General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)

NASA CR-134941 VOLUME XII

SAC



ENERGY CONVERSION ALTERNATIVES STUDY -ECAS-

WESTINGHOUSE PHASE I FINAL REPORT

Volume VII – METAL VAPOR RANKINE TOPPING-STEAM & BOTTOMING CYCLES

by P.B. Deegan

WESTINGHOUSE ELECTRIC CORPORATION RESEARCH LABORATORIES

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION NATIONAL SCIENCE FOUNDATION

> NASA Lewis Research Center Contract NAS 3-19407

(NASA-CR-134941-Vol-7)ENERGY CONVERSIONN76-23698ALTERNATIVES STURY (ECAS), WESTINGHOUSEHC\$7.50PHASE 1. VOLUME 7:METAL VAPOR RANKINETOPPING-STEAM BOTTOMING CYCLESFinal Report(Westinghouse Research Labs.)198 p HCG3/4428172

1,	Report No. NASA CR-134941	2. Government Access	sion No.	3. Recipient's Catalo	g No.
	Volume 7	-			-
4.	Title and Subtitle ENERGY CONVERSION ALTERNATIVES S	STUDY (ECAS),		5. Report Date February 12,	1976
	VOLUME VII - METAL VAPOR RANKINE	E TOPPING-STEAM B	OTTOMING CYCLES	6. Performing Organ	ization Code
7.	Author(s) P. B. Deegan, et al		······································	8. Performing Organi Westinghouse 76-9E9-ECAS-	zation Report No. Report No. R1v.7
			· · ·	10. Work Unit No.	
9,	Performing Organization Name and Address Westinghouse Electric Corporation	on			
	Research Laboratories			11, Contract or Grant	t No.
	Pittsburgn, PA 15255			NAS 3-19407	
				13. Type of Report a	nd Period Covered
12,	Energy Research and Development	Administration		Contractor R	eport
	National Aeronautics and Space A National Science Foundation	Administration		14. Sponsoring Agenc	y Code
15.	Washington, D.C. Supplementary Notes		······		
	Project Managers: W. J. Brown, NASA Lewis Research D. T. Beecher, Westinghouse Rese	h Center, Clevela earch Laboratorie	nd, OH 44135 s, Pittsburgh, PA	15235	
16,	Abstract				
	Adding a metal vapor Rankine co	pper to a steam c	Stinionew of a p	autor plant Pote	conperature
	at which hear is added to the cy	dered Program	and fluidized had	or pressurized (w	dth an
	descented law Pty and flor) be:	ilore pro pecumed	One of the tern	arv gystems studi	ed shows
	alast afficiency of 42 3% with	e nlant canitaliz	ation of \$66.7/kW	and a cost of el	ectricity
	of 8 19 mills/MI (29.5 mills/kWI	h).			,
	•				
		· · · · ·			
17.	Key Words (Suggested by Author(s))		18. Distribution Stateme	nt	
	potassium turbine	COSt			
	•	T			
	cesium temperature	coar	Unclassified -	Unlimited	
	gas plant	COAL	Unclassified -	Unlimited	
	cesium temperature gas plant steam efficiency	COAL	Unclassified -	Unlimited	
19,	cestum temperature gas plant steam efficiency Security Classif, (of this report) Unclassified	20. Security Classif. (c Unclassif:	Unclassified - of this page) Led	Unlimited 21. No. of Pages 190	22. Frice*

* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-C-168 (Rev. 10-75)

ACKNOWLEDGMENTS

Section 8 entitled "Metal Vapor Rankine Topping-Steam Bottoming Cycles" was centered at the Westinghouse Advanced Reactors Division with the primary responsibility assumed by P. B. Deegan.

Others contributing to the concept study were:

- W. F. Guerin, who defined and costed the liquid metal subsystems.
- J. D. Mangus, who provided technical consultation.
- R. K. Sayre, who designed and costed the liquid metal condenser-steam generator.
- F. A. Beldecos of Power Generation Systems, who sized the needed metal vapor turbines.
- J. L. Steinberg and G. J. Silvestri of the Westinghouse Steam Turbine Division who calculated the performance and price of certain steam turbines.
- C. T. McCreedy and S. M. Scherer of Chas. T. Main, Inc. of Boston, who prepared the balance of plant description and costing, site drawings, and provided consultation on plant island arrangements and plant constructability.

i

TABLE OF CONTENTS

ļi ļi

NASA Re	eport No. R-134941			
Volume	I	Section 1	L	INTRODUCTION AND SUMMARY
		Section 2	2	GENERAL ASSUMPTIONS
Volume	II	Section 3	3	MATERIALS CONSIDERATIONS
Volume	III	Section 4	è	COMBUSTORS, FURNACES, AND LOW- BTU GASIFIERS
Volume	IV	Section 5	5	OPEN RECUPERATED AND BOTTOMED GAS TURBINE CYCLES
Volume	V	Section 6	5	COMBINED GAS-STEAM TURBINE CYCLES
Volume	VI	Section 7	7	CLOSED-CYCLE GAS TURBINE SYSTEMS
Volume	VII	Section 8	3	METAL VAPOR RANKINE TOPPING-STEAM BOTTOMING CYCLES
Volume	VIII	Section 9)	OPEN-CYCLE MHD
Volume	IX	Section 1	LO	CLOSED-CYCLE MHD
Volume	X	Section 1	L 1	LIQUID-METAL MHD SYSTEMS
Volume	XI	Section 1	L 2	ADVANCED STEAM SYSTEMS
Volume	XII	Section 1	.3	FUEL CELLS

ii

EXPANDED TABLE OF CONTENTS

Volume VII

		Page
ACKNOWLEDGMENTS	•	i
TABLE OF CONTENTS	•	ii
SUMMARY	•	vi
8. METAL VAPOR RANKINE TOPPING-STEAM BOTTOMING CYCLES	•	8-1
8.1 State of the Art	٠	8-1
8.1.1 Previous Studies	•	8-9
8.2 Basic Liquid-Metal Rankine Topping Cycle Plant	•	8-11
8.3 Method of Performing Calculations	•	8-22
8.4 Results of the Parametric Study	•	8-29
8.4.1 Matrix of Components and Parametric Variations	••	8-29
8.4.2 Effect of Furnace-Combustor Type		8-31
8.4.3 Effect of the Gas Turbine Recuperator		
Effectiveness	•	8-31
8.4.4 Effect of Liquid-Metal Recirculation	•	8-32
8.4.5 Effect of Exhaust Gas Feedwater Heaters and		
Economizers	•	8-32
8.4.6 Effect of Compressor Pressure Ratio	•	8-33
8.4.7 Effect of Air Equivalence Ratio	•	8-35
8.4.8 Effect of Gas Turbine Inlet Temperature	•	8-35
8.4.9 Effect of Metal Vapor Turbine Inlet Temperature	•	8-38
8.4.10 Effect of Steam Throttle Temperatures	•	8-39
8.4.11 Effect of Steam Throttle Pressure	•	8-39
8.4.12 Effect of Nonreheat vs Reheat Steam Turbine	•	8-41
8.4.13 Effect of Working Fluid		8-41
8.4.14 Effect of Power Level	•	8-43

EXPANDED TABLE OF CONTENTS (Continued)

Page

8.5	Capital and Ins	stallation Costs of Plant Components	8-43
	8.5.1 Method	of Component Sizing	8-43
	8.5.1.1	Pressurized Fluidized Bed	8-43
	8.5.1.2	Pressurized Furnace	8-46
	8.5.1.3	Liquid-Metal Vapor Drum	8-46
	8.5.1.4	Liquid-Metal Vapor Turbine	8-47
	8.5.1.5	Metal Vapor Condenser-Steam Generator	8-47
	8.5.1.6	Liquid-Metal Condenser Hot Well	8-54
	8.5.1.7	Liquid-Metal Dump Tank	8-54
	8.5.1.8	Liquid-Metal Pumps	8-55
	8.5.1.9	Liquid-Metal Piping	8-56
	8.5.1.10	Liquid-Metal Storage Tanks	8-57
	8.5.1.11	Liquid-Metal Inventory	8-58
	8.5.1.12	Plant Arrangement and Component	
		Modularization	8-59
	8.5.2 Method	of Component Cost Evaluation	8-61
	8.5.2.1	Pressurized Fluidized Bed	8-61
	8.5.2.2	Pressurized Furnace	8-62
	8.5.2.3	Combustor Pressurizing Subsystem	8-63
	8.5.2.4	Liquid-Metal Subsystem Tanks	8-65
	8.5.2.5	Liquid-Metal Vapor Turbine	8-65
	8.5.2.6	Liquid-Metal Condenser - Steam Generator	8-67
	8.5.2.7	Liquid-Metal Pumps	8-69
	8.5.2.8	Liquid-Metal Piping	8-69
	8.5.2.9	Liquid-Metal Inventory	8-69
	8.5.2.10	Liquid-Metal Auxiliary Subsystem	8-73
	8.5.2.11	Summary of Liquid-Metal Subsystem	
		Direct Costs	8-73
8.6	Analysis of O	verall Cost of Electricity	8-75
	8.6.1 Matrix	of Component and Parameter Variations	8-75

iv

EXPANDED TABLE OF CONTENTS (Continued)

			Page
	8.6.2	Effect of Furnace Combustor Type	8-77
	8.6.3	Effect of Coal Type on PFB	8-77
	8.6.4	Effect of Component and Parameter Variations	
		on PFB	8-79
	8.6.4	Effect of System Temperatures on PFB	8-83
	8.6.5	Effect of System Temperature on PFB	8-83
	8.6.6	Effect of Working Fluid on Preliminary Optimum	
		Plant	8-87
	8.6.7	Effect of Nominal Power Variation	8-87
	8.6.8	Summary Sheets	8-89
	8.6.9	Additional Considerations	8-89
8.7	Conclu	usions and Recommendations	8-97
8.8	Refere	ences	8-105
Appendix	A 8.1	Liquid-Metal Rankine Topping Cycle Parametric	
		Points System Configuration and Parametric State	
	۰.	Points	8-106
Appendix	A 8.2	Liquid-Metal Topping Cycle Parametric Point	
		Summary Sheets	8-157
Appendix	A 8.3	Detailed Accounts Listing, Points 1, 4 and 49	8-166

SUMMARY

Adding a metal vapor Rankine topping cycle to a steam cycle is a way to increase the mean temperature at which heat is added to the cycle and to raise the efficiency of the power plant. The majority of this study uses potassium as the working fluid with a few cesium points for comparison. The systems studied use either a pressurized fluidized bed boiler burning coal directly or a pressurized boiler burning clean fuel gas from an integrated low-Btu gasifier. Included in the cycles are a pressurizing gas turbine with its associated recuperator, and a gas economizer and feedwater heater. The base case system assumes a 1255°K (1800°F) pressurizing turbine inlet temperature and a 15 to 1 pressure ratio. The liquid-metal vapor generator is a fluidized bed boiler. The liquid-metal system uses a boiler with a 2.5 to 1 recirculation ratio, and several four-stage - 30 rps (1800 rpm) double flow-25 MW turbine-generators which exhaust into a metal vapor condenser-steam boiler where steam is raised for a nearly conventional steam-bottoming plant.

The metal vapor enters the turbine at 1033° K (1400° F) and the condenser-steam generator at 866°K (1100° F). The steam-bottoming plant uses a 24.132 MPa (3500 psi) either single or nonreheat plant. The high pressure feedwater heating is accomplished partly by extraction steam and partially by exhaust gas feed heating. A temperature difference of 166.7°K (300° F) is assumed across the metal vapor turbine. The steam reheat and/or superheat temperature is 55.5°K (100° F) less than the metal vapor condensing temperature. These variables are not varied independently.

Calculations show the potassium-topped plant with a capitalization of \$667/kW and a plant efficiency of 42.3%.

vi

Results show the comparable cesium cycle to have an efficiency about 0.5 point higher than the potassium cycle but to have a 0.44 mill/MJ (1.6 mills/kWh) higher cost of electricity. The need for both the gasifier and pressurized furnace compared to just a pressurized fluidized bed boiler results in a 17% high plant capitalization. The pressurized fluidized bed system is the choice for the case for further s vdy. Also indicated are a 10 to $1 - 1255^{\circ}$ K (1800°F) pressurizing gas turbine, a 1033°K (1400°F) metal turbine inlet temperature, and a 24.132 MPa/811°K/ 811°K (3500 psi/1000°F/1000°F) steam-bottoming plant.

The 1200 MW plant, made up of several distinct pressurized boiler and liquid-metal turbine loops with the exception of the steam turbine which is common to all loops, can be expected to have a higher availability than a normal.plant with line dependence on all major components.

The pressurized fluidized bed boiler plant shows a cost of electricity of 8.19 mills/MJ (29.5 mills/kWh). Extrapolation to other conditions than those calculated shows possible efficiencies of 44% with a possible capital cost of \$583/kW and a COE of 6.94 mills/MJ (25 mills/kWh). Some limited potential for this plant may exist.

> REPRODUCIESLATY OF THE ORIGINAL PAGE IS POOR

vii

8. METAL VAPOR RANKINE TOPPING-STEAM BOTTOMING CYCLES

Figure 8.1 is a simplified schematic of an energy conversion system utilizing a Rankine metal vapor topping-steam bottoming cycle. The area enclosed by the heavy broken line is the liquid-metal system discussed in this section. The areas outside the heavy broken line include the furnace-boiler, the pressurizing gas turbine generator, and the steam turbine generator, described in greater detail in Sections 4, 5, 6, and 12. Design support for material selection and the fabrication methods suggested are presented in Section 3.

8.1 State of the Art

Considering the generation of power at present-day temperatures and higher, it must be recognized that steam as a working fluid presents serious problems. It requires too high an operating pressure, and it absorbs too little heat at the maximum cycle temperature. Combining a Rankine steam cycle with a Rankine metal vapor topping cycle overcomes these problems and offers the potential for higher cycle efficiencies.

Historically, between 1922 and 1949, six commercial power generating stations were installed and successfully operated with mercury vapor topping turbines at throttle conditions of about 0.8619 MPa (125 psi) gauge/788°K (958°F). In 1949, the Schiller Station of Public Service of New Hampshire went into operation with a total capacity of 40 MWe, of which 15 MWe were generated by the mercury vapor turbine generator. The 10 MWe mercury turbine generator installed at the Hartford Electric Light Company's South Meadow station in 1928 operated until 1947. It was replaced by a 15 MWe unit in 1949. In general, the metal vapor turbine presented few problems, but some boiler corrosion and necessary replacement did occur. These plants exhibited an efficiency



Fig. 8, 1-Schematic liquid metal Rankine topping cycle

8-2

REPROPINITE OF THE

H

15% higher than did steam plants with similar top temperatures. Three of these mercury plants were still operating in 1961, but the development of more efficient steam plants (modern plants with higher inlet steam temperatures) and the value of the mercury inventory have since caused themto be dismantled.

More recently, small power plants for space stations using metal vapor turbines (potassium) have been studied. There are now ongoing programs utilizing liquid-metal subsystems for liquid-metal fast breeder reactor (LMFBR) power plants. The pertinent components for which a body of technology has been developed for use in liquid-metal systems are metal vapor condenser-steam generators, feed heaters, pumps, piping systems, valving, expansion joints, purification systems, trace heating systems, inventory control, and metal vapor turbines.

The condenser-steam generator parameters listed in Table 8.1 are indicative of the state of the art as developed by the Energy Research and Development Administration (ERDA) for the LMFBR program.

	Evaporator	Superheater
Temperatures, °F		
Sodium in	855	950
Sodium out	700	855
Water in	470	715
Water out	715	905
Sodium Velocity, ft/s	8.5	11.0
Steam Exit Velocity, ft/s	37.4	173
Pressure Drop, psi		
Water	44	245
Sodium	21	29

Table 8.1 - LMFBR Steam Generator Operating Conditions

System	Hallam EBR-2		Enrico Fermi 500 MWe FBR		P.F.R.	ANL 1000 MWe	FFTF 400 MWL	
Primary System Pumps	· ·							
Design	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	
Туре	Free surface	Free surface	Free surface	Free surface	Free surface	Free surface	Free surface	
Number of units	2	2	3	3	3	3	4	
Capacity, gpm	7200	5500	38,500	38,500	21,100	62,500	11,750	
Dynamic head, ft	160	200	310	379	333	375	385	
Design temp., °F	1000	800	1000	1100	752	1175	800	
Motor speed, rpm	900	1075	900	600	960	520	870	
Motor power, hp	350	350	1060	4000	200	6000	1.300	
Sealing arrangement	Mechanical shaft seal	Hermetically sealed drive motor	Mechanical shaft seal	Mechanical shaft seal	Mechanical shaft seal	Mechanical shaft seal	Mechanical shaft seal	
Material	304 SS	304 SS	304 SS	304 SS			[
Type of speed control	Eddy current • coupling	Variable freq. and voltage	Wound rotor . motor w/liquid rheostat	Eddy current coupling	Hydraulic coupling	WR/DC	Eddy current coupling	
Secondary System Pumps						· · · · ·		
Design	Centrifugal	ac linear	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	
Туре	Free surface	Induction	Free surface	Free surface	Free surface	Free surface	Free surface	
Number of units	3	1	3	3	3	3	4	
Capacity, gpm	7200	6500	13,000	45,300	20,400	55,200	11,450	
Dynamic head, ft	170	142	100	226	159	250	222	
Design temp., °F	1000	700	1000	965	752	1085	675	
Motor speed, rpm	900	1180 (MG set)	900	850	960	870	800	
Motor power, hp	350	500 (MG set)	350	3000	750	3500	745	
Sealing arrangement	Mechanical shaft seal	Total metal enclosure	Mechanical shaft seal	Mechanical shaft seal	Mechanical shaft seal	Mechanical shaft seal	Mechanical shaft seal	
Material	304 SS	304 SS	2-1/4% Cr - 1% Mo	304 SS				
Type of speed control	Eddy current coupling	Variable Volt. (MG set)	Eddy current coupling	Eddy current coupling	Hydraulic coupling	WR/DC	Eddy current coupling	
	1	1				1		

Table 8.2 - Characteristics of Sodium Pumps^a

^aPrototype FFF7 pump/fabrication complete - January 1971 Prototype demonstration pump/fabrication complete - January 1972 500 FBR pump P.O. - January 1971.

8-4

RAPROETOTIETT (P. 1115 ORIGINAL, JULIA IS POOR The technology involved in the liquid-metal feedheater is similar to that developed for the intermediate heat exchanger (IHX) of the LMFBR. The liquid-metal operating conditions in Table 8.1 are comparable to those expected in the feedheater. The feedheater can operate at higher temperatures than those indicated because it is not limited by nuclear reactor temperatures.

Existing steam generators and IHXs have been operating at capacities in the order of 30 and 100 MWt per unit, respectively. The LMFBR program is designing them for 100 and 300 MWt per unit, respectively.

Initial estimates of liquid-metal flow rates and required pump heads indicate that a centrifugal pump will be selected according to pump state of the art. Figure 8.2 shows the range of flows and heads of existing liquid-metal pumps. The pumps of the LMFBR program, listed on Tables 8.2 and 8.3, provide additional information on centrifugal pump designs and operating conditions. The metal vapor Rankine topping cycle liquid-metal pump would be classified in the secondary pump parameter range, especially for the design head. The application of electromagnetic (EM) pumps is also a possibility.

Characteristics	SRE	HNPF	
Capacity, gpm	2,500	7,200	
Design Temperature, °F	1,200	1,000	
Total Dynamic Head, ft	145	160	
Motor Horsepower, hp	150	350	
Hours of Operation	14,000	9,000	

Table	8.3	-	Free	Surface	Sodium	Pumps
-------	-----	---	------	---------	--------	-------

Table 8.4 lists the sizes and designs of liquid-metal valves which have been built and tested. These valves are of the order-of-



Fig. 8, 2-Typical liquid metal pump characteristics

8-6

		Wa 4 - 1	Size		Se	Service Conditions					
Reactor	Valve Function	Valves in Loop	Size, in	Stem Seal	Approx. Temp., °F	Approx. Pressure, psi	Approx. Flow, gpm				
EBR-I	Block	15	4,6	Double bellows	600	20	291				
ERB-II	Throttle	2	4	Close clearance	700	56	630				
FERMI	Throttle	3	6	Double bellows	600	118	1,000				
	Check	3	16	None	600	. 118	10,000				
HALLAM	Block	9	14, 16	Freeze seal	950	57	6,750				
	Check	3	16	None	610	37	6,750				
SRE	Block	9	6	Bellows and freeze seal	850						
SRE-PEP	Block	4	4, б	Bellows and freeze seal	1160	47	1,540				
	Throttle	1	8	Torque tube	650	19	1,420				

Table 8.4 - Large Valves in Liquid-Metal Cooled Reactors^a

^aAll valves had stainless steel bodies.

Table 8.5 - Previous Studies

- 1. Condenser-Steam Generator
 - Westinghouse Primary Steam Generator Development Program
 - AI MSG Steam Generator Study
 - EBR-II
- 2. Liquid-Metal Feedheater
 - Foster Wheeler Corp. LMFBR and FFTF IHX Design Report
 - Fermi IHX
 - Hallam IHX
 - ALCO Sine-Wave IHX (SCTI)
- 3. Liquid-Metal Pumps
 - Westinghouse Large Sodium Pump Study
 - Fermi Pump
 - British PFR Pump
 - Hallam Pump
 - EM Pump Studies
- 4. Liquid-Metal Piping
 - Material Compatibility Studies
 - Piping Stress Analysis Codes
 - Pipe Hangers and Penetration Studies
 - Piping Insulation Selection' Studies
- 5. Liquid-Metal Valves
 - Valve Development Program
 - Valve Operating Experience

- 6. Liquid-Metal Vapor Turbine
 - Two- and Three-Stage Potassium Turbine Test by General Electric
 - Potassium Turbine Tests by Garrett
 - Liquid-Metal Rankine Cycle Space Power Application
- 7. Inventory Control Development Programs for:
 - Level Instruments
 - Expansion Tanks, Dump Tank
 - Flowmeters
 - Temperature Instruments
 - Pressure Instruments
 - Leak Detectors
- 8. Liquid-Metal Purification Development Program for:
 - Liquid-Metal Solubility Studies
 - Hot and Cold Traps
 - Soluble Getters
 - Sampling Techniques
 - Chemical Analysis
 - EM Flowmeters
 - Plugging Meters
 - Electrochemical Meters
- 9. Trace Heating
 - Heater Development Program
 - Hanger and Insulation Development

8-8

2

magnitude size required for the metal vapor Rankine topping cycle. The LMFBR program is studying sodium valve development in order to improve on present valve capabilities.

In addition to the state of the art of mercury vapor turbines established for the mercury topping cycle power plants, much effort has been expended in space vehicle application of alkali-metal vapor turbines. The space program has also been investigating the feasibility of other liquid metals as working fluids for power generation.

Liquid-metal vapor turbines have been built and tested by General Electric for NASA and by Airesearch Manufacturing for the U. S. Air Force. A two-stage potassium turbine was operated successfully for 18 Ms (5000 hr) by General Electric.

The same may be said of liquid-metal inventory controls, purification systems, and trace heating: the technology exists. These systems have been built and tested for the Fermi, EBR-II, and Hallam in this country, and by several foreign nations. They have been designed for the Fast Flux Test Facility (FFTF), and many aspects of the systems have been tested in various facilities. Development programs are in progress to enhance the state of the art in these areas.

8.1.1 Previous Studies

As intimated previously, the steam generator studies for the IMFBR program provided information applicable to the condenser-steam generator. Table 8.5, Item 1, lists a few of the studies available. The Westinghouse Primary Steam Generator Development Program in particular provides an initial concept for design of the condenser-steam generator.

The design of the liquid-metal feedheater will closely resemble the IHX of the IMFBR program. Item 2 of Table 8.5 lists a design report and three actually built IHXs as reference studies.

Item 3 of the same table lists a Westinghouse study that provides liquid-metal pump design procedures, as well as sizing and costing information. Atomics International also has a similar study available, which is not listed. Under Item 3 are listed three centrifugal pumps which were built and tested. The final entry refers to the studies on EM pumps.

The EM pumps avoid the uncertainty of hydrostatic or hydrodynamic bearings operating in high-temperature liquid metal. EM pumps require no bearing, nor do they requires seals since there is no penetration of the liquid-metal envelope. The utilization of EM pumps would additionally simplify the liquid-metal transport system.

Item 4 of Table 8.5 is concerned with piping systems for liquid metals. One of the major requirements of such a system is the compatibility of the liquid metal with the piping material, as discussed in Section 4. Material is available from the LMFBR program and the metal vapor Rankine cycle program for space vehicle application. Also available under the LMFBR program are piping stress analysis codes and a Westinghouse development analysis procedure. Development programs are also involved with pipe hangers, penetrations, and insulation materials.

As mentioned previously, liquid-metal valve development programs are in progress using past operating experience as a guide. These are listed in Item 5.

Item 6 concerns previous studies on liquid-metal vapor turbines. Listed first are the two- and three-stage potassium turbine tests performed by General Electric under NASA CR-924 and NASA CR-1483, respectively. Also listed are the potassium turbine tests by Airesearch under contract to the Air Force.

Items 7, 8, and 9 of Table 8.5 cover the auxiliary system of inventory control, purification, and trace heating. Listed under the individual systems are developed programs for specific components and equipment required in the systems.

Uncertainties and development problems do exist in a liquidmetal system, but previous studies and testing programs have provided a good background for resolving them. Current FFTF and other LMFBR development programs are advancing the state of the art in these areas.

8.2 Basic Liquid-Metal Rankine Topping Cycle Plant

The parametric analysis of Task I for the liquid-metal Rankine topping cycle included 50 different plant designs, as shown in Table 8.6. The work scope specifically required that the analysis include pressurized fluidized bed combustion of coal and a pressurized furnace burning low-Btu gas made from coal. It was decided to incorporate two base cases in the parametric analysis: Base Case 1, a pressurized fluidized bed (PFB) plant, and Base Case 2, a pressurized furnace (PF) plant.

The plant site arrangement and size for Base Case 1 is shown as Figure 8.3. The plant island arrangement is illustrated on Figure 8.4 as supplied by Chas. T. Main, Inc., the architect/engineer. Figures 8.5 and 8.6 represent the plant site and plant island arrangement drawings for Base Case 2.

The flow schematics and location of state points for a PFB plant and a PF plant are shown in Figures 8.7 and 8.8, respectively. The components and flow paths denoted by dashed lines represent variations in the system configuration that were investigated. The base case system configurations are represented by solid-line components.

The configuration, performance, and state point values of Base Cases 1 and 2 are shown in Tables 8.7 and 8.8, respectively, for 1200 MWe size plants.

The base cases were assumed to be as simple as possible—hence the absence of recuperators, gas-heated feedwater heaters or economizers, and liquid-metal extractions. Based on availability studies for the liquid-metal fast breeder, plant availability is lower for sodium reheat steam cycles than nonreheat steam because of the increased probability of sodium/water reaction in the event of a steam tube rupture. Thus, a nonreheat steam cycle was selected for the two base cases.

A recirculating liquid-metal boiler was selected instead of a once-through boiler for the base cases in order to improve heat transfer coefficients and to mitigate possible overheating of the furnace tubes at

TABLE 8.6- LIQUID METAL VAPOR RANKINE TOPPING CYCLE

	Compound Matrix						Parameter Matrix											
	Pressurized Combustor	fuet	Recuperator Effectiveness	Liquid Metal Circulation Ratio	Liquid Metal Feedheater	Gas Feedwater Heater	Gas Economizer	Stages of Steam Reheat	Compressor Pressure Ratio	Air Equivalent Ratio	Gas Turbine Inlet Temperatura	Llquíd Metal Inlet Temperature (°F)	.lquld Metal Condenser Cemperature (°F)	Steam Turbine Throttle femperature (°F)	Steam Turbine Throttie Pressure (psig)	Steam Turbine Back Pressure Lin, Ho. Abs, J	Cycte Power (MWe)	-Iquid Metal
Variabi Values	Press, Furnace Press, Fluid, Bed	Bituminous Sub-bit Lignite	0, 0, 7, 0, 8	1:1,25:1	If Applicable	No, Yes	No, Yes	0,1	5, 10, 15	1. 2, 2. 0, 3.0	1600, 1700, 1800	1400, 1500, 1600	1100, 1200, 1300	1000, 1100, 1200	3500, 2400	2, 31, 9	400, 800, 1200, 1600	
Case N																		
10	PFB	Bit	0	2.5:1	If Applicable	No	No	0	15	1.2	1800	1400	1100	1000	3500	7	1200	К
2		Sub-bit																
3	PC	Lignite				<u> </u>												
		Sub-bit																
6		Lignite																
	PFB		0.7															
	PF		0.8															
10			0.8					_		·····							·	
11	PFB			1:1		•												
12	PF OCD			1:1		V												
14	PF					Yes						· · · · ·						
15	PFB						Yes					·						
16	PF						Yes											
	PER																	
19	PFB								. 10	2.0								
20										3.0					· · · ·			
Z1	ļ										1600							
											1700	7500	1200					<u> </u>
24												1600	1300					
Z					· · · · ·							1500	1200	1100				
												1600	1300	1200				
			· · ·					- -				1600	1200	1100				
29												1500	1200	1200				
30															2400			
	j{						{					1500	1200	1100]		
					······			-				1000	1200	1400				
34								1				1500	1200	1100				
								1				1600	1300	1200				
X												· · · ·					·····.	
36																ź		<u>├</u>
																9		
40				2.5:1		res	NO	+			1600	1400	1100	1000	3500	3.5	600	
42								++						łł			900	<u> </u>
43	PF																600	
<u>4</u>						-+	-+-7		$+ \mp$								900	
<u></u>	PF6					-+-{	++							[]			1600	
																+	100	
48			\square														1500	
	PTB						+	+									1200	
	rt l	•									t I	•					1200	

(1) Case No. 1 is Base Case and All Blanks Have Same Value As Base Case

8-12

REPRODUCTION OF THE ORIGINAL PAGE IS PUOR

Dwg. 8505020







Fig. 8, 4-Plant Island arrangement for a metal vapor Rankine topping plant with a pressurized fluidized bed boiler



Fig. 8.5-Rankine metal vapor topping-steam bottoming cycle with a pressurized furnace (Base Case 2)

Dwg, 2570582

REPRODUCTIVE OF THE ORIGINAL PAGE IS POOR -15 Aster



STM = 700 MW Vapor = 200 MN, 4 at 50 MN GT = 300 MW, 4 at 75 MN

20.00

Fig. 8.6—Plant island arrangement for a metal vapor Rankine topping plant with a pressurized furnace and integrated coal gasifier



Fig. 8.7 - Schematic liquid metal rankine topping cycle pressurized furnace



					* * * * * * * * CSSLOTS	
	PCHER OUTPUT(MME) FURNACE PR.FLD CCAL MCRKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIC AIR EQUIVALENCE RATIO	1200 GAS TURBI DEED TEMPERA BIT GAS ELDNO K GAS FEELW U.U L.M.JIPOU 15 L.M.FEEDW 1.2 STADES OF	NE INLET TURE (JEG-F) MIZER PTEF HEATER LATION RATIO FAIER STEAM REHEAT	1800-0 NO HJ 2.5 1 NO	L.M.SYSTEA PRESSURIZING SUBSY STEAM CYCLE GROSS PLANT NET PLANT NET PCWER DUTPUT (M	. C97 STEM . 267 .420 .380 .370 WEJ 1169.57
	**** STATE POINTS ****	TOTAL FLOW 19536 LSM/HR	TEMPERATURE Jeg-F	PRESSUR PSIA	E THERMAL LCAD 10EDV BTUZHR	POWER OUTPUT
	1 L.M. TURBINE INLET	7.382	1406.000	15.2	00	188.000
	2 L.M.CONDENSER		1100.000	2.4	00 5.856	
	3 L.M.FEED PUMP	5277.000 GPM	1100.000	33.9	00	.363
	4 L.M.RECIRC PUMP	13574.000 GPM	1280.000	20.6	10	.173
210	5 L.M.BOILER INLET		1280.000		6.600	
-	6 STEAM TURBINE THROITLE	6.774	1000.000	3515.0	0.0	720.600
	7 STEAM REHEAT		0.000	0.0	00	
	8 ST.COND.BACK PRESS.			3.5	0CIN.HG 3.396	
	9 FINAL FEEDWATER		560 .000			
	14 COND/SG WATER INLET		\$69.000			
	11 COMPRESSOR INLET	10.320	59.000	14.69	90	
	12 GAS TURBINE INLET	11.216	1800.000			291.500
	13 GAS ECON. GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		0.000		0.003	
	15 STACK GAS EXHAUST		844.000			
	16 AS RECEIVED COAL	499.400T/HR			10.775	

Table 8.7 - Liquid-Metal Rankine Topping Cycle Components and Operating Parameters for Base Case 1

Ĕ

	Table 8.8 - Liquid-Metal Rankine Topping Cycle Components and Operating Parameters for Base Case 2					
		Tarometers	TOL Dase Case 2		* * * * * * * EFFICI	ENCIES * * * *
	PCWER OUTPUT(NWE) FURNACE PR.FU GCAL NCRCING FLUIJ RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSUFE RATIC AIR EQUIVALENCE RATIO	1200 GAS TURBI RNACE TEMPERA BIT GAS ELUNO K GAS FEELW 0.0 L.M.SIRCU 1.5 L.M.FEEDH 1.2 STABES OF	WE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1809+0 NO NO 2.5 1 NO G	L.M.SYSTEM PRESSURIZING SUBSY STEAM CYCLE GROSS PLANT NET PLANT NET PCWER OUTPUT (M)	• 0 37 STEM .263 • 420 .365 .356 we) 1169.88
	**** STATE POINTS ****	TOTAL FLOW 19616 Lemann	TEMPERATURE DEG-F	PFESSURF PSIA	THERMAL LCAD 10e09 Btu/Hr	POWER OUTPUT MWE
	1 L.M.TURBINE INLET	7.327	1400.000	15.23	Ũ	186.500
	2 L.M.CONDENSER		1100.005	2.41	5.813	
	3 L.M.FEED PUMP	5245.000 GPM	1100.000	33.590	I	, 356
	4 L.M. RECIRC PUMP	13491.000 GPM	1280.000	20.550	I	.170
8-2	5 L.M.BOILER INLET		1282.000		6.551	
0	E STEAM TURBINE THROTTLE	6.724	1990.000	3515.00	0	715.300
	7 STEAN REHEAT		0.000	C.00	0	
	E ST.COND.BACK PRESS.			3.50	0IN.HG 3.372	
	S FINAL FEEDWATER		560.000			
	10 COND/SG WATER INLET		560.000			
	11 COMPRESSOR INLET	10.056	59.000	14.69	G	
	12 GAS TURBINE INLET	10.960	1800.000			298.600
	13 GAS ECON.GAS INLET,		0.090		9.000	
	14 GAE FWH GAS INLET		6.000		0.003	
	15 STACK GAS EXHAUST		857.000			
	11 AS RECEIVED COAL	520.000T/HR			11.220	

the hot end. Recirculation also provides for easier start-up and control, and reduction of mass transfer and corrosion. A recirculation ratio of 2.5 to 1 was selected because, for the heat fluxes estimated in the vapor generators, departure from nucleate boiling (DNB) occurred at approximately 50% quality. The recirculation ratio of 2.5 to 1 corresponds to 40% quality entering the metal vapor drum and provides sufficient conservatism to avoid the problems of DNB and film boiling in the liquid-metal vapor generators.

The recirculation ratio is defined as the ratio of total liquidmetal flow through the furnace/boiler divided by the feed flow.

A gas turbine inlet temperature of 1255°K (1800°F) was selected as the maximum temperature allowed for pressurized fluidized bed combustion of coal to avoid melting and agglomeration of the ash. In conjunction with the liquid-metal temperatures selected, the 1255°K (1800°F) temperature tended to minimize the PFB and PF heat transfer areas and, hence, minimize capital cost.

A potassium vapor turbine inlet temperature of 1033° K (1400°F) provided a reasonable turbine throttle pressure, 104.8 kPa (15.2 psi) abs. Since the PFB and PF are limited to overall heat transfer coefficients approximately equal to the flue gas coefficients [< 283 W/m²-°K (< 50 Btu/hr-ft²-°F)], the log mean temperature difference is maximized with 1033°K (1400°F) liquid metal. Reduction below 1033°K (1400°F) would result in a subatmospheric throttle pressure for the liquid-metal turbine. The liquid-metal condensing temperature of 866°K (1100°F) provided a reasonable condenser pressure [16.55 kPa (2.4 psi) abs] and condenser/steam generator hot-end temperature difference.

The steam turbine throttle conditions of 24.132 MPa (3500 psi) abs, 811°K (1000°F) provide high steam cycle efficiency. The supercritical pressure eliminates potential problems of tube fatigue and uncertainties associated with DNB. The 11.85 kPa (3-1/2 in Hg) abs back pressure represents wet cooling tower conditions. Wet towers are environmentally

more acceptable than are once-through and more economical for heat rejec-

Potassium was selected as the working fluid because more data were available. For this reason the study concentrated on the effects of component and parameter variations on a potassium subsystem, assuming that the results of a potassium subsystem would apply to cesium as well.

8.3 Method of Performance Calculation

The performance of the metal vapor Rankine topping-steam bottoming cycle was calculated by a combination of computer codes and hand calculation. Computer codes were used for the performance of the steam turbine subsystem and the pressurized combustor subsystem, and hand calculations determined the performance of the liquid-metal subsystem.

The hand calculation of the metal vapor turbine was based on an isentropic expansion turbine efficiency of 78%. For an inlet condition of 1033°K (1400°F) and 99% quality, the potassium vapor left the turbine at 866°K (1100°F) and 90% quality. Approximately 202 kJ/kg (\sim 87 Btu/1b) of useful work could be extracted from the potassium by expansion through a turbine for the above conditions. The amount of useful work for the 1089°K/922°K (1500°F/1200°F) turbine-condenser conditions and the 1144°K/978°K (1600°F/1300°F) turbine-condenser conditions was assumed to be approximately the same as for the 1033°K/866°K (1400°F/1100°F) cycle.

Further calculations on a volumetric flow basis demonstrated that a 25 MWe potassium turbine would be of a double-flow, four-stage design with a 1.82 m (6 ft) diameter disk and run at 30 rps (1800 rpm). The cesium turbine was designed for the same $1033^{\circ}K/866^{\circ}K$ (1400°F/1100°F) turbine-condenser conditions, with 90% exhaust quality and a 76% efficiency. The useful work for these conditions was calculated to be $\sim 61.2 \text{ kJ/kg}$ ($\sim 26.3 \text{ Btu/lb}$).

The performance of the pressurizing combustor subsystem was evaluated by computer program using the pressurized combustor type, the coal type, recuperator effectiveness, the compressor pressure ratio, air equivalence ratio, and gas turbine inlet temperature as denoted for the 50 parametric points of the metal vapor Rankine topping cycle of Table 8.6. The output included the quantities of heat available from the combustor, Q_b/W_a ; the stack-gas cooler, Q_2/W_a ; and the power generated by the gas turbine generator, P/W_a , as a function of the airflow rate, W_a , and the fuel-to-air ratio, W_f/W_a .

The steam turbine subsystem efficiencies, as determined by computer code, were based on the steam turbine throttle temperatures and pressure and condenser back pressures given in Table 8.6. All cases utilized an 800 MWe steam turbine. The final feed temperatures were 566 and 550°K (560 and 530°F) for 24.132 and 16.547 MPa (3500 and 2400 psi) gauge conditions, respectively, with eight feedwater heaters. For the case which utilized a gas feedwater heater in parallel with the turbine feedwater train, the final feed temperature was 529°K (492°F) with seven feedwater heaters. The stack outlet temperature, total flue gas flow, and flue gas composition were included as input. For cases with steam reheat the reheat temperature was assumed equal to the steam throttle temperature, and the IP turbine inlet pressure was always taken as 4.137 MPa (600 psi) abs.

The integration of the three subsystems was performed by simple hand calculation in an iterative process. Assuming the metal vapor turbine-generator produced 100 MWe, P_{LMT} , with a known useful work, ΔH_{LMT} , the liquid-metal flow rate, W_{LMT} , is:

$$W_{\rm LM} = P_{\rm LMT} / \Delta H_{\rm LMT}$$
(8.1)

For any given metal vapor cycle the liquid-metal enthalpy rise in the boiler, $\Delta H_{\rm b}$, and enthalpy drop in the condenser-steam generator, $\Delta H_{\rm c}$, are known. So with W_{LM} of Equation 8.1 the heat available to the boiler, Q_h, is:

$$Q_{b} = W_{LM} \Delta H_{b}$$
 (

8-23

(8.2)

and the heat rejected to the steam, Q_c , is:

$$Q_{c} = W_{LM} \Delta H_{c}$$
(8.3)

For the pressurizing combustor subsystem performance values, the airflow rate, W_a , is:

$$W_a = \frac{Q_b}{(Q_b/W_a)}$$
(8.4)

and the power generated by the gas-turbine generator, P_{gt} , is:

$$P_{gt} = (P/W_a) W_a$$
 (8.5)

In the case of a gas economizer or feedwater heater, the heat transferred in the stack-gas cooler, Q_2 , is:

$$Q_2 = (Q_2/W_a) W_a$$
 (8.6)

If there is no gas economizer or feedwater heater, then Q_2 is 0. To determine the power produced by the steam-turbine generator, the total heat added to the steam-turbine subsystem, Q_{stm} , is:

$$Q_{stm} = Q_c + Q_2 \tag{8.7}$$

and using the steam-turbine cycle efficiencies, η_{stm} , as determined by computer code, the steam-turbine rating, P_{stm} , is:

$$P_{stm} = (Q_{stm}) n_{stm}$$
(8.8)

The summation of the power generated by the three subsystems is the total plant power, P_{total}. In order to determine the liquid-metal and airflows,

the thermal loads, and the three subsystem power ratings of a 1200 MWe rated plant, a new liquid-metal flow rate, W'_{LM} , was calculated from Equation 8.9:

$$W'_{LM} = W_{LM} (1200/P_{total})$$
 (8.9)

Letting W_{LM} equal W'_{LM} , the above procedure, Equations 8.2 through 8.8, was repeated.

Once the reiteration is completed, the remaining flow rates needed to size equipment can be calculated. The steam throttle flow rate, W_{stm} , was calculated as:

$$W_{stm} = \frac{Q_c + Q_2}{\Delta H_{cs} + \Delta H_2}$$
(8.10)

where ΔH_2 is the water enthalpy rise in the gas economizer and/or gas feedwater heater.

In order to optimize the amount of heat input for a gas economizer with the cost of the heat exchanger, estimates indicate that $\sim 50\%$ of the heat available at the stack-gas cooler, Q_2 , should be used to economize the feedwater going to the condenser-steam generator. Obviously, all of Q_2 cannot be available for economizing, since the exhaust stack-gas temperature 416°K (290°F) is lower than the final feedwater temperature of 529°K (492°F).

The water-steam enthalpy rise, ΔH_c , in the condenser-steam generator includes the enthalpy rise for the throttle steam flow and the reheat steam flow. A good approximation of the water enthalpy rise is defined by:

$$\Delta H_{cs} = \Delta H_{stm} + C \Delta H_{rh}$$
(8.11)

Coal	Illinois Bituminous	Montana Subbituminous	North Dakota Lignite
As Received			
Moisture, % (Moistl)	13.0	24.3	36.7
HHV, Btu/1b	10788	8944	6890
LHV, Btu/1b	10230	8372	6248
Lockhopper			э.,
Moisture, % (Moist2)	3	20	27
HHV, Btu/1b	12028	9452	7946
LHV, Btu/1b	11525	8907	7365
Maximum Practicable Drying			
Moisture, % (Moist3)	0	16	18
HIV, Btu/1b	12400	9925	8926
LHV, Btu/1b	11913	9405	8401

Table 8.9 - Heating Values of Coals with Various % Moistures

REPRODUCEDENTY OF THE ORIGINAL PAGE IS POOR
where ΔH_{stm} is the throttle steam enthalpy rise above that at the economizer exit, ΔH_{rh} is the reheat steam enthalpy rise, and C is a constant which varies from 0.88 to 0.895, depending on throttle conditions.

This approximation of the high-pressure turbine extraction steam flow agrees within \pm 3% for computer-calculated performance values. The flue gas flow rate, W_g, based on the fuel/air ratio, W_f/W_a, which is given in the pressurizing combustor subsystem performance, is:

$$W_{g} = [1 + (W_{f}/W_{a})] W_{a}$$
 (8.12)

and the as fired coal flow, W_{f} , is:

7

$$W_{f} = (W_{f}/W_{a}) W_{a}$$
 (8.13)

The as received coal flow rate depends on the type of coal used and the type of combustor. For a pressurized fluidized bed the as received coal use rate, tons/hr, is:

Tons/hr =
$$W_f \left(\frac{1-Moist2}{1-Moist1} \right)$$
 (8.14)

where Moistl and Moist2 are listed in Table 8.9 for the three types of coal considered. For a pressurized furnace the coal use rate is:

$$Tons/hr = W_c/(1.0-Moistl)$$
(8.15)

where Moistl is also listed in Table 8.9. For a pressurized fluidized bed the total heat input of the plant Q_{total} is determined by:

$$Q_{total} = (Tons/hr) HHV$$

(8.16)

where HHV, the higher heating values of the three coals, are listed for the various moisture contents in Table 8.9.

The gasification subsystem for a pressurized furnace plant requires heat for drying the coal, and process steam and air for the production of low-Btu fuel gas. It was assumed that these heating requirements were satisfied by the hot exhaust flue gas from the pressurizing combustor subsystem at the stack-gas cooler, Q_2 . When a gas economizer was used to add heat in the steam turbine subsystem, approximately half the heat available at the stack-gas cooler, Q_2 , was used to economize the feedwater. The other half of Q_2 was assumed sufficient to satisfy the drying and process heat requirements of the gasification subsystem.

For a case where a gas feedwater heater was used in parallel with the extraction feedwater heater string, the process steam requirement was not satisfied (see Table 8.6 Cases 14, 43, 44, 45, and 50). The process steam heat, Q_{ps} , then was assumed to be an added thermal load on the pressurized furnace plant. The process steam rate, W_{ps} , was determined as:

$$W_{\rm ps} = (W_{\rm ps}/W_{\rm a}) W_{\rm a} \tag{8.17}$$

where $(W_{ps}^{/W})$, was calculated by the pressurizing combustor subsystem performance computer code for a pressurized furnace.

The thermal load of the process steam, Q_{ps} , was evaluated by:

$$Q_{ps} = W_{ps} \Delta H_{ps}$$
(8.18)

where ΔH_{ps} was the water enthalpy rise from the enthalpy at the steam condenser to the enthalpy of saturated steam at a saturation pressure 1.5 times the pressurized furnace operating pressure. [For the applicable cases this saturation pressure was 1.5 times 1.520 MPa (15 atm), or P_{sat} is 2.28 MPa (330 psi) abs.] Hence, for cases 14, 43, 44, 45, and 50 of Table 8.6, the total heat input of the plant was:

$$Q_{total} = (Tons/hr) HHV + Q_{ps}$$
 (8.19)

The gross plant cycle efficiency, $\eta_{\rm Gross},$ then, was given by:

$$n_{\rm Gross} = P_{\rm total} / Q_{\rm total}$$
 (8.20)

where Q_{total} is given by Equation 8.16 for PFB and by Equation 8.19 for PF. With the various subsystem flows evaluated, the parametric points of the liquid-metal subsystem components were sized for each of the parametric points of Table 8.6.

8.4 Results of the Parametric Study

8.4.1 Matrix of Component and Parameter Variations

The work scope of this study required the metal vapor Rankine topping cycle to be investigated for a variety of furnace combustor types, fuel (coal types), cycle configurations, major cycle parameters, and power levels. The matrix of the 50 parametric points for the metal vapor Rankine topping cycle is shown on Table 8.6. Base Case 1, the pressurized fluidized bed, and Base Case 2, the pressurized furnace-gasifier system, are listed in Table 8.6 as Points 1 and 4, respectively.

The first 39 cases served as a sensitivity study to determine the effects of component and parameter variation for a constant power level. This sensitivity study was then used to determine a preliminary optimum case by combining the components and parametric values which individually provided the best cycle performance and which were estimated to be cost effective. This preliminary optimum cycle was used to determine the effect of power level variation for a PFB plant (Points 40, 41, 42, and 49) and a PF plant (Points 43, 44, 45, and 50). Points 46, 47, and 48 were used to study the effects of power-level variation and cesium as the working fluid in a PFB plant.

Table 8.10 - Effect on Cycle Performance of PFB and PF Plants for Parameter and Component Variation

Comment /Downston	Overall Energy Efficiency, %						
component/farameter	PFB	Point No.	PF	Point No.			
Coal Type							
Illincis No. 6 bituminous	35.9	1	35.0	4			
Montana subbituminous	35.8	2	38.1	5			
North Dakota lignite	34.8	3	38.8	6			
Recuperator Effectiveness							
ε = 0.0	35.9	1	35.0	4			
ε = 0.7	36.4	7	35.3	9			
ε = 0.8	36.4	8	35.4	10			
Recirculation Ratio				•			
25:1	35.9		35.0	-			
1:1 (once through)	35.9	11	35.0	12			
Gas Feedwater Heater	43.4	13	40.9	14			
Gas Economizer	39.7	15	38.8	16			

8.4.2 Effect of Furnace-Combustor Type

The effect of furnace-combustor type (PFB and PF) on performance was investigated, while varying several other parameters and components. Table 8.10 lists the parameter and components varied for both furnace-combustor types and the resulting overall energy efficiency. In all cases except the Montana and North Dakota coal cases, the PFB shows a higher efficiency. The lower PF efficiency is due to the 90% efficiency of the integrated gasifier producing low-Btu gas from the coal.

8.4.3 Effect of the Gas Turbine Recuperator Effectiveness, ε

The effect of preheating air at the inlet to the furnacecombustor with the gas turbine exhaust was determined for recuperator effectiveness of $\varepsilon = 0.7$ and $\varepsilon = 0.8$. The addition of a recuperator to the PFB raised the air inlet temperature 33.3 and 38.9°K (60 and 70°F) for an effectiveness of 0.7 and 0.8, respectively, over Base Case 1, which had no recuperation. The preheating reduced the required airflow and the power split in the cycle to improve the overall efficiency 1.4% above Base Case 1. For the PF plant the air temperature was raised 38.9 to 44.4°K (70 to 80°F) for 0.9 and 1.1% efficiency improvement for effectiveness of $\varepsilon = 0.7$ and $\varepsilon = 0.8$, respectively.

It was assumed that the recuperators would not be cost effective for the small efficiency improvements. Furthermore, the 22.2 to 27.8°K (40 to 50°F) drop in recuperator exhaust gas temperature would reduce the effectiveness of the gas-heated economizer and/or feedwater heaters and increase their cost. The recuperators were not, therefore, incorporated into the preliminary optimum.

8~31

8.4.4 Effect of Liquid-Metal Recirculation

As shown on Table 8.6, both once-through and recirculating liquid-metal boiler subsystems were studied. The cycle efficiency for the once-through system was negligibly higher than the recirculating system. The liquid-metal recirculation pumps required 0.17 MWe (less than 0.015%) of the net power output.

The once-through unit will cost less due to smaller liquidmetal inventory, storage tanks, and the absence of recirculation pumps, piping, and vapor drum. The recirculation ratio of 2.5 to 1 was selected to avoid DNB and all its subsequent problems. Recirculation also provides for easier control and a heated makeup inventory in case of loss of water flow for any reason. For these reasons the recirculating boiler system was selected for the preferred case.

8.4.5 Effect of Exhaust Gas Feedwater Heaters and Economizers

For Base Cases 1 and 2 the combustor pressurizing subsystem turbine exhaust gas was assumed to be used to provide process heat to other subsystems (such as process steam in the PF gasifier plant). In the case of the gas-heated feedwater heaters, all the heat available from the stack-gas coolers was transferred to the feedwater.

The resulting cycle efficiencies of 43.4 and 40.9% for the PFB and PF, respectively, were the highest found. The PFB plant efficiency increased 20.9% over Base Case 1; and the PF plant efficiency increased 16.9% over Base Case 2. The PF increase was not as large as the PFB case due to the gasifier process steam requirements. Because of the economizer exhaust gas temperature limitation imposed by the final feedwater temperature of 529°K (492°F), the exhaust gas transferred approximately half the available stack-gas cooler energy to the gas-heated economizer. The performance improvement was still significant (half the

> REPRODUCTION OF THE ORIGINAL FROM IS POOR

amount of the feedwater heaters), 10.6% for the PFB and 10.9% for the PF. In the case of the PF the process steam requirements were supplied by the remaining available stack-gas cooler energy.

It was assumed that incorporation of both the gas feedwater heater and the economizer would not be cost effective. The larger increase in overall efficiency due to the gas-heated feedwater heater was the basis for its selection as optimum. Preliminary calculations, however, indicate that there is too much heat available in the gas feedwater heater with the assumed 529° K (492° F) maximum feedwater temperature. With this assumption the feedwater flow to the turbine extraction feedwater heater string is greatly reduced. The resulting low-pressure steam turbine exhaust flows are, therefore, larger than for full extraction machines, thereby causing large exhaust losses if the same low-pressure ends were chosen; or the use of larger, more costly ends if this is unacceptable. Reduced steam turbine efficiencies were assumed when a gas feedwater heater was incorporated. A logical optional approach would have been to remove the 529° K (492° F) assumed maximum feedwater temperature.

8.4.6 Effect of Compressor Pressure Ratio

Calculations were performed for combustor pressurizing subsystem pressure levels of 0.506, 1.013, and 1.520 MPa (5, 10, and 15 atm). The resulting overall energy efficiencies increased with increasing pressure ratio, as shown on Figure 8.9. On the basis of efficiency, the 15-to-1 compressor ratio was selected for the preliminary optimum plant.

On the other hand, a compressor pressure ratio of 10 to 1 results in a stack-gas cooler gas inlet temperature 311°K (100°F) higher than a 15-to-1 pressure ratio. There is also approximately 22% more stack-gas cooler energy available to the more efficient steam turbine by means of the gas feedwater heater and/or gas economizer. The effect on overall energy efficiency for a compressor pressure ratio of 10 to 1 with a gas feedwater heater and/or a gas economizer warrants further investigation.



Fig. 8.9—Effect compressor pressure ratio on overall energy efficiency for a pressurized fluidized bed boiler plant

Similarly, the energy available to the steam turbine may be increased by preheating the air to the furnace combustor and lowering the compressor pressure ratio to 10 to 1. Under these conditions the condenser-steam generator heat available to the steam turbine increases approximately 10%. The stack-gas cooler heat available decreases accordingly. Reduction in the amount of gas feedwater heating is in the proper direction for obtaining the optimum flow split through the parallel gas feedwater and the extraction feedwater string (mentioned in Subsection 8.4.5).

The present study has investigated the effects of individually and separately varying such components and parameters as recuperators, gas economizers, gas feedwater heaters, and compressor pressure ratios. The optimum plant configuration and parameters, however, can only be obtained by investigating the above parameters and components in combination, a task beyond the scope of Task I of this study.

8.4.7 Effect of Air Equivalence Ratio

Three values of air equivalence ratio, ϕ_{air} , were investigated. The minimum ϕ_{air} of 1.2 for fluidized bed combustion was used for Base Cases 1 and 2. Additional values of ϕ_{air} used were 2.0 and 3.0. As shown on Figure 8.10, the overall energy efficiency decreases drastically as ϕ_{air} increases above $\phi_{air} = 1.2$. As the airflow increases, less energy is available to heat the liquid metal. At a ϕ_{air} of 1.2, approximately 40% of the available heat is required to heat the air. At a ϕ_{air} of 2.0 almost 75%; and at a ϕ_{air} of 3.0 fully 90% of the heat available is heating the air (see Figure 8.10). The base case ($\phi_{air} = 1.2$) was selected as optimum.

8.4.8 Effect of Gas Turbine Inlet Temperature

The maximum allowable fluidized bed temperature is 1283°K (1850°F) because of the desulfurization reaction. Therefore, the maximum gas turbine inlet temperature selected was 1255°K (1800°F). Turbine inlet temperatures of 1144 and 1200°K (1600 and 1700°F) were also studied. The overall energy efficiency increased as the gas turbine inlet temperature decreased, as shown on Figure 8.11. The efficiency increased 6% as







Fig. 8. 11 —Effect of gas turbine inlet temperature on overall energy efficiency for a pressurized fluidized bed boiler plant

the gas turbine inlet temperature was reduced from 1255 to 1144°K (1800 to 1600°F). This improved efficiency was the result of reducing the percentage of the total available energy absorbed by the combustor pressurizing subsystem. As the gas turbine inlet temperature was lowered, more of the available energy was transferred to the more efficient steam turbine. Figure 8.11 also shows the percent of available energy absorbed by the pressurizing subsystem as a function of temperature.

On the basis of overall efficiency the 1144°K (1600°F) gas turbine inlet temperature was selected as optimum. As will be demonstrated in Subsection 8.6, however, a lower gas turbine inlet temperature at the same pressure ratio reduces the log mean temperature difference in the stack-gas coolers which transfer energy to the steam turbine feedwater, thus increasing the cost of electricity for this plant. The interaction of gas turbine inlet temperature with stack-gas coolers and recuperators is as significant as is compressor pressure ratio. Again, an optimum plant cannot be determined until the interaction of the parameters and components of the combustor pressurizing subsystem has been investigated thoroughly.

8.4.9 Effect of Metal Vapor Turbine Inlet Temperatures

In studying the effect of liquid-metal temperature variation, a constant 166.7°K (300°F) temperature difference was maintained from liquid-metal turbine inlet to the condenser-steam generator. The liquidmetal temperature variations investigated were 1033°K inlet/866°K outlet (1400°F/1100°F), 1089°K/922°K (1500°F/1200°F), and 1144°K/978°F (1600°F/ 1300°F). The effect of this variation on overall energy efficiency was negligible. The efficiency improved only 0.3% over the entire range (see Figure 8.21b). The Base Case 1 liquid-metal temperatures of 1033°K/ 866°K (1400/1100°F) were selected for the preliminary optimum case. The lower temperatures tend to mitigate high-temperature material and development problems.

To fully appreciate liquid-metal system temperature variation effects, the effect of liquid-metal temperature differences should be investigated. The liquid-metal turbine preliminary design calculations, however, indicated that the pressure drop through a moisture separator or reheater were unacceptable. Preliminary studies further indicated that internal moisture separation was not practical due to the low-turbine speeds. The liquid-metal turbine temperatures were based on these considerations and a maximum 10% moisture. Additional effort in the turbine design area should rectify these difficulties.

8.4.10 Effect of Steam Throttle Temperature

The steam throttle temperatures of 811, 866, and 922°K (1000, 1100, and 1200°F) were investigated. Unlike the previous parameter variations, the steam temperature was not varied separately but was varied with the liquid-metal temperature. In each case a 55.5°K (100°F) temperature difference was assumed between the liquid-metal condensing temperature and the steam turbine throttle temperature. The results of the steam turbine throttle temperature variations are, therefore, not completely independent.

The steam temperature was varied with steam pressure for both reheat and nonreheat turbines. As the steam temperature increases, the steam turbine Rankine cycle efficiency increases. Figure 8.12 illustrates the increase in overall energy efficiency as the steam temperature increases.

The steam throttle temperature of 811°K (1000°F) was recommended for the preliminary optimum case. This decision was based on steam turbine and condenser-steam generator design considerations. Material and development problems are diminished at the lower temperature, as are component costs.

8.4.11 Effect of Steam Throttle Pressure

Variation of the steam throttle pressure was limited to one subcritical and one supercritical pressure. The values of pressure investigated were 16.547 and 24.132 MPa (2400 and 3500 psi) gauge. Figure 8.12 demonstrates the Rankine cycle principle that as pressure

Curve 683059-A



Fig. 8. 12 – Effect steam throttle temperature on overall energy efficiency for a pressurized fluidized boiler plant

REPRODUCTORATY OF THE ORIGINAL PAGE IS POOR

increases for a constant steam temperature, the steam turbine efficiency improves; and as steam turbine efficiency increases, the overall energy efficiency increases. In the nonreheat cases the overall efficiency increases better than 1.7% at a given steam temperature when the steam pressure increases from 16.547 to 24.132 MPa (2400 to 3500 psi) gauge. In the reheat cases, the improvement in overall energy efficiency is about 1.4%.

The 24.132 MPa (3500 psi) gauge throttle pressure was selected on the basis of efficiency. It was also selected because, at 24.132 MPa (3500 psi) gauge, DNB and all its uncertainties are avoided in the condenser-steam generator.

8.4.12 Effect of Nonreheat versus Reheat Steam Turbine

Referring to Figure 8.12 shows the effect on overall efficiency as a function of pressure and temperature of the steam. For a given steam temperature, the overall efficiency improvement of reheat versus nonreheat is approximately a constant 2.5%, regardless of the temperature. The reheat cycle was selected for incorporation in the preliminary optimum.

8.4.13 Effect of Working Fluid

The effect of cesium versus potassium as the working fluid in the liquid-metal subsystem was studied only for the preliminary optimum case. It was assumed that cesium would not be competitive with potassium. The calculation of the preliminary optimum plant, however, resulted in an overall energy efficiency of 42.9% for the cesium and 42.4% for the potassium.

The 1.2% efficiency advantage for cesium over potassium demonstrated that cesium is competitive with potassium. Final conclusions should not be made at this time due to the preliminary nature of the calculations and designs. Further effort is required, particularly in the turbine design.



8-42

Fig. 8. 13-Flow sheet for a fluidized bed boiler plant

8.4.14 Effect of Power Level

No effort was made at this time to determine the effect on cycle performance for power variation. The efficiencies were assumed constant with power level to determine the effect of plant thermal rating on the cost of electricity.

8.5 Capital and Installation Costs of Plant Components

This section is divided into two segments: the first subsection presents the method of component sizing; the second outlines the method of component costing.

Component sizing and economic evaluation were performed by the various cognizant design groups for the metal vapor Rankine topping cycle subsystems. Flow schematics of the PFB and PF plant cycles are shown in Figures 8.13 and 8.14, respectively. The schematics show the cycle subsystems as labeled blocks.

The combustor pressurizing subsystem was sized and cost evaluated by the combustor-furnace and low-Btu gasifier design group (see Section 4). The combustor pressurizing subsystem consisted of coal handling and processing, compressor turbogenerator, the stack-gas cooler, the fluidized bed gasifier and boiler and related hot gas piping, and process air and steam piping. The steam turbine subsystem sizing and cost evaluation were performed by Westinghouse Large Turbine and Heat Transfer Divisions. The balance of plant was evaluated by Chas. T. Main, Inc. (see Section 2). The heat rejection subsystem was included in the assumptions of Section 2.

The method of sizing and costing plant components for the liquid-metal subsystem and its related subsystems, as shown in Figure 8.15, are presented in this section.

8.5.1 Method of Component Sizing

8.5.1.1 Pressurized Fluidized Bed

The sizing of the pressurized fluidized bed boiler, PFB, is covered in Section 4). The liquid-metal considerations in the design



Fig. 8. 14-Flow sheet for a pressurized furnace plant cycle

Dwg. 6352A76



Fig. 8. 15-Flow sheet for the liquid metal turbine subsystem

and sizing of the PFB were the heat required, Q_{b} , as determined in Subsection 8.3 by Equation 8.2. The overall heat transfer coefficient was assumed to be equivalent to the bed-side heat transfer coefficient [83.8 W/m²-°K (50 Btu/hr-ft²-°F)]. The tube-side liquid-metal pressure drop was assumed to be equal to that of the pressurized furnace, approximately 6% of the operating pressure. Finally, four PFB modules are assumed to be required for every 300 MWe of plant capacity.

8.5.1.2 Pressurized Furnace

The pressurized furnace, PF, design was an adaptation of the recirculating-type boiler proposed by A. P. Fraas (Reference 8.2). To ensure sufficient flow for a 2.5-to-1 circulation ratio, a centrifugal pump provides the driving force in an external recirculation loop which headers the subcooled liquid metal into the bottom of the furnace. The cold feed passes through the headers into tube bundle clusters and rises up through the combustion chamber to an upper set of headers. The twophase mixture leaving the PF enters a liquid-metal vapor drum. The vapor is separated from the saturated liquid and passed to the liquid-metal turbine. The saturated liquid passes to a mixing header, where it mixes with the cold liquid-metal feed coming from the condenser-steam generator.

8.5.1.3 Liquid-Metal Vapor Drum

The liquid-metal vapor drum was sized on the assumption that under the worst transient surge the drum will never be more than twothirds full of iquid, and that under normal conditions it is approximately half-filled with liquid. The Clinch River Breeder Reactor Plant (CRBRP) steam drum was sized on these criteria. The transient time of the saturated water in the CRBRP steam drum was calculated to be 60 s (1 min). It was then assumed that the worst transient surge in a liquidmetal topping cycle would not be as severe as in CRBRP, so the transit time for the liquid-metal drum was assumed to be half that of CRBRP, or 30 s (0.5 min). The volume of the drum, Vol_d, was then determined by:

$$Vol_{d} = \frac{2(RC - 1) W_{LM} t}{N_{d} \rho_{\ell}}$$
(8.21)

8-46

REPRODUCE OF THE ORIGINAL, FALLS IS POOR where RC is the circulation ratio; W_{LM} is the total metal vapor mass flow rate to the turbine; N_d is the number of vapor drums; ρ_{ℓ} is the density of saturated liquid metal; and t is the transit time.

8.5.1.4 Liquid-Metal Vapor Turbine

The liquid-metal vapor turbine design was limited by available technology for large disk forgings of superalloys and refractory alloys. To compensate for the size limitations, the liquid-metal turbines are assumed to be modularized, double-flow units with built-up rotors. The rotors are similar to aircraft gas turbines, built up of disks and spacer rings rather than of a single-solid forging. The material candidates for the liquid-metal vapor turbine are discussed in Subsection 3.7, as are the bearing and shaft seal techniques.

The potassium turbine was designed (see Figure 8.16) as a 25 MWe, four-stage, double-flow, 1800 rpm turbine with a 1.83 m (6 ft) disk. Each generator is a four-pole, 1800 rpm machine rated at 30 MVA. The efficiencies assumed for the four stages of the potassium turbine were 82, 81, 79, and 75%, respectively. In the preliminary design the cesium turbine was assumed to have only two stages with similar power rating. Its efficiency was assumed to be 76%.

For the base case plant rating of 1200 MWe there are two liquid-metal turbines in tandem in each of the four liquid-metal loops, for a total of eight turbines. Since each turbine is double flow, the single condenser-steam generator in each loop would have four inlets.

8.5.1.5 Metal Vapor Condenser-Steam Generator

Steam condensers for power plants are not designed in accordance with the ASME Unfired Pressure Vessel code. This is probably because the design pressure of such units is not over 105.4 kPa (15 psi). In the case of a potassium condenser, however, the hot potassium vapor is a lethal and flammable fluid, and liquid potassium reacts violently with water. For these reasons it is recommended that the potassium condenser vessel be designed in accordance with Section VIII (Unfired Pressure Vessels).

Dug. 257C5n6

Nole: Major aerodynamic design constraint has been imposed by technical factors related to the procurement of acceptable rough disc forgings. Disc not to exceed 6 feet (maximum) diameter. Mtl. Spec. (TZM)

1/10 Scale

	1-C	1-R	2-C	2-R	3 C	3-R	4-C	4-R
Mean Dia, in	70, 50	1	75.30		80.35		84, 50	
Blade Exit, ht	11.45	11.50	14.00	14.88	17.90	19,00	21.00	21.75
Base Dia_ in	59.05		61.30		62.45		66.50	
Gauging, %	25.0	36.2	30.0	42.9	32.0	44.8	38.0	52,8
Flow Area, in ²	690.8		992.0		1447.5		2194.5	
Min Reaction %	15.0		17.5		22.5		26.3	
Hub/Tip		0.72		0.67		0.62		0.60
Pitch, in	1							
Blades/Row								



Double Flow 1800 RPM - 4 Pole Nominal Rating - 25,000 kW/30,000 kVA MWe

Fig. 8. 16-Longitudinal section of a potassium turbine

The design of power plant steam condensers is based upon the use of straight condenser tubing, the most economical form. The long straight tubes are supported at intervals by drilled plates. These large rectangular plates also serve as stays, or braces, for the flat condenser wall plates. Thus, the condensers are good for full vacuum but very little internal pressure. The slight differential expansion between the tubes and shell is taken up by the flexing of a flat steel membrane at one tubesheet.

In attempting to transpose such a design to a potassium vapor condenser operating at 811 to 978°K (1000 to 1300°F), generating highpressure superheated steam within the tubes, many fundamental problems are encountered. The tubesheet thicknesses become prohibitive if conventional steam condenser tube spacing is used; if compact tube bundles are used, however, vapor velocities entering the tube bundle exceed sonic values.

To overcome these problems and at the same time allow for tube expansion, the condenser configuration shown in Figure 8.17 is recommended. The tube bundle is basically cylindrical, with the core of the cylinder large enough to avoid direct vapor impingement from the wet turbine exit vapor, moving at around 243.8 m/s (800 ft/s). Metal droplets at such velocities would most likely erode the tubes.

The tubes in the bundle are closely spaced radially, but are separated 11.43 to 15.24 cm (4-1/2 to 6 in) axially, 15.24 cm (6 in) for the lowest pressure [16.55 kPa (2.4 psi) abs] and 11.43 cm (4-1/2 in) for the higher pressures. For the 978°K (1300°F) designs the radial depth of the bundle has been increased because of the much greater driving head available on the potassium side.

The cylindrical tube bundle is surrounded by a spherical shell, which is recommended for two reasons: first, it is the only configuration which does not require stiffening rings in accordance with the ASME code. External stiffening rings are technically unacceptable because of excessive thermal stresses and consequent warping; and internal



Fig. 8. 17 - Liquid metal condenser/steam generator

8-50

stiffening rings would interfere with drainage, complicate the bundle supports, and decrease usable volume. Second, a sphere is the most economical of material, being basically half the thickness of the corresponding cylinder. Another important reason for the use of a spherical shell is the large inherent reserve on allowable internal pressure. Thus, to meet full vacuum (as specified in the Code) the wall thickness required results in an allowable internal pressure of about 0.517 MPa (75 psi) gauge, which means that there is virtually no possibility of a condense; rupture due to a potassium-water reaction.

Since the condenser, as a pressure vessel, must be provided with pressure relief; since this pressure relief must be in the form of a vacuum-supported rupture disk; and since the rupture disk must operate below the creep temperature [700°K (800°F)], the rupture disk must be at the bottom of a liquid potassium pool. In the design shown in Figure 8.17 these conditions are met by providing a stagnant pool of potassium in the condenser drain line to act as an insulation layer. This pool also should act as a trap for water should a large water leak occur. The resulting potassium-water reaction will rupture the disk, but the bulk of the potassium will be retained in the hot-well storage tank.

The header-type tube bundles will be assembled externally to the shell, with all welding done on the outside. The completed tube bundle would be lowered into a hemisphere, a second hemisphere lowered into place, and the girth seam welded. Repairs to the bundle would be made by entering the condenser through a manway.

The steam generating tubing is designed in accordance with the procedures for Unfired Pressure Vessels, Section VIII, Part I, with the exception of the HA-188 tubing, which is not a Code-recognized material. The stress values used for the HA-188 tubing, however, are based upon the same criteria as are Code-allowable stress values (Reference 8.3).

Although the temperature gradient across the tube walls in some portions of the boiler-condenser was high, with consequent high thermal stresses, the practical effect of such conditions on the design will

	સા	mber of Tubes	<u> </u>	Heat Transfer Area		Sabara	Tubes, Steam Generator			Tubes, Reheater		
Case No.	No. Evaporator Superheater	Reheater	Steam Generator	Reheater	Diameter, ft	ID	OD	Material	ID	OD	Material	
1 2	386 372	642 619		10,600 10,230		27.2 26.8	0.625 0.625	0.858	800 H 800 H			
3	360	600		9,890		26.3	0.625	0.858	800 H			
4	383	638		10,530		27.2	0.625	0.858	800 H			
5	383	639	[10,560		27.2	0.625	0.858	800 H			
6	384	640		10,580		27.2	0.625	0.858	800 H			
7	390	650		10,730		27.4	0.625	0.858	800 H			
8	390	650		10,730		27.4	0.625	0.858	800 H			
9	386	643		10,610		27.3	0.625	0.858	800 H			
10	386	643	1	10,610		27.3	0.625	0.858	800 H			
11	386	643		10,600		27.2	0.625	0.858	800 H			
12	383	638		10,530		27.1	0.625	0.858	800 H			
13	390	650		10,730		27.4	0.625	0.858	800 H			{
14	374	623		10,292		26.8	0.625	0.858	800 H			
15	365	608		10,040		26.5	0.625	0.858	800 H			ļ
16	363	605		9,985		26.4	0.625	0.858	800 H			
17	379	632]	10,434		26.7	0.625	0.858	800 H		l.	1
18	377	628		10,374		26.7	0.625	0.858	800 H			
19	302	503		8,315		24.1	0.625	0.858	800 8			
20	179	298	ł	4,926		18.6	0.625	0.858	800 H			
21	412	687		11,320		28.1	0.625	0.858	800 H			Į
22	399	665		10,970		27.7	0.625	0.858	800 8]
23	385	642		10,570		27.2	0.625	0.858	800 H			
24	384	639		10,544		27.1	0.625	0.858	800 H			
25	388	658		13,085		24.0	0.625	1.00	800 H			
26	317	529		10,507	5 500	21.0	0.025	0.903	000 V	1 5	1 75	800 H
27	325	4/5	200	8,248	5,580	20.7	0.025	0.000	800 H	1.5	1 1 75	800 H
28	375	625	200	10,114	5,600	25.8	0.53	0.750	000 n	1 1.5	1 75	800 H
29	250	420	200	8,301	0,445	25.0	0.025	0.903	NA-100	1.7	1.12	000 n
30	360	600		8,4/3		24.5	0.625	0.788	800 H	Į .		
. 31	331	551		9,714		21.0	0.625	0.911	800 H	1		
32	300	500		7,786	r 0/0	20.2	0.625	0.830	HA-180	1	1 75	800 H
33	300	500	200	8,200	5,948	20.7	0.625	0.700	800 H	1.5	1.75	200 H
34	276	460	200	8,070	5,650	24.1	0.025	0.911	1000 H	1.5	1 75	800 H
35	248	414	200	6,452	0,000	22.0	0.025	0.000	600 HA-100	1.5	1.75	000 n
36	355	592		9,770		20.1	0.025	0.700	200 1]	ļ	J
37	375	625		10,310		20.8	0.625	0.708	200 H			1
38	379	632		10,430		26./	0.625	0.000	800 H	1	ł	1
39	402	6/0		11,040		27.8	0.025	0.038	000 n			

Table 8.11 - Tube Bundle Design Summary

depend upon the number of such temperature cycles, since thermal stresses are considered to be transient. Such transient conditions must be considered in a subsequent study phase.

In calculating the heat transfer, the mass velocity and inside diameter of the tubes were held constant, not only to simplify the calculations but also to minimize random variations in results. Also, for the 866°K (1100°F) vapor-condensing temperature, sphere size was considered to vary as the square root of surface, rather than as the cube root. In other words, the radial thickness of the tube bundle was held constant. This was done to hold condensing vapor pressure drop to a constant value. For the higher condensing pressures and temperatures, a more compact bundle was assumed, but space was allowed so that all welding could be done from outside the bundle. See Table 8.11 for the tube bundle design summary.

Tubing costs were based on communications with International Nickel Co., Huntington, West Virginia, for Incoloy 800 H; and Stellite Division at Kokomo, Indiana, for HA-188. Tubing costs are probably somewhat low, however, as costs were not quoted to a definite specification. Even if tubing costs were doubled, though, the overall cost of the boilercondenser would not be greatly affected, as tubing material was rarely more than 10% of the calculated overall condenser cost.

The basic heat transfer tube material chosen was Incoloy 800 H, because it is resistant to chloride and caustic stress-corrosion cracking. For temperatures over 922°K (1200°F), however, the strength of Incoloy 800 H falls to such a low value that HA-188 material is more economical for the high-pressure applications.

For the reheaters, where the pressure is low, Incoloy 800 H can be used for all cases. While Croloy might be considered for reheater tubing, it is very doubtful that a transition weld could be fabricated that would withstand the temperature cycles, and the steam-side corrosion rate would be excessive. For the spherical shell, Type 316 SS material is the most economical, as it results in a greater than 10% wall-thickness saving as compared to Type 304, thus negating the cost advantage of Type 304. Incoloy 800 H must be used for the spherical shell, however, as it is the only material acceptable for external pressure at design temperature [978°K (1300°F)] under the ASME Pressure Vessel Code.

8.5.1.6 Liquid-Metal Condenser Hot Well

Ordinarily, the hot wells were assumed to be within the condenser shell. For the purpose of mitigating liquid metal/water reaction the liquid-metal condenser hot well was placed outside the condenser shell, as shown in Figure 8.17. This separation minimizes the possibility of the bulk of the saturated liquid metal coming into direct contact with water in the event of a steam-tube leak or rupture, and mitigates the potential severity of the liquid metal/water reaction. It reduces the possible damage due to the liquid-metal reaction, reduces the amount of liquid-metal inventory which must be dumped, and shortens cleanup and recommissioning time.

The hot well was sized to hold a minute's worth of liquid metal at $\sim 60\%$ of the capacity available (see Equation 8.21). This excess volume allows for thermal expansion of the liquid metal and eliminates the need for expansion tanks in the liquid-metal loop.

8.5.1.7 Liquid-Metal Dump Tank

The four liquid-metal dump tanks were sized to accommodate the reaction products of a liquid metal/water reaction in the condenser-steam generator. This accident was assumed to produce the worst pressure surge and largest quantity of reaction products to the dump tank. Each dump tank hold-up volume was evaluated for a minute of normal hot-well mass flow of saturated liquid at the rupture disk design pressure of 0.207 MPa (30 psi) gauge.

As mentioned in Subsection 8.5.1.6, the liquid-metal hot well has been removed from the condenser shell to reduce the surface area of liquid metal in the event of a steam-tube rupture. The design of the

8-54

REPARTORIA OF THE ORIGRAD

condenser drain line in Figure 8.17 shows the stagnant pool of liquid metal above the rupture disk in the condenser dump line and the smaller drain line to the hot well which runs off the dump line at a right angle. In the event of a large tube leak or tube rupture, the water will collect in the stagnant pool, and the pressure rise due to the liquid metal/ water reaction will rupture the disk. The reaction products will flow to the dump tank. The bulk of the liquid metal is relatively uncontaminated while it is drained to the storage tank where it is processed to remove any impurities.

Each dump tank liquid hold-up is 70% of its capacity. A small fraction of the capacity is filled with a matrix of metal rods which acts as a condensing surface for the entering vapor. The remaining capacity, \sim 30%, is for expansion.

The dump tank is equipped with a vent line to blow off the hydrogen produced by the reaction. A scrubber to remove liquid-metal/water reaction products and a flame suppressor will be provided in the vent line.

8.5.1.8 Liquid-Metal Pumps

The liquid-metal feed or condensate pump in each of the four loops was assumed to be a free surface centrifugal type, similar to the intermediate system pumps of the Fast Flux Test Facility (FFTF) and CRBRP. The pump operates at the temperature of the liquid-metal condensate. The pump head was calculated equivalent to the sum of the frictional losses in the vapor and feed piping; the turbine pressure loss, and the static head due to the hot well to mixing header elevational difference [10.1 m (\sim 30 ft)].

In the once-through liquid-metal subsystem design the feed pump head had the additional requirement of making up the single- and two-phase total pressure losses of the liquid-metal vapor generator.

In the recirculation liquid-metal subsystem design, recirculation pumps were assumed to make certain that sufficient head was available to provide a 2.5-to-1 circulation ratio in each of the four loops. The circulation pumps operate at the temperature resulting from the mixture of

one and one-half parts saturated liquid from the liquid-metal vapor drum, which is 167°K (300°F) hotter than the one-part condensate liquid. For conservatism the entire vapor generator pressure drop was assumed to be in the two-phase region. Additional conservatism was added by neglecting static heads. The circulation pump head was calculated as the sum of the frictional loss from the mixing header to the boiler inlet, and the twophase friction (Reference 8.4) and momentum losses of the boiler and exhaust piping to the vapor drum.

Table 8.12 lists the ranges of pump capacities and total developed heads calculated for the various system configurations, operating parameters, and working fluids. The frictional and momentum pressure losses of the pressurized fluidized bed vapor generator was assumed equal to those of the pressurized furnace.

Pump	Working	Capacities,	gpm Total	
	Fluid	gpm	Head, ft	
Feed Pump	K	4,400 to 5,600	70 to 170	50 to 150
	Cs	7,400	80	200
Recirc. Pump	K	11,000 to 14,500	12 to 21	25 to 50
	Cs	19,000	9	60

Table 8.12 - Range of Pump Performance Characteristics

8.5.1.9 Liquid-Metal Piping

The liquid-metal piping was assumed to be welded pipe conforming to Section VIII of the ASME Pressure Vessel Code. Piping material selection was based on the recommendation of Subsection 3.7 of this report (see Table 3.39), with the exception that 316 SS was used for all cold-leg piping.

The cold-leg liquid piping was sized on the basis of a 7.62 m/s (25 ft/s) flow velocity, for both feed and recirculation piping. The

two-phase piping from the furnace to the drum was based on a flow velocity of less than 3.05 m/s (10 ft/s), and the vapor piping at 182.9 m/s (600 ft/s) flow velocity. Smooth pipe friction factors were assumed.

Table 8.13 shows the various sizes and lengths assumed for the liquid-metal piping.

	Outside Diameter, in	Number per Plant	Total Length, ft
Feed Piping	9 (12) ^b	4	800
Recirc. Piping	10 (14) ^b	8	500
Two-Phase Piping	30	16	400
Vapor Piping	72	8	1600

Table 8.13 - Liquid-Metal Loop Piping Dimensions

^aWall thickness with operating conditions and material according to Section VIII Unfired Pressure Vessel.

^bCesium.

8.5.1.10 Liquid-Metal Storage Tanks

The liquid-metal storage tanks in each loop were sized to hold the entire liquid-metal inventory plus 20% at the liquid-metal turbine inlet temperature. The outside diameter and length were limited to 3.65 and 10.67 m (12 and 35 ft), respectively, to allow for shipment by normal routing and placement below the condenser-steam generator hot-well tank.

Four separate tanks were employed to allow for the appropriate sizing of each tank and to reduce the quantity of potassium in each container, thus diminishing the risk of a major spill or leak.

The tanks also act as dump tanks in the event of a sudden increase in oxygen level. The system purity is continuously monitored by

£I-57

oxygen meters. In the event of a liquid metal/water reaction in the condenser and rupture of the rupture disk described in Subsections 8.5.1.6 and 8.5.1.7, the condenser exhausts to the dump tank while the rest of the loop components drain to the storage tank. This minimizes the contamination of the bulk of the loop liquid metal and permits leak tests to determine the location and extent of damage. The system is designed to drain by gravity to the storage tank. Separate lines from the major loop components are sized to gravity drain in a minimum of time. These lines and their valving will be designed to eliminate failure due to thermal shock. The tanks will be maintained at some intermediate temperature to avoid thermal shock damage by a continuous bleed-and-feed line. This bleed-and-feed line will be plumbed to a hot trap to purify the liquid metal in the event of an emergency dump.

Since the tank must be located at the lowest elevation in the system, a lined concrete pit was selected.

8.5.1.11 Liquid-Metal Inventory

The liquid-metal inventory was determined as the sum of the liquid-metal hold-up of the furnace-boiler, the vapor drum, the vapor ducting, the hot-well tank, the liquid feed piping, and recirculation piping. For conservatism 20% was added to account for liquid metal in the vapor turbines, the condenser-steam generator, the impurity monitoring system, and the receiving and processing system.

Table 8.14 represents the inventories calculated for the two liquid metals considered and for once-through and recirculating liquidmetal systems. Adjustments were made for the liquid-metal inventory requirements of other cases. The inventories were corrected by the ratio of the liquid-metal flow rate of the case being considered to the liquidmetal flow rate of the appropriate reference case. The flow ratio correction was applied only to that 64% of the total inventory which is flow-rate dependent (drum and hot-well hold-up volumes).

	Pot	assium	Cesium			
	Recirc.	Once-through	Recirc.	Once-through		
PF and PFB	80,000	80,000	176,500	176,500		
Main Piping	15,500	15,500	51,000	51,000		
Recirc. Piping	24,300		65,900			
Drum	90,000		476,500			
Hot Well	120,000	122,000		381,200		
	329,800	217,500	1,151,100	608,700		
Miscellaneous (20%)	66,000	43,500	230,200	121,700		
Total Inventory	395,800	261,000	1,381,300	730,400		
	1			I		

Table 8.14 - Liquid-Metal Inventories, 1b

8.5.1.12 Plant Arrangement and Component Modularization

As discussed in Subsection 8.5.1.10, the liquid-metal storage tanks were modularized for ease of placement, shipment, and reduction of liquid-metal volume in the event of a leak or spill. This is true of all the liquid-metal tanks and drums. The liquid-metal turbines were modularized to compensate for the current technological inability to forge large disks of superalloys and refractory alloys.

The number of modules of the various components and the plant arrangement were selected to allow for partial plant operation. By proper component sizing, arrangement, and plumbing, a loop consisting of a combustor pressurizing subsystem and a liquid-metal subsystem can operate totally independently of other such loops to provide steam to a single steam turbine subsystem. Such an arrangement provides the flexibility for partial plant operation, which significantly increases the plant availability.

Point No.	Parameter Variation	Airflow, lb/s	$(W_i/W_R)^{0.8}$	Reference Case	Cost x 10 ⁻³ , \$	Units Required
1	Base Case 1	716	1.00	1	23.277	4
2	Subbituminous	722	1.00	2	20.875	4
3	Lignite	741	1.00	. 3	22.412	4
7	ε = 0.7	710	0.993	1	23.3	4
8	ε = 0.8	710	0.993	1	24.3	4
11	RC = 1:1	716	1.00	1	23.3	4
13	GFWHTR	596	0.863	1	20.1	4
15	GAS ECON	645	0.920	1	21.4	4
17	PR = 5	810	1.00	17	32.202	4
18	PR = 10	740	1.00	18	24.998	4
19	a = 2.0	641	1.00	19	12.413	8
20	φ = 3.0	712	1.00	20	11.153	12
21	TG = 1600°F	680	0,988	22	23.653	4
22	$TG = 1700^{\circ}F$	690	1.00	22	24.352	4
23	TK = 1500°F/1200°F	716	1.00	23	23.882	4
24	TK = 1600°F/1300°F	710	1.00	24	28.236	4
25	3500 psig/1100°F	700	0.982	23	23.454	4
26	3500 psig/1200°F	690	0.977	24	27.6	4
27	3500/1000/1000*	700	0.982	1	22.9	4
28	3500/1100/1100*	690	0.971	23	23.2	4
29	3500/1200/1200*	673	0.958	24	27.1	4
30	2400 psig/1000°F	722	1.007	1	23.46	4
31	2400 psig/1100°F	716	1.00	23	23.9	4
32	2400 psig/1200°F	700	0.989	24	27.9	4
33	2400/1000/1000*	710	0.993	1	23.72	4
34	2400/1100/1100*	700	0.982	23	23.46	4
35	2400/1200/1200*	680	0.966	24	27.3	4
36	2400/2 in Hg abs	715	1.00	1	23.3	4
37	2400/9 in Hg abs	756	1.044	1	24.335	4
38	3500/2 in Hg abs	706	0.982	1	22.9	4
39	3500/9 in Hg abs	740	1.027	1	23.9	4
40	600 MWe	566	1.00	49	23.653	2
41	900 MWe	566	1.00	49	23.653	3
42	1500 MWe	566	1.00	49	23.653	5
46	Cs, 1200 MWe	582	1.00	46	23.68	4
47	Cs, 600 MWe	582	1.00	46	23.68	2
48	Cs, 1500 MWe	582	1.00	46	23.68	5
49	1200 MWe	566	1.00	49	23.653	4
	1	1			And A second second second second second	

Table 8.15 - Pressurized Fluidized Bed Cost Data

*psig/°F/°F

8-60

REPRODUCTION OF THE ORIGINAL SECONDS POOR For this study four loops were selected as the basis of component sizing and arrangement.

8.5.2 Method of Component Cost Evaluation

8.5.2.1 Pressurized Fluidized Bed

The cost evaluation of the pressurized fluidized bed (PFB) is covered in Section 4. For the liquid-metal vapor Rankine topping cycle study twelve PFB cases were sized and costed on the basis of the heat load required by the liquid metal, the gas turbine inlet temperature, the gas turbine compression ratio, and the air equivalence ratio. Among the twelve cases were the costs of the PFB for the three different fuels (Points 1, 2, and 3), the variations in compressor pressure ratio (Points 17 and 18), the air equivalence ratio (Points 19 and 20), gas turbine inlet temperature (Point 22), liquid-metal temperatures (Points 23 and 24), and the preliminary optimum plants with potassium (Point 49) and cesium (Point 46) as the working fluid. For cases where the above variables were similar, the cost of the PFB was determined by:

where

AFR =
$$(W_a'/W_a)^{0.8}$$
 (8.23)

where

\$ = cost of reference PFB

W_a = compressor airflow rate of reference PFB (1b/s)

 $W_{a}' = \text{compressor airflow rate of new PFB (lb/s).}$

Table 8.15 lists the point number, the compressor airflow, the AFR installed costs per unit PFB, and the number of units per plant. There are four PFB modules per unit. The cost of materials and the cost of installation per unit was determined to be 64 and 36%, respectively, of the installed cost per unit.

8.5.2.2 Pressurized Furnace

The pressurized furnace (PF) (Base Case 2, Point 4) was adapted from the design proposal of A. P. Fraas in 1973. The thermal duty per furnace of Base Case 2 is 20% higher than the Fraas proposal. The header drums, downcomer pipes, and vapor separator incorporated inside the Fraas furnace are external to the Base Case 2 PF design. Thus, the total furnace and boiler weight of the Fraas design was considered conservative for the Base Case 2 PF total weight.

The material cost of the Base Case 2 PF was determined by applying a \$22.05/kg (\$10/1b) cost of material. This figure is comparable to the installed cost of fossil-fired boilers. To be conservative, an additional 20% was included to the Base Case 2 PF as installation because of the liquid-metal environment. It is assumed that this estimate is accurate within 25%.

For the other PF cases calculated, the cost of material and cost of installation were corrected according to the ratio of unit thermal ratings as in Equation 8.22. The thermal rating ratio (TRR) replaced AFR in Equation 8.23 and is defined as:

$$TRR = (Q_{i}/Q_{R})^{0.8}$$
 (8.24)

where Q_i is the unit thermal rating in Btu/hr and Q_R is the reference unit thermal rating.

Table 8.16 lists the costs of materials and installation per furnace, the point number, the furnace thermal rating ratio, and the total number of furnaces.
Point No.	Parameter Variation	Unit Thermal Rating x 10 ⁻⁹ , Btu/hr	(Q ₁ /Q ₄) ^{TRR}	Material Cost x 10 ⁻³ , \$	Install Cost x 10 ³ , \$	Number Units
4	Base Case 2	0.819	1.00	2200	450	8
5	Subbituminous	0.820	1.00	2200	450	8
6	Lignite	0.822	1.00	2200	450	8
9	$\varepsilon = 0.7$	0.827	1.00	2200	450	8
10	ε = 0.8	0.827	1.00	2200	450	8
12	RC = 1:1	0.819	1.00	2200	450	8
14	GFWHTR	0.676	0.858	1900	390	8
16	Gas Economizer	0.740	0.922	2000	415	8
43	600 MWe	0.756	0.938	2100	420	4
44	900 MWe	0.756	0.938	2100	420	6
45	1500 MWe	0.756	0.938	2100	420	10
50	1200 MWe	0.756	0.938	2100	420	8
anofo	ronae Costs:	Material	\$2 200 000			

Table 8.16 - Pressurized Furnace Costing Data^a

^aReference Costs: Material \$2,200,000 Installation \$450,000.

8.5.2.3 Combustor Pressurizing Subsystem

The combustor pressurizing subsystem cost evaluation is detailed in Section 4. This includes recuperators, gas-heated economizers, and feedwater heaters, hot gas piping and the pressurizing gas turbine generators which were cost evaluated by the combustor-furnace, and low-Btu gasifier design groups for a pressurizing gas turbine generator air inlet

Point No.	(w _a /650) ^{0.8}	Recupe Cost x Referenc	rator 10 ⁻⁶ ,\$ e/Actual	Stack-Ga Cost x Referenc	s Cooler 10 ⁻⁶ , \$ e/Actual	Hot Gas x 10 ⁻ Referenc	Piping 6, \$ e/Actual	Pressu Gas T Generator Referenc	rizing urbine x 10 ⁻⁶ , \$ e/Actual
1	1.08					2,0	2.2	6.7	7.2
2	1.088					2.0	2.0	6.7	7.29
3	1.11					2.0	2.2	6.7	7.44
4	1.061					2.0	2.0	6.7	7.1
5	1.049					2.0	2.0	6.7	7.03
6	1.0367					2.0	2.0	6.7	6.95
7	1.073	1.9	2.0			2.0	2.1	6.7	7.2
8	1.073	3.2	3.4			2.0	2.1	6.7	7.2
9	1.049	2.5	2.6			2.0	2.0	6.7	7.03
10	1.049	4.3	4.5			2.0	2.0	6.7	7.03
11	1.08					2.0	2.2	6.7	7.2
12	1.06					2.0	2.1	6.7	7.1
13	0.933	}		1.7	1.6	2.0	1,9	6.7	6.2
14	0.91			1.7	1.54	2.0	1.8	6.7	6.1
15	0.994			1.7	1.7	2.0	2.0	6.7	6.7
16	0.975			1.7	1.66	2.0	1.9	6.7	6.6
17	1.19							5.7	6.8
18	1.11							5.9	6.5
19	0.994							6.7	6.6
20	1.073							6.7	7.2
21	1.0367					1.8	1.86	6.5	6.7
22	1.049					1.9	2.0	6.6	6.9
23	1.080					2.0	2.2	6.7	7.2
24	1.073	ļ				2.0	2.1	6.7	7.2
25	1.061					2.0	2.0	6,7	7.1
- 26	1.049					2.0	2.0	6.7	7.03
27	1.061	ļ				2.0	2.0	6.7	7.1
28	1.049			1. A.		2.0	2.0	6.7	7.03
29	1.0367					2.0	2.0	6.7	6.9
30	1.088					2.0	2.2	6.7	7.3
31	1.08					2.0	2.2	6.7	7.2
32	1.061					2.0	2.1	6.7	7.1
33	1.073					2.0	2.1	6.7	7.2
34	1.061					2.0	2.1	6.7	7.1
35	1.0367					2.0	2.0	6.7	6.95
36	1.08					2.0	2.2	6.7	7.2
37	1.128					2.0	2.2	6.7	7.5
38	1.061					2.0	2.1	6.7	7.1
39	1.11					2.0	2.2	6.7	7.4
40	0.925			1.5	1.390	1.6	1.6	6.5	6.0
41	0.925			1.5	1.390	1,8	1.6	6.5	6.0
42	0.925			1.5	1.390	1,8	1.6	6.5	6.0
43	0.895			1.5	1.340	1.8	1.6	6.5	5.8
44	0.855			1.5	1.340	1.8	1.6	6.5	5.8
45	0.895	1		1.5	1.340	1,8	1.6	6.5	5.8
46	0.915			1.5	1.37	1.8	1.6	6.5	5.9
47	0.915			1.5	1.37	1.8	1.6	6.5	5.9
48	0.915			1.5	1.37	1.8	1.6	6.5	5,9
49	0.925			1.5	1.490	1.8	1.6	6.5	6.0
50	0.895			1.5	1,340	1.8	1.6	6.5	5.8

Table 8.17 - Combustor Pressurizing Subsystem Costs

flow rating of 294.8 kg/s (650 lb/s). These costs were corrected by Equation 8.22 with Equation 8.23 replaced by:

$$AFR = (W_a/650)^{0.8}$$
 (8.25)

Table 8.17 lists appropriate point number, the AFR, the unit costs of the individual component, and number required. The recuperator material and installation costs are 75 and 25%, respectively, of the total unit costs given in Table 8.17. The same is true of the gas-heated economizers and feedwater heaters. The total installed cost of the hot gas piping is listed. The gas turbine installation cost is assumed constant.

8.5.2.4 Liquid-Metal Subsystem Tanks

The liquid-metal subsystem tanks and vapor drum were cost evaluated on the basis of stainless steel, ASME Class 1, nonreactor development technology standards. The vessel cost was \$33.07/kg (\$15/1b) per vessel. Insulation cost was $$430.60/m^2$ ($$40/ft^2$). Both these installed costs are adapted from CRBRP costs and include 10% for installation. For conservatism, the unit cost of material and insulation was assumed to be 90% and installation 10% of the total installed costs. Table 8.18 illustrates the various tanks sized and costed for a total plant potassium flow rate of 0.9072 Mg/s (7 2 x 10⁶ lb/hr). The costs evaluated for the liquid-metal vapor drums are believed accurate to 10%; and the costs of the other liquid-metal tanks are believed to be conservatively high (approximately 30%).

8.5.2.5 Liquid-Metal Vapor Turbine

The potassium turbine generators were costed from a Westinghouse Steam Turbine Division catalog price listing for 25,000 kW rating. To compensate for the use of superalloys and refractory alloys the catalog price was approximately doubled for a \$3 million material cost. The cesium turbine, which was designed with only two stages instead of the four stages in the potassium turbine, was assumed to cost two-thirds as

Item	Size Diameter x Length, ft	Cost/Vessel x 10 ⁻³ , \$	Insulation x 10 ⁻³ , \$	Installed Cost x 10 ⁻³ , \$	Quantity	Total Installed Cost x 10 ⁻³ , \$
Potassium Storage Tank	10 x 30	1,181	38	1,219	4	4,876
Potassium Hot-well Tank	8 x 25	787	26	813	4	3,252
Potassium Dump Tank	8 x 20	630	21	651	4	2,604
Potassium Drum	8 x 22	693	23	716	4	2,864

Table 8.18 - Typical Liquid-Metal Subsystem Tank Cost Data

much as the potassium turbine, or \$2 million. For both turbines the cost of installation was 9% of the material cost.

The accuracy of the liquid-metal turbine cost evaluation is difficult, at best, to estimate. Even a \pm 50% accuracy would represent approximately a 2% variation in the overall plant cost. If the cost errors were higher than 50%, the integrated system would need to be reoptimized.

The obvious conclusion is that the design, manufacture, and cost evaluation of liquid-metal vapor turbines requires greater depth and effort.

8.5.2.6 Liquid-Metal Condenser-Steam Generator

The method of cost evaluation of the liquid-metal condensersteam generator is illustrated on Table 8.19 for Base Case 1. Table 8.20 lists the cost summary for Points 1 through 39. The remaining Points (40 through 50) are comparable to Point 27 in Table 8.20. The cost of material was assumed to be 70% of the total cost listed in Table 8.20, and the installation cost 30% of the total cost.

		·····
Item	· Material, \$	Labor, \$
Spherical Housing	106,000	233,000
Insulation	(Included above)	94,000
Steam Gen. Tubing	149,000	
Steam Gen. Headers		
Inlet	2,000	
Outlet	160,000	
Crossover	118,000	
Tube Supports	170,000	
Fabrication and Tests	•	1,285,000
Totals	705,000	1,612,000
Total Cost, per Condense	er	\$2,317,000

Table 8.19 - Point 1 Boiler Condenser Cost

Point No.	Sphere Material, Labor, and Insulation x 10 ⁻³ , \$	Main Headers and Miscellaneous (Varies with Surface) > 10 ⁻³ , \$	Fabrication and Test (Varies with Surface) $\times 10^{-3}$, \$	Heat Transfer Tubing x 10 ^{-,3} , \$	1 Condenser Total Cost x 10 ⁻³ , \$
1	471	412	1,285	148	2,317
2	459	398	1,243	144	2,244
3	440	384	1,200	139	2,163
4	471	409	1,280	148	2,308
5	471	410	1,282	148	2,311
6	471	411	1,283	149	2,314
7	479	417	1,303	151	2,350
8	479	417	1,303	151	2,350
9	475	412	1,290	149	2,326
10	475	412	1,290	149	2,326
11	471	412	1,289	149	2,325
12	469	409	1,280	148	2,306
13					
14	459	400	1,250	145	2,254
15	448	390	1,220	141	2,199
16	445	388	1,211	140	2,184
17	455	406	1,266	146	2,273
18	455	403	1,260	146	2,267
19	329	323	1,010	117	1,779
20	172	191	598	69	1,030
21	561	440	1,375	159	2,535
22	500	426	1,330	154	2,410
23	472	410	1,283	148	2,313
24	470	409	1,280	148	2,307
25	326	509	1,586	315	2,736
26	219	408	1,276	667	2,570
27	455	20 536	1,675	116 87	2,889
28	423	20 610	1,910	139 88	3,190
29	631	20 571	1,790	527	3,440
30	381	329	1,030	86	1.826
31	219	377	1,179	163	1.938
32	253	20 302	945	354	1,874
33	455	20 54છ	1,725	84 93	2,925
34	331	20 523	1,664	136 88	2,762
25	253	505	1 600	293	2 934
دد در	600	200	1,580	103	2,834
36	433	380	1,186	100	2,099
37	456	401	1,251	105	2,213
38	455	406	1,266	146	2,273
39	490	429	1,340	155	2,414

Table 8.20 - Cost Summary of Liquid-Metal Condenser Steam Generator

8.5.2.7 Liquid-Metal Pumps

The cost evaluation of the liquid-metal recirculation and feed pumps was based on CRBRP intermediate pump costs and on engineering judgements for the reduced range of topping cycle pump performance characteristics in Table 8.12. The cost evaluation reflects pump costs based on commercial standards rather than on the RDT standards of the CRBRP pumps. The pump costs also include allowances for the shorter pump shaft lengths than those designed for CRBRP.

8.5.2.8 Liquid-Metal Piping

The liquid-metal piping was cost evaluated as welded pipe under ANSI B-31 Specification. Three tables are provided which show in detail the cost breakdown for pipe sizes of interest in the liquid-metal subsystem. The tables includes cost of material, fittings, shop fabrication, and shop support (which gives the manufacturing cost). The installation includes field erection and support costs. Finally, total installed costs of insulation and trace heating is added on. For simplicity the material cost, which includes piping material, insulation, and trace heating was estimated to be 75% of the total installed cost. The installation cost was, therefore, 25% of the installed cost for each pipe size. These cost values are considered to be \pm 5% accurate.

Table 8.21 lists the costs of stainless steel piping. Table 8.22 presents the costs of Incoloy 800 piping. The cost of Incoloy 800 pipe was assumed to be twice the cost of stainless, fabrication 1.5 times more costly, and field erection twice as much as for stainless. Table 8.23 represents the cost evaluation of Haynes 188. The Haynes 188 material was assumed to cost six times as much as stainless. The shop fabrication was assumed to be twice as much, and field erection three times as expensive, as stainless steel. These cost estimates are assumed to be accurate within 5%.

8,5.2.9 Liquid-Metal Inventory

Liquid-metal inventory was evaluated on the basis of information supplied by Callery Chemical Company. The potassium inventory was

Pipe Size, in	8	9	10	30	48
Cost	22.70	24.90	27.00	121.90	1,063.90
Fitting	26.90	37.50	48.10	426.70	552.10
Fabrication	36.20	38.80	41.50	181.20	223.70
Support	120.40	125.90	131.40	274.40	274.40
Total		227.10	248.00	1,017.80	2,114.10
Field Erection	40.20	57.90	75.60	202.10	316.50
Support	35.90	35.90	35.90	35.90	35.90
Insulation	14.20	15.50	16.70	51.00	51.00
Trace	54.60		64.80	170.00	
		<u>111.10</u>	117.40	256.90	····
Total Installed		396.10	441.00	1,476.80	2,687.50
M = 75% x Tot. In	l nst.	300.00	330.00	1,100.00	2,000.00
I = 25% x Tot. In	nst.	100.00	110.00	380.00	690.00

Table 8.21 - Costs of Stainless Steel Welded Pipe under ANSI B-31 Specification, \$/ft

Pipe Size, in	9	10	30	48
Cost 2 x SS	49.80	54.00	243.80	*
Fittings	37.50	48.10	426.70	
Fabrication 1.5 x SS	58.20	62.25	271.80	
Support	125.90	<u>131.40</u>	274.40	
	271.40	295.75	1,216.70	
Field Erection 2 x SS	115.80	151.20	404.20	
Support	35.90	35.90	35.90	
Insulation	15.50	16.70	51.00	
Trace	59.70	64.80	170.00	
	111.10	117.40	256.90	
Total Installed	498.30	564.35	1,877.80	3,411.00
M = 75% Tot.Inst.	= 375.00	425.00	1,400.00	2,560.00
I = 25% Tot.Inst.	= 125.00	140.00	480.00	850.00

Table 8.22 - Cost of Incoloy 800 Welded Pipe, \$/ft

*Assume Total Inst. = 1.27% SS Inst.

Pipe Size, in	9	10	30	48
Cost = 6 x SS	149.40	162.00	731.40	*
Fittings	37.50	48.10	426.70	
Fabrication 2 x SS	. 77.60	83.00	362.40	
Support	125.90	<u>131.40</u>	274.40	
Total Shop	390.40	424.80	1,794.90	
Field Erection 3 x SS	173.70	226.80	606.30	
Support	35.90	35.90	35.90	
Insulation	15.50	16.70	51.00	
Trace	59.70	64.80	170.00	
Total Extras	<u>111.10</u>	<u>117.40</u>	256.90	
Total Installed	675.20	769.00	2,658.10	4,834.80
M = 75% Tot.Inst.	= 500.00	575.00	2,000.00	3,600.00
I = 25% Tot.Inst.	= 175.00	190.00	660.00	1,240.00

Table 8.23 - Cost of HA-188 Welded Pipe, \$/ft

Assume Total Inst. = 180% SS

evaluated at 3.70/kg (1.68/lb). The cesium inventory was evaluated at 39.68/kg (18.00/lb) on the basis of 100,000 lb/31.53 Ms (1 yr). The potassium costs are considered to be \pm 5% and the cesium \pm 20%.

8.5.2.10 Liquid-Metal Auxiliary Subsystem

The liquid-metal auxiliary subsystems were evaluated from CRBRP auxiliary liquid-metal subsystems. Auxiliary subsystem costs were partially scaled for the Rankine topping cycle based on inventory, piping length, and component sizes.

Table 8.24 lists the costs evaluated for each auxiliary subsystem.

Subsystem	Material x 10 ⁻³ , \$	Installation $\times 10^{-3}$, \$
Receiving and Processing	6,200	2,000
Impurity Monitoring	800	250
Inert Gas Receiving and Processing	1,700	400
Leak Detection	250	200
Trace Heating	2,500	2,000
Total	11,450	7,100

Table 8.24 - Liquid-Metal Auxiliary Subsystem Costs

The total material and installation cost is approximately 10% of the liquid-metal subsystem cost and 5% of the total plant direct costs. The assumed accuracy of \pm 15% is n gligible when compared to the liquid-metal subsystem cost.

8.5.2.11 <u>Summary of Liquid-Metal Subsystem Direct Costs</u> The direct costs of the liquid-metal components and auxiliary systems are summarized in Table 8.25 for the preliminary optimum

	Material Cost x 10 ⁻⁶ , \$	Installation Cost x 10 ⁻⁶ , \$
Boiler	60.672	34.128
Turbine	24.000	2.160
Condenser-Steam Gen.	6.160	2.640
Hot well	2.700	0.440
Piping	5.063	1.696
Drum	2.360	0.360
Recirculation Pump	0.860	0.069
Feed Pump	1.440	0.115
Inventory	0.640	0.013
Storage Tank	5.200	0.600
Dump Tank	2.280	0.344
Receiving and Processing	6.300	2.000
Impurity Monitor	0.800	0.250
Cover Gas	1.700	0.400
Leak Detection	0.250	0.200
Trace Heating	2.500	2.000
	122.925	47.415
Total Direct Cost	\$170	 0,340,000

Table 8.25 - Summary of Liquid-Metal Subsystem Direct Costs, Preliminary Optimum Potassium Rankine Topping Cycle

potassium Rankine topping cycle (Point 49). Much of the costing data is based on engineering judgement rather than on actual cost estimates. The results are of the proper magnitude and are expected to be accurate to \pm 30%. Such an error to the total plant capitalization is approximately 7%, which is within the accuracy for similar plant estimates. Such an error will not change the conclusions of this study, for which the systematic cost evaluation should provide reasonable comparisons, regardless of the absolute validity. The cost difference evaluated in the cases considered are meaningful.

Improvement in cost estimates for the Rankine topping cycle is possible only through greater efforts on the part of liquid-metal component designers and manufacturers, particularly for the liquid-metal turbine.

8.6 Analysis of Overall Cost of Electricity

8.6.1 Matrix of Component and Parameter Variations

The work scope of this study required that the liquid-metal Rankine topping cycle be investigated for a variety of furnace combustor types, fuels (coal), cycle configurations, major cycle parameters, and power levels. The matrix of the 50 parametric points for the liquidmetal vapor Rankine topping cycle is shown on Table 8.6. Base Case 1, the pressurized fluidized bed, and Base Case 2, the pressurized furnace, are listed on Table 8.6 as Points 1 and 4, respectively.

The first 39 cases served as a sensitivity study to determine the effects of component and parameter variation for a constant power level. This sensitivity study was then used co determine a preliminary optimum case by combining the components and parameter values which individually provided the best cycle performance and which were estimated to be cost effective. The economic model was not available for a cost evaluation of the sensitivity study.

This preliminary optimum cycle was used to determine the effect of power level variation for a PFB plant (Points 40, 41, 42, and 49) and



Fig. 8. 18—Performance and cost of electricity for a pressurized fluidized bed boiler and pressurized furnace 1200 MWe plants burning Illinois No. 6

8-76

REPRODUCED ITY OF THE ORIGINAL MACE IS POOR a PF plant (Points 43, 44, 45, and 50). Points 46, 47, and 48 were used to study the effects of power level variation and cesium as the working fluid in a PFB plant.

The economic, natural resources requirement, and environmental intrustion analyses were performed on the 50 points calculated after the performance analysis was completed. Availability of the economic analysis at an earlier date would have resulted in a more cost-effective and more efficient preliminary optimum cycle than that depicted in Points 40 to 50. This is particularly true in the selection of coal, gas-heated economizer utilization, and gas turbine inlet temperature.

8.6.2 Effect of Furnace-Combustor Type

In Section 8.2 the plant configurations and operating state points of the PFB and PF base case plant were shown on Tables 8.7 and 8.9, respectively. The effect of furnace-combustor type on performance and cost of electricity for the PFB and PF base cases using Illinois No. 6 coal are illustrated on Figure 8.18. The higher PFB cycle efficiency and its lower cost of electricity relative to the PF is due to the high cost and \sim 90% efficiency of the gasifier to produce the low-Btu gas from the coal. The high cost of electricity from the PF gasifier system is due to the higher capital cost, as shown in the chart on Figure 8.18. The higher fuel and maintenance costs for the PF indicate the gasifier inefficiency. On the basis of lower cost and higher efficiency the PFB is the recommended furnace-combustor type for the liquid-metal Rankine topping cycle.

8.6.3 Effect of Coal Type on PFB

Three types of coal were evaluated for the liquid-metal Rankine topping cycle. The three coals and their effect on the performance and cost of a PFB plant are illustrated on Figure 8.19. Illinois No. 6 bituminous coal produces a higher cycle efficiency and lower fuel cost, as shown in the chart, due to its higher heating value. For this reason the Illinois No. 6 was selected for the preliminary optimum cycle prior to the availability of the cost evaluation. However, further analysis



Dwg. 6370A06

Fig. 8. 19-Effect of coal type on pressurized fluidized bed boiler plant performance and cost of electricity

indicates that the Montana subbituminous produces the lowest cost of electricity, 8.6% less than Illinois No. 6, with only a 0.3% loss in cycle efficiency. The high cost of using the Illinois No. 6 is due to its high sulfur content (\sim 4.9 times higher than the Montana or North Dakota). The high sulfur content requires much more dolomite for sulfur removal, as indicated by the operating and maintenance costs, which are almost double those of the other two coals. The higher sulfur content is also reflected in the capital cost for larger fuel handling and process sytems and for waste disposal.

Thus, the recommended fuel for the liquid-metal Rankine topping cycle is Montana subbituminous, not Illinois No. 6 bituminous, as shown in Table 8.6 for the preliminary optimum cycle.

8,6.4 Effect of Component and Parameter Variation on PFB

The matrix of points investigated in this study included variations of components and parameters in the combustor pressurizing subsystem, the steam subsystem, and type of heat rejection for both PFB and PF plants. These points are listed and numbered in Table 8.6. The performance and state point values for all cases are included in Appendix A 8.1 on computer printout sheets. The optimum point of each component or parameter variation is plotted against the base case cycle efficiency and cost of electricity for the 1200 MWe PFB plant burning Illinois No. 6 coal in Figure 8.20. Reference to the matrix of parametric points on Table 8.6 shows the range of values investigated for each of the components and parameters listed on the bottom of the bar chart of Figure 8.20.

Notice that most of the optimum points are the same as the base case. Had the points been run with the optimum coal, Montana subbituminous, all the optimum points would show improvement over Base Case 1.

The use of a recuperator to preheat air in the combustor pressurizing subsystem resulted in an increase in cycle efficiency of 1.4% over cycles with no recuperation for recuperator effectiveness of both $\varepsilon = 0.70$ and $\varepsilon = 0.80$. Thus, recuperation was found to be unjustified for a 15 to 1 pressure ratio. The optimum point was Base Case 1 with no





recuperation. Similar results were obtained for recuperation with a PF plant.

Although not shown on Figure 8.20, a once-through liquid-metal subsystem was investigated for PFB and PF plants. The cycle efficiencies were the same as those of the base cases, with a slight cost advantage for a once-through system. On the basis of ease of control and avoidance of DNB with all its problems and uncertainties, the recirculation system was selected as optimum.

In the case of a gas-heated feedwater heater, the variation was no feedwater heater or incorporation of a gas feedwater heater in parallel with the steam turbine extraction feedwater string. As shown on Figure 8.20, the incorporation of the feedwater had a significant effect on the performance and cost of electricity. The cycle efficiency increased 21%, and the cost decreased 9.7%, in comparison with Base Case 1. For a PF plant the improvement was comparable. Incorporation of a gasheated feedwater heater, therefore, was selected.

The next variation shown on Figure 8.20 is a gas-heated economizer. Again, the options were either inclusion or omission of the economizer installed between the condenser-steam generator and the final feedwater heater. The cycle efficiency increased 10%, with a 4% reduction in the cost of electricity for a PFB plant.

In the initial design of the liquid-metal vapor turbine, extraction feedheating was determined to be inappropriate. Moisture separation was also ruled out because of the low pressure available and the inability to take the momentum losses. Hence, liquid-metal feedheating was not considered in this study.

One of the combustor pressurizing subsystem parameters investigated was the combustor pressure level. Values of [0.506, 1.013, and 1.519 MPa (5, 10, and 15 atm)] were used [1.519 MPa (15 atm) being the base case]. As illustrated by the appropriate bar chart in Figure 8.20, a 15:1 compressor pressure ratio was the optimum of the values studied.

The results showed that cycle performance increased, while the cost of electricity decreased, with increasing pressure ratio.

The final combustor pressurizing subsystem parameter studied was the air equivalence ratio, ϕ_{air} . In addition to the minimum value of 1.2 (base case) for fluidized bed combustion of solid fuels, values of ϕ_{air} equal to 2.0 and 3.0 were used. The investigation showed that values significantly higher than 1.2 have disastrous effects on the liquid-metal topping cycles. For ϕ_{air} of 2.0 and 3.0 the cycle efficiency compared to the base case ϕ_{air} of 1.2 decreased 46 and 69%, respectively; while the cost of electricity increased 40 and 110%, respectively. The base case ϕ_{air} of 1.2 was selected as optimum.

With regard to the steam subsystem, the effect of one stage of steam reheat was compared to a nonreheat cycle. The plot shown on Figure 8.20 is the optimum point for a 24.136 MPa (3500 psi) gauge, 811°K/811°K (1000°F/1000°F) reheat steam cycle. It was selected as optimum from among single reheat and nonreheat cycles at 24 and 16 MPa (3500 and 2400 psi) gauge with temperatures at 811, 866, and 922°K (1000, 1100, and 1200°F). For both nonreheat and reheat cycles, and for both pressures considered, the 866 and 922°K (1100 and 1200°F) temperatures showed increasing improvement in efficiency but also increasing costs. At the two higher temperatures there are materials problems to contend with.

For the selection of steam pressure, the base case value of 24.132 MPa (3500 psi) gauge showed an advantage over 16.547 MPa (2400 psi) gauge for both performance and cost of electricity at &11°K (1000°F) steam temperature, as expected. Additionally, the steam pressure of 24.132 MPa (3500 psi) gauge was selected as optimum because at supercritical pressure DNB and its associated problems and uncertainties are avoided.

The base case heat rejection was a wet cooling tower. Oncethrough and dry cooling tower heat rejection systems were also investigated. Even though the once-through has a 2% advantage in both cycle efficiency and cost of electricity, the wet cooling tower system was selected for environmental reasons. Based on a 5% differential in

efficiency and cost, the wet cooling towers were selected over dry cooling tower heat rejection. Figure 8.20 shows the bar chart for the optimum heat rejection selection.

8.6.5 Effect of System Temperatures on PFB

The study also included the variation of the major cycle temperatures. Figure 8.21 shows the effects of varying the inlet temperatures of the three turbines on the cycle efficiency and cost of a PFB plant at 1200 MWe.

The uppermost curve demonstrates the results of lowering the gas turbine inlet temperature from the 1255°K (1800°F) maximum allowable fluidized bed temperature to 1144°K (1600°F). Note the 6% increase in cycle efficiency as the gas turbine inlet temperature decreases to 1144°K (1600°F). Due to the delay in the availability of the costing model, the increased cycle efficiency was the basis for selecting the gas turbine temperature for the preliminary optimum plant. It was assumed that the increased heat transfer area and, hence, increased cost of the furnacecombustor due to the reduced gas-side temperature, would not increase the plant capital cost significantly; that the lower temperature would mitigate cost increases by allowing the use of less exotic materials; and that the improved efficiency would reduce the increase in the cost of electricity. As indicated on Figure 8.21a the capital cost at 1144°K (1600°F) gas inlet temperature decreased below the 1255°K (1800°F) capital cost. Although not shown, the cost of electricity decreased 2.0 and 0.4% for 1144 and 1200°K (1600 and 1700°F), respectively, when compared to the base case gas turbine inlet temperature of 1255°K (1800°F). The recommended gas turbine inlet temperature of 1144°K (1600°F) was selected, vith 1255°K (1800°F) as an alternate.

The second set of curves, Figure 8.21b, shows the effects of variations in liquid-metal turbine inlet temperatures. A constant temperature differential of 166.7°K (300°F) was assumed from turbine inlet to the liquid-metal condenser-steam generator. The liquid-metal system was investigated at three conditions 1033°K inlet/866°K condenser





(1400°F/1100°F), 1089°K/922°K (1500°F/1200°F), and 1144°K/978°F (1600°F/ 1300°F). The gas turbine inlet temperature and steam turbine inlet temperatures were held constant at 1255 and 811°K (1800 and 1000°F), respectively. As Figure 8.21b demonstrates, the capital cost increased as much as 4% with increasing liquid-metal temperatures over the 1033°K (1400°F) base case. This was caused by the increased heat transfer area and the cost of construction materials in the liquid-metal subsystem. The cycle efficiency increase is negligible, considering the uncertainties of this study. With a definite economic incentive to minimize the liquid-metal temperatures, the 1033°K/866°K (1400°F/1100°F) liquid-metal temperatures were selected for investigation in Task II. The lower liquid-metal temperatures mitigate materials and development problems, particularly in the condenser-steam generator.

Up to this point all the parameter variations have been individual variations. Figure 8.21c shows the effect of steam throttle temperature variations; but for the steam temperatures the liquid-metal turbine temperature also varied (see Table 8.6, cases 23 through 35). For the steam temperatures listed in Figure 8.21c, the corresponding liquid-metal turbine inlet temperature is found directly above in Figure 8.21b. The gas turbine inlet temperature was held constant at 1255°K (1800°F). The values plotted in Figure 8.21c were the results for a 24.132 MPa (3500 psi) gauge single reheat steam cycle. The figure shows that both cycle efficiency and capital cost increase as the steam temperature increases: but when compared to the 811°K (1000°F) steam temperature case, the increase in capital cost is more than twice the increase in cycle efficiency for the 922°K (1200°F) case. The cost of electricity is 3.2 and 9.2% higher than 811°K (1000°F) steam for 866 and 922°K (1100 and 1200°F), respectively. Again, this is the result of higher costs for high-temperature materials to meet the temperature requirements in the steam turbine and the liquid-metal subsystem.

To ease the high cost and reduce the material and development problem, a steam throttle temperature of 811°K (1000°F) was recommended.

Dwg. 6370A07



Fig. 8.22—Performance and cost of electricity of a potassium and a cesium topping cycle for best study plant configuration

The parametric analysis described above concluded with the selection of the preliminary optimum plant configuration and operating parameters, as shown in Point 49 of Table 8.6.

8.6.6 Effect of Working Fluid on Preliminary Optimum Plant

As described in Section 8.2, an initial assumption in the parametric analysis was that cesium would not be competitive with potassium as the working fluid for the liquid-metal Rankine topping cycle. The basis for this assumption was the limited supply of cesium available and the initially high cost estimates. The initial cesium inventory requirement was approximately 635 Mg (1,400,000 lb). The availability of cesium data was also limited. Thus, the parametric analysis of the metal vapor Rankine topping cycle concentrated on potassium as the working fluid. The results of that analysis were assumed to pertain to cesium within a reasonable degree of accuracy for preliminary evaluation.

Points 46, 47, and 48 of Table 8.6 define the cesium topping cycle and power level variation. Points 40, 41, 42, and 49 define the potassium topping cycle. Except for the working fluid these cases are similar. The results of Point 49 and 46 are shown on Figure 8.22 for potassium and cesium, respectively.

Due to the preliminary nature of the cesium turbine design and the lack of cesium data available, the large uncertainties of the cesium cycle tend to reduce the feasibility of application when compared with potassium. The results definitely demonstrated that cesium is competitive with potassium as the working fluid in a metal vapor topping cycle. These results, however, contain too many uncertainties to make a final selection at this time. Further effort, particularly in the design of the cesium turbine, is required.

8.6.7 Effect of Nominal Power Variation

The final variation analyzed in this study was nominal power level. Figure 8.23 shows the effect of various power applications on preliminary optimum plant configurations with cesium and potassium as the



Fig. 8.23—Effect of nominal power on performance and cost of electricity for pressurized fluidized bed boiler

working fluids. The dashed curves show the relatively constant cycle efficiency over the range of power applications selected. The solid curves demonstrate the reduction in the cost of electricity as the nominal plant rating increases.

8.6.8 Summary Sheets

The natural resource requirements and environmental intrusion for Base Cases 1 and 2 are shown on the summary sheets in Tables 8.26 and 8.27, respectively. The sizes, weights, and costs of the major liquidmetal subsystem components and cooling towers are also included on the summary sheets.

Although they are not recommended points for Task II, the summary sheets for the preliminary optimum plants with potassium and cesium are included as Tables 8.28 and 8.29. They are a close approximation of the final results and improvements expected for the further optimization of the liquid-metal vapor Rankine topping cycle.

8.6.9 Additional Considerations

The overall costs and efficiencies of the 50 parametric points are included in Appendix A 8.2. Figure 8.24 is a plot of the overall efficiency versus capital cost for several of the cases considered. Figure 8.25 is a plot of the capital cost versus cost of electricity for the same cases.

In analyzing the overall cost of electricity, a new optimum cycle parameter and component configuration may be extrapolated. The plant will be similar to the preliminary optimum plant except for a 1255°K (1800°F) gas turbine inlet temperature and the burning of Montana subbituminous coal. A line AC has been drawn through Base Case 1 and the gas feedwater heater Point 13 in both Figures 8.24 and 8.25. Drawing the line A'C' parallel to AC through the subbituminous coal (Point 2) determines the locus of subbituminous coal, gas feedwater heater plants with a nonreheat steam plant.

On both figures line EG is drawn through the bituminous coal plant (Point 1) and the subbituminous coal plant (Point 2). Parallel line

		· · · · · · · · · · · · · · · · · · ·			
Parameter Values		Performance and Cost		Natural Resources	
Net Power (MWe) Combustor Pressurizing Subsystem	1133.6	Power Plant Efficiency, %	35.9	Coal, 15/kWh	9.881
Combustor type	PFB	Overall Energy Efficiency, Z	35.9	Sorbent, 1b/kWh	0.466
fuel	Illinois No. 6	Capital Cost, 10 ⁶ \$	776.1	Total Water, gal/kWh	0.767
Gas turbine inlet temp., °F	1800	Capital Cost, \$/kWe	684.6	Cooling water	0.611
Compressor pressure ratio	15	Cost of Electricity, mills/kWh	31.58	Gasifier process	0,000
Air equivalence ratio	1.2	<u> </u>		Condensate makeup	0.006
		(b)		Waste-handling slurry	0.096
Liquid-Metal Subsystem				Scrubber waste	0.053
Fluid	ĸ			NO suppression	0 000
Turbine inlet temperature, °F	1400			x suppression	0.000
Condensing temperature. °F	1100			Total Land, acres/100 MWe	114.6
Circulation matio	2 5.1			Main plant	16.5
CITCHIACION TACIO	2			Disposal land	77.2
Steam Turbine Subsystem				Access railroad	20.8
Turbine inlet temperature, °F	1000				
Turbine inlet pressure, psig	3500			(c)	
Reheat temperature, °F	NA				
Condensing pressure, in Hg abs	3.5				
Heat Rejection	Wet towers				
	L				

Table 8.26 - Summary Sheet Liquid-Metal Rankine Topping Cycle Base Case No. 1, Point 1

(a)

	Ma		······································			
Component	Size, ft (W x L (or D) x H)	Weight, 10 ³ 15	Cost Mfg., 103 \$	FOB Plant, \$/kWe	Units Required	Total Cost, 10 ³ \$
PFB	13.6 x 121	700	5,820	4.98	16	93,160
L-M Turbine	and the second		3,000	2.56	8	24,000
Condenser-Steam Generator	27.2	155	2,300	1.97	4	9,200
Cooling Tower	43 x 40 x 70		230	0.20	13	2,990

_		
	(ð	I)

Environs	ental Intrusion		
	1b/10 ⁶ Btu	1b/kWn	
S0,7	0.723	0.0068	
NO	0	0	
нс	0	0	
CO	0	0	
Particulates	0.0365	3.45×10^{-4}	
•	Btu/kWh		
Heat to Water	2904		
Heat, Total Rejected	5239		
	1b/kWh	lb/day	
Wastes	(
Ash	0.084	2.36×10^{6}	
Spent sorbent	0.464	13.03 x 10 ⁶	

					· · · · · ·	· · · · · · · · · · · · · · · · · · ·	
Parameter Values			Performance and Co	st		Natural Resources	
Net Power (MWe) Combustor Pressurizing Subsystem	1144.4		Power Plant Efficiency,	7.	34.8	Coal. 1b/kWh	9.904
Combustor type	PFB		Overall Energy Efficien	су, 2	35.0	Sorbent, 1h/kWh	0.478
Fuel	Illinois No. 6		Capital Cost, 10 ⁶ \$		926.1	Total Water, gal/kWh	0.813
Gas turbine inlet temp., °F	1800		Capital Cost, \$/kWe		809.2	Cooling water	0.601
Compressor pressure latio	15		Cost of Electricity, mi	lls/kWh	35.88	Gasifier process	0.052
Air equivalence ratio	1.2	1	- <u></u>		L	Condensate makeup	0.006
			(b)			Waste-handling slurry	0,099
Liquid-Hetal Subsystem						Scrubber waste	0.054
Fluid	K					NO suppression	0.000
Turbine inlet temperature, 'F	1400					Total Land, acres/100 MWe	113.9
Condensing temperature, "F	1100					Main plant	17.3
Circulation ratio	2.5:1				•	Disposal land	75.98
Steam Turbine Subsystem						Access railread	20.65
Turbine inlet temperature, °F	1000						<u> </u>
Turbine inlet pressure, psig	3500					(c)	
Reheat temperature, °F	NA						
Condensing pressure, in Hg abs	3.5						
Heat Rejection	Wet towers						
(a)	<u></u>					Environmental Intrusion	·

Table 8.27 - Summary Sheet Liquid-Hetal Rankine Topping Cycle Base Case No. 2, Point 4

Najor Components						
Component	Size, ft (W x L (or D) x H)	Weight, 10 ³ 1b	Cost Mfg., 103 \$	FOB Plant, Ş/kWe	Units Required	Total Cost, 10 ³ \$
PFB	14.5 x 25	220	2,200	1.95	8	17,600
Condenser-Steam Generator	27.2 (sphere)	155	2,300	2.04	4	9,200
Cooling Tower	43 x 40 x 70		230	0.20	13	2,990

8-91

(d)

	<u>16/10⁶ Btu</u>	<u>lb/kWh</u>
so ₂	0.723	0.0074
NO	0	0
нс	0	o
CO	0	0
Particulates		
	Btu/kWh	
Heat to Water	2990	
Heat, Total Rejected	5730	
	<u>lb/kWh</u>	<u>lb/day</u>
Wastes		
Ash	0.090	2.44×10^{6}
Spent sorbent	0.498	13.4×10^6

(e)

Parameter Values		Performance and Cost		Natural Resources	
Net Power (MWe) Combustor Pressurizing Subsystem	1140.0	Fower Plant Efficiency, %	42.4	Coal, 1b/kWh	0.746
Combustor type	PFB	Overall Energy Efficiency, Z	42.4	Sorbent, 1b/kWh	0.395
Fuel	Illinois No. 6	Capital Cost, 10 ⁶ \$	760.3	Total Water, gal/kWh	0.737
Gas turbine inlet temp., °F	1600	Capital Cost, \$/kWe	666.9	Cooling water	0.603
Compressor pressure ratio	15	Cost of Electricity, mills/kWh	29.60	Gasifier process	0.000
Air equivalence ratio	1.2	····	L	Condensate makeup	0.007
•		(b)		Waste-handling slurry	0.082
Liquid-Metal Subsystem	1			Scrubber waste	0.045
Fluid	ĸ			NO_ suppression	0.000
Turbine inlet temperature, °F	1400			Total Land, acres/100 MUe	102 6
Condensing temperature, °F	1100			Main plant	16 /
Circulation ratio	2.5:1			Disposal land	10.4 65 /
Steam Turbine Subsystem				Access railroad	20.7
Turbine inlet temperature, °F	1000				
Turbine inlet pressure, psig	3500			(c)	
Reheat temperature, °F	1000				
Condensing pressure, in Hg abs	3.5				
Heat Rejection	Wet towers				
(a)	· ·			Environmental Intrusion	

Table 8.28 - Summary Sheet Liquid-Metal Rankine Topping Cycle, Point 49

Major Components						
Component	Size, ft (W x L (or D) x H)	Weight, 10 ³ 15	Cost Mfg., 103 \$	FOB Plant, \$/kWe	Units Required	Total Cost 10 ³ \$
PFB	16.6 x 100	840	5,910	5.05	16	94,612
L-M Turbine			3,000	2.56	8	24,000
Condenser-Steam Generator	26.7 (sphere)	196	2,300	1.96	4	9,200
Cooling Tower	43 x 40 x 70		230	0.20	13	2,990

Environmental Intrusion						
1b/10 ⁶ Btu	lb/kJh					
0.723	0.0058					
0	0					
0	0					
0	0					
0.043	3.46×10^{-4}					
Btu/kWh						
3156						
3934						
<u>lb/kWh</u>	<u>1b/day</u>					
0.072	2.01 x 10 ⁶					
0.395	11.1×10^6					
	ental Intrusion <u>1b/10⁶ Btu</u> 0.723 0 0 0.043 <u>Btu/kWh</u> 3156 3934 <u>1b/kWh</u> 0.072 0.395					

(e)

Parameter Values		Performance and Cost		Natural Resources	
Net Power (MWA) Combustor Pressurizing Subsystem	1139.9	Power Plant Efficiency, %	42.9	Coal, 1b/kWh	0.737
Combustor type	PFB -	Overall Energy Efficiency, %	42.9	Sorbent, 1b/kWh	0.390
Fuel	Illinois No. 6	Capital Cost, 10 ⁶ \$	823.2	Total Water, gal/kWh	0.780
Gas turbine inlet temp., °F	1600	Capital Cost, \$/kWe	722.2	Cooling water	0.649
Compressor pressure ratio	15	Cost of Electricity, mills/kWh	31.25	Gasifier process	0.000
Air equivalence ratio	1.2		[·	Condensate makeup	0.007
		(b)		Waste-handling slurry	0.081
Liquid-Metal Subsystem				Scrubber waste	0.044
Fluid	Cs			NO ₂ suppression	0.000
Turbine inlet temperature, °F	1400			Total Land, acres/100 MWe	103.31
Condensing temperature, °F	1100			Main plant	16.4
Circulation ratio	2.5:1			Disposal land	64.6
Steam Turbine Subsystem				Access railroad	22 33
Turbine inlet temperature, °F	1000				
Turbine inlet pressure, psig	3500			(c)	
Reheat temperature, °F	1000				
Condensing pressure, in Hg abs	3.5				
Heat Rejection	Wet towers				
(2)	L			Environmental Intrusion	

Table 8.29 - Summary Sheet Liquid-Metal Rankine Topping Cycle, Point 46

Major Components							
Component	Size, ft (W x L (or D) x H)	Weight, 10 ³ 15	Cost Mfg., 103 \$	FOB Plant, \$/kWe	Units Required	Total Cost, 10 ³ \$	
PFB	16 x 100	770	5,590	4.78	16	89,430	
L-M Turbine			2,000	1.71	8	16,000	
Condenser-Steam Generator	26.7 (sphere)	196	2,300	1.96	4	9,200	
Cooling Tower	43 x 40 x 70	 	230	0.20	14	3,220	

(d)

Environm	ental Intrusion	
	15/10 ⁶ Btu	15/kWh
s0,	0.723	0.0054
ทอ้	0	0
нс	0	o
CO ···	0	0
Particulates	0.0418	3.10×10^{-4}
	Btu/kWn	
Heat to Water	3214	
Heat, Total Rejected	3929	
	1b/kWh	1b/day
Nastes		
Ash	0.065	2.36×10^{6}
Spent sorbent	0.364	10.219 x 10 ⁶

8-93

4

Curve 683062-B







E'G' is drawn through the bituminous coal plant with a gas feedwater heater and intersects line A'C' at Point B' to account for the reduced overall efficiency due to subbituminous coal. Point B' on Figures 8.24 and 8.25 determines a new plant burning subbituminous coal with 1255°K (1800°F) gas turbine inlet temperature, a gas-heated feedwater heater, a nonreheat 24.132 MPa (3500 psi) gauge steam turbine. Point B' on Figure 8.24 has an efficiency of 44.0% and a \$583/kWe capital cost.

The line HK has been drawn through Point 1 [a 24.132 MPa (3500 psi) gauge nonreheat steam turbine cycle] and Point 27 [a 24.132 MPa (3500 psi) gauge reheat steam turbine] in Figures 8.24 and 8.25 to define the rate of change of energy efficiency versus capital cost for reheat versus nonreheat steam cycles. Parallel line H'K' was drawn through the new subbituminous burning plant with a gas feedwater heater point B' on both figures. Assuming the same 0.8 percentage point efficiency improvement of reheat (Point 27) over nonreheat (Point 1), a subbituminous coal plant F' with reheat steam is determined along line H'K' for 44.0% overall energy efficiency on Figure 8.24. The new optimum plant F', with a 24.132 MPa (3500 psi) gauge steam turbine, 1255°K (1800°F) gas turbine inlet temperature, burning subbituminous coal, has a capital cost of \$583/ kWe at 44.0% overall energy efficiency on Figure 8.24.

If we follow the same procedure on Figure 8.25, the new optimum plant F' with a capital cost of \$583/kWe along line H'K' has a cost of electricity of 7.17 mills/MT (25.8 mills/kWh). Optimum plant F' has a 3.8% improvement in overall energy efficiency and an approximately 13% reduction in the cost of electricity over the preliminary optimum plant estimates.

On the basis of conventional power plant data, an additional cost reduction is possible. Redesign of the pressurized fluidized bed • units to allow for greater utilization of shop fabrication instead of field erection could reduce construction time by three to six months. Such a reduction in time would significantly reduce the interest costs during construction.

Component modularization not only reduces construction time, but also facilitates and lends itself to the concept of partial plant operation. With the independent loop arrangement described briefly in Subsection 8.5.1.11 the availability of the liquid-metal vapor Rankine topping cycle plant can be significantly improved. Aside from loss of feedwater flow in the single steam turbine or loss of fuel from the coalhandling system, each of the four loops may operate independently of the other three.

The concept of power unit modules also provides for extension of the capital investment period. Rather than build a 1200 MWe plant all at once and tie up investing capital, one 300 MWe basic power unit is installed with full-size fuel handling and part-load operating steam turbine. When the first basic power unit begins producing power, additional power units can be added as load demand increases. In this way investment capital is available for other uses.

Appendix A 8.3 contains a listing of the economic model of the direct cost accounts and the cost of electricity for the preliminary optimum plant cycle with potassium (Point 49) and Points 1 and 4.

8.7 Conclusions and Recommendations

The results of this study indicate that a liquid-metal vapor Rankine topping cycle plant offers desirable plant performance. Development of the full potential of a direct coal-fired liquid-metal vapor Rankine topping cycle requires the development of high-temperature materials, the liquid-metal turbine, and the fluidized bed boiler. Power plant efficiencies of 40 to 44% are obtainable, based on current liquidmetal vapor turbine technology.

The economic potential of the system is limited by high costs for power conversion and liquid-metal heat transfer and piping equipment. The lowest electrical costs determined were about 8.05 mills/MJ (29 mills/ kWh). Futther optimization studies could improve the plant design performance and, therefore, the cost of electricity. Extrapolations presented

in Section 8.6, for example, imply costs more in the area of 7.17 mills/ MJ (25.8 mills/kWh).

These results are adequate for a preliminary design and assessment of the relative effects of components and parameters on the system performance and costs. Further studies are required to optimize the plant configuration and parameters. Final conclusive performance and cost values can only be forthcoming upon completion of those studies.

Of all the systems considered, the costing factors of the metal vapor turbine are the most uncertain, due to the preliminary nature of the design, particularly at the high temperatures studied. The costing factors of the pressurized combustors are also uncertain, and are lacking for liquid-metal subsystems of both the combustor subsystems and liquidmetal subsystems. Extensive liquid-metal power system technology being developed will provide considerable data on the further development of the liquid-metal topping cycle.

The major limiting factors are suitable high-temperature materials and the uncertainties of high-temperature liquid-metal technology. Improved design and high-temperature metal technology would probably reduce the heat transfer and power conversion equipment costs, improving the attractiveness of the cycle.

The performance analysis of the 50 cases demonstrated that the combination of individually optimized components and parameters does not recessarily yield an optimum plant. The resulting cycle efficiencies could have been significantly improved by optimization of the combination of components and parameters investigated, without assuming advancement in the state of the art of the technologies involved. The analysis, however, did provide direction in selecting a new base case for further optimization. It also demonstrated that cycle efficiencies higher than conventional fossil-fired plants are attainable.

The economic analysis of the 50 cases demonstrated that high capital costs are generally required to obtain high cycle efficiencies; but it also provided direction in the selection of system configuration,
operating parameters, and, in particular, fuel for a new base from which to continue plant optimization. For example, the extrapolations of Subsection 8.6.9 indicate ~ 4% improvement in overall efficiency to 44.0% and a reduction in the cost of electricity of 13% to 7.17 mills/MJ (25.8 mills/kWh) over the preliminary optimum estimates. These improvements are the result of using Montana subbituminous coal instead of Illinois No. 6 and of raising the gas turbine inlet temperature to 1255°K (1800°F). The conclusions of Section 8.4 indicate that additional improvements in overall cycle efficiency may be obtained by combining the gas-heated feedwater heaters and economizers with recuperators at a compressor pressure ratio of 10 to 1 rather than 15 to 1. Further conclusions from Subsection 8.6.9 indicate significant reduction in the interest during construction by reducing construction time. Modularization of the pressurized fluidized beds could potentially reduce the construction period by three to six months. The utilization of modularized basic power units for part-load operation significantly improves the plant availability over the value assumed for this study. Modularized basic power units also provide for extension of the capital investment period, another potential cost reduction.

The recommended system configuration and parameters for Task II are listed in Table 8.30. The plant described is the recommended base case from which to continue the further optimization of the liquid-metal topping cycle. The values listed are the result of the economic and performance analysis described above.

An alternate liquid-metal vapor topping cycle is also recommended on Table 8.30. The final choice of working fluid cannot be made without further analysis. The performance and cost of electricity of the cesium topping cycle of Task I are suspect due to the uncertainties in the cesium property and thermodynamic data and to the preliminary nature of the cesium turbine design and performance. A more detailed study of cesium and, in particular, the cesium turbine is a prerequisite before final selection of the working fluid.

	Base	Alternate
Power, MWe	1200	
Furnace	PFB	
Coal	Montana	
Working Fluid	Potassium	Cesium
Recuperator Effectiveness	0.7	
Gas-Heated Feedwater, Heater	Yes	
Gas-Heated Economizer	Yes	
Compressor Pressure Ratio	10	
Air Equivalence Ratio	1.2	
Gas Turbine Inlet Temp., °F	1800	
LM. Turbine Inlet Temp., °F	1400	
LM. Condenser-Steam Generator Temperature, °F	1100	
Steam Throttle Temperature, °F	1000	
Reheat Temperature, °F	1000	
Steam Throttle Pressure, psig	3500	
Condenser Back Pressure, in Hg abs	3.5	

Table 8.30 - Recommended System Configuration and Parameters

8-100

1

Additional conclusions of the Task I parametric analysis are listed in Table 8.31. A list of recommendations applicable to Task II are found in Table 8.32.

The preliminary optimum cycle demonstrated a cycle overall efficiency of 42.4% for potassium and 42.9% for cesium at a cost of electricity of about 8.21 and 8.67 mills/MJ (29.6 and 31.2 mills/kWh), respectively. These are preliminary results. Additional optimization studies will show a significant increase in cycle efficiency and greatly improve the attractiveness of the cost of electricity. Final conclusions and judgements on the liquid-metal vapor topping cycle cannot be made until the completion of these additional studies.

- 1. Pressurized fluidized bed plant is more efficient and more cost effective than pressurized furnace plant.
- 2. Subbituminous coal is the most cost effective in a pressurized fluidized bed.
- 3. A gas-heated feedwater provides the most significant improvement in plant efficiency.
- 4. A gas-heated economizer is cost effective.
- 5. Efficiency decreases as the air equivalence ratio increases above a minimum value of 1.2.
- Increasing the liquid-metal vapor turbine inlet temperature beyond 1033°K (1400°F) is not economically justifiable.
- 7. Increasing steam temperature above 811°K (1000°F) is not cost effective for either reheat or nonreheat steam cycles.
- A supercritical steam pressure of 24.132 MPa (3500 psi) gauge is more efficient and cost effective than is the subcritical steam of 16.547 MPa (2400 psi) gauge.
- 9. Variation of system parameters separately does not provide the optimum cycle when individual optimums are combined.
- 10. Cesium is almost competitive with potassium as the selection of the liquid-metal working fluid.
- 11. Varied separately and individually, plant efficiency improves for increased compressor pressure ratio in the range 5 to 15 to 1 and for decreasing gas turbine inlet temperature in the range 1255°K (1800°F) to 1144°K (1600°F). Recuperation in the combustor pressurizing subsystem is not economically justifiable. In proper combinations together, however, and with stack-gas regeneration, potential plant efficiencies are higher at the maximum gas turbine inlet temperature [1255°K (1800°F)] and at a compressor pressure ratio of 10 with recuperation than the maximum efficiency values obtained individually.

Table 8.32 - Preliminary Recommendations

- 1. Provide a potassium boiler design with nucleation site promoters to protect the boiler tubes by reducing the high wall-temperature differences which occur during the vaporization of potassium.
- 2. Provide an ejector system on the condenser-steam generator to remove noncondensibles.
- 3. Provide liquid-metal vapor line sized to 40% full power vapor flow to by-pass the turbine and pass vapor directly to the condenser in the event of a loss of turbine event.
- 4. Provide a saturated liquid-metal by-pass line from the drum to the condenser as a means of reducing dissolute corrosion (10% flow).
- 5. Provide a liquid-metal hot trap in the above mentioned saturated liquid 10% flow by-pass line to remove oxygen in order to reduce corrosion.
- 6. Perform a feasibility study of jet pump or natural circulation to replace the recirculation pump.
- 7. Perform a feasibility study of the EM pump as a liquid-metal feed pump.
- Study the liquid-metal component relative elevations to reduce pumping requirements.
- 9. Reevaluate recuperator effectiveness as a function of the compressor pressure ratio and the gas turbine inlet temperature.
- 10. Evaluate the gas turbine intercooling when recuperation is not feasible.
- 11. Reevaluate the gas feedwater heater and gas economizer effect on cycle.
- 12. Evaluate in detail the condenser-steam generator duplex-tube design with metallic bonds for liquid-metal/water reaction protection.

Table 8.32 continued

- 13. Evaluate the thermal stress on the water inlet side of the condensersteam generator.
- 14. Perform a transient analysis study to determine the saturated liquid hold-up requirements of the liquid-metal drum.
- 15. Perform a transient analysis study to determine the dump-tank, ventline, and rupture-disk criteria in the event of a liquid-metal/water reaction.
- 16. Perform a transient analysis of the boiler in liquid-metal/water reaction transient.
- 17. Analyze the liquid-metal turbine and condenser to mitigate damage in the event of steam tube rupture.
- 18. Perform detailed design studies of potassium and cesium turbines.
- 19. Provide protective partitions separating liquid-metal turbine generators and condensers in the event of a liquid-metal/water reaction.
- 20. Provide a scrubber system and flame suppressor on liquid-metal/ water reaction vent lines.
- 21. Evaluate the use of 300 MWe basic power modules to extend the capital investment period and provide better availability.
- 22. Evaluate component modularization to reduce the time of construction.

8.8 References

- 8.1 J. D. Mangus, "Steam Generator and Turbine-Generator Cycle Selection for the Westinghouse Demonstration Plant," WARD-217, October 1971.
- 8.2 A. P. Fraas, "A Potassium-Steam Binary Vapor Cycle for Better Fuel Economy and Reduced Thermal Pollution," Journal of Engineering for Power, Trans. ASME, Vol., January 1973, pp. 53-62.
- 8.3 Private communication with J. Tackett of Stellite Division, Cabot Corporation.
- 8.4 L. R. Smith, M. R. Tek, and R. E. Balzhiser, "Pressure Drops and Void Fractions in Horizontal Two-Phase Flows of Potassium," AIChE Journal, 12, Vol. 12, January 1966, pp. 50-58.
- 8.5 R. J. Rossbach, E. Schnetzer, H. E. Nichols, and S. E. Eckard, "Performance of a Two-Stage, 200 HP Turbine in Wet Potassium Vapor," AIAA Specialists Conference on Rankine Space Power Systems, Vol. 1, CONF-651026, October 1965.

Appendix A 8.1

LIQUID-METAL RANKINE TOPPING CYCLE PARAMETRIC POINTS SYSTEM CONFIGURATION AND PARAMETRIC STATE POINTS

CASE	NO.	1
------	-----	---

				* * * * * * * FEFTOTI	ENCIES # # # #
PCWER OUTPUT(MWE) FURNACE PR.FL CCAL WORKING FLUID RECUPERATOR EFFECTIVENESS CGMPRESSOR PRESSURE RATIO	1200 GAS TURBI D.BED TEMPERA BIT GAS ECONO K GAS FEEDW D.O L.M.CIRCU 15 L.M.FEEDH	NE INLET TURE (DEG-F) MIZER MATEF HEATER MATION RATIO MEATER	1600+0 NO NO 2+5 1 NO	L.M.SYSTEM PRESSURIZING SUBSY STEAM CYCLE GROSS PLANT NET PLANT	.097 STEN .267 .420 .380 .370
AIR EQUIVALENCE RATIO	1.2 STAGES OF	STEAM REHEAT	0	NET POWER OUTPUT (M	NE) 1169.57
**** STATE POINTS ****	TOTAL FLOW 10E05 LBM/HR	TEMPERATURE Deg-F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT MWE
1 L.M.TURBINE INLET	7.332	1400.000	15.2	0 0	188.000
2 L.M.CONDENSER		1105.000	2.4	00 5.856	
3 L.M.FEED PUMP	527 7. 000 GPM	1100-000	33.9	0 0	.363
4 L.M.REGIRC PUMP	13574.000 GPM	1280.000	20.6	10	.173
5 L.M.BOILER INLET		1280.000		6.600	
E STEAM TURBINE THROTTLE	6.774	1000.000	3515.0	0 0	720+500
7 STEAM REHEAT		0-000	0.0	0.0	
8 ST.COND.BACK PRESS.			3.5	00IN.HG 3.396	
S FINAL FEEDWATER		560.000			
10 COND/SS WATER INLET		560.000			
11 COMPRESSOR INLET	10.320	59.000	14.6	90	
12 GAS TURBINE INLET	11.216	1800.000			291.500
13 GAS ECON.GAS INLET.		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		344.000			
16 AS RECEIVED COAL	499.400T/HR	- ·		10.775	

REPRODUCESCULT OF THE ORIGINAL PACE IS POOR

CASE	NO.	2	

			* •	T T T T EFFICIE	ENUIES + + + +
POWER OUTPUT(MWE) FURNACE PR.FLD CGAL SU WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSUFE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURJIN -GED TEMPERAT BJIT GAS ECONOM K GAS FEEDWA G.O L.M.CIRCUL 15 L.M.FEEDHE 1.2 STAGES OF	E INLET URE (DEG-F) IZER TEF HEATER ATION RATIO ATER STEAM REHEAT	1500.0 L.M NO PRE NO STE 2.5 1 GRC NO NET O NET	A.SYSTEM ESSURIZING SUBSYS EAM CYCLE DSS PLANT I PLANT I POWER OUTPUT(MI	.097 Stem .280 .420 .374 .365 NE) 1169.34
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSURE PSIA	THERMAL LOAD 10e09 btu/hr	POHER OUTPUT MHE
1 L.M.TURBINE INLET	7.113	1400.000	15.200		161.000
2 L.M.CONDENSER		1100.000	2.400	5.643	-
3 L.M.FEED PUMP	5085.000 GPM	1100.000	31.720		. 324
4 L.M.RECIRC PUMP	13080.000 GPM	1280.000	20.230		.155
5 L.M.BOILER INLET		1280.000		6.360	
E STEAM TURBINE THROTTLE	6.527	1000.000	3515.000		694.400
7 STEAM REHEAT		0.000	0.000		
8 ST.COND. BACK PRESS.			3.500IN	I.HG 3.27.3	
9 FINAL FEEDWATER		560.000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	10.427	59.000	14.690		
12 GAS TURBINE INLET	13.318	1800.000			324.400
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		851.000	анан сайтан с		
14 AS RECEIVED COAL	611.600T/HR			10.940	

	CA	SE	NO.	- 3
--	----	----	-----	-----

* * * * * * EFFICIENCIES * * * * *

PCWER OUTPUT(MWE) FURNACE PR.FLE CGAL MCRKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSON PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI • JED TEMPERA LIG GAS ECONO K GAS FEEDW D.O L.M.CIRCUI 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATEF HEATER LATION RATIO EATER STEAM REHEAT	1600•0 NO NO 2•3 1 NO 0	L.H.SYSTE PRESSURIZ STEAM CYC GROSS PLA NET PLANT NET POWER	M ING SUBSY: LE NT OUTPUT (M	• 09 STEM • 28 • 42 • 36 • 35 ME) 1169• 4
**** STATE POINTS ****	TOTAL FLOW 10E06 LBH/HR	TEMPERATURE DEG-F	PRESSU PSIA	E THER 10E0	MAL LOAD 9 BTU/HR	POWER OUTPUT NWE
1 L.M.TURBINE INLET	6.872	1400.000	15.2	20 0		175.000
2 L.H.CONDENSER		1100.000	2.4	•0 0	5.452	
3 L.M.FEED PUMP	4913.000 GPM	1100.000	29.7	70		•293
L L.M.RECIRC PUMP	12637.000 GPM	1250.000	19.6	390		- 140
5 L.H.BOILER INLET		1280.000			6.144	
6 STEAM TURBINE THROTTLE	6.306	1000.000	3515.0	0.0		670.900
7 STEAM REHEAT		0.000	0.0	0.0		
8 ST.COND.BACK PRESS.			3.5	500IN.HG	3.162	
9 FINAL FEEDWATER		560.000				
10 COND/SG WATER INLET		560.000				•
11 COMPRESSOR INLET	10.676	59.000	14.6	90		
12 GAS TURBINE INLET	12.086	1800.000				354.000
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FNH GAS INLET		0.000			0.000	
15 STACK GAS EXHAUST		855.000				
16 AS RECEIVED COAL	812.600T/HR				11.198	

C.	ASE	NG.	
-			

		CASE NU. 4				
	·			* * * * *	+ + EFFICIE	ENGIES * * * * * *
PCHER OUTPUT(MWE) FURNACE PR.FUR CCAL MCRKING FLUID RECUPERATOR EFFECTIVENESS CCMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI NACE TEMPERA BIT GAS ECONO K GAS FEEDW 0.0 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES GF	NE INLET TURE (DEG-F) MIZER ATEF HEATER LATION RATIO EATER STEAM REHEAT	1600.J NG NO 2.1 NO U	L.M.SYSTI PRESSUPII STEAM CYC GROSS PLI NET PLAN NET POWER	EM ZING SUBSYS CLE ANT F R OUTPUT (M)	• 097 • 263 • 420 • 365 • 356 • 1169• 88
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THEI	RMAL LOAD D9_btu/hr	POWER OUTPUT HWE
1 L.M.TURBINE INLET	7.327	1400.000	15.2	0 0		186.500
2 L.M.CONDENSER		1100.000	2.4	0 0	5.813	
3 L.H.FEED PUMP	3245.000 GPM	1100.000	33.5	90		• 356
4 L.M.RECIFC PUMP	13491.000 GPM	1280.000	20.5	50		.170
E L.M.BOILER INLET	•	1280.000			6.551	
E STEAH TURBINE THROTTLE	6.724	1000.000	3515.0	0.0		715.300
7 STEAH REHEAT		0 • 6 0 0	0.0	0.0		
8 ST.COND.BACK PRESS.			3.5	00IN.HG	3.372	
9 FINAL FEEDWATER	•	560.000				
10 COND/SG WATER INLET		560.000				·
11 COMPRESSOR INLET	10.056	59.000	14.0	90		
12 GAS TURBINE INLET	10.960	1800.000				298.600
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FHH GAS INLET		0.000			0.000	
15 STACK GAS EXHAUST		857.000				
16 AS RECEIVED COAL	520.000T/HR				11.220	

ORICE ing or the

~		~ ~	
	Δ `	. –	
÷		·	

			UMAE NU. 5			
					* * * * * * * EFFIC	IENCIES + + + + +
	FURNACE PR ENG	1200 GAS TURBI	NE INLET	44.00.0	I N OVOTON	
		NAUG IERPEKA Ratt cas econo	NTTES	10000	L.M.SYSTEM	• U97
	WCRKING FLUTE	K GAS EFERN	41265 ATER HEATER	NO	STEVE CACLE	TOIEM +2/0
	RECUPERATOR EFFECTIVENESS	G.O L.M.CIRCU	LATTON RATTO	2. 1	GROSS PLANT	. 378
	COMPRESSOR PRESSURE RATIO	15 L. M. FEEDH	EATER	NO	NET PLANT	- 369
	AIR EQUIVALENCE RATIO	1.2 STAGES OF	STEAM REHEAT	Ð	NET POWER OUTPUT (NWE) 1169.39
		TOTAL FLOW	TEMPERATURE	PRESSUE		
	**** STATE POINTS ****	10E06 LBH/HR	DEG-F	PSIA	10E09 BTU/HR	MHE
	1 L.M.TURBINE INLET	7.337	1400.000	15.2	20.0	18E.800
	2 L.M.CONDENSER		1100.000	2.4	.00 5.821	1.
	3 L.M.FEED PUMP	3245.000 GPM	1100.000	33.5	590	.356
	4 L.M.RECIRC PUMP	13491.000 GPM	1280.000	20.5	550	.170
8-1	E L.M.BOILER INLET		1280.000		6,560	
F	E STEAM TURBINE THROTTLE	6.733	1000.000	3515.0	0.0	71E . 729
	7 STEAM REHEAT		0.000	0.0	100	
	8 ST.COND. BACK PRESS.			3.5	00IN.HG 3.376	
	S FINAL FEEDWATER		560.000	- 		
	10 COND/SG WATER INLET		560 . 000	- -1		
	11 COMPRESSOR INLET	9.950	59.000	14.6	90	
	12 GAS TURBINE INLET	10.865	1600.000			296.800
	13 GAS ECON.GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		0.000		0.000	
	15 STACK GAS EXHAUST		57.000			

604.600T/HR

14 AS RECEIVED COAL

10.815

~ * ~		•
UASE	NC.	0

		CAR THORT				· LIFTOIL	NOIES
	FURNACE PR.FU COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSULE RATIO AIR EQUIVALENCE RATIO	1200 GAS TORBI *NACE TEMPERA LIG GAS ECONO K GAS FEEDW 0.0 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES CF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1800.0 NO NO 2.5 1 NO C	L.M.SYSTE Pressuriz Steam Cyc Gross Pla Net Plant Net Power	M ING SUBSYS LE NT OUTPUT(M)	.097 .75M .251 .420 .383 .373 .573 .1169.39
	**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSU	RE THER 10E0	MAL LOAD 9 BTU/HR	POWER OUTPUT HNE
	1 L.M.TURBINE INLET	7.353	1400.000	15.3	200		187.300
	2 L.M.CONDENSER		1100.000	2.4	+0.0	5.833	
	3 L.H.FEED PUMP	3245.000 GPM	1100.000	33.5	590		.356
	4 L.H.RECIRC PUMP	13491.000 GPM	1280.000	20.5	550		.170
8-1-	5 L.M.BOILER INLET		1280.000			6.575	
12	E STEAM TURBINE THROTTLE	6.747	1000.000	3515.0	0 0		717.800
	7 STEAM REHEAT		0.000	0.	00		
	8 ST.COND.BACK PRESS.			3.5	GOIN.HG	3.383	
	9 FINAL FEEDWATER		560.000				
	10 CONDISG WATER INLET		£60.000				
	11 COMPRESSOR INLET	9.826	59.000	14.6	90		
	12 GAS TURBINE INLET	10.809	1800.000				294 • 800
	13 GAS ECON.GAS INLET,		0.000			0.000	
	14 GAS FWH GAS INLET		0.000			0.000	
	1E STACK GAS EXHAUST		858.000				
	16 AS RECEIVED COAL	776.100T/HR				10.695	

REPROPRISE TY OF THE ORIGINAL FALS 13 POOR

			CHAE NUS /				
					* * * * *	+ EFFICIENC	IES * * * * *
	FURNACE BEAFLO	1200 GAS TURBI	NE INLET	1-00-0-	T. M. SYSTE	. .	697
	COAL	BIT GAS ECONO	MIZER	NO	PRESSURIZ	ING SUBSYSTE	M .272
	WORKING FLUID	K GAS FEEDW	ATER HEATER	NO	STEAM CYC	LE	.420
	RECUPERATOR EFFECTIVENESS	.7 L.M.CIRCU	LATION RATIO	2." 1	GROSS PLA	NT	.385
	COMPRESSOR PRESSURE RATIO	15 L.M.FEEDH	EATER	NO	NET PLANT		.375
	AIR EQUIVALENCE RATIO	1.2 STAGES UP	SIEAM REHEAT	ų	NET POWER	OUTPUT (MWE)	1169.36
	**** STATE POINTS ****	TOTAL FLOW 10ED6 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	RE THER 15e0	MAL LOAD F 9 btu/hr	OHER OUTPUT
	1 L.M.TURBINE INLET	7.463	1400.000	15.	200		190.000
	2 L.M.CONDENSER		1100.000	2.	400	5.920	
	3 L.M.FEED PUMP	533 7. 000 GPM	1100.000	34 -	700		.375
	4 L.M.REGIRC PUMP	13730.000 GPM	1280.000	20.1	740		•179
8-11	5 L.M.BOILER INLET		1289.000			6.673	
i.v	E STEAH TURBINE THROTTLE	6.848	1000.000	3515.	00 OT		728.600
	7 STEAN REHEAT		0.000	0.1	000		
	5 ST.COND.BACK PRESS.			3.5	5001N.HG	3.434	
	9 FINAL FEEDWATER		560.000				
	10 COND/SG WATER INLET		560.000				X
	11 COMPRESSOR INLET	10.197	59.000	14.6	590		
	12 GAS TURBINE INLET	11.082	1800.000				281.300
	13 GAS ECON.GAS INLET,		0.000			0.000	
	14 GAS FWH GAS INLET		0.000			0.000	
	15 STACK GAS EXHAUST		801-000				
	1E AS RECEIVED COAL	493.400T/HR				10.645	

CAPE

CASE NO. 8

					· · · · · · · ELLT	TEMPTED
PI F1 C1 R1 C1 A	DHER OUTPUT(MWE) JRNACE PR.FLD DAL DRKING FLUID ECUPERATOR EFFECTIVENESS CMPRESSOR PRESSURE RATIO IR EQUIVALENCE RATIO	1200 GÁS TURBI .3ED TEMPERA BIT GAS ECONO K GAS FEEDH .8 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1800.0 NO NO 2.5 1 NO 0	L.M.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET PCWER OUTPUT (•097 •274 •420 •385 •376 HWE) 1169•36
. 4 . 1	*** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT NNE
· 1	L.M.TURBINE INLET	7 - 469	1400.000	15.2	0 0	190.200
ź	L.M.CONDENSER		1100.000	2.4	00 5.925	
3	L.M.FEED PUMP	5337.000 GPM	1100.000	34.7	00	.375
L	L.M.REGIRC PUMP	13730.000 GPM	1280.000	20.7	40	•179
<u>د</u>	L.M.BOILER INLET		1280-000		6.678	
÷ 6	STEAM TURBINE THROTTLE	6.854	1000-000	3515.0	0 0	729.100
7	STEAM REHEAT		0.000	0.0	0 0	
. 8	ST.COND.BACK PRESS.			3.5	90IN.HG 3.437	
ģ	FINAL FEEDWATER		j60•000			
10	CONDISG WATER INLET		560.000			
11	COMPRESSOR INLET	10.172	59.000	14.6	90	
12	GAS TURBINE INLET	11.054	1800.000			250.600
13	GAS ECON.GAS INLET,		0.000		0.000	
14	GAS FWH GAS INLET		0.000		0.000	
15	STACK GAS EXHAUST		794.000			
16	AS RECEIVED COAL	492.200T/HR			10.620	

C 4 C C	110	<u> </u>
1.4 7	NIL.	
0.00		

			CASE NUL 3			
	POWER OUTPUT (MWE)	1200 GAS TURBIN	E INLET		* * * * * * * EFFICIE	INCIES + + + + +
	FURNACE PR.FUN CGAL NORKING FLUID RECUPERATOR EFFECTIVENESS	NACE TEMPERAT BIT GAS ECONON K GAS FEEDWA .7 L.M.CIRCUL	URE (DEG-F) MIZER MTER HEATER LATION RATIO	1800.0 NO NO 2.5 1	L.H.SYSTEM PRESSUPIZING SUBSYS STEAM CYCLE GROSS PLANT	.097 STEM -255 -420 -368
	AIR EQUIVALENCE RATIO	15 L.M.FEEDHE 1.2 STAGES OF	STEAM REHEAT	ม อ	NET POWER OUTPUT (MI	•359 (E) 1169•38
	**** STATE POINTS ****	TOTAL FLOW 10ED6 L6M/HR	TEMPERATURE DEG-F	PRESSURE PSIA	THERMAL LOAD	POWER OUTPUT MWE
	1 L.M.TURBINE INLET	7.399	1+00-000	15.20	n	188-400
	2 L.H.CONDENSER		1100-000	2 60	n E 560	1000400
	3 L. H. FEED PIINP	5201.000 CON	1100.000	2449	6	76 5
		13610 000 CPM	1280 000	20 54	0	• 305
5	E L.M. BOTLER TNLET	13010-000 000	1200-000	20+54		•175
	6 STEAM TURBING TURBITUR	6 700	1280.000	7545 00	6.515	
	C STEAM TURBINE THRUTTLE	0.189	1000+000	3515.00		722.300
	7 STEAM REHEAT		0.000	0.00	C .	
	8 ST.COND.BACK PRESS.			3.50	OIN.HG 3.484	
	9 FINAL FEEDWATER		560.000			
	10 COND/SG WATER INLET		j60.000			
	11 COMPRESSOR INLET	9.973	59.000	14.69	0	
	12 GAS TURBINE INLET	10.870	1800.000			289.200
	13 GAS ECON.GAS INLET,		0.00		0.000	
	14 GAS FWH GAS INLET		0.000		0.000	
	15 STACK GAS EXHAUST		327.000			
	16 AS RECEIVED COAL	515.300T/HR			11.118	

\

CASE NO. 10

ENGTER.

					E11140	Ichoico
	FURNACE PR.FI COAL WCRKING FLUID RECUPERATOR EFFECTIVENES CCMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURALI UXNACE TEMPERA 9IT GAS ECONO K GAS FEEDW S .8 L.M.CIRCUL 0 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) AIZER HEATER LATER HEATER LATION RATIO EATER STEAM REHEAT	1600.0 NO 2.5 1 NO 0	L.M.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(• 097 • 267 • 420 • 369 • 360 • 1169• 38
	**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSURE	THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT NWE
	1 L.H.TURBINE INLET	7.403	1400.000	15.20	0	188.500
	2 L.M.CONDENSER		1100.000	2.40	5.873	
	3 L.H.FEED PUMP	5291.000 GPH	1100.000	34-14	0	• 365
	4 L.M.RECIRC PUMP	13610.000 GPM	1280.000	20.64	0	•175
8-1	5 L.M.BOILER INLET		1280.000		6.619	
16	E STEAM TURBINE THROTTLE	E 6.793	1000.000	3515.00	10	722.700
	7 STEAM REHEAT		0.000	0.00	t deservation of the second	
	8 ST.COND.BACK PRESS.			3.50	01N.HG 3.406	
	9 FINAL FEEDWATER		560.000			
	10 CONDISG WATER INLET		560.000			
	11 COMPRESSOR INLET	9.953	59.000	14.69	0	-
	12 GAS TURBINE INLET	10.848	1800.000			288.700
	13 GAS ECON.GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		0.000		0.000	
	15 STACK GAS EXHAUST		821.000			
	16 AS RECEIVED COAL	514.200T/HR			11.094	

REPRODUCTION OF THE ORIGINAL FACE IS POOR

CASE NO. 11

				- + + + + + + EFFICI	ENCIES * * * * *
POWER OUTPUT (HWE)	1200 GAS TURBIN	E INLET			
FURNACE PR.FLD	BED TEMPERAT	URE (DEG-F)	1500+0	L.M.SYSTEM	• 097
GCAL	BIT GAS ECONOM	IZER	NO	PRESSURIZING SUBSY	STEM .267
WORKING FLUID	K GAS FEEDWA	TER HEATER	NO	STEAM CYCLE	•420
RECUPERATOR EFFECTIVENESS	0.0 L.M.CIRCUL	ATION RATIO	1 1	GROSS PLANT	• 380
COMPRESSOR PRESSURE RATIO	15 L.M.FEEDHE	AT ER	NO	NET PLANT	• 370
AIR EQUIVALENCE RATIO	1.2 STAGES UP	STEAM REMEAT	÷ U	NET POWER OUTPUT (M	WE) 1169.68
	TOTAL FLOW	TEMPERATURE	PRESSUR	E THERMAL LOAD	POWER OUTPUT
**** STATE POINTS ****	10E06 LBM/HR	DEG-F	PSIA	10E09 BTU/HR	MWE
1 L.M.TURBINE INLET	7.382	1400.000	15.2	100	188.000
2 L.M.CONDENSER		1100.000	2.4	00 5.856	
3 L.M.FEED PUMP	3277.000 GPM	1100.000	31.2	24.0	.331
4 L.M.RECIFC PUMP	-0.000 GPM	1100.000	-0.0	100	-0.000
5 L.M.BOILER INLET		1100.000		6.600	
E STEAM TURBINE THROTTLE	6.774	1000.000	3515.0	100	720.700
7 STEAM REHEAT		0.000	0.0	0 0	
8 ST.COND. BACK PRESS.			3.5	00IN.HG 3.396	
9 FINAL FEEDWATER		560.000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	10.321	59.000	14.6	59 0	
12 GAS TURBINE INLET	11.217	1800.000			291.300
13 GAS ECON.GAS INLET.		0.000		0.000	
14 GAS FWH GAS INLET		0.000	• • 1.	0.000	
15 STACK GAS EXHAUST		644 . 00 F			

10.775

499.200T/HR

8-117

16 AS RECEIVED COAL

CASE N	10.	12
--------	-----	----

					+ + + + + + + FEET	TENOTES # # # # #
	POWER OUTPUT(MME) FURNACE PR.FU COAL WCRKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200GAS TURBINRNACETEMPERATBITGAS ECONOMKGAS FEEDWA0.0L.M.CIRCUL15L.M.FEEDHE1.2STAGES OF	E INLET URE (DEG-F) IZER TER HEATER ATION RATIO ATER STEAM REHEAT	1600.0° NO NO 1 1 NO B	L.M.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT	•097 SYSTEM •263 •420 •365 •356 (MWE) 1169•58
	**** STATE POINTS ****	TOTAL FLOW 10E06 Lam/Hr	TEMPERATURE DEG - F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/H	D POWER GUTPUT
	1 L.M.TURBINE INLET	7.323	1400.000	15.2	0 0	186.500
	2 L.M.CONDENSER		1100.000	2.4	00 5.809	
	3 L.M.FEED PUMP	5235.000 GPM	1100.000	31.0	40	. 327
	4 L.H.RECIRC PUMP	-0.000 GPM	1100.000	-0.0	00	-0.000
8-11	5 L.M.BOILER INLET		1100.000		6.548	
	E STEAM TURBINE THROTTLE	6.720	1000.000	3515.0	0 0	714.900
	7 STEAM REHEAT		0.000	0.0	00	
	8 ST.COND.BACK PRESS.			3.5	00IN.HG 3.369	
	9 FINAL FEEDWATER		560.000			
	10 COND/SG WATER INLET		560.000			
	11 COMPRESSOR INLET	10.052	59.000	14.6	90	
	12 GAS TURBINE INLET	10.956	1800.000	• .		298.500
	13 GAS ECON.GAS INLET,		0.000	· · · · · · · · · · · · · · · · · · ·	0.000	
	14 GAS FWH GAS INLET		0.000		0.000	
	15 STACK GAS EXHAUST		857.000	:		
	16 AS RECEIVED CCAL	519.400T/HR			11.207	

CASE	NO.	13
------	-----	----

				+ + + + + + + EFFIC	IENCIES + + + +
FURNACE PR.FLD FURNACE PR.FLD COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBIN • 3ED TEMPERAT BIT GAS ECONON K GAS FEEDNA 0.0 L.M.CIRCUL 15 L.M.FEEDHE 1.2 STAGES OF	IE INLET URE (DEG-F) IIZER ITER HEATER ATION RATIO ATER STEAM REHEAT	1200.0 NO YES 2.5 1 NO 0	L.M.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(.097 YSTEM .269 .440 .457 .449 MWE) 1169.70
**** STATE POINTS ****	TOTAL FLOW 10e06 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT
1 L.M.TURBINE INLET	6.140	1400.000	15.2	0.0	156.400
2 L.M.CONDENSER		1100.000	2.4	00 5.871	
3 L.M.FEED FUMP	+389.000 GPM	1100.000	24.2	50	.209
4 L.M.RECIRC PUMP	11290.000 GPM	1280.000	18.9	50	.100
5 L.M.BOILER INLET		1280.000		5.490	
E STEAH TURBINE THROTTLE	5.214	1000.000	3515.0	0 0	802.800
7 STEAM REHEAT		0.000	0 • 0	0 0	
E ST.COND.BACK PRESS.			3.5	00IN.HG 3.487	
S FINAL FEEDWATER		492.000			
10 COND/SG WATER INLET		492.000			
11 COMPRESSOR INLET	8.584	59.000	14.6	90	
12 GAS TURBINE INLET	9.329	1800.000			240.800
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		352.000		1.355	
15 STACK GAS EXHAUST		290.000			
16 AS RECEIVED COAL	415.400T/HR			8.963	

1

CASE	NO.	14
------	-----	----

				* * * * *	+ EFFICIE	ENCIES * * * * *
POWER OUTPUT(MWE) FURNACE PR.FUR CCAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBIN NACE TEMPERAT BIT GAS ECONO K GAS FEEDWA 0.0 L.M.CIRCU 15 L.M.FEEDHE 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATEF HEATER LATION RATIO EATER STEAM REHEAT	1600.0 NO YES 2.5 1 NO 0	L.M.SYSTE PRESSURIZ STEAM CYC GROSS PLA NET PLANT NET POWER	M ING SUBSYS LE NT OUTPUT (M)	.097 Stem .263 .440 .429 .419 Me) 1169.71
**** STATE POINTS ****	TOTAL FLOW 10EJ6 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	RE THER 10E0	HAL LOAD 9 btu/hr	POWER OUTPUT
1 L.M.TURBINE INLET	6.053	1400+000	15.	200		154.100
2 L.M.CONDENSER		1100.000	2.	+00	5.802	
3 L.M.FEED PUMP	+327.000 GPM	1100-000	23.	630		•200
4 L.M.RECIRC PUMP	11130.000 GPM	1280.000	18.	840		.096
5 L.M.BOILER INLET		1280.000			5.411	
& STEAM TURBINE THROTTLE	5.194	1200.000	3515.	000		799.600
7 STEAM REHEAT		0.000	0.	000		
8 ST.COND. BACK PRESS.			3.	500IN.HG	3.474	
9 FINAL FEEDWATER		+92.000				
10 COND/SG WATER INLET		492.000				
11 COMPRESSOR INLET	8.307	59.000	14.1	690		
12 GAS TURBINE INLET	9.054	1800.000				246.300
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FWH GAS INLET		865.000			1.401	
15 STACK GAS EXHAUST		290.000				
16 AS RECEIVED COAL	429.200T/HR				9.630	

CASE NO. 15

			-		- CLETCIC	HOTED
PCWER OUTPUT(AWE) FURNACE PR.FLD COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI •BED TEMPERA BIT GAS ECONO K GAS FEEDW 0.0 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1500.0 YES NO 2.5 1 NO 8	L.M.SYSTE Pressupiz Steam Cyci Gross plai Net plant Net power	M ING SUBSYS LE NT OUTPUT (M)	.097 .265 .432 .419 .408 (E) 1168.93
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSUR	E THER 10E0	MÁL LOAD 9 btu/hr	POWER OUTPUT MWE
1 L.H.TURBINE INLET	6.697	1-00.000	15.2	20 0		170.500
2 L.M.CONDENSER		1100.000	2.4	00	5.313	
3 L.M.FEED PUMP	5039.000 GPM	1100.000	28.4	0.0		.271
4 L.M.RECIRC PUMP	12315.000 GPM	1280.000	19.6	60		•129
5 L.M.BOILER INLET		1280.000			5.987	
E STEAM TURBINE THROTTLE	6.417	1000.000	3515.0	00		766.100
7 STEAM REHEAT		0.000	0.0	00		
E ST.COND.BACK PRESS.			3.5	OOIN.HG	3.466	
9 FINAL FEEDWATER		492.000	· · · ·			•
10 COND/SG WATER INLET		560.000				
11 COMPRESSOR INLET	9.363	59.000	14.6	90		
12 GAS TURBINE INLET	10.176	1800.000				262.700
13 GAS ECON.GAS INLET.		852.000			.739	
14 GAS FWH GAS INLET		0.000	· ·		0.00	
15 STACK GAS EXHAUST		290.000				
1E AS RECEIVED COAL	453.100T/HR				9.776	

*			*		CEETCTENCIES # # #	#
-	τ.	-		•	FFFIGLENGLES * * *	

	POWER OUTPUT(MWE) FURNACE PR.FUE CCAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI NACE TEMPERA BIT GAS ECONO K GAS FEEDM 1.0 L.M.CIRCU 15 L.M.FEEDM 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1200.0 YES NO 2.3 1 NO 0	L.M.SYST PRESSURI STEAM CY GROSS PL NET PLAN NET POWE	EM ZING SUBSYS CLE ANT IT R OUTPUT(MI	.097 STEM .263 .432 .404 .394 NE) 1169.c2	
		TOTAL FLOW	TEMPERATURE	PRESSU	RE THE	RMAL LOAD	POWER OUTPUT	
	**** STATE POINTS ****	10ED5 LBH/HR	CEG-F	PSIA	10E	09 3TU/HR	MWE	
	1 L.M.TURBINE INLET	6.622	1400.000	15.	200		168.600	
	2 L.M.CONDENSER		1100.000	2.	400	5.254	•	
	3 L.M.FEED PUMP	+734.000 GPM	1100.000	27 .	810		• 262	
	4 L.N.RECIRC PUMP	12177.000 GPM	1280.000	19.	560		•125	
	5 L.M.BOILER INLET		1280.000			5.921		
2	E STEAM TURBINE THROTTLE	6.576	1000.000	3515.	000		762.000	
;	7 STEAM REHEAT		0.000	0.	000			
	8 ST.COND. BACK PRESS.			3.	500IN.HG	3.419		
	9 FINAL FEEDWATER		492.000					
	10 COND/SG WATER INLET		560.000					
	11 COMPRESSOR INLET	9.090	59.000	14.	690			
	12 GAS TURBINE INLET	9.907	1800.000				269.480	
	13 GAS ECON.GAS INLET.		865.000			.766		
	14 GAS FWH GAS INLET		0.000			0.000		
	15 STACK GAS EXHAUST		290.000					
	14 AS RECEIVED COAL	469.700T/HR				10.134		

1 . 2

CASE NO. 17

DOUCD OUTDUT (HUE)	1200 CAS TUDOT				CHOICO
FURNACE P*.FLU GCAL WCRKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1250 GAS TORSE 3ED TEMPERA 3IT GAS ECONO K GAS FEEDH 0.0 L.M.CIRCU 5 L.M.FEEDH 1.2 STAGEL OF	NE INLE TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1:00.0 NO NO 2.5 1 NO 0	L.M.SYSTEM PRESSURIZING SUBSY STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(N	•097 STEM •201 •420 •336 •327 IWE) 1169•50
**** STATE POINTS ****	TOTAL FLOW 10EJ6 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	RE THERMAL LOAD 10E09 BTU/HR	POWER CUTPUT
1 L.M.TURSINE INLET	7.265	1400.000	15.	200	185.000
2 L.M.CONDENSER		i100.000	2.	400 5.763	
3 L.M.FEED PUMP	5194.000 GPM	1100.000	32.	98.0	•346
4 L.M.RECIRC PUMP	13360.000 GPM	1280.000	20.	÷40	.165
5 L.M.BOILER INLET		1280.008		6.495	
E STEAN TURBINE THROTTLE	6.657	1000.000	3515.	000	709.300
7 STEAM REHEAT		0 - 0 0 0	0.	000	
8 ST.COND. EACK PRESS.			3.	500IN.HG 3.343	
9 FINAL FEEDWATER		560.000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	11.682	59.000	14.	590	
12 GAS TURBINE INLET	12.696	1806.000			305.700
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		1150.000			
16 AS RECEIVED COAL	565.300T/HR			12.197	

CASE NG. 18

				* * *	+ + + EFFICI	ENCIES * * * * *
POWER OUTPUT(MHE) FURNACE PR.FLE CCAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE PATIO	1200GAS TURBIN0.3EDTEMPERATBITGAS ECONOSKGAS FEEDHA0.0L.M.CIRCUI10L.M.FEEDHA1.2STAGES OF	NE INLET FURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1800.0 NO NO 2.51 NO D	L.M.S PRESS STEAM GROSS NET F NET F	SYSTEM SURIZING SUBSYS I CYCLE S PLANT PLANT POWER OUTPUT(M	.097 STEM .252 .420 .368 .359 HE) 1169.50
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	RE	THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT NWE
1 L.M.TURBINE INLET	7.224	1400.000	15.	200		184.000
2 L.H.CONDENSER		1100.000	2.	400	5.731	
3 L.H.FEED PUNF	5150.000 GPH	1100.000	32.	980		• 346
4 L.H.RECIFC PUMP	13360.000 GPM	1280.000	20.	440		.165
5 L.M.BOILER INLET		1280.008			ó.459	
E STEAM TURBINE THROTTLE	6.629	1000.000	3515.	000		705.300
7 STEAM REHEAT		0.000	0	000		
8 ST.COND.BACK PRESS.			3.	500IN.H	IG 3.324	
9 FINAL FEEDWATER		560.000				
10 COND/SG WATER INLET		560.000				
11 COMPRESSOR INLET	10.662	59.000	14.0	690		
12 GAS TURBINE INLET	11.588	1800.000				310.700
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FWH GAS INLET		0.000			0.000	
15 STACK GAS EXHAUST		949.000				
1E AS RECEIVED COAL	515.900T/HR				11.131	

CASE NO. 19

₩.	₩.	#	#	-	EFFICIENCIES * * * *

PCHER OUTPUT(MHE) FURNACE PR.FLD CCAL	1200 GAS TURBI •BED TEMPERA BIT GAS ECONO	NE INLET TURE (DEG-F) MIZER	1800.J NO	L.M.SYS PRESSUR	TEM IZING SUBSYS	•097 STEM •125
WCRKING FLUID RECUPERATOR EFFECTIVENESS CCMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	K GAS FEEDW 0.0 L.M.CIRCU 15 L.M.FEEDH 2.0 STAGES OF	ATER HEATER LATION RATIO EATER STEAM REHEAT	NO 2.5 1 NO 0	GROSS P NET PLA NET POW	YCLE LANT NT ER OUTPUT(MI	.420 .212 .207 ME) 1169.01
**** STATE POINTS ****	TOTAL FLOH 10E36 LBM/HR	TEMPERATURE DEG-F	PRESSUR	RE TH	ERMAL LOAD E09 BTU/HR	POWER OUTPUT NWE
1 L.M.TURBINE INLET	5.789	1400.000	15.2	200		147.400
2 L.M.CONDENSER		1100.000	2•*	-00	4.593	
3 L.H.FEED PUMP	4138.000 GPH	1100.000	21.	310		.175
4 L.M.RECIRC PUMP	10645.000 GPM	1280.000	20.3	50		.129
5 L.N.BOILER INLET		1280.000			5.175	
6 STEAM TURBINE THROTTLE	5.313	1000.000	3515.0	000		565.200
7 STEAM REHEAT		0.000	0.0	000		
& ST.COND.BACK PRESS.			3.5	500IN.HG	2.664	
9 FINAL FEEDWATER		560.000				
10 COND/SG WATER INLET		560.000				
11 COMPRESSOR INLET	18.485	59.000	14.6	590		
12 GAS TURBINE INLET	20.089	1800.000				487.300
13 GAS ECON.GAS INLET.		0.000			0.000	
14 GAS FWH GAS INLET		0.000			0.000	
15 STACK GAS EXHAUST		817.000				
16 AS RECEIVED COAL	894.400T/HR				19.297	

CASE NO. 20

				T T T EFFICIE	rates + + + + +
1200 GAS TURBIN •BED TEMPERA BIT GAS ECONO K GAS FEEGW 0.0 L.M.CIRCU 15 L.M.FEEDH 3.0 STAGES OF	NE INLET TURE (DEG-F) MIZER ATEF HEATER LATION RATID EATER STEAM REHEAT	1830.5 NO NO 2.= 1 NJ 0	L.M.SY PRESSU STEAM GROSS NET PL NET PO	STEM RIZING SUBSYS CYCLE PLANT ANT WER OUTPUT (M)	.097 STEM .096 .420 .127 .124 HE) 1169.77
TOTAL FLOW 10ED3 LBM/HR	TENPERATURE DEG-F	PRESSU PSIA	RE T	HERMAL LOAD DE09 BTU/HR	POWER OUTPUT NWE
3.421	1400.000	15.	200		87.400
	1100.000	2.	400	2.722	
2446.000 GPM	1100.000	32.	440		.160
5290.000 GPM	1280.000	20.	350		.076
	1280.000			3.068	
3.148	1000.000	3515.	000		334.900
	0.000	0.	000		
		3.	500IN.HG	1.579	
	560.000				
	560.000				
30.770	59.000	14.	690		
33.441	1800.000				777.700
	0.000			0.000	
	0.000			0.000	
	805.000				
1488.900T/HR				32.125	
	1200 GAS TURBI • 3ED TEMPERA PIT GAS ECONO K GAS FEEDM 0.0 L.M.CIRCU 15 L.M.FEEDH 3.0 STAGES OF TOTAL FLOM 10ED3 LBM/HR 3.421 2446.000 GPM 0290.000 GPM 3.148 30.770 33.441	1200 GAS TURBINE INLET .3ED TEMPERATURE (DEG-F) SIT GAS ECONOMIZER K GAS FEEDWATE F HEATER D.O L.M.CIRCULATION RATIO 15 L.M.FEEDHEATER 3.C STAGES OF STEAM REHEAT TOTAL FLOW TEMPERATURE 10ED3 LBM/HR DEG-F 3.421 1400.000 2446.000 GPM 1100.000 2446.000 GPM 1280.000 1280.000 3.148 1000.000 560.000 560.000 30.770 59.000 33.441 1600.000 0.000 0.000 805.000 1488.900T/HR	1203 GAS TURBINE INLET .3ED TEMPERATURE (DEG-F) 1630.6 SIT GAS ECONOMIZER NO K GAS FEEDWATE F HEATER NO J.G L.M.CIRCULATION RATID 2.5 1 15 L.M.FEEDHEATER NJ 3.C STAGES JF STEAM REHEAT 0 TOTAL FLOW TEMPERATURE PRESSU 16ED3 LBM/HR DEG-F PSIA 3.421 1400.000 15. 1100.000 2. 2446.000 GPM 1100.000 32. 5290.000 GPM 1280.000 20. 1280.000 0. 3.148 1000.000 3515. 0.000 0. 3.148 1000.000 14. 3.441 1800.000 14. 3.441 1800.000 14. 3.441 1800.000 14. 3.441 1800.000 0.000 14. 3.445.900T/HR	1200 GAS TURBINE INLET .3ED TEMPERATURE (DEG-F) 1630.6 L.M.SY SIT GAS ECONOMIZER K GAS FEEDWATEF HEATER 0.0 L.M.CIRCULATION RATIO 1.0 L.M.CIRCULATION RATIO 2.5 1 GROSS 1.5 L.M.FEEDHEATER NO NET PL 3.6 STAGES OF STEAM REHEAT 0 NET PO TOTAL FLOW TEMPERATURE PRESSURE T 10ED3 LBM/HR DEG-F PSIA 1 3.421 1400.000 15.200 1100.000 2.400 2446.000 GPM 1100.000 32.440 32.90.000 GPM 1280.000 20.350 1280.000 3.148 1000.000 3515.000 0.000 0.000 3.500IN.HG 560.000 30.770 59.000 14.690 30.770 59.000 14.690 0.000 0.000 0.000 805.000 1488.900T/HR	1200 GAS TURBINE INLET

ORIGUNAL ZALL IS POOR

CASE NO. 21

				* * * * *	* EFFICIE	NGIES * * * * *
PCWER OUTPUT(MWE) FURNACE PR.FLC CGAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBIN • 3ED TEMPERAT 3IT GAS ECONON K GAS FEEDWA 9.0 L.M.CIRCUL 15 L.M.FEEDHE 1.2 STAGES OF	E INLET URE (DEG-F) HIZER HEATER ATION RATIO EATER STEAM REHEAT	1:00.3 NO NO 2:5 1 NO 0	L.M.SYSTEM PRESSUPIZI STEAM CYCL GROSS PLAN NET PLANT NET PCWER	NG SUBSYS E T OUTPUT (MM	.097 TEM .291 .420 .403 .393 E) 1169.27
**** STATE POINTS ****	TOTAL FLOW 10EJ5 LBM/HR	TEMPERATURE DEG-F	PRESSU PSI 4	E THERM	AL LOAD BTU/HR	PONER OUTPUT NNE
1 L.M.TURBINE INLET	7.883	1400.000	15.2	200		200.700
2 L.M.CONDENSES		1100.000	2.4	00	6.253	· · · · · ·
3 L.H.FEED PUMP	3635.000 GPM	1100.000	38.4	10		.442
L.M.RECIRC PUMP	1+496+000 GPM	1280.000	21.3	370		.211
5 L.M.BOILER INLET		1280.000			7.048	
E STEAM TURBINE THROTTLE	7.234	1000.000	3515.0	0.0		769.500
7 STEAM REHEAT		0.000	0.0	00		
8 ST.COND.BACK PRESS.			3.5	00IN.HG	3.627	
9 FINAL FEEDWATER		560.000				
10 COND/SG WATER INLET		560.000				
11 COMPRESSUR INLET	9.737	59.000	14.8	90		
12 GAS TURBINE INLET	10.583	1600.000				229.700
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FWH GAS INLET		0.000			0.000	
15 STACK GAS EXHAUST		726.000				
16 AS RECEIVED COAL	471.100T/HR				10.165	

CASE NO. 22

EFFICIENCIES *

PCHER OUTPUT (MNE)	1200 GAS TURBI	NE INLET				
FURNACE PR.FLO	- BED TEMPERA	TURE (DEG-F)	1700.0	L.M.SYSTE	EM	.097
CCAL	BIT GAS ECONO	MIZER	NO	PRESSURI	ZING SUBSYS	STEN .254
WCRKING FLUID	K GAS FEEDW	ATER HEATER	ND	STEAM CYC	CLE	•420
RECUPERATOR EFFECTIVENESS	9.0 L.M.CIRCU	LATICN RATIO	2.5 1	GROSS PL	ANT	• 394
COMPRESSOR PRESSURE RATIO	15 L.M.FEEDH	EATER	NO	NET PLAN	r	.385
AIR EUUIVALENUE RATIU	1.2 STAGES OF	STEAM REHEAT	ð	NET PONER	R_OUTPUT (MI	E) 1169.32
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	RE THEF	RHAL LOAD 19 BTU/HR	POWER OUTPUT MME
1 L.M.TURBINE INLET	7.639	1400.000	15.	200		194.500
2 L.M.CONDENSER		1100.000	2.0	4 00	6.060	
3 L.H.FEED PUMP	5460.000 GPH	1100.000	36.	220		.402
4 L.M.RECIEC PUMP	14047.000 GPM	1280.000	21.	000		•192
5 L.M.BOILER INLET		1280.000			6.830	
E STEAM TURBINE THROTTLE	7.010	1000.000	3515.1	000		745.800
7 STEAM REHEAT		0.000	0.1	000		
E ST.COND.BACK PRESS.			3.	500IN.HG	3.515	
9 FINAL FEEDWATER		560.000				
10 COND/SG WATER INLET		560.000				
11 COMPRESSOR INLET	9.941	59.000	14.0	590		
12 GAS TURBINE INLET	10.804	1700.000				259.600
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FWH GAS INLET		0.000			0.00	
15 STACK GAS EXHAUST		790.000				
18 AS RECEIVED COAL	461.000T/HR				10.375	

CASE NG. 23

				ELLIDIEN	OTC3
PCWER OUTPUT(4WE) 1 FURNACE PK.FLD. COAL WORKING FLUID RECUPERATOR EFFECTIVENESS CCMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBIN BED TEMPERAT BIT GAS ECONON K GAS FEEDWA D.O L.M.CIRCUL 15 L.M.FEEDHE 1.2 STAGES OF	NE INLET TURE (DEG-F) AIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1500.0 No 2.5 1 No 0	L.H.SYSTEM PPESSURIZING SUBSYST STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT (MWE	.098 EM .267 .420 .381 .371) 1169.42
**** STATE POINTS ****	TOTAL FLOW 10236 LBM/HR	TEMPERATURE DEG-F	PRESSUR! PSIA	E TH ermal Load 10 E09 Btu/ hr	POWER OUTPUT MWE
1 L.M.TURBINE INLET	7.435	1500.000	24.7	0 0	190.600
2 L.M.CONDENSER		1200.000	4.8	00 5.840	
3 L.H.FEED PUMP	5444.000 GPM	1200.000	43.6	0 0	.460
4 L.M.RECIRC PUMP	1+028.000 GPM	1380.000	29.3	30	•141
5 L.M.BOILER INLET		1380.000		6.593	
& STEAH TURBINE THROTTLE	6.755	1000.000	3515.0	0 0	718.600
7 STEAM REHEAT		0.600	0.0	0 0	,
8 ST.COND. BACK PRESS.			3.5	001N.HG 3.387	
9 FINAL FEEDWATER		560.000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	10.310	59.000	14.6	90	
12 GAS TURBINE INLET	11.205	1800.000			290.800
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		844.000			
16 AS RECEIVED COAL	498.900T/HR			10.75?	

CASE NO. 24

* * * *

				* * * * * * * EFETOTENO	TEC # # # # #
POWER OUTPUT (MWE)	1200 GAS TURBI	NE INLET	4600 3	I M CVCTCM	163
COAL PRIFE	BIT GAS ECONO	MIZER	NO	PRESSURIZING SUBSYSTE	M .267
WORKING FLUID	K GAS FEEDW	ATER HEATER	NO	STEAM CYCLE	.420
RECUPERATOR EFFECTIVENESS	0.0 L.M.CIRCU	LATION RATIO	2.5 1	GROSS PLANT	.381
COMPRESSOR PRESSURE RATIO	15 L.M.FEEDH	EATER	NO	NET PLANT	• 372
AIR EGOIVALENDE RATIO	1.C STAGES UP	SIEAM REMEAT	U .	NET FORER COTFOR (HRE)	1109-27
AAAA CTATE BOTHTE AAAA	TOTAL FLOW	TEMPERATURE	PRESSUR		
STATE FUINTS	IUEUO LUNAK	DCG-P	PSIA	LUEUS BIOTHK	HAC.
1 L.M.TURBINE INLET	7.583	1600.000	38.2	0 0	193.100
2 L.H.CONDENSER	* - a a	1300-000	8 • 8	00 5.824	
3 L.M.FEED PUMP	3608.000 GPM	1300-000	58.5	8 D	.611
4 L.M.RECIRC PUMP	1+446.000 GPM	1480.000	42.5	90	.138
5 L.M.BOILER INLET		1480.000		6.577	
E STEAM TURBINE THROTTLE	6.737	1000.000	3515.0	0.0	716.700
7 STEAM REHEAT		0.000	0.0	0 0	
E ST.COND.BACK PRESS.			3.5	00IN.HG 3.378	
S FINAL FEEDWATER		560.000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	10.285	59.000	14.6	90	
12 GAS TURBINE INLET	11.178	1800.000			290.200
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		344.000			
16 AS RECEIVED COAL	497-700T/HP			10.733	

8-130

REPRODUCED TY OF THE ORIGINAL PACE IS POOR

			UASE NU. 29			
					* * * * * * * EFFIC	IENCIES * * * * *
	FURNACE	FLJ.BED TEMPERA	NE INLEI TURE (DEG-F)	1800.0	L.M.SYSTEM	-098
	WCRKING FLUID	K GAS FEEDW	ATER HEATER	NO	STEAM CYCLE	.430
	RECUPERATOR EFFECTIVENE	SS 0.0 L.H.CIRCU	LATION RATIO	2.5 1	GROSS PLANT	.386
	COMPRESSOR PRESSURE RAT	IO 15 L.M.FEEDH	EATER	NO	NET PLANT	.376
	AIR EQUIVALENCE RATIO	1.2 STAGES UP	SIEAM REHEAT	U	NET POWER OUTPUT	MWE) 1169.73
	**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG+F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT
	1 L.M.TURBINE INLET	7.331	1500.000	24.7	6 ð	188.000
	2 L.M.CONDENSER		1200.000	4.9	00 5.756	
	3 L.M.FEED PUMP	5368.000 GPM	1200.000	42.5	20	. 44 0
	4 L.M.RECIRC PUMP	13831.000 GPM	1380.000	29.2	0 0	.135
œ	E L.M.BOILER INLET		1380.000	·	6.500	
-131	E STEAM TURBINE THROTT	LE 6.140	1100.000	3515.0	0 0	725.400
	7 STEAM REHEAT		0.000	0.0	00	· ·
	E ST.COND.BACK PRESS.			3.5	00IN.HG 3.282	
	9 FINAL FEEDWATER		560.000			
	10 CONDISG WATER INLET		560.000			
	11 COMPRESSOR INLET	10.165	59.000	14.6	90	
	12 GAS TURBINE INLET	11.047	1800.000			286.900
	13 GAS ECON.GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		0.000		0.000	
	15 STACK GAS EXHAUST		844.000			
	16 AS RECEIVED COAL	491.900T/HR			10.613	

~ • •

CASE NO. 26

*						EFETOTENOTES & & & & &	
•	-	-	-	-	-		

PCWER OUTPUT(MWE)	1200	GAS TURET	NE INLET				
FURNACE	PR.FLU.SED	TEMPERA	TURE (DEG-F)	1600.0	L.M.SYS	STEM	.100
CCAL	BIT	GAS ECONO	HIZER	NO	PRESSUR	IZING SUBSYS	STEN .267
WORKING FLUID	Υ K	GAS FEEDW	ATER HEATER	NO	STEAM C	YCLE	.443
RECUPERATOR EFFECTI	VENE15 0.0	L.H.CIRCU	LATION RATIO	2.5 1	GROSS F	PLANT	• 394
COMPRESSOR PRESSURE	RATIO 15	L.M.FEEDH	EATER	би	NET PLA	NT	.384
AIR EQUIVALENCE RAT	10 1.2	STAGES OF	STEAM REHEAT	. D	NET POP	ER OUTPUT (MI	E) 1169.34
**** STATE POINTS *	T0	TAL FLOW J5 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	RE TH 10	HERMAL LOAD Degg btu/hr	POWER OUTPUT MWE
1 L.M.TURBINE INLE	T d	7.3+3	1600.000	38.	200		187.000
2 L.M.CONDENSER			1300.000	8.	800	5.640	
3 L.M.FEED PUMP		5431.000 GPM	1300.000	55.	770		.555
4 L.M.RECIRC PUMP	1	3988.000 GPM	1480.000	42 .	320		.125
5 L.M.BOILER INLET			1480.000			6.369	
E STEAM TURBINE TH	ROTTLE	5.607	1200.000	3515.	000		732.000
7 STEAN REHEAT			0.000	0.	000		
& ST.COND.BACK PRES	SS.			3.	500IN.HG	3.141	
9 FINAL FEEDWATER			560.000				
10 COND/SG WATER IN	LET		560.000				
11 COMPRESSOR INLET		9.959	59.000	14.	690		
12 GAS TURBINE INLE	г	10.823	1800.000				281.000
13 GAS ECON.GAS INL	ET,		0.000			0.000	
14 GAS FWH GAS INLE	T		0.000			0.000	
15 STACK GAS EXHAUS	T		844.000				
16 AS RECEIVED COAL		481.900T/HR				10.397	

CASE	NO.	27		* *

.

¥	¥	¥	¥	*	¥	EFFICIENCIES	#	Ŧ		Ŧ
									-	

PCHER OUTPUT(HWE) FURNACE PR.FLU COAL HORKING FLUID RECUPERATOR EFFECTIVENESS CCHPRESSON PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBIN 1350 TEMPERAT BIT GAS ECONOM K GAS FEEDWA 0.0 L.M.CIRCUL 15 L.M.FEEDHE 1.2 STAGES OF	E INLET URE (DEG-F) IZER TER HEATER ATION RATIO ATER STEAM REHEAT	1€00.0 NO NO 2.≚ 1 NO 1	L.H.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(M	•097 (STEM •267 •435 •388 •378 (HE) 1169•41
**** STATE POINTS ****	TOTAL FLOW 10EJ6 LBM/HR	TEMPERATÜRE DEG-F	PRESSUR PSIA	THERMAL LOAD	POWER CUTPUT HNE
1 L.M.TURBINE INLET	7.227	1400.000	15.2	20 0	184.000
2 L.M.CONDENSER		1100.000	2.4	00 5 .733	
3 L.H.FEED PUMP	3166.000 GPM	1100.000	32.6	60	.340
4 L.M.RECIRC PUMP	13290+008 GPM	1280.000	20.3	190	.163
 p 5 L.M.BOILER INLET		1280.000		6.461	
 E STEAM TURBINE THROTTLE	5.269	1000.000	3515.0	0.0	730.700
7 STEAM REHEAT		1000.000	600.0	0.0	
E ST.COND.BACK PRESS.			3.5	00IN.HG 3.239	
9 FINAL FEEDWATER		360 . 000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	10.104	59.000	14.6	90	
12 GAS TURBINE INLET	10.981	1800.000			285.200
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		844 . 000			
16 AS RECEIVED COAL	488.900T/HR			10.549	

CASE NO. 28

* *

					* * * * * * * EFFICI	IENCIES + + + + -
	PCWER OUTPUT(MWE) FURNACE PR.FLO GCAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1220GAS TURBI0.8EDTEMPERA3ITGAS ECONOKGAS FEEDH0.0L.M.CIRCU15L.M.FEEDH1.2STAGES OF	NE INLET TURE (DEG-F) MIZER ATEF HEATER LATION RATIO EATER STEAM REMEAT	1600.0 NO NO 2.5 1 NO 1	L.M.SYSTEM PRESSURIZING SUBSY STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(N	.098 (STEM .267 .449 .396 .336 1HE) 1169.48
	**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	THERMAL LOAD	POWER CUTPUT
	1 L.M.TURBINE INLET	7.194	1500.000	24.	700	183.000
	2 L.M.CONDENSER		1200.000	4.4	5.512	
	3 L.M.FEED PUMP	5236.000 GPM	1200.000	40.0	530	-408
	L L.M.RECIRC PUMP	13492.000 GPM	1360.000	28.	96 0	.125
çم	5 L.M.BOILER INLET		1380.000		6.338	
134	E STEAM TURBINE THROTTLE	4.807	1100.000	3515.	0 0 0	737.400
	7 STEAM REHEAT		1100.000	600.	000	
	8 ST.COND.BACK PRESS.			3.5	500IN.HG 3.095	
	9 FINAL FEEDWATER		560.000			
	10 COND/SG WATER INLET		560.000			
	11 COMPRESSOR INLET	9.907	59.000	14.6	590	
	12 GAS TURBINE INLET	10.767	1800.000			279.600
	13 GAS ECON. GAS INLET.		0.000		0.000	
	14 GAS FWH GAS INLET		0.005		0.000	
	15 STACK GAS EXHAUST		844.000			
	16 AS RECEIVED COAL	479.400T/HR			10.343	

REPRODUCTATE OF THE ORIGINAL PART IS POOR
CASE NO. 29

	*	¥	*	*	*	CEET	CTEN	TES		#	*	-	4
-	-	Ŧ	-	-	-		1.1 5 141		-			-	

	PCHER OUTPUT(MWE) FURNACE PR.FLC COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR FRESSUPE RATIO AIR EQUIVALENCE PATIO	1200 GAS TURBI - BED TEMPERAT BIT GAS ECONON K GAS FEEDH 0.0 L.M.CIRCUL 15 L.M.FEEDH 1.2 STAGES OF	NE INLET IURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REMEAT	1800.0 NO 2.5 1 NO 1	L.M.SYSTE PRESSURIZ STEAM CYC GROSS PLA NET PLANT NET POWER	M ING SUBSYS Le NT OUTPUT (MI	.100 STEM .267 .462 .404 .394 HE) 1169.39
	**** STATE POINTS ****	TOTAL FLOW 10ED6 LBM/HR	TEMPERATURE DEG-F	PRESSU	RE THER 10E0	MAL LOAD 9 btu/hr	POHER OUTPUT
	1 L.M.TURBINE INLET	7.155	1600.000	38.	20 0		182.200
	2 L.M.CONDENSER		1300.000	8.1	500	5.49.	
	3 L.M.FEED PUMP	3292.000 GPM	1300.000	53.4	40.0		.514
	4 L.M.RECIRC PUMP	13631.000 GPM	1480.000	42•:	110		• 116
a,	5 L.M.BOILER INLET		1480+000			6.206	
2	6 STEAM TURBINE THROTTLE	4.430	1200.000	3515.	000		743.900
	7 STEAM REHEAT		1200.000	600.	000		
	8 ST.COND.BACK PRESS.			3.5	500IN.HG	2 • 950	
	9 FINAL FEEDWATER		560.000				
	10 COND/SG WATER INLET		560.000				
	11 COMPRESSOR INLET	9.705	59.000	14.1	590		
	12 GAS TURBINE INLET	10.5+7	1800.000				273.900
	13 GAS ECON.GAS INLEY,		0.000			0.000	
	14 GAS FWH GAS INLET		0.000			0.000	
	15 STACK GAS EXHAUST		644.000				
	16 AS RECEIVED COAL	469.600T/HR				10.132	

C.1	121	F	MAD.		3	n
	· ب		. U	•	J	•

* * * * * * EFFICIENCIES * * * * *	
------------------------------------	--

	POMER OUTPUT(MWE) FURNACE PR.FLO COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI •BED TEMPERA BIT GAS ECONO K GAS FEEDW 0.0 L.H.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET FURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1500.0 NO NO 2.5 1 NO B	L.H.SYSTEM PRESSURIZI STEAM CYCL GROSS PLAN NET PLANT NET POWER	NG SUBSYS E IT OUTPUT (MI	.097 STEM .290 .410 .374 .365 NE) 1169.45
	**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERM 10E09	AL LOAD BTU/HR	PONER OUTPUT NHE
	1 L.M. TURBINE INLET	7.490	1400.000	15.2	0 0		190.700
	2 L.H.CONDENSER		1100.000	2.4	0.0	5.942	
	3 L.M.FEED PUMP	5354,000 GPM	1100-000	34.9	10	•	.379
	4 L.H.RECIRC PUNP	13773.000 GPM	1280 e 000	20.7	70		.181
	5 L.M.BOILER INLET		1280.000			6+696	
8-1	6 STEAM TURBINE THROTTLE	6.338	1000.000	2415.0	0.0		713.800
36	7 STEAM REHEAT		0.000	0.0	0 0		
	8 ST.COND.BACK PRESS.			3.5	DÖIN.HG	3.506	
	9 FINAL FEEDWATER		530.000				
	10 COND/SG WATER INLET		530.000				
	11 COMPRESSOR INLET	10.471	59.000	14.6	90		
	12 GAS TURBINE INLET	11.380	1800-000				295.500
	13 GAS ECON.GAS INLET,		0.000			0.000	
	14 GAS FWH GAS INLET		0.000			0.000	
	15 STACK GAS EXHAUST		844.000				
	16 AS RECEIVED COAL	506.700T/HR				10.933	

CASE NO. 31

EFFICIENCIES

POWER OUTPUT (MWE)	1200 GA: 8-FLC-8ED	S TURBINE INLE	ET 166-F) 1600-0	I.M.SYSTE	TM .	. 19.6
COAL	BIT GAS	ECONOMIZER	NO	PRESSURIZ	ING SUBSYSTE	H •257
WORKING FLUID	K GAS	5 FEEDWATER HE	ATER NO	STEAM CYC	LE	
RECUPERATOR EFFECTIVEN	ESS 0.0 L.1	.CIRCULATION	RATIO 2.5 1	GROSS PL	INT	• 380
COMPRESSOR PRESSURE R	VIIO 15 L.	I.FEEDHEAT IR	NO	NET PLANT		• 371
AIR EQUIVALENCE RAFIO	1.2 31	AGES OF STEAM	REHEAT	NET POWER	COUTPUT (MNE)	1169.60
	TOTAL F			URF THEF		OWER OUTPUT
**** STATE POINTS ****	10EJ6 LB	I/HR DEG	G-F PSI	A 10E0	9 BTU/HR	MHE
1 L.M.TURBINE INLET	7.	•86 1 <u>5</u> 00	0.000 24	•700		190.600
2 L.M.CONDENSER		1200	4-000 4	005.	5.840	
3 L.M.FEED PUMP	5444.	000 GPM 1200	43	• 60 0		.460
4 L.M.RECIRC PUMP	1+028.	000 GPM 1380	.000 29	.330		.141
5 L.M.BOILER INLET		1380	.000		6.594	
E STEAM TURBINE THROT	TLE 5.	324 1100	2415	.000		718.600
7 STEAM REHEAT		C	.000 0	• 00 0		
8 ST.COND.BACK PRESS.	•		3	.500IN.HG	3.387	
9 FINAL FEEDWATER		530	.000			
10 COND/SG WATER INLET	•	530	.000			
11 COMPRESSOR INLET	10.	59	9.000 14	•690		
12 GAS TURBINE INLET	11.	206 1800	.000			290.990
13 GAS ECON.GAS INLET	,	C	0.000		0.000	
14 GAS FWH GAS INLET		0	.000		0.000	
15 STACK GAS EXHAUST		* 844				
16 AS RECEIVED COAL	498.	DOT/HR			10.764	

			CASE NO. 32				
	POWER OUTPUT(MWE) FURNACE Pr.FLE GGAL WCRKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI D-BED TEMPERA BIT GAS ECONO K GAS FEEDW D-D L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1800.0 NO 2.5 1 NO J	L.M.SYSTE PRESSURIZ STEAM CYC GROSS PLA NET PLANT NET POWER	TING SUBSY: CLE INT R OUTPUT (M	.100 STEM .267 .430 .387 .377 HE) 1169.40
	**** STATE POINTS ****	TOTAL FLOW 10ED6 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THER	RMAL LOAD 19 btu/hr	POWER CUTPUT NNE
	1 L.M.TURBINE INLET	7.476	1600.000	38.2	0 0		190.400
	2 L.M.CONDENSER		1300.000	8.8	00	5.740	
	3 L.M.FEED PUMP	********* GPM	1308.000	57.4	90		.586
	4 L.M.RECIRC PUMP	1+242.000 GPM	1480.000	42.4	70		-132
œ	5 L.M.BOILER INLET		1480.000			6.485	
-138	E STEAM TURBINE THROTTLE	5.3ö9	1200.000	2415.0	0.0		723.500
	7 STEAM REHEAT		0.000	0.0	0.0		
	& ST.COND.BACK PRESS.			3.5	ODIN.HG	3.273	
	S FINAL FEEDWATER		530.000				
	10 COND/SG WATER INLET		530.000				
	11 COMPRESSOR INLET	10.141	59.000	14.6	90		
	12 GAS TURBINE INLET	11.021	1800.000				286.200
	13 GAS ECON.GAS INLET,		0.000			0.000	
	14 GAS FWH GAS INLET		0.000			0.000	
	15 STACK GAS EXHAUST		844.000				
	1F AS RECEIVED COAL	490.700T/HR				10.587	

CASE NG. 33

* * * * * * EFFICIENCIES * * * *

	POWER OUTPUT(MWE) FURNACE P°.FLC COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI -350 TEMPERA 3IT GAS ECONO K GAS FEEDW 0.1 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1600•0 NO NO 2.5 1 NO 1	L.M.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(•097 YSTEM •267 •426 •383 •374 MWE) 1169•49
	**** STATE POINTS ****	TOTAL FLOW 10ED5 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT
	1 L.M.TURBINE INLET	7.320	1-00.000	15.2	0 0	186.400
	2 L.H.CONDENSER		1100.000	2.4	5.307	
	3 L.H.FEED PUMP	5233.000 GPM	1100.000	33.4	50	. 354
	4 L.M.RECIRC PUMP	13460.000 GPM	1280.000	20.5	20	•169
8	5 L.M.BOILER INLET		1280.000		5.544	
20	E STEAM TURBINE THROTTLE	5.238	1000.000	2415.0	0 0	724.800
	7 STEAM REHEAT		1000.000	600.0	90	
	8 ST.COND.BACK PRESS.			3.5	00IN.HG 3.333	
	9 FINAL FEEDWATER		530.000			
	10 COND/SG WATER INLET		530.000			
	11 COMPRESSOR INLET	10.234	59.000	14.6	90	
	12 GAS TURBINE INLET	11-122	1800.000			288.800
	13 GAS ECON.GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		0.000		0.000	
	15 STACK GAS EXHAUST		644 .000			
	16 AS RECEIVED COAL	495.200T/HR			10.684	

+ + + + + + EFFICIENCIES + + + + +

	FURNACE PRIFIC	1200 GAS TURBI BED. TEMPERA	NE INLET TURE (DEG-F)	1800.0	L.H.SYSTEM	• 098
	CGAL HORKING FUITD	BIT GAS ECONO	MIZER ATE E VEATED	NO	PRESSURIZING SUBSY	SIEM .207
	RECUPERATOR FEFECTIVENESS	DAD LAMACIRCH	LATION RATIO	. 2.5 1	GROSS PLANT	- 389
	COMPRESSOR PRESSURE RATIO	15 LaMaFEEDH	FATER	NO	NET PLANT	.38
	AIR EQUIVALENCE RATIO	1+2 STAGES OF	STEAM REHEAT	1	NET POWER OUTPUT (M	WE) 1169-75
	**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSURE PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT
	1 L.M.TURBINE INLET	7.316	1500.000	24.7	00	186.300
	2 L.M.CONDENSER		1200.600	4.80	5.707	
	3 L.H.FEED PUMP	3320.000 GPM	1200.000	41.85	50	•429
	L .N.RECIRC PUMP	13709.000 GPM	1380.000	29.12	20	.131
.00	5 L.M.BOILER INLET		1380.000		ō. 444	
·140	E STEAM TURBINE THROTTLE	4.840	1100.000	2415.00	0 0	729.600
	7 STEAM REHEAT		1100.000	660.00	0	
	& ST.COND.BACK PRESS.			3.50	3.219 3.21 9	
	9 FINAL FEEDWATER		530.000			
	10 COND/SG WATER INLET		530.000			
	11 COMPRESSOR INLET	10.076	59.000	14.6	90	
	12 GAS TURBINE INLET	10.950	1800.000			284 • 400
	13 GAS ECON.GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		0.00%		0.000	4
	15 STACK GAS EXHAUST	•	844 = 000			
	16 AS RECEIVED COAL .	487.500T/HR			10.518	

CASE NG. 35

TOTENOTES

				COLUMN STATE	HOILS
FURNACE PR.FLD FURNACE PR.FLD COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI •BED TEMPERA BIT GAS ECONO K GAS FEEDH 0.0 L.M.CIRCU 13 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1800.0 L NO P NO S 2.デ 1 G NO N 1 N	.M.SYSTEM RESSURIZING SUBSYS TEAM CYCLE ROSS PLANT IET PLANT IET POWER OUTPUT(N)	•100 STEH •267 •452 •399 •369 HE) 1169•36
**** STATE POINTS ****	TOTAL FLOW 10ED6 LBM/HR	TEMPERATURE DEG-F	PRESSURE PSIA	THERNAL LOAD 10e09 btu/hr	POWER OUTPUT MWE
1 L.H.TURBINE INLET	7.253	1603-000	38.200		184.700
2 L.H.CONDENSER		1300.000	8.300	5.570	
3 L.M.FEED PUHP	336 5.0 00 GPM	1300-000	54.630		•535
4 L.M.RECIRC PUMP	13817.000 GPH	1480.000	32.220		•121
5 L.M.BOILER INLET		1-80-000		6.291	
E STEAM TURBINE THROTTLE	4.466	1200-000	2415.000		737.700
7 STEAN REHEAT		1200.000	600.000	I	
8 ST.COND. EACK PRESS.			3.500	IN.HG 3.052	
S FINAL FEEDWATER		530.000			
10 COND/SG WATER INLET		530.000			
11 COMPRESSOR INLET	9.837	59.000	14.690	I	
12 GAS TURBINE INLET	10.691	1900-000			277.600
13 GAS ECON.GAS INLET.		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		844.000			
16 AS RECEIVED COAL	476.000T/HR			10.270	

				- + + + + + + EFFICI	ENGIES + + + +
POWER OUTPUT (MHE)	1200 GAS TURBI	NE INLET			
FORNAUE PROFEL	SEU TEMPERA	10KE (UEG-F)	1600-0	L.M.SYSIEM	• 097
LUAL CLUTD	SII GAS EGUNU	MIZER	NU	PRESSURIZING SUBST	SIEM .267
NURKING FLUID	S GAS FEEDW	AIER HEALER	NU	STEAM GYCLE	• 421
RECOPERATOR EFFECTIVENESS	U.C L.M.CIRCU	LATION RATIO	2.02 1	GRUSS PLANT	• 380
COMPRESSUR PRESSURE RATIO	15 L.M.FLEUH	EATER	- NO	NET PLANT	• 371
AIR EQUIVALENCE RATIO	1.2 STAGES OF	STEAM REHEAT	3	NET POWER OUTPUT (M	NE) 1169.38
**** STATE POINTS ****	TOTAL FLOW 10E36 LBM/HR	TEMPERATURE DEG-F	PRESSU PSIA	PE THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT MWE
1 L.M.TURBINE INLET	7.371	1400.000	15.	20.0	187.700
					20,0100
2 L.H.CONDENSER		1100.000	2.4	+00 5.047	
3 L.H.FEED PUMP	3269.000 GPM	1100.000	33.	350	.361
4 L.H.RECIRC PUMP	13554.000 GPM	1280.000	20.	500	.173
5 L.M.BOILER INLET		1289.000		6.591	
E STEAM TURBINE THROTTLE	6.237	1000.000	2415.	000	721.300
7 STEAM REHEAT		0.000	0.0	000	
E ST.COND.BACK PRESS.			2.	000IN.HG 3.385	
9 FINAL FEEDWATER		530.000			
10 COND/SG WATER INLET		530.000			
11 COMPRESSOR INLET	10.306	59.000	14.9	590	
12 GAS TURBINE INLET	11.201	1800-000			290.900
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		844.000			
16 AS RECEIVED COAL	498.700T/HR			10.760	

CASE NO. 37

				ELLIDIE	NOTES
PGHER OUTPUT(MWE) FURNACE COAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBIN -3ED TEMPERA BIT GAS ECONON K GAS FEEDW 0.0 L.M.CIRCUN 15 L.M.FEEDHN 1.2 STAGES 07	NE INLET TURE (DEG-F) MIZER ATTR HEATER LATION RATIO CATER STEAM REHEAT	1800.0 NO NO 2.5 1 NO J	L.M.SYSTEM PRESSURIZING SUBSYS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(MW	.097 TEM .267 .383 .360 .351 E) 1168.70
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSURE PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT MWE
1 L.H.TURBINE INLET	7.790	1~00.000	15.20	0	198.400
2 L.M.CONDENSER		1100.000	2.4	00 ê.180	
3 L.M.FEED PUMP	5569.000 GPM	1100.800	37.58	50	•426
4 L.M.RECIRC PUMP	14325.000 GPM	1280.000	21.23	30	.204
5 L.M.BOILER INLET		1280.000		6.965	
6 STEAM TURBINE THROTTLE	6.591	1000.000	2415.00	00	693 .50 0
7 STEAM REHEAT		0.000	0.00	0	
8 ST.COND.BACK PRESS.			9.00	001N.HG 3.813	
9 FINAL FEEDWATER		530.000			
10 COND/SG WATER INLET		530.000			
11 COMPRESSOR INLET	10.692	59.000	14.69	90	
12 GAS TURBINE INLET	11.837	1800.000			307.400
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		844.000			
16 AS RECEIVED COAL	527.000T/HR			11.370	

				+ + + + + + EFFIC	EENCIES # # # # #
POWER OUTPUT(MWE) FURNACE PR.FLE COAL WORKING FLUID RECUPERATOR EFFECTIVEAESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200GAS TURBI0.3E0TEMPERABITGAS ECONOKGAS FEEDW0.0L.M.CIRCU15L.M.FEEDH1.2STAGES OF	NE INLET ITURE (DEG-F) MIZER MATER HEATER MATER HEATER LATICN RATIO MEATER STEAM REHEAT	1630+0 NO NO 2-5 1 NO J	L.M.SYSTEM PRESSURIZING SUBSI STEAM CYCLE GROSS PLANT NET PLANT NET POHER OUTPUT(N	.037 ISTEM .207 .432 .386 .377 IWE) 1169.50
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT MWE
1 L.M.TURBINE INLET	7.258	1400.000	15.2	0 0	184.800
2 L.M.CONDENSER		1100.000	2.4	00 5.755	
3 L.M.FEED PUMP	5188.000 GPM	1100.000	32.9	30	.345
4 L.M.RECIRC PUMP	13346.000 GPM	1280.000	20.4	30	•165
E L.M.BOILER INLET		1280.000		6.489	
E STEAM TURBINE THROTTLE	6.600	1000-000	3515.0	00	728.800
7 STEAM REHEAT		0.000	0.0	00	
8 ST.COND.BACK PRESS.			2.0	00IN.HG 3.271	
9 FINAL FEEDWATER		560.000			
10 COND/SG WATER INLET		560.000			
11 COMPRESSOR INLET	10.147	59.000	14.6	90	
12 GAS TURBINE INLET	11.028	1800.000			286.400
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		0.000		0.000	
15 STACK GAS EXHAUST		844.008			
16 AS RECEIVED COAL	491.000T/HR	1		10.594	

8-144

SEE SE

E CONTRACTOR

		CASE NO. 39				
ROUER OUTPUT (MUE)	1200 080 1000	THE THEFT		* * * * *	* EFFICIE	NGIES * * * * *
FURNACE PR.FLC	ASTORS	ATURE (DEG-F)	1806-0	L.M.SYSTE	м	. 097
COAL	BIT GAS ECON	OHIZER	NO	PRESSURIZ	ING SUBSYS	TEN .267
WORKING FLUID	K GAS FEED	WATER HEATER	NO	STEAM CYC	LE	.392
RECUPERATOR EFFECTIVENESS	0.0 L.M.CIRC	ULATION RATIO	2.5 1	GROSS PLA	NT	• 365
COMPRESSOR PRESSURE RATIO	15 L.M.FEED	HEATER	NO	NET PLANT		• 356
AIR EQUIVALENCE RATIO	1.2 STAGES O	F STEAM REHEAT	0	NET POWER	OUTPUT (MW	E) 1169.41
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE .DEG-F	PRESSUR PSIA	E THER 10E0	HAL LOAD 9 BTU/HR	POWER OUTPUT HWE
1 L.M.TURBINE INLET	7.691	1400.000	15.2	0 0		195.800
2 L.M.CONDENSER		1100.000	2.4	00	6.101	
3 L.M.FEED PUMP	5498.000 GP	M 1100.000	36.6	80		•410
4 L.M.RECIRC PUMP	14143.000 GP	M 1280.000	21.0	90		.196
5 L.M.BOILER INLET	·	1280.000			6.876	
E STEAM TURBINE THROTTLE	7.057	1000.000	3515.0	0 0		700.700
7 STEAM REHEAT		0.000	0.0	00		
6 ST.COND.BACK PRESS.			9.0	DDIN.HG	3.709	
9 FINAL FEEDWATER		560.000				
10 COND/SG WATER INLET		560.000				
11 COMPRESSOR INLET	10.752	59.000	14.6	90		
12 GAS TURBINE INLET	11.685	1800.000				303.500
13 GAS ECON.GAS INLET.		8.000			0.000	
14 GAS FWH GAS INLET		0.000			0.000	
15 STACK GAS EXHAUST		644.000				
16 AS RECEIVED COAL	520.300T/H	R			11.226	

			* * * * * * * EFFICI	ENCIES # # # # #
GAS TURB	INE INLET			
TEMPER	ATURE (DEG-F)	1600.0	L.H.SYSTEM	• 0 97
GAS ECON	OMIZER	NO	PRESSURIZING SUBSYS	STEN .256
GAS FEED	WATER HEATER	YES	STEAM CYCLE	.433
L.M.CIRC	ULATION RATIO	2.5 1	GROSS PLANT	•446
L.M.FEED	HEATER	NO	NET PLANT	.435
STAGES 0	F STEAM REHEAT	1	NET POWER OUTPUT (M	WE) 584.80
FLOW	TEMPERATURE	PRESSURE	THERMAL LOAD	POWER OUTPUT
LBM/HR	DEG-F	PSIA	10E09 BTU/HR	HWE
3.441	1400-000	15.20	0	87.630

**** STATE POINTS ****	10E06 LBM/HR	DEG-F	PSIA	10E09 BTU/HR	MWE
1 L.M.TURBINE INLET	3.441	1400.000	15.200		87.630
2 L.M.CONDENSER		1100.000	2 • 400	2.730	
3 L.H.FEED PUMP	+920.000 GPM	1100.000	29.850		.147
4 L.M.RECIRC PUMP	12657.000 GPM	1280.000	19.910		.070
5 L.M.BOILER INLET		1280.000		3.077	
6 STEAM TURBINE THROTTLE	2.685	1000.000	3515.000		413.330
7 STEAM REHEAT		1000.000	600.000		
8 ST.COND.BACK PRESS.			3.500IN.H	G 1.847	
9 FINAL FEEDWATER		492.000			
10 COND/SG WATER INLET		492.000			
11 COMPRESSOR INLET	4.250	59.000	14.690		
12 GAS TURBINE INLET	4.632	1600.000			99.050
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		852.000		•527	
15 STACK GAS EXHAUST		290.000			
1€ AS RECEIVED COAL	212.750T/HR			4.590	

8-146

PCHER OUTPUT (HHE)

RECUPERATOR EFFECTIVENESS 0.0

COMPRESSOR PRESSURE RATIO

AIR EQUIVALENCE RATIO

WORKING FLUID

FURNACE COAL 500 PR.FLD.9ED

BIT

15

1.2

TOTAL

K

GASE NO	J. 41	
---------	-------	--

				* * * * * * * EFFIC	IENCIES + + + + +
PGWER OUTPUT(MWE) FURNACE PR.FLC GGAL WORKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	\$00GAS TURBI\$350TEMPER/3ITGAS ECONOKGAS FEED/0.0L.M.CIRCU15L.M.FEED/1.2STAGES OF	INE INLET ATURE (DEG-F) DMIZER MATER HEATER ULATION RATIO HEATER F STEAM REHEAT	1606.0 NO YES 2.5 1 NO 1	L.M.SYSTEM PRESSURIZING SUBS STEAM CYCLE GROSS PLANT NET PLANT NET POWER OUTPUT(.097 YSTEM .256 .433 .446 .435 MWE) 677.21
**** STATE POINTS ****	TOTAL FLOW 10eJ6 LBH/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMAL LOAD 10E09 btu/hr	POWER OUTPUT
1 L.M.TURBINE INLET	5.163	1400.000	15.2	00	131.450
2 L.M.CONDENSER		1100.000	2.4	00 4.095	
3 L.M.FEED PJMP	+920.000 GPM	1100.000	29.8	50	•220
L L.M.RECIRC PUMP	12657.000 GPH	1280.000	19.9	10	•105
5 L.M.BOILER INLET		1280-000		4.615	
E STEAM TURBINE THROTTLE	4.027	1000.000	3515.0	0 0	620.000
7 STEAM REHEAT		1000.000	600.0	0 0	
& ST.COND.BACK PRESS.			3.5	00IN.HG 2.771	
9 FINAL FEEDWATER		492.000			
10 COND/SG WATER INLET		492-000			
11 COMPRESSOR INLET	6.375	59.000	14.5	90	
12 GAS TURBINE INLET	6.948	1600.000			148.580
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		852.000		.792	
15 STACK GAS EXHAUST		290.000			
18 AS RECEIVED COAL	319.130T/HF	2		6.885	

* * * * * * EFFICIENCIES * * * *

	POWER OUTPUT(MWE)	1500 GAS TURBI	NE INLET				
1	FURNACE PK.FLI	.SED TEMPERA	TURE (DEG-F)	1600.0	L.H.SYSTEH	ł	.097
	COAL	SIT GAS ECONO	MIZER	NO	PRESSURIZI	ING SUBSYS	TEH .256
ļ	ACRKING FLUID	K GAS FEEDW	ATER HEATER	YES	STEAM CYCL	.E	•433
;	CHOPERATUR EFFECTIVENESS	3.0 L.M.CIRCU	LATION RATIO	2+5 1	GROSS PLAN	11	• 445
	ATR FOUTVALENCE RATTO	1.2 STAGES OF	STEAN DEMENT	1	NET PLANE		+432 51 4/42 01
			STERN KENCKT	. •	NET FOREK	UUTFUTIAN	C/ 1402+01
	**** STATE POINTS ****	TOTAL FLOW 10EJ6 LBH/HR	TEMPERATURE DEG-F	PRESSU	RE THERM 10E09	IAL LOAD BTU/HR	POWER OUTPUT
	1 L.M.TURBINE INLET	8.604	1400.000	15.2	200		219.090
	2 L.M.CONDENSER		1100.000	2.4	+00	6.820	
	3 L.M.FEED PUMP	+920.000 GPM	1100.000	29.8	850		.367
	4 L.M.RECIRC PUMP	12657.000 GPM	1280.000	19.9	910		.176
	5 L.H.BOILER INLET		1280.000			7 •692	
,	E STEAM TURBINE THROTTLE	6.711	1000.000	3515.0	000		1033.330
	7 STEAM REHEAT		1000.000	600.0	00		
	6 ST.COND.BACK PRESS.			3.5	500IN.HG	4.618	
	9 FINAL FEEDWATER		492.000				
1	C CONDISG WATER INLET		-92.000				
1	1 COMPRESSOR INLET	10.625	59.000	14.8	90		
1	2 GAS TURBINE INLET	11.579	1600-000				247.625
1	3 GAS ECON.GAS INLET,		0.000			9.000	
1	4 GAS FWH GAS INLET		852.000			1.320	
. 1	.F STACK GAS EXHAUST		290.000				
1	E AS RECEIVED COAL	531.880T/HR				11-475	

CA	SE	NO.	43
	~		

* * -#

				* * * * * * * EFFICIENCIES	* * * * *
PCHER OUTPUT (HWE)	6 0 0	GAS TURBINE INLET			
FURNACE	P= FUF NACE	TEMPERATURE (DEG-F)	1600.0	L.H.SYSTEM	.097
COAL	BIT	GAS ECONOMIZER	NO	PRESSURIZING SUBSYSTEM	.262
WCRKING FLUID	ĸ	GAS FEEDWATER HEATER	YES	STEAM CYCLE	.433
RECUPERATOR EFFECTI	VENESS 0.0	L.H.CIRCULATION RATIO	2.5 1	GROSS PLANT	.416
COMPRESSOR PRESSURE	RATIO 15	L.H.FEEDHEATER	NO	NET PLANT	. 406
AIR EQUIVALENCE RAT	10 1.2	STAGES OF STEAM REHEAT	· 1	NET POWER OUTPUT (HHE)	584.81

**** STATE POINTS ****	TOTAL FLOW 10E35 LBH/HR	TEMPERATURE DEG-F	PRESSURE PSIA	THERMAL LOAD 10e09 btu/hr	POWER OUTPUT
1 L.H.TURBINE INLET	3.384	1400.000	15.200		86.160
2 L.M.CONDENSER		1109.000	2.400	2.684	
3 L.M.FEED PUMP	+337.000 GPM	1100.600	28.930		.140
4 L.M.RECIRC PUMP	12444.000 GPM	1280.000	19.750		.067
5 L.M.BOILER INLET		1280.000		3.025	
E STEAM TURBINE THROTTLE	2.666	1000.000	3515.000		410.400
7 STEAM REHEAT		1000.000	600.000		
E ST.COND.BACK PRESS.			3.500IN.H	G 1.834	
9 FINAL FEEDWATER		492.000			
10 COND/SG WATER INLET		492.000			
11 COMPRESSOR INLET	4.079	59.000	14.690		
12 GAS TURBINE INLET	4.458	1600.000			103.450
13 GAS ECON.GAS INLET.		0 . 0 0 0		0.000	
14 GAS FWH GAS INLET		865.000		•550	
15 STACK GAS EXHAUST		290.000			
16 AS RECEIVED COAL	218.020T/HR			4.922	

EFETOTENCIES #

* * * *

.....

	POWER OUTPUT(NWE)	-60 GAS THRAT	NE THLET		2001010	
	FURNACE PR.FUR	NACE TEMPERA	TURE (DEG-F)	1500.0 L.M	.SYSTEM	.097
	CCAL	3IT GAS ECONO	MIZER	NO PRE	SSURIZING SUBSYS	STEN .262
	WORKING FLUID	K GAS FEEDW	ATER HEATER	YES STEA	AN CYCLE	.433
	RECUPERATOR EFFECTIVENESS	C.O L.M.CIRCU	LATION RATIO	2.5 1 GR0	SS PLANT	•416
	COMPRESSOR PRESSURE RATIO	15 L.M.FEEDH	EATER	NO NET	PLANT	•406
	AIR EQUIVALENCE RATIO	1.2 STAGES OF	STEAM REHEAT	1 NET	POWER OUTPUT (M)	E) 877-22
		TOTAL FLOW	TEMPERATURE	PRESSURE	THERMAL LOAD	POWER OUTPUT
	**** STATE POINTS ****	10E06 LBM/HR	DEG-F	PSIA	10E09 BTU/HR	MHE
	1 L.M.TURBINE INLET	5.075	1400.000	15.200		129.240
	2 L.H.CONDENSER		1100.000	2.400	4.625	
	3 L.M.FEED PUMP	+837.000 GPM	1100.000	28.930		.210
	4 L.M.RECIRC PUNP	1244 4.000 GPM	1280.000	19.750		.130
,	5 L.M.BOILER INLET		1280.000		4.538	
	6 STEAM TURBINE THROTTLE	3.998	1000.000	3515.000		615.600
	7 STEAM REHEAT		1000.000	600.000		
	& ST.COND.BACK PRESS.			3.500IN	HG 2.751	
	S FINAL FEEDWATER		492.000			
	10 COND/SG WATER INLET		492.000			
	11 COMPRESSOR INLET	6.119	59.000	14.690		
	12 GAS TURBINE INLET	6.687	1600.000			155.180
	13 GAS ECON.GAS INLET,		0.000		0.000	
	14 GAS FWH GAS INLET		865.000		• 826	
	15 STACK GAS EXHAUST		290.000			
	16 AS RECEIVED COAL	327.020T/HR			7.383	

8-150

REPRODUCIDENTY OF THE ORIGINAL TAGE IS POOR

CASE NO. 45

* * * * * * EFFICIENCIES *		Ŧ	Ŧ	¥
----------------------------	--	---	---	---

PO	WER OUTPUT (MWE)	1800 GAS TURBI	NE INLET			
FU	RNACE PR.FUS	NACE TEMPERA	TURE (DEG-F)	1600.0	L.M.SYSTEM	.097
CC	AL	BIT GAS ECONO	HIZER	NO	PRESSURIZING SU	JBSYSTEM
WO	RKING FLUID	K GAS FEEDW	ATER HEATER	YES	STEAN CYCLE	. 433
RE	CUPERATOR EFFECTIVENESS	0.0 L.M.CIRCU	LATION RATIO	2.5 1	GROSS PLANT	•416
00	MPRESSOR PRESSURE RATIO	15 L.M.FEEDH	IEATER	NO	NET PLANT	.406
AI	R EQUIVALENCE RATIO	1.2 STAGES OF	STEAM REHEAT	1	NET POWER OUTPU	JT (MWE) 1462.03
**	** STATE POINTS ****	TOTAL FLOW 10ED5 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMAL LO 10E09 BTU	DAD POWER OUTPUT
. 1	L.M.TURBINE INLET	8.459	1400.000	15.2	0 0	215.400
2	L.H.CONDENSER		1100.000	2•4	00 6.71	LO
3	L.M.FEED PUMP	→637.000 GPM	1100.000	28.9	30	.349
4	L.H.RECIRC PUMP	12444.000 GPM	1280.000	19.7	ĒO	.167
5	L.M.BOILER INLET		1280.000		7.56	53
6	STEAM TURBINE THPOTTLE	6.664	1000.000	3515.0	0.0	1026.000
7	STEAM REHEAT		1000-000	600.0	0 0	
8	ST.COND. EACK PRESS.			3.5	00IN.HG 4.58	5
9	FINAL FEEDWATER		492.000			
16	COND/SG WATER INLET		+92+000			
11	COMPRESSOR INLET	10.198	59.000	14.5	90	
12	GAS TURBINE INLET	11.145	1000.000			258.630
13	GAS ECON.GAS INLET,		0.000		0 • 0 0	10
14	GAS FWH GAS INLET		865.000		1.37	6
15	STACK GAS EXHAUST		290.000			
ie	AS RECEIVED COAL	545.040T/HR			12.30	15

* * * * * * EFFICIENCIES * * * * *

PCHER OUTPUT(MNE) FURNACE COAL MCRKING FLUID RECUPERATOR EFFECTIVENESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI NACE TEMPERA BIT GAS ECONO CS GAS FEEDW 0.0 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER DLATION RATIO EATER STEAM REHEAT	1600.0 NO YC3 2.7 1 NO 1	L.M.SYSTE PRESSURIZ STEAM CYC GROSS PLA NET PLANT NET PONER	EM ZING SUBSYS CLE ANT F R OUTPUT (M)	•136 STEM •256 •433 .452 .441 HE) 1168.92
**** STATE POINTS ****	TOTAL FLOW 10E05 LBM/HR	TEMPERATURE DEG-F	PRESSU	RE THER 10e0	RMAL LOAD 15 BTU/HR	POWER OUTPUT MWE
1 L.H.TURBINE INLET	27.263	1400.000	15.2	20 0		194.11
2 L.M.CONDENSER		1100.000	2.:	+00	5.349	
3 L.M.FEED PUMP	8786.000 GPM	1103.000	56.5	570		1.108
4 L.M.RECIRC PUMP	22707.000 GPM	1280.000	21.1	130		. 400
5 L.H.BOILER INLET		1280.000			6.066	
6 STEAM TURBINE THROTTLE	5.265	1000.000	3515 . 8	30-0		810.64
7 STEAM REHEAT		1000.000	600.0	000		
& ST.COND.BACK PRESS.			3.5	500IN.HG	3.623	
9 FINAL FEEDWATER		492.000				
10 COND/SG WATER INLET		+92.000				
11 COMPRESSOR INLET	8.378	59.000	14.0	590		
12 GAS TURBINE INLET	9.130	1000.000				195.25
13 GAS ECON.GAS INLET,		0.000			0.000	
14 GAS FWH GAS INLET		852.000			1.040	
15 STACK GAS EXHAUST		Sa0*000				
16 AS RECEIVED COAL	419.395T/HR				9.048	

+ + + + + + EFFICIENCIES + + + + +

POWER OUTPUT(MWE)		INE INLET			
FURNACE PR. FUI	RNACE TEMPERA	ATURE (DEG-F)	1600.0	L.M.SYSTEM	.106
COAL	BIT GAS ECONO	DMIZER	NO	PRESSURIZING SUBSYS	STEM .256
WCRKING FLUID	CS GAS FEED	ATER HEATER	YES	STEAM CYCLE	• 433
RECUPERATOR EFFECTIVENESS	J.O L.M.CIRCU	JLATION RATIO	2.5 1	GROSS PLANT	.452
COMPRESSOR PRESSURE RATIO	15 L.M.FEEDH	HEATER	NO	NET PLANT	.441
AIR EQUIVALENCE RATIO	1.2 STAGES OF	F STEAM REHEAT	1	NET POWER OUTPUT (MI	NE) 584.47
**** STATE POINTS ****	TOTAL FLOW 10E06 LBM/HR	TEMPERATURE DEG-F	PRESSURE PSIA	THERMAL LOAD 10E09 BTU/HR	POWER OUTPUT
1 L.M.TURBINE INLET	13.632	1400.000	15.20	10	97.06
2 L.M.CONDENSER		1100.000	2.40	2.674	
3 L.M.FEED PUHP	8786.000 GPM	1100.000	56.57	0	. 554
4 L.M.RECIRC PUMP	22707.000 GPM	1280.000	21.13	30	.200
5 L.H.BOILER INLET		1280.000		3.033	
E STEAM TURBINE THROTTLE	2.633	1000-000	3515.00	0	420.790
7 STEAM REHEAT		1000.000	600.00	0	
& ST.COND.BACK PRESS.			3.50	DIN.HG 1.812	
9 FINAL FEEDWATER		492.000			
10 COND/SG WATER INLET		492.000			
11 COMPRESSOR INLET	4.189	59.000	14.69	0	
12 GAS TURBINE INLET	4.551	1600.000			97.63
13 GAS ECON.GAS INLET,		0.000		0.000	
14 GAS FWH GAS INLET		852.000		.520	
15 STACK GAS EXHAUST		290.000			
16 AS RECEIVED COAL	209.70T/HR			4.524	

CASE	NO.	48
------	-----	----

					* * * * *	<pre>* * EFFICIE</pre>	NCIES + + + + +
PCWER OUTPUT FURNACE CCAL WORKING FLUI RECUPERATOR CGMPRESSOR P AIR EQUIVALE	(MWE) 12 PR.FURNA D EFFECTIVENESS D RESSURE RATIO NGE RATIO 1	S0GAS TURBICETEMPERAITGAS ECONOCSGAS FEEDW.0L.M.CIRCU15L.M.FEEDH.2STAGES OF	NE INLET TURE (DEG-F) MIZER ATEF HEATER LATION RATIO EATER STEAM REHEAT	1600.0 NO YES 2.8 1 NO 1	L.M.SYSTE PRESSURI STEAM CYC GROSS PLAN NET PLAN NET POWE	EM ZING SUBSYS CLE ANT T R OUTPUT (M)	•136 •256 •433 .452 .441 HE) 1~61•15
**** STATE P	OINTS ****	TOTAL FLOW 10EJ6 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THE 10E	RMAL LOAD 09.btu/hr	POWER OUTPUT MWE
1 L.H.TURBI	NE INLET	34.080	1400-000	15.2	20 0		242.640
2 L.M.CONDE	NSER		1100.000	2.4	0 0	6.686	
3 L.H.FEED	PUNP	8786.000 GPM	1100-000	56.5	70		1.385
4 L.M.RECIR	C PUMP	22707.000 GPM	1280.000	21.1	.30		.500
5 L.M.BOILE	RINLET		1280.000			7.583	
E STEAM TUR	BINE THROTTLE	6.581	1000.000	3515.0	00		1013.300
7 STEAM REH	EAT		1008.000	600.0	00		
& ST.COND.8	ACK PRESS.			. 3.5	ODIN.HG	4.529	
9 FINAL FEE	DWATER		492.000				
10 COND/SG W	ATER INLET		492.000				
11 COMPRESSO	RINLET	10.473	59.000	14.6	90		
12 GAS TURBI	NE INLET	11.379	1600.000				244.060
13 GAS ECON.	GAS INLET,		0.000			0.000	
14 GAS FWH G	AS INLET		852.000			1.301	
15 STACK GAS	EXHAUST		290.000				
16 AS RECEIVE	ED COAL	524.250T/HR				11.311	

			CASE NO. 49		+ + + + + + E	FFICIENCIES *	* * * *
	PCHER OUTPUT(4WE) FURNACE PR.FLD CCAL MCRKING FLUID RECUPERATOR EFFECTIVE AESS COMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI D.BED TEMPEKA BIT GAS ECONO K GAS FEEDW D.O L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATICN RATIO EATER STEAM REHEAT	1600.0 NO YES 2.5 1 NO 1	L.M.SYSTEM PRESSURIZING S STEAM CYCLE GROSS PLANT NET PLANT NET POWER GUTH	SUBSYSTEM PUT (MWE)	.097 .256 .433 .446 .435 1169.61
	.**** STATE POINTS ****	TOTAL FLOW 10ED6 LBM/HR	TEMPERATURE DEG-F	PRESSURE PSIA	THERMAL I 10E09 bt	LOAD POWER I Uzhr Mni	OUTPUT
	1 L.H.TURBINE INLET	6.883	1400.000	15.20	0	17!	5.270
	2 L.M.CONDENSER		1100-000	2.40	0 5.	÷60	
	3 L.M.FEED PUMP	+920.000 GPM	1100.000	29.85	0		•294
	4 L.H.RECIRC PUMP	12657.000 GPM	1280.000	19.91	0		•141
ŝ	5 L+M-BOILER INLET		1280.000		6.3	154	
155	6 STEAM TURBINE THROTTLE	5.369	1000.000	3515.00	0	821	6.660
	7 STEAN REHEAT		1000.000	600.00	0		
	& ST.COND.BACK PRESS.			3.50	OIN.HG 3.0	594	
	5 FINAL FEEDWATER		492.000				
	10 COND/SG WATER INLET		-92.000				
	11 COMPRESSOR INLET	8.500	59.000	14.69	0		
	12 GAS TURBINE INLET	9.263	1600.000			19/	8.100
	13 GAS ECON.GAS INLET,		0.000		0.(000	
	14 GAS FWH GAS INLET		852.000		1.	055	
	15 STACK GAS EXHAUST		290.000				
	16 AS RECEIVED COAL	425.500T/HR			9.:	181	

* * * * * * EFFICIENCIES * * * * *

	POWER OUTPUT(MWE) FURNACE PR.FUE COAL WORKING FLUID RECUPERATOR EFFECTIVENESS CCMPRESSOR PRESSURE RATIO AIR EQUIVALENCE RATIO	1200 GAS TURBI ENACE TEMPERA BIT GAS ECONO K GAS FEEDW 0.0 L.M.CIRCU 15 L.M.FEEDH 1.2 STAGES OF	NE INLET TURE (DEG-F) MIZER ATER HEATER LATION RATIO EATER STEAM REHEAT	1600.0 NO YES 2.7 1 NO 1	L.M.SYSTEM PRESSURIZIN STEAM CYCLE GROSS PLANT NET PLANT NET POWER O	G SUBSYST	.097 IEM .263 .433 .416 .406 .1169.63
	**** STATE POINTS ****	TOTAL FLOW 10EJ6 LBM/HR	TEMPERATURE DEG-F	PRESSUR PSIA	E THERMA 10E09	L LOAD BTU/HR	POWER OUTPUT MWE
	1 L.M. TURBINE INLET	6.767	1400.000	15.2	0.0		172.320
	2 L.M.CONDENSER		1100.000	2.4	0 0	5.368	
	3 L.M.FEED PUMP	+837.000 GPM	1103.000	28.9	30		.279
	4 L.M.RECIRC PUMP	12444.000 GPM	1280.000	19.7	50		•133
8	5 L.M.BOILER INLET		1280.000			6.050	
-156	E STEAH TURBINE THROTTLE	5.331	1000.000	3515.0	0 0		820.800
	7 STEAM REHEAT		1000.000	600.0	06		
	& ST.COND.BACK PRESS.			3.5	90IN.HG	3.668	
	S FINAL FEEDWATER		492.000				
	10 COND/SG WATER INLET		492 • 00 0				
	11 COMPRESSOR INLET	8.158	59.000	14.6	90		
	12 GAS TURBINE INLET	8.916	1600.000				206.900
	13 GAS ECON.GAS INLET,		0+000			0.000	
	14 GAS FWH GAS INLET		865.000			1.101	
	15 STACK GAS EXHAUST		290.000				
	16 AS RECEIVED CCAL	436.030T/HR				9.844	

Appendix A 8.2

LIQUID-METAL RANKINE TOPPING CYCLE PARAMETRIC POINTS SUMMARY SHEETS

Table A 8.2.1

RANKINE METAL VAPOR TOPPING-STEAM CYCLE SUMMARY PLANT RESULTS

PARAMETRIC POINT THERMODYNAMIC EFF OVER PLANT EFF OVERALL ENERGY EFF CAP COST MILLION \$ CAPITAL COST.\$/KWE COE CAPITAL COE FUEL COE FUEL COE OP & MAIN COST OF ELECTRIC EST TIME OF CONST	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
PARAMETRIC POINT THERMODYNAMIC EFF POWER PLANT EFF OVERALL ENERGY EFF CAPICAL COST.S/KWE COE CAPITAL COE FUEL COE OP & MAIN COST OF ELECTRIC EST TIME OF CONST	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
PARAMETRIC POINT THERMODYNAMIC EFF POWER PLANT EFF CAP COST MILLION \$ CAPITAL COST.\$/KWE COE CAPITAL COE CAPITAL COE OP 3 MAIN COST OF ELECTRIC EST TIME OF CONST	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	23 24 • CC0 • CC0 • 360 • 360 781 • 671 823 • 214 689 • 465 726 • C89 21. 776 22 • 953 8 • 059 1 • 859 1 • 859 1 • 853 31. 713 32 • 871 6 • 500 5 • 500
PARAMETRIC POINT THERMODYNAMIC EFF POWER PLANT EFF OVER PLANT EFF CAP COST MILLION \$ CAPITAL COST • \$/KWE COE CAPITAL COE CAPITAL COE FUEL COE OP 8 MAIN COST OF ELECTRIC EST TIME OF CONST	25 26 • 000 • 000 • 365 • 373 799• 054 955• 857 704• 339 753• 484 22•266 23• 819 7•949 7• 778 1• 841 1• 812 32• 055 33• 410 5• 500 6• 500	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	29 30 -000 000 -383 353 835 424 772 847 788 096 682 438 24 913 21 573 7.575 8 219 1.778 1.882 34 2267 31 874 6.500 6.500	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
PARAMETRIC POINT THE RMODYNAMIC EFF POWER PLANT EFF CAP COST MILLION S CAPITAL COST.STAKE COE CAPITAL COE CAPITAL COE OP & MAIN COE OP & MAIN COST OF ELECTRIC EST TIME DF CONST.	33 34 . CCC . CDO 362 368 362 368 783.820 917.674 691.168 720.565 21.849.22.779 8.014 7.886 1.849 1.828 31.712 32.493 6.500 6.500	$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	37 38 -CDC -CDD -336 -366 -336 -366 -336 767 -740 725 -225 673 957 -22 -925 21 -305 -22 -925 21 -305 -22 -925 21 -305 -33 -442 31 -010 -6 -500	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

REPRODUCTION OF THE ORIGINAL PLON IS POOR

Table A 8,2.1 Continued

RANKINE METAL VAPOR TOPPING-STEAM CYCLE SUNMARY PLANT RESULTS

PARANETRIC POINT THERMODYNAMIC EFF Poyer plant eff	41 000 423	42 • 800 • 423	43 •000 •398	44 •000 •398	45 •000 •398	46 • 000 • 429	47 .000 .429	₹8 •CCD •₹29
 OVERALL ENERGY EFF CAP COST MILLION \$ CAPITAL COST.\$/KWE COE CAPITAL	\$73.661 571.515 21.228	423 965.793 678.296 21.442	443.079 772.283 24.414	•400 554•3631 760•438 24•039	460 105-025 771-160 24-378	429 923-205 722-150 22-829	429 421.3211 739.208 23.368	•429 044 • 248 732 • 816 23 • 166
COE FUEL COE OP & MAIN COST OF ELECTRIC EST TIME OF CONST	6.852 1.678 29.758 6.181	5.852 1.678 29.972 5.759	7.293 1.800 33.506 5.757	7.293 1.800 33.132 6.181	7.293 1.800 33.471 6.759	6.756 1.661 31.246 6.500	6.756 1.661 31.785 5.757	6.756 1.661 31.583 6.753
PARAMETRIC POINT	49	50	5	52	53	54	55	56
THERNODYNAMIC EFF Power plant EFF Overall energy EFF CAP COST Million \$	000 424 760 293	-000 -398 -400 892-804	000- 000- 000- 000-	000 000 000 000	000 000 000 000	000 000 000 000	000 000 000 000	000 000 000 000
CAPITAL COST.S/KWE COE CAPITAL COE FUEL COE OP 8 MAIN	666.942 21.084 6.847 1.672	769.360 24.321 7.293 1.800	000 000 000 000	000 000 000 000	000 000 000 000	000 000 000 000	000 000 000 000	000 000 000 000
EST TIME OF CONST	29.60Z 6.500	33.413	.000	-000 -000	.000	.000	000	-000 -000

Table A 8.2.2

RANKINE METAL VAPOR TOPPING-STEAM CYCLE SUMMARY PLANT RESULTS

and the second	• • • • • •	··· • ••				· · · · · · · · · · · ·		• • • • • • • •
PARAMETRIC POINT	1	2	3	4	5	6	7	8
TOTAL CAPITAL COST .MS	776.68	721.36	741.96	926.07	872.11	881.71	790.66	811.15
P LIG MET VAPOR GENERATORS MS	53.548	53.504	57+344	17-600	17-600	17-600	59-648	62 • 208
A STEAM TURB-GEN & FEED STG INS	21.200	21.160	21-116	21.200	21 200	21-200	21-235	21 -235
N MET VAP COND-STEAM GEN MS	9.340	27-053	8.860	25-140	9.340	9.340	9.34 <u>0</u> 27.183	9-340
GAS TURB PUMPUP-REC-PIPING MS	37.600	37.160	38.560	36.400	36.120	35.800	36 800	36.800
LIG MÉT AUX ELEC EQUIP. •N\$	2.750	2.750	2.750	2-750	2.750	2-750	2.750	2.750
R TOT HAJOR COMPONENT COST .HS	181.716	174.597	179.072	137.338	137.058	136.738	180.956	183-516
E TOT HAJOR COMPONENT COST S/KWE	160.303	151-849	156-742	120-010	117-655	117-601	159-564	161 • 822
U SITE LABOR +\$/KWE	86 652	77.398	80-392	104.470	94 797	96.202	38-275	20.731
L TOTAL DIRECT COST \$/KWE	324.547	298-276	308.650	382.727	354-882	359.379	330 488	338-960
PROF & OWNER COSTS +S/KWE	25.964	23 862	29-692	30-618	28 391	28 750	26 439	27.117
R ESCALATION COST •\$7KWE	117,152	107.354	111.130	138.474	128 108	125.760	119.301	122 394
E INT DURING CONSTRUCTION . S/KWE	141-939	130.068	134-643	167.772	155-213	157-215	144-543	148 290
K COST OF ELEC-CAPITAL MILLS/KWE	21.643	19.833	20.530	25.582	23.657	23.972	22.040	22.611
D COST OF ELEC-FUEL MILLS/KWE	8.081	8.095	8.325	8.334	7.905	7-817	7 973	7 . 973
W TOTAL COST OF ELEC MILLS/KNE	31.586	28.858	29.823	35.879	32 552	32.786	31.859	32-430
N COE D.5 CAP. FACTOR .MILLS/KWE	$-\frac{38.191}{77.458}$	34-919		43-665	39.764	- <u>40-069</u>	38-582	39-325
COE 1.2XCAP. COST INILLS/KWE	35.915	32.824	33.929	40.995	37.286	37.581	35.267	36-953
COE 1.2XFUEL COST MILLS/KWE	33-203	30.477	31+488	37.546	34-134	34 350	33-454	34.025
COE (ESCALATION=D) MILLS/KWE	27.058	24.708	25.527	30.526	27.600	27.770	27.247	27 699
3 1 1								
50 0							-	
PARAMETRIC POINT	9	10	11	12	13	14	15	16
TOTAL CAPITAL COST	944.61	959.52	767.41	917.65	730,10	869.67	752.69	900-68
L LIG HET TURBINE	24.000	24.000	24.000	24.000	24 000	24.000	24.000	24.000
A STEAM TURB-GEN & FEED STG INS	21.210	21-210	21-200	21-200	26.180	26 000	26 405	26 285
T LIQ NET CIRC & PROCESS SYS INS	26.153	26 158	23 320	22.300	26.163	25.143	26.433	25.408
GAS TURB PUMPUP-REC-PIPING .HS	35.120	36-120	37.600	35.400	32.400	32.800	39.900	39.380
LIG HET AUX ELEC EQUIP (HS	2.150	2.150	2.750	2.730	2.150	2 . 7 50	2.150	2.150
R TOT MAJOR COMPONENT COST +MS	137.173	137.178	177_250	177.500	171 000	177 677	197.177	148.467
	TTO BAS	110 011	155 999	115 725	111.003	110 005	100 000	125 001
S BALANCE OF PLANT COST +\$/KWE	119.845 164.261	119.841 168.962	156.899 77.593	116.734 158.243	150.599 71.915	119.805	160.988 71.892	125.891
S BALANCE OF PLANT COST \$/KWE U SITE LABOR \$/KWE TOTAL OTPECT COST \$/KWE	119.846 164.261 106.315 390.422	119.841 168.962 107.821 396.624	156-899 77-593 86-204 320-695	116.734 158.243 104.041 379.018	150.599 71.915 80.903	119.805 141.640 96.935	160.988 71.892 84.926	125 891 144 662 100 862
S BALANCE OF PLANT COST \$5/KWE U SITE LABOR L TOTAL DIRECT COST \$5/KWE I INDIRECT COST \$5/KWE S/KWE	119.845 164.261 106.315 390.422 54.221	119.841 168.962 107.821 396.624 54.989	156.899 77.593 86.204 320.696 43.964	116.734 158.243 104.041 379.018 53.061	171.803 150.599 71.915 80.903 303.417 41.261	119-805 141-640 96-935 358-380 49-437	160.988 71.892 89.926 317.807 43.312	125.891 144.662 100.362 371.415 51.440
S BALANCE OF PLANT COST \$/KWE U SITE LABOR L TOTAL DIRECT COST \$/KWE I INDIRECT COSTS \$/KWE PROF & OWNER COSTS \$/KWE B CONTINGENCY COST \$/KWE	119.846 164.261 106.315 390.422 54.221 31.234 37.090	119.841 168.962 107.821 396.624 54.989 31.730 37.679	156-899 77-593 86-204 320-696 43-964 25-6556	116.734 158.243 104.041 379.018 53.061 30.321 36.007	171.803 150.599 71.915 80.903 303.417 41.261 24.273 28.825	119-805 141-640 96-935 358-380 49-437 28-670	160 988 71 892 84 926 317 807 43 312 25 425 30 192	125.891 144.662 100.862 371.415 51.440 29.713 35.280
S BALANCE OF PLANT COST \$/KWE U SITE LABOR \$/KWE L TOTAL DIRECT COST \$/KWE I INDIRECT COSTS \$/KWE PROF & OWNER COSTS \$/KWE B CONTINGENCY COST \$/KWE R ESCALATION COST \$/KWE	119.846 164.261 106.315 390.422 54.221 31.234 37.090 141.222	119.841 163.962 107.821 396.624 54.983 31.730 37.679 143.439	156-899 77-593 86-204 320-696 43-964 25-656 30-466 115-843	116.734 158.243 104.041 379.018 53.061 30.321 36.007 137.214	171.003 150.599 71.915 80.903 303.417 41.261 24.273 28.825 109.509	119.805 141.640 96.935 358.380 49.437 28.670 34.046 129.540	160-988 71-892 84-926 317-807 43-312 25-425 30-192 114-729	125.891 144.662 100.862 371.415 51.440 29.713 35.284 134.308
S BALANCE OF PLANT COST \$/KWE U SITE LABOR \$/KWE I TOTAL DIRECT COST \$/KWE PROF & OWNER COSTS \$/KWE B CONTINGENCY COST \$/KWE R ESCALATION COST \$/KWE I TOTAL COPTATION \$/KWE COPTATION COST \$/KWE S/KWE	119-846 164-261 106-315 390-422 54-221 31-234 37-C90 141-222 171-102 825-290	119.841 168.962 107.821 396.624 54.589 31.730 37.679 143.439 173.789 838.250	156-899 77-593 86-204 320-696 43-964 25-656 30-466 115-843 140-353 140-977	116.734 158.243 104.041 379.018 53.061 30.321 36.007 137.214 166.245 801.855	150.599 71.915 80.903 303.417 41.261 24.273 28.825 109.509 132.679	119-805 141-640 96-9350 358-380 49-437 28-670 34-046 129-540 156-948 757-021	160-988 71-892 89-926 317-807 43-312 25-425 30-192 114-729 139-003	125.891 144.662 100.362 371.415 29.713 35.284 134.308 162.725
S BALANCE OF PLANT COST *5/KWE U SITE LABOR *5/KWE L TOTAL DIRECT COST *5/KWE PROF & OWNER COSTS *5/KWE B CONTINGENCY COST *5/KWE R ESCALATION COST *5/KWE A TOTAL CAPITALIZATION *5/KWE K COST OF ELEC-CAPITAL*MILLS/KWE	119-846 164-261 106-315 390-422 54-221 31-234 37-090 141-222 171-1022 825-290 26-089	119.841 168.962 107.821 396.624 54.989 31.730 37.679 143.439 173.789 838.250 26.499	156-899 77-593 86-204 320-696 43-964 25-656 30-466 115-843 140-353 140-353 676-977 21-401	116.734 158.243 104.041 379.018 53.061 30.321 36.007 137.214 166.245 801.856 25.349	150.599 71.915 80.903 303.417 41.261 24.273 28.825 109.509 132.679 639.964 639.964 20.231	119-8805 141-640 996-935 358-380 99-4870 39-4870 39-4870 39-6460 129-540 156-9481 156-9481 723-931	160 988 71.892 817.892 317.807 43.312 25.425 30.492 114.729 139.403 670.467 21.195	125.891 144.662 100.662 371.415 51.440 29.713 134.308 162.725 784.885 24.885 24.8812
S BALANCE OF PLANT COST * \$/KWE U SITE LABOR * \$/KWE L TOTAL DIRECT COST *\$/KWE PROF & OWNER COSTS *\$/KWE B CONTINGENCY COST *\$/KWE R ESCALATION COST *\$/KWE E INT DURING CONSTRUCTION *\$/KWE A TOTAL CAPITALIZATION *\$/KWE D COST OF ELEC-CAPITAL *MILLS/KWE D COST OF ELEC-FUEL *MILLS/KWE O COST OF ELEC-FUEL *MILLS/KWE	II9-846 164-261 IUE-315 390-422 54-221 31-234 37-C90 141-222 I71-102 825-290 26-269 8-26-2694 1-953	119.841 163.962 107.821 396.624 31.730 37.679 143.439 173.789 838.250 26.499 838.250 26.499 838.251	156-899 77-593 86-204 320-696 43-964 25-656 115-843 140-353 576-977 21-401 8-863	115-734 158-243 104-041 379-018 53-061 30-321 137-214 166-245 801-245 801-866 25-3399 8-3399 8-3399	$\begin{array}{c} 171 & 60393\\ 71 & 9153\\ 80 & 903\\ 303 & 417\\ 41 & 261\\ 24 & 273\\ 28 & 825\\ 109 & 509\\ 132 & 679\\ 639 & 509\\ 639 & 964\\ 20 & 231\\ 6687\\ 1 & 6687\\ \end{array}$	119-805 141-640 96-935 358-380 49-437 28-670 34-670 129-540 156-948 757-021 23-931 757-1770	160 988 71.892 89.926 317.807 43.312 25.425 30.192 114.729 139.403 670.467 21.195 7.744	125.891 144.662 100.662 371.415 51.440 29.713 35.284 134.308 162.725 784.885 24.812 _7.509 1.885
S BALANCE OF PLANT COST * \$/KWE U SITE LABOR * \$/KWE T TOTAL DIRECT COST *\$/KWE PROF & OWNER COSTS *\$/KWE B CONTINGENCY COST *\$/KWE R ESCALATION COST *\$/KWE A TOTAL CAPITALIZATION *\$/KWE A TOTAL CAPITALIZATION *\$/KWE D COST OF ELEC-EVEL *MILLS/KWE O COST OF ELEC-EVEL *MILLS/KWE W TOTAL COST OF ELEC-EVEL *MILLS/KWE	119.846 164.261 106.315 390.422 54.221 31.234 37.090 141.222 171.102 825.290 26.089 8.264 8.264 1.953 36.306	119.841 168.962 107.825 396.624 54.983 37.679 143.439 173.789 838.250 26.499 838.251 1.945 8.241 1.945 35.689	156-839 77-593 86-204 320-696 43-964 25-656 30-465 30-465 30-465 30-465 30-465 30-465 30-465 31-803 31-345	$\begin{array}{c} 116 & 734 \\ 158 & 243 \\ 108 & 091 \\ 379 & 018 \\ 53 & 061 \\ 36 & 027 \\ 137 & 214 \\ 166 & 275 \\ 801 & 860 \\ 28 & 338 \\ 1.963 \\ 35 & 646 \end{array}$	$\begin{array}{c} 1 & 1 & 0 & 0 \\ 1 & 5 & 0 & 5 & 3 \\ 1 & 5 & 0 & 5 & 0 \\ 3 & 0 & 3 & 0 & 3 & 0 \\ 3 & 0 & 3 & 0 & 3 & 4 & 1 \\ 2 & 0 & 0 & 0 & 0 & 3 \\ 3 & 0 & 3 & 0 & 3 & 0 \\ 1 & 2 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 &$	139.805 141.640 96.935 358.380 45.437 28.670 134.640 95.437 28.670 149.540 156.948 757.021 23.931 7.7130 1.770 32.831	160 • 988 71 • 8926 317 • 8072 25 • 425 30 • 192 1149 • 0037 670 • 467 21 • 195 7 • 303 670 • 472 25 • 422 670 • 472 25 • 422 670 • 472 7 • 303 7 • 304 3 · 305 7 • 304 7 • 304 7 • 305 7 • 3	125.891 144.662 100.862 371.415 29.713 35.284 162.725 784.885 24.812 7.509 34.151
S BALANCE OF PLANT COST *5/KWE U SITE LABOR *5/KWE T INDIRECT COST *5/KWE PROF & OWNER COSTS *5/KWE B CONTINGENCY COST *5/KWE R ESCALATION COST *5/KWE A TOTAL CAPITALIZATION *5/KWE COST OF ELEC-CAPITAL *1LLS/KWE D COST OF ELEC-FUEL *MILLS/KWE O COST OF ELEC-FUEL *MILLS/KWE W TOTAL COST OF ELEC-FUEL *MILLS/KWE W TOTAL COST OF ELEC-FUEL *MILLS/KWE N COE D.5 CAP. FACTOR *MILLS/KWE	119.846 164.261 166.315 390.4222 54.221 31.234 31.234 141.222 171.102 26.089 8.264 36.306 1.632 36.306 31.3400 31.3400 31.3400 31.3400 31.3400 31.3400 31.3400 31.3400 31.3400 31.3400 31.3400	119.841 163.962 167.821 396.624 54.6283 31.730 37.679 143.879 143.8250 26.499 8.249 36.689 36.689 44.750 31.646	156-839 77-593 86-204 320-696 43-964 25-6556 30-466 115-843 140-353 676-977 21-401 8-081 31-345 31-345 37-876 27-257	116-734 158-243 104-041 379-018 53-061 30-321 36-007 137-214 136-225 801-856 801-856 801-856 80334 25-349 8-334 35-546 433-546 30-818	111-005 150-593 71-915 80-905 303-417 41-261 24-273 28-825 109-5679 539-964 20-231 6-677 1.647 28-554 34-735 24-686	19.805 141.640 96.935 358.388.38670 34.046 129.540 156.948 757.021 23.931 7.130 32.831 32.831 32.831 32.831 23.2331 32.831 32.831 32.831 32.831 32.831 32.831	160 - 328 71 - 892 84 - 92 317 - 807 43 - 312 25 - 425 30 - 192 114 - 72 139 - 003 670 - 467 21 - 193 - 7 - 303 - 303 - 7 - 303 - 305 - 30	125.891 144.662 100.862 371.415 29.713 35.284 162.725 784.885 24.812 1.830 1.830 34.151 41.705 29.24
S BALANCE OF PLANT COST *5/KWE U SITE LABOR *5/KWE T INDIRECT COST *5/KWE PROF & OWNER COSTS *5/KWE B CONTINGENCY COST *5/KWE E INT DURING CONSTRUCTION *5/KWE A TOTAL CAPITALIZATION *5/KWE COST OF ELEC-CAPITAL *11LS/KWE D COST OF ELEC-FUEL *MILLS/KWE O COST OF ELEC-FUEL *MILLS/KWE W TOTAL COST OF ELEC * MILLS/KWE COE 0.5 CAP. FACTOR *MILLS/KWE COE 0.5 CAP. FACTOR *MILLS/KWE	$\begin{array}{c} \textbf{I19.846}\\ \textbf{I64.261}\\ \textbf{I06.315}\\ \textbf{390.425}\\ \textbf{390.425}\\ \textbf{370.345}\\ \textbf{370.345}\\ \textbf{370.345}\\ \textbf{370.345}\\ \textbf{370.345}\\ \textbf{370.345}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.234}\\ \textbf{371.345}\\ \textbf{371.345}\\ \textbf{371.345}\\ \textbf{371.345}\\ \textbf{371.345}\\ \textbf{371.524}\\ \textbf{371.524}\\$	119.841 168.962 17.7.821 396.6243 31.730 37.679 143.479 173.789 838.250 26.499 8.249 35.689 44.750 44.750 41.989	156-839 77-593 86-204 320-696 43-964 25-656 115-843 115-843 1140-353 676-977 21-401 1-8623 31-345 37-876 37-876 27-257 35-625	116-734 158-243 158-243 104-04 30-321 379-018 53-061 30-321 36-007 137-214 136-2245 801-866 25-339 8-339 1965 25-339 35-646 433-354 35-646 430-716	$\begin{array}{c} 111 \\ 150 \\ 503 \\ 71 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 80 \\ 915 \\ 915 \\ 80 \\ 915 \\ $	19.805 141.640 96.935 358.380 49.437 28.670 34.046 129.540 126.948 757.021 156.948 757.021 156.948 757.021 1.770 1.770 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.2.831 4.726 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7276 3.7277777777777777777777777777777777777	160 - 328 71 - 892 84 - 922 317 - 807 43 - 312 25 - 425 30 - 1292 114 - 703 670 - 467 7 - 303 1 - 74 1 - 74 21	125.891 144.662 100.862 371.415 29.713 35.284 162.725 784.885 24.812 1.835 1.851 41.705 34.151 41.705 39.424 39.413
S BALANCE OF PLANT COST *5/KWE U SITE LABOR *5/KWE T INDIRECT COST *5/KWE PROF & OWNER COSTS *5/KWE B CONTINGENCY COST *5/KWE E INT DURING CONSTRUCTION *5/KWE A TOTAL CAPITALIZATION *5/KWE COST OF ELEC-CAPITAL *1LLS/KWE COST OF ELEC-FUEL *MILLS/KWE O COST OF ELEC-FUEL *MILLS/KWE COF 0.5 CAP. FACTOR *MILLS/KWE COF 0.8 CAP. FACTOR *MILLS/KWE COF 1.2XFUEL COST *MILLS/KWE	$\begin{array}{c} \textbf{I19.846}\\ \textbf{I64.261}\\ \textbf{I64.261}\\ \textbf{I06.315}\\ \textbf{390.4221}\\ \textbf{370.345}\\ \textbf{370.340}\\ \textbf{1271.222}\\ \textbf{37.290}\\ \textbf{141.222}\\ \textbf{825.290}\\ \textbf{26.089}\\ \textbf{825.290}\\ \textbf{8.254.331}\\ \textbf{36.254.331}\\ \textbf{36.254.331}\\ \textbf{37.554.331}\\ \textbf{37.555.331}\\ 37.555.$	119.841 169.8421 169.9621 199.8621 199.8621 199.8625 199.87 199.77 199.77 199.77 199.77 199.77 199.77 199.7	156-839 77-593 86-204 320-696 43-964 25-656 30-4666 115-843 15-843 15-843 15-843 1-863 1-863 31-353 31-355 37-876 35-625 32-961 29-795	116-734 158-243 158-243 104-048 53-061 30-321 36-007 137-214 136-2245 801-8566 25-339 25-339 1-965 25-339 1-965 25-339 1-965 31-965 33-845 40-716 33-815	$\begin{array}{c} 111 \\ 150 \\ 503 \\ 71 \\ 915 \\ 80 \\ 905 \\ 303 \\ 303 \\ 41 \\ 74 \\ 126 \\ 129 \\ 539 \\ 825 \\ 109 \\ 539 \\ 964 \\ 20 \\ 231 \\ 6.677 \\ 1.647 \\ 1.647 \\ 1.647 \\ 1.647 \\ 1.647 \\ 28 \\ 554 \\ 34 \\ .556 \\ 24 \\ .5600 \\ 29 \\ .800 \\ 27 \\ .084 \end{array}$	19.805 141.640 96.935 358.380 49.437 28.670 34.046 12.9.540 156.948 757.021 156.948 757.021 156.948 757.021 1.770 1.770 3.2.831 4.046 3.7.617 34.257 31.099	160 - 328 71 - 892 84 - 926 317 - 807 43 - 312 25 - 425 30 - 129 114 - 705 30 - 129 114 - 705 30 - 129 139 - 003 670 - 467 21 - 129 670 - 467 21 - 129 670 - 467 21 - 129 670 - 467 21 - 129 30	125.891 144.662 371.415 51.415 29.713 152.725 29.713 153.725 24.812 754.835 24.812 754.835 24.812 754.835 24.812 754.835 24.812 755.835 24.855 24.855 24.8555

alle alle

Table A 8.2.2 Continued

RANKINE METAL VAPOR TOPPING-STEAM CYCLE SUMMARY PLANT RESULTS

PARAMETRIC POINT	17 18	19 20	21	22	23	24
TOTAL CAPITAL COST *** P LIG MET VAPOR GENERATORS *** L LIG MET TURBINE *** A STEAM TURB-GEN & FEED STG *** N MET VAP CONP-STEAM GEN *** 1 LIG MET CIRC & PROCESS SYS *** GAS TURB PUMPUP-REC-PIPING *** LIG MET AUX ELEC EQUIP ***	859.55 32.432 24.000 24.000 24.000 21.130 21.130 21.130 21.190 9.3400 9.3400 9.3400 9.3400 9.3400 9.3400 9.3400 9.34000000000000000000000000000000000000	915.66 1178.92 63.488 36.016 24.000 12.000 20.890 20.405 7.320 4.160 26.023 25.088 68.860 110.400 2.750 2.750	775 • 14 - 60 • 544 - 24 • 000 21 • 310 16 • 000 27 • 60 8 34 • 240 2 • 750	784 •57 62 • 336 24 • 000 21 • 260 • 620 27 • 448 35 • 600 2 • 750	781.67 61.184 24.000 21.200 9.340 27.448 37.600 2.750	823-21 72-192 24-000 1-290 9-340 29-348 37-200 2-750
R TOT MAJOR COMPONENT COST *** E TOT MAJOR COMPONENT COST **** S BALANCE OF PLANT COST ***** U SITE LABOR **** L TGTAL DIRECT COST ***** PROF & OWMER COST ***** B CONTINGENCY COST ***** E INT DURING CONSTRUCTION ***** A TOTAL CAPITALIZATION ***** K COST OF ELEC-CAPITAL ****** O COST OF ELEC-CAPITAL ****** O COST OF ELEC-CAPITAL ********* U TOTAL CAPITALIZATION ****** COE 0.************************************	$\begin{array}{c} 202.780 & 183.148 \\ 179.835 & 161.751 \\ 60.444 & 78.213 \\ 99.592 & 89.172 \\ 359.972 & 329.136 \\ 50.843 & 45.778 \\ 28.798 & 26.331 \\ 134.197 & 31.258 \\ 130.442 & 118.990 \\ 158.041 & 144.166 \\ 762.252 & 695.367 \\ 24.093 & 21.982 \\ 2.034 & 1.904 \\ 35.320 & 32.240 \\ 42.660 & 38.946 \\ 35.320 & 32.240 \\ 42.660 & 38.946 \\ 35.320 & 32.240 \\ 35.320 & 32.240 \\ 35.320 & 32.240 \\ 35.320 & 32.240 \\ 35.320 & 32.240 \\ 35.320 & 32.240 \\ 35.320 & 32.340 \\ 35.320 & 32.340 \\ 35.320 & 35.320 \\ 35.320 & 35.$	$\begin{array}{c} 213,271,260,819\\ 194,031,249,137\\ 96,833,132,697\\ 109,468,149,134\\ 395,332,530,968\\ 53,279,76,058\\ 31,627,42,477\\ 37,557,50,442\\ 142,551,192,698\\ 172,712,233,469\\ 833,057,1126,112\\ 26,335,35,599\\ 14,939,26,182\\ 2,916,4,546\\ 52,201,77,216\\ 39,177,59,675\\ 49,457,73,545\\ 47,177,71,661\\ 42,280,63,257\\ 38,679,58,276\\ \end{array}$	180.452 158.940 77.462 86.995 323.398 44.368 25.872 30.723 116.828 14.547 682.735 682.735 682.735 682.735 21.583 1.6828 1.793 30.984 37.570 26.863 37.570 26.863 32.506 26.468	$\begin{array}{c} 183 & 014 \\ 161 & -288 \\ 877 & -778 \\ 878 & -345 \\ 327 & +133 \\ 45 & -057 \\ 26 & -193 \\ 327 & +104 \\ 45 & -057 \\ 26 & -193 \\ 31 & -104 \\ 118 & -356 \\ 591 & +353 \\ 21 & -858 \\ 143 & -353 \\ 21 & -858 \\ 143 & -353 \\ 21 & -886 \\ 31 & +622 \\ 31$	$183 \cdot 522$ $161 \cdot 874$ $77 \cdot 520$ $87 \cdot 392$ $326 \cdot 786$ $44 \cdot 570$ $26 \cdot 143$ $31 \cdot 045$ $117 \cdot 980$ $142 \cdot 942$ $589 \cdot 465$ $21 \cdot 796$ $1 \cdot 859$ $1 \cdot 859$ $31 \cdot 713$ $38 \cdot 363$ $27 \cdot 552$ $30 \cdot 135$ $27 \cdot 153$	$196 \cdot 03 f 0 \\ 172 \cdot 902 \\ 77 \cdot 507 \\ 93 \cdot 221 \\ 47 \cdot 543 \\ 27 \cdot 490 \\ 32 \cdot 630 \\ 124 \cdot 247 \\ 126 \cdot 535 \\ 124 \cdot 247 \\ 156 \cdot 535 \\ 126 \cdot 535 \\ 126 \cdot 535 \\ 126 \cdot 535 \\ 126 \cdot 535 \\ 128 \cdot $
PARAMETRIC POINT	25 26	27 28	29	30	31	32
TOTAL CAPITAL COST .MS P LIG MET VAPOR GENERATORS .MS L IIG WET TURBINE A STEAM TURB-GEN & FEED STG .MS N MET VAP COND-STEAN GEN .MS I LIG MET CIRC & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIG MET AUX ELEC EQUIP .MS	799.08 855.86 60.032 70.656 24.000 24.000 26.400 31.500 10.460 10.180 27.438 29.153 36.400 36.120 2.750 2.750	777-11 820.63 58.624 59.392 24.000 24.000 21.230 31.550 11.020 11.860 27.068 27.248 36.400 36.120 2.750 2.750	896.42 69.376 24.000 41.860 12.420 29.048 35.600 2.750	772-85 60-058 24-000 21-600 7-940 27-188 38-000 2-750	795.45 61.184 24.000 26.700 8.220 27.368 37.600 2.750	851.52 71.424 24.000 31.900 8.220 29.268 36.800 2.750
R TOT MAJOR COMPONENT COST *MS E TOT MAJOR COMPONENT COST *JKWE S BALANCE OF PLANT COST *JKWE U SITE LABOR *JKWE I TOTAL DIRECT COST *JKWE PROF & OHNER COSTS *JKWE B CONTINGENCY COST *JKWE R ESCALATION COST *JKWE E INTOURING CONSTRUCTION *JKWE	$\begin{array}{c} 187.480 \\ 204.359 \\ 165.251 \\ 179.915 \\ 30.359 \\ 88.544 \\ 95.506 \\ 335.156 \\ 35.156 \\ 26.732 \\ 29.570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 31.745 \\ 33.9570 \\ 33.957$	$181.092 192.920 \\ 159.579 169.801 \\ 77.968 82.742 \\ 86.955 90.328.742 \\ 44.347 46.068 \\ 324.503 342.872 \\ 45.347 46.068 \\ 30.828 32.573 \\ 17.180 123.595 \\ 141.573 169.746 \\ 143.575 \\ 143.5$	215-054 189-066 99-078 373-845 50-581 29-908 15-515 134-857 163-390	181-536 160-299 76-832 86-378 323-509 44-053 25-881 30-733 116-777	137-822 165-685 78-984 88-225 332-894 44-995 25-631 31+625 120-072 145-478	204.362 180.108 80.258 355.266 355.266 355.265 28.451 28.451 128.451 128.451 128.451 128.451 128.451 128.451 128.451 128.451 128.451 128.451 128.451 128.451 128.5555 128.5555 128.5555 128.5555 128.55555 128.55555 128.5555557 128.555557 128.5555757 128.5555757 128.5555757 128.5555757 128.55575757575757575757575757575757575757
A TOTAL CAPITALIZATION •\$/KWE K COST OF ELEC-CAPITAL #MILLS/KWE D COST OF ELEC-FUEL •MILLS/KWE W TOTAL COST OF ELEC •MILLS/KWE W TOTAL COST OF ELEC •MILLS/KWE N COE D.\$ CAP. FACTOR •MILLS/KWE COE D.\$ CAP. FACTOR •MILLS/KWE COE D.\$ CAP. FACTOR •MILLS/KWE 	704.339 753.484 22.266 23.819 7.949 7.778 1.841 1.812 32.055 33.410 38.846 40.667 27.806 28.369	688.791 722.283 21.648 22.833 7.906. 7.737 1.633 1.805 31.387 32.375 37.993 39.336 27.254 28.019	788.096 24.913 7.575 1.778 34.267 41.852 29.521	582-438 21-573 	701-695 22-182 8-081 1-859 32-122 38-888 27-889	750-455 23-724 7-927 1-834 33-485 40-713 23-962

Table A 8.2.2 Continued

RANKINE METAL VAPOR TOPPING-STEAM CYCLE SUMMARY PLANT RESULTS

						-		. .
PARAMETRIC POINT	33	34	35	36	37	38	39	40
TOTAL CAPITAL COST	783.82	817.67	853.17	769.34	813.40	767.74	811.56	390.5n
P LIG MET VAPOR GENERATORS .NS	50.723	50.058	69.988	59.648	62.208	58.624	61-284	30-336
L LIG MET TURBINE MS	24.000	24 000	24.000	24-000	24.000	29-000	23.000	12.000
N HET VAP COND-STEAM GEN MS	11.020	10.740	10.740	8.760	9.160	22-335 9-34C	23.570	5-292
T LIG HET CIRC & PROCESS SYS .MS	27.083	27-263	29.048	27.078	27.598	27-058	27-453	17-624
GAS TURB PUMPUP-REC-PIPING MS	37.280	36.800	36.000	37.600	38.800	36 - 200	38.400	15.200
LIG HEI NON CELC LEGIF #M#	28730	20750	24150	20150	20130	2 * 1 JU	20130	10313
R TOT HAJOR COMPONENT COST .MS	184.376	193.531	214 676	182.756	188.866	161.117	187.377	94.581
S BALANCE OF DLANT COST	162.582	21 147	105-8/9	160-549	108-393	258-993	166-910	166-057
U SITE LABOR +5/KWE	87.312	90.287	99.314	85.570	89.037	85 310	88.739	93-541
L TOTAL DIRECT COST +\$/KWE	327.461	341.981	372-592	320.377	344-989	319-486	343-894	344.566
PROF & OWNER COSTS +\$/KWE	26 197	27.358	29.807	25 630	27 599	25 559	27-512	27-565
B CONTINGENCY COST +\$/KWE	31.109		35.396	30.436	32.779	30.351	32-670	30.175
R ESCALATION COST #\$/KWE F INT DHRING CONSTRUCTION _\$/KWE	118-271	123 301	134.471	115-651	124 099	115-326	123.703	107-987
A TOTAL CAPITALIZATION +\$/KWE	691.168	720.565	785 835	675.854	725 225	673.957	722.912	685.601
<u>K COST OF ELEC-CAPITAL MILLS/KWE</u>	21.849	22.773	24.842	21.365	22.926	21.305	22.853	21.673
O COST OF ELEC-FUEL MILLS/KNE	8-014	1.828	1.792	8-05/	8-621	7-917	8=495	6.852
W TOTAL COST OF ELEC +MILLS/KWE	31.712	32 493	34 310	31.218	33 442	31.010	33-226	30 202
N COE 0.5 CAP. FACTOR +MILLS/KWE	<u>38.378</u>	39-438	41.874	<u>. 37.739</u>	<u>40.431</u>	_37.513	40-193	36816_
COE 1.2XCAP. COST MILLS/KWE	36 082	37.048	39.278	35 491	38-027	35-271	37.797	34.537
COE 1.2XFUEL COST .MILLS/KWE	33.315	34-070	35-845	32-227	35.166	32.594	34-925	31 573
COE (FSCALATTONED) •HILLS/KRE	27 140	27.726	29.112	26.747	28-544	55 555		28 749
		270720				LOBDOL	200131	209761
	<u>6</u> 1	47	- 47	- <u>66</u>		65	67	<u> </u>
PARAMETRIC POINT	41	42	-43	-44	45	46	4 7	48
TOTAL CAPITAL COST	41 573.65	42 365.79	-43 443.08	44 654.36	45	46 823,20	47 421•32	48 1844-25
TOTAL CAPITAL COST TOTAL CAPITAL COST LIQ MET VAPOR GENERATORS LIQ MET VAPOR GENERATORS MA MA MA MA MA MA MA MA MA MA	41 573.66 45.504 18.000	42 965.79 75.840 30.000	43.08 8.800 12.000	44 654.36 13.200 18.000	45 1106.02 22.000 30.000	46 823.20 60.521 16.000	47 421.32 30.310 8.000	48 1044.25 75.776 20.000
PARAMETRIC POINT TOTAL CAPITAL COST P LIQ MET VAPOR GENERATORS LIQ MET TURBINE STEAM TURBINE A STEAM TURBINE A STEAM TURBINE A STEAM TURBINE	41 573.66 45.504 18.000 19.228	42 965.79 75.840 30.000 31.973	43.08 8.800 12.000 12.730	44 654.36 13.200 18.000 19.115	45 1106.02 22.000 30.000 31.785	46 823.20 65.521 16.000 25.530	47 421.32 30.310 8.000 11.905	48 1044.25 75.776 20.000 31.898
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST P LIQ MET VAPOR GENERATORS LIQ MET VURBINE A STEAM TURB-SEN & FEED STG M MET VAP COND-STEAM SEN T LTO MET COND-STEAM SEN M MET VAP COND-STEAM SEN T TO MET COND-STEAM SEN M MET VAP COND-STEAM SEN M M M M M M M M M M M M M M M M M M M	41 573.66 45.504 18.000 19.228 7.863 22.082	42 965.79 75.840 30.000 31.973 13.105	43.08 8.800 12.000 12.730 5.186	44 654.36 13.200 18.000 19.115 7.779 7.773	45 1106.02 22.000 30.000 31.785 12.965 12.965	46 823.20 65.521 16.000 25.530 10.644	47 421.32 30.310 8.000 11.905 5.322	48 1044.25 75.776 20.000 31.898 13.305
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST PLIQ MET VAPOR GENERATORS A STEAM TURBINE A STEAM TURBOEN & FEED STG M MET VAP COND-STEAM SEN TLIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING MS	41 573.66 45.504 18.000 19.228 7.863 22.082 22.900	42 965.79 75.840 30.000 31.973 13.105 31.009 38.000	43.08 8.800 12.000 12.730 5.186 17.112 14.920	44 654.36 13.200 18.000 19.115 7.779 21.312 22.200	45 1106.02 22.000 30.000 31.785 12.965 29.724 37.000	46 823+20 65-521 16+000 25-530 10-644 50-000	47 421.32 30.310 8.000 11.905 5.322 35.907 15.000	48 1044.25 75.776 20.000 31.898 13.305 72.856 37.500
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST P LIQ MET VAPOR GENERATORS A STEAM TURBINE A STEAM TURB-GEN & FEED STG M MET VAP COND-STEAM GEN T LIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING LIQ MET AUX ELEC EQUIP MS	41 573.66 45.504 18.000 19.228 7.863 22.082 22.082 22.080 2.053	42 965.79 75.840 30.000 31.973 13.105 31.009 38.000 3.437	43.08 8.800 12.000 12.730 5.186 17.112 14.920 1.375	44 654.36 13.200 19.115 7.779 21.312 22.200 2.063	45 1106.02 22.000 30.000 31.785 12.965 29.724 37.000 3.464	46 823.20 65.621 16.000 25.530 10.644 60.003 30.000 2.750	47 421.32 30.310 8.000 11.905 5.322 35.907 15.000 1.375	48 1044.25 75.776 20.000 31.898 13.898 13.805 72.866 37.500 3.437
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST P LIQ MET VAPOR GENERATORS LIQ MET YURBINE A STEAM TURB-SEN & FEED STG M MET VAP COND-STEAM SEN T LIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING GAS TURB PUMPUP-REC-PIPING LIQ MET AUX ELEC EQUIP MS R TOI MAJOR COMPONENT COST MS	41 573.66 45.504 18.000 19.228 7.863 22.082 22.082 22.000 2.003 2.	42 965.79 75.846 30.000 31.973 13.105 31.009 38.600 3.437 223.363	43 443.08 8.800 12.000 5.186 17.112 14.920 1.375 72.122	44 654.36 13.200 18.000 19.115 7.779 21.312 22.260 2.063	45 1106.02 22.000 30.000 31.785 12.965 29.724 37.000 3.464 166.938	46 823.20 66.521 16.000 25.530 10.644 60.033 30.000 2.750 2.750	47 421-32 30-310 8-000 11-905 5-322 35-907 1-375 107-819	48 1044.25 75.776 20.000 31.898 13.305 72.866 37.500 3.437 254.722
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST P LIQ MET VAPOR GENERAIORS LIQ MET VURBINE A STEAM TURB-GEN & FEED STG M MET VAP COND-STEAM BEN T LIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING GAS TURB PUMPUP-REC-PIPING LIQ MET AUX ELEC EQUIP R TOT MAJOR COMPONENT COST E TOT MAJOR COMPONENT COST SYKWE	41 573.66 45.564 18.000 19.228 7.863 22.082 22.300 2.053 137.540 161.061	42 965.79 75.840 30.000 31.973 13.105 31.009 38.000 3.437 223.363 156.872	-43 443.08 8.800 12.000 5.186 17.112 14.920 1.375 72.122 125.709	44 654.36 13.200 18.000 19.115 7.779 21.312 22.200 2.063 103.669 120.474	45 1106.02 22.000 30.000 31.785 29.55 29.724 37.000 3.464 166.938 116.335	46 823.20 6C.521 16.000 25.530 10.644 60.033 30.000 2.750 2.750 205.573 18C.344	47 421-32 30-310 8-000 11-905 5-322 35-907 15-000 1-375 107-819 189-168	48 1044.25 75-776 20.000 31.838 13.305 72.866 37.500 3.437 254.782 254.782
PARAMETRIC POINT TOTAL CAPITAL COST .MS P LIQ MET VAPOR GENERATORS .MS LIQ MET TURBINE .MS A STEAM TURB-GEN & FEED STG .MS I LIQ MET COND-STEAM SEN .MS T LIQ MET CIPC & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET AUX ELEC EQUIP .MS R TOT MAJOR COMPONENT COST .S/KWE S BALANCE OF PLANT COST .S/KWE	41 573.66 45.5C4 18.000 19.228 7.863 22.982 22.9082 2.082 2.082 137.540 1361.001 766.856	42 965.79 75.840 30.000 31.973 33.105 38.000 3.437 223.363 156.872 71.549	43 443.08 8.800 12.730 5.186 17.112 14.920 1.375 72.122 125.709 156.378	44 654.36 13.200 19.115 7.779 21.312 22.200 2.063 103.669 120.674 148.142	45 1106.02 22.000 30.000 31.785 22.9655 22.9724 37.000 3.464 166.933 116.335 116.335 142.712	46 823 - 20 66 - 521 16 - 000 25 - 573 30 - 644 60 - 033 30 - 000 2 - 750 205 - 573 180 - 344 180 - 344 71 - 742	47 421.32 30.310 8.000 11.905 5.322 15.000 1.375 107.619 189.168 82.581	48 1044-25 75-776 20.000 31.698 13.808 13.305 72.866 37.500 3.437 254-732 178.797 11.089
TOTAL CAPITAL COST .MS P LIQ MET VAPOR GENERATORS .MS LIQ MET YURBINE A STEAM TURB-SEN &FEED STG .MS I LIQ MET YURBINE A STEAM TURB-SEN &FEED STG .MS I LIQ MET CIRC & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET AUX ELEC EQUIP .MS R TOT MAJOR COMPONENT COST .SKWE S BALANCE OF PLANT COST .SKWE U SITE LABOR .SKWE L TOTAL DIRECT COST .SKWE	41 573.66 45.5C4 18.000 19.228 7.863 22.300 2.C53 137.540 151.001 76.856 88.333 326.190	42 965.79 75.840 31.973 13.105 38.000 3.437 223.363 156.572 71.549 85.729	43 443.08 8.800 12.700 5.186 17.112 14.920 1.375 72.122 156.378 105.837 387.926	44 654.36 13.200 19.115 7.779 21.312 22.260 2.063 103.669 120.474 148.142 100.544 369.140	45 1106.02 22.000 30.000 31.785 12.9655 29.724 37.000 3.464 166.938 116.335 142.712 97.876 983	46 823.20 66.521 16.000 25.530 10.644 60.033 30.000 2.750 205.573 180.344 71.742 90.601	47 421-32 30-310 8-000 11-905 5-322 5-322 15-000 1-375 107-819 185-168 84-581 98-700 372-849	48 1044.25 75.776 20.000 31.898 13.305 72.866 37.500 3.437 254.782 178.797 71.080 90.460 90.460 30.337
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST P LIQ MET VAPOR GENERATORS MS A STEAM TURB-GEN & FEED STG M MET VAP COND-STEAM SEN T LIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING MS LIQ MET AUX ELEC EQUIP MS R TOT MAJOR COMPONENT COST	41 573.66 45.5C4 18.0D0 19.228 7.863 22.082 22.300 2.C53 137.540 151.001 76.856 88.333 326.190 45.C50	42 965.79 75.840 30.000 31.973 13.105 31.009 38.800 3.437 223.363 71.549 85.729 31.4.151 43.722	43 443.08 8.800 12.730 5.186 1.375 72.122 15.709 156.378 105.837 387.925 53.917	44 654,36 13,200 18,000 18,000 7,779 21,312 22,260 2,063 103,669 120,874 148,142 100,544 369,160 51,278	45 1106.02 22.000 30.000 31.782 37.000 3.464 166.933 116.335 142.712 97.876 356.9833 49.917	46 823.20 66.521 16.000 25.530 10.643 30.000 2.750 205.573 180.348 71.75 90.601 342.588 46.207	47 421.32 30.310 8.000 11.905 5.322 35.907 15.000 1.375 107.819 189.168 84.531 98.700 372.449 56.337	48 1044.25 75.776 20.000 31.898 13.305 72.866 37.500 3.437 254.732 178.797 71.080 90.460 340.337 46.135
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST LIQ MET YUAPOR GENERAIORS MET YURB-DEN & FEED STG MET VAP COND-STEAM BEN GAS TURB PUMPUP-REC-PIPING GAS TURB PUMPUP-REC-PIPING LIQ MET AUX ELEC EQUIP MS R TOT MAJOR COMPONENT COST S BALANCE OF PLANT COST S BALANCE OF PLANT COST S CALL T TOTAL DIRECT COST S SALWE PROF & OWMER COST S SALWE CONTINGENCY COST S SALWE	41 573.66 45.564.4 18.000 19.228 7.863 22.082 22.300 2.082 22.300 2.082 137.540 161.061 76.856 88.333 326.190 26.095 27.005 27.0	42 965.79 75.840 31.973 13.1059 31.973 13.1059 38.600 3.437 223.363 71.5549 85.729 314.5549 85.729 85.759	43 443.08 8.800 12.000 12.730 5.186 1.375 14.920 1.375 72.122 125.709 156.378 105.837 387,9255 53.977 31.034	44 654.36 13.200 18.000 19.179 22.312 22.2663 103.669 120.474 148.142 100.544 369.160 51.278 29.533 77.30	45 1106.02 22.000 30.000 31.30.000 31.30.000 3.464 166.938 116.395 142.712 37.876 356.987 49.917 28.559 76.557	46 823 • 20 66 • 521 16 • 000 25 • 65 4 30 • 000 2 • 750 2 • 750 2 05 • 57 3 180 • 34 2 05 • 57 3 180 • 34 2 05 • 57 3 2 0 • 601 3 • 2 • 580 2 • 580	47 421.32 30.310 8.000 11.905 5.5322 35.907 1.5.000 1.375 107.819 189.168 84.581 98.700 372.449. 55.337 29.796 729.796	48 1044.25 75.776 20.000 31.898 13.305 72.866 37.500 3.437 254.782 178.797 71.080 90.460 33.40.337 46.135 27.227 27.227
TOTAL CAPITAL COST	41 573.66 45.5C4 18.5000 19.228 7.863 22.082 22.300 137.540 151.001 76.856 88.333 326.190 45.C50 26.095 25.947 11.085	42 365.79 75.840 31.973 31.109 38.000 33.437 33.403 223.367 223.367 23.437 243.722 25.132 30.657 19.087	43 443.08 8.8000 12.730 5.186 17.112 14.920 1.375 72.125.709 156.378 387.925 53.977 31.034 33.974 121.642	44 654.36 13.200 19.115.7 7.779 21.312 22.200 13.663 103.663 120.474 148.142 100.544 369.160 51.278 29.533 33.892 25.735	45 1106.02 22.0000 31.785 12.9555 29.724 37.000 3.464 166.938 116.335 142.712 97.876 356.983 49.917 28.559 34.837 135.391	46 823.20 66.621 15.550 10.644 60.033 30.000 2.750 2.750 2.750 2.573 2.1.752 2.544 71.7621 342.6588 46.207 2.7.415 32.5554	47 421-32 30-310 8-000 11-305 5-322 35-307 15-000 1-375 107-61 189-168 84-581 94-581 372-449 56-337 56-337 16-6330	48 1044 • 25 75 • 776 20 • 000 31 • 898 13 • 305 72 • 866 37 • 500 3 • 437 254 • 787 71 • 080 90 • 46 • 135 27 • 227 33 • 213 28 • 659
TOTAL CAPITAL COST .MS PARAMETRIC POINT TOTAL CAPITAL COST .MS LIQ MET YURBINE A STEAM TURB-GEN & FEED STG .MS I LIQ MET YURBINE A STEAM TURB-GEN & FEED STG .MS I LIQ MET COND-STEAM BEN .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET AUX ELEC EQUIP R TOT MAJOR COMPONENT COST .MS E TOT MAJOR COMPONENT COST .MS E SBALANCE OF PLANT COST .S/KWE S BALANCE OF PLANT COST .S/KWE I TOTAL DIRECT COST .S/KWE PROF & OMMER COSTS .S/KWE B CONTINGENCY COST .S/KWE B CONTINGENCY COST .S/KWE R FSCALATION COST .S/KWE R FSCALATION COST .S/KWE R FSCALATION COST .S/KWE	41 573.66 45.5C4 18.000 19.228 7.863 22.082 22.300 2.063 137.540 151.061 151.061 155.051 326.130 25.957 111.0857 111.057	42 965.79 75.8400 31.973 31.1099 38.000 3.437 223.363 156.872 71.549 314.549 314.7549	43 443.08 8.8000 12.730 5.186 17.112 14.920 1.375 72.122 72.122 72.125.709 156.378 387.925 53.977 31.034 33.972 121.642 123.642 125.742 1	44 654.36 13.200 19.115 7.779 21.312 22.200 2.663 103.674 369.162 51.278 29.533 33.892 125.780 125.780	45 1106.02 22.000 30.000 31.785 12.9655 29.724 37.000 3.464 166.939 116.395 142.712 97.876 356.982 49.917 28.559 34.837 135.391 155.474	46 823 • 201 165 • 500 105 • 6633 205 • 575 205 • 575 39 • 6038 205 • 575 180 • 0050 205 • 573 180 • 0050 39 • 6038 39 2 • 6038 39 2 • 6038 39 2 • 5755 32 • 5755 1255 • 720	47 421-32 30-310 8-000 11-305 5-322 5-322 15-000 1-375 107-819 189-168 88-581 9-700 9-70-64 372-449 550-337 29-736 32-617 116-930	48 1044 • 25 75 • 776 20 • 000 31 • 893 13 • 305 572 • 866 37 • 500 3 • 437 254 • 782 771 • 080 90 • 460 90 • 460 90 • 460 37 • 530 37 • 530 30 • 437 30 • 533 128 • 553 127 • 524 6
TOTAL CAPITAL COST .MS PARAMETRIC POINT TOTAL CAPITAL COST .MS LIQ MET VAPOR GENERATORS .MS LIQ MET TURBINE .MS A STEAM TURB-GEN & FEED STG .MS I LIQ MET TURBCE & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET AUX ELEC EQUIP R TOT MAJOR COMPONENT COST .MS E TOT MAJOR COMPONENT COST .MS E TOT MAJOR COMPONENT COST .MS E TOT MAJOR COMPONENT COST .MS LIQ MET AUX ELEC EQUIP NS R TOT MAJOR COMPONENT COST .MS E TOT AL DIRECT COST .MS MKNE L TOTAL DIRECT COST .S/KWE B CONTINGENCY COST .S/KWE R ESCALATION CONSTRUCTION .S/KWE A TOTAL CAPITALIZATION .S/KWE	41 573.66 45.564 18.000 19.228 7.863 22.902 2.082 22.300 2.063 137.540 156.001 166.856 88.333 325.190 26.095 25.947 111.085 133.149 671.515 21.228	42 965.79 75.840 31.973 13.105 38.000 3.437 223.363 156.872 71.549 85.729 31.415 43.725 31.43.725 31.43.725 31.43.725 31.45.547 678.236 71.542 30.6577 119.0877 115.647 71.5547 75.840 71.5547 76.8236 71.547 71.549 71.5547 76.8236 71.5547 76.8236 71.548 71.5547 77.82547 77.82547 71.5547 77.82547 77.8487 77.8477 77.8477 77.8477 77.84777 77.84777 77.847777 77.8477777 77.847777777777777777777777777777777777	43 443.08 8.800 12.700 5.186 17.112 14.920 1.375 72.122 125.709 105.837 387.927 31.034 33.977 123.640 123.735 77.2.283 25.414 14.375 53.977 1.21,640 1.23.977 1.23.977 2.283 2.2.414 1.2.22 2.2.414 1.2.375 1.2.2 1.2.375 1.2.2	44 654.36 13.200 19.115 7.779 22.200 2.063 103.669 120.674 148.142 100.544 369.160 51.276 29.533 33.892 1250.780 760.438 24.032 76.0438 76.0438 24.032 76.0438 76.045	45 1106.02 22.000 30.000 31.785 12.9655 12.9655 37.000 3.464 166.938 142.712 97.876 356.983 49.917 28.8559 34.837 135.391 165.474 771.160 28.779	46 823 • 221 16 • 050 10 • 6433 30 • 000 20 5 • 573 80 • 000 20 5 • 573 180 • 693 37 • 750 20 5 • 573 180 • 693 46 • 20 7 290 • 693 46 • 20 7 27 • 555 32 • 575 32 • 575 32 • 575 123 • 575 123 • 575 32 • 575 35 35 35 35 35 35 35 35 35 35 35 35 35	47 421.32 30.310 8.000 11.905 5.322 35.300 1.375 107.619 189.168 89.581 98.700 372.419 50.337 29.736 32.617 116.930 37.2579 739.208	48 1044.25 75.776 20.000 31.698 13.305 72.866 37.500 3.437 254.782 178.797 71.080 90.460 90.460 90.460 31.637 340.337 46.1355 27.227 33.213 128.559 157.248 732.2816 732.
TOTAL CAPITAL COST .MS P LIQ MET VAPOR GENERATORS .MS LIQ MET YURBINE .MS A STEAM TURBINE .MS M MET VAP COND-STEAN SEN .MS I LIQ MET CIRC & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET AUX ELEC EQUIP .MS R TOT MAJOR COMPONENT COST .S/KWE S BALANCE OF PLANT COST .S/KWE I NDIRECT COSTS .S/KWE Y STE LABOR .S/KWE I NDIRECT COSTS .S/KWE B CONTINGENCY COST .S/KWE B CONTINGENCY COST .S/KWE A STEAM CONTING .S/KWE A STALATION COSTS .S/KWE CONTINGENCY COST .S/KWE A TOTAL CAPITALIZATION .S/KWE	41 573.66 45.5C4 18.000 19.228 7.863 22.300 2.C53 137.540 161.001 76.856 88.333 326.130 45.C50 26.095 25.947 113.185 133.1515 21.228 6.852	42 965.79 75.840 31.973 31.007 31.973 33.105 38.000 3.437 223.363 156.572 71.549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 85.729 31.4.1549 31.549 31.5	43 443.08 8.800 12.700 5.186 17.112 14.920 1.375 72.122 125.3709 105.837 387.922 156.378 387.927 1.034 33.977 1.23.977 1.23.974 1.23.974 1.23.9772 1.23.9777 1.23.9777 1.23.9777 1.23.9777 1.23.97777 1.23.9777 1.	44 654.36 13.200 19.115 7.779 21.312 22.260 2.063 103.669 120.474 148.142 100.544 359.164 359.165 51.278 33.892 125.780 760.438 24.039 7.293	45 1106.02 22.000 30.000 31.785 12.9655 29.724 37.000 3.464 166.938 116.395 142.712 97.876 356.9917 28.559 91.35.391 165.474 771.160 24.378 7.2233	46 823.521 16.500 10.6433 30.000 2.750 205.573 90.603 71.772 90.603 71.772 90.603 71.772 90.603 46.5374 71.772 90.601 34.2555 123.574 149.722.160 22.829 6.736	47 421.32 30.310 8.000 11.905 5.322 35.307 15.000 1.375 107.819 183.168 84.581 98.700 372.4.9 50.337 29.736 32.617 116.430 137.579 739.208 23.358 6.755	48 1044.25 75.776 20.000 31.893 13.305 72.866 37.500 3.437 254.782 178.797 71.080 90.460 90.460 90.465 90.455 27.227 33.213 128.659 157.246 23.166 23.166 6.756
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST LIQ MET YUAPOR GENERAIORS A STEAM TURB-SEN & FEED STG M MET VAP COND-STEAM SEN TILG MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING MS TOT MAJOR COMPONENT COST S BALANCE OF PLANT COST S BALANCE OF PLANT COST S BALANCE OF PLANT COST S SALANCE OF STS TOTAL DIRECT COST S SKWE CONTINGENCY COST S SKWE B CONTINGENCY COST S SKWE B CONTINGENCY COST S SKWE CONTINGENCY COST S SKWE B CONTINGENCY COST S SKWE COST OF ELEC-CAPITAL MILLS/KWE A TOTAL CAPITALIZATION SKWE S TOTAL CAPITALIZATION SKWE S COST OF ELEC-OP& MILLS/KWE S COST OF ELEC-OP& STANT	41 573.66 45.504 18.000 19.228 7.863 22.60 137.540 161.001 76.856 88.333 326.130 26.035 29.947 111.085 133.149 671.515 21.228 6.852 20.578 21.5788 21.578	42 365.79 75.840 30.000 31.973 31.009 38.000 33.400 33.400 33.400 33.400 33.400 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.0000 34.00000 34.00000 34.00000 34.0000 34.0000000000 3	43 443.08 8.8000 12.730 5.186 17.112 14.920 1.375 72.125.709 156.378 387.925 73.925 74.925 75.35 75.35 75	44 654.36 13.200 19.115 7.779 21.312 22.200 103.669 120.474 148.142 100.5474 148.142 35.839 125.735 150.480 760.480 760.480 76.293 150.480 76.293	45 1106 . 02 22 .0000 30 .0000 31 .785 12 .9655 12 .9657 37 .000 37 .000 37 .000 39 .64 166 .938 142 .712 97 .873 142 .712 97 .873 142 .712 165 .933 142 .712 165 .933 145 .714 165 .935 165 .935 165 .935 165 .935 165 .935 165 .935 165 .935 165 .935 165 .935 175 .935 165 .935	46 823 - 20 66 - 5030 10 - 6433 30 - 0000 25 - 573 180 - 3742 90 - 6033 32 - 75 380 - 3742 91 - 6033 32 - 5344 27 - 53444 27 - 53444 27 - 53444 27 - 53444 27 - 534444 27 - 534444 27 - 53444444 27 - 53444444	47 421.32 30.3100 11.905 5.322 35.300 15.000 15.000 15.000 15.000 15.000 15.000 15.000 15.000 372.449 50.337 50.337 15.32 50.337 15.32 137.579 739.208 23.568 1.5661	48 1044 • 25 75 • 776 20 • 000 31 • 898 13 • 898 13 • 898 37 • 500 3 • 437 25 • 797 71 • 080 90 • 46 1357 27 • 227 33.213 157 • 246 72 • 859 157 • 246 23 • 1661 1 • 661
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST LIQ MET YURBINE A STEAM TURB-GEN & FEED STG M MET WAP COND-STEAM BEN T LIQ MET COND-STEAM BEN M MET WAP COND-STEAM BEN T LIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING GAS TURB PUMPUP-REC-PIPING K TOT MAJOR COMPONENT COST S BALANCE OF PLANT COST S CONTINGENCY COST T INDIRECT COST S KWE N TOTAL CAPITALIZATION K COST OF ELEC-FUEL MTLLS/KWE D COST OF ELEC-FUEL MTLLS/KWE N TOTAL COST OF ELEC-MELLS/KWE N COST OF ELEC-FUEL MTLLS/KWE N TOTAL COST OF ELEC MELLS/KWE N COST OF ELEC-FUEL MTLLS/KWE N COST OF ELEC-FUEL MTLLS/KWE N COST OF ELEC-FUEL MTLLS/KWE N COST OF ELEC-FUEL MTLLS/KWE N COST OF ELEC MILLS/KWE	41 573.66 45.5040 19.228 7.863 22.900 22.900 22.63 22.6540 137.540 1451.001 76.856 88.333 326.190 45.050 26.095 25.947 11.085 21.228 5671.518 571.578 21.228 1.678 29.758 36.238	42 365.79 75.8400 31.973 31.1009 38.0007 33.105 33.437 223.437 25.6572 31.4529 31.4.151 43.752 25.1327 31.4.5557 578.2957 578.2957 578.2957 578.257 578.257 578.257 578.2555 1.678 29.972 36.5515	43 443.08 8.8000 12.730 5.186 17.112 14.920 1.375 72.125.709 156.378 387.925 53.927 31.5587 387.925 53.927 31.5587 72.25.709 123.640 124.640 124.640 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.7000 125.70000 125.70000 125.70000 125.700000 125.7000000000000000000000000000000000000	44 654.36 13.200 19.115 7.779 22.200 22.200 13.663 120.474 148.142 29.533 33.892 150.785 150.785 24.039 760.485 24.039 7.233 1.800 33.132 40.455 1.800 33.132 40.455 1.800 3.132 40.455 1.800 3.132 40.455 1.800 3.132 40.455 1.800 3.132 40.455 1.800 3.132 40.455 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 3.132 1.800 1.80	45 1106.02 22.000 30.000 31.785 12.9555 29.724 37.000 3.464 166.938 142.712 97.876 356.983 142.712 97.876 356.983 142.712 165.474 724.378 7.293 1.800 33.471 49.895 1.800 33.471 49.895 1.800 33.471 40.895 1.800 33.471 40.895 1.800 33.471 40.895 1.800 33.471 40.895 1.800 33.471 40.895 1.800 3.455 1.800 3.345 1.800 3.455 3.4555 3.4555 3.4555 3.4555 3.4555 3.4555 3.4555 3.4555 3.455	46 823 • 20 16 • 500 10 • 643 30 • 0050 30 • 0	47 421-32 30-310 8-000 11-905 5-322 35-307 15-000 1-375 107-819 189-168 84-581 9-756 372-049 56-337 15-000 372-049 56-337 15-000 372-049 56-337 15-000 372-049 137-579 739-208 23-3568 -6-756 1-6651 31-785 189-67	48 1044 • 25 75 • 776 20 • 000 31 • 898 13 • 305 72 • 866 37 • 500 3 • 437 254 - 787 71 • 080 90 • 46 • 135 27 • 227 33 • 213 128 • 65 157 • 246 6 • 756 6 • 756 1 • 565 1 •
TOTAL CAPITAL COST .MS PARAHETRIC POINT TOTAL CAPITAL COST .MS LIG MET YURBINE A STEAM TURB-GEN & FEED STG .MS M MET VAP COND-STEAM BEN .MS T LIG MET CIRC & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIG MET AUX ELEC EQUIP .MS R TOT MAJOR COMPONENT COST .S/KWE S BALANCE OF PLANT COST .S/KWE I TOTAL DIRECT COST .S/KWE LIG MET COSTS .S/KWE COST OF PLANT COST .S/KWE R TOT MAJOR COMPONENT COST .S/KWE I TOTAL DIRECT COST .S/KWE LIG MET COSTS .S/KWE N MET COSTS .S/KWE COST OF ELEC-CAPITAL.MILLS/KWE N TOTAL COST OF ELEC .MILLS/KWE N COE D.S CAP. FACTOR .MILLS/KWE	41 573.66 45.504 18.000 19.228 7.863 22.982 22.900 2.063 137.540 24.063 37.540 137.540 26.035 25.947 111.0678 21.228 6.852 21.678 29.758 29.758 25.703	42 365.79 75.840 31.973 31.909 38.000 3.437 223.363 3.437 223.363 3.437 225.132 25.132 35.457 19.0577 145.597 578.236 577.578 578.236 578.236 577.578 578.236 578.236 577.578 578.236 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 578.236 577.578 577.578 578.236 577.578 578.236 577.5787 577.5787 577.5787	$\begin{array}{c} 4 \\ 4 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\$	44 654.36 13.200 19.115 7.779 22.200 2.063 103.669 120.674 148.142 100.5474 100.5476 51.278 29.533 33.8925 150.438 24.039 7.602438 24.039 7.2933 1.600 33.132 40.45550	45 1106.02 22.000 30.000 31.785 29.724 37.000 3.464 166.938 142.712 97.876 356.987 49.917 28.559 34.837 1.25.474 7711.160 24.378 7.233 1.600 33.471 40.895 28.825	46 823 • 201 165 • 554 60 • 0000 2 • 5750 30 • 0000 2 • 5757 180 • 5748 39 2 • 554 39 2 • 5748 46 • 201 39 2 • 5748 46 • 201 39 2 • 5757 1249 • 1255 1249 • 722 • 160 22 • 8293 1 • 2466 31 • 2466 31 • 2466 32 • 2557 1 • 25572 1 • 2572 1	47 421-32 30-310 8 000 11-305 5-322 5-322 15-000 1-375 107-819 189-168 38-581 38-581 38-581 32-617 115-830 372-449 56-337 115-830 372-579 739-208 23-558 6-756 1-661 51-661 51-661 51-665 5	48 1044 • 25 75 • 776 20 • 000 31 • 893 13 • 3056 37 • 500 3 • 437 254 • 782 178 • 797 71 • 080 90 • 460 90 • 460 90 • 460 90 • 460 128 • 559 37 • 524 6 • 756 23 • 166 6 • 756 1 • 583 38 • 644 27 • 165
TOTAL CAPITAL COST .MS P LIQ MET VAPOR GENERATORS .MS LIO MET TURBINE .MS A STEAM TURB-GEN & FEED STG .MS M MET VAP COND-STEAM BEN .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET CIRC & PROCESS SYS .MS GAS TURB PUMPUP-REC-PIPING .MS LIQ MET AUX ELEC EQUIP R TOT MAJOR COMPONENT COST .MS E TOT MAJOR COMPONENT COST .MS E TOT MAJOR COMPONENT COST .MS LITE LABOR .S/KWE S BALANCE OF PLANT COST .S/KWE S BALANCE OF PLANT COST .S/KWE I TOTAL DIRECT COST .S/KWE B CONTINGENCY COST .S/KWE E INT DURING CONSTRUCTION .S/KWE A TOTAL CAPITALIZATION .S/KWE A TOTAL CAPITALIZATION .S/KWE A TOTAL CAPITALIZATION .S/KWE A TOTAL COST OF ELEC-CAPITAL .MILLS/KWE D COST OF ELEC-COPENANN.MILLS/KWE N COE 0.5 CAP. FACTOR .MILLS/KWE COE 1.2XCAP. COST	41 573.66 45.504 18.000 19.228 7.863 22.982 22.902 2.062 2.063 137.540 151.001 76.856 853 326.130 26.095 29.947 111.085 29.947 111.085 29.947 111.085 21.228 6.852 1.678 29.758 36.238 25.703 34.004	42 965.79 75.840 31.973 31.009 38.000 3.437 223.363 156.872 71.549 85.729 31.43.725 31.43.725 31.43.725 31.45.547 678.295 21.442 25.132 21.442 25.857 21.645 21.645 21.645 21.678 23.65516 5.5587 3.55877 3	43 443.08 8.800 12.770 5.186 17.112 14.920 15.70 12.5.70 12.5.70 125.70 156.378 105.837 53.977 31.034 33.974 123.642 123.642 123.642 123.642 123.854 24.414 1.800 33.850 40.941 1.800 33.854 90.941 1.8000 1.8000 1.8000 1.8000 1.8000 1.80	44 654.36 13.200 19.115 7.779 21.22.200 2.063 103.669 120.674 148.142 100.544 369.160 51.278 29.533 35.892 1250.780 76.0438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.438 24.039 7.293 1.50.550	45 1106.02 22.000 30.000 31.785 12.9655 12.9655 37.000 3.464 166.938 142.712 97.876 356.983 49.917 28.559 34.8559 135.391 165.474 7711.160 24.378 7.293 1.800 24.3787 28.8255 3.471 10.895 28.825 3.471 10.895 28.825 3.471 10.895 28.825 3.471 10.895 28.825 3.471 10.895 28.825 3.471 10.895 28.825 3.471 10.895 28.825 28.855 28.855 28.855 28.855	46 823 • 201 165 • 5500 10 • 6633 2 • 7 50 20 5 • 57 3 180 • 600 2 • 7 50 20 5 • 57 3 180 • 600 2 • 7 50 20 5 • 57 3 180 • 600 2 • 7 50 2 • 5 • 57 3 3 • 2 • 55 7 2 • 5 • 7 2 • 7 2 • 7 •	47 421-32 30-310 8-000 11-905 5-322 35-907 15-000 1-375 107-619 189-168 89-581 98-700 372-849 50-337 52-377 29-736 32-617 116-930 137-579 739-208 23-568 23-569 1-651 1-785 38-907 27-329 23-569 1-651 1-785 38-907 27-329	48 1044 - 25 75 - 776 20 - 000 31 - 893 13 - 305 72 - 866 37 - 500 3 - 837 254 - 732 178 - 797 71 - 080 90 - 460 90 - 400 90 - 400
TOTAL CAPITAL COST PARAMETRIC POINT TOTAL CAPITAL COST LIQ MET VAPOR GENERAIORS MET VAP A STEAM TURB-BEN & FEED STG MET VAP COND-STEAM BEN TLIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING HS LIQ MET CIRC & PROCESS SYS GAS TURB PUMPUP-REC-PIPING HS LIQ MET CONDONENT COST SKWE TOT MAJOR COMPONENT COST SKWE S BALANCE OF PLANT COST SKWE USITE LABOR TINDIRECT COST SKWE B CONTINGENCY COST SKWE B CONTINGENCY COST SKWE R FSCALATION COST OF ELEC-CAPITAL MILLS/KWE COE 0.5 CAP. FACTOR MILLS/KWE COE 1.2XCWEL COST MILLS/KWE COE 1.2XCWELCOST MILLS/KWE COE (CONTINGENCY COST MILLS/KWE COE 1.2XCWELCOST MILLS/KWE COE 1.2XCWELCOST MILLS/KWE COE 1.2XCWELCOST MILLS/KWE COE (CONTINGENCY COST MILLS/KWE COE 1.2XCWELCOST MILLS/KWE COE 1.2XCWELCOST MILLS/KWE COE 1.2XCWECY=0) MILLS/KWE COE (CONTINGENCY COST MILLS/KWE COE 1.2XCWECY=0) MILLS/KWE COE (CONTINGENCY=0) MILLS/KWE COE (CONTINGENCY=0) MILLS/KWE	41 573.66 45.504 18.000 19.228 7.863 22.902 2.082 22.300 2.062 22.300 2.053 137.540 145.050 26.095 25.947 111.085 21.515 21.528 25.703 34.004 31.128 28.270	42 965.79 75.840 31.973 13.105 38.000 3.437 223.363 156.872 71.549 85.729 31.43.722 25.132	43 443.08 8.800 12.700 12.700 13.75 13.5 17.112 13.75 72.122 125.37 105.837 31.034 33.977 31.034 33.977 31.034 33.977 2121 22.5 772.283 772.283 772.283 772.283 24.29 1.800 33.9572 1.21 2.5 3.977 31.800 33.977 2.283 3.977 2.283 3.977 31.800 33.977 2.283 3.977 3.284 3.977 2.283 3.977 3.284 3.977 3.284 3.977 3.285 3.8755 3.8755 3.8755 3.8755 3.8755 3.87555 3.87555555555555555555555555555555555555	44 654.36 13.200 19.112 7.779 21.312 2.063 103.669 120.474 148.142 100.544 359.164 359.164 359.164 150.780 760.438 24.639 7.233 1.50.780 760.438 24.639 7.233 1.50.780 760.438 24.639 7.233 1.50.780 760.435 2.550 3.55500 3.55500 3.55500 3.55500 3.55500 3.55500 3.55500 3.55500 3.555000 3.555000 3.555000 3.555000 3.5550000 3.555000 3.5550000	45 1106.02 22.000 30.000 31.785 12.9655 29.724 37.000 3.464 166.938 116.335 142.712 97.876 98.9837 135.8983 145.474 771.160 24.378 1.806 24.378 1.806 28.825 28.	46 823 • 201 16 • 0500 10 • 6433 30 • 0000 2 • 7 50 205 • 573 46 • 2505 32 • 574 46 • 2505 32 • 574 46 • 2505 32 • 574 123 • 574 123 • 574 10 • 661 31 • 220 22 • 8554 10 • 661 32 • 574 10 • 661 33 • 220 22 • 8554 10 • 661 35 • 812 35 • 812 32 • 5591	47 421-32 30-310 8-000 11-905 5-322 5-322 15-000 1-375 107-819 88-581 98-700 372-849 9185-168 32-617 116-530 137-579 739-208 23-568 1-651 31-651 31-651 31-651 31-651 31-651 31-651 31-651 31-756 727-829 33-136 31-2718	48 1044.25 75.776 20.000 31.8305 72.866 37.500 3.437 254.782 178.797 71.080 90.460 90.460 90.460 33.253 128.659 157.226 533.166 732.816 23.1651 33.8.644 27.165 36.216 32.938 53.857 1.582 1.582 1.551 3.551

Table A 8.2.2 Continued

RANKINE METAL VAPOR TOPPING-STEAM CYCLE SUMMARY PLANT RESULTS

PARAMETRIC POINT	49	50	51	52	53	54	55	56
TOTAL CAPITAL COST .MS	760.23	882.80	• CC	.00	.08	•CC	.00	•00
P LIG MET VAPOR GENERATORS .MS	50.572	17.500	•000	.000	.000	.000	•000	-000
A STEAM TURB-GER & FEED STG .MS	25.590	25-430	•006	-000	-000	-860	-000	•000
N MET VAP COND-STEAM GEN .MS	10.484	9.172	.000	.000	000	-CCC	.000	-000
T LIG HET CIRC & PROCESS SYS .HS	26.543	25.518	-000	-000	-000	.000	.000	-000
TO WET ANY FLEC FONTP	2 750	31 200	•000	•000	-000	-006	-000	-000
	20130	20130	-000	-000	• 886	•000	•000	•800
R TOT MAJOR COMPONENT COST MS	180.539	135.720	-000	.000	-660	-000	.000	-000
S RALANCE OF DLANT COST	158.572	118-2/9	-000	-028	-000	-000-	-000	•000
U SITE LABOR +\$/KWE	85.579	99.359	200	ិតិតិតិ	.000	.000		-000
L TOTAL DIRECT COST +S/KWE	315.658	363.855	-000	000	- <u>.</u> 000	003.	000	.000
I INDIRECT COSTS +\$/KWE	43-646	50-673	•000	•000	•000	•000	-000	-000
B CONTINGENCY COST #\$/KWE	29 988	39.566	.000	-UUU - 000	-000	-000	-000	-900
R ESCALATION COST .S/KWE	114.126	131.651	-000	000.	000	203	000	-000
E INI DURING CONSTRUCTION *\$/KWE	138-273	159.506	•000	-000	•000	-000	-000	•00ð
K COST OF FLEC-CAPITAL MILLS/KWE	21.084	29-321	-000	-000 -000	-000	-000	-000	•000 •000
D COST OF ELEC-FUEL .MILLS/KWE	6.847	7.293	.000	000	.000	000	.000	000
N TOTAL COST OF CLEC - MTLLS/KWE	1.572		-000	•000	•000	-000	-200	-000
N COE D.5 CAP. FACTOR MILLS/KWE	36 039	40-821	1000	2000	-000	<u>-200</u>	-000	-000
COE D.B CAP. FACTOR MILLS/KWE	25.574	28.778	.000.	.000	.000	000	000	-000
CUE 1.2XCAP. COST #MILLS/KWE	33.819	38.278	•000	• 000	•000	-000	-000	•000
COE (CONTINGENCY=D) MILLS/KWE	28 077	31.555	-000	1000	-000	•UUU •000	•000	•000
COE (ESCALATION=D) .HILLS/KWE	25 191	28.324	.000	1000	000	.000	100-	-000

.....

163

Table A 8.2.3

RANKINE NETAL VAPOR TOPPING-STEAN CYCLE NATURAL RESOURCE RECUIREMENTS

	PARAMETRIC POINT	i	2	3	4	5	6	7	3
	COAL. LB/KW-HR	•38127	1206477	1.42149	.90383	1.00215	1-27605	86 94 5	.86346
	SORBANT OR SEED +LB/KW-HR	46628	.12096	.13558	-47822	.11384	.12171	-46003	-46003
	TOTAL WATER GAL/KW-HR	•767	-664	<u>•653</u>	-813	•722	•721	•772	•772
	COOLING WATER			,565	. 601		.594		618
	GASIFIER PROCESS H20	•00000	•00000	•00000	•05206	.05111	-04793	.00000	•00000
	CONDENSATE MAKE UP	.00610	.00580	DC564	-00666	. CO59C	. 00593	CO617	-00617
	WASTE HANDLING SLURRY	.0965	.8250	.0281	•0990	•0236	D252	•0352	•0952
	SCRUBEER WASTE WATER	.05288	.05271	.05402	.05423	.04961	·C4849	.05217	.05217
	NOX SUPPRESSTON	100000	00000	00000	.00000	00000	00000	00000	-00000
	TOTAL LAND ACRESZICONVE	114-59	67.39	69-51	113.94	65-32	67.10	113.58	113.54
	MATN PLANT	16.50	16.26	16.37	17.30	17.00	17-03	16.49	15.49
	DISPOSAL LAND	77.24	30.57	34.05	75.98	28.03	29.74	76.21	76.21
£	I AND END ACCESS DD	20.35	20.56	19.10	29.65	20.29	20.33	20.80	20.88
	LAND FOR ADDEDD AN	20000	20000	10010		20.023	20000	20004	20404
	PARAMETRIC POINT		TO	11	17		··· ····		- TIS
		00537	00702	00127	00707	72012	77775	705	01875
	SADRANT OD SEEN-I RAVULUD	*7578	*7707	800121 800121	87971	20232	80012	82180	87007
	TOTAL VATED, CAL //U-UD	• 4 / 3 4 7	-+1232 01C	• • • • • • • • • • •	- 41841	• 38323	• • • • • • • • • • • • • • • • • • • •	*****	• • • • • • • • • • • • • • • • • • • •
	CONTRACTOR ONLY DE CONTRACTOR		040	·	····	•/ <u>-2</u> -		<u>• </u>	
	CACTETED DOARSE 120	05107	651/0	00000	0001	00000	001/	000000	0000
	OWDILIEK LKOULDD HCD	-U2102	•00148	• 000000	00200	-000000	•04434	-000000	-U4621
	CUNDENSAIE MAKE UP	•00505	• 1,0,0,0,0	•00910	• 00000	• UU 5 / 5	*UU658	• • • • • • • • • • • • • • • • • • • •	•UU63/
	MASTE HANDLING SLURRY	1982	·	0965	<u> </u>	<u></u>		<u></u>	0892
- ÷	SCRUBBER MASIE WAIER	·N2318	-05363	 05288 	•U5423	-04363	•04639	+64/79	-04886
	NUX SUPPRESSION	.00000	.00000	•00000	-00000	-C00CC	.00000	-00000	-00000
\$	TOTAL LAND ACRES/100MWE	113.30	113.09	114-59	113.94	100.93	102 81	107.03	106.31
2	MAIN PLANT	11.30	17.30	16.50	17.30	16.39		16.44	17.25
	DISPOSAL LAND	75+35	75.14	77+24	75.98	63 • 8Z	65,00	69.81	68.46
	LAND FOR ACCESS RR	20.65	20.65	20.85	ZD.65	20.72	20.57	20.78	20.50
	and the second sec				an a		A reason of the second second second		
~									
<u>م</u>	PARAMETRIC POINT	17	18	19	20	21	22	23	24
8-16	PARAMETRIC POINT	17 1.00197	18 • 91105	19 1.62910	20 2+35522	21 -82968	22 -84912	23 •87884	24 • 87881
8-164	PARAMETRIC POINT COAL: LB/KW-HR SORBANT OR SEED:LB/KW-HR	17 1.00197 .53014	18 91105 48204	19 1.62910 .86196	20 2.35522 1.51070	21 -82968 -43899	22 - 84 91 2 - 9 927	23 •87884 •45499	24 •87881 •45498
8-164	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED,LB/KW-HR TOTAL WATER, GAL/KW-HR	17 1.00197 .53014 .781	18 •91105 •48204 •760	19 1.62910 .86196 .776	20 2.35522 1.51070 .795	21 •82968 •43899 •799	22 •84912 •9927 •782	23 •87884 •95999 •765	24 •87881 •46498 •763
8-164	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED, LB/KW-HR TOTAL WATER, GAL/KW-HR COOLING WATER	17 1.00197 .53014 .781 .605	18 •91105 •48204 •760 •599	19 1.62910 .86196 .776 .495	20 2-85522 1-51070 -795 -308	21 •82968 •43899 •799 •652	22 •84912 •84927 •782 •632	23 •87884 •45499 •765 •510	24 •87881 •46498 •763 •608
8-164	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED, LB/KW-HR TOTAL WAIER, GA/KW-HR COOLING WATER GASIFIER PROCESS H2D	17 1.00197 .53014 .781 .605 .00000	18 91105 •4820 •760 •599 •00000	19 1.62910 .86196 .776 .495 .00000	20 2-35522 1-51070 -795 -308 -00000	21 •82968 ••3899 •799 •652 •00000	22 .84912 .44927 .782 .632 .00000	23 -87884 -95999 -765 -510 -00000	24 •87881 •46498 •763 •608 •00000
8-164	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WAIER. 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP	17 1.00197 .53014 .781 .605 .00000 .00504	18 •91105 •820 •760 •599 •00000 •00598	19 1.62910 .86196 .776 .495 .00000 .00494	20 2-35522 1-51070 -795 -308 -00000 -00307	21 •82968 ••3899 •799 •60000 •00000 •00651	22 -84912 -782 -782 -632 -00000 -00631	23 -87884 -9599 -765 -610 -00000 -00000	24 •87881 •46498 •763 •608 •00000 •00667
¹ 8–164. L	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED,LB/KW-HR TOTAL WATER, GA/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDEWSATE MAKE UP WASTE HANDLING SLURRY	17 1.00197 -53014 -781 -605 -00000 -00604 -1097	18 91105 • 48204 • 760 • 599 • 000598 • 00998	19 1.62910 .86196 .776 .495 .00000 .00494 .1784	20 2-35522 1-51070 -795 -308 -00000 -00307 -3127	21 .82968 .43899 .799 .6522 .00000 .00651 .0909	22 .84912 .782 .632 .00000 .00000 .00050 .0930	23 •87884 •46499 •765 •610 •00000 •00608 •0963	24 •87881 •763 •608 •00000 •000607 •0963
¹ 8–164. Law	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED, LB/KW-HR TOTAL WATER, 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDEWSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER	17 1.00197 -53014 -781 -605 -00000 -006C4 -1097 -06012	18 •91105 •820• •760 •599 •00000 •00598 •0998 •05\$66	19 1.62910 .86196 .776 .495 .00000 .00494 .784 .09775	20 2.35522 1.51070 .795 .308 .00000 .00307 .3127 .17131	21 •82968 •799 •652 •00000 •00651 •0909 •09978	22 .84912 .4927 .782 .632 .00000 .00509 .05095	23 •87884 •96999 •765 •610 •00000 •00608 •0963 •05273	24 •87881 •4698 •763 •608 •00000 •00607 •0963 •0573
¹ 8–164. Law.	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP. WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION	17 1.00197 .53014 .781 .605 .00000 .006C4 .1097 .06012 .000C0	18 91105 • 48204 • 760 • 599 • 00000 • 00598 • 0998 • 05466 • 00000	19 1.62910 .86196 .776 .495 .00000 .00494 .1784 .09775 .00000	20 2-35522 1-51070 -795 -308 -00000 -00307 -3127 -17131 -00000	21 •82968 •53899 •652 •00000 •00651 •0909 •09978 •00000	22 -84912 -782 -632 -00000 -00531 -0930 -05095 -00000	23 •87884 •95999 •765 •610 •00000 •00608 •0963 •0963 •05273 •00000	24 •87881 •46498 •763 •608 •00000 •00667 •0963 •05273 •00000
8-164 Law	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED, LB/KW-HR TOTAL WAIER, GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE	17 1.00197 53014 .605 .00000 .006C4 .1097 .06012 .00000 .025.37	18 91105 48204 760 599 00000 00598 0998 05466 00000 117.24	19 1.62910 .86196 .776 .495 .00000 .00494 .1784 .09775 .00775 .00000 176.34	20 2-35522 1-51070 -795 -308 -00000 -00307 -3127 -17131 -00000 278-54	21 .82968 .53899 .652 .00000 .00651 .0909 .04978 .00000 111.61	22 -84912 -782 -632 -00000 -00505 -00000 113-34	23 •87884 •46999 •765 •610 •00000 •00608 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •09000 •14 •37	24 •87881 •46498 •763 •608 •00000 •00667 •0963 •05273 •05273 •00000 114 •37
8-164. Live 1.3.4	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. GAL/KW-HR COOLING WATER GASIFIER PROCESS H20 CONDENSATE MAKE UP., WASTE MANDLING SLURRY SCRUBBER WASTE WATER NOT SUPPRESSION TOTAL LAND ACRES/IDCHNE MAT PLANT	17 -00197 -53014 -781 -605 -00000 -00604 -006012 -000000 125-37 -16-58	18 91105 •48204 •760 •599 •0000 •00598 •0998 •0558 •0998 •055866 •00000 •117-552	19 1.62910 .86196 .776 .495 .00000 .60494 .1784 .05775 .00000 176.34 .776	20 2.35522 1.51070 .795 .308 .00000 .00307 .3127 .17131 .00000 278.54 .17.85	21 82968 • 3899 • 799 • 652 • 00000 • 020651 • 0309 • 03978 • 00000 111.6547	22 84912 782 632 00000 C0631 05095 00000 113.34 16.48	23 87884 95999 -765 -610 -00000 -00608 -0963 -05273 -00000 114 -37 15 -49	24 87881 •763 •608 •00000 •00667 •0963 •05273 •00000 114-37 16-49
8-164 Las	PARAMETRIC POINT COAL, LB/KW-HR SORBANT OR SEED, LB/KW-HR TOTAL WATER, GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DTSPOSAL LAND	17 1.00197 .53014 .781 .605 .00000 .00604 .1097 .00000 125.37 16.58 87.82	18 91105 • 48204 • 760 • 599 • 00000 • 00598 • 0998 • 0998 • 0998 • 00000 117-24 15-52 79-85	19 1.62910 .86196 .776 .495 .00000 .00494 .1784 .09775 .00000 176.34 17-01 142-79	20 2.35522 1.51070 735 .208 .00000 .00307 .3127 .17131 .00000 278.54 17.85 250.26	21 -82968 -33899 -799 -652 -00651 -0909 -03978 -00000 -111-61 15-47 72-72	22 -84912 -782 -782 -632 -00000 -00930 -00930 -00930 -00930 -00930 -00000 -113-34 -76-48 -76-48	23 87884 •454999 •765 •610 •00000 •09608 •09608 •09608 •0963 •05273 •05273 •00000 114.37 15.49 77.63	24 87881 •763 •763 •00000 •00607 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •05273 •0963 •05273 •05273 •056 •0763 •056 •0763 •0760 •0763 •0760 •0763 •0760 •0763 •0763 •0760 •0763 •0760 •0763 •0760 •0763 •0760 •076 •0763 •0763 •0760 •0760 •076 •076 •076 •076 •0763 •076
8-164. Last 1	PARAMETRIC POINT COAL+ LB/KW-HR SORBANT OR SEED-LB/KW-HR TOTAL WAIER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP + WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS BR	17 •00197 •53014 •605 •00000 •00504 •1097 •06012 •00000 125-37 16-58 87-82 20-96	18 91105 *8204 *76C *593 *00000 *00598 *0398 *0398 *0398 *0398 *0398 *0398 *0398 *0398 *0398 *0398 *05466 *00000 117.24 *16*52 79*85 20*87	19 1.62910 .861956 .495 .00000 .00494 .1784 .09775 .00000 176.34 17.01 142.79 15.58	20 2.35522 1.51070 .795 .208 .00000 .00307 .3127 .17131 .00000 278.54 17.86 256.226 .10.42	21 .82968 .33899 .652 .00000 .0509 .03978 .00000 1116.47 72.72 .22.42	22 84 912 -782 -632 -00000 -0930 -000 -	23 87884 •45999 •765 •610 •00000 •00608 •0963 •05273 •00000 114.37 16.49 77.03 20.85	24 87 881 • 46 98 • 763 • 608 • 00000 • 00607 • 0963 • 05273 • 00000 • 114 • 37 • 16 • 49 77 • 03 • 7 • 03 • 20 • 85
1 8-164 Live 134	PARAMETRIC POINT COAL + LB/KW-HR SORBANT OR SEED + LB/KW-HR TOTAL WATER + GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP + WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR	17 -00197 -53014 -605 -00000 00664 -1097 -06012 -00000 125.37 16.58 87.82 20.96	18 91105 •48204 •599 •00000 •00598 •0998 •0998 •00998 •00000 117.24 16.52 79.85 20.87	19 1.62910 .86196 .495 .00000 .00494 .1784 .00775 .00000 176.34 17.01 142.79 15.54	20 2.35522 1.51070 .00000 .00307 .3127 .7131 .00000 278.54 276.26 10.42	21 82968 •\$3899 •652 •00000 •00651 •0909 •04978 •00000 111•61 15•47 72-72 22•42	22 .84 912 .632 .00000 .05053 .05095 .00000 113.34 .648 .74.42 .22.43	23 87884 96999 •765 •610 •00000 •0963 •000 •0000 •0000 •0000 •0000 •0000 •0000	24 87 881 • 64 98 • 00000 • 00607 • 00607 • 00503 • 005273 • 00000 • 14 • 37 • 16 • 49 77 • 03 20 • 85
1 8-164. Live 134 K	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE MAIN PLANT DISPOSAL LAND LÂND FOR ACCESS RR	17 -53014 -781 -605 -00000 -00604 -1097 -06012 -00000 125.37 16.58 87.82 20.96	18 91105 •48204 •595 •00000 •00598 •03 •05 •05 •05 •05 •05 •05 •05 •05 •05 •05	$\begin{array}{c} 19\\ \bullet 62910\\ \bullet 86196\\ \bullet 495\\ \bullet 00000\\ \bullet 00494\\ \bullet 1787\\ \bullet 00706\\ \bullet 0970\\ \bullet 1763\\ \bullet 00700\\ 176-34\\ \bullet 17-01\\ \bullet 142-79\\ \bullet 15-54\end{array}$	20 2.35522 1.51070 .795 .208 .00000 .00307 .717131 .00000 278.54 17.86 256.26 10.42	21 82968 •\$3899 •\$52 •000051 •0909 0\$978 •00000 11160 15.47 72.72 22.42	22 84 912 • 4 927 • 632 • 00000 • 00631 • 0930 • 05095 • 00000 113.34 16.48 74.42 22.43	23 8788 8788 610 00000 00000 000 000 000 000 000 000 000 000 000 00 000 000 000 00 00 000 00	24 87881 •5498 •00000 •00607 •0963 •05273 •00000 •05273 •00000 •14*37 •16*49 77.03 20.85
8-164. Liss and Rise	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP., WASTE MANDLING SLURRY SCRUBBER WASTE WATER NOT SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR	17 -00197 -53014 -605 -00000 -00604 -1097 -06012 -00000 125.37 16.58 87.82 20.96	18 91105 •48204 •599 •00000 •00598 •03988 •000000000 •03888 •03988 •03888 •0388 •0388 •0388 •0388 •0388 •03888 •0388 •03888 •0388 •03888 •03888 •03888 •03888 •03888 •03888 •03888 •03888 •0388 •03888 •0388 •03888 •0388 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •038888 •0388888 •038888 •038888 •038888 •038888 •0388888 •038888 •0388888 •0388888 •03888888 •038888 •03888888 •0388888 •038888 •03888888 •0388888 •03888	$\begin{array}{c} 19\\ \bullet& 86195\\ \bullet& 776\\ \bullet& 776\\ \bullet& 495\\ \bullet& 00000\\ \bullet& 00494\\ \bullet& 1784\\ \bullet& 09775\\ \bullet& 00000\\ 176\bullet 34\\ 17001\\ 142\bullet 79\\ 15\bullet 54\end{array}$	20 2.35522 1.51070 .00000 .00307 .3127 17131 .00000 278.58 17.85 250.26 10.42	21 82968 •\$3899 •652 •00005 •0965 •09978 •09978 •090978 •09097 •09978 •09000 111•61 15•61 72*72 22*42	22 	23 87884 9599 00000 00000 00000 00000 14.37 16.49 77.03 20.85	24 87 881 • 66 998 • 600000 • 00667 • 009637 • 00967 • 00967 • 009637 • 00967
8-164. Low 1.1 Kine	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER GAL/KW-HR GASIFIER PROCESS H2D CONDEWSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHME MAIN PLANT DISPOSAL LAND LÂND FOR ACCESS RR PARAMETRIC POINT	17 1.00197 -53014 -781 -00000 -005C4 -005C4 -00000 125.37 16.58 87.82 20.95	18 91105 •42204 •595 •00000 •00598 •0398 •0398 •05466 •00000 117.24 16.52 79.85 20.87 -26	19 1.62910 .86136 .00000 .00494 .1784 .09775 .00000 176.34 17.01 142.79 16.54 .27	20 2+35522 1+51070 •795 -308 •00000 •00307 •717131 •00000 278+54 17+86 25C+26 10+42	21 82968 •\$3899 •\$52 •0000 •00651 •0909 •00051 •00051 •00051 •00051 •00051 •0005 •000 •00	22 .84 912 .44 927 .632 .00000 .00631 .0930 .05095 .00000 113.34 .648 .74.42 .22.43 .30	23 87884 87884 -765 -610 00000 00000 00008 -0068 -0068 -00	24 87881 •763 •763 •608 •0000 •00607 •0963 •09607 •0963 •09607 •0963 •09607 •16-49 77.03 20.85
8-164 Live and Rideway	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP., WASTE MANDLING SLURRY SCRUBBER WASTE VAL NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. BR/KW-HR	17 -00197 -53014 -781 -605 -00000 -005C4 -1097 -06012 -00000 125.37 -16.58 87.82 20.96 -25 	18 91105 •48204 •599 •00000 00598 •0398 •0398 •0398 •00000 117.24 15.52 79.85 20.87	19 •86195 •776 •495 •00000 •00494 •1784 •09775 •00000 176.34 17-01 142.79 16.54 27 86275	20 2.35522 1.51070 .795 .208 .00000 .00307 .3127 .17131 .00000 278.54 17.85 250.26 10.42	21 82968 •\$3899 •652 •00000 •00651 •090978 •090978 •090978 •09000 11:•647 72.•72 22.•42 29 82509	22 84 912 • 782 • 632 • 00000 • 005095 • 00000 113 • 34 74 • 42 22 • 43 30 PBC 28	23 87884 87884 9599 560 00000 00608 00608 00000 114.37 16.49 77.03 20.85 31 88125	24 87 881 • 56 998 • 508 • 00000 • 0000 • 00000 •
8-164 Live	PARAMETRIC POINT COAL. LBXW-HR SORBANT OR SEED.LB/KW-HR TOTAL WAIER GAL/KW-HR GASIFIER PROCESS H2D CONDENSATE MAKE UP , WASIE HANDLING SLURRY SCRUBBER WASIE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHME MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LBXW-HR SCRUBT OF CEP.TB/WD-DB	17 -53014 -781 -605 -0000 -006C4 -1097 -06012 -000C0 125-37 16-58 87-82 20-96 -25 -86586 -86586	18 91105 76C 5930 00000 00598 00598 00598 005966 00000 117.24 16.552 75.85 20.87 26 88825 88825 88825	19 1.62910 .86136 .495 .0000 .00494 .03775 .00000 176.34 17-01 142.79 15.54 .27 .86216 .8625	20 2-35522 1-51070 -795 -208 -00000 -00307 -3127 -17131 -00000 278-54 -17-86 256-266 10-42 -10-42 -23 -84375 -84375	21 82968 • 43899 • 652 • 00000 • 00651 • 0909 • 0909 • 09378 • 00000 1116 • 1547 72.72 222.42 29 • 82609 • 82609	22 	23 8788 956999 765 610 00000 00608 0963 05273 00000 114.37 16.49 77.03 20.85 31 88125 8627	24 87881 •763 •608 00000 •09607 •0963 •09000 •05273 •00000 114-37 -16-49 77.03 20.85 32 •86450
18-164 Live of A Rishward	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WAIER GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP . WASTE HANDLING SLURRY SCRUBBER WASTE WAKE UP . WASTE HANDLING SLURRY SCRUBBER WASTE WARE NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR	17 -00197 -53014 -605 -00000 00604 -1097 -06012 -000000 125.37 16.58 87.82 20.96 -55865 -9586586 -9586586	18 91105 •48204 •599 •00000 00598 •0398 •05466 •00000 117.24 75.85 20.87 26 •84825 •44381	19 •86195 •776 •495 •00000 •00494 •1784 •05775 •00000 176.34 17.01 142.79 15.54 27 •86216 •45617 •45617	20 2.35522 1.51070 .795 .208 .00000 .00307 .71713 .00000 278.54 17.86 250.26 10.42 .0.42 .84375 .4464370	21 82968 •43899 •652 •00000 •00651 •0909 •0978 •00000 11:61 15.47 72.72 22.42 29 •82609 •43709	22 .84 912 .762 .632 .00000 .05095 .00000 11334 .648 .74.42 .2243 .89628 .47422	23 87884 87884 599 765 50000 0000 000 0000 000 000 000 000 000 0000 000 000 000 000 000	24 87 881 • 5763 • 508 • 00000 • 00607 • 00607 • 00607 • 00607 • 009637 • 009637 • 009637 • 00900 • 019649 77.03 20.85 32 • 85450 • 45741
¹ 8–164. Line of A. Kilmonel	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR COOLING WATER. GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDEMSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR CORDANT OR SEED.LB/KW-HR TOTAL WATER. GAL/KW-HR	17 -00197 -53014 -605 -00000 -00604 -1097 -06012 -00000 125-37 16-37 16-37 16-37 -00000 25-37 16-37 -00000 -25-37 -25-37 -37-37 -25-37 -2	18 91105 76C 593 00000 00598 00598 05466 0000C 117.24 15.52 75.85 20.87 26 84825 54881 714 75481 724	19 •861956 •776 •776 •776 •776 •776 •776 •1784 •09755 •00000 1784 •09755 •00000 176-34 17011 142-79 16-54 27 •85617 •7355 •85617 •75557 •85617 •75557 •85617 •75557 •85575 •85575 •855757 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •855777 •8557777 •8557777 •8557777 •85577777777777 •85577777777777777777777777777777777777	20 2.35522 1.51070 00000 00307 .3127 17131 00000 278.58 17.85 250.26 10.42 250.26 10.42 23 .684375 .44543 .705	21 82968 •\$3899 •\$52 •00000 •096978 •0909 •09978 •0909 •09978 •00000 111-61 16-61 72.72 22.42 29 •82609 •43769 •677	22 34 912 -782 -782 -632 00000 -06631 -0930 -0930 -05095 -00000 113-34 -648 74-42 -22-43 -30 -89628 -99628 -750 -	23 •8788 •9599 •765 •610 00000 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0963 •0965 •0956 •0965 •0965 •0965 •0965 •0965 •0965 •0965 •0965 •0965 •05277 •005 •0555 •0555 •0555 •0555 •0555	24 87881 •763 •00000 •00607 •0963 •09000 •0963 •09000 •0963 •09000 •144-37 16-49 77.03 20.85 32 •86450 •45751 •741 •741
18-164 Live 134 Kine vari	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KH-HR TOTAL WATER 6AL/KW-HR TOTAL WATER 6AL/KW-HR	17 -53014 -781 -605 -00000 00604 -1097 -06012 -000000 125.37 16.58 87.82 20.96 -45865 -743 -590 -00000 -743 -743 -590 -743 -590 -743 -590 -743 -590 -743 -590 -743 -590 -743 -590 -743 -590 -743 -743 -743 -743 -745 -745 -745 -745 -745 -745 -745 -745 -745 -745 -755	18 91105 •46204 •595 •00000 •00598 •0398 •00000 •0 •04000 •0 •05 •05 •00000 •0 •05 •05 •00000 •0 •05 •05	$\begin{array}{c} 19\\ \bullet 86,196\\ \bullet 776\\ \bullet 495\\ \bullet 0000\\ \bullet 00494\\ \bullet 03778\\ \bullet 00494\\ \bullet 03778\\ \bullet 00494\\ \bullet 1784\\ \bullet 0379\\ \bullet 0376\\ \bullet 1760\\ 17601\\ 142.79\\ 15654\\ \hline 27\\ \bullet 86216\\ \bullet 45617\\ \bullet 552\\ \bullet 552\\ \bullet 552\\ \bullet 9725\\ \bullet 9$	20 2.35522 1.51070 .795 .208 .00000 .00307 .717131 .00000 278.54 17.86 256.26 10.42 .23 .64375 .556 .556 .0556	21 82968 •\$3899 •652 •000051 •0909 0\$978 •00000 11:61 15.47 72.72 22.42 29 <u>82609</u> •\$3769 •\$3769 •\$570 •	22 84 912 • 4 927 • 782 • 632 • 00000 • 00631 • 0930 • 05095 • 00000 113.34 74.42 22.43 30 • 89628 • 47422 • 22.43	23 87884 87884 999 765 610 0000 00000 0000 0000 00000 0000 00000 00000 0000 000000	24 87881 •763 •763 •763 •608 •00000 •09607 •09607 •09607 •09607 •09607 •0960 •09607 •0960 •09607 •0960 •09607 •0960 •097 •000
18–164 Liver ind Riseward I	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP., WASTE MANDLING SLURRY SCRUBBER WASTE WATER NOT SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. GAL/KW-HR CODLING WATER GASIFIER PROCESS H2D	17 -53014 -53014 -53014 -605 -00000 -006012 -00000 125.37 -06012 -00000 125.37 -06012 -00000 125.37 -00000 -25.36 -95865 -743 -590 -00000 -00000 -757 -757 -558 -757 -558 -558 -758 -757 -5588 -558	18 91105 •48204 •599 •00000 •00598 •0998 •0998 •0998 •0998 •00000 117.24 •00000 117.25 79.85 20.87 26 •84825 •44381 •714 •560000 •00000	19 •86195 •776 •495 •00000 •00494 •1784 •05775 •00000 176.34 17-01 142.79 16.54 27 •86216 •45617 •735 •532 •00000	20 2.35522 1.51070 .795 .308 .00000 .00307 .717131 .00000 278.54 17.86 250.26 10.42 .23 .84375 .54643 .705 .54643	21 82968 •\$3899 •652 •000051 •090978 •00000 111-61 15-67 72-72 22-42 29 •\$2609 •\$3769 •677 •677 •677 •677	22 84 912 • 4 927 • 632 • 00000 • 05095 • 00000 113 • 34 • 652 • 09305 • 05095 • 00000 113 • 34 • 648 74 • 42 22 • 43 30 • 89628 • 47422 • 750 • 632 • 00000 • 6528 • 6528 • 7620 • 6528 • 762 • 762 • 750 • 7	23 87884 •65999 •765 •610 •00000 •09633 •05273 •00000 114 •37 16 •49 77 •03 20 •85 31 •88125 •8627 •765 •610 •00000	24 87 881 • 66 498 • 608 • 00000 • 00667 • 00667 • 00667 • 00963 • 00000 • 114.37 • 00000 • 124.37 • 00000 • 124.37 • 00000 • 124.37 • 00000 • 0365 • 0365
18-164 Linis and Andrews I.	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDEWSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHME MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR CODLING WATER GASIFIER PROCESS H2D CONDEWSATE MAKE UP.	17 -53014 -781 -605 -00600 -00504 -00504 -006012 -00000 125.37 16.58 87.82 20.96 -45865 -743 -590 -00000 -00614 -0000	18 91105 • 46204 • 599 • 00000 • 00598 • 0398 • 00669 • 006	19 1.62910 .86136 .00000 .00494 .1784 .00705 .00000 176.34 17.01 142.79 15.54 .27 .86216 .532 .532 .000618	20 2+35522 1+51070 00000 000307 -717131 000000 278+54 17+86 25C+26 10+42 23 -84375 -556 -00000 -00023	21 82968 •\$3899 •\$52 •000051 •0909 •0009 •00009 •0000 •0000 •0000 •0000 •0	22 .84 912 .632 .00000 .00631 .0930 .05095 .00000 113.34 .648 .74.42 .22.43 .30 .89628 .47422 .6322 .0000 .6322 .0000	23 87884 87884 999 765 610 00000 00008 00008 00008 00000 114.37 16.49 77.03 20.85 31 88125 • 46627 • 610 00000 00000 00000 • 7.05 • 610 • 7.05 • 7.55 • 7.	24 87881 •763 •608 •0000 •00607 •09637 •09637 •09637 •09637 •09637 •09632 •09642
8-164 Live and Richards Lives	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WAIER. 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP., WASTE HANDLING SLURRY SCRUBBER WASTE VAKE UP., WASTE HANDLING SLURRY NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. 6AL/KW-HR COLING WATER COLING WATER HAR UP. COMDEMSATE MAKE UP.	17 -00197 -53014 -605 -00000 -00504 -1097 -06012 -00000 125.37 -06012 -00000 125.37 -00000 125.37 -00000 -588 -87.82 -25 -86586 -95.855 -74.3 -590 -00000 -00514 -592	18 91105 •48204 •599 •00000 00598 •0398 •0398 •05466 •00000 117.24 79.85 20.87 26 •84825 •44381 •714 •564 •564 •00619 •00619	19 •86195 •776 •495 •000000 •00494 •1784 •05775 •00000 176.34 17-01 142.79 15.54 27 •86216 •45617 •735 •582 •00618 •0944	20 2.35522 1.51070 .795 .208 .00000 .00307 .7171 .7131 .00000 278.54 17.86 25C.26 10.42 .23 .84375 .544543 .705 .500000 .00623 .00623 .00224	21 82968 • 3899 • 652 • 00000 • 00651 • 0909 • 0978 • 00000 11:•61 15•47 72.•72 22.•42 29 • 82609 • 43709 • 677 • 530 • 60628 • 09052	22 84 912 • 84 912 • 632 • 00000 • 005095 • 00000 113 • 34 74 • 42 22 • 43 30 • 89628 • 47 422 • 750 • 632 • 00000 • 113 • 34 • 632 • 00000 • 00605 • 00982	23 87884 5765 5610 00000 00608 00963 00000 114.37 16.49 77.03 20.85 31 88125 -610 00609 -06509 -0955	24 87 881 • 763 • 608 • 00000 • 00000 • 000007 • 00007 • 0
18-164 Liver and Rideousd Invision	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR GASIFIER PROCESS H2D CONDEWSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCMME MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER, 6AL/KW-HR CDOLING WATER GASIFIER PROCESS H2D CONDEMSATE MAKE UP, WASTE HANLING SLURRY SCRUBBER WASTE WATER	17 -00197 -53014 -781 -00605 -00605 -00605 -00602 -006012 -00000 125-37 16-582 87-82 20-36 -95-865 -743 -590 -0000 -00614 -552 -00000 -00614 -552 -00000 -00604 -052014	18 91105 760 5930 00000 00598 00598 00598 00598 00598 00598 00598 00598 00508 00508 26 84825 44381 714 564 00619 0929 05089	19 1.62910 .86136 .4955 .0000 .00494 .1784 .03775 .00000 176.34 17-01 142.79 16.54 .58216 .5822 .5822 .5822 .005173 .0984 .05173	20 2-35522 1-51070 -0080 -00307 -3127 -17131 -00000 278-54 -17-86 256-26 10-42 -14-85 -10-42 -23 -84375 -44543 -556 -00623 -00524 -05262	21 82968 • 3899 • 652 • 000651 • 0909 • 0909 • 0905 • 077 • 530 • 000628 • 000528 • 000558 • 00058 •	22 	23 87 884 95 999 765 610 00000 00608 00963 005273 000000 114.37 16.499 77.03 20.85 31 88125 -86627 -610 00000 00509 -0965 -0965 -0965	24 87881 • 6763 • 608 • 00000 • 000000 • 00000 • 00000000 • 000000 • 000000 • 000000 • 0000
18-164 Live with Rube was lower with	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP . WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHNE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER. 6AL/KW-HR TOTAL WATER. FALLKW-HR COOLING WATER GASIFIER PROCESS H2D COMDENSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION	17 -00197 -53014 -605 -00000 00604 -1097 -06012 -00000 125.37 16.58 87.82 20.96 -55855 -55855 -55855 -590 -00000 -00614 -0949 -00000	18 91105 48204 595 00000 00598 055466 00000 117.24 16.52 79.85 20.87 26 84825 44381 714 564 000519 00519 00509 00509 00509	19 •86195 •495 •00000 •00494 •1787 •0766-34 17-01 142-79 15-54 27 •86215 •45617 •532 •0984 •05173 •0984 •05173 •0508	20 2.35522 1.51070 .795 .2080 .00307 .71713 .00000 278.54 17.86 250.26 10.42 .23 .84375 .556 .00000 .00023 .0324 .0324 .0324 .0324 .0324 .0324	21 82968 •43899 •652 •00000 •0651 •0909 •0978 •0909 •0978 •00000 11:•61 15•47 72.72 22.42 29 •82609 •43709 •530 •00028 •0905 •0955 •0905	22 84 912 -782 -632 -00000 -06631 -0930 -05095 -00000 113.34 74.42 22.43 30 -89628 -87422 -532 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -0000 -632 -00000 -632 -648 -74-42 -632 -6532 -6553 -6552 -6553 -6553 -655	23 87884 87884 5610 00000 00000 00000 00000 10963 00000 114.37 16.49 77.03 20.85 31 88125 5627 5610 00000 00609 00965 5287 00900	24 87 881 • 56 98 • 00000 • 000000 • 00000000 • 000000 • 000000 • 00000 • 00000 • 0
18–164 Love what Reserves Investigat	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR GASIFIER PROCESS H2D CONDENSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHME MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER, EAL/KW-HR COOLING WATER GASIFIER PROCESS H2D COMDEMSATE MAKE UP, WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE	17 -53014 -781 -605 -006024 -006024 -1097 -06012 -00000 125-37 16-58 87-82 -20-96 -25 -65865 -743 -590 -00000 -00612 -00000 -00000 -00000 -05201 -05201 -00000 -05201 -00000 -05201 -00000 -05201 -00000 -05201 -00000 -05201 -00000 -05201 -00000 -00524 -00000 -00524 -00000 -00524 -00000 -00524 -00000 -00524 -00000 -00524 -00000 -00524 -00000 -00000 -00524 -00000 -00000 -00000 -00524 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -00000 -000000 -000000 -000000 -000000 -00000 -00000 -000000 -00000 -00000 -00000 -00000 -000000 -000000 -00000 -000000 -000000 -000000 -000000 -000000 -000000 -000000 -000000 -000000 -0000000 -0000000 -0000000 -0000000 -00000000	18 91105 76C 5930 00000 00598 005466 00000 117.24 75.52 75.85 20.87 26 84825 26 84825 74.85 74.85 74.85 005089 02929 05089 00000 119.22	19 1.62910 .86136 .4955 .0000 .00494 .1784 .03775 .00000 176.34 17.01 14.59 15.54 .582 .582 .05173 .5984 .05173 .00000 .0984 .05173 .00000	20 2.95522 1.51070 .208 .000307 .3127 .17131 .000000 278.54 .17.86 250.26 10.42 .23 .84375 .44543 .556 .00000 .00224 .05062 .00000 .0024 .05062 .00000	21 82968 • 43899 • 652 • 000651 • 0909 • 0909 • 09378 • 00000 111•6•47 72.72 22.42 29 • 82609 • 82609 • 82609 • 677 • 530 • 00628 • 0068 • 0068	22 34 912 -34 927 -632 00000 -0631 -0930 -05095 -00000 113.39 -36.48 74.42 22.43 -30 -648 74.42 22.43 -750 -632 -00000 -06378 -0982 -05378 -00000	23 87 88 87 88 956 999 765 610 00000 00000 00000 00000 00000 114.37 16.49 77.03 20.85 31 88125 96627 •765 •610 00000 00965 •05287 •00000 •0965 •05287 •00000 •0965 •05287 •000000 •0000000 •00000000	24 87 881 • 763 • 608 00000 • 00607 • 00963 • 00000 • 00607 • 00963 • 00000 • 14 • 37 • 16 • 49 77 • 08 20 • 85 32 • 86 450 • 741 • 589 • 000012 • 00612 • 00612
18-164 Live it A Rideous Live in Article	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KH-HR TOTAL WATER F GAL/KW-HR TOTAL WATER MASTE WATER MASTE HANDLING SLURRY SCRUBBER JASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDDHWE MAIN PLANT	17 -00197 -53014 -605 -00000 -00504 -00000 125.37 16.58 87.82 20.96 -5785 -590 -00000 -00514 -590 -00000 -00549 -00000 -00549 -00000 -00549 -00000 -00549 -00000 -00549 -00000 -00000 -00549 -000000 -000000 -00000 -0	18 91105 •46204 •595 •00000 •D0598 •0398 •0398 •05466 •00000 117.24 16.52 79.85 20.87 20.87 26 •84825 •4488 •564 •564 •564 •564 •564 •00619 •05089 •05089 •05089 •05089	$\begin{array}{c} 19\\ \bullet 86,196\\ \bullet 776\\ \bullet 495\\ \bullet 0000\\ \bullet 00494\\ \bullet 1787\\ \bullet 00700\\ 176,34\\ 17.01\\ 142.79\\ 15.54\\ \end{array}$	20 2.35522 1.51070 .795 .208 .00000 .00307 .717131 .00000 278.54 17.86 256.26 10.42 .23 .64375 .556 .00600 .00623 .0324 .0556 .00224 .03244 .0324 .0324 .0324 .0324 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .03244 .032444 .032444 .03244444444 .032444444444444444444444444444444444444	21 82968 •\$3899 •652 •00651 •0909 0\$978 •00000 111.61 15.47 72.72 22.42 29 <u>82609</u> •\$370 •00628 •09057 •00000 106.43 16.43 •00000	22 .84 912 .632 .00000 .05095 .00000 113.34 16.48 74.42 22.43 30 .899628 .47422 .2.43 30 .632 .00000 113.34 .648 .74.42 .2.43 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .00000 .632 .000000 .0000000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .00000 .00000 .00000 .00000 .00000 .00000 .000000 .000000 .000000 .000000 .000000 .000000 .000000 .00000000	23 87884 87884 999 765 610 00000 00000 00000 00000 114.37 16.49 77.03 20.85 31 88125 •6627 •6627 •6627 •6627 •00000 00000 00000 •000000 •0000000 •000000 •000000 •0000000 •0000000 •0000000 •0000000 •00000000	24 87 881 • 763 • 763 • 0000 • 00607 • 00608 • 00000 • 00607 • 00608 • 00000 • 00607 • 00608 • 00000 • 00608 • 00000 • 00608 • 00000 • 00608 • 00000 • 000000 • 00000 • 000000000 • 000000 • 00000 • 00000 • 00000
1 8–164. Line of A Ride on State Institution	PARAMETRIC POINT COAL+ LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER & GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDENSATE MAKE UP , WASTE HAWDLING SLURRY SCRUBBER MASTE VATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL + LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER & GAL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDEWSATE WAKE UP , WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDDWE MAIN PLANT DISPOSAL LAND	17 1.00197 .53014 .605 .00604 .00604 .00602 .00000 125.37 16.58 .875.8658 .743 .590 .00000 .004514 .6949 .05201 .00000 .0349 .05201 .00000 .0349 .05201 .00000 .0349 .05201 .00000 .0349 .05203 .05203 .05203 .05203 .05203 .05249 .05203 .05249 .000000 .00000000	18 91105 76C 593 00000 00598 0398 05466 0000C 117.24 16.52 79.8825 20.87 26 84825 44881 714 00619 02329 05089 00000 110.02 16.46 74.35	19 1.62910 2.86136 .4950 .00494 .9775 .00000 176.34 17.01 14.07 16.54 .735 .65617 .735 .656216 .735 .65627 .6554 .6555 .6555 .6555 .6555 .6555 .055557 .055557 .055557 .055557 .055557 .055557 .055557 .05577 .05577 .05577	20 2.35522 1.51070 .208 .00307 .17131 .00000 278.52 17.86 250.25 .0042 .0042 .0042 .0042 .0042 .0042 .005	21 82968 •\$3899 •652 •00000 •00651 •090978 •00000 11:•647 72.*72 22.*42 29 •82609 •\$3709 •677 •530 •60000 •0905 •0905 •09000 •00528 •0905 •0905 •0907 •00000 •00000 •00000 •00000 •00000 •0000	22 34 912 -4 927 -782 -632 00000 -06631 -0930 -05095 -00000 113.34 -648 74.42 22.43 -89628 -89628 -89628 -9762 -632 -0000 -0582 -00000 -0582 -05878 -00000 -0582 -05878 -00000 -0582 -05878 -00000 -0582 -058378 -00000 -0582 -058378 -00000 -0582 -058378 -00000 -0582 -058378 -00000 -0582 -0595 -00000 -050000 -05000 -00000 -05000 -05000 -000000 -0000000 -00000 -00000000	23 87 88 87 88 95 99 765 61C 00000 00000 00000 00000 00000 114.37 16.49 77.03 20.85 31 88125 6627 765 60000 00000 00000 00060 00060 00060 00060 00060 00060 00060 00060 00060 00060 00060 00060 00060 00060 00060 000000	24 87881 •763 •608 00000 •0963 •0963 •09000 •0963 •09000 •0963 •09000 •0963 •0963 •09000 •0963 •0968 •09
1 8-164 Live and Richards Investigated I	PARAMETRIC POINT COAL. LB/KW-HR SORBANT OR SEED.LB/KW-HR TOTAL WATER 6AL/KW-HR COOLING WATER GASIFIER PROCESS H2D CONDEWSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER WASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHME MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR PARAMETRIC POINT COAL. LB/KW-HR CODLING WATER GASIFIER PROCESS H2D CONDEWSATE MAKE UP WASTE HANDLING SLURRY SCRUBBER VASTE WATER NOX SUPPRESSION TOTAL LAND ACRES/IDCHWE MAIN PLANT DISPOSAL LAND LAND FOR ACCESS RR	17 -53014 -781 -605 -00600 -00604 -00602 -00000 125.37 16.58 87.82 20.96 -958 	18 91105 48204 593 00000 00598 00586 00000 117.24 16.52 79.85 79.85 79.85 20.87 26 84825 44381 714 564 00619 00598 00598 00000 10.52 17.44 564 5083 00000 10.52 10	19 1.62910 .86136 .0000 .00494 .1787 .0000 176.34 17.01 142.79 15.54 .532 .00058 .0944 .05173 .0944 .05173 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .05173 .00406 .0944 .0516 .0944 .0516 .0526 .0516 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .0056 .00576 .0056 .0056 .0056 .00576 .0056 .00576 .00566 .00576 .00566 .00576 .005666 .005666 .005666 .005666 .005666 .0056666 .0056666 .0056666 .005666666 .00566666666666666666666666666666666666	20 2.35522 1.51070 .795 .208 .00000 .00307 .717131 .00000 278.54 17.86 25C.26 10.42 .00423 .84375 .556 .00623 .00623 .00262 .00623 .00262 .00262 16.46 .45 .555 .19.20	21 82968 •\$3899 •\$52 •000051 •0909 •0909 •0978 •00000 111.61 15.47 72.72 22.42 29 •82609 •82609 •3769 •530 •00028 •09052 •09052 •09052 •0957 •09052 •0957 •09052 •0957 •09052 •0957 •0957 •0955 •0055 •0955 •00	22 	23 87884 87884 9610 00000 00000 00000 00000 00000 00000 00000 00000 114.37 16.49 77.03 20.85 31 88125 •46627 •00509 •005000 •00500 •00500 •00500 •005000 •005000 •00500 •00	24 87 881 • 763 • 763 • 0000 • 00607 • 00607 • 00607 • 00607 • 00607 • 00607 • 00607 • 00607 • 00607 • 00608 • 00000 • 00607 • 00608 • 00000 • 000000 • 00000 • 00000 • 00000 • 000000 • 00000 • 000000 • 00000000 • 000000 • 00000 • 00000 • 00000 • 00000

REPROS ECON ET

Table A 8.2.3 Continued

÷.,

RANKINE METAL VAPOR TOPPING-STEAM CYCLE NATURAL RESOURCE REQUIREMENTS

	PARAMETRIC POINT	23	34	35	36	37	38	39	40
	COAL, LB/KW-HR	37400	85998	-83709	.87760	94018	-8633 <u>3</u>	92544	.74719
	- TOTAL WATER CALIKN-HR	-754	-749	-636	-46434	-43/45	-45679	-153	•39534
:	COOLING WATER	600	597	-548	1000	COC.	000	.000	662
	GASIFIER PROCESS H20	.00000	.00000	.00000	.00000	33000.	.00000	_ <u>.000000</u> _	•00000
	CONDENSATE MAKE UP	.00614	.00617	.00623	.00508	-00594	C0614	•00599	•D0597
	WASTE HANULING SLURRY	•U95/	• U942	=U31/	•0961	-1U3U	•0346	a1015	-0818
	NOY SUPPRESSION	-00000		10000		10000			-00000
:	TOTAL LAND ACRES/100MNE	113.94	112.68	109.02	93.35	178.51	92.09	175.5C	112.72
	WAIN PLANT	16.49	16.48	16.45	16-43	16.67	16-42	16.66	24-88
<u> </u>	DISPOSAL LAND	76.61	75.38	13.37	76.9Z			<u>81</u> -20	55-92
	LAND FUR ALCESS RR	20#04	20.03	13.20	• • • •	12043	•uu	11.14	22+35
	PARAMETRIC POINT	41 7870C	42	45	70000	45	46 77077	47	48
	SORBANT OR SEED I B/KU-HR	-39538	- 39535	-41847	-41851	-15155	-33982	-73987	-13013
	TOTAL WATER - GAL/KW-HR	796	796	839	839	639	780	780	780
_	COOLING WATER	.652	.562	•652	.652	•652	.649	.548	.549
	GASIFIER PROCESS H20	-00000	-00000	-C4555	-04556	-04555	-00000	000000	•00200
	WASTE HANDI THE SLUPPY	-00057	-00057	+00007	-00607	-0266	-0207	-00635	-0207
	SCRUBBER WASTE WATER	04434	04483	04745	04746	-04745	04421	04421	-04420
	NOX SUPPRESSION	- 00000	-0000C	.00000	.00000	.00000	•00000	.00000	.000000
	TOTAL LAND ACRES/100HWE	108.42	102.84	114.83	110.25	104-41	103-31	111-77	100-61
i	TALN PLANT	19.51	19.35	- 20.13	20.21	12-03			14.0.22
	LAND FOR ACCESS RR	23.41	22 99	22 18	23 24	22 82	22.33	22.33	21.69
œ							-2		
Ė.			.						
Ūn i	PARAMETRIC POINT	49	50	51	52	57	58	55	56
	COAL + LB/KW-HR	.74665	79091	.00000	.00000	-00000	-00000	-00000	-00000
	SORBANT OR SEED + LB/KW-HR	39505	.41847	.C00000	.00000	-00000	.000000	.000000	00000
	TOTAL WATER, GAL/KW-HR	•737	-839	-000	.000	•00C	•000	•000	-000
	COOLING WATER	2000	n#552	2000	0000	000	003	0000	000
	CONDENSATE MAKE UP	00636	80687	.000000	-00000	-00000	100000	-000000	-000000
÷	WASTE HANDLING SLURRY	.0818	-0865	.0000	. 0000	0000	.0000	.0000	-0000
· •	SCRUBBER WASTE WATER	.04480	.04745	.00000	00000	-0000C	-00000	-00000	•00000
	NOX SUPPRESSION	100000	100000	-000000	-00000	•00000	•0000 <u>0</u>	-00cöö	-000000
<u>م</u> لينة	MATN PLANT	16.40	17.26	-00	- 00	 			UU
	DISPOSAL LAND	65.44	66.49		.00	100	00.	JO.	-00
	LAND FOR ACCESS RR	20.73	22-18	• 00	• DŪ	-00	-00	+00	-00

BRKPT PRINTS

APPENDIX A 8.3

DETAILED ACCOUNTS LISTING POINTS 1, 4, 49, and 46

RANKINI MITAL VAPOR TOPPING-SIEAM CYCLE ACCOUNT LISTING								
ACCOUNT N	0. & NAME.	UNIT	AMOUNT	HAT S/UNIT	INS SJUNIT	HAT COST#\$	INS COST,\$	
STTE DEVELO	PMENT	LCOT	197 6	1000.00	 חר	197000 00		
1. 2 CLEAP	ING LAND	ACRE	62.3	1000-00	60C 0C	187666.00	37396-25	
1. 3 GRADI 1. 4 ACCES	NG LAND	MILE	187.0	115000.00	110000.00	375000.00	550000.00	
1. 5 LOOP	RAILROAD TRA	CK MILE	2.5	120000.00	76060.00	300000-00	175000.00	
1. 7 OTHEN	SITE COSTS	ACRE	COUNT 1 :	-00 -854 ACCO	INT TOTAL S	396406.86	396406-85	
i chochi i t	THE DIRECT C	.0				190,00100	1,12002012	
EXCAVATION	& PILING	1 Y D7	75150 0		7 PA		225850 00	
2. 2 PILIN	IG	FT	200400.0	6.50	8.50	1302600-00	1703-00-00	
PERCENT_I	HAL DIRECT C	IN AL			UNI LIUIALES		1328850-00	
PLANT ISLAN	D CONCRETE						_	
3. 1 PLAN	IS CONCRET	S YD3	25050.0			<u>1753500</u> .00	2004000.00	
PERCENT	TAL DIRECT C	OST IN AC	COUNT 3 =	1.021 ACCO	JNT TOTAL \$	1753500.00	2004000-00	
HEAT DE LECT	TON SYSTEM							
4. 1 COOLI	NG TOWERS	EACH	13.0	•00	-00	1995500.00	994500-00	
4 3 SURF	CE CONDENSER	FT2	334080.2	00	CC	1747562 12	268856 17	
PERCENI IC	HAL DIRECT C	USI IN AC	COUN1 4 -	2-086 ACCO	JNT IDIAL+S	4882305-31	2/90937-34	
STRUCTURAL	EEATURES.							
5. 1 STAT 5. 2 SILOS	STRUCTURAL & SUNKERS	ST TON	27300.0	C5C-CC 1800-CD	175 CC 756 DC	17745000.00	4777560.0C	
5. 3 CHIM	TURAL FEATUR	FT FACH	•C	725000-00	15000.00	725000-00	155000 00	
PERCENT	TAL DIRECT C	OST IN AC	COUNT	6 364 ACCD	UNT TOTAL .S	18470000.00	4943500-00	
OUT DTHAC								
5. 1 STATI	ON EUTLOINGS	FT3	7500600.0	•15	.15	1200000.00	1200000-00	
5. 2 ADNIN 5. 3 WAREH	OUSE & SHOP	FT2	20000.0	16.00 12.00	14.CC 8.00	320000.00 240000.00	280000.00	
PERCENT TO	TAL DIRECT C	OSI IN AC	COUNT E =	ACCO	INT TOTALES.	176000.00	169000.00	
FUEL HANDET	NG & STORAGE	•						
7. 1 COAL	HANDLING SYS	ТРН_	499-5	•00	<u>00</u>	10117825-12	- 1313571 .81	
	OIL HAND. SY	S CAL	25000000		.00	290836-01	227825-41	
PERCENT H	TAL L'AREUT C			- 3.433 AUCUL	DNI LUIALIS	136//662.62	6103743 • 34	
FUEL PROCES	SING		-				•	
3. 1 COAL 8. 2 CARBO	DRYER & CRUS	HER TPH	0	0000	00 00	- 00 - 60	-00	
8. 3 GASIF	IERS	TPH	• 0	.00	• OG	- 00	• 00	

REPRODUCTICLY OF THE ORIGINAL CODES FOOD

Table A 8.3.1 Continued

	RANKINE METAL	VAPOR TOPP	ING-SI	TEAM CYCLE	ACCOUNT LIST	ING	
ACCOUNT NO.	8 NAME + U	INIT ANO	DAT 1	HAT SJUNIT	INS SUNT	HAT COST-S	INS COST#\$
FIRING SYSTEM 9.1 PERCENT TOTA	1_DIRECI_COSI	IN ACCOUNT	•0 9 =	.00 	.CG	•00	•00
VAPOR GENERAT	OR (FIRED)		•				
10. 1 PRESSUR 10. 2 FLUID B PERCENT TOTA	IZE BOILER ED SOILER L DIRECT COS	EA EA I IN ACCOUNT	4.0 10 =	.00 14912000.00 25.333 ACCOU	8387999.94 JNT TOTAL:5	59648000.00 59648000.00	33551999.75 33551999.75
ENERGY CONVER 11. 1 STEAM T 11. 2 GAS TUR	TER URBINE GENERI BINE GENERATO	TOR	1.0	19708000.00 7200000.00	1255014.50	19700000.00 28800000.00	1255014.50
11. 3 LIQUID 11. 4 LIQUID 11. 5 LIQUID	<u>METAL TURB-GE</u> Metal drum Met recirc pu	INP	8.0 4.0 4.0	<u>3000000.00</u> 650000.00 215000.00	270000.00 95000.00 17200.00	24000000.00 2600000.00 860000.00	2159999-97 380000-00 68800-00
11. 6 LIQ MET 11. 7 LIQ MET 11. 8 LIQ MET	COLD LEG PIP COLD LEG PIF CONDENSATE I	NG 201 E 131 PUMP		2330.00 310.00 450000.00	780-00 104-00 36000-00	4650000.00 403000.00 1800000.00	1560000.00 135200.00 144000.00
11. 9 LIS MET PERCENT TOTA	INVENTORY L DIRECT COST	IN ACCOUNT	110=	675000.00 25.963 ACCOL	13500.00 INT TOTAL	675000.00 83498000.00	13500-00 12020514-37
COUPLING HEAT 12.1 L M CON 12.2 HOT WEL	EXCHANGER D-STEAM GEN L TANK	EA EA	4.0 4.0	1610000.00	690000.00 110000.00	6440000.00 2900000.00	2760000-00 440000-00
PERCENT TOTA	L DIRECT COST	IN ACCOUNT	12 =	3.409 ACCD	INT TOTAL+S	9390000.00	3280000-08
13. 1 GAS-AIR 13. 2 ECONOMI 13. 3 GAS SEE	RECUPERATOR		•0 •0	-00 -00	•00 •00	00. 00-	•00 •00
13. 4 FEED WA	TER HEATER ST L DIRECT COST	RING IN ACCOUNT	$\frac{1}{13} =$	1500000.00 \$20 ACCOU	INT TOTAL S	1500000,00 1500080,00	45000 00 5000 00
WATER TREATHE		SDM 1	5-3	2500-00	700-00	288230.90	90707.20
14. 2 CONDENS PERCENT TOTA	ATE POLISHING	KWE 72060 IN ACCOUNT	14 =	1.25 .484 ACCOU	.30	900749.98 1188989.97	216180.00 296887.20
POWER CONDITI	ONING B TRANSFORMER	8807	33.3	-00-	.00	1594347.28	31886.95
15. 3 GAS TUR PERCENT TOTA	B TRANSFORMER L DIRECT COST	RMER 2296 3562 In Account	25-6 17.8 15 =	2.359 ACCOU	LCG	2545736.06 8647246.37	637-74 00 32524-68

Table A 8.3.1 Continued RANKINE METAL VAPOR TOPPING-STEAM CYCLE ACCOUNT LISTING ACCOUNT NO. & NAME . UNIT AMOUNT MAT S/UNIT INS S/UNIT MAT COST.S INS COST.S AUXILIARY KECH _GUIPKENT 15.1 JOILER FETO PUMP EDR.KW_ 534575.G 1.57 .18 1143231.87 68457.08 16.2 OTHER PUMPS KWE 5840C5.G .38 .12 661920.EC 82080.00 16.4 AUXILIARY BOILER PPH .0 4.06 .30 50000.00 200000.00 832199.99 16.4 AUXILIARY BOILER PPH .0 620000.00 200000.00 620000.00 200000.00 16.5 LIG MET RECEIVING-PROC 1.0 620000.00 150000.00 5200000.00 200000.00 16.5 LIG MET SIGNAGE TANK EA .942.1300000.00 150000.00 80000.00 200000.00 16.5 LIG MET SIGNAGE TANK EA .942.1300000.00 150000.00 80000.00 250000.00 16.5 LIG MET SIGNAGE TANK EA .942.1300000.00 150000.00 80000.00 250000.00 16.8 COVER GAS.SYSTEM EA 1.0 176000.00 400000.00 250000.00 340000.00 16.9 LIG MET DUMP TANK EA 4.0 570000.00 85000.00 340000.00 340000.00 16.9 LIG MET DUMP TANK EA 4.0 570000.00 85000.00 340000.00

 PIPE & FITTINGS
 1370.0
 3000.00
 1800.00
 9110000.00
 2466000.00

 17.1 CONVENTIONAL PIPING TON
 1370.0
 3000.00
 1800.00
 9110000.00
 2466000.00

 17.2 HOT CAS PIPING EA
 4.0
 220000.00
 00
 80000000
 00

 17.3 STEAM PIPING & FITTINGS
 0
 0
 00
 00
 00

 PERCENT TOTAL DIRECT COST IN ACCOUNT 17 = 4.179 ACCOUNT TOTAL.5
 12310000.00
 2466000.00

 -----_____

 AUXILIARY ELEC EQUIPMENT
 1140000.0
 1.40
 .17
 1596000.00
 193800.00

 18. 1 MISC MOTERSETC
 1140000.0
 1.95
 .95
 2223000.00
 513000.00

 18. 2 SWITCHGEAR & MCC. PAN.KWE
 1140000.0
 1.95
 .95
 2223000.00
 513000.00

 18. 3 CONDUIT.CASLES.TRAYS
 FT
 4930000.0
 1.32
 1.36
 5507599.94
 6704799.94

 18. 4 ISOLATED PHASE BUS
 FT
 17CC.0
 510.00
 452.00
 857000.00
 490200.00

 18. 5 LIGHTING & COMMUN
 KWE
 1140000.0
 .35
 .43
 39500.00
 490200.00

 18. 5 LIGHTING & COMMUN
 KWE
 1140000.0
 .35
 .43
 39500.00
 490200.00

 18. 5 LIGHTING & COMMUN
 KWE
 1140000.0
 .35
 .43
 39500.00
 490200.00

 18. 5 LM.LEAK DETECTION SYSTEA
 .140
 250000.00
 .250000.00
 200000.00
 200000.00

 18. 7 LM TRACE HEATING SYSTEM
 1.0
 2500000.00
 200000.00
 2000000.00
 2000000.00

 PERCENT TOTAL DIRECT COST IN ACCOUNT 18 = 6.852 ACCOUNT TOTAL \$
 14342599.87
 10866799.75
 10866799.75

 8-169
 CONTROL, INSTRUMENTATION
 EACH
 1-C
 560000.00
 15000.00
 55000.00
 15000.00

 19. 2 GTHER CONTROLS
 EACH
 1.0
 125000.00
 74000.00
 77400.00
 77400.00
 77400.00
 74000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00
 78000.00

 PROCESS WASTE SYSTEMS
 .0
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 .00
 STACK BAS CLEANING 21. 1 PRECIPITATOR 21. 2 SCRUBBER 21. 3 MISC STEEL & DUCTS EACH . KNE
 1.1.1
 PRECIPITATOR
 EACH.
 .0
 8784224.25
 5709745.69

 21.4
 2
 SCRUBBER
 KNE
 .C
 21.51
 5.86

 21.3
 MISC STEEL & DUCTS
 0
 .CC
 .CC

 PERCENT TOTAL DIRECT COST IN ACCOUNT 21
 .DCE
 ACCOUNT TOTAL.S
 .00 -CC . CO .00 •06 .00 ٠. TOTAL DIRECT COSTS.S . . 269573120.00 98227531.00

. .

Table A 8.3.2

RANKINE METAL VAPOR TOPPING-STEAN SYCLE COST OF ELECTRICITY.MILLS/KW.HR PARAMETRIC POINT NO. 1

ACCOUNT	RATE	LABOR RATE , SAHR	
Contraction of the state of the	PERCENT 5.00	8.50 10.60 15.	00 21.5C
TOTAL DIRECT COSTS #5	.C 3252736C8.	348440475. 367900648. 40857	4340. 468908204.
INDIRECT COST \$	51.6 28356249.	40171352. 50096040. 7089	0622. 101609892.
PPOF & OWNER COSTS +5	0.0 26021083.	27375238 29432652 3269	3947. 37512656.
CONTINGENCY COST.\$	9.5 30900392.	33101845. 34950561. 3882	4062 44546279
SUB TOTAL + S	.0 410552736.	449588908. 482379296. 55108	2960. 652577024.
ESCALATION COST.S	6.5 113026815.	123773630. 132800955. 15171	5348. 1/965/0/2.
INIRESI DURING CONSIS_	<u>11-0</u> <u>136941182</u>	- 149961822 - 160839102 - 16301 797790359 - 776079000 - 90651	3792 100907255
TUTAL CAPITALIZATION +>	10 5 10 41057	26,17138 21,64255 24	72504 29 27876
COST OF FLEC-ENT	.0 3.03106	2-08105 8-08105 3-	03106 3.08105
COST OF ELECTOLL	-D 1-86282	1.86282 1.85282 1.	85282 1.86282
TOTAL COST OF FIEC	0 28.36336	30.11527 31.58645 34.	66893 39.22259
TOTAL GODT OF CLEV			
ACCOUNT	RATE	CONTINGENCY. PERCENI	
	PERCENT -5.00	-06 S-58 5-	
TOTAL DIRECT COSTS.S	.6 357900543.	36/300648• 36/900648• 36/90	U548= 35/360548= 2040 - 50052080
INDIRE CI CUSINS	0 D 20030040+	29N72D52, 29A32D52, 29A3	2052 29432052
CONTROCHON COST -	20 0 _19735072	1. THOSE 1. 1879	5032 73580129
SHO TOTAL COST -	.0 429033764	447423736 482379296 46582	3768. 521008864.
ESCALATTON COST-S	6.5 118114699.	123178926 132800955 12824	3152 143435830
INTREST DURING CONST. \$	10.0 143105553.	149241230, 160399162, 15537	7012. 173784178.
TOTAL CAPITALIZATIC: +\$	G 690253958.	719848944. 776079403. 74944	3928. 878228664.
COST OF ELEC-CAPITAL	13.0 19.24914	20.07446 21.64256 20.	89973 23-37573
T COST OF ELEC-FUEL	_C 3_C8166	8.08105 8.08106 8.	08106 8-08106
COST OF ELEC-OF & MAIN	0 1.86282	1.35282 1.85282 1.	56232 1.86282
S TOTAL COST OF ELEC	U 29.19303	3U-U1835 31-58645 3U-	84301 33-31301
ACCOUNT	DATE	ESCAPATION DATE. PEDCENT	
ALL MURLE	PERCENT 5.00	6.5C 8.DO 1C.	00 00
TOTAL DIRECT COSTS+S	C 367900643.	367900049. 367900648. 36790	C648. 357900648.
TNDTRFCT COST .S	51.C . 5003604C.	50096040. 50096040. 5009	6040. 50096040.
PODE P OUNTO COSTS -S	0 C 20172552	- 296720112. 296720152. 2967	2052 29432052

 TOTAL DIRECT COSTS:\$
 .C
 36790C643.36790C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.3670C648.379296.482779296.48277296.48277296.48277296.48277296.48277296.48277296.48277296.48277266.4827128089106.8081068.081068068.0810680682.1.886282.1.886282.1.886282.1.886282.

ACCOUNT	RATE		INT DURING	CONST. PERCEN	Ц.,	
	PERCEN	T 6.00	5.00	10.00	12.50	15.60
TOTAL DIRECT COSTS \$	•D	367908648.	367900648.	367900648.	367900643.	367906643.
INDIRECT COST.S	51.0	50096040.	5667684C.	50006040.	50096040.	50096640.
PROF & OWNER COSTS.S	8 <u>. C</u>	25432052	29432052.	23432052-	29432052	29932052
CONTINGENCY COST +S	9_5	34950561.	34950561.	34950551.	34950561.	34950561.
SUB TOTAL .S	_ 0	482379296.	482379296.	492379296.	482379296.	482379296+
ESCALATION COST+\$	6.5	132800955.	132806955.	132800955.	132800955.	132800955.
INTREST DURING CONSTRS	15.0	927.26997.	125149246.	160899162.	206271256	2538766.64 .
TOTAL CAPITALIZATION +5	_ C	707907240.	741329468.	776679468.	821451504 .	869056912.
COST OF ELEC-CAPITAL	18.0	19.74144	20.67349	21.64256	22.90786	24.23543
COST OF ELEC-FUEL	" Ω	8.08105	9.CS105	8.08100	8.08106	8.08105
COST OF ELEC-OP & MAIN	.0_	1.35232	1.86282	1.96282	1-86282	1.86232
TOTAL COST OF ELEC	.0	29.68533	30.61738	31,58645	32.85174	34.17932
Table A 8.3.2 Continued

RANKINE METAL VAPOR TOPPING-STEAN CYCLE COST OF ELECTRICITY.MILLS/KW.HR PARAMETRIC POINT NO. 1

ACCOUNT	RATE	FIXED CHARGE RATE, PCT	
	PERCENT 10.CC	14.40 18.00	21.60 25.00
TOTAL DIRECT_COSTS .S	G 35790E648.	367902648. 367900648.	50092048 50095040
INDIRECT COSTAS	8 r 23432852	29432052 29432052	29432052 29432052
CONTINGENCY COSTAS	9.5 34950551	34950561 34950561	34350561. 34950561.
SUB TOTAL +\$.0 482379296	482379256. 482379296.	462379296 482379296
ESCALATION COST.S	5.5 132800955.	132800955. 132800955.	
INTREST DURING CONSIS	<u>10.0 160899167</u>	776079669 775079608	775073008 775073408
IDIAL CAPITALIZATION **	25 0 12.02755	17-31405 21-64256	25.97108 30.05912
COST OF ELEC-CAPITAL		8.02106 8.03106	3.08106 8.08105
COST OF FIEC-OP & MAIN	1_8E282	1.86282 1.85282	1.86282 1.86282
TOTAL COST OF ELEC	.0 21.96753	27.25794 31.38645	5 35-91496 40-00 300
A GOOLINT	DATE.	FUEL COST. \$710446 BTL	
	PERCENT .SC	.85 1.50	2.50 1.02
TOTAL DIRECT COSTS - S	.0 367900648.	367906648. 367900648.	357900648. 367900648.
INDIRECT COST.S	51.0 50096040.	. 50096040 . 5009604C.	, 50096040. 50036040. 20872052 29872052
PROF & OWNER COSIS.S	8.0 29932052	<u>29932052</u> 30950561 <u>30950561</u>	
CUNILINGENCI CUSIPS	5.5 54550501 8 182379296	452379296, 482379296.	482379296. 482379296.
FSCALATION COSTAS	6.5 132800955	132800955. 132800955.	132800955 132800955
INTREST DURING CONST.S.	18.0 160899162.	160899162 160899162	160399162 160899162
TOTAL CAPITALIZATION,S	.0 776079408	776079408 776079408	775073408 776079408
COST OF ELEC-CAPITAL	19-0 21-64259	21.64256 21.64256	23.75783 9.59728
COST OF ELECTIVEL	-D 1-86233		1.86282 1.85282
TOTAL COST OF FLEC	28 2589	31.58545 37.76609	47.27322 33.20265
7	- • • • •	CADACTTY EACTOR. REPORT	INT
ACCIUNI	PERCENT 12-00	45.00 50.00	65.00 80.00
TOTAL DIRECT COSTS .S	C 367900648.	. 367900648. 367900648.	367900648. 367900648.
INDIRECT COST, 5	51.0 50096040.	50096040. 50098040.	50096040. 50096040.
PROF & OHNER COSTS +	8,C 29432052.	29432652 29432052	29932052 29932052
CONTINGENCY COST.S	9.5 34950551	. 34950361. 34930561. 	AR2379296 AR2379296
SUB IDIAL S	5 132800955	132300955, 132800955	132300955 132800955
TWIREST DURING CONST.S	10.0 160899162	160899162 160899162	160899162. 150899162.
TOTAL CAPITALTZATION,5	.0 776079403	776079408. 776079408.	776079409. 776079408.
COST OF ELEC-CAPITAL	18.0 117.2305	31.26148 28.1353	21.54256 17.58458
COST OF ELEC-FUEL	- <u>C</u> <u>S</u> -CS105		5 8.08105 5 1.86282 1.78821
TOTAL COST OF FLEC	128-4235	41-36752 38-1905	31-58645 27-45386
IDIAL CUST OF ELEC) 47930125 2097202-	

		RANK	INE MET	AL VAPOR	TOPPIN	G-STE	EAM (CYCLE						
	ACCO	UNT NO A	UX POWE	RIMWE I	PERC PL	ANT P	PO¥	OPERATIO	IN COS	T MAINT:	ENANCE C	OST		
				8-29750		13.54	4654		5-44	310	13,13			
		É.	1	1-97123		18-02	2377	141	.000	100	-00			
		14		00000		.00	DOOO	1	2.470	166	-00	000		
		- 18		7 9 32360		15.5	4311		3.75	205	00			
	тот	ALS	5	6.41913		5.85	5923	149	57 ST	ăăă	13.13	911		
	NOW	RANKINE NETA	LVAPOR	TOPPING-	-STEAM	CYCL	E BA	SE CASE I	INPUT			77 5200		
••••	NOM	HEAT RATE.	BTU/KW-	HR	8980.92	07	NE	T HEAT RA		STU/ KW-H	R	507.1334		
	ST	TURB HEAT RA	TE CHAN	IGE	1.01	70								
	CON	DENSER	. TN UG		3 50	00		WRED NE S	WELLS	-		3-000		
	NUM	BER OF TUBES.	/SHELL		7035 57	20	TU	BE LENGTE	I. FT			69.5067		••••
	U.	BTU/HR-FT2-F			508.55	35	TÉ	RMINAL TE	IMP DI	CFF F		5.0000		
	1112	TON TEMP. F			77.00	inn	API		-			15-6713		
	RAN	GE, F	··· • ···		23.00	iõč -	OF	F DESIGN	TEMP	F	·····	51.1000		
	011	DESIGN PRES	* IN HG	A	4.11	.86	LP	TURBINE	BLADE	LEN. L	N	25.0000		
_		1200.1	0002		000	3_			098	4	00	5		-SCO
	Ģ	726.6	00 7	-	3.500	_ <u>2</u> _2	33961	000000000000000000000000000000000000000			3.000	10	1.	000
	11	2-0	00 12	1	91-500 87-000	18		3-00	10 19	t A		20	2	580
_			22	250	50,000	23		.00	10 24	i	7300.000	25		000
	26	7500000.0	00 27	2000	000.000	26		20000.00		2601	0000-000	30	· _ •!	500
	35	493868đ či		170	000.000	วี้รี้		1.00	io že	3	1.000	40	725000	666
	- 11-	166000.0	00 42.	6600	00.000	43		15000.00	0.4	1.25	000.0000	. 45	7.75000-	000
	45	-0	00 47		5.350	48		3.01	10 49	3	2.000	50		000
	ິ່1		000 ~~?		4,000	. 3		•0	000	4	.86	0 5	23300000	.000
			00 7		1.000	. <u>3</u> .		4.00	<u>ic</u>	3	8.000	10.		000
	16	19700000.0		200	100 100	13	7	200000.00	10 11	•	4.000	20	3000000	000
œ	21.	•01	CO 22	65000	000.00	23		95000.00	10 20	21	5000-000	25	•	ŏŏŏ
4	25	2330.0	$\frac{00}{10} - \frac{27}{77}$	6750	80.000	28		310-00	20 23	9	104,000	30	450000-1	
72	35	2300000.0	00 37 00 37	e i bu	000	33		725868.00	10 39 10 39	11	0006,000	30 40	4	000
	51	- 01	06 42		.000	43		1.00	10 44	ł	-000	45	•1	ŌŌŌ
	- 45	<u>- Ui</u>	00 47	15000	<u>-000</u>	43		•UL	30 49 30 50	3		56 .		
4.	รีธิ	.0	00 57	200000	000	53		1.00	io 59	3	4.000	60	1.	000
	61	1-01	62 62	00000	4.000	63	6	200800-00	00 64	200	000.000	ទុទ	1300000-0	000
	<u>60</u> 77	570000-0	11 72	3601	00.000 00.000	73-	····· /	ຊວມນາມມູດໄ ຊູກເ	10 - 50	226			.9800000.	
	75	1.0	ŏŏ 77		1.000	78	:	250000.00	jõ 79	5 20	000.0000	зč	2500000	000
	81	2000000.0	00 <u>82</u>		•CCC	83		- 22	30 84	1	-000	35		200
		1	<u>92</u>		CON	93	-			2		95	. 1.	
2	96	0	çe 00		.000	28		.00	iõ ši	ė	-000	100	-1	000

REPRODUCT ORIGINAL are ao e

	RANKINE META	L VAPOR	TOPPING-S	TEAM CYCLE	ACCOUNT LIS	TING	
ACCOUNT NO.	& NAME.	UNIT	AMOUNT	MAT SZUNIT	INS SJUNIT	MAT COST.s	INS COST,\$
SITE DEVELOPH	IENT	ACRE	198-0	1006-00	-86	198000-00	-00
1. 2 CLEARIN	G LAND	ACRE			600-00 7020-00	-00	39596 04
1. 3 GRADING 1. 4 ACCESS 1. 5 LOOP RA	RATLROAD	MILE	5.0	115000-00 120000-00 125000-00	110000.00 70000.00	575000-00 360000-00	55000C.00 210000.00
1. 7 OTHER S PERCENT TOTA	TTE COSTS	ACRE T IN AC	COUNT 1 =	.767 ACCOU	NT TOTAL,S	415889.52 1549889.52	416889.52 1810485.55
EXCAVATION 8 2. 1 COMMON	PILING EXCAVATION	YD3	71556-0	•00	3+00	•00	214550.00
2. 2 PILING PERCENT TOTA	L DIRECT COS	T.IN.AC	COUNT 2.3		NT. TOIALes.	1240200.00	1621300.00
PLANT ISLAND	CONCRETE	×57				4	
	STRUCTURES	YD3	23350.0		BU.CU	1659500-00	1908000-00
PERCENI IDIA	IT DIMECT CO2	I IN AU	COOMI 3 =	-81/ ACC09	NI IUTALIS	199300-00	1905000.00
HEAT REJECTIC 4. 1 COOLING	N SYSTEM TOWERS	EACH	13.0	.00	.00	1995500.00	994500.00
4. 2 CIRCULA 4. 3 SURFACE	TING H20 SYS	EACH FT2	381365.9	.00 .00	03. 07.	1131192.05 1738058.08	1516785.56 266956.12
PERCENT TOTA	L DIRECT COS	T IN AC	COUNT 4 =	1.745 ACCOU	NT TOTALIS	4864750.86	2778241.69
STRUCTURAL FE	ATURES	TON	27560-0	650.00	175-00	17745958-00	\$777500-00
5. 2 SILOS	BUNKERS	тең	• <u>P</u>	1800.00	750.00	-00	-80
5. 4 STRUCTU	BAL FEATURES	Ę <u>Ą</u> ĊH	COUNT 1	725000.00	165000.00	725000.00	165000.00
FERGENI IDIA	IC DIRECT CD3	1 10 40		. Jejik AULUU	NI LUIALY>	19410000-00	4343300e00
5. 1 STATION	BUILDINGS	F13	7500000.0	.15	•16	1200000.00	1200000.00
5. 2 ADMINST S. 3 WAREHOU	RATION ISE & SHOP	FT2 FT2	20000-0 20000-0	16.00 12.00	14.00	320000.00 240000.00	280000.00 168000.00
PERCENT TOTA	L_DIECCT_COS	I IN AC	COUNT 6 =	-775 ACCOU	NT TOTAL .	1760000.00	1640000.00
FUEL HANDLING	& STORAGE						
7. 2 DOLONIT	E HAND SYS	тен тен	273.6	- 30 - 00-	-08 •08	<u>10319369.87</u> 3579441.31	<u>4364834-87</u> 1610568-86
7. 3 FUEL OI PERCENT TOTA	L HAND. SYS	T IN AC	2600000.0 COUNT 7 =	.00 4.656 ACCOU	.00 NT TOTAL.S	259836.01 14189647.12	227825-41 6203230-06
FUEL PROCESSI	NG	· · · · · · · ·	د م <u>ر</u> میت میدهد. ومن	·····			· · · ·
BA 2 CARBONI	ZERS CRUSHE	R TPH TPH	.0 .0	•00_	00. 00	.00 .00	:20
5. 3 GASIFIE	RS	TPH	517-2	-00 32 175 ACCOU	NT TOTAL .C	50190844-00	50732349-50

Table	A 8.3.4 Conti	nued					
	RANKI	NE METAL VAPOR	TOPPING-S	TEAM CYCLE A	CCOUNT LIST	TING	
ACCOU	NT NO. & NA	ME. UNIT	AMOUNT	NAT \$JUNIT I	NS SJUNIT	HAT COST.S	INS COST, S
FIRING	SYSTEM T TOTAL DIR	ECT_COST_IN_AC	COUNT 9 =	000 ACCOU	T TOTAL	.00 .00	00- 00-
VAPOR GI 10. 1, P 10. 2 F PERCEN	ENERATOR (F Ressurize B Luid Bed Bo T Total Dir	IRED) OILER EA ILER EA ECT COST IN AC	8.0 COUNT 10 =	2200000.00 00 4.840 ACCOUN	45000.00 00 17 Total+\$	17600000.00 00 1760000.00	3600000.00 00 3600000.00
ENERGY 11. 1 S 11. 2 G	CONVERTER TEAN TURBIN AS TURBINE	E GENERATOR Generator Turb-gen	1.0 4.0 8.0	19700000.00 7100000.00 3000000.00	1257514.48 1576000.00 270000.00	19700000.00 28400000.00 24000000.00	2257514.48 6304000.00 2159399.97
11. 4 L 11. 5 L 11. 6 L	IGUID METAL Iguid Met R Ig Met Hot I Ig Met Cold	DRUM ECIRC PUMP LEG PIPING LEG PIPE	4.0 4.0 2000.0 1300.0	625000.00 215000.00 1820.00 310.00	90000.00 17200.00 630.00 104.00	2500000.00 860000.00 3640000.00 403000.00	3600CC-00 68800-00 1260000-00 135200-00
11. 8 L 11. 9 L PERCEN	IQ MET COND IQ MET INVE T TOTAL DIR	ENSATE PUMP Ntory Ect cost in Ac	1.0 COUNT 11 =	452000-00 665000-00 21-387 ACCOUN	36000.00 13300.00 T TOTAL,\$	1800000.00 665000.00 81968000.00	144000.00 13309.00 11702814.37
CCUPLIN 12.1L 12.2H PERCEN	G HEAT EXCH M COND-STE OT WELL TAN T TOTAL DIR	ANGER Am gen ea K Ect cost in ac	4.0 COUNT 12 =	1610000.00 725000.00 2.863 ACCOUN	690000.00 110000.00 T TOTAL,\$	6440000.00 2300000.00 9340000.00	2760000.00 _440000.00 3200000.00
HEAT RE	COVERY HEAT		-6	-00-	-00	-60	-06
13. 2 E 13. 3 G 13. 4 F PERCEN	CONONIZER AS FEED VAT ED WATER H Total Dir	ER HEATER EA Eater String Ect Cost in Ac	COUNT 13 =	.00 .00 1500000.00 .353 ACCOUN	45000.00	.00 .00 150000.00 150000.00	.00 45000.00 45000.00
NATER T	REATMENT.						
14. 1 DI 14. 2 CI PERCEN	EMINERALIZE DNDENSATE P T TOTAL DIR	R GPN Olishing Kwe Ect cost in Ac	1107-4 715300-0 COUNT 14 =	2000.00 1.25 .900 ACCOUN	560-CO 30 IT TOTAL:\$	2214824-53 894125-00 3108949-53	620150+87 214598+00 834740+87

Table A	3.3.4 F	Cont	inued ENE ME	TAL VAPO	R TOPPINC- Rametric P	STEAM CYCLI	E AC	COUNT LIS	TING	
ACCOUNT	NO.	8. N/	AME	UNIT	AMOUNT	MAT S/UNI	r IN	AZ \$/UNIT	HAT COST.5	INS COST.S
AUXILIARY 15. 1 BOI 16. 2 OTH 15. 3 MIS 16. 4 AUX 16. 5 LIQ 16. 6 LIQ 16. 7 LIQ 16. 8 COV 15. 9 LIQ PERCENT	MECH LER PL C SEA MET MET MET ER GI MET LOTAI	H EQU FEED IMPS RVICE RY EC STOE IMPL AS SI DUMP	JIPMEN PUMP EIVER EIVING RAGE_T URITY PTANK RECT_C	T &DR - KWE KWE PPH -PROC ANK EA MONITOR EA OST IN A	579535.0 684000.0 1140000.0 4.0 1.0 1.0 1.0 4.0 4.0 4.0 4.0	1. 5200000 1300000 300000 1700000 570000 5.446 AC	67 88 17 00 00 00 00 00 00 00 00 00 00 00 00 00	-10 -12 -73 2000000-00 150000-00 250000-00 40000-00 86000-00 1 TQTAL \$	1134823.44 501920.00 1333800.00 620000.00 520000.00 520000.00 50000.00 1700700.00 2280000.00 19250543.25	67353-50 82080-00 832199-99 2000000-00 600000-00 25000-00 344000-00 4576233-94
PIPE & FI 17. 1 CON 17. 2 HOT 17. 3 STE PERCENT	GAS AM P TOTAL	PIPI PIPI PIPIN PIPIN	PIPI ING G & FI RECT C	NG TON EA TTINGS OST IN A	1540.0 4.0 CCOUNT 17	3000. 2000000. = 3.514 AC	00 20 20 20 20 20	1800.00 -CG .00 T TOTAL;\$	\$520000.60 8660666.00 12626000.60	2772000.00. 00 2772000.00
AUXILIARY 18.1 MIS 18.2 SON 18.3 CON 18.4 ISO 18.5 LIG 18.5 LH 18.7 LM PERCENT	ELEC C NOT TCHGI DUTT LATEL HTINC LEAK TRACI TOTAL	C EQU TERS EAR & CABL D PH/ S & C DETE E HEA L DIF	UIPMEN •ETC <u>R MCC.</u> LES•TR ASE SU COMMUN ECIION ATING RECT C	T AYS FI S FT KWE SYS EA SYSTEM OST IN A	1140000.0 1140000.0 4930000.0 1140000.0 114000.0 1.0 1.0 CCOUNT 18	1- 1- 510- 250000- = 5-756 AC	40 95 32 00 35 00 00 00 00	•17 455 450-00 450-00 20000000 20000000 101ALy\$	1596000.00 2223000.00 5507599.94 867000.00 399000.00 250000.00 250000.00 14342595.87	193800.00 513000.00 670479.94 76500.00 490206.00 20000.00 200000.00 10866739.75
CONTROL 19. 1 COM 19. 2 OTH PERCENT	INST PUTE ER CO TOTAL	RUMEN R DNTRO L DIN	NTATIO OLS RECT. C	N EACH OST IN A	1.0 1.0 CCOUNT_19	560000. 125006C. = .616_AC	CDUN 00 00	15000.00 774000.00 1 TOTAL:5	660000.00 1250000.00 1910000.00	15000.00 77406C.00 789000.00
PROCESS M 20- 1 BOT 20- 2 DRY 20- 3 WET 20- 4 ONS PERCENT	ASTE IOM_I ASH SLUI ITE I IOTAI	SYSI ASH RRY DISPO	TEMS	TPH TPH TPH ACRE OST IN A	49.6 273.6 859.5 CCOUNT 20	2804410. 6945489. 5131. = 5.369 AC	00 69 19 90 Count	 701102.67 1736372.30 7873.33 [.00 2804410.69 6945489.19 4462321.12 14212221.00	701102.67 7736372.30 346066.81 83541.75
STACK GAS 21. 1 PRE 21. 2 SCR 21. 3 MIS PERCENT	CIPT UBBEI C STI TOTAL	ANING IATOF EEL 1 L DIF	E DUCT	EACH KWE Sost in A		9025730. 21. = .0CE AC	50 72 00 Count	5866725-75 9•96 •00 T TOTAL:\$	00. 00- 00- 00- 00-	00. 00- 00- 00-
TOTA	L DI	RECT	COSTS	,\$			· · · ·	318	434380.00 1	19554747.00

.

.....

RANKINE METAL VAPOR TOPPING-STEAM CYCLE COST OF ELECTRICITY.HILLS/KW.HR PARAMETRIC POINT NO. 5

ACCOUNT	RATE		LABOR RA	ATE: SZHR		
TOTAL DIRECT COSTS.5	PERCEN	T 5.00 3861C6876.	8.50 414303748.	10.60 437989124.	15.00 487615624.	21.50 560927496.
INDIRECT COST + S	51.0	34512973.	48893379.	60972920. 35039129.	86282434.	123671488
CONTINGENCY COST S	<u> </u>	35680153	39358855.	41608966.	46323484	53288111.
ESCALATION COST + \$	5.5	134400264.	147480434	158467778	181488873-	215497320
TOTAL CAPITALIZATION \$	- 10-0-	785425664	861855248	926074520	1060608200	1259351136
COST OF ELEC-CAPITAL	13.0	21.69633 3.33370	23.80787 8.33370	25.58156 8.33370	29-29787	34.78788 8.33370
COST OF ELEC-OP & MAIN	• 🖪	1.96351	1 96351	1 96351	1-96351	1.96351
IVIAL CUSI OF ELLO		316333333	5 (61050)	3340,077	55655566	13-00505
ACCOUNT	RATE		CONTINGENCY	PERCENT		
TOTAL DIRECT COSTS,5	PERCEN "D	T -5.00 437989124.	437989124.	9.50 437989124.	5-UU 437989124-	437989124.
INDIRECT COST.S	51.0	60972920 • 35039129 •	50972920. 35039129/	60972920 • 35039129 •	60972920 - 35039129-	60972920. 35039129.
CONTINGENCY COST \$	20.0	-21899456	534001172	41608966	21899456	87597824
ESCALATION COST,S	5.5	140983656.	147012664-	158467778.	153041672.	171128696.
TOTAL CAPITALIZATION,5		823898536.	359131632.	926074520	894364728	1000064024.
COST OF ELEC-CAPITAL	18.0	22.75909 8.33370	23.73235	25.58155 8.33370	24.70562 8.33370	27.62542 8.33370
COST OF FLEC-OP & MAIN	Ū.	1 96351	1.96351	1,96351	1.95351	1-96351
B INIAL COST OF LELC	av	000000000	0.001000	00001011	000000000	a. USECUU
ria di constante d						
ACCOUNT	RATE		ESCALATION J	RATE PERCE	NI	
ACCOUNT	PERCEN	T 5.00 437989124.	ESCALATION J 5.50 437989124.	RATE PERCEI 8.00 437989124.	NT 10.00 437989124.	•00 437989124•
ACCOUNT TOTAL DIPECT COSTS .S INDIRECT COSTS .S	PERCEN	T 5.00 437989124. 50972920. 35039129.	ESCALATION J 6.50 437989124. 60972920. 35039129.	RATE PERCEI 8.00 437989124. 60972920. 35639129.	NI 10.00 437989124. 60972920. 35039129.	.00 437989124. 60972920. 35039129.
ACCOUNT TOTAL DIPFCT COSTS + S INDIRECT COSTS - S PROF & OWNER COSTS - S CONTINGENCY COST, S CONTINGENCY COST, S	PERCEN JI 10 SI 10 8.0	T 5.00 437989124. 50972920. 35039129. 41608966. 575610136	ESCALATION J 6.50 437989124. 60972920. 35039129. 41608966. 575610136.	RATE PERCEI 8.00 437989124. 60972920. 35039129. 41608966. 575610136.	NT 10.DD 437989124. 60972920. 35039129. 41608966. 575610136	•00 437989124• 60972920• 35039129• 41608956• 575610136
ACCOUNT TOTAL DIPFCT COSTS, INDIRECT COST, PROF & OWNER COSTS, CONTINSENCY COST, SUB TOTAL, SUB TOTAL, ESCALATION COST, SUB	RATE - PERCEN 31:0 8:0 9:5	7 5.00 437989124 50972920 35039129 41608956 575610136 118952302	ESCALATION J 6.50 437989124. 60972920. 35039129. 41608966. 575610136. 158467778.	RATE: PERCE 8.00 437989124. 50972920. 35039129. 41608956. 575610136. 199873080.	NI 437989124 - 60972920 - 35039129 - 41608966 - 575610136 - 258143944 -	•00 437989124 60972920 35039129 41608966 575610136 -
ACCOUNT TOTAL 21PF CT COSTS, INDIRECT COST, PROF & ONNER COSTS, CONTINSENCY COST, SUB TOTAL, E SCALATION COST, INTREST DURING CONST, INTREST DURING CONST, INTREST ADDRING CONST, INTREST AD	RATE PERCEN J1:0 8:0 9:5 0 0 10:0	7 5.00 437989124. 50972920 35039129. 41608966. 575610136. 183315482. 8778779122.	SCALATION.J 5-50 437989124- 35039129- 35039129- 41608956- 575610136- 158467778- 191996608- 191996608- 925074520-	BATE: PERCE 8.00 437989124. 50972920. 35039129. 41608966. 575610136. 199873080. 201014638.	NI 10.D0 437989124. 35039129. 41608966. 575610136. 258143944. 213580044. 1047334120.	.00 437989124 60972920 35039129 41608966 575610136 0 156686850 732296984
ACCOUNT TOTAL 21PF CT COSTS, INDIRECT COST, PROF & OWNER COSTS, SUB TOTAL, ESCALATION COST, TOTAL CAPITALIZATION; COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL	RAIE. PERCEN J1:0 9.5 0 10.0 18.0	T 5.00 437989124. 50972920. 415089666 575510135. 118952302. 183315482. 277877912. 24.25019 8.33370	ESCALATION J 6.50 437989124- 60972920- 35039129- 41608956- 158467778- 19199668- 925074520- 25.58156 8-33370	RATE: PERCE 8.00 437989129. 35C39129. 41608966. 575610136. 199873080. 201014638. 3764978488. 8.33370	NI 10.00 437989124. 60972920. 35039129. 41608966. 2575610136. 25804040. 1047334120. 28.93119 8.33370	.00 437989124. 60972920. 35039129. 41608966. 575610136. 0. 156686850. 732296984. 20.22872 8.33370
ACCDUNT TOTAL 219FCT COSTS, INDIRECT COSTS, PROF & OWNER COSTS. SUB TOTAL, ESCALATION COST, TOTAL CAPITALIZATION; COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CPUEL COST OF ELEC-CPUEL	RAIE. PERCEN JI.0 8.0 9.5 0 10.0 10.0 10.0	T 5.00 437989124. 50972920. 35039129. 41508968. 575510136. 183315482. 877877912. 24.25019 8.33370 1.96351. 35.54740	SCALATION J 5.50 437989124- 60972920- 35039129- 41608956- 158467778- 191995668- 925074520- 25.58156 8-33370 1.96337- 5.87877	RATE: PERCE/ 8.00 437989129. 35039129. 35039129. 575610136. 199873080. 201014638. 3764978488. 26.97449 8.33370 1.96351. 37.27168	NI 10.00 437989124. 60972920. 35039129. 41608966. 575610136. 258143944. 2135800440. 1047334120. 28.93119 8.33370 1.96351 39.22880	.00 437989124. 60972920. 35039129. 41603966. 575610136. 0. 156686850. 732296984. 20.22872 8.33370 1.96351 30.55592
ACCOUNT TOTAL CIPFCT COSTS, INDIRECT COST, CONTINGENCY COST, SUB TOTAL, ESCALATION COST, TOTAL CAPITALIZATION; COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL	RAIE. PERCEN JI.C 8.5 9.5 0 10.0 16.0 16.0 16.0	T 5.00 437989124. 50372920. 35039129. 416083666 575610136. 118952302. 183315482. 877877912. 24.25019 8.3370 1.96351. 34.54740	ESCALATION. J 6.50 437989124. 60972920. 35039129. 41608956. 158467778. 191995618. 925074520. 25.58156 8.3370 1.96351. 35.87877	RATE: PERCE 8.00 437989129. 35C391292. 35C391292. 575610136. 199873080. 201014638. 276497848. 26.97449 8.33370 1.96351. 37.27164	NI 10.00 437989124. 60972920. 35039129. 41608966. 575610136. 258143944. 21358049. 1047334120. 28.93119 8.33370. 1.96351. 39.22840.	.00 437989124. 60972920. 35039129. 41503966. 575510136. 0. 155686850. 732296984. 20.22872 8.33370 1.96351 30.52592
ACCOUNT TOTAL CIPFCT COSTS, INDIRECT COSTS, PROF & OWNER COSTS, SUB TOTAL, TOTAL S ESCALATION COST, TOTAL CAPITALIZATION, COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-FUEL	RATE. PERCEN J1:00 9.50 10:00 10:00 10:00 10:00 00 00 00 00 00 00 00 00 00 00 00 00	T 5.00 437989124. 50972920. 35039129. 41608366 575610136. 118952302. 183315882. 87877912. 24.25019 8.3370 1.96351 34.54740	ESCALATION. J 6:50 437989124. 60972920. 35039129. 41608956. 158467778. 191996618. 925074520. 25.58156 8.33370 1.96351. 35.87877 LNT DURING 1	RATE . PERCEJ 8.00 437989129. 35039129. 35039129. 575610136. 199873080. 201014638. 376497848. 26.97449 8.33370 1.96351. 37.27164	NI 10.00 437989124. 60972920. 35039129. 41608966. 2515510136. 25143944. 213586040. 1047334120. 28.9319. 8.33370. 1.96351. 39.22840. NT	.00 437989124. 60972920. 35039129. 41503966. 575510136. 0. 155586850. 732296984. 20.22872 8.33370 1.96351 30.52592
ACCOUNT TOTAL DIFFCT COSTS, INDIRECT COST, PROF & OWNER COSTS, SUB TOTAL, CONTINGENCY COST, SUB TOTAL, ESCALATION COST, TOTAL CAPITALIZATION, COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC COST OF ELEC	RATE. PERCEN J1:00 31:00 9.50 10:00 10:00 10:00 10:00 10:00 00 20 20 20 20 20 20 20 20 20 20 20 2	T 5.00 437989124. 50972920. 35039129. 41608966 575610136. 118952302. 183315882. 87877912. 24.25019 8.33370 1.96351 34.54740 7.66.00 437939124.	ESCALATION. J 6:50 437989124. 60972920. 35039129. 41608966. 158467778. 191996618. 925074520. 25.58156 8:33370 1:96351. 35.87877 ENT DURING (1 8:00 \$37989124.	RATE. PERCEJ 8.00 437989129. 50539129. 575610136. 199873080. 201014638. 376497848. 26.97449 8.33370 1.96351. 37.27164 20NSI.PERCEJ 10.00 437989124.	NI 10.00 437989124. 60972920. 35039129. 41608966. 2515610136. 25143944. 213586040. 1047334120. 28.93170. 1.96351. 39.22840. NT 12.50 437989124.	.00 437989124. 60972920. 35039129. 41603966. 575510136. 0. 155680850. 732296984. 20.22872 8.3370 1.96351 30.52592 15.00 437989124.
ACCOUNT TO TAL DIFFCT COSTS, S INDIRECT COST, S PROF & OWNER COSTS, S CONTINGENCY COST, S SUB TOTAL, S ESCALATION COST, S INTEST DURING CONST, S TOTAL CAPITALIZATION, S COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC COST	RATE. PERCEN 31:00 9:50 10:000	T 5.00 437989124. 50972920. 35039129. 416089666 575510136. 183315882. 877877912. 24.25019 8.33370 1.96351 34.54740 437939124. 60972920. 35039129.	ESCALATION. J 6:50 437989124. 60972920. 35039129. 41608966. 158467778. 191996618. 925074520. 25.58156 8:33370 1:96351. 35.87877 INT DURING (1 8:00 237999124. 60972920. 35039129.	RATE. PERCEJ 8.00 437989129. 50539129. 575610136. 199873080. 201014638. 376497848. 26.97449 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.96457164 8.33370 1.97457164 8.33370 1.97457164 8.33370 1.97457164 8.33370 1.97457164 8.33370 1.97457164 8.33370 1.97457164 8.5337164 8.5337164 8.33370 1.97457164 1.97457164 1.97457164 1.97457164 1.97457164 1.97457164 1.97457164 1.97457164 1.97457164 1.97457164 1.9757164 1.9757164 1.9757164 1.97457164 1.97571	NI 10.00 437989124. 60972920. 35039129. 41608966. 258143944. 213586040. 1047334120. 28.93119 8.33370. 1.963511 39.22840 NT 12.50 437989124. 60972920. 35039129.	.00 437989124. 60972920. 35039129. 41603966. 575610136. 0. 156686850. 732296984. 20.22872 8.3370 1.96351 30.52592 15.00 437989124. 60972920.
ACCOUNT TO TAL DIPFCT COSTS, INDIRECT COST, PROF & OWNER COSTS, SUB TOTAL, CONTINGENCY COST, SUB TOTAL, COST OF ELEC-CAPITAL COST OF ELEC-SAPITAL COST OF ELECST, SUB TOTAL OTAL COSTS, SUB TOTAL S	RATE: PERCEN 31:00 9:00 10:000	5.00 437989124. 50972920. 35039129. 41608966. 575510135. 18952302. 183315482. 877877912. 24.25019 8.33370 1.96351 34.54740 437939124. 60972920. 35039129. 41608966. 575610135.	SCALATION. J 6:50 437989124. 60972920. 35039129. 41608966. 575610136. 19199668. 925074520. 25.58156 8.33370 1.96351. 35.87877 INT DURING (8.0972920. \$35039124. 60972920. \$35039129. 41608966. \$75610136.	RATE. PERCEJ 8.00 437989124. 6D972920. 35039129. 41608966. 199873080. 201014638. 376497848. 26.97444. 8.33370 1.56351. 37.27164 20NSI.PERCEJ 437989124. 60972920. 350039129. 41608966. 575610136.	NI 10.00 437989124. 60972920. 35039129. 41608966. 258143944. 213586040. 1047334120. 28.93119 8.33370. 1.963511 39.22840 9.37989124. 60972920. 437989124. 60972920. 51608966. 51608966. 51608966. 516135.	.00 437989124. 60972920. 35039129. 41603966. 0. 156686850. 732296984. 20.22872 8.3370 1.96351 30.52592 15.00 437989124. 60972920. 35039129. 41608966.
ACCOUNT TO TAL DIPFCT COSTS, INDIRECT COST, PROF & OWNER COSTS, SUB TOTAL, CONTINGENCY COST, SUB TOTAL, ESCALATION COST, TOTAL CAPITALIZATION, COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP, & MAIN TOTAL DIRECT COSTS, INDIRECT COST, PROF & OWNEB COSTS, SUB TOTAL, SUB TO	RATE PERCE 38:00 10:000	T 5.00 437989124. 50372920 35039129. 41608966 575610136 118952302. 183315482. 877877912. 24.25019 8.33370 1.96351 34.54740 437939124. 60972920. 35039129. 41608966. 555610136. 156467778. 10568611	SCALATION. J 6:50 437989124. 60972920. 35039129. 41608966. 575610136. 191996618. 925074520. 25:58156 8:33370 1:96351. 35:87877 INT DURING (8:7989124. 60972920. \$35039129. 41608966. 575610136. 158467778. 555567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55567778. 55577778. 55577778. 55577778. 55577778. 55577778. 55577778. 55577778. 55577778. 5557778. 55577778. 55567778. 55567778. 55567778. 5557778. 55577778. 55577778. 55577778. 55577778. 55577778. 5557777777777777777777777777777777777	RATE. PERCEJ 8.00 437989124. 6D972920. 35039129. 41608966. 199873080. 201014638. 976497848. 26.97448. 8.33370 1.56351. 37.27164 20NSI. PERCEJ 10.00 437989124. 60972920. 350039129. 41608966. 5755610136. 158467776. 1997676.	NI 10.00 437989124. 60972920. 35039129. 41608966. 258143944. 213586040. 1047334120. 28.93119 8.33370. 1.96351 39.22840 NT 12.50 437989124. 60972920. 35039129. 41608966. 575610135. 158467778.	.00 437989124. 60972920. 35039129. 41603966. 575610136. 0. 156686850. 732296984. 20.22872 8.3370 1.96351 30.52592 15.00 437989124. 60972920. 35039129. 41608966. 575610136. 158467778.
ACCOUNT TO TAL DIPFCT COSTS, INDIRECT COST, PROF & OWNER COSTS, SUB TOTAL, CONTINGENCY COST, SUB TOTAL, ESCALATION COST, TOTAL CAPITALIZATION, COST OF ELEC-APITAL COST OF ELEC-APITAL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP, & MAIN TOTAL DIRECT COSTS, INDIRECT COST, SUB TOTAL, CONTINGENCY COST, SUB TOTAL, SUB TOTAL, SUB TOTAL, SUB TOTAL, SUB TOTAL, SUB TOTAL, SUB TOTAL, TOTAL COST, SUB TOTAL, SUB	RAIE. PERCO 3100 9.50 16.00 16.00 16.00 16.00 16.00 16.00 51	5.00 437989124. 50372920. 35039129. 41608966. 575610136. 118952302. 183315482. 877877912. 24.25019 8.33370 4.97939124. 60972920. 35039129. 41608966. 575610136. 1.9648611. 844726520.	SCALATION. J 6:50 437989124. 609729200 35039129. 41608966 575610136. 158467778. 925074520. 25.58156 8:33370 1:96351. 35.87877 INT DURING (8:00 *37989124. 609729202 *35039129. 41608966. 575610136. 150850476. 88467778. 150530476.	BATE. PERCE 8.00 437989124. 60972920. 35039129. 41608966. 575610136. 199873080. 201014638. 976497848. 26.97444 8.33701 1.95351. 37.27164 20NSI. PERCE 10.00 437989124. 60979220. 35039129. 41608966. 5755610136. 191996608. 926074520.	NI 10.00 437989124. 60972920. 535039129. 41608966. 575610136. 258143944. 213580040. 28.93119 8.33370 12.50 437989124. 60972920. 35039129. 41608966. 575610135. 158467778. 980215008. 980215008. 158467778. 980215008. 158467778. 980215008. 15846778. 15846778. 15846778. 15846778. 15846778. 15846778. 15846778. 15846778. 1584678. 15846. 15846. 15848.	.00 437989124. 60972920 35039129. 41603966. 57561036. 0. 156686850. 732296984. 20.22872 8.33370 1.96351 30.52592 15.00 437989124. 60972920. 35039129. 41608966. 57361036. 158467778. 302944140. 1637022048.
ACCOUNT TO TAL DIPFCT COSTS, PROF & OWNER COSTS, SUB TOTAL, CONTINSENCY COST, SUB TOTAL, ESCALATION COST, TO TAL CAPITALIZATION, COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL DIRECT COSTS, PROF & OWNER COSTS, SUB TOTAL, CONTINGENCY COST, SUB TOTAL, COST, PROF & OWNER COSTS, SUB TOTAL, SUB TOTAL, COST, CONTINGENCY COST, SUB TOTAL, COST, TOTAL COST, SUB TOTAL, COST, CONTINGENCY COST, SUB TOTAL, COST, CONTINGENCY COST, SUB TOTAL, COST, CONTINGENCY, CONT, COST, CONTINGENCY, COST, CONTINGENCY, COST, CONTINGENCY, COST, CONTINGENCY, COST, CONTINGENCY, COST, COST, CONTINGENCY, COST, CONTINGENCY, COST, CONTINGENCY, COST, COST, CONTINGENCY, COST, CONTINGENCY, COST, CONTINGENCY, COST, COST, COST, COST, COST, CONTINGENCY, COST,	RAIE: PERCO 3::00 9:50 9:50 1:00 1:00 1:00 1:00 1:00 1:00 1:00 1	T 5.00 437989124. 50372920 35039129. 41508966 57555101356. 18952302. 183315482. 877877912. 24.25019 8.33370 1.96351 34.54740 V 575510136. 15039129. 41608966. 5755610136. 1508467778. 844726520. 23.33443 8.33370	ESCALATION J 6.50 437989124. 60972920. 575610136. 158467778. 191996668. 25.58156 8.33370 1.96351. 35.87877 ENT DURING (1 8.37989124. 60972920. 35039129. 15608966. 158467778. 158457778. 8.3037129. 8.3037129. 150530778. 8.3037129. 150530778. 8.3037129. 150530778. 8.3037129. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 150530778. 1505307778. 100718.	RATE. PERCE 8.00 437989124. 60972920. 35039129. 41608966. 575610136. 199873080. 26.97449. 8.3351. 37.27164 20NSI. PERCE 10.00 437989124. 60972920. 35039129. 41608966. 575610136. 158467778. 191996608. 926074520. 25.58156 8.33370	NI 10.00 437989124. 60972920. 550512920. 555510136. 258143944. 213580040. 28.93119 8.33719 437989124. 60972920. 35039129. 41608966. 575610136. 158467778. 960215808. 27.07714 8.33370	.00 437989124. 60972920. 35039129. 41608966. 575610136. 0. 156686850. 732296984. 20.22872 8.3370 1.96351 30.52592 437989124. 60972920. 35039129. 41608966. 575610136. 158467778. 30294440. (037022048. 28.64634 8.33370

REPRODUCT ORIGINAL THE OF THE

Table A 8.3.5 Continued

RANKINE METAL VAPOR TOPPING-STEAM CYCLE COST OF ELECTRICITY.MILLS/KW.HR PARAMETRIC POINT NO. 4

ACCOUNT	RATE	FIXED CHARG	E_RATE PCT_		
TOTAL DIRECT COSTS +5	D 43796	UU 14.4U 9124.437989124.	437989124	437989124	437989124
INDIRECT COST.S	51.0 6097	2920. 60972920.	60972920.	60972920.	50972920.
PROF_&_OWNER_COSTS #	3 U 1503 9 5 9160	9129 350 9129	41608966	41608966	41608966
SUB TOTAL	C 57561	0136. 575610136.	575610136.	575610136 .	575610136.
ESCALATION COST+S TNTREST DURING CONST+S	5.5 1584t 10.0 19199	6608. 191996668.	15846///8.	15846///8.	158457778.
TOTAL CAPITALIZATION.S	0 92607	4520 926074520	925074520	325074520.	926074520.
COST OF ELEC-CAPITAL	25 6 14	33370 8.33370	8.33370	8.33370	8.33370
COST OF ELEC-OP & MAIN	.C .1.	96351 1.96351	1-26351.	1.96351	1.96351
TOTAL COST OF ELEC	•U 243	50313 50.15245	32.01011	40.93508	45+82715
ACCOUNT	DATE	FUEL COST.	4/10++5 BTH		
	PERCENT	50 .85	1.50	2.50	1.02
TOTAL DIRECT COSTS S	-D 43798	9124 437989124	437989124	437989124	437989124
PROF & OWNER COSTS \$	3.0 3503	9129. 35039129.	35039129	_35039129.	35039129
CONTINGENCY COST +\$	9.5 4160	8966. 41608966.	41608966.	41608966.	41608966.
SUB JUIAL S	-U 5/561 6-5 15846	7778 158467778	158467778-	158467778	5/5610136 - 158467778 -
INTREST DURING CONST.S.	10.0 19199	6608. 191996608.	191996608	191996608	191996608
TOTAL CAPITALIZATION.S	. 6 92607	4520. 926074520.	926074520	926074520	926074520
COST OF ELEC-CAPITAL	10 23	90218 8.33370	14.78653	24.51088	10.00044
COST_OF_ELEC-OP_&_MAIN.		96351 1.96351	1.96351	1.96351	1.96351
TOTAL COST OF ELEC	•ū 32.	44724 35-87877	42.25160	52,05595	37.54551
				_	
ACCOUNT	PEDCENT 12	CAPACITY FA	CTOR PERCEN	I	90 00
TOTAL DIRECT COSTS #\$	60 43798	9124. 437989124.	437989124.	437989124 .	437989124
INDIRECT COST.S	51.0 6097	2920. 60972920.	60972920.	60972920.	60972920.
CONTINGENCY COST.S	9-5 4150	8955 41508955	41608966-	1508966-	41603955
SUB TOTAL + \$	0 57561	0136. 575610136.	575610136	575610136	575610136.
ESCALATION COST + S	5=5 15846	7778. 158467778.	158467778.	158467778.	158467778
TOTAL CAPITALIZATION'S	.0 92607	4520. 926074520.	926074520.	926074520	926074520
COST OF ELEC-CAPITAL	18.0 138.	56679 36.95114	33.25503	25.58156	20.78502
COST OF ELEC-PUEL	-U 8-	21857 2.12566	2-07483	8.33378	8.33370
TOTAL COST OF ELEC	0 150.	11906 47.41050	43.66456	35.87877	31.00761

.

RANKINE METAL VAPOR TOPPING-STEAM CYCLE

	ACCOUN	NT NO	AUX	POVER	•MWE	PERC P	LANT	P0W	OPERATIO	N COS	T MAI	INTENA	NCE C	05T		
		7		Ť	-54857		13	57405	146	3-942	225		.00		···· · •	
		14		10	29180		18	00000	8	7-191	31		-00			
	TOTAL	20		28	82114		51.	82695	162	9.062	275		13.08	000		
	R	ANKINE MET	ALN	APOP	TOPPING	-STEAN	CYC	LE BAS	ECASE	NPUT			10000	101 100 7007	,	
	NOM	EAT RATE	BTL	IZKW-H	R	9349.9	998	NET	HEAT RA	TE, B	TU/ K	I-HR	9	804.3522	2	
	CONDE	ENSER	AIL E. T	CHANG	E.,	•3	181	ATT TA			-			7 6000		
	NUMBE	R OF TUBE	5751	IELL	n	6985.9	SÖC	TUE	ELENGTH	FT		• • • • • • • • •		69-5067		
	HEAT	REJECTION	F			77 0	222	100	TINAL IC		LFF# F			5.0000	, 1 ,	
	RANGE	F				23.0	000	ÖFF	DESIGN	TEMP	F	 		51.4000		
		LSIGN PRE	5 1	N HG	д	2.4	196	<u>г</u> р	TURBINE	BLADE	E LEN	IN .	~~~	25.000	3	_
······	- E	715.	300	7		3.500	8	33720	00000.00	0 9	9	• •	3.000	105		ŋ
	11	1.	000	17	1	98.600	13		1.00	0 14	1	0770	4.000 5.000	20	1.000	
	26	7500000	<u>ono</u>	27	200	00.000	- 28		20000.00	0 29	2	26000	0.000	30	-000	ċ
	36	4930000	02.4	37	17	00.000	38		1.00	0 34		****	1.000	35 40	725000-000	
	46		000	47		000	48 48		150CU_00 3.CO	0.49	<u>د</u>	.25000	2.000	<u>45</u>	.779000.000	-
	51	8	.000	52 2		- 5-350	ο.	3 2	200000.0	00	4	4500	00.000	3 5	•60	۵
00 ·	11	4.	000	12	20		13		1300.00	0 .9 0 14)	··· - · ·	8.000	10 15	4-000	-
.78	16	197000000	2000 200	22	6250	00.000	13	71	90000.00	D 19 D 24	3	21500	.000	20 25	3000000-000	
	31	1820.	000		6650	30.000 C0.C00	28	·····		029 0 34) 	10	4.000	30	450000-000 4-000	
	36 41	2300000.	000 000	37 42		.000 .000	38 43	7	25000.00	0 39 0 44) 	11000	000.0	40 45	-000	
	<u>45</u> 51		000. 000	47 52	15008		- 48		.00 .00	049 0.54)		-000 -000	58 55	-050 -000	
	56 61	1.	000 000	57 62		.00C 4.000	58 63	62	1.00 0000000	0 59 0 64)) 2	00000	4.000	60 65	1-000	
	66 71	150000 570000-	000 000	. 67 72	8000 860	00.000	-:68 73		50000.00 4.00	0. <u>69</u> 0 74	L <u>1</u> 2	Z0000 00000	0.000	70	400000-000	
	76 81	2000000	000 COC	77 82		1.000	78 83	2	500C0.00 .CC	0 79 0 84	. –	20000	000.0	90 85	2500000.000	
	91	·····	90G. 000	87 92	•. ••••		- 38	-		0			-000	30	-000	
a' -	36		oõõ	97		.000	98		-00	ō šś	i i		3000	100	-000	

		RANKINE ME	TAL VAPOR	TOPPING-S	TEAN CYCLE Int No.49	ACCOUNT LIS	TING	
	ACCOUNT NO.	& NAME .	UNIT	AMOUNT	MAT \$/UNIT	INS S/UNIT	MAT COSTIS	INS COST.S
	SITE DEVELOPH 1. 1 LAND CC 1. 2 CLEARIN 1. 3 GRADING 1. 4 ACCESS 1. 5 LOOP RA 1. 5 SIDING 1. 7 OTHER S PERCENT TOTA	SENT IST LAND RAILROAD TILROAD TRA R. R TRACK ITE COSTS L DIRECT C	ACRE ACRE ACRE CK MILE MILE ACRE OST IN AC	187-6 62-3 187-0 5-0 2-5 0 0 0 0 0 0 0	1000.00 .00 115000.00 12000.00 125000.00 .00 .883 ACCOU	•00 500-00 11000-00 70000-00 80000-00 •00 NT TOTAL+5	187000-00 -00 575000-00 300000-00 -00 395406-86 1458406-86	-00 37395.25 561000.00 550000.00 175000.00 396405.86 1719803.11
	EXCAVATION 8 2. 1 COMMON 2. 2 PILING PERCENT TOTA	PILING EXCAVATION	YD3 FT QST IN_AC	75150.0 200400.0 Count 2 =	•00 6-50 •898 ACCOU	3.00 8.50 NT TOTAL:5	00 1302600.00 1302600.00	225450.00 1703400.00 1928850.00
-	PLANT ISLAND 3. 1 PLANT I 3. 2 SPECIAL PERCENT TOTA	CONCRETE S. CONCRET STRUCTURE L DIRECT C	E YD3 S YD3 OST IN AC	25050.0 Count 3 =	70.00 .00 1.044 ACCOU	80.00 00 NT TOTAL.	1753500.00 00 1753500.00	2004000.00 00 2004000.00
8- -	HEAT REJECTIO 4. 1 COOLING 4. 2 CIRCULA 4. 3 SURFACE PERCENT TOTA	N SYSTEM TOWERS TINS H20 S CONDENSER L DIRECT C	EACH YS EACH FT2 OST IN AC	13.0 1.0 381071.3 COUNT 4 =	-00 -00 -00 2.123 ACCOU	00 00 00 00 NT Total\$	1995500.00 1130319.83 1737028.50 4852848.31	994500.00 1515616.03 266750.29 2776866.31
19 ¹ 1 97	STRUCTURAL FE 5. 1 STAT. S 5. 2 SILOS & 5. 3 CHIMNEY 5. 4 STRUCTU PERCENT TOTA	ATURES TRUCTURAL BUNKERS RAL FEATUR L DIRECT C	ST. TON TPH FT ES EACH OST IN AC	27300.0 .0 1.0 CōUNT 5 =	650-00 1800-00 725000-00 5-507 ACC00	175-00 750-00 166000-00 NT TOTAL:3	17745000.00 00 725000.00 18470000.00	\$777500.00 00 00 166000.00 49\$3500.00
L.	BUILDINGS 5.1 STATION 5.2 ADMINST 6.3 VAREHOU PERCENT TOTA	EUILDINGS RATION SE & SHOP L DIRECT C	FT3 FT2 FT2 OST IN AC	7500000.0 20000.0 2000.0 2000.0 2000.0 2000.0 2000.0	•16 16•00 12•00 •945 ACC90	-16 14-00 8-00 NT_TOTAL:5	1200000.00 320000.00 24000.00 1760000.00	1200000.00 280000.00 160000.00 1640000.00
-	FUEL HANDLING 7. 1 COAL HA 7. 2 DOLOMIT 7. 3 FUEL OI PERCENT TOTA	& STORAGE NDLING SYS E HAND. SY L HAND. SY L DIRECT C	S TPH S GAL OST IN AC	425.6 225.2 260000.0 COUNT 7 =	-00 -00 -00 3.709 Accou	+00 +00 +00 •00 •00 NT TOTAL	5921766,19 3002740.47 290836.01 9215342.62	2517738.03 1385278.22 227826.41 4130892.66
	FUEL PROCESSI 8. 1 COAL DR 8. 2 CARBONI 9. 3 GASIFIE PERCENT TOTA	NG Yer & Crusi Zers RS L Direct C	HER TPH TPH DST IN AC	COUNT 8 =	00- 00- 01- 00-20A 000-	-CD -DD -DC NT TOTAL:\$	80. 00. 83. 00.	00 00 00 00 00

Table A 8.3.7

	Table A	8.3.7 R	Continued ANKINE	METAL V	APOR TO	PPING-	STEAM	CYCLE	ACCOUN	T LIS	TING			···· • • • • • • • • • • • • • • • • •	
	ACCOUN	IT NO.	8 NAME.	UNI	T AI	HOUNT	MAT S	13.43 VUNIT	INS \$/	UNIT	MAT C	DST:\$	INS C	OST+\$	
	FIRING S 9.1 PERCENT	YSTEH TOTAL	DIRECT	COST I	N ACCOU	NT 90	= .0(00 ACCD	UNT_TOT	•00 FAL•\$		•00	·····	•00 •00	-
.	VAPOR GE 10. 1 PR 10. 2 FL PERCENT	NERATO Essurt UID BE Total	R (FIRE ZE BOIL D BOILE DIRECT	D) ER ^R cost 1	EA EA N Accou	90 NT 10	15163 =26.3	-00 3000-00 15 ACCO	85315 UNT TOT	-00 893-87 FAL:\$	C0672 60672	•00 00•00	34127 34127	•00 999•50 999•50	
••• •• •••••	ENERGY C 11. 1 ST 11. 2 GA 11. 3 LI 11. 4 LI 11. 6 LI 11. 6 LI 11. 8 LI 11. 9 LI PERCENT	ONVERT EAM TU S TURB GUID M GUID M GUID M G MET G MET G MET G MET TOTAL	ER RBINE GEN ETAL TU ETAL DR ETAL DR ET RECI HOT LEG COLD LE CONDENS INVENTO DIRECT	ENERATO ERATOR RB-GEN UM PIPING G PIPE ATE PUM RY COST I	R P N Accou	1.0 4.0 4.0 2000.0 1300.0 1.0 NT 11	19700 6000 3000 215 300 215 640 =25.00	0000.00 0000.00 0000.00 0000.00 0000.00 310.00 0000.00 0000.00 0000.00 0000.00	12093 15760 2700 172 172 1288 128 128 128	394 • 25 000 • 00 000 • 00 200 • 00 200 • 00 200 • 00 300 • 00 300 • 00 300 • 00 300 • 00	19700 24000 24000 23600 860 4660 403 1440 640 78063	000 - 00 000 - 00	1209 5304 2159 360 1560 135 115 12 11925	394-25 999-97 999-97 800-00 800-00 200-00 200-00 200-00 800-00 800-00 394-12	
8-180	COUPLING 12-1 L 12-2 HO PERCENT	HEAT M COND T WELL TOTAL	EXCHANG -STEAM TANK DIRECT	ER Gen Cost I	EA EA N ACCOU	4.0 4.0 NT 12	1946 671 = 3.96	5000.00 5000.00 53 ACCO	8340 1100 UNT TOT	100-00 100-00 FAL+\$	77840 2700 10484	000.00 000.00 000.00	3336 440 3776	000-00 000-00 000-00	
-	HEAT REC 13.1 GA 13.2 EC 13.3 GA 13.4 FE PERCENT	OVERY S-AIR Snomiz S FEED ED WAT Total	HEAT EX RECUPER ER WATER ER HEAT DIRECT	CH. ATOR HEATER ER STRI COST I	EA EA EA Ng N Accou	.0 4.0 1.0 NT 13	1042 1720 = 2•03	-00 -00 2500-00 000-00 37 ACCO	3475 516 Unt tot	.00 .00 500-00 500-00 FAL,\$	4170 1720 5890	00 - 00 00 - 00 00 - 00 00 - 00 00 - 00	1390 51 1441	00 00 000 000 600 000	
	WATER TR 14. 1 DE 14. 2 CO PERCENT	EATMEN MINERA INDENSA TOTAL	T LIZER TE POLI DIRECT	SHING K COST I	PN WE 82 N Accou	132.3 5700.0 NT 14	= •47	2500.00 1.25 74 ACCO	7 דכד דאט	00.00 •30 AL+\$	330 1033 1364	679.99 374.98 254.97	92 248 340	590.40 010.00 600.39	
	POWER CO 15. 1 ST 15. 2 ME 15. 3 GA PERCENT	NDITIO M TURB T VAP S TURB TOTAL	NING TRANSF TURB TR TRANSF DIRECT	ORMER ANSFORM ORMER COST I	101 ER 21 24 N ACCOU	0411.1 4133.3 2122.2 VT 15	= 2.41	-00 -00 -00 3 ACC0	UNT TOT	•00 •00 •00 AL+\$	1751 4488 2407 86472	257•39 381•25 507•84 246•37	35 35	025-15 700-50 725-65	

REPRODUCT ORKINAL IS POOR

Table A 8.3.7 Continued

-	RANKINE	METAL VAPO	R TOPPING-S	TEAM CYCLE	ACCOUNT LIST	TING	
ACCOUNT 1	NO. & NAME.	UNIT	AMOUNT	MAT \$/UNIT	INS \$/UNIT	HAT COST.S	INS COST.S
AUXILIARY H 16. 1 BOILE 15. 2 07HET 16. 3 MISC 16. 4 AUXII 16. 5 LIG 16. 6 LIG 16. 7 LIG 15. 8 COVE 16. 9 LIG PERCENT T	MECH EQUIPM ER FEED PUM SERVICE SY LIARY BOILE NET RECEIVI MET STORAGE MET IMPURIT R GAS SYSTE MET DUMP TA OTAL DIRECT	ENT P & DR - KWE S KWE R PPROC TANK EA Y MONITOR M EA NK EA	785365.6 684000.0 1140CC0.0 1.0 4.0 1.0 4.0 6.0 4.0 CCOUNT 16 -	1.67 .83 1.17 4.00 6300000.00 1300000.00 300000.00 570000.00 570000.00 570000.00	-10 -12 -380 2060060.00 150000.00 250000.00 250000.00 40000.00 86000.00 86000.00 86000.00	1311559.53 6C1920.00 1333800.60 6300000.00 520000.00 860600.00 170000.00 2280006.00 19527279.50	78536.50 82090.00 832199.99 2000000.00 60000.00 250000.00 344000.00 4586816.44
PIPE & FIT 17. 1 CONVE 17. 2 HOT 17. 3 STEAL PERCENT T	TINGS ENTIONAL PI GAS PIPING M PIPING & OTAL DIRECT	PING TON EA Fittings Cost in A	1370_0 4-0 CCOUNT 17	3000-00 1600000-00 3-606 ACCOU	1800-00 -00 -00 JNT TOTAL,5	4110000.00 6400000.00 .00 10510000.00	2 466000 -00 -00 -00 2466000 -80
AUXILIARY E 18. 1 MISC 18. 2 SWIT 18. 3 COND 18. 4 ISOL 18. 5 LIGH 18. 5 LM II 18. 7 LM II PERCENT T	ELEC EQUIPM MOTERS ETG CHGEAR & MC UIT CABLES ATED PHASE TING & COHM EAK DETECTI RACE HEATIN DTAL DIRECY	ENT C PAN KWE TRAYS FT BUS FT UN KWE ON SYSEA G SYSTEM COST IN A	1140000.0 1140000.0 4930000.0 1700.0 1140000.0 1.0 CCOUNT 18 =	1.40 1.95 1.32 510.00 250000.00 250000.00 250000.00	-17 -*5 450.00 20000.00 20000.00 20000.00 20000.00	15960CD +00 2223000 +00 6507599 94 867000 +00 399000 +00 250000 +00 1\$342599 -87	193800.00 513000.00 6704799.94 76500.00 490200.00 200000.00 200000.00 10866799.75
CONTROL. IN 19. 1 COMPU 19. 2 OTHEN PERCENT TO	ŃŜTRÜMENTAT Uter R controls Dial direct	ION EACH EACH COST IN A	1.0 1.0 CCOUNT_19 =	660000-00 1250000-00 -750 ACCDU	15000.00 774000.00 JNT TOTAL.\$	666000.00 1250000.00 1910000.00	15000.00 774000.00 789000.00
PROCESS WAS 20. 1 BOTTO 20. 2 DRY / 20. 3 WET 20. 4 ONSIT PERCENT TO	STE SYSTEMS DM ASH ASR SLURRY TE DISPOSAL DTAL DIRECT	TPH TPH TPH ACRE COST IN A	•0 90•9 225•2 746•0 CCOUNT 20 =	-00 2400835-16 5715449-06 5272-45 5-588 ACCOL	00 500208.79 1428852.27 8081.34 INT TOTAL,5	00 2400835.16 5715449.06 3933406.16 12049690.25	600208-75 1428862-27 6028918-81 8057989-81
STACK GAS C 21. 1 PRECI 21. 2 SCRUE 21. 3 MISC PERCENT TO	CLEANING EPITATOR BBER STEEL & DU DTAL DIRECT	EACH KWE CTS COST IN A	.0 .0 CCOUNT 21 =	7752708-06 21-55 -000 ACCOL	5039260.19 9.88 .00 PNT TOTAL,\$	00- 00- 00- 00-	00. 00. 00. 00.
TOTAL	DIRECT COS	TS+\$	ana meta virti an		262	282562-00	97557834.00

RANKINE METAL VAPOR TOPPING-STEAM CYCLE COST OF ELECTRICITY.HILLS/KW.HR PARAMETRIC POINT NO.43

1 0 0 0 W W T						
A CONTRACTOR AND A	RATE		LABOR RA	TE \$/HR		
	PERCENT	6.00	8.50	16.60	15.00	21.50
TOTAL DIRECT COSTS#\$.0 3	17503976.	340512835.	359840392.	400336096-	450159296 -
TNDTRFCT COST+\$	51.0	28162921.	39897471.	49754494.	70467363.	100917134-
PROF 2 OWNER COSTS - S	8.0	25400318.	27241631.	28787231.	32026887.	36812743.
CONTINGENCY COST #\$	9.5	30162877.	32348725.	34184837.	38031929.	43715133.
SUB TOTAL +S	•O 4	01230088.	440000116-	472566948.	540802208	641604288 .
ESCALATION COST .S	6.5 1	10450252.	121133797.	130099576.	148885016 -	176636234.
INTREST DURING CONST.S	10.0 1	33831583.	146763450.	157626222-	180386312+	214009168-
TOTAL CAPITALIZATION +5	.0 6	45521920.	707897360.	760292736	870073536.3	032249688
COST OF ELEC-CAPITAL	18.0	17.90084	19-53055	21-08353	24-12/84	28-52511
COST OF ELEC-FUEL	• <u>0</u>	5-84663	5.84663	6-84663	5-04003	6.64663
COST OF ELEC-OP & MAIN		1.6/201	1. 1/201			
TOTAL COST OF ELEC	•U	SP*41348	28.14920	73.007T1	32.09040	3/ .143/3
		,	ONTTHECKEY.	DEDCENT		
ACCUUNT	- KALEN-	•••• ** **** *	ON THECHCI		5 00	20.00
TATH ATALAT GARTE A	PERCENT		750000707	750000707	750900707	759840392
TUTAL DIRECT CUSTS #\$		133646332+ 19758098	00764003225	19750h9b	19752292	69754694
INDIREUS COSTES	21-1	29797271	28787231	28787231	28787231	28787231
PROF & UNNER LUSISVS	- 70-0 -	17992019	20101231	34184837	17992019.	71968078
SIR TOTAL S	2.0.4	20397096	438382112	472566948.	456374128.	510350188.
ESCALATTON COST .S	651	15735080.	120688354.	130099576.	125641628.	140501454 -
IN TREST DURING CONST .S	10.0 1	40222454 .	145223760.	157626222 .	152225054 -	170228942
TOTAL CAPTTALTZATION, \$.0 6	76347640.	705294224.	760292736.	734240800.	821080575.
COST OF ELFC-CAPITAL	18.0	18.75566	19,55837	21.08353	20.36109	22.76922
COST OF FLEC-FUEL	• 0	6.84663	6.84663	6.84663	6-84663	5.84663
COST OF ELEC-OP & MAIN	_ C	1.67201	1.67201	1.67201	1.67201	1.67201
TOTAL COST OF ELEC	• 0 · · ·	27.27430	28.07701	29.60217	28-87975	31.28786
<u>é</u>						
	01 T E				3.2.	
ACCOUNT	RATE		SCALALION	RAILS PLACE	11. 10.00	00
ACCOUNT	PERCENT	5.00	SCALAIION J	8+00 7599/0392	10.0C	-00
TOTAL DIRECT COSTS - \$	PERCENT	5.00 59840392.	5CALAIION) 6.50 359840392.	8 • CO 359840392 •	10.00 359840392.	-00 359840392-
TOTAL DIRECT COSTS.\$	RATE PERCENT 0 3 51.0	5.00 59840392. 49754494.	5CALAIION) 5.50 359840392. 49754454. 28797231	8+C0 359840392- 45754494- 28787231	10.00 359840392. 49754494. 28787231.	-00 359840392- 49754494- 28787231-
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S	RATE PERCENT 003 51.0 8.0	5.00 59840392. 49754494 28787231. 34784837.	50359840392. 49754454. 28797231. 38188837.	8.00 359840392. 45754454. 28787231. 34184837.	10.00 359840392. 49754494. 28787231. 34184837.	-08 359840392. 49754494. 28787231. 34184837.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S	RATE PERCENT 003 51.0 8.0 9.5	5.00 59840392. 49754494. 28787231. 34184837. 57256948.	559840392 49754454 28787231 34184837 472565948	8.00 359840392. 49754494. 28787231. 34184837.	10.00 359840322. 49754494. 28787231. 34184837. 472555948.	-CD 359840392- 49754494- 28787231- 34184837- *72555948-
TOTAL DIRECT COSTS.S INDIRECT COST.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S FSC ALATION COST.S	RATE PERCENT 51.0 3 9.5 9.5	5.00 59840392. 49754494. 28787231. 34124837. 72566948. 97657985.	504LA110N_) 6-50 359840392- 49754454- 28787231- 34184837- 472566948- 130099576-	RATE: PERCE 8.CO 359840392. 49754494. 28787231. 34184837. 472565948. 164092682.	10.DC 35984D332. 49754434. 28787231. 34184837. 472566948. 211932152.	-CO 359840392. 49754494. 28787231. 34184837. *72556948. C.
TOTAL DIRECT COSTS.\$ INDIRECT COST.\$ PROF & ONNER COST.\$ CONTINGENCY COST.\$ SUB TOTAL \$ ESCALATION COST.\$ TNREST DUBTING CONST.\$	RATE PERCENT 51.0 8.0 9.5 0 4 10.0 1	5.00 59840392. 49754494. 28787231. 34184837. 172566948. 97657983. 50499152.	524LA110N 5-50 35984D392- 49754454- 28797231- 34184837- 472566948- 130099576- 157626222-	RATES PERCEN 8 -CC 359840392. 45754454. 28787231. 34184837. 472565948. 164092682. 165029884.	10.00 3598403322. 49754494. 28787231. 34184837. 472566948. 211932152. 175345882.	00 359840392. 49754494. 28787231. 34184837. *72555948. 0. 128637462.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S INTREST DURING CONST.S	RATE PERCENT 51.0 9.5 0 4 10.0 1 10.0 1	5.00 59840392. 49754494. 28787231. 34124837. 72566948. 97657983. 50499152. 20724020.	SCALAIION 359840392. 49754454. 28797231. 34184837. 472566948. 130099576. 157626222. 760292736.	8 - CC 35 9840392 49754494 28787231 34184837 4725659488 164092682 165029884 801689564 801689564	10.00 359840332. 49754434. 28787231. 34184837. 472566948. 211932152. 175345882. 859844976.	-00 359840392. 49754994. 28787231. 34184837. 472565948. 0 128637462. 501204408.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S TOTAL CAPITALIZATION S COST OF FIECCAPTIAL	RATE PERCENT 51.0 8.0 9.5 0 4 10.0 10.0 10.0 18.0	5.00 59840392. 49754494. 28787231. 34184837. 172556948. 9765798. 50499152. 20724080. 19.98626	SCALAIION 359840392. 49754454. 28797231. 34184837. 472566948. 130099576. 157626222. 760292736. 21.08353.	8 - CC 35 98 403 92 - 49754494 - 28787231 - 34184837 - 472565948 - 164092682 - 165029884 - 801689554 - 22 - 23149	10.00 359840392. 49754494. 34184837. 472566948. 211932152. 175345882. 859844976. 23.84419	-00 359840392. 49754494. 28787231. 34184837. *72566948. 0 128637462. 60120408. 16.67188
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S NOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL	RATE PERCENT 51.0 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5	5-00 559840392. 49754494. 28787231. 34184837. 72556948. 9765798. 50499152. 20724080. 19.98626 6.84663	SCALAIION 359840392. 49754454. 28797231. 34184837. 472566948. 130099576. 157626222. 760292736. 21.08253 6.84263	8 - LC - LC - SC - SC - SC - SC - SC - SC	10.00 359840392. 49754494. 28787231. 34184837. 472566948. 211932152. 175345882. 859844976. 23.844976. 23.844193 6.84663	-00 359840392. 49757494. 28787231. 34184837. *72566948. 0. 128637462. 601204408. 16-67188. 6.84663
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-DV & MAIN	RATE PERCENT 351.0 9.5 0 1 10.0 1 18.0 18.0	5-06 559840392. 49754494. 28787231. 34184837. 72566948. 97657983. 507993152. 20724080. 19.986263 6.84665 1.67201		8 - C - C - C - C - C - C - C - C - C -	10.00 359840392 49754434 28787231 34184837 77256988 211932152 175345882 859844976 23.84467 6.84663 6.84663 1.677201	-00 359840392. 49754994. 28787231. 34184837. 472565948. 0. 128637462. 501204408. 16.67188 6.84663 _1.67201
TOTAL DIRECT COSTS.\$ INDIRECT COSTS.\$ PROF & OWNER COSTS.\$ CONTINGENCY COST.\$ SUB TOTAL.\$ ESCALATION COST.\$ INTREST DURING CONST.\$ YOTAL CAPITALIZATION.\$ COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC	RATE PERCENT 351.0 9.5 0 4.0 10.0 18.0 18.0 18.0 18.0 18.0 18.0 18	5-00 559840392. 49754494. 28787231. 34184837. 172566948. 97657948. 20724080. 19.98626 6.84663 1.67201 28.50490		A 1 6 - CG 359840392 - 49754954 - 39184837 - 39184837 - 49725659482 - 164092682 - 165029884 - 80168950 - 22-23169 6 - 84605 1 - 67201 30 - 75013	10.00 359840332. 49754494. 28767231. 34184837. 472566948. 211932152. 1753458824. 859844976. 23.84419 6.84663 1.67201 32.36283	-00 359840392. 49757494. 28787231. 34184837. 472566948. 0. 128637462. 601204408. 16.67188 6.846633 1.667201 25.19052
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S TNTREST DURING CONST.S NOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CPUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC	RATE PERCENT 3 0 9 5 0 10 0 10 0 10 0 10 0 10 0 10 0 10 0	5-06 5598403922. 49754444. 28787231. 34184837. 72556948. 97657983. 50499152. 20724080. 19-98626 6.84663 1.67201 28.50490		8 10 359840392 4575494 49757494 28787231 34184837 472565948 1640926682 165029884 165029884 22.23149 6.84563 1.67201 30.75013 30.75013	10.00 359840392 49754494 28787231 34184837 472566948 211932152 559844976 23.84419 6.84663 1.67201 32.36283	-00 359840392. 4975494. 28787231. 34184837. *72556948. 0. 128637462. 501204408. 16-67188 6.84663 1.67201 25.19052
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S TNTREST DURING CONST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-DP & MAIN TOTAL COST OF ELEC	RATE PERCENT 351.0 9.5 00 10.0 18.0 18.0 0 0	5-06 5598403922. 49754494. 28787231. 34184837. 72566948. 97657983. 20724080. 19.98626 6.84666 6.84663 1.67201 28.50490		8 - C - C - C - C - C - C - C - C - C -	10.00 359840392 49754494 28787231 472566948 211932152 175345882 859844976 23.849476 23.849476 23.849476 1.620 23.849419 6.84663 1.6728458 2.36283	-00 359840392. 49754494. 28787231. 34184837. 472565948. 0. 128637462. 501204408. 16.67188 6.84663 1.67201 25.19052
TOTAL DIRECT COSTS.\$ INDIRECT COSTS.\$ PROF & ONNER COSTS.\$ CONTINGENCY COST.\$ SUB TOTAL.\$ ESCALATION COST.\$ INTREST DURING CONST.\$ TOTAL CAPITALIZATION.\$ COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL	RATE PERCENT 9.5 9.5 0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	5-06 559840392 49754444 28787231 34184837 50499152 20724080 19-98626 6-84663 1-67201 28-50490	SCALATION 5.50 359340392. 49754454. 28737231. 34184837. 34184837. 34184837. 31099576. 157626222. 760292736. 21.093553 6.84063. 1.67201. 29.60217. ENT DURING 1	RAILS, FERUES 359840392. 49754454. 28787231. 34184831. 4725669488. 164092682. 165029884. 801689504. 22.23149 6.84663 1.67201. 30.75013 CONST.FERCE	10.00 3598403322. 49754454. 28787231. 34184837. 72566948. 211932152. 175345882. 859844976. 23.844976. 23.844976. 32.84663 1.67201. 32.36283	.00 359840392. 49757494. 28787231. 3484837. *72565948. 0. 128637462. 601204408. 16.67188. 6.84663. 1.67201. 25.19052
ACCOUNT TOTAL DIRECT COSTS.S INDIRECT COST.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CPUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC	RATE PERCENT 51.0 9.5 0 10.0 10.0 10.0 10.0 10.0 10.0 7 18.0 0 0 0 0 8.0 7 8.0 8.0 7 8.0 7 8.0 7 8.0 8.0 8.0 7 8.0 8.0 8.0 8.0 7 8.0 7 8.0 7 8.0 7 8.0 7 8.0 7 8.0 7 8.0 7 8.0 9.0 9.0 9.0 8.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9	5-00 5598403922. 49754494. 28787231. 34184837. 72556948. 97657983. 50499152. 20724080. 19-98626 6.84663 1.67201 28.50490		RALE, FERUES 359840392- 49754494- 28787231- 34184837- 472565948- 164092682- 165029884- 22-23149 6-84663 1-67201 30-75013 CONST.PERCE. 10-00 56800	10.00 359840392. 49754494. 28787231. 34184837. 211932152. 259844976. 23.84419 6.84653 1.67201 32.36283 NT 122.50 759840302	-00 359840392. 4975494. 28787231. 34184837. *72556948. 0. 128637462. 501204408. 16-67188 6.84663 1.67201 25.19052
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & ONNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-SP & MAIN TOTAL COST OF ELEC	RATE PERCENT 31.0 9.5 00 10.0 18.0 18.0 18.0 0 18.0 0 8.0 18.0 1	5-00 559840392. 49754494. 28787231. 34184837. 72566948. 97657983. 20724080. 19.98626 6.84666 6.84666 19.98626 6.84659 1.67201 28.50490	SCALATION 5:50 359340392. 4975454. 287975454. 72565948. 130099576. 1370265948. 130099576. 157626222. 760292736. 21.08353 6.84C63 1.67201 29.60217 ENT DURING 1 8.00 359840392.	A 1 6 7 EU 359840392 - 49754954 - 39787231 - 49725659482 - 164092682 - 165029884 - 801689504 - 22-23169 6 - 84663 1 - 672013 30 - 75013 CONSI - PERCE 10 - 00 359840392 - 4 - 974497	10.00 359840392 49754494 28787231 34184837 472566948 211932152 175345882 859844976 23.849476 23.849476 23.849476 12.50 32.36283	-00 359840392. 49754494. 28787231. 34184837. 472565948. 0. 128637462. 501204408. 16.67188 6.84663 1.667201 25.19052 15.00 359840392.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S INTREST DURING CONST.S INTREST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC ACCOUNT TOTAL DIRECT COSTS.S EDDDE COUNTE COSTS.S	RATE PERCENT 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5	5-00 559840392. 4975444. 28787231. 34184837. 50439152. 20724080. 19-98626 6-84663 1.67201 28.50490 59840392. 49754494.	SCALATION 5.50 359840392. 49754454. 28797231. 34184837. 130099576. 157626222. 760292736. 21.08353 6.84663 1.67201 29.60217 KNT DURING 3.00 3.00 3.00 3.00 2.075459. 2.07	RAILS, FLACE, 359840392. 49754494. 28787231. 34184837. 4725659488. 1640926882. 1640926884. 165029884. 22.23149 6.84663 1.67201 30.75013 CONST.PERCE. 359840392. 49754494. 28787231.	10.00 3598403322. 49754494. 28787231. 34184837 472566948. 211932152. 175345882. 859844976. 23.84419 6.84663 1.67201 32.36283 VT	-00 359840392. 49757494. 28787231. 34184837. 472566948. 0. 128637462. 601204408. 16.67188. 6.84663. 1.67201. 25.19052 15.00 359840392. 49754494. 26787231.
	RATE PERCENT 9.5 0 10.0 10.0 10.0 10.0 10.0 10.0 10.0	5-00 5598403922. 49754494. 28787231. 34184837. 72556948. 97657983. 50499152. 20724080. 19-98626 6.84663 1.67201 28.50490 59840392. 49754494. 28787231. 2849494.	SCALATION 550 359840392 4975454 28797231 34184837 472566948 130099576 157626222 760292736 21.08353 6.84763 1.67201 29.60217 (NT DURING 8.00 359840392 49754454 28787231 34184837	KALLS FERUES 359840392- 49754494- 28787231- 34184837- 4725659483- 164092682- 165029884- 801689504- 22-23149 6-84563 1-67201 3D-75013 CONSIPERCE 10-00 359840392- 49754494- 28787231- 34184337- 49754494- 28787231- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 34184337- 3418437- 3418437- 3418437- 3418437- 3418437- 3418457- 34185757- 34185757- 341845757- 3418575757-	10.00 359840392 49754434 28787231 34184837 472566948 211932152 23.844976 23.844976 23.844976 1.67201 32.36283 1.67201 32.36283 1.67201 32.36283 1.2750 359840392 49754494 28787231 35184837	-00 359840392. 49754944. 28787231. 34184837. *72565948. 0. 128637462. 6012C4408. 16-67188 6.84663 1.67201 25.19052 15.00 359840392. 49754494. 28787231. 34184837.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S YOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-SUEL ACCOUNT TOTAL DIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S	RATE PERCECT 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	5-06 559840392. 49754449. 28787231 34184837 72566948. 9765798; 20724080. 19-98626 6.84663 1.67201 28-50499 559840392. 49754494. 2878754494. 28787231. 34184837.	SCALATION 5.50 359840392. 49754454. 28737231. 34184837. 34184837. 34184837. 34184837. 34184837. 130099576. 21.08353. 6.84263. 1.67201. 29.60217 INT DURING 1 8.00 359840392. 49754454. 28787231. 34184837. 34184837.	A 1 L 5 FERVES 359840392 - 49754954 - 28787231 - 497554954 - - 497554958 - 497554958 - 22-2316938 - - - - - - - - - - - - -	10.00 3590403322 49754494 28787231 34184837 7256988 211932152 175345882 859844976 23.84419 6.84663 1.67201 32.36243 1.67203 12.50 359840392 49754494 3754494 3754494 3754494 49754494 37566948	-00 359840392. 49757494. 38787231. 34184837. *72566948. 0. 128637462. 601204408. 16.67188 6.84663 1.67201 25.19052 15.00 359840392. 4975494. 28787231. 34184837.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S NTREST DURING CONST.S NOTAL CAPITALIZATION.S COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC ACCOUNT TOTAL DIRECT COSTS.S INDIRECT COST.S SUB TOTAL.S SUB TOTAL.S SUB TOTAL.S FSCALATION COST.S	RATE PERCENT 3 51.0 9.5 9.5 9.5 9.5 9.5 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	5-00 559840392. 4975444. 28787231. 34184837. 72556948. 97657985. 20724020. 19-98626 6.84663 1.67201 28.50490 559840392. 49754494. 28787231. 34184837. 72556948. 34184837.		RAIL, FLE, FLE, S.C. 359840392. 49754494. 28787231. 34184837. 34184837. 4725659488. 1640926882. 122.23149 6.84663 1.672C1 30.75C13 CONST.PERCE. 10.00 359844532. 28787231. 35984532. 28787231. 35984532. 359855. 35984532. 35	10.00 359840392 49754494 28787231 34184837 472566948 211932152 23.844976 23.844976 23.844976 1.67201 32.36283 1.67209 3.48437 3.48437 3.47256988 3.5756988 1.50099576 1.500957757777777777777777777777777777777	-00 359840392. 49754494. 28787231. 34184837. *72566948. 0. 128637462. 601204408. 16.67188. 1.67201. 25.19052 15.00 359840392. *9754494. 28787231. 34184837. *72566948. 130099576.
TOTAL DIRECT COSTS.\$ INDIRECT COST.\$ PROF & OWNER COST.\$ CONTINGENCY COST.\$ SUB TOTAL.\$ ESCALATION COST.\$ TNTREST DURING CONST.\$ TOTAL CAPITALIZATION.\$ COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-DP & MAIN TOTAL COST OF ELEC ACCOUNT TOTAL DIRECT COSTS.\$ INDIRECT COST.\$ SUB TOTAL\$ COST.\$ SUB TOTAL\$ SUB TOTAL\$ SUB TOTAL\$	RATE PERCENT 9.5 9.5 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10	5-00 5598403922. 49754494. 28787231. 34184837. 72556948. 97657983. 50499152. 20724080. 19-986263 6-84663 1.67201 28.50490 559840392. 49754494. 28787231. 34184837. 72566948. 300995768. 300995768. 300995768. 300995785.	SCALATION 5.50 359840392 4975454 287975454 472566948 130099576 157626222 760292736 21.09353 6.84633 1.67201 29.60217 INT DURING 1975452 49754454 28787231 34184837 472566948 1300995766 123583174	KALL, FLRUE, 359840392. 49754454. 28787231. 34184837. 4725659482. 164092682. 165029884. 801689504. 22.23149 6.84563 1.67201. 3D.75013 CONSI.PERCE. 10.00 359840392. 49754494. 28787231. 34184037. 472566948. 130099576. 157625222.	10.00 359840392 49754434 28787231 34184837 472566948 211932152 175345882 23.844976 23.844976 23.844976 12.50 12.50 32.36283 NT 12.50 359840392 49754494 28787231 34184837 472566948 130099576 20207578	-00 359840392. 4975494. 28787231. 34184837. *72565948. 0. 128637462. 6012C4408. 1.667188 6.84663 1.67201 25.19052 15.00 359840392. 49754494. 28787231. 34184837. 472566948. 130099576.
TOTAL DIRECT COSTS.\$ INDIRECT COSTS.\$ PROF & ONNER COSTS.\$ CONTINGENCY COST.\$ SUB TOTAL.\$ ESCALATION COST.\$ INTREST DURING CONST.\$ TOTAL CAPITALIZATION.\$ COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC PROF & ONNER CONT. TOTAL COST OF ELEC TOTAL COST OF ELEC COST OF ELEC CONT. CONT	RATE PERCENT 3 51.00 9.5 9.5 0 10.000 10.000 10.000 10.000 100 1	5-00 559840392. 49754444. 28787231- 34184837- 55439152- 20724080. 19-98626 6-84663 1.67201 28.50490 59840392. 49754494. 28787231. 34184837. 1256694. 13099576. 90840785. 93507304.	SCALATION 5.50 359340392. 49754454. 28737231. 34184837. 34184837. 34184837. 34184837. 37256948. 130099576. 1.57626222. 760292736. 21.08353 6.84063. 21.08353 1.67201. 29.60217. NT DURING 1 3.00 359840352. 49754459. 28787231. 34184837. 130099576. 123583174. 725249688.	RAIL & FLG 359840392. 49754494. 28787231. 497554954. 1640926848. 1640926848. 165029884. 22.2316938. 1.65029884. 1.657201. 30.7521. 30.7524934. 28787231. 28787231. 28787231. 28787231. 28787231. 397544938. 1300995268. 1300995222. 157625222. 760292736.	10.00 3598403322. 49754454. 28787231. 34184837. 77256948. 211932152. 17534582. 859844976. 23.8441976. 1.67201. 32.36283 1.67201. 359840392. 49754494. 28787231. 34184837. 472566948. 130099576. 202075378. 8024741896.	-00 359840392. 49757494. 28787231. 34184837. *72565948. 0. 128637462. 601204408. 16.67188. 6.84663. 1.67201. 25.19052 359840392. 49754494. 28787231. 34184837. 472566548. 130099576. 288712216. 851378936.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S NOTAL CAPITALIZATION.S COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL DIRECT COSTS.S PROF & OWNER COSTS.S SUB TOTAL.S ESCALATION COST.S SUB TOTAL.S ESCALATION COST.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S CONTINGENCY COST.S CONTINGENCY COST.S COST OF ELEC-CAPITAL COST OF ELECCAPITALIZATION.S CONTINGENCY COST.S	RATE PERCENT 3 51.00 9.5 9.5 9.5 10.0 1 10.0 1 18.0 .0 10.0 1 18.0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0	5-00 559840392. 49754494. 28787231. 34184837. 72556948. 97657983. 50499152. 20724080. 19-986263 1.67201 28.50490 559840392. 49754494. 28787231. 34184837. 72556948. 34184837. 72556948. 90840785. 93507304. 19.23151		KALL, FL, FL, KUL, 359840392. 49754494. 28787231. 34184837. 472565948. 1640926882. 165029884. 22.23149 6.84563 1.672C1 30.75C13 CONST.PERCE. 10.00 35984C392. 49754494. 29754494. 29754931. 3184837. 472566948. 157625222. 760292736. 21.68353	10.00 359840392. 49754494. 28787231. 34184837. 211932152. 23.844976. 23.844976. 23.844976. 23.844976. 23.84413 1.67201 32.36283 NT 12.50 359840392. 49754494. 28787231. 34184837. 472566948. 13009976. 202075378. 804741896. 22.31614	-00 359840392. 4975494. 34184837. *72565948. 0. 128637462. 601204408. 1.6-67188. 1.6-67188. 1.6-67188. 1.6-67188. 1.6-67201. 25.19052 359840392. 49754494. 28787231. 34184837. 472566348. 13009576. 2851378936. 2351378936. 23506942
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-FUEL ACCOUNT TOTAL DIRECT COSTS.S INDIRECT COST.S SUB TOTAL.S ESCALATION COST.S SUB TOTAL S SCALATION COST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL	RATE PERCECTT 51.00 9.5 9.5 9.5 9.5 9.5 10.000 10.00 10.000 10.000 10.000 10.000 100	5-06 559840392. 49754444. 28787231- 34184837- 3765798; 50499152. 20724080. 1998626 6-84663 1.67201 28.50490 559840392. 49754494. 28787231. 34184837. 72556948. 30099576. 90840785. 3935073151. 6-84563	SCALATION 5.50 359340392. 49754454 28737231 34184837 34184837 34184837 472566948 130099576 21.08353 6.84263 1.67201 29.6021 29.6021 29.6021 29.6021 29.6021 29.6021 29.6021 29.6021 29.6021 20.13549 20.13549 6.84653 20.13549 6.84653 20.13549 20.13549 6.84653 20.13549	A 1 L 5 FLG 359840392. 49754494. 39118493837. 497572317. 3911849382. 1640926884. 1640926884. 165029884. 22.2316938 1.657201. 30.75021. 30.75021. 59840392. 49754494. 30.75021. 59840392. 49754231. 39840392. 49754231. 39840392. 49754231. 39840392. 49754231. 30.750292735. 30.750292735. 21.0282735. 21.0282735. 34.553. 6.9455. 34.553. 35.553. 34.553. 3	$\begin{array}{c} 10.00\\ 359040322\\ +9754494\\ -28787231\\ -34184837\\ +72566948\\ -211932152\\ +7256824\\ +7256824\\ -238844976\\ -23.884976\\ -23.884976\\ -23.884976\\ -23.884976\\ -34184837\\ -23.884976\\ -34184837\\ -34184837\\ -34184837\\ -34184837\\ -34184837\\ -34184837\\ -20207578\\ -20207578\\ -20207578\\ -20207578\\ -22.31614\\ -22.31614\\ -2.48663\\ -22.31614\\ -5.88663\\ -22.31614\\ -5.88665\\ -22.3164\\ -5.8866\\ -5.8$	-00 359840392. 49757494. 38787231. 37184837. *72566948. 0. 128637462. 601204408. 16.67188 6.846633 1.67201 25.19052 359840392. 49754494. 22787231. 34184837. 472566948. 130099576. 2871378936. 23.66948. 23.66938.
TOTAL DIRECT COSTS.S INDIRECT COSTS.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S INTREST DURING CONST.S COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC ACCOUNT TOTAL DIRECT COST.S PROF & OWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONST.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL COST OF ELEC-CAPITAL	RATE PERCENT 3 51.0 9.5 9.5 9.5 9.5 9.5 9.5 9.5 10.0 10.0 10.0 7 18.0 0 8.0 9.5 7 18.0 7 8.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 9.5 7 18.0 7 8 10.0 19.5 7 18.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19	5-06 559840392. 49754494. 28787231. 34184837. 50439152. 20724080. 19-98626 6.84663 1.67201 28.50490 59840392. 49754494. 34184837. 3519484. 35184837. 35184857. 3518457. 351857.3517. 351857. 351857. 351857.351857. 351857. 351857.351857.	SCALAIION 5-50 359340392. 49754454. 28797231. 34184837. 472566948. 157625222. 760292736. 21.08353 6.840392. 4975454. 359840392. 472566948. 28787754531. 359840392. 472566948. 28787754531. 359840392. 472566948. 28787754531. 359840392. 472566948. 28787754531. 28787754531. 359840392. 472566948. 28787754531. 28787754531. 359840392. 472566948. 28787754531. 20.13583174. 726249688. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.1358431. 20.135843. 20.13584. 20.1354. 20.15584. 20.15584. 20.15584. 20.15584. 20.15584. 20.15	RAILE FLG 359840392. 49754494. 497574954. 28767231. 497574954. 28767231. 472569488. 1640926884. 1640926884. 22.2319. 96.84662. 1667201. 300.7521. 30.7521. 300.7521. 30.7524. 359840392. 49757231. 359840392. 49757231. 359840392. 49757231. 371849348. 1300995762. 1500995762. 21.02827353. 21.02927353. 21.028353. 21.0284502. 21.028563.	$\begin{array}{c} 10.00\\ 359840392\\ 49754494\\ .28787231\\ .34184837\\ .7256948\\ .211932152\\ .23.844193\\ .259844976\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .23.84419\\ .24.8421\\ .24.8421\\ .24.8421\\ .24.8423$	-00 359840392. 49754494. 34184837. *72566948. 0. 128637462. 601204408. 1.667188. 6.84663. 1.67201. 25.19052 15.00 359840392. *9754494. 26787231. 34184837. *72566948. 130099576. 248712416. 851378936. 23.60942. 6.86631. 5.7201.

Table A 8.3.8 Continued

RANKINE METAL VAPOR TOPPING-STEAM CYCLE COST OF ELECTRICITY.MILLS/KW.HR PARAMETRIC POINT NO.43

ACCOUNT	RATE. PERCENT	F1	IN THE CHARGE	RATE. PCT	21.50	25.00
TOTAL DIRECT COST INDIRECT COST \$	S#\$ 03 51.0	59840392 . 49754494 . 28787231 .	359840392 . 49754454. 28787231.	359840392• 3 49754494• 28787231•	59840392• 3 49754494• 28787231•	359840392. 49754494. 28787231.
CONTINGENCY COST: SUB TOTAL +\$	9.5 •0 4	34184837.	34184837. 472566948.	34184837. 472566948.	34184837 • 72566948 •	34184837 • • 72566948 •
INTREST DURING CO TOTAL CAPITALIZAT	NST.S 10.0 1 TON.S	57626222. 60292735	157626222 760292726	157626222• 1 760292736• 7	57526222. 60292736.	157626222• 760292736•
COST OF ELEC-CAPI COST OF ELEC-FUEL COST OF FLEC-OP 8	TAL 25.D NAIN 0	11.71307 5.84663 1.67201	16.86692 6.84663 1.67201	21.08353 6.84663 1.67201	25-30023 5-84663 1-67201	5-84663 1-67201
TOTAL COST OF ELD	te vo	20.23171	25.38546	29.60217	33.81887	37.80132
ACCOUNT	RATE		UEL COST. \$	210 ++6 BTU	2 50	1.02
TOTAL DIRECT COST		5984C392	359846392.	359840392. 3	59840392	359840392.
INDIRECT COST.S	51.0	49754434	49754494	49754494.	49754494	49754494
CONTINGENCY COST	\$ 9.5	34184837	34184837	34184837	34184837.	34184837
SUB TOTAL .S		72566948	72566948	472566948	72566948	472566948.
INTREST DURING CO	NST \$ 10.0 1	57626222	157626222	157526222. 1	57626222	157626222.
TOTAL CAPITALIZA	IDN'S C 7	60232735	760292736	760292736	21-08353	760292736
COST OF ELEC-FUEL	0	4.02743	6.84663	12.08230	20 13716	8.21595
COST OF ELEC-OP	MAIN .D	1.57201		1.67201	1 67201	1.67201
D INTAL CUST OF ELE	•0	20010251	23.00211	34603103	42803203	30431143
ACCOUNT	PATE.	C.	APACTTY FAC	TOR. PERCENT	-	
	PERCENT	12.00	45.00	50.00	65.00	80.00
TOTAL DIRECT COST	[S∎\$ _0 3 51-0	59840392 . 49754494	49754494	359840392• 3	15989U39Z.	49754494
PROF & OWNER COST	rs•s 9.0	28787231	28787231.	28787231	28787231	28787231.
CONTINGENCY COST	e\$ 9,5 _Ω#	34184837°	34184837-	3418483/+	34184837	34184837+ 472566948-
ESCALATION COST -	6 5 1	30099576.	130099576	130099576. 1	30099576	130099576 -
INTREST DURING CO	NST <u>\$ 10 0 1</u>	57525222	15/626222	157526222	57525222	15/626222 760292736
COST OF ELEC-CAPI	TAL 18.0	114-20244	30.45398	27.40858	21.08353	17-13037
COST OF ELEC-FUEL		5.84563	5.84663	5.84663 1.78333	6.84663 1.67281	6.84653 1.59740
TOTAL COST OF ELE		123.97614	39.13478	36 03855	29.60217	25 5740
-						

	RANKINE	METAL VAP	POR TOPPING	-STEAM	CYCLE				
ACCOU TOTA NOMI NOM ST T	NT NG AUX 7 3 14 20 20 20 20 20 20 20 20 20 20 20 20 20	POWER.YWF 8.3435 6.211 10.139 .COU 10.9502 23.7165 60.023 APOR TOPP /KW-HR CHANSE	PERC PLA 53 1 73 1 70 1 20 1 20 1 34 5 10 1200.00 7651.905 .978	NT POW 4 8979 6 3473 6 9904 8 2572 9 5070 5 2661 5 2661 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0PERATION (2 55. 2 1264. 0 14. 3 7. 2 1281. 4 2 2 1281. ASE CASE INPLET POWER, MW ET HEAT RATE	CCST MAI CC832 67934 30682 30682 00000 45271 45271 UT 5 • 9TU/KW	NTENANCE CO 13.091 .000 .000 .000 .000 .000 13.031 .HR 80	ST 70 00 00 00 00 00 00 00 00 00 00 00 00	
DESI NUMB UT B HE AT	GN PRESSURE, I ER OF TUBES/SH TU/HR-FT2-F REJECTION	N HG A ELL	3.500 6980.503 . 508.353	10 N 54 T 55 T	UMBER OF SHE UBE LENGTH. I ERMINAL TEMP	LLS FT DIFF. F		3-0000 59-5067 5-0000	
DESI RANS OFF	GN TEMP, F E, F Design pres, I	IN HG A	77.000 23.000 2.417	10 A 10 0 15 L	PPROACH. F FF DESIGN TEL P TURBINE BL	MP, F ADE LEN,	IN	15.6713 51.4000 25.0000	
1 5 11 15 21 31 35 41 45 8 51 1 8 51	1200,500 825,700 1.205 2.005 50000,000 1.000 4930000,000 15000,000 15000,000 000 200 000 000 000 000 000 000	2 7 12 17 22 27 32 37 42 47 52 52 52 7 12	*CCG 3.500 188.100 25550.600 20000.000 1700.000 1700.000 5.350 5.350 4.000 1.600 2000.000	3 336 118 22 23 338 338 338 338 34 3 3 3 4 4 3 3 3 5 5 5 5 5 5 5 5 5 5	446 940006.000 1.000 20001.000 20001.000 1.000 1.500.000 3.000 4.000 1.500.000	9 14 17 24 29 23 39 44 49 19	000 3.000 5.000 27365.005 600000.006 1.000 250060.000 2.000 2.000 8.000	5 10 15 22 30 35 45 5 5 10 5	6 - 500 1 - 000 - 000 2 - 500 - 000 - 500 1 - 000 774000 - 000 237000 - 000 4 - 000 - 000
16151 2251 334 455 5561 660 7751 8861 96	19700006.000 2330.000 2780000.000 000 000 000 150006.000 570000.000 2000000.000 2000000.000 000 000	17 227 59 222 59 37 47 57 57 667 77 667 81 77 87 782 87 87 87 997	20000 000 780 200 20000 000 000 20000 000 20000 000 20000 000 20000 000 2000 000 2000 000 2000 000 2000 000 000	112227445586772838	6000660.000 30000.000 310.000 575000.000 1.000 000 1.000 1.000 250000.000 250000.000 250000.000 250000.000 000 000 000 000 000 000	194949494949494949494949494949494949494	110000 104000 104000 1000000 0000 0000 00000 00000 000000	225050505050505050505050505050505050505	50000000000000000000000000000000000000

REPROTATE LIGHT OF THE ONIGHNAL FROM IS POOR

RANKINE METAL VAPOR TOPPING-STEAM CYCLE ACCOUNT LISTING PARAMETRIC POINT ND.45 ACCOUNT NO. & NAME, UNIT AMOUNT MAT \$/UNIT INS \$/UNIT MAT COST.\$ INS COST.\$

		e		· ·
SITE DEVELOPMENT 1. 1 LAND COST 1. 2 CLEARING LAND 1. 3 GRADING LAND 1. 4 ACCESS RAILROAD 1. 5 LOOP RAILROAD TRACK 1. 6 SIDING R TRACK 1. 7 OTHER SITE COSTS PERCENT TGTAL 2THECT COST	ACRE 197.0 ACRE 52.3 ACRE 187.0 MILE 5.0 MILE 2.5 MILE 0 ACRE 0 T IN ACCOUNT 1 =	1660.00 -00 -00 500.00 15060.00 11000.00 120000.00 7000.00 125060.00 86600.00 -00 -00 -314 ACCJUNT TOTAL,s	167020-08 -00 575000-00 300000-00 -00 396405-36 1458406-86 1	•00 37396-26 561000-00 556000-00 175000-00 396406-86 1719803-11
EXCAVATION & PILING 2. 1 COMMON EXCAVATION 2. 2 PILING PERCENT TOTAL DIRECT COST	YD3 75150.0 FT 200400.0 T IN ACCOUNT 2 =	.0C 3.0C 5.50 8.50 .927 ACCOUNT TOTAL*\$.00 1302600.00 1302600.00	225450-00 1703400-00 1928850-00
PLANI ISLAND CONCRETE 3. 1 PLANT IS. CONCRETE 3. 2 SPECIAL STRUCTURES PERCENT TOTAL DIRECT COST	YD3 25050.0 YD3 0 F in account 3 =	70.0C 80.CC .00 .00 .962 ACCOUNT TOTAL;\$	1753508.00 00 1753500.00	2004000 <u>+06</u> •00 2004000•00
HEAT REJECTION SYSTEM 4. 1 COOLING TOWERS 4. 2 CTRCULATING H2C SYS 4. 3 SURFACE CONDENSER PERCENT TOTAL DIRECT COS	EACH 14-C EACH 14-C FT2 409753.4 T IN ACCOUNT 4 = 2	-00 -00 -00 -00 -00 -00 -00 ACCJUNT TOTAL+5	2149000.00 1215394.06 1837454.39 5201848.44	1071000.00 1629685.83 286827.41 2887517.22
2 STRUCTURAL FEATURES 5 1 STAT. STRUCTURAL ST. 5 2 SILOS & BUNKERS 5 3 CHIMNEY 5 4 STRUCTURAL FEATURES PERCENT TOTAL DIRECT COST	• 19N 27300.0 TPH 50 FT 50 EACH 1.0 T IN ACCOUNT 5 - 5	550.00 175.00 1860.00 750.00 725000.00 166600.00 994 ACCOUNT TOTAL:\$	17745000-00 -C0 -00 725000-00 18470000-00	\$777500.00 •00 •00 \$543500.00
BUILDINGS 6.1 STATION BUILDINGS 6.2 ADMINSTRATION 6.3 WAREHOUSE & SHOP PERCENT TOTAL DIRECT COST	FT3 7500000.0 FT2 20000.0 FT2 20000.0 TIN ACCOUNT 5 =	-16 -16 16.00 14.00 12.00 8.00 .876 ACCOUNT TOTAL, \$	1200000.00 320000.00 240000.00 1760000.00	1266666.00 28000.00 160660.60 164000.00
FUEL HANDLING & STORAGE 7.1 COAL HANDLING SYS 7.2 DOLOMITE HAND. SYS 7.3 FUEL OIL HAND. SYS PERCENT TOTAL DIRECT COS	TPH 419.9 TPH 222.2 GAL 25C0600.0 T IN ACCOUNT 7 = 3	00 00 00 00 00 00 00 00 00 00 00 00 00	5850870.50 2966731.44 290836.01 9108437.87	2491311.41 1371040.98 227826.41 4090778.78
FUEL PROCESSING 8. 1 COAL DRYER & CRUSHEI 3. 2 CARBONIZERS 8. 3 GASIFIERS PERCENT TOTAL DIRECT COS	R TPH -G TPH -O TPH -O T IN ACCOUNT 3 =	00 00 00 00 00 00 00 00 00 00 00 00 00 0	06- 00- 00- 00-	00- 00- 00- 00-

	Table A 9	2 10 Com	tinued			ا رسینی در مص			
	TADLE A O.	RAN	KINE METAL	VAPOR TO PARAME	PPING-ST	EAM CYCLE NT NO.46	ACCOUNT LIST	TING	
	ACCOUNT	NO. 8	NAME. U	AIT A	HOUNT M	AT SJUNIT	INS S/UNIT	HAT COSTIS	INS COST.S
	FIRING SY 9.1 PERCENT	STEN Total D:	ERECT COST	IN ACCOU	NT SO=	00. 1600A 000.	-80 JNT TOTAL+\$	00. 00	00• 00•
	VAPOR GEN 10. 1 PRE 10. 2 FLU PERCENT	ERATOR SSURIZE ID BED Total D	(FIRED) BOILER BOILER IRECT COST	EA EA In Accou	.0 4.0 1 NT 10 =2	00- 5155200-00 4-248 Accol	00 8524799-87 Int total.s	•00 68626820•00 60628800•00	•00 34099199•50 34099199•50
	ENERGY CO 11. 1 STE 11. 2 GAS 11. 3 LIQ 11. 4 LIQ 11. 5 LIQ 11. 6 LIQ 11. 7 LIQ 11. 8 LIQ 11. 9 LIQ PERCENT	NVERTER AM TURB TURBIN UID MET UID MET MET HO MET CO MET CO MET IN TOTAL D	INE GENERA E GENERATO AL TURB-GEI PECIRC PUH T LEG PIPI LD LEG PIPI NDENSATE P VENTORY IRECT COST	TOR R NS E UMP In Accou	1-0 1 4-0 4-0 2000-0 130C-0 4-0 1-0 2 NT 11 =3	9700000.00 5900000.00 2000000.00 235000.00 235000.00 2330.00 367.00 495000.00 6.115 ACC0	1215823.09 157600.00 180000.00 1350000.00 18800.00 780.00 124.00 39600.00 572720.00 JNT TOTAL+\$	1970000.00 23600000.00 1600000.00 94000.00 94000.00 466000.00 477100.00 198000.00 2863600.00 2863600.00	1215823.09 6304000.00 143999.98 5440000.00 7520.00 156000.00 161200.00 158400.00 572720.00 15927343.00
	COUPLING 12. 1 L M 12. 2 HOT PERCENT	HEAT EX COND-S Well T Total D	CHANGER TEAM GEN ANK TRECT COST	EA EA IN ACCOU	4.0 4.0 NT 12 =	1911000.00 750000.00 3.691 ACCO	81900C.CC 125000.CO JNT TOTAL.5	7644000.00 300000.00 10644000.00	3276000.00 50000.00 3776000.00
8-186	HEAT RECO 13.1 GAS 13.2 ECO 13.3 GAS 13.4 FEE PERCENT	VERY HE -AIR RE NOMIZER FEED W D WATER TOTAL D	AT EXCH. CUPERATOR ATER HEATE HEATER STI IRECT COST	EA EA R EA Ring In Accou	4.0 1.0 NT 13 =	.00 .00 1027500.00 172000.00 1.856 ACCO	.00 .00 342500.00 51600.00 JNT TOTAL.\$	00 00 4110000-00 172000-00 5830000-00	-00 -00 1370000-00 51600-00 1421600-00
<u> </u>	HATER TRE 14. 1 DEM 14. 2 CON PERCENT	ATMENT INERALI Densate Total D	ZER POLISHING CRECT COST	GPM KWE 81 IN ACCOU	123.7 0600.0 NT 14 =	2500.00 1.25 428 ACCO	700.00 30 197 Total \$	324239-99 1013249-98 1337489-97	90787.20 243180.00 333967.20
	POWER CON 15. 1 STM 15. 2 MET 15. 3 GAS PERCENT	DITIONI TURE T VAP TU TURE T TOTAL D	NG RANSFORMER RB TRANSFOI RANSFORMER LRECT COST	99 RMER 23 IN ACCOU	0733.3 7294,5 8638.9 NT 15 =	-00 -00 -00 2.223 ACCOU	- 00 - 00 - 00 - 00 JNT TOTAL+5	1727447•28 4516406 -1 9 2403333•00 8647246 - 37	34548-95 690-98 -00 35238-92

C)

	Tabl	Le A	8.	3.1	0 Cc	nti	nued				-													
					RA	NKI	NE	META	L VAF	OR	TOPP 15 TR	ING-	STEA	MC	AE	ACC	אטס	r LIS	TING	;				,
	AC	ເດນ	NT	ND	. 8	NA	ME,		UNIT		ANC	UNT	MAT	5/1	UNIT	INS	\$/1	JNIT	HAT		5T, \$	INS	COST	, \$
						• • • •	· • · -	-		•		•. • •••	.								• • •	•		·
	AUXI 16. 16. 16. 16. 16. 16. 16. PER	LIA 1234 55789 CEN	RY OIL INC INC INC INC INC INC INC INC INC INC	MER STEERE	CH FERV ARY T G AS T AL	EQU ED ICEO ECOR MPU SY DIR	IPM PUM SY ILE IVI AGE STE STE ECT	ENT P & D S R NG-P TAN TAN Y MO M NK COS	R.KWE KWE PPH ROC K NITOF NITOF F T IN	ACC	7700 5340 1400		62 17 8 17 7 7 7 7 7	2000 7100 3000 7000 7000 7000	1.67 .23 1.17 4.00 00.00 00.00 00.00 00.00 00.00 ACC0	20 22 23 4 1 UNT	000 850 500 250 7 97	• 11 • 12 • 80 • 00 • 00 • 00 • 00 • 00 • 00 • 00		28601 50193 33380 20000 34000 30000 70000 58000 34173	LE - 87 20 - 00 - 00 - 00 - 00 - 00 - 00 - 00 -	200 114 250 50 50		• 00 • 99 • 00 • 00 • 00 • 00 • 00 • 00
	PIPE 17. 17. 17. PER	8 1 C 2 H 3 S CEN	FII ONV OT TE/ T	ITI GA M IOT	NGS TIO S P PIP AL	NAL IPI ING DIR	PI NG ECT	PING FITT Cos	TON EA INGS T IN	L- ACC	13 DUN T	70.0 4.0 17	18 = 3.	30 000 322	00.00 00.00 00.00 ACCO	UNT	. 181 T 91	00.01 •01 •01	105	1000 10000	00.00 00.00 00.00	246 246	6000	00 00 00 00
1-8-12	AUXI 18. 18. 18. 18. 18. 18. 18. 18. PER	LIA 1230 1234 567 CEN	RY ISC WIT ONI SOL IGH M 1 M 1	EL MICH DUI ATI EA FRA FOT	EC GEA ED NG DK CE	EQU RS ABL PHA ETEA DIR	IPM ETC MC SE SE SE SE SE SE SE TIN ECT	ENT C PA TRAY BUS UN S S S S Y COS	N KWE S FI KWE YS EX STEN T IN	1 1 1 ACC	1400 1401 5300 17 1400		- 25	5 2500 2600 453	1.40 1.95 1.32 10.00 .35 00.00 60.00 Acco	20 UNT	4 000 000 101	1.30 50.00 00.00 AL.\$		59600 2300 5075 36700 39900 50000 50000 3425	00.00 00.00 29.94 10.00 10	19 51 670 76 20 20 20 1086	3800 3000 14799 5000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000	•00 •94 •00 •00 •00 •00 •75
37	CONT 19. 19. PER	ROL 1 C 2 O CEN			TRU ER Con AL	MEN TRO DIR	TAT LS ECT	ION Cos	EACH CACH T IN	ACC	DUNT	1.0	12 =	600 500 691	00.00 00.00 ACCO	7 UN T	150 790 191	00.01 00.01 AL.5	12	5000 5000 1000	00.00 00.00 00.00	71	5000 4000 19000	-00 -00 -00
-	PROC 20- 20- 20- 20- PER	ESS 12 23 4 0 CEN	NA RY ET NSI T_1	ST AS SL TE	E S AS URR DI AL	YST H Y DIR	EMS SAL ECT	cos	TPH TPH ACRE T IN	ACCI	2 7 7 0 UN 1	40.3 22.2 36.1 20	23 56 = 5	753 395 52 088	.00 45.91 80.31 86.89 ACCD	5 14 UNT	938 098 810 107	-00 35.44 95.04 95.04	1 3 5 3 1 1	37534 53953 9182 90674	00 5.51 30.31 20.72 46.87	59 140 596 796	3836 19895 3765 7497	•00 •48 •08 •56 •06
	STAC 21. 21. 21. PER	K G 1 P 2 S 3 M CEN	AS REC CRU ISC T	CL IP IBB S fot	EAN ITA ER TEE AL	L & DIR	DU FCT	CTS Cos	EACH KWE	ACCI	DUNT	21	76 =	723 000	18.81 21.51 .00 ACCO	49 UNT	870) T 07/	9.91 9.91 Cl	<u>}</u>	• • •	00 00 00 00	· · · ·	•	•00 •00 •00
4.4		TO	TAL	D	IRE	CT	cos	15,5										287	3585	564.0	10 1	03278	379-	00

`

RANKINE METAL VAPOR TOPPING-STEAM CYCLE COST OF ELECTRICITY.MILLS/KW.HR PARAMETRIC POINT N9-46

ACCOUNT	RATE.	LABOR RATE, S/HR	
TOTAL DIRECT COSTS.S INDIRECT COST.S PROF & DWNER COSTS.S CONTINGENCY COST.S SUB TOTAL.S ESCALATION COST.S INTREST DURING CONSI.S TOTAL CAPITALIZATION.S COST OF ELEC-CAPITAL COST OF ELEC-COPI & MAIN TOTAL COST OF ELEC	PERCENT 6.GG 0 345818020 51.G 29814324 3.O 2765544 9.5 32852712 0 436150488 6.5 120073979 10.0 145479394 761703856 13.0 19.45955 0 1.66133 0 1.66133 0 27.87698	$\begin{array}{c} \textbf{8.50} & 10.80 \\ \textbf{370176128} & \textbf{39663563940} \\ \textbf{42236958} & \textbf{52671972} \\ \textbf{29614050} & \textbf{31250955} \\ \textbf{35166732} & \textbf{37110509} \\ \textbf{477193904} & \textbf{511670372} \\ \textbf{477193904} & \textbf{511670372} \\ \textbf{131373356} & \textbf{149864966} \\ \textbf{159169558} & \textbf{170669294} \\ \textbf{767756849} & \textbf{823204560} \\ \textbf{21220584} & \textbf{22.82907} \\ \textbf{5675603} & \textbf{6.75603} \\ \textbf{5.75603} & \textbf{1.56133} \\ \textbf{329.70220} & \textbf{31.24643} \end{array}$	135.00 21.50 74535810 106838283. 74535810 1068384659. 34680576 39747063. 41183185 47199637. 533906776 69051963. 194763978. 230358394. 93942624.111108368. 26.05202 26.05202 30.81321 6.75603 6.75603 1.66133 1.66133 34.46932 39.23056
ACCOUNT	RATE,	CONTINGENCY. PERCENT	70.00
TOTAL DIRECT COSTS. INDIRECT COSTS. PRGF & OWNER COSTS. SUB TOTAL. ESCALATION COST. TOTAL CAPITALIZATION. COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-FUEL COST OF ELEC-OF & MAIN TOTAL COST OF ELEC	PERCENT -5.00 0 39053565940 51.0 52671972 8.0 31250955 20.0 -195313947 0 455028020 5.5 125271039 10.0 151776056 0 732075112 18.0 20.3016 0 5.7560 0 1.66133 0 28.7192	$\begin{array}{c} .00\\ 3 206 36 69 40 . 3 206 36 69 40 . \\ 5 26 71 97 2 . \\ 5 26 71 97 2 . \\ 3 12 5C 95 5 . \\ 3 12 5C 95 5 . \\ 3 12 5C 95 5 . \\ 3 11 10 50 95 5 . \\ 3 71 10 50 95 5 . \\ 3 71 10 50 95 6 . \\ 3 71 10 50 95 6 . \\ 1 50 2 90 96 4 . \\ 1 70 64 82 32 0 16 64 90 5 6 . \\ 7 5 34 90 56 . \\ 8 22 20 85 6 . \\ 7 21 17 32 2 2 . \\ 22 . 22 90 5 6 . \\ 7 5 75 60 3 5 . \\ 7 5 75 60 3 5 . \\ 7 5 75 60 3 1 . \\ 6 1 33 1 . \\ 1 66 1 33 1 . \\ 29 . 5 90 6 8 31 . 24 6 4 3 \end{array}$	3.00 20.000 3.00356940. 390636940. 52671972. 52671972. 5125055. 11250955. 19331847. 78127387. 494091708. 552687248. 136025429. 152157016. 164805879 184350604. 794923008. 893194864. 22.04477 24.65911 6.75603 6.75603 1.66133 1.66133 30.45212 33.07647
ACCOUNT	RATE, PERCENT 5-00 -0 390535940 51-0 52671972	ESCALATION RATE, PERCE 6-50 390636940. 390636940. 52671972. 52671972	T 10.00 .00 390636940. 390536940. 52671972. 52671972.
PROF & DWNER COSTS. \$ CONTINGENCY COST. \$ SUB TOTAL \$ FOR TITON COST. \$	8.0 31250955 9.5 37110509 0 511670372	31250955. 31250955. 37110509. 37110509. 511670372. 511670372.	31250955. 31250955. 37110509. 37110509. 511670372. 511670372. 229468870.
TOTAL CAPITALIZATION - S TOTAL CAPITALIZATION - S COST OF ELEC-CAPITAL COST OF ELEC-FUEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC	10.0 162952482 0 780361728 19.0 21.64059 0 6.7560 0 1.6613 0 30.0583	170569294. 178585586 823204560. 868026784 22.82907 24.07208 6.75603 6.75603 1.65133 1.65133 1.55133 1.65133 1.31.24643 32.48943	139355202 139281806 53093444C 650952176 25.81829 18.05218 6.75603 6.75603 1.66133 1.66133 34.23565 26.46953
ACCOUNT. TOTAL DIRECT COSTS+S INDIRECT COSTS+S	RATE, PERCENT 6.00 .0 39063694C. 51.0 52671972	INT DURING CONST.PERCE 8.00 10.00 390536940.390636940. 52671972.52671972.	NT

	PERCEN	I DeALL	0ສ ແນ	TOPDO	17430	T0000
TOTAL DIRECT COSTS	G	390636940.	398636940.	390636940.	390636940.	392636940.
TNOTRECT COST	51.0	52571972.	52671972.	52671972.	52671972.	52671972•
PROF & OWNER COSTS \$	8 <u></u> C	31250955.	31250955.	31250955.	31250955	31250955.
CONTINGENCY COSTIS	9.5	37110509.	37110509.	37110509.	37110509.	37110503.
SUB TOTAL +5	_ D	511570372.	511670372-	511670372.	511670372.	511670372 -
ESCALATION COSTAS	5.5	140864906.	140864906.	140864905.	140864906.	140864906+
TNTREST DURTNG CONST.S	15.0	98357573	133809291.	170669294.	218796478 .	269292584
TOTAL CAPITAL TZATIONIS	-0	750892840.	786344550.	823204560.	871331744.	921827856 -
COST OF FLEC-CAPTIAL	18.6	28.82373	21.80687	22.82907	24.16373	25.56409
COST OF FIFC-FUEL	ē	6.75603	6.75503	6.75603	6.75603	8.75603
COST OF FLEC-OP & MATN	• D	1.56133	1.66133	1.66133	1.66133	1.66133
TOTAL COST OF FLEC	0	29-24108	30.22423	31-24643	32-58189	33.98144
forme cont of chart					-	

, E

REPROPUCT ITY OF THE DRIGHT Table A 8.3.11 continued

RANKINE KETAL VAPOR TOPPING-STEAM CYCLE COST OF ELECTRICITY MILLS/KW.HR

	PARAME IRIC	POINI	NU-40	** *	 	*****

ACCOUNT	RATE	FIXED CHARGE RATE, PCT	
TOTAL DIRECT COSTS.\$ INDIRECT COST.\$ PDOS COST.\$	PERCENT 10.00 0 390536340 51.0 52671972 0 31250955	14.40 18.00 21.60 390536940. 390536940. 3905369 52671972. 52671972. 526719 31250955. 31250955. 312509	25.00 40. 390636940. 72. 52671972.
CONTINGENCY COST +\$ SUB TOTAL +\$ ESCALATION COST +\$	9.5 37110509 0 511670372 6 5 140864906	37110509, 37110509, 371105 511570372, 511670372, 5116703 140864906, 140864906, 1408649	09. 37110509. 72. 511670372. 06. 140864906.
TOTAL CAPITALIZATION + S COST OF ELEC-CAPITAL	10.0 176669294 0 823204580 25.0 12.68232	170669234 170669294 1706692 823204560 823204560 8232045 18-26326 22-82907 27-39	94. 170569294. 50. 823204550. 488 31.70704
COST OF ELEC-FOEL COST OF ELEC-OP & MAIN TOTAL COST OF ELEC		$\begin{array}{c} \textbf{1.66133} \\ \textbf{1.66133} \\ \textbf{26.68061} \\ \textbf{31.24643} \\ \textbf{35.81} \end{array}$	
ACCOUNT	RATE	FUEL COST: \$/10++6 BTU	
TOTAL DIRECT COSTS +5	PERCENT 50 0 390636940	.85 1.50 2.50 390636940, 390636940, 3906369	1.02
INDIRECT COST + \$ PROF & OWNER COSTS + \$ CONTINGENCY COST + \$	51.0 52671972 8.C 31250955 9.5 37110509	52671972 52671972 526719 31250955 31250955 312509 37110509 37110509 371105	72. 52671972. 55. 31250955. 09. 37110509.
SUB TOTAL + \$ ESCALATION COST+ \$ INTREST DURING CONST-\$	0 511670372. 6.5 140364906. 10-0 170669294.	511670372. 511670372. 5116703 140354906. 140854905. 1408649 170659294. 170669294. 1706692	72. 511670372. 06. 140864906.
TOTAL CAPITALIZATION + \$ COST OF ELEC-CAPITAL	18.0 823204560 1.8.0 22.82507	823204560 823204560 8232045 22.82907 22.82907 22.82 5.75503 11.92251 19.87	60. 823204560. 907 22.82907 668 8.10724
COST OF ELEC-OP & MAIN		1.66133 1.66133 1.66 31.24643 36.41280 44.36	133 1.66133 107 32.59763
ACCOUNT	BATE,	CAPACITY FACIOR PERCENT	
TOTAL DIRECT COSTS.5 INDIRECT COST.5 PROF & OWNER COSTS.5	51.0 52671972 3.0 31250955	390636940. 390636940. 3906369 52671972. 52671972. 526719 31250955. 31250955. 312509	40. 390636940. 72. 52671972.
CONTINGENCY COST +5 SUB TOTAL +5 ESC NATION COST -5	9.5 37110509 0 511670372 6.5 140864906	37110509. 37110509. 371105 511670372. 511670372. 5116703 140864905. 140864905. 1408649	09. 37110509. 72. 511670372.
INTREST DURING CONST \$	10 0 170669294 C 823204550	170669294 170669294 1706692 823204560 823204560 8232045	<u>94. 170669294</u> 60. 823204560
COST OF ELEC-CAPITAL COST OF ELEC-FUEL	13.0 123.65747 0 5.75603	32.97532 29.67779 22.82 6.75603 6.75603 6.75	907 18.54862 603 6.75603
TOTAL COST OF ELEC	.0 1.33.32909	41.55483 38.20647 31.24	643 26.89137
 A second sec second second sec			

Table A 8.3.12

RANKINE HETAL VAPOR TOPPING-STEAM CYCLE

	ACCOUN	TNO	AUX	POWER	MNE	PERC	PLAN	T PO	DN .	DPERATI	ON C	COST	MAINTEN	NANCE CO	IST		
		4			-6201	7	16	.01	241		52-1	14910		14_021	89	_	· · ·
		7		- 5	1292	7	10	-20	194	11	88.6	5580Z		-000	300		
		8		10	-Uo43	1	16	• 15	100		· ·			-001	100		
	· · · · · ·	14		10	-00000			•			14-1	2819		-001	100		
		18			-00300	¥		-12	203		يە يە						
	TOTAL	ζu		23	-4621.	ř.	38	. 33	223		~{*	35876			100		
	DAL	3 NVTNE VET				0	u cv	1000	0.00			22404		14.02.	(83		
	NONTN		ឹងមុខ័	AFUR	10551	1200.	in o i		NET	PINES.	MUP	1.1			39-9205		
		FAT DATE.	BTI	ZKU-H	5	7550	3316	É.	NET	HEAT D	ATE	BTH	AN THE		242-2710		•
	ST TU	RAHFAT	ATE	CHANG	F	1000	9781	í i	10-1	near n			i a a - aiç		140 02 114		
	CONDE	NSER						-									
÷	DESIG	N PRESSUR	E. 1	IN HG.	A	3.	5000	1	NUM	BER DE	SHEL	LLS			3.0000		
	NUMBEI	R OF TUBE	S/SF	IELL		7505	9598	5	TUB	E LENGT	H. F	FT			69 . 5067		
	U, 8T	U/HR-FT2-	-F			608.	.3535	5	TER	MINAL T	EMP	DIFF	• F		5-0000	1	
	HEAT	REJECTION	<u> </u>					-			-						
_	DESIG	N TEMP F				<u></u>	.0000		APPI	RDACH	F				15-6713	-	
	RANGE	F F				23.	•ບັບບັບ	3	OFF	DESIGN	TE	MP F			51-4000		
	UFF DI	EDTON NES	28 1	LN HO	A	2.	4235	2	LP	TURBINE	BL	ADE LI	CNS IN		22*0080)	
	1	1200	1 <u>- CO</u> C	2		-1	ากก	3		-	452			100-	15	r.	- 500
	<u> </u>	810.	600	7		3.50	ົ້ດ	8 34	5230	ດຕິລັກກະກັ	00	ີ່ຊື່		3-000	ั 1ก 🌅	1 1 1 1	000
	11 ·	1.	ČČČ	12		195.2	50 1	3		1.0	ōō	14		CCC	15		ăăă
	16	2.	000	17		187.00	10 1	18		3.0	00	<u>19</u>		5.000	20	2.	500
	21		.000	22	2	5050.60	3G 2	23		-C	00	24	27:	300.000	25		000
-	2 6	7500000.	000	27	21	0000-00	30 2	28		20000.0	00	29	25000	000-000	30	•	600
	31		.000	34		13/0-00	10 3	5		-8	60	34		1.000	35	1.	000
	35	4930000	2000	31	561		10 2	17		1 5000 0	00	33	1250	1.000	- U	125000-1	DÖD
<u> </u>		TOODDO	non	- 25.		1000000		3	ترجيت ال	12000.0	nn.	20	144201	20000000	40	114000	000
	51		ើពីព័ត្	52		5.3	ร์กั่	1.5		3.0	00	40		2.000	10	•	000
8	1	-	. oon	2		4.1	ຳດັດ	3			กกก	4		្តំភូមិព	ה ו	23680000	-000
÷	6		ČŌŌ	7		1.00	50 O	ຮັ		4 • Č	ČÕ	<u>و</u>		a.000	10	4	តិភ័តិ
8	11	4.	000	12		2000.00	10100	.3		1300.0	00	14		4.000	15	1.	ñññ
	15	19700008.	.000	17		•00	1 00	.8	59	00000.0	00	19		.000	20	2000000.	000
	21		, סמס	22	118	0000-00	10 2	23	13	ទ០០០០-០	00	24	2350	100.000	25	•	000
	<u>b</u>	2336	ក្តប្តូប		3057	<u> 180 - 00</u>	<u> </u>	8		<u></u>	<u><u><u></u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	<u>29</u>		124.000	30	495000 .	000
	31	2720000		34	28836	ວບບບຸະບິດ	10 2	22	7		20	34	1 2 5	4+000	35	4.	
	30 N1	2130000	000	51		a 00	ב טנ הרו	17		1.0	00	53	1251	200-000	40	-	000
	ΤĖ		រកតត	47		10.	រក រ			1.0	ก็ก็	24		1000	40	1370000	ក្តម្ភភូមិ
	51	• • • • • • • •	ີດດັດ:	52	1720	າດດດີດັກ	10 5	ž		ň	កត	54	•	ិតតត	55	13700004	non
	56		ōōō	57		. Or	50 3	8		1.6	õõ	59		4.000	ด้ดี	1.	ñññ
	61	1.	000	62		4.00	00 6	3	621	00000.0	ōō	64	20000	000.000	65	1710000	ŏŏŏ
2	66	285000.	000	67	800	0000.00	10 6	8	2	50000.0	CO	69	17000	000-000	70	400000.	ÖÖÖ .
ñ	71	770000	000	72	125	5000.00	0 7	3		4.0	00 1	74	16000	000-000	75		000
้อ	75	1.	000	77		1.00	10 7	8	2.	50060 . G	00	79	2000	100-000	80	2508080.0	000
D D	81	2000000*	000	32		• ប្តូរ្	10 2	5		•0	uu	84		-000	85	ا ہ ر	000
ŗ	00		360	81		•VL	10 8	3		• []	<u> </u>	89			20	1.	000
	31	-	000	34		- 20	10 2	13		• <u>u</u>	20	34		•000	35	-	000
•	30	6	لالان	21			າບ ສ	7 Q			υu	33		- 666	T OR		000

76

660-301