure of social visits by various publics? | ____ | ____ |
| 4. Encourage use of other media - telephone, office mail system, etc. when personal visits are not necessary. | ____ | ____ |

### III. WRITING

| Do You: | Yes | No |
|---|---|---|
| 1. Make simple outlines for letters, memoranda, reports and more detailed outline for major writing tasks? | ____ | ____ |
| 2. Use a simple, direct style communication, getting right to the point? | ____ | ____ |
| 3. Make use of form letters and form paragraphs for routine correspondence? | ____ | ____ |



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## Saving Time With: TELEPHONE GADGETRY, FILING

### TELEPHONE

| Do You: | Yes | No |
|---|---|---|
| - Have your secretary place and answer most calls? (saves time both ways) | ____ | ____ |
| - Know ahead of time what you want to discuss and the types of references you might need? | ____ | ____ |
| - Bring the conversation to a prompt close when the business of the telephone conversation is finished? | ____ | ____ |

NOTE: Although some indicate the professional should do his own direct dialing and receive his own calls it generally is not the most efficient use of professional time.

### GADGETRY

| | Yes | No |
|---|---|---|
| (Photocopier, telephone devices, dictating units, carbonless paper, etc.) Usually multiplies human effort and eliminates drudgery. Do you use them? | ____ | ____ |

| Does It: | | |
|---|---|---|
| - Have benefits which exceed the cost or burdens? | ____ | ____ |
| - Replace something else? | ____ | ____ |
| - Fit into the operating style of you and your unit? | ____ | ____ |
| - Provide simplicity? | ____ | ____ |
| - Increase flexibility? | ____ | ____ |
| - Reduce storage or inventory problems? | ____ | ____ |

### FILING

| Do You: | Yes | No |
|---|---|---|
| - Have a well defined system so you, your secretary, and others know and can use it? | ____ | ____ |
| - Save only the essentials (those "just in case" items should not be saved and will merely clutter files)? | ____ | ____ |
| - Have a systematic way for disposing file materials? | ____ | ____ |
| - Have your secretary do the filing? | | |
| - File responses to letters with the original letter? | ____ | ____ |
| - Use a system of reminders for future events (e.g. "hold file" by day or week)? | ____ | ____ |

C. W. Lifer - Ohio

## Saving Time Through: DELEGATION

| | How Do You Rate? Yes | No |
|---|---|---|
| **A. Items that can be delegated: (Do you delegate the following?)** | | |
| 1. Fact finding and analysis | ____ | ____ |
| 2. Formulation of goals - not final determination | ____ | ____ |
| 3. Preparation of first drafts | ____ | ____ |
| 4. Performance of routines and carrying out details | ____ | ____ |
| 5. Tasks others can do better, sooner, cheaper | ____ | ____ |
| 6. Representing you at meetings, conferences, etc., where your points of view can be exposed | ____ | ____ |
| 7. Tasks which will help subordinates to develop through exposure | ____ | ____ |
| 8. Tasks after decisions are made | ____ | ____ |
| NOTE: A key point in delegation is to hold your people more accountable for results instead of methods. | | |
| **B. Items that can't be delegated: (Do you handle yourself?)** | | |
| 1. Making final decisions - deciding on goals, etc. | ____ | ____ |
| 2. Executing tasks where goals are not clear | ____ | ____ |
| 3. Hiring, discipline, firing of immediate staff | ____ | ____ |
| 4. Unique or highly personalized tasks that will not come up again | ____ | ____ |
| 5. Things that must be kept absolutely secret | ____ | ____ |
| 6. Personal representation where your presence is important | ____ | ____ |
| 7. Emergency, short term tasks where there is not time to explain | ____ | ____ |

C. W. Lifer - Ohio

## WORKING WITH YOUR SECRETARY OR ASSISTANT

There is nothing that can save time for a manager more than a good secretary. Today's effective secretary must be knowledgeable and effective in the management of people as well as of paper and pushbuttons.

### How does your secretary rate?

| | Yes | No |
|---|---|---|
| 1. Does your secretary know the full range of your responsibilities and activities in your organization? Does she understand your personal goals and ambitions and how they fit in with organizational objectives? | ____ | ____ |
| 2. Can you leave the office for as much as three or four weeks, confident that your business and personal affairs will be conducted responsibly and expeditiously in your absence? | ____ | ____ |
| 3. Does she help you organize your time, coordinate your appointments and schedules, meet your deadlines - all without nagging and pestering you? Is she herself a well-organized person? | ____ | ____ |
| 4. Does she initiate, handle and follow through on projects without your having to remind her about them? | ____ | ____ |
| 5. Is she courteous, helpful, respectful and solicitous of your business associates, visitors, clients and customers? Do they speak of her favorably? | ____ | ____ |
| 6. Is she imaginative? Creative? Does she present original ideas for your consideration? Does she suggest new ways to improve your work? Does she suggest new systems or procedures? | ____ | ____ |
| 7. Is she resourceful? Does she show initiative in getting past a problem without running to you with her troubles? | ____ | ____ |
| 8. Does she move paper efficiently? Can she tactfully pry loose papers and projects that have remained on your desk too long - and that other executives are waiting for? Does she shake loose data other executives are holding and that you are waiting for? | ____ | ____ |
| 9. Are her basic secretarial skills (such as filing, stenography, and telephone manner) beyond reproach? | ____ | ____ |



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| | Yes | No |
|---|---|---|
| 10. Is she calm in a crisis? Gracious when tension mounts? When the pressure is on and you lose your temper or self-composure, does she shrug it off and continue to function as well as before? | ____ | ____ |
| 11. Do you have her absolute loyalty and confidence? Can you trust her with confidential information, both personal and business? | ____ | ____ |
| 12. Does she read widely and knowledgeably, bringing to your attention published items pertinent to your business or personal affairs? | ____ | ____ |
| 13. Is she a valuable source of information, obtaining facts that would be difficult, awkward or impossible for you to obtain on your own? | ____ | ____ |
| 14. Does she have a personal self-improvement program? Does she attend classes and lectures or participate in programs that are organization oriented? Does she try to learn more about your organization, your particular job, your customers or your type of work? | ____ | ____ |
| 15. Is she articulate? Does she express herself well in summarizing information for you, both verbally and in writing? Does she give instructions clearly and precisely? Does she know how you feel about certain policies or practices, and does she communicate this to others as well as you do? | ____ | ____ |
| 16. Does she work every day until her job is done, regardless of the hour or the many interruptions without giving up? | ____ | ____ |
| 17. Is she a manager in the sense that she can farm out her work to others when necessary? That is, can she delegate, supervise and take responsibility for work not completed by herself? Can she train or help train other members of your staff? | ____ | ____ |
| 18. Can she handle routine matters and projects for you on a day-to-day basis without your intervention? | ____ | ____ |
| 19. Does she keep track of vital dates for you, dates needed by your boss, or his office (meeting dates, deadlines, vacations and such)? | ____ | ____ |
| 20. Can she do basic research for you - gather information for a report, for example, or even write a rough draft? | ____ | ____ |

*Source Adapted from The Time Trap, McKenzie, 1972
C. W. Lifer - Ohio



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## MY PLAN OF ACTION
## FOR MORE EFFECTIVE TIME USE

### INSTRUCTIONS

1. Take two separate sheets of paper on which to write the answers to the following questions:

   - Question #1 - What are my long term work goals?
   - Question #2 - What are my short term work goals?

2. Now go back over both lists and set priorities by the A, B, C, method. Remember A goals are high value goals, B for medium value, and C for low value goals. You can have any number of A's, B's or C's.

3. The next step is to identify the A that is most important, next important, etc. This means you have one A1, one A2, one A3 and so forth. Do this for each list.

4. Now. . .with a fresh piece of paper . . .write down all the activities you can do in the next week to move along the A1 on either the short term or long term goals list.

5. Finally. . .again with the A, B, C method. . .prioritize the activities list and choose an A1, and A2, and an A3.

   When this exercise is completed, you have started to get control of your time. You now are prepared to concentrate your time on important priorities. You have a positive direction in which to move. You can continue on your own to develop time management skills for your work. . .for your life.

6. Use your team members as consultants to help you refine your plan.



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# TEACHING OUTLINE

# CONDUCTING MEETINGS

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TEACHING OUTLINE

CONDUCTING MEETINGS

I. OBJECTIVES

Participants will be able to:

1. Effectively prepare for leading a group meeting.

2. Describe the functions of the leader of a group meeting.

3. Verbally explain the actions which constitute a Task Function and the ones that constitutes a Group Relations Function.

II. INSTRUCTOR PREPARATION

1. Study the discussion leader's guide for the film "Meeting in Progress."

2. Review the participants workbook "Conference Leadership: The Critical Functions," for the above film.

3. Preview the film "Meeting in Progress."

4. Review Chapter 9 - The Role and Functions of the Group in Management 18.

III. SCHEDULE OF EVENTS

1. Go directly to the film's discussion leader's guide and follow the two and one-half hour method of presenting the film. 2 - 1/2 hours



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2. Assignment - 5 min.

- o Preview the Participants Assignment sheet for the next session.

Total hours scheduled
2 hours and 35 minutes

Concentrated on:

- o Why the answers are preferred
- o Items #1 and 3 <u>below</u> the heavy line
- o Suggest discussing Item #2 for the first 3 - 4 stops and then only periodically thereafter

4. Application - 10 min.

- o Ask participants to complete the blue application sheet
- o Ask 2 - 3 to share what they learned

5. Assignment

- o Preview the participants' assignment sheet for the next session.

Total Hours Scheduled:

2 hours and 30 minutes



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# CONDUCTING MEETINGS

## Participants' Assignment

**OBJECTIVES**

Participants will be able to:

1. Effectively prepare for leading a group meeting.

2. Describe the functions of the leader of a group meeting.

3. Verbally explain the actions which constitute a Task Function and the ones that constitute a Group Relations Function.

**READING**

- Review Chapter 9 - The Role & Function of the Group in Management 18.

**HOMEWORK**

- Continue to refine your responsibilities as a supervisor.



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What norms were established by the group? How did the group deal with those who violated the norms?

What "roles" were played by various group members? (Team player, craftsman, challenger, loner, dictator, creative idea person, summarizer, etc.) What effect did they have on the group functioning?

How did the group balance the need for both creativity and conformity?

Was there a person of a minority race, or female in the group? If yes, how did the group relate to him/her?

What, in your opinion, was the most important thing you gained from this exercise?



1362

# CONFERENCE LEADERSHIP: THE CRITICAL FUNCTIONS

Written by:
Oliver D. Fowler, Ph.D.
and
Malcolm Macurda

for use with

The Roundtable Film:

## MEETING IN PROGRESS

For additional copies of this Manager's Guidebook, write to:

ROUNDTABLE FILMS, INC.
113 North San Vicente Boulevard
Beverly Hills, Calif. 90211

REPRODUCED WITH PERMISSION
MAY 1978

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# INTRODUCTION

A great deal of today's problem solving and decision making in business, industry, government, and other organizations is done through people acting together in conferences and staff meetings. Similarly, off the job, in various community and social activities, conferences and meetings are common ways of formulating plans of action and achieving objectives.

It is important, therefore, to be able to conduct a conference effectively when you are called upon to do so. It is the purpose of this guidebook, used with the film "Meeting In Progress," to prepare you to take the role of a group leader when the occasion arises.

The principles you learn here apply not only to leading a group, but also to participating more effectively as a member. By understanding the group processes better, you will be able to make greater contributions toward the team effort, since at times each member of a smoothly working group performs the same functions as the leader.

## PREPARING FOR A MEETING

If you are to lead a conference, some initial preparation on your part will start things off smoothly. Briefly:

### 1. ARRANGE A SUITABLE PLACE FOR THE MEETING.

If it is necessary to reserve a conference room ahead of time, make sure it is available to you for the use of your group exclusively. The room should be of appropriate size with adequate seating arrangements and should be well lighted and ventilated. It should be quiet and free from distracting intrusions.

### 2. SELECT AND NOTIFY THE PARTICIPANTS.

They should be informed of the general purpose of the meeting with sufficient advance notice so that they can gather any information they may need for the meeting, as well as adjust their work or personal schedules to the time set for the meeting.

### 3. PREPARE ANY VISUAL AIDS YOU MAY NEED.

These may range from simple things, such as a blackboard, chalk, and eraser, to charts and graphs, slides, or other material. Make sure that these aids are on hand in order to avoid wasteful delays after the meeting has started.

### 4. PREPARE YOURSELF FOR THE MEETING.

Gather all the information you will need ahead of time. Do your homework by thinking through the problem and what you hope to accomplish with the meeting. Consider what each member of the group might have in the way of knowledge, experience, or information to contribute to the meeting. Above all, have a definite purpose or objective for the meeting, even though this may change in the course of the meeting. Unnecessary or purposeless meetings should be avoided.

Critical Point # 1:

The problem here is _____

_____

Your answer (check one):

☐ (A) By pointing out the benefits that would follow from a solution of the problem. (Page 30-I)

☐ (B) With a realistic statement of the consequences of the problem. (Page 16-II)

☐ (C) With a clearcut definition of the problem. (Page 14-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

There are six TASK FUNCTIONS and six GROUP RELATIONS FUNCTIONS.
(These were listed earlier on pages ii and iii).

1. This point in the meeting calls for (check one):
   ☐ a Task Function
   ☐ a Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



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## GROUP RELATIONS FUNCTIONS

ENCOURAGING: Being friendly, warm and responsive to others; accepting others and their contributions; regarding others by giving them an opportunity for recognition.

EXPRESSING GROUP FEELINGS: Sensing feeling, mood, relationships within the group; sharing one's own feelings with other members.

HARMONIZING: Attempting to reconcile disagreements; reducing tension; getting people to explore their differences.

MODIFYING: When one's own idea or status is involved in a conflict, offering to modify one's own position; admitting error; disciplining oneself to maintain group cohesion.

GATE-KEEPING: Attempting to keep communication channels open; facilitating the participation of others; suggesting procedures for sharing opportunities to discuss group problems.

EVALUATING: Evaluating group functioning and production; expressing standards for group to achieve; measuring results; evaluating degree of group commitment.

## PROCEDURE FOR USING THIS GUIDEBOOK:

On the following pages you will find questions about each critical point in the film. At these points, the discussion leader will stop the projector and allow you time to answer the questions. Simply follow the instructions indicated.

Watch the film closely and listen carefully to what the participants in the group meeting are saying.

The discussion leader will tell you when to turn to each of the following pages and write in your answers to the questions.

The questions you will be asked to answer at critical points in the film are for practice purposes only, to help improve your sensitivity, knowledge and skill. This is not a standardized test. Also, the answers, while generally applicable to similar situations, may vary under certain specific circumstances. Because of the complexity of group relationships, there are no absolute answers which cover *all* possible situations with certainty.

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Critical Point # 2:

The problem here is _____

_____

Your answer (check one):

☐ (A) Wait. Someone in the group will feel compelled to get the ball rolling again. (Page 15-I)

☐ (B) Express what you sense is the group's feeling at the moment. (Page 27-I)

☐ (C) Call on each man for his ideas. (Page 19-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a:
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



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Critical Point # 3:

The problem here is _____

_____

Your answer: (check one):

☐ (A) Change the subject diplomatically. (Page 24-I)

☐ (B) Ask Ansel where that kind of reasoning is going to lead. (Page 28-I)

☐ (C) Ask the group how they feel about his criticism. (Page 30-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a:
   ☐ Task Function
   ☐ Group Relations Function
2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



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Critical Point # 4:

The problem here is _____

_____

Your answer:

☐ (A) Ask the group how they want to proceed. (Page 14-I)

☐ (B) Ask the group for more facts about the problem. (Page 24-II)

☐ (C) Move the discussion away from the sensitive area. (Page 21-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



1369

Critical Point # 5:

The problem here is _____

_____

Your answer:

☐ (A) Give the group your opinion and any additional information you have. (Page 21-I)

☐ (B) Summarize the situation so far, without expressing your opinion. (Page 26-I)

☐ (C) Give Charlie a chance to explain further why he wants to tear down one of the machines. (Page 25-I)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function
2. The element of the above function you would use here is
3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



1310

Critical Point # 6:

The problem here is_____

_____

Your answer:

☐(A) Defend your definition of the problem. (Page 29-II)

☐(B) Communicate your reasoning more clearly so that the group will get a fresh start. (Page 20-II)

☐(C) Modify your definition of the problem. (Page 17-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



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Critical Point # 7:

The problem here is _____

_____

Your answer:

☐ (A) Indicate in a firm but friendly manner that the group is beginning to repeat itself. (Page 27-II)

☐ (B) Try to clarify the situation by reviewing the alternatives. (Page 22-II)

☐ (C) Move the group along by expressing your opinion as to what is causing the problem. (Page 18-I)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function
2. The element of the above function you would use here is
3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



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Critical Point # 8:

The problem here is _____

_____

Your answer:

☐ (A) Summarize the accomplishments and ask the members to be ready with proposals for correcting the situation at the next meeting. (Page 22-I)

☐ (B) Keep going by pointing out that the major objective was to arrive at a solution. (Page 13-I)

☐ (C) Devote some time to trying to reconcile differences before going ahead. (Page 26-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



1373

Critical Point # 9:

The problem here is_____

_____

Your answer:

☐ (A) Ask Ansel what's bothering him. (Page 25-II)

☐ (B) Apologize for the group's having criticized him earlier. (Page 17-I)

☐ (C) Encourage him with individual recognition. (Page 29-I)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



1374

Critical Point # 10:

The problem here is _____

_____

Your answer:

☐ (A) Have each man reconsider his position before you decide who is right. (Page 13-II)

☐ (B) Ask the men to get together later and iron out their differences. (Page 18-II)

☐ (C) Help the men settle their differences by getting the others to give their opinions. (Page 16-I)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



1375

Critical Point = 11:

The problem here is_____

_____

Your answer:

☐ (A) Let them know where you stand by making your own feelings known. (Page 23-I)

☐ (B) Ask the group to pick a representative of each point of view to study the matter further. (Page 15-II)

☐ (C) Try to stimulate a deeper perception by summarizing the progress so far. (Page 28-II)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function
2. The element of the above function you would use here is
3. Put down, in your own words, what you would say if you were the group leader at this point in the meeting:

_____

_____

_____

DISCUSSION NOTES:



1376

Critical Point # 12:

The problem here is _____

_____

Your answer:

☐ (A) Check out your impression with the group to see if there actually is a consensus. (Page 19-I)

☐ (B) Assume they will accept the program if most members are willing to carry it out, and ask for volunteers. (Page 23-II)

☐ (C) Let the group know they've done a good job and make the necessary assignments. (Page 20-I)

TURN TO THE PAGE INDICATED AFTER THE ANSWER YOU SELECTED.

*DO NOT PROCEED FURTHER ON THIS PAGE* until the instructions tell you to do so.

---

1. This point in the meeting calls for a
   ☐ Task Function
   ☐ Group Relations Function

2. The element of the above function you would use here is

3. Put down in your own words, what you would say if you were the group leader at this point in the meeting.

_____

_____

_____

DISCUSSION NOTES:



1377

Critical Point # 8: PAGE 13-I

Your answer:(B) Keep going by pointing out that the major objective was to arrive at a solution.

"B" is the best answer. By focussing attention on the major objective of the meeting and keeping it going, he prevents the group from disbanding before its mission is accomplished. He has evaluated the group functioning and productivity up to this point, has seen that its results have not been achieved, that they are not at this point totally committed to continuing, and that they are not achieving the standards of performance which he expects and of which he knows they are capable. From the leader's viewpoint, the conclusion that the work of the group is finished is premature. The good leader evaluates the progress and performance of the group objectively and does not allow himself to be swayed by attitudes or actions contrary to the group's purpose.

You are right. Now turn back to page 8 and answer the questions below the heavy line.

Critical Point # 10: PAGE 13-II

Your answer: (A) Have each man reconsider his position before you decide who is right.

Answer "A" forces the opponents into having to defend themselves further, thus intensifying the conflict instead of lessening it. If the leader then makes a decision, he is playing the role of the all-wise father instead of acting as a group leader. This may be resented by other members of the group, as well as by the opponent who is not favored by the decision. The leader's task is to reduce tension and restore objectivity so that the group work may proceed. His assumption of the role of judge may force the conflict underground, but it may continue to smolder there.

Please turn back to page 10 and select another answer.



1378

Critical Point # 4: PAGE 14-I

Your answer: (A) Ask the group how they want to proceed.

Answer "A" might work. But at this point Ansel is apparently voicing a need for the group leader to take charge and get down to business again. Having already gotten his own feelings and opinions out, and having listened to those of the others, he has had enough of this and feels it is time for more work on the problem. If the decision about what to do now were thrown back to the group, Ansel might resent the fact that the leader did not take charge at that point and might become more emotional and less cooperative. Also, such an indecisive question at this point puts the leader in a weak light.

Please turn back to page 4 and select a better answer.

Critical Point # 1: PAGE 14-II

Your answer: (C) With a clear-cut definition of the problem.

Answer "C" is the preferred one. A group of people called together to discuss a problem needs to be oriented very soon to the subject matter of the conference. Unless the group perceives the problem and its related factors clearly, the group cannot begin to attack the problem intelligently. Therefore, the first thing the group leader must do is to isolate the problem and define it. He should also check to be sure that the group understands the problem and its dimensions, and accepts it as the task to be undertaken.

Failure of the group leader to initiate the group's activity by a clear-cut definition of the task at hand is one of the reasons many conferences waste time and create feelings of frustration among the participants.

You are correct. Now turn back to page 1 and fill out the answers to the questions below the heavy line.



1379

Critical Point # 2: PAGE 15-I

Your answer: (A) Wait. Someone in the group will feel compelled to get the ball rolling again.

Answer "A" is sometimes effective, if pressure builds up within the group until someone feels impelled to break the silence with his own expression of feeling and a constructive suggestion. However, the feeling which erupts spontaneously may be destructive at times. And if no one says or expresses anything, including the leader, the leader himself may become the butt of their unexpressed feelings. It is natural that they look to the leader for guidance and direction, and if he does not provide this, their emotions may build and resolve themselves into resentment directed at the leader for not performing his function. Therefore, the leader must be prepared to step in and take charge at such times, in order to maintain the cohesion of the group and redirect its energies into more productive channels.

While this answer could work in certain circumstances, please turn back to page 2 and try to select a better alternative.

Critical Point # 11: PAGE 15-II

Your answer: (B) Ask the group to pick a representative from each point of view to study the matter further.

Answer "B" stops the conference short of reaching a successful conclusion. It creates feelings of frustration and futility. There may, of course, be times when it is obvious that the group cannot proceed further without additional facts which they do not have at this point. At such times, a halt in the proceedings to allow time to gather the necessary information is the only realistic course to pursue, rather than attempt to push the group to a premature decision based upon insufficient evidence. But when all the facts are on the table, such a tactic is merely sidestepping the issue. It shows a weakness of the leader in avoiding his responsibility of keeping the group mobilized toward its goal and getting the job done. It is then wasteful of time and harmful to the feeling of group coherence and unity. Such delaying tactics are often readily recognized by the group and tend to lower the status of the group leader in their eyes.

Please turn back to page 11 and select another answer.



1380

Critical Point # 10: PAGE 16-I

Your answer: (C) Help the men settle their differences by getting the others to give their opinions.

The best answer is "C". As the situation is now, the differences of opinion between Ansel and Brett have mounted to the point of open hostility. The leader is posed with the task of taking steps to reduce the resultant tension. If the leader can mobilize the group to help these two men explore their differences, the men can then become more objective about them, and the emotional tension which has been built up will be drained off. Calling on the other members of the group to express their ideas will take the focus off the immediate conflict between the two men, and they will be able to see how the others in the group react to their viewpoints. Thus, as each of the two opponents sizes up the feedback he gets from the group, he will soon learn where he stands, how much support he has, and how much sense his ideas make to the others.

In the process of helping two antagonists to explore their differences, hidden agendas may be uncovered. That is, a man may be trying to maintain his position in opposition to the other's viewpoint not because of the reasons he has put forth so far, but because something personal and heretofore unrevealed is at stake. In such a case, the opposing viewpoint is a threat to him, and the surface reasons for which he has argued are only a cover-up for his emotionally-based resistance. When the threat has come out in the open and has been dealt with, the tension will be dissipated and he can then take a more objective point of view.

You are right. Now turn back to page 10 and fill in the answers to the questions below the heavy line.

Critical Point # 1: PAGE 16-II

Your answer: (B) With a realistic statement of the consequences of the problem.

Answer "B" carries with it the implication of threat if the problem is not solved by the group. In addition, it may have adverse consequences, since it may inhibit free and open discussion and create hostility. There are times, of course, when the group needs to be informed of realistic consequences which may develop due to conditions of which they are not aware. In such exceptions, the statements made would be given as additional information about the problem.

Please turn back to page 1 and select a better answer.



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Critical Point # 9: PAGE 17-I

Your answer: (B) Apologize for the group's having criticized him.

Answer "B" would align the leader with Ansel against the rest of the group and drag the proceedings down to an emotional issue rather than further them on a realistic basis. This course of action might also be resented by Ansel himself, since in this "special treatment" he is accorded, he would be singled out as an individual rather than treated as a group member; this contains the hidden implication that Ansel must be treated as a child whose feelings have been hurt. Also, there may be other reasons why Ansel is not talking at this point. At such times, a man who already has status with the group and confidence in his own opinions may deliberately withhold them until he feels that the timing is appropriate to gain more favorable acceptance of them.

Please turn back to page 9 and select another answer.

Critical Point # 6: PAGE 17-II

Your answer: (C) Modify your definition of the problem.

Answer "C" is best. Since the leader is now in conflict with the rest of the group, he should not go on the defensive at this point. Instead, his action should be such that it preserves the unity of the group and makes it possible for the conflict to be resolved. Only in this way can the group get on with its work of solving the problem at hand. Therefore, the leader must be able to re-evaluate his own position critically in the light of new information. He must be willing and prepared to admit his own error or the possibility that he is mistaken. The leader's status does not automatically entitle him to be right. His ability to modify his own position is a vital force in building good group relationships. He should not, of course, compromise merely to "save his own face." This would weaken his position in the eyes of the other members of the group and lessen their respect for his opinions. But neither should he attempt to maintain a position of infallibility. After all, he too is human and subject to error. He must not press his own position too hard if to do so would endanger group cohesion. As leader of the group, he must discipline himself in order to keep the interests of the group foremost.

You are right. Now turn back to page 6 and fill in the answers to the questions below the heavy line.



1382

Critical Point # 7: PAGE 18-I

Your answer: (C) Move the group along by expressing your opinion as to what's causing the problem.

Answer "C" is an attempt by the leader to dominate the group by expressing his own opinion rather than focussing on the facts. Instead of participating with the group, he has already made the decision for them, thus excluding them from the process. It should be remembered that the leader himself is not infallible. His function at this point is not to take over the work of the group itself.

Please turn back to page 7 and select another answer.

Critical Point # 10: PAGE 18-II

Your answer: (B) Ask the men to get together later and iron out their differences.

Answer "B" is wrong since, in effect, it demands that the two men stifle their differences for the time being. This would leave each man in a state of tension which would very likely increase and so hamper his further participation. The differences which have arisen should be regarded as part of the group process and worked out in the group. The leader who adopts the policy of asking the two men to get together and iron out their differences later is actually labeling these differences as personal and thus removing them from the field of the group, where they have arisen. The forward progress of the group would be stymied by such an action rather than promoted.

Now turn back to page 10 and select another answer.



1383

Critical Point # 12: PAGE 19-I

Your answer: (A) Check out your impression with the group to see if there actually is a consensus.

Answer "A" is the preferred one. At this point, the leader has picked up cues that the pilot program has gained some favor, but he is not yet certain if it has sufficient backing to make it workable. Therefore, he needs to check out his impression with the group to see what the views of the members of the group actually are about the pilot program—whether or not they are ready to commit themselves to the program, carry it out successfully, and accept the results of it, providing they are clear-cut. In other words, a consensus is necessary. Otherwise, the plan will miscarry. However, 100% agreement is not essential. Nor is it necessary to poll members of a small group to make certain of the degree of consensus.

You are right. Now turn back to page 12 and fill in the answers to the questions below the heavy line.

Critical Point # 2: PAGE 19-II

Your answer: (C) Call on each man for his ideas.

Answer "C" usually forces each man to take a definite stand. He is thus apt to be put on the defensive and to defend his own opinions and feelings if they oppose those of the other members of the group. This can be harmful to the feeling of group unity and coherence since the group may break down in its function as a whole when each man becomes pitted against the others as individuals, rather than continuing to cooperate in a joint effort. Thus this approach may destroy rather than maintain the group function. It may also be based upon the mistaken notion that consensus of the members of the group will be maintained if a "roll call" is taken. It can happen at times that the members will agree merely for the sake of agreement, thus blocking any real progress. But if they disagree, their feelings of being "put on the spot" will tend to sharpen their differences rather than resolve them.

Please turn back to page 2 and select another answer.



1384

Critical Point # 12: PAGE 20-I

Your answer: (C) Let the group know they've done a good job, and make the necessary assignments.

The leader who jumps the gun by assuring the group that they have done a good job and proceeds then to assign the work necessary may be acting on the basis of his own anxiety and wishful thinking. He wants to get the meeting over with and does not want to face up to the possibility that the program in reality does not have sufficiently strong backing by the group. In other cases, this same tactic is deliberately resorted to by the manipulative type of leader who is relying on giving the members of the group a "snow job" in order to get their cooperation. In both instances, use of this tactic shows a lack of appreciation of the importance of getting the genuine cooperation and participation of the group members.

Please turn back to page 12 and select another answer.

Critical Point # 6: PAGE 20-II

Your answer: (B) Communicate your reasoning more clearly so that the group will get a fresh start.

Answer "B" assumes that the leader is really right but has not made his own definition of the problem clear enough to the group. Though this might possibly be the case, it is more probable that the leader is not listening to the input which he is receiving. Instead of re-evaluating his own definition of the problem, he is sticking to it and trying to persuade the others to accept it.

Please turn back to page 6 and select another answer.



135

Critical Point # 5: PAGE 21-I

Your answer: (A) Give the group your opinion and any additional information you have.

Answer "A" is the preferred one. The group has reached a point where they now need the leader's help. They have given much thought to the problem and made many suggestions. When the group now asks for more information or the leader's opinion, he should give it to them. If Mac has been sensitive to the group's progress and their present difficulty, it is up to him to try to help them out at this time. However, in doing this, he should stick to the objective facts as he sees them and avoid taking sides in a personal manner. In other words, he should not make a judgment as to who is right and who is wrong. To do this would tend to split the group, put some persons on the defensive, and create friction unnecessarily. But the leader should have the courage to state his opinion in an impersonal manner, making sure it is based on the evidence so far, rather than taking a biased attitude toward anyone with whom his opinions differ.

You are correct. Now turn back to page 5 and fill in the answers to the questions below the heavy line.

Critical Point # 4: PAGE 21-II

Your answer: (C) Move the discussion away from the sensitive area.

Answer "C" is not really applicable here. The sensitivities of the group have already been fairly well aired at this point. If the leader had tried to avoid facing these issues and allowing their feelings and opinions to come out, he would, of course, have shown a weakness in his leadership. But now it is time to get back to the facts, and Ansel's question is actually a request for the leader to get the ball rolling again in the direction of solving the problem.

Please turn back to page 4 and select another answer.



1386

Critical Point # 8: PAGE 22-I

Your answer: (A) Summarize the accomplishments and ask the members to be ready with proposals for correcting the situation at the next meeting.

"A" is incorrect. Such an action indicates that the leader has not properly evaluated the group's performance and potential for solving the problem during this meeting and is willing to go along with those who wish to end the meeting prematurely. He is compromising his position as a leader by aiding those who wish to postpone further work on the problem to a later date. In so doing, he reveals himself to the group as a weak leader who can be manipulated into postponing the meeting unnecessarily, and he is apt to lose the respect of other members who wish to continue.

Please turn back to page 8 and select another answer.

Critical Point # 7: PAGE 22-II

Your answer: (B) Try to clarify the situation by reviewing the alternatives.

Answer "B" is the most satisfactory response. By now, many ideas have been brought out concerning the possible causes of the problem. In such a situation, the tendency is for the group to prescribe a cure before the real cause is actually determined. It is therefore time for the leader to step in and review the alternatives so that the group can begin to see more clearly the issues before them. By doing this—perhaps by listing the alternatives on the blackboard, for instance—much of the confusion can be cleared up. This will help prevent the group from "jumping the gun" to reach premature conclusions before the evidence has been fully developed.

You are right. Now turn back to page 7 and fill in the answers to the questions below the heavy line.



138

Critical Point # 11: PAGE 23-I

Your answer: (A) Let them know where you stand by making your own feelings known.

Answer "A" does nothing to resolve the differences in the group. Taking sides with one faction or the other at this point may only result in widening the rift between the opposing forces. The task of the leader in such circumstances is to keep from becoming embroiled himself in the existing emotional conflict and get the group back to the more objective approach of examining the facts which need to be considered in order to carry out the work of the group.

Now turn back to page 11 and select another answer.

Critical Point # 12: PAGE 23-II

Your answer: (B) Assume they will accept the program if most members are willing to carry it out, and ask for volunteers.

Answer "B" assumes a consensus. It is true that asking for volunteers to carry out the plan may reveal it. However, if sufficient volunteers are not forthcoming, the leader has put himself into an awkard position by his mistaken assumption.

Please turn back to page 12 and select another answer.



1388

Critical Point # 3: PAGE 24-I

Your answer: (A) Change the subject diplomatically.

Answer "A" avoids the real issue at stake. By trying to change the subject diplomatically, the group leader would in effect be stifling the open expression of feelings, thus forcing the conflict to go underground. If this should happen, the emotional tensions built up would not be released, but would most likely continue to intensify, tending to create a chasm in the group, rather than fostering the ongoing feeling of the group's being able to work out its internal problems. While harmony may be the leader's aim in changing the subject, any surface agreement which results is apt to be only an illusion. To adopt this policy is an admission of weakness on the part of the leader who would rather avoid the emotional conflict than face it and let it work itself out. Such a policy, by blocking the feelings aroused, tends also to block the progress of the group toward completion of its task. If feelings and opinions cannot be expressed freely in the group, the members will feel inhibited by the leader's attitude.

Please turn back to page 3 and select another answer.

Critical Point # 4: PAGE 24-II

Your answer: (B) Ask the group for more facts about the problem.

The best answer is "B". The group has provided part of the answers and the need now is to gather more information to assist the group to reach a sound conclusion. At this particular point in the discussion, the group has gotten some of their feelings out, and it is up to the leader to get them back to the unfinished task at hand. He will do this by seeking further information from them in order to fill out the factual picture more fully.

You are right. Now turn back to page 4 and fill in the answers to the questions below the heavy line.



1389

Critical Point # 5: PAGE 25-I

Your answer: (C) Give Charlie a chance to explain further why he wants to tear down one of the machines.

Answer "C" would delay reaching the conference objectives. Since Charlie obviously is very biased, he could easily sidetrack the discussion if allowed to proceed further with his suggestion. Charlie has already presented his ideas, and no further purpose would be served by allowing him to expand upon them at this point, unless Mac felt that in his own opinion Charlie had come up with a possible solution.

Please turn back to page 5 and select another answer.

Critical Point # 9: PAGE 25-II

Your answer: (A) Ask Ansel what's bothering him.

Answer "A" would put Ansel on the spot. He would most likely react in a defensive manner, perhaps by expressing resentment toward either the leader or the group as a whole. This would tend to widen the chasm between him and the rest of the group rather than to draw him back into active participation. If the group leader has been sensitive to what has been going on, he will already have a pretty good idea why Ansel isn't participating—namely, that Ansel may feel that his earlier attempts at expressing his opinions were not received in a welcome manner.

Please turn back to page 9 and select another answer.



1390

Critical Point # 5: PAGE 26-I

Your answer: (B) Summarize the situation so far, without expressing your opinion.

Answer "B" evades the issue, since the leader has been asked a direct question. Not to answer it might well create resentment. The group at this point feels it has made all the input possible, and they now want the leader's thinking. However, summarizing the situation so far is often necessary at some points in the group's work process. In such a case, the leader might offer a tentative conclusion for the group to accept or reject. But here, Mac is being questioned about a specific point which has come up.

Please turn back to page 5 and select another answer.

Critical Point # 8: PAGE 26-II

Your answer: (C) Devote some time to trying to reconcile differences before going ahead.

"C" is not the best answer at this point. In some instances during a group meeting, it is wise to devote some time to reconciling differences before going ahead. But at this time, the differences already have been thoroughly explored, and valuable time might be lost and the differences frozen even more. If the leader has evaluated the progress and performance of the group properly, he will know that the group is capable of going on to achieve its objective without trying to get unanimous agreement. Therefore, further work of the group is in order.

Please turn back to page 8 and select another answer.



1391

Critical Point # 2:

PAGE 27-I

Your answer: (B) Express what you sense is the group's feeling at the moment.

The most satisfactory answer is "B". If the group leader expresses what he senses to be the feelings of the group at the moment, he brings these feelings out in the open—makes them explicit. The unspoken feelings at such a time are apt to block the group unless they are dealt with. Each participant feels that he and the group have come to a stop. They have run out of ideas, and no one has anything else to say or contribute. By "reflecting" their feelings, the group leader shows them that he is aware of their feelings, accepts them as normal at such a time, and in fact shares them himself. He must, of course, be sensitive to their feelings and reflect them correctly in order to do this.

By reflecting their feelings he gives them a sense of understanding and support. Also, by his attitude and words, he exercises true leadership by "breaking the block," that is, he shows them that, while he is in the same boat as they are, regarding his own feelings, he is not willing to stop there. He is solidifying the feelings of the participants in the group as a whole, himself included, but also mobilizing the energies behind these feelings toward further group effort. If he did not do this, the group might come to a halt in its activities and actually dissolve. By bringing the disruptive emotional mood out into the open, he helps the group to recognize it as a problem common to all and to surmount it so that the group activity in solving the problem at hand may be taken up again.

You are right. Now turn back to page 2 and fill out the answers to the questions below the heavy line.

Critical Point # 7:

PAGE 27—II

Your answer: (A) Indicate in a firm but friendly manner that the group is beginning to repeat itself.

Answer "A" may sometimes work. However, this leaves it up to the group to pick up the suggestion, and someone else in the group must then try to clarify the issues before the group can move along. If this does not happen, the group may wander further afield in their confusion. It is much simpler and quicker if the leader himself can penetrate quickly and sharply to the heart of the dilemma.

Please turn back to page 7 and select another answer.



1392

Critical Point # 3: PAGE 28-I

Your answer: (B) Ask Ansel where that kind of reasoning is going to lead.

Answer "B" puts Ansel on the spot in front of his peers. In effect, he is being reprimanded by the leader for expressing his feelings openly. This tactic is apt to create resentment on Ansel's part toward the leader and may either discourage him from further participation in the group's activity or put him on the defensive, thus, in effect, isolating him from the group. Such a tactic might also boomerang upon the leader himself, since the leader's action may cause some of the other group members to come to Ansel's rescue, thereby putting Mac in the awkward position of defending himself.

Criticizing a person in front of his peers is detrimental to interpersonal relationships in the group and should be avoided at all costs.

Please turn back to page 3 and select another answer.

Critical Point # 11: PAGE 28-II

Your answer: (C) Try to stimulate a deeper perception by summarizing the progress so far.

"C" is the best answer. The differences are now all out in the open. Hidden agendas have been uncovered and the group has become divided. There is danger of a stalemate at this point, unless the leader takes steps to remove the roadblocks and move the group onward toward the desired objectives. He can do this by summarizing what has happened so far, sticking to the objective facts that have been developed, and avoiding becoming embroiled in the personal issues. By his own example, he induces the members of the group to take a more objective attitude and to focus their attention on proceeding with the solution of the problem at hand. The sensitive leader does not cut off emotional expression in the group prematurely, but he knows when it has run its course sufficiently and when it is profitable to direct the group's efforts back to the task. Summarizing the progress so far is an excellent way to do this.

You are correct. Now turn back to page 11 and fill in the answers to the questions below the heavy line.



1393

Critical Point # 9: PAGE 29-I

Your answer: (C) Encourage him with individual recognition.

The best answer is "C". At this point Ansel, the oldest and most experienced member of the group, has dropped out of the discussion. He has not participated actively since he expressed his own opinions much earlier and most emphatically. But he has been listening, and he may have a valuable contribution to make at this time. Dominick has just questioned Ansel and gotten a noncommittal answer. It is now up to the leader to try to draw Ansel out and induce him to participate again. He can do this by encouraging Ansel, giving him open recognition before the group for his past contributions to the organization. Deserved praise is often effective in getting a reticent member to open up with the group.

You are right. Now turn back to page 9 and fill out the answers to the questions below the heavy line.

Critical Point # 6: PAGE 29-II

Your answer: (A) Defend your definition of the problem.

Answer "A" would indicate that the leader is not taking into consideration the input which the group has provided. Instead, he is bent on defending his own position. But, like any other member of the group, the leader also should be flexible and open-minded, receptive to new ideas and to the possibility that he could be wrong. Otherwise, he is not functioning as part of the group himself. He should be strong enough to accept new ideas and criticism and evaluate the facts objectively.

Please turn back to page 6 and select another answer.



1394

Critical Point # 1: PAGE 30-I

Your answer: (A) By pointing out the benefits that would follow from a solution of the problem.

Answer "A" is only in order if the leader knows that there is opposition to solving the problem, and even in this case it may do little good if the opposition is strong. In most groups, the task of solving the problem is more or less accepted by the group as part of their job. For the leader to start off this way, in such a case, by trying to "sell" the group on doing their work would be an indication of weakness on the part of the leader and would not enhance the respect of the group for him.

Please turn back to page 1 and select another answer.

Critical Point # 3: PAGE 30-II

Your answer: (C) Ask the group how they feel about his criticism.

Answer "C" is the preferred one. The group is now under attack by one of its members. This will arouse feelings among the other members of the group, and they therefore should be allowed to voice these feelings and opinions. The leader should not intervene at this point, but let the group handle the disagreement. Criticisms should not be stifled in a group. Often they are valid and stimulating. If they are destructive, it is better to let the group itself work out the conflict openly, rather than sidestep it. In this way, the emotional energies generated can be drained off and then redirected into an attack on the problem rather than on members of the group. When disagreements are allowed to work themselves out, the constructive group atmosphere will eventually prevail, and a step forward toward completing the task at hand will often have been made. The leader, then, should remain neutral at such a point as this, encouraging the other members of the group to express their feelings rather than take sides or try to force a premature resolution of the conflict.

You are right. Now turn back to page 3 and fill out the answers to the questions below the heavy line.



1395

# TEACHING OUTLINE

# PERFORMANCE APPRAISAL

1396

## TEACHING OUTLINE
## PERFORMANCE APPRAISAL

### I. OBJECTIVES

1. Discuss the concepts of Performance Appraisal and how they impact the working relationships between a supervisor and subordinate brought to bear during the appraisal process.

2. Identify and demonstrate the principles of a good coaching system.

3. Explain and discuss the Corporate Performance Appraisal Policy/Procedure and the responsibility for administering it.

### II. INSTRUCTOR'S PREPARATION

1. Review the Manager's Guide to the Performance Appraisal Process used with the Corporate Performance Appraisal Forms.

2. Review Chapter 18 of Management 18: Coaching and Developing Subordinates. Give special attention to the section, Implementing a Results Approach to Performance Reviews.

3. Preview the film Who Wants to Play God? Determine key points to be emphasized in post-viewing discussion.

4. Obtain copies of the role play situation sheets, G/C For PA-1 (Notification of PA), timing sequence and Corporate Performance Appraisal Forms for the workshop activity.

5. Prepare and develop concepts of role play workshop activity.



1397

## III. SCHEDULE OF EVENTS

1. Conduct a brief group discussion concerning participants' experiences during the past week in using constructive correction with their employees. - 10 min.

2. Define Performance Appraisal. Conduct a brief discussion on what Performance Appraisal is. - 5 min.

3. Discuss briefly the benefits of an effective performance appraisal system. - 5 min.
   - o For the organization
   - o For the employee
   - o For the manager

4. Compile a discussion list (use flip-chart or chalkboard) of common problems participants may have encountered with previous performance appraisals. Examples: personal bias, awarding average ratings to everyone, ignoring EEO considerations, inconsistent standards, insufficient employee performance monitoring, etc. - 10 min.

   It is suggested that solving these problems should be deferred. The activities during the session should be directed to address their importance and lead way to a resolution at that appropriate time.

5. Discuss the key elements of performance appraisal - 10 min.
   - o Job Perceptions - Supervisor/Subordinate
     - Responsibility - What has to be done?
     - Authority - What are the parameters to get it done?
     - Accountability - To what degree was it done?
   - o Self Appraisal
   - o Coaching



1398

- o Development Objectives
  - Skills
  - Performance
  - Career
- o Others

6. Review the G/C Performance Appraisal system, especially highlight the procedures and use of the form. - 30 min.
   - o Manager's Guide to the Performance Appraisal Process
   - o Forms

7. Show the film Who Wants to Play God? - 30 min.
   - o We are about to view the film Who Wants to Play God? which portrays a model for effectively preparing for and conducting the appraisal interview. Make the point that, seldom will we ever have a situation as ideal as the one shown in the film, however, the film offers us valuable guidelines, a track to run on, if you will, a model to work toward.
   - o The film portrays several phases of a performance appraisal interview. Ask participants to make notes of the techniques the manager uses in each phase.
   - o Show the film (25 minutes showing time).
   - o Conduct a 6-7 minute post film discussion to emphasize the "complete cycle."

8. Set the stage for the workshop activity - a role play. Performance analysis and coaching workshop. -30 min.
   - o Make the point we now have a model to guide us through an appraisal interview.
   - o Select two (2) participants to act as manager and subordinate for the role play situation. Allow the two to make a brief preparation outside the classroom

and instruct the remaining participants to serve as observers. Charge the observers to note the appropriate methods to be used in conducting the performance appraisal based on what they learned in this class session.

Note: It may be necessary to stop the role play if it is extending beyond the time allotted.

- o Conduct a summary of the mock appraisal interview. Ask the group (observers) to:
  - Identify positive points to reinforce their use.
  - Resolve problem areas by offering suggestions for corrective action.

9. Summary and Application - 10 min.
   - o Ask participants to write on their application sheets the most significant points they learned in this session.
   - o Ask one or two participants to briefly share this with the group.

10. Briefly review the assignment for next session. - 5 min.

Total Scheduled Time
2 hours 25 minutes



1400

# PERFORMANCE APPRAISAL
## PARTICIPANT'S ASSIGNMENT

**OBJECTIVES**

1. Discuss the concepts of Performance Appraisal and how they impact the working relationships between a supervisor and subordinate brought to bear during the appraisal process.

2. Identify and demonstrate the principles of a good coaching system.

3. Explain and discuss the Corporate Performance Appraisal Policy/Procedure and the responsibility for administering it.

**READING**

1. Review - Chapter 18 - Coaching and Developing Subordinates.

2. Read and Complete - Chapter 19 - Training and Developing - (Yellow notebook)

**HOMEWORK**

1. Identify recent work or behavior by one of your employees which needs to be corrected. Using what you learned in the "Correcting" Session, make the necessary corrections with this employee prior to this session on Performance Appraisal.

2. Be prepared to report at this session the successes and difficulties encountered in No. 1 above.

3. Complete the Performance Analysis Chart in Management 18 prior to this session.

4. Review and become familiar with the "My Subordinate Coaching Plan Worksheet" contained in this notebook.



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## MY SUBORDINATE COACHING PLAN
## WORKSHEET

1. Complete the Performance Analysis Chart in Management 18.

2. How will I get mutual agreement with my subordinates concerning the following? (In Management 18.)

   A. The content of the work/activities for which the subordinates are responsible.

   B. Factors upon which his performance will be judged (i.e., quality, quantity, cost, innovation, estimating accuracy, self-development and service to others).

   C. How performance will be measured.

   D. Specific minimum results/standard to meet in each area.



1402

3. How will my coaching system do the following? (In Management 18.)

A. Let the subordinate know what is expected of him.

B. Give the subordinate an opportunity to perform.

C. Let the subordinate know how he is doing.

D. Give the subordinate assistance and support.

E. Reward the subordinate on the basis of results achieved.



1423

# Memorandum

GILBERT ASSOCIATES, INC.

to: October 8, 1985

from: Human Resources

subject: PERFORMANCE APPRAISAL REVIEW DATES

Employees in your organizational unit whose annual performance appraisals are due January, 1986, are shown on the attachment.

Completed and signed appraisal forms should be forwarded to the Compensation Staff or your designated Human Resources Representative for review and inclusion in the employee's permanent personnel file. This document will be returned upon request for the employee's next salary review. However, if a performance appraisal is completed within two months of an employee's next salary review date, it may be retained and returned with the Personnel Action Form.

V. J. Koren

VJK:das
Attachment

1404

Gilbert Commonwealth Companies

# EXEMPT/NON-EXEMPT

# PERFORMANCE APPRAISAL

| | | |
|---|---|---|
| NAME: | EMPLOYEE NUMBER: | HIRE DATE: |
| POSITION TITLE: | POSITION CODE: | POSITION START DATE: |
| SECTION: | SECTION NUMBER: | DIVISION: |
| SUPERVISOR-SECTION: | DATE ASSIGNED THIS SUPERVISOR: | |
| SUPERVISOR FOR PROJECT (IF ANY): | DATE ASSIGNED THIS SUPERVISOR: | |
| APPRAISAL PERIOD - FROM: | TO: | |

The performance appraisal process is a year-round effort involving formal and informal employee coaching and counseling sessions It is that format which formulates the basis for the annual performance review. This form is intended to foster communication between supervisor and employee for the annual review. Employees are urged to share their concerns, suggestions, and goals. The supervisor should provide feedback on performance, suggestions for improvement, and plans for development. Ratings awarded to performance should be based on measured output.

## PERFORMANCE APPRAISAL RATINGS

5 - **Outstanding - Far Exceeds Requirements**

Performance consistently and substantially exceeds all expected position results over a sustained period (ex. 2-3 yrs.). The employee's performance is far superior to the majority of employees in the same or similar positions. In addition, an employee at this level should have reached a very high degree of expertise and excel in every essential element of the assigned position.

4 - **Frequently Exceeds Requirements**

Performance frequently exceeds all expected position results The employee's performance is better than the majority of employees in the same or similar positions.

3 - **Competent**

Performance meets expected position results. The employee's performance is generally equal to the majority of employees in the same or similar positions.

2 - **Meets Minimum Requirements**

Performance meets some but not all expected position results. The employee's performance is sometimes below the majority of employees in the same or similar positions. An employee whose performance is consistently evaluated at this level may be considered for a position which is more compatible with his/her abilities. This rating level may also apply to entry level or inexperienced employees who still require considerable supervision and training before performance is fully satisfactory.

1 - **Unsatisfactory**

Performance does not meet expected position results. The employee's performance is frequently below the majority of employees in the same or similar positions. An employee at this rating level should be placed on probation and should be ineligible for a salary increase. A specific plan should be established for the employee to improve his/her performance within a given time period. If no improvement is made within the time period established in the improvement plan, the employee should then be terminated.

1405

% x RV = WR

| I. Objectives: List the tasks, assignments, or key results expected. | % Wgt* | II. Performance Results: List the results in relation to Section I. Consider timeliness, quality and quantity. | Rating Values | Wgt Rating |
|---|---|---|---|---|
| | | | | |
| | 100% | | Total Weighted Rating Values | |

5. Outstanding
4. Frequently Exceeds Requirements
3. Competent
2. Meets Minimum Requirements
1. Unsatisfactory

* Total wgt not greater than 100%

1406

# PERFORMANCE PLANNING WORKSHEET

Name _____ Section _____ Section No. _____

Supervisor _____ Supervisor for Project _____

Performance Appraisal Period _____

The performance appraisal process is a year-round effort involving formal and informal employee coaching and counseling sessions. The Performance Planning worksheet is intended as a living document retained by the supervisor to record objectives, assignments, etc. acquired by the employee at the outset and throughout the appraisal period. The data collected on this form then serves as the basis for the annual performance review. Objectives for the new appraisal period should begin use of the form. A weighting factor should be given to each objective and placed in the column next to the objective. As objectives emerge during the course of the appraisal period they should be added to the worksheet. At the end of the appraisal period the total weighting should not exceed 100%. Only major objectives should be included and should not exceed 12.

## PERFORMANCE PLANNING WORKSHEET

Weight x RV = WR

| I. Objectives: List the tasks, assignments, or key results expected. | % Wgt* | II. Performance Results: List the results in relation to Section I. Consider timeliness, quality and quantity. | Rating Values | Wgt Rating |
|---|---|---|---|---|
| | | | | |

(over)

1407

# PERFORMANCE PLANNING WORKSHEET

Weight x RV = WR

| I. Objectives: List the tasks, assignments, or key results expected. | % Wgt* | II. Performance Results: List the results in relation to Section I. Consider timeliness, quality and quantity. | Rating Values | Wgt Rating |
|---|---|---|---|---|
| | | | | |
| | 100% | | | |

Total Weighted Rating Values _____

**RATING VALUES**

5. Outstanding
4. Frequently Exceeds Requirements
3. Competent
2. Meets Minimum Requirements
1. Unsatisfactory

* Total wgt not greater than 100%

| III. PERFORMANCE FACTORS | COMMENTS | Wgt X | Rating Value = | Wgt Rating |
|---|---|---|---|---|
| 1. **Job Knowledge:** technical background and skills required to perform the job function, keeping current on Company policies, procedures | | | | |
| 2. **Volume of Work:** amount of work produced in a given time period | | | | |
| 3. **Quality of Work:** accuracy, appearance, orderliness, and thoroughness of work, attention to detail | | | | |
| 4. **Organizational skills:** ability to plan, establish priorities and properly utilize time and resources to accomplish tasks | | | | |
| 5. **Communication:** ability to listen, write, and speak effectively | | | | |
| 6. **Interpersonal relations:** the effectiveness of cooperating with supervisors, subordinates, fellow employees, and/or clients, tact, sensitive to the needs of others | | | | |
| 7. **Initiative:** seizing new opportunities, confronting problems, extending beyond initial assignment; assertiveness | | | | |
| 8. **Performance stability:** maintaining high performance under pressure conditions, adaptability, cooperating with other working units | | | | |
| 9. **Dependability:** attendance, punctuality; ability to complete assignments on schedule | | | | |
| 10. **Leadership (where applicable):** use of available resources, delegation; coordination of Team Member | | | | |
| 11. **Actions employee has taken resulting from suggestions offered during previous performance appraisal** | | | | |
| 12. Other factors affecting performance | | | | |

**Wgt**

3 = Very Important
2 = Avg Importance
1 = Least Important

**Rating Value**

5 = Outstanding
4 = Frequently Exceeds Requirements
3 = Competent
2 = Meets Minimum Requirements
1 = Unsatisfactory
NA = Not Applicable

TOTALS: A [ ] B [ ]

Avg Wgt Rating = $\frac{B}{A}$ = C

C [ ]

Avg Wgt Rating

Performance Factors

1409

## IV. OVERALL PERFORMANCE RATING (Based on analysis of items I, II, III)

Wgt

Avg. rating of Section II x (70% to 90%) = _____

Avg. rating of Section III x (30% to 10%) = _____

Overall rating (total above) _____

Comments:

## V. PERFORMANCE PLAN

Performance planning for the next period: consider employee goals, possible assignments, special duties; skills needed to perform future assignments; strengths/weaknesses in Section III; target dates for accomplishments.

### Suggestions for improvement:

### Skills development:

### Long range employee goals:

## VI. REVIEWS

1. Prepared by _____ Date _____
2. Approved by _____ Date _____
3. Reviewed by _____ Date _____
4. Employee Comments:

I have reviewed this appraisal with my immediate supervisor

_____ Employee

_____ Date

1410

# MANAGEMENT/SUPERVISORY

# PERFORMANCE APPRAISAL

| | | |
|---|---|---|
| NAME: | EMPLOYEE NUMBER: | HIRE DATE: |
| POSITION TITLE: | POSITION CODE: | POSITION START DATE: |
| SECTION: | SECTION NUMBER: | DIVISION: |
| SUPERVISOR-SECTION: | DATE ASSIGNED THIS SUPERVISOR: | |
| SUPERVISOR FOR PROJECT (IF ANY): | DATE ASSIGNED THIS SUPERVISOR: | |
| APPRAISAL PERIOD - FROM: | TO: | |

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## PERFORMANCE APPRAISAL RATINGS

**5 - Outstanding - Far Exceeds Requirements**

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**3 - Competent**

Performance meets expected position results. The employee's performance is generally equal to the majority of employees in the same or similar positions.

**2 - Meets Minimum Requirements**

Performance meets some but not all expected position results. The employee's performance is sometimes below the majority of employees in the same or similar positions. An employee whose performance is consistently evaluated at this level may be considered for a position which is more compatible with his/her abilities. This rating level may also apply to entry level or inexperienced employees who still require considerable supervision and training before performance is fully satisfactory.

**1 - Unsatisfactory**

Performance does not meet expected position results. The employee's performance is frequently below the majority of employees in the same or similar positions. An employee at this rating level should be placed on probation and should be ineligible for a salary increase. A specific plan should be established for the employee to improve his/her performance within a given time period. If no improvement is made within the time period established in the improvement plan, the employee should then be terminated.

1411

% x RV = WR

| I. Objectives: List the tasks, assignments, or key results expected. | % Wgt* | II. Performance Results: List the results in relation to Section I. Consider timeliness, quality and quantity. | Rating Values | Wgt Rating |
|---|---|---|---|---|
| | | | | |
| | 100% | | Total Weighted Rating Values | |

5. Outstanding
4. Frequently Exceeds Requirements
3. Competent
2. Meets Minimum Requirements
1. Unsatisfactory

* Total wgt not greater than 100%

1412

# PERFORMANCE PLANNING WORKSHEET

Name _____ Section _____ Section No. _____

Supervisor _____ Supervisor for Project _____

Performance Appraisal Period _____

The performance appraisal process is a year-round effort involving formal and informal employee coaching and counseling sessions. The Performance Planning worksheet is intended as a living document retained by the supervisor to record objectives, assignments, etc. acquired by the employee at the outset and throughout the appraisal period. The data collected on this form then serves as the basis for the annual performance review. Objectives for the new appraisal period should begin use of the form. A weighting factor should be given to each objective and placed in the column next to the objective. As objectives emerge during the course of the appraisal period they should be added to the worksheet. At the end of the appraisal period the total weighting should not exceed 100%. Only major objectives should be included and should not exceed 12.

## PERFORMANCE PLANNING WORKSHEET

Weight x RV = WR

| I. Objectives: List the tasks, assignments, or key results expected. | % Wgt* | II. Performance Results: List the results in relation to Section I. Consider timeliness, quality and quantity. | Rating Values | Wgt Rating |
|---|---|---|---|---|
| | | | | |

(over)

1413

# PERFORMANCE PLANNING WORKSHEET

Weight x RV = WR

| I. Objectives: List the tasks, assignments, or key results expected. | % Wgt* | II. Performance Results: List the results in relation to Section I. Consider timeliness, quality and quantity. | Rating Values | Wgt x Rating |
|---|---|---|---|---|
| | | | | |
| | 100% | | | |

Total Weighted Rating Values _____

**RATING VALUES**

5. Outstanding
4. Frequently Exceeds Requirements
3. Competent
2. Meets Minimum Requirements
1. Unsatisfactory

* Total wgt not greater than 100%

1414

| III. PERFORMANCE FACTORS | COMMENTS | Wgt | X Rating Value | = Wgt Rating |
|---|---|---|---|---|
| 1. **Job Knowledge:** technical skills required to manage the function | | | | |
| 2. **Planning and organizing:** establishing objectives and priorities; meeting schedules; delegating assignments | | | | |
| 3. **Directing:** coordinating workloads; communicating clearly; utilizing available resources; evaluating outcomes: | | | | |
| 4. **Interpersonal relations:** interacting with peers and supervisors; motivating subordinates | | | | |
| 5. **Communication:** ability to listen, write, and speak effectively; establishing lines of communication with supervisors, subordinates, associates | | | | |
| 6. **Problem solving and decision making:** problem areas, fact-finding; establishing alternate solutions; arriving at sound decisions | | | | |
| 7. **Development of Personnel:** measuring employee performance, identifying skill development needs, coaching/developing employee capabilities | | | | |
| 8. **Initiative/Innovation:** acting on new opportunities; orientation to quality results; promoting the goals and objectives of the organization | | | | |
| 9. **Actions taken resulting from suggestions offered during previous performance appraisal** | | | | |
| 10. **Other factors affecting performance** | | | | |

**Wgt**

3 = Very Important
2 = Avg Importance
1 = Least Important

**Rating Value**

5 = Outstanding
4 = Frequently Exceeds Requirements
3 = Competent
2 = Meets Minimum Requirements
1 = Unsatisfactory
NA = Not Applicable

TOTALS: A [ ] B [ ]

Avg Wgt Rating = B/A = C

C [ ]

Avg Wgt Rating Performance Factors

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## IV. OVERALL PERFORMANCE RATING (Based on analysis of items I, II, III)

Wgt

Avg. rating of Section II x (70% to 90%) = _____

Avg. rating of Section III x (30% to 10%) = _____

Overall rating (total above) _____

Comments:

## V. PERFORMANCE PLAN

Performance objectives for the next period: consider the goals and objectives of the manager and organization; skills if needed to perform future assignments; strengths/weaknesses in Section III; target dates for accomplishments, long range career goals, if identified.

### Suggestions for improvement:

### Skills development:

### Long range goals:

## VI. REVIEWS

1. Prepared by _____ Date _____
2. Approved by _____ Date _____
3. Reviewed by _____ Date _____
4. Employee Comments:

I have reviewed this appraisal with my immediate supervisor.

_____ Employee

_____ Date

# INDEX OF TASKS

# PROCUREMENT REVIEW ENGINEER

# (PRE)

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# *INDEX OF TASKS PROCUREMENT REVIEW ENGINEER (PRE)*

The tasks for which a Procurement Review Engineer is responsible are:

| TASK NO. | TASK NAME |
|---|---|
| PRE-1. | Review the procurement activities of the Responsible Procurement Engineers and Procurement Technicians. |
| PRE-2 | Determine interfaces with other organizations necessary to complete procurement activities. |
| PRE-3 | Review all safety related stock description changes, additions and deletions. |

1418

TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

JOB TITLE: PROCUREMENT REVIEW ENGINEER

TASK NO.: PRE-1

Review the procurement activities of the Responsible Procurement Engineers and Procurement Technicians.

---

| | |
|---|---|
| **TASK CONDITIONS:** | This review is equivalent to a design verification review. |
| **TASK STANDARDS:** | Compliance with procedures and Industry Codes and Standards such as ASME and ANSI. |
| **TOOLS/EQUIPMENT:** | None. |
| **REFERENCES:** | Calvert Cliffs Instruction CCI-162 "Procurement of Items and Services for Calvert Cliffs".<br><br>Procurement Engineering Procedures (PEP's).<br><br>DESP-7 "Design and Design Review". |
| **PERSONNEL SAFETY CONSIDERATIONS:** | No special personnel safety considerations. |
| **HUMAN INTERFACES:** | Supervisor Procurement Engineering.<br><br>Responsible Procurement Engineers<br><br>Procurement Technicians<br><br>Material Engineering Analysis Unit (MEAU) personnel.<br><br>Purchasing & Materials Management Department (P&MMD) personnel.<br><br>Procurement Coordination Unit (PCU) personnel.<br><br>Procurement Quality Unit (PQU) personnel.<br><br>Receiving Inspection Unit (RIU) personnel.<br><br>Vendor Audits Unit (VAU) personnel.<br><br>Design Review Engineers, Design Engineers and Designers.<br><br>Chemistry personnel.<br><br>Vendors. |

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# TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

JOB TITLE: PROCUREMENT REVIEW ENGINEER

TASK NO.: PRE-1

Review the procurement activities of the Responsible Procurement Engineers and Procurement Technicians.

---

**CONSEQUENCES OF INADEQUATE PERFORMANCE:**

Technical errors in the procurement documents, if any, may not be detected and corrected.

Errors of omission in the procurement documents, if any, may not be detected and corrected.

Incorrect or substandard parts may be purchased.

---

Analysis:_____ Date:_____

Verification:_____ Date:_____

1420

TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

JOB TITLE: PROCUREMENT REVIEW ENGINEER

TASK NO.: PRE-1

Review the procurement activities of the Responsible Procurement Engineers and Procurement Technicians.

---

**CONSEQUENCES OF INADEQUATE PERFORMANCE:**

Technical errors in the procurement documents, if any, may not be detected and corrected.

Errors of omission in the procurement documents, if any, may not be detected and corrected.

Incorrect or substandard parts may be purchased.

---

Analysis: [signature] Date: 8/17/90

Verification: _____ Date: _____

1421

TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

TASK NO.: PRE-1

Review the procurement activities of the Responsible Procurement Engineers and Procurement Technicians.

---

| ELEMENTS | SKILLS & KNOWLEDGE |
|---|---|
| **1.1 Using ANSI N45.2.11, Paragraph 6.3.1 as a guide examine the procurement documents to assure the nineteen basic questions have been addressed, as applicable to the item being purchased.** | 1.1.1 Must know the criteria listed in ANSI N45.2.11, Paragraph 6.3.1, items 1 thru 19.<br>1.1.2 Must be able to correctly implement PEP-16. |
| **1.2 If interface reviews are necessary, initiate task PRE-2.** | 1.2.1 No special skill or knowledge is needed. |
| **1.3 Examine the completed procurement package to assure that all procurement engineering and interface activities have been completed.** | 1.3.1 Must be familiar with the overall procurement process.<br>1.3.2 Must know the documentation requirements which provides the evidence of completed activities. |
| **1.4 Process the procurement package.** | 1.4.1 Must know the procedure for processing the procurement packages. |

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TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

JOB TITLE: PROCUREMENT REVIEW ENGINEER

TASK NO.: PRE-2

TASK: Determine interfaces with other organizations necessary to complete procurement activities.

---

| | |
|---|---|
| **TASK CONDITIONS:** | Portions of task PRE-1 are prerequisites to this task. |
| **TASK STANDARDS:** | Compliance with procedures. |
| **TOOLS/EQUIPMENT:** | None. |
| **REFERENCES:** | Procedure PEP-1 "Technical Evaluations".<br>Procedure PEP-5 "Upgrades".<br>Procedure PEP-14 "Dedication Testing - Master Procedure".<br>Procedure PEP -15 "Post Installation Testing". |
| **PERSONNEL SAFETY CONSIDERATIONS:** | No special personnel safety considerations. |
| **HUMAN INTERFACES:** | PEU personnel.<br>MEAU, P&MMD, PCU and PQU personnel.<br>Chemistry personnel.<br>Vendors. |
| **CONSEQUENCES OF INADEQUATE PERFORMANCE:** | Proper interface review(s) may not be performed. |

---

Analysis: [signature] Date: 8/17/90

Verification: _____ Date: _____

1423

TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

TASK NO.: PRE-2

TASK: Determine interfaces with other organizations necessary to complete procurement activities.

---

| ELEMENTS | SKILLS & KNOWLEDGE |
|---|---|
| **2.1 Send procurement documentation to the external organizations for an interface review.** | 2.1.1 Must know the procedure for processing the procurement packages. |
| **2.2 Follow-up transmittal to assure that the procurement documentation with the documentation of the interface review is returned to PEU.** | 2.2.1 No special skill or knowledge is needed. |
| **2.3 Return the documentation to the Responsible Procurement Engineer for completion of their tasks.** | 2.3.1 No special skill or knowledge is needed. |

TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

JOB TITLE: RESPONSIBLE PROCUREMENT ENGINEER:

TASK NO.: PRE-3

TASK: Review all safety related stock description changes, additions and deletions.

---

| | |
|---|---|
| **TASK CONDITIONS:** | Must have access to original stock descriptions. |
| **TASK STANDARDS:** | Compliance with procedural requirements. |
| **TOOLS/EQUIPMENT:** | None. |
| **REFERENCES:** | Calvert Cliffs Instruction, CCI-162 "Procurement of Items and Services for Calvert Cliffs".<br>Procedure PEP-4, "Stock Description Changes, Deletions, and Additions".<br>Procedure PEP-13, "Equivalency Evaluation". |
| **PERSONNEL SAFETY CONSIDERATIONS:** | No special personnel safety considerations. |
| **HUMAN INTERFACES:** | PCU personnel.<br>PQU personnel.<br>PMMD personnel. |
| **CONSEQUENCES OF INADEQUATE PERFORMANCE:** | Items which may be incorrect for the intended application could be installed. |

---

Analysis: [signature] Date: 8/17/90

Verification: _____ Date: _____

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TASK ANALYSIS DATA COLLECTION FORM

PROGRAM: PROCUREMENT PROJECT

TASK NO.: PRE-3

TASK: Review all safety related stock description changes, additions and deletions.

---

| ELEMENTS | SKILLS & KNOWLEDGE |
|---|---|
| **3.1 Perform "Like-For-Like" determinations.** | 3.1.1 Must know the accepted meaning of "Like-For-Like." |
| | 3.1.2 Must know the Industry Guidelines (EPRI/NCIG). |
| | 3.1.3 Must know the step-by-step process in the approved PEU Procedures. |
| | 3.1.4 Must be familiar with the plant systems, components and parts used at Calvert Cliffs Nuclear Power Plant (CCNPP). |
| | 3.1.5 Must know the plant records retrieval system. |
| **3.2 Perform equivalency evaluations.** | 3.2.1 Must know the Equivalency Evaluation process. |
| | 3.2.2 Must know the Dedication/Upgrade process. |
| **3.3 Review proposed stock descriptions for accuracy and completeness.** | 3.3.1 Must know how to use the MMS, CCETS and NUCLEIS data systems. |
| **3.4 Recommend disposition of stock material.** | 3.4.1 Must know the step-by step process of the approved PEP procedures. |
| | 3.4.2 Must know the Equivalency Evaluation process. |

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# *DIF RANKING PROCUREMENT REVIEW ENGINEER (PRE)*

The DIF Ranking is an evaluation of each task using the criteria of task difficulty, importance and frequency.

The DIF Rank Number assigned to each task was selected using the DIF Task Selection Model included with this training needs analysis.

The tasks for which a Procurement Review Engineer is responsible are:

| TASK NO.<br>DIF RANK NO.<br>TRAIN/RETRAIN | TASK NAME |
|---|---|
| PRE-1.<br>DIF-1<br>TRAIN | Review the procurement activities of the Responsible Procurement Engineers and Procurement Technicians. |
| PRE-2<br>DIF-7<br>TRAIN | Determine interfaces with other organizations necessary to complete procurement activities. |
| PRE-3<br>DIF-13<br>NO TRAIN | Review all safety related stock description changes, additions and deletions. |

# PROCUREMENT PROGRAM PROJECT
## DIF TASK SELECTION MODEL

| DIFFICULT | IMPORTANT | FREQUENCY | TRAIN/RETRAIN | DIF RANK # |
|---|---|---|---|---|
| VERY | YES | VERY | YES | 1 |
| | | MODERATE | YES/YES | 2 |
| | | INFREQUENT | YES/YES | 3 |
| | NO | VERY | NO | 4 |
| | | MODERATE | YES | 5 |
| | | INFREQUENT | YES | 6 |
| MODERATE | YES | VERY | YES | 7 |
| | | MODERATE | YES/YES | 8 |
| | | INFREQUENT | YES/YES | 9 |
| | NO | VERY | NO | 10 |
| | | MODERATE | NO | 11 |
| | | INFREQUENT | YES | 12 |
| NOT | YES | VERY | NO | 13 |
| | | MODERATE | NO | 14 |
| | | INFREQUENT | YES | 15 |
| | NO | VERY | NO | 16 |
| | | MODERATE | NO | 17 |
| | | INFREQUENT | NO | 18 |

# *TRAINING NEEDS ANALYSIS PROCUREMENT REVIEW ENGINEER (PRE)*

| TRAINING NEED | TRAINING |
|---|---|
| **1. Must know the overall procurement process at CCNPP to be able to recognize and appreciate the Procurement Review Engineer's role in the overall process, as well as the responsibilities of other personnel to the procurement process.** | Classroom. Attend CCI-162 training session which presents the overall procurement process, responsibilities and CCNPP requirements. |
| **2. Must know the Industry Guidelines and Regulations which govern the procurement process.** | Classroom. Attend "Industry and Regulatory Guidelines For The Procurement Program at CCNPP" training session. |
| **3. Must know the PEU Procedures.** | Classroom. Attend PEP-1, PEP-2, PEP-3, PEP-4, PEP-5, PEP-6, PEP-7, PEP-8, PEP-9, PEP-10, PEP-11, PEP-12, PEP-13, PEP-14, PEP-15, and PEP-16 training sessions. |
| **4. Must know the criteria listed in ANSI N45.2.11, Paragraph 6.3.1, items 1 thru 19.** | Self study. This document is available in the technical library. |
| **5. Must know the documentation requirements which provides the evidence of completed activities.** | Classroom. These documentation requirements will become known through attendance at the procedural training sessions (PEP-1 thru PEP-16). |
| **6. Must know the procedure for processing the procurement packages.** | Classroom. The procedure for processing the procurement packages will be know from the CCI-162 training session. |

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# LEAD AUDITOR

# TRAINING PROGRAM

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# LEAD AUDITOR TRAINING PROGRAM

## *STUDENT MANUAL*

**Gilbert/Commonwealth, Inc.**
**QUALITY ASSURANCE**
**TRAINING SERVICES**

# FUNDAMENTALS OF AUDITING

1431

**MODULE:** III

**TITLE:** THE ROLE OF THE AUDITOR

**OBJECTIVES:** Upon completion of this module, the student will be able to:

1. List two factors which can affect the ability of an auditor to obtain and objectively assess information.
2. Describe why an auditor needs to understand human factors in order to increase his/her efficiency in performing an audit.
3. Identify three organizations or individuals impacted by the results of the audit.
4. List three methods which may be used by the auditor to deal with hostility displayed by a member of the audited organization.
5. Identify two factors which may induce stress on the part of the auditor, and describe a method for dealing with each factor.

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## 1.0 INTRODUCTION

The results of the audit depend to a large extent on the quality and quantity of information obtained during the audit, as well as on the correct interpretation of this information. Therefore, the auditor must obtain as much information as possible in the time available; continuously test the validity of evidence presented; exhibit an insatiable appetite for reason, logic, and objective evidence; and attempt to relate each piece of information to overall program controls. In order to perform this role effectively, certain factors affecting the ability to obtain and objectively assess information must be clearly understood. These factors include basic auditing principles and human factors.

### 1.1 BASIC AUDITING PRINCIPLES

Thorough Knowledge of Quality Practices

The successful auditor must possess a thorough knowledge of quality practices in order to evaluate the quality system used and to determine if it is operating effectively.

Well Planned Scope of Audit

In preparing for an audit, care should be taken to assure that the audit appropriately covers all areas within its scope. The scope must be well defined during the planning phase so that time at the audit site is used effectively. There must be no appearance that the audit team is on a fishing expedition.

Practiced Techniques

Once the basic auditing techniques have been learned, the auditor must be afforded the opportunity to practice the techniques. This can be accomplished by:

- Role playing in a laboratory environment
- Assisting in actual audits with over-the-shoulder supervision until proficiency is achieved

## 2.0 HUMAN FACTORS

Auditing is a form of communication that is simultaneously an art and a science. It is an art to successfully initiate and then maintain a dialogue with the auditee(s) that permits the auditor to locate the object of his search. Auditing is also a science in that it requires the application of carefully planned and selected investigative techniques. The common denominator and key to a successful audit is the ability to deal successfully with the human element.

The auditor does not need to be a professional psychologist. However, there are certain factors that the auditor should understand and be ready to deal with in order to increase auditing effectiveness.

## 2.1 AN ENVIRONMENT FOR STRESS

The performance of an audit has the potential for causing multiple stresses among the participants. The effectiveness of the Quality Assurance Program, as revealed by an audit, is of immediate concern to a number of different centers of authority:

1. Management of the Quality Assurance Program within which the auditing function operates - The audit is a key source of data indicating overall QA program effectiveness.

2. The customer or the project management organization - The audit indicates the effectiveness of the quality system in place and provides confidence in the product or service.

3. Management of the audited organizations and/or activities - Audit results provide information as to the effectiveness with which their personnel are complying with established policies and procedures.

4. The personnel who accomplish the activities that are audited - Audit results are a measure of their performance.

5. Regulatory or licensing agencies (if any) - Regulatory or licensing agencies often use results of the audit system as evidence of effectiveness of quality verification activities, as well as evidence of compliance with regulatory/licensing requirements.

**Stress: Audited Organization**

The auditor, charged with the responsibility of verifying that activities are being performed in accordance with established requirements, can induce stress. Therefore, the auditor must avoid committing emotional aggression or producing "stress shocks" in individuals during the audit. The auditor must also be able to recognize the symptoms of stress and be able to deal with the reactions that stress produces in the audited organization. Stress arises when an individual feels threatened. The individual may feel threatened from what he perceives as a personal (identity) intrusion, or from what he perceives as an intrusion into his area of responsibility (territorial intrusion). The reaction to either type of perceived intrusion is sometimes displayed as hostility.

<u>Common Hostility Reactions</u>

1. Progressive Hostility

   Even though an audit interview may begin peaceably, hostility may arise at a later time. As the interview progresses, the interviewee may grow increasingly antagonistic. The auditor should pause in such instances to reflect on his approach. Has he been displaying a "judgmental" attitude? Has there been an air of condescension or of disbelief? Has the auditor been guilty of defensive reaction to something said by the interviewee? If the auditor determines that he

has not evoked the hostility, he may conclude that the conversation is approaching areas of noncompliance.

2. Sudden Hostility

A sudden, unexpected outbreak of hostility can indicate that the questioning has touched on something that the interviewee knows is in conflict with requirements. This can occur when the interviewee has the responsibility for accomplishing an activity, but does not have the authority to carry that activity out; resulting in frustration.

3. Immediate Hostility

This type of hostility can take several forms:

a. Vocal Expression/Body Language - The individual expresses immediate disagreement and displeasure with the audit and may try to intimidate the auditor by "staring the auditor down."

b. Avoidance - The individual may refuse to respond to audit questions; may give short, close-ended responses; or may give responses which do not directly answer the auditor's questions. The individual may also avoid direct eye contact during the interview.

This type of hostility is typically indicative of weaknesses in management understanding and support of the quality program, and frequently indicates a need to evaluate policies and practices at higher levels of management.

**Minimizing the Potential for Hostility**

The auditor can begin to minimize the potential for hostility during the initial interview. He should use sensitivity and judgement in determining the appropriate interview techniques to be employed; and should tailor these techniques to the personality of the individual and to the type of reaction that he expects from that individual. The auditor should ask simple questions with a minimal amount of probing.

**Dealing with Hostility**

When encountering hostility, the auditor may revert to creating a "straw man" to divert and diffuse the hostility. For example, the auditor might ask the interviewee "How would you explain your approach to an inspector from the Regulatory Agency?" The interviewee's attention and hostility would then be directed toward a non-existent individual; and, since it is not possible to argue with someone not present, the interviewee may shift to a less hostile, more logical mode in responding.

Another method that the auditor may use is to redirect the line of questioning. He may even close the interview until the interviewee has had time to cool down. In addition, the auditor may redirect the focus of the conversation from a "personal"