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CONCEPTUAL DESIGN OF ADVANCED CENTRAL RECEIVER POWER
SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. FINAL REPORT

Volume 4, Commercial and Pilot Plant Cost Data

MASTER

March 1979

Work Performed Under Contract No. EG-77-C-03-1483

Rockwell International
Energy Systems Group
Canoga Park, California

U.S. Department of Energy

DISTRICT

Solar Energy

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**CONCEPTUAL DESIGN
OF
ADVANCED CENTRAL RECEIVER POWER SYSTEMS
SODIUM-COOLED RECEIVER CONCEPT
FINAL REPORT**

**VOLUME IV
COMMERCIAL AND PILOT PLANT COST DATA**

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MARCH 1979

**PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
AS PART OF
CONTRACT NO. EG-77-C-03-1483**

Rockwell International
Energy Systems Group

MCDONNELL DOUGLAS

Salt River Project
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PREFACE

This report is submitted by the Energy Systems Group to the Department of Energy under Contract EG-77-C-03-1483 as final documentation. This Conceptual Design Report summarizes the analyses, design, planning, and cost efforts performed between October 1, 1977 and September 1, 1978. The report is submitted in four volumes, as follows:

- Volume I Executive Summary
- Volume II Book 1, Commercial Plant Conceptual Design
 Book 2, Appendices
- Volume III Development Plan and Pilot Plant Description
- Volume IV Commercial and Pilot Plant Cost Data

The principal contractors supporting the Rockwell International Energy Systems Group, in this conceptual design effort, together with the main areas of responsibility, included McDonnell Douglas Aircraft Corporation as responsible for the Collector and Master Control Subsystem; Stearns-Roger Services, Inc. as responsible for Electric Power Generating Subsystem, Tower Design and Civil Engineering; and Salt River Project as the Utility Consultant. The University of Houston supported McDonnell Douglas in the Collector Field Studies. Personnel contributing to this design program and to the final report included:

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I. INTRODUCTION

This volume of the Advanced Central Receiver Final Report presents the cost data using the Cost Breakdown Structure identified in the Preliminary Specification. Cost summaries are presented in the following sections for the 100-MWe and 281-MWe Commercial Plant and a 10-MWe Pilot Plant. Cost substantiation data for this volume are presented in the Appendices.

Other cost summary data include Nth Plant data for the 100-MWe and 281-MWe Commercial Plants, and a summary for the alternative concept Air-Rock Storage System.

The main description of the plant costing technique occurs as part of Section II for the 100-MWe Baseline Concept.

II. 100-MWE COMMERCIAL PLANT COST

The cost summaries for the 100-MWe Commercial Plant are presented in this section for the baseline plant with an all-sodium storage system and for the alternative air-rock storage system. While the major cost estimating effort was for the first commercial plant, cost projections for the Nth Plant are also presented. A description of the cost methodology is given here also.

A. 100-MWe BASELINE CONCEPT

Table 1 presents a cost summary for the 100-MWe Baseline Concept. A brief description of the costing methodology is included here for each of the major subsystems. The plant configuration is shown schematically in Figure 1 with plant parameters given in Table 2.

1. Collector Cost Analysis

a. Costing Results

Summarized costing results relating to the Collector Equipment subsystem are shown for Pilot, First, and Nth Commercial power plants that employ liquid sodium as a coolant in the receiver. These costs are based on data developed in association with the Prototype Heliostat study. Appendices A, B, C, and D provide further breakdown of these costs. Nonrecurring costs for Commercial Plants are shown as nil because those costs that are not already paid for in prior development are allocated over all production and included in the overhead. Visibility is buried in the Pilot and First Commercial costs but has been listed separately for Nth Commercial because of the likelihood of compensating "break-throughs" to occur that would tend to support the eventual realization of the projection before visibility is applied. The Operations and Maintenance (O&M) costs include the costs of ongoing spares and repair parts as well as field maintenance.

TABLE 1
100-MWe BASELINE CONCEPT WITH ALL-SODIUM STORAGE
(Sheet 1 of 4)

		Solar Plant Capital Investment Cost (\$000)						
		First Commercial			Nth Plant			
4000	Solar Plant Cost			152,614				123,693
4100	Site, Structures and Miscellaneous Equipment		5,381			5,271		
4110	Site		1,500			1,500		
4111	Land							
4112	Yard work							
4120	Buildings		2,200			2,100		
4121	Turbine Building	1,386			1,386			
4122	Administration Buildings	180			180			
4123	Warehouse and Maintenance Buildings	300			300			
4124	Control Building	216			216			
4125	Other	118			18			
4130	Miscellaneous Equipment		1,681			1,671		
4131	Transportation and Lifting Equipment	721			711			
4132	Communication Equipment	110			110			
4133	Other	850			850			
4200	Turbine Plant Equipment		19,424			19,424		
4210	Turbine Generators and Accessories		10,856			10,856		
4220	Heat Rejection System		4,215			4,215		
4230	Condensing Systems		320			320		
4240	Feed-Heating or Recuperator System		1,655			1,655		
4250	Working Fluid Circulation, Treatment, and Auxiliary Inventory Containment Equipment		2,378			2,378		
Subtotal			24,805			24,695		

TABLE 1
100-MWe BASELINE CONCEPT WITH ALL-SODIUM STORAGE
(Sheet 2 of 4)

	Solar Plant Capital Investment Cost (\$000)						
	First Commercial			Nth Plant			
4300 Electric Plant Equipment			4,834			4,301	
4310 Switchgear		860			860		
4320 Station Service Equipment		1,502			1,502		
4330 Protective Equipment		253			253		
4340 Power Wiring, Electrical Structures and Wiring Containers		938			938		
4350 Master Control Equipment		1,281			748		
4351 Hardware	697			487			
4352 Hardware Design & Engineering	332			185			
4353 Software Design, Development, and Test	252			76			
4400 Collector Equipment			60,596			45,820	
4410 Reflective Unit		16,956			12,460		
4420 Drive Unit		24,177			18,420		
4421 Azimuth or Horizontal Drive							
4422 Elevation or Vertical Drive							
4423 Motors							
4424 Position Indicators or Encoders							
4425 Power Distribution and Emergency Supply							
4430 Control and Instrumentation		2,621			1,720		
4431 Sensor or Calibration Equipment							
4432 Field Control Electronics							
4433 Control Signal Distribution Equipment							
4440 Foundation and Site		10,918			8,590		
4450 Heliostat Support and Protection		2,525			1,910		
4451 Heliostat Support Structure							
4452 Heliostat Protective Enclosure							
4453 Lightning Protection							
4460 Field Assembly and Check Out		3,399			2,720		
4470 Design and Engineering							
Subtotal			65,430			50,121	

TABLE 1
100-MWe BASELINE CONCEPT WITH ALL-SODIUM STORAGE
(Sheet 3 of 4)

		Solar Plant Capital Investment Cost (\$000)					
		First Commercial			Nth Plant		
4500	Receiver Equipment			23,305			19,852
4510	Receiver Unit		8,551			7,451	
	4511 Absorber Unit	4,022			3,258		
	4512 Support Structure	236			236		
	4513 Receiver Circulation Equipment	1,526			1,190		
	4514 Instrumentation and Control	1,452			1,452		
	4515 Transportation, Field Erection, and Installation	1,315			1,315		
4520	Riser, Downcomer, and Horizontal Piping		4,942			4,942	
4530	Working Media Cost		183			183	
4540	Tower		3,166			3,166	
4550	Foundation						
4560	Steam Generator or Working Media Heat Transfer Equipment		5,144			4,110	
4570	Design and Engineering		1,319			0	
4600	Thermal Storage Equipment			12,086			11,400
	4610 Media Containment Equipment		4,356			4,072	
	4620 Media Circulation Equipment		724			688	
	4630 Working Fluid Circulation Equipment		0			0	
	4640 Discharging Heat Exchangers		0			0	
	4650 Charging Heat Exchangers		0			0	
	4660 Foundation		300			300	
	4670 Design and Engineering		306			0	
	4680 Media		6,400			6,400	
4800	Distributables and Indirect Costs			26,988			17,565
	4810 Temporary Facilities, Equipment, etc.		1,200			1,000	
	4820 Spare Parts		601			503	
	4830 Architectural Engineering Services		1,482			1,450	
	4840 Construction Management		3,394			3,113	
	4850 Plant Startup and Checkout		1,000			500	
	4860 Contingency		19,311			11,499	
Subtotal				62,379			48,877

TABLE 1
100-MWe BASELINE CONCEPT WITH ALL-SODIUM STORAGE
(Sheet 4 of 4)

Summary Category 4800 Calculations	
4810 - Temporary Facilities - See Breakdown Sheet in Appendix	
4820 - Spare Parts 1/2% of 4200 through 4600	
4830 - A&E Services 5% of 4100 through 4300	
4840 - Construction Management 5% of 4100 through 4300; 4400, 50, and 60; 4514, 15, 20, 40, 50, and 60; 4610 through 4660	
4850 - Startup and Checkout - 20 Man-Years at \$50K/yr	
4860 - Contingency - 10% of 4100 through 4400 29% of 4500 and 4600	
4860 - Contingency on Nth Plant - 10% of 4100 through 4400 12.9% of 4500 and 4600	

Items		O&M Costs (\$000/yr)					
		First Commercial			Nth Plant		
OM100	Operations Supervision			693			301
OM200	Maintenance Materials			581			253
	OM210 Spare Parts		581			253	
	OM211 Turbine and Electric Plant	320			139		
	OM212 Collector Equipment	195			85		
	OM213 Receiver Equipment				29		
	OM214 Thermal Storage Equipment	66					
	OM220 Material for Repair						
	OM230 Other						
OM300	Maintenance Labor			1,112			810
	OM310 Scheduled Maintenance	1,112			810		
	OM320 Corrective Maintenance						
Total				2,386			1,364

42400-1096C

Figure 1. 100-MWe Baseline Concept With All-Sodium-Storage

TABLE 2
ADVANCED CENTRAL RECEIVER SYSTEM — 100-MWe
COMMERCIAL PLANT SUMMARY DATA
(Sheet 1 of 2)

Net Electrical Power (MWe)	100
Parasitic Power (MWe)	
Daytime	12
Nighttime	6
Insolation (W/m ²)	950
Maximum Solar Power Absorbed (MWt)	390
Nominal Solar Power Absorbed for Direct Operating (MWt)	260
Plant Net Efficiency (%)	22.9
Collector Field Configuration	Single 360 ⁰ , North Biased
Solar Multiple, Equinox Noon	1.5
Number of Heliostats	14,100
Heliostat Shape and Size [m (ft)]	Square, 7.38 x 7.42 (24.2 x 24.3)
Number of Towers/Receivers	1
Land Area (acre)	780
Receiver Mid-Point Elevation [m (ft)]	174 (571)
Receiver Configuration	External Cylinder
Number of Receiver Panels	24
Receiver Height and Diameter [m (ft)]	16.1 x 16.1 (52.8 x 52.8)
Receiver Maximum Heat Flux (MW/m ²)	1.53
Sodium Temperatures [°C (°F)]	288/593 (550/1100)
Receiver Sodium Flow Rate [kg/hr (lb/hr)]	3.66 x 10 ⁶ (8.07 x 10 ⁶)
Steam Generator Sodium Flow Rate (Direct Operation) [kg/hr (lb/hr)]	2.34 x 10 ⁶ (5.29 x 10 ⁶)

TABLE 2
ADVANCED CENTRAL RECEIVER SYSTEM — 100-MWe
COMMERCIAL PLANT SUMMARY DATA
(Sheet 2 of 2)

Thermal Storage Capacity (MWth)	805
Total Sodium Inventory kg (lb)	7.6×10^6 (16.8×10^6)
Steam Generator and Reheater Type	Modular Steam Generator
Steam Conditions [MN/m^2 , $^{\circ}\text{C}$ (psia, $^{\circ}\text{F}$)]	
Initial	12.51, 538 (1815, 1000)
Reheated	2.72, 538 (394, 1000)
Steam Flow Rate [kg/hr (lb/hr)]	
Daytime	3.32×10^5 (7.32×10^5)
Nighttime	3.15×10^5 (6.95×10^5)
TSS Sodium Flow Rate [kg/hr (lb/hr)]	2.31×10^6 (5.09×10^6)
Feedwater Temperature [$^{\circ}\text{C}$ ($^{\circ}\text{F}$)]	234 (453)
Turbine Back Pressure [MN/m^2 (in. Hg)]	0.007 (2.0)
Heat Rejection [MW (Btu/hr)]	
Daytime	158 (540×10^6)
Nighttime	150 (511×10^6)

Cost Element	1978 DOLLARS IN MILLIONS			
	Pilot	1st Commercial	Nth Commercial	
			100 MWe	300 MWe
Nonrecurring	\$ 4.70	—	—	—
Transport and Lift Equipment	\$ 0.24	\$ 0.54	\$ 0.53	\$ 1.53
Collectors	\$10.55	\$60.60	\$45.82	\$131.82
Visibility	—	—	\$ 5.63	\$ 16.20
Total Collect	\$10.55	\$60.60	\$51.45	\$149.55
Initial Spares	\$ 0.01	\$ 0.04	\$ 0.02	\$ 0.06
1st Year O&M	\$ 0.09	\$ 0.80	\$ 0.77	\$ 2.22
Follow-on O&M	\$ 0.06	\$ 0.46	\$ 0.45	\$ 1.29

b. Basic Scenarios

The prototype heliostat projections are based on a specific set of cost driving ground rules and assumptions, design characteristics, and production scenarios. Although covered in previous sections of this report, a summary of the major drivers is useful in understanding costing results.

c. Major Costing Ground Rules

The costs that are presented assume the following major financial ground rules:

- 1) First half of 1978 dollars — no escalation.
- 2) Eight percent fee applied to each CBS line item.
- 3) Interest during construction (IDC) not costed.
- 4) No state sales tax applied due to uncertainty of state and potential tax rulings.
- 5) Special collector production profit center assumed for commercial costing.

- 6) Minimal manufacturing support practice for commercial production. No analysis except as purchased from the outside.
- 7) Overhead and fringe benefits applied as a factor on direct labor only.
- 8) Nth Commercial cost projected as that typical of the tenth year of operation of production facilities at 25,000 units produced per year. First Commercial cost reflects first year production in same facilities.
- 9) Commercial vendor quotes and production facility manning baseline at 25,000 heliostats per year. Pilot Plant material quoted basis at 1700 units.
- 10) Assumed utility operations hourly labor rate (\$15) – actual not known.
- 11) Commercial grade (non-mil standard) electronic components.
- 12) Scrap and rework, machine downtime, labor efficiency, operations refix factors, and first year failure rate factors applicable.
- 13) Cost reduction curves applied where specific cost difference from the 25,000 per year or 1700 unit baseline are not identified.

d. Technical Characteristics

Figure 2 summarizes the technical characteristics of the selected design. Key top level cost drivers include the enlarged reflector area (49 m^2) that has been divided into two main panels for ease of transport and installation; inverted stowage which is accomplished with a second screw jack and other additional hardware; the harmonic azimuth drive; and the factory-integrated drive-pedestal-electronics assembly which may be checked and calibrated in the factory. Other important drivers include the deep pile foundation which features a 1.22 m above grade tapered pipe interface extension; the use of a weldment versus a casting for the drive housing; and the stringer-semi-radial beam mirror backing structure configuration. Except for inversion, these design characteristics generally have allowed a simplified production scenario as well as purchased part and material economics.

9272-10

Figure 2. Prototype Heliostat Baseline

e. Baseline Scenarios

Main features of the baseline commercial production-installation scenario are listed below.

- 1) 25,000 units per year
- 2) 62,500 ft² production facility (no site assembly plant)

Central, unnamed location – outside Los Angeles
Integrated mirror line and harmonic drive fabrication
Automated assembly-transfer
NC machining

- 3) Low skill labor – <300 factory direct
- 4) Private fleet transportation
- 5) Four basic installations – mechanized using special equipment

Foundation
Pedestal-drive-electronic unit
L&R reflector
Power-control distribution

- 6) One shift per operation (240 days)

The Pilot Plant heliostat is assumed to be produced at Huntington Beach. As indicated, the Commercial baseline has been oriented to the 25,000 units per year production rate. The main changes associated with First Commercial production include reduced lapsed times, some increase in manning requirements reflecting startup problems of scheduling, line flows, equipment and tooling breakdowns, and material availability. Also, material costs are expected to be higher according to historical pattern.

The operations and maintenance scenario calls for the use of conventional handling equipment, mobile test vans, and special mirror washing equipment. In most cases, defective assemblies or components are first removed and replaced

with a spare or a previously repaired part and then the defective item is repaired or scrapped. The main exceptions occur where certain structural damage may be repaired in-place. The preponderance of maintenance actions involve repairs rather than scrapping defective hardware.

f. Costing Approach

The costing approach has been to develop a data base associated with the 25,000 units per year production rate and then perturb the data base to reflect special circumstances associated with the Pilot and First Commercial plant. The 25,000 unit data base has been developed as resource loads for labor where operator and support positions required for each item of production equipment or responsibilities are counted and classified by skill in order to accumulate staffing by CBS. Vendor quotes on ongoing 25,000 units per year requirements and at 1700 units were obtained for important cost items and catalogs consulted for common items. Like item costs were employed where certain electronic components have been projected as being available off the shelf at future dates. Appropriate factors have been applied to the data base along with burdened labor rates to arrive at total costs.

Changes to the 25,000 per year data base were accomplished specifically where design or production differences were identified and generally through appropriate changes in factors, labor rates, and overhead rates and through cost reduction curve logic. Costs not specifically addressed were altered along a cost reduction curve. Each basic cost entry has been "pegged" to a specific point on a cost reduction curve. For First Commercial, the cost is adjusted in accordance with cost reduction logic to a new estimate for the new production scenario.

Operations and maintenance costs are based on both resource loading and direct estimates of hours, unit investment cost for replaced or spared parts, and on quotes or prior study information on operations materials such as washing solution. Spares and repair parts are the product of annual failures (based on failure rates tables), hardware unit costs estimated for investment, and repair or replacement factors. Corrective maintenance is the product of crew size and

lapsed time or a direct hour estimate for bench labor, annual failures, repair factors for bench labor, and burdened labor rates. Scheduled maintenance is based on direct estimates or crew size and burdened labor rates, material quotes, and estimated frequencies. Results were factored to consider efficiency, added first year failures or problems, and refix where the first attempt at repair is not successful and must be redone.

For Commercial plants, applied labor and burden rates vary between factory, field, and operations. Factory rates are based on low side national average labor costs and MDAC burden and G&A experience at volume production facilities. MDAC Huntington Beach rates were used for Pilot Plant. Installation rates are based on Riverside, California, trade labor and fringe rates adjusted to allocate distributable cost. Both the factory and field rates include an 8% fee. The O&M labor rate has been estimated at \$15/h and does not include fee since the utility presumably would not charge itself a fee.

2. Receiver Subsystem

Material cost value was arrived at by vendor quotations and supplier catalogs based on commercial grade. Labor hours were developed by past experience and estimating manuals, a productivity factor was included due to height and location. The labor dollars per hours were based on fabrication and installation to be in the southern California area.

The piping systems are fabricated according to ASME B31.1, Heat Exchangers and Tanks, Section VIII Codes and Standards.

All exterior piping and equipment requiring insulation shall be weather proofed; the remainder shall be painted.

The estimate is based on 1978 dollars and excludes interest during construction, cost of land, and state and local taxes.

Cost reduction for the Nth Plant was the result of components which could be manufactured utilizing a learning curve.

Each receiver panel is fabricated with 100 tubes, 3/4-in. OD by 0.049 wall, Type 304 stainless steel, welded into 6-in. Type 304 stainless steel standard pipe. All material is commercial with standards per ASME Section VIII Code. All tube-to-tube and tube-to-header welds are made by using automatic weld process commercially available. All active tubes are coated with Pyromark, a heat collecting material. Costs include welding jig and weld development. All tube butt welds are radiographed. No installation costs are included.

3. Thermal Storage Subsystem

The hot sodium storage tank is a standard API type vessel 100-ft in diameter and 45-ft shell height with cone roof and column supports, all constructed with Type 304 stainless steel. The shell walls vary from 1/4-in. thickness at the top course to 1-in. thickness at the bottom course. The bottom is 1/4-in. plate and the roof is 3/16-in. thick. The vessel is of all-welded construction.

The cold sodium storage tank is a standard API type vessel 100-ft in diameter and 41-ft shell height with cone roof and column supports, all constructed of SA.516-70 and SA36 carbon steel. The shell walls vary in thickness of 1/4-in. top course to 11/16-in. bottom course. The bottom is 1/4-in. plate and the roof is 3/16-in. thick. The vessel is of all-welded construction.

A ring is provided around the base of each tank to provide a lateral seismic tie between the concrete base and the tank, with slotted attachments for thermal growth. A drip basin is also included around the base of the tanks.

The pump, piping, and valves are priced in the same manner as that used for the receiver subsystem.

4. Master Control Cost Analysis

a. Costing Results

Summarized costing results relating to the Master Control Equipment subsystem are shown here for the Pilot Plant and for the First and Nth Commercial

power plants that employ liquid sodium as a coolant in the receiver. Appendices A, B, C, and D provide a further breakdown of these costs. The nonrecurring

Cost Element	1978 DOLLARS IN MILLIONS			
	Pilot	1st Commercial	Nth Commercial	
			100 MWe	300 MWe
Nonrecurring	\$1.25	\$0.58	\$0.26	\$0.26
Investment	0.73	0.58	0.41	0.41
Visibility	0.14	0.12	0.08	0.08
Total	\$2.12	\$1.28	\$0.75	\$0.75
1st Year O&M	\$0.05	\$0.05	\$0.05	\$0.05
Followon O&M	\$0.05	\$0.05	\$0.05	\$0.05

costs for Hardware Design and Engineering (4352) and Software Design, Development and Test (4353) cover unique effort associated with the sodium control concept. The investment cost represents the cost of production-procurement, installation and checkout of the Master Control Unit (MCU) and includes an 8% fee. The visibility applies to the investment only and indicates a protected cost. However, it is just as likely that the lower projection will occur. The operations and maintenance indicate the costs of the various service contracts for the equipment procured for the MCU. It is important to note that the costs for the specialized subsystem controllers are not covered by the Master Control Subsystem Cost.

b. Basic Scenario

The Pilot Plant provides for the first "all-up" sodium system solar plant control. Both the Pilot Plant and the First Commercial require special data acquisition hardware that disappears in the Nth scenarios.

The First Commercial installation is assumed to be equivalent to the third in line following prior development, including the Pilot Plant. However, the

Figure 3. Master Control Unit

prior development relates more to the smaller Pilot Plant and water-steam systems. The Nth unit is costed as the 14th unit. For any given installation, the console is assembled and checked out, probably through simulation at the laboratory in Huntington Beach. After testing, the console is disassembled into major components and packaged and shipped to the installation site where it is reassembled and checked out for system operation. It is assumed that each installation is identical.

Although the commercial costs for the MCU are given in 1978 dollars, technological advances are taken into account, especially for the processor and the disc. The MCU will provide monitor and control of all system and subsystem parameters necessary to ensure safe and proper operation of the plant. The control practices are proven and off-the-shelf substantiating simple interface between the master control and each subsystem.

Those parameters that are pertinent to the evaluation of plant performance, safety and operation are displaced and/or recorded. The master control is designed to operate the plant essentially automatically with the override capability of the operator. Should the operator desire, the subsystem control can be accomplished through manual operation through single console control with easily read displays.

In general, the master control provides coordinated control and integration of the subsystems for single operator, single console control. Figures 3, 4, and 5 provide further insight on the technical characteristics of the costed hardware.

c. Costing Approach

Costs were developed based on specific identification of hardware requirements and the manpower on lapsed time necessary to perform the necessary assembly, testing and installation and other tasks. The preponderance of the material requirement is in the form of purchased parts, so that it was possible to obtain these costs along with the monthly maintenance contract costs from supplier catalogs. Hours have been developed as an extension of the manning and lapsed

9272-11

Figure 4. Pilot and First Plants – Master Control Subsystem – Block Diagram

Figure 5. Nth Plants - Master Control Subsystem - Block Diagram

9272-12

times. Factors have been added to the costs to cover the 8% fee, rework, direct support of the engineering time, and efficiency. Labor has been costed on a 90% cost reduction curve, but material items, with the exception of processors, have been costed the same for all plants. The processors have been costed in accordance with the expected state-of-the-art for the time frames involved. Overhead is included as a factor on the applied labor rate. All labor is assumed part of the engineering burden centers. Transportation has been costed as a factor of the hardware cost.

B. ALTERNATIVE CONCEPT WITH AIR-ROCK STORAGE

The cost summary for the 100-MWe Commercial Plant with the air-rock storage system is presented in Table 3. Backup cost data are presented in Appendix B. A flow schematic of the receiver and storage subsystem are shown in Figure 6.

The cost data of Table 3 are the same as those of Table 1 except for CBS 4600, Thermal Storage, and for CBS 4520 for the additional piping. CBS 4800 also changes since this item is proportional to the other subsystem costs.

TABLE 3
100-MWe PLANT WITH AIR ROCK STORAGE
(Sheet 1 of 3)

		Solar Plant Capital Investment Cost (\$000)						
		First Commercial Air-Rocks			Nth Plant Air-Rocks			
4000	Solar Plant Cost			153,083				124,982
4100	Site, Structures and Miscellaneous Equipment		5,381			5,381		
4110	Site		1,500			1,500		
	4111 Land							
	4112 Yard Work							
4120	Buildings		2,200			2,200		
	4121 Turbine Building	1,386			1,386			
	4122 Administration Buildings	180			180			
	4123 Warehouse-Maintenance Buildings	300			300			
	4124 Control Building	216			216			
	4125 Other	118			118			
4130	Miscellaneous Equipment		1,681			1,681		
	4131 Transportation and Lifting Equipment	721			721			
	4132 Communication Equipment	110			110			
	4133 Other	850			850			
4200	Turbine Plant Equipment		19,424			19,424		
	4210 Turbine Generators and Accessories	10,856			10,856			
	4220 Heat Rejection System	4,215			4,215			
	4230 Condensing Systems	320			320			
	4240 Feed-Heating or Recuperator System	1,655			1,655			
	4250 Working Fluid Circulation, Treatment, and Auxiliary Inventory Containment Equipment	2,378			2,378			
Subtotal			24,805			24,805		

TABLE 3
100-MWe PLANT WITH AIR ROCK STORAGE
(Sheet 2 of 3)

		Solar Plant Capital Investment Cost (\$000)					
		First Commercial Air-Rocks			Nth Plant Air Rocks		
4300	Electric Plant Equipment			4,834			4,301
4310	Switchgear		860			860	
4320	Station Service Equipment		1,502			1,502	
4330	Protective Equipment		253			253	
4340	Power Wiring, Electrical Structures, and Wiring Containers		938			938	
4350	Master Control Equipment		1,281			748	
4351	Hardware	697			487		
4352	Hardware Design and Engineering	332			185		
4353	Software Design, Development, and Test	252			76		
4400	Collector Equipment			60,596			45,820
4410	Reflective Unit		16,956			12,460	
4420	Drive Unit		24,177			18,420	
4421	Azimuth or Horizontal Drive						
4422	Elevation or Vertical Drive						
4423	Motors						
4424	Position Indicators or Encoders						
4425	Power Distribution and Emergency Supply						
4430	Control and Instrumentation		2,621			1,720	
4431	Sensor or Calibration Equipment						
4432	Field Control Electronics						
4433	Control Signal Distribution Equipment						
4440	Foundation and Site		10,918			8,590	
4450	Heliostat Support and Protection		2,525			1,910	
4451	Heliostat Support Structure						
4452	Heliostat Protective Enclosure						
4453	Lightning Protection						
4460	Field Assembly and Checkout		3,399			2,720	
4470	Design and Engineering						
Subtotal				65,430			50,121

TABLE 3
100-MWe PLANT WITH AIR ROCK STORAGE
(Sheet 3 of 3)

		Solar Plant Capital Investment Cost (\$000)					
		First Commercial Air-Rocks			Nth Plant Air Rocks		
4500	Receiver Equipment			24,588			21,397
4510	Receiver Unit		9,388			8,586	
	4511 Absorber Unit	4,022			3,220		
	4512 Support Structure	236			236		
	4513 Receiver Circulation Equipment	1,526			1,526		
	4514 Instrumentation and Control	2,289			2,289		
	4515 Transportation, Field Erection, and Installation	1,315			1,315		
4520	Riser, Downcomer, and Horizontal Piping		5,362			5,362	
4530	Working Media Cost		183			183	
4540	Tower		3,156			3,156	
4550	Foundation						
4560	Steam Generator or Working Media Heat Transfer Equipment	5,144			4,110		
4570	Design and Engineering	1,355			0		
4600	Thermal Storage Equipment			11,021			9,978
4610	Media Containment Equipment		538			538	
4620	Media Circulation Equipment and Buffer Storage		1,900			1,900	
4630	Working Fluid Circulation Equipment		1,391			1,250	
4640	Discharging Heat Exchangers		6,051			5,450	
4650	Charging Heat Exchangers						
4660	Foundation		240			240	
4670	Design and Engineering		300				
4680	Media		601			600	
4800	Distributables and Indirect Costs			27,239			18,681
4810	Temporary Facilities, Equipment, etc.	1,200			1,200		
4820	Spare Parts	600			505		
4830	Architectural Engineering Services	1,482			1,455		
4840	Construction Management	3,693			3,449		
4850	Plant Startup and Checkout	1,000			500		
4860	Contingency	19,264			11,572		
Subtotal				62,848			50,056

78-N27-62-20A

Figure 6. Advanced Central Receiver - Combined Air-Rock and All-Sodium Storage

III. 281-MWe COMMERCIAL PLANT COST

The 281-MWe Commercial Plant cost summary is presented in Table 4. The cost data is for the Nth Plant. Backup cost data are presented in Appendix C.

A. 281-MWe PLANT DESCRIPTION

The 281-MWe plant flow schematic is shown in Figure 7. The concept is identical with that for the 100-MWe plant with two exceptions. Two evaporator units are used in parallel, and an additional feedwater heater is inserted on the suction side of the feedwater pump, giving a total of seven heaters. Table 5 provides a summary of basic 281-MWe plant data. The design data sheets of Appendix D, Vol II provide a list of system and component performance and design data.

TABLE 4
281-MWe COMMERCIAL PLANT WITH ALL-SODIUM STORAGE
(Sheet 1 of 4)

		Solar Plant Capital Investment Cost (\$000)			
		Nth Plant			
4000	Solar Plant Cost				306,034
4100	Site, Structures and Miscellaneous Equipment			11,239	
4110	Site		2,829		
4111	Land				
4112	Yard Work				
4120	Buildings		7,950		
4121	Turbine Building	5,500			
4122	Administration Buildings				
4123	Warehouse-Maintenance Buildings	1,600			
4124	Control Building				
4125	Other	850			
4130	Miscellaneous Equipment		460		
4131	Transportation and Lifting Equipment	350			
4132	Communication Equipment	110			
4133	Other				
4200	Turbine Plant Equipment			38,759	
4210	Turbine Generators and Accessories		21,560		
4220	Heat Rejection System		9,875		
4230	Condensing Systems		577		
4240	Feed-Heating or Recuperation System		3,203		
4250	Working Fluid Circulation, Treatment, and Auxiliary Inventory Containment Equipment		3,544		
Subtotal				49,998	

TABLE 4
281-MWe COMMERCIAL PLANT WITH ALL-SODIUM STORAGE
(Sheet 2 of 4)

		Solar Plant Capital Investment Cost (\$000)		
		Nth Plant		
4300	Electric Plant Equipment			6,865
4310	Switchgear		1,502	
4320	Station Service Equipment		2,163	
4330	Protective Equipment		300	
4340	Power Wiring, Electrical Structures, and Wiring Containers		2,231	
4350	Master Control Equipment		669	
4350	Hardware	408		
4352	Hardware Design and Engineering	185		
4353	Software Design, Development and Test	76		
4400	Collector Equipment			131,820
4410	Reflective Unit		35,830	
4420	Drive Unit		53,030	
4421	Azimuth or Horizontal Drive			
4422	Elevation or Vertical Drive			
4423	Motors			
4424	Position Indicators or Encoders			
4425	Power Distribution and Emergency Supply			
4430	Control and Instrumentation		4,890	
4431	Sensor or Calibration Equipment			
4432	Field Control Electronics			
4433	Control Signal Distribu- tion Equipment			
4440	Foundation and Site		24,720	
4450	Heliostat Support and Protection		5,550	
4451	Heliostat Support Structure			
4452	Heliostat Protective Enclosure			
4453	Lightning Protection			
4460	Field Assembly and Check Out		7,800	
4470	Design and Engineering			
Subtotal				138,685

TABLE 4
281-MWe COMMERCIAL PLANT WITH ALL-SODIUM STORAGE
(Sheet 3 of 4)

		Solar Plant Capital Investment Cost (\$000)		
		Nth Plant		
4500	Receiver Equipment			42,077
4510	Receiver Unit		16,425	
4511	Absorber Unit	6,288		
4512	Support Structure	455		
4513	Receiver Circulation Equipment	4,342		
4514	Instrumentation and Control	2,802		
4515	Transportation, Field Erection, and Instal- lation	2,538		
4520	Riser, Downcomer, and Horizontal Piping		9,538	
4530	Working Media Cost		520	
4540	Tower		7,652	
4550	Foundation			
4560	Steam Generator or Working Media Heat Transfer Equipment		7,942	
4570	Design and Engineering			
4600	Thermal Storage Equipment			30,490
4610	Media Containment Equipment		8,025	
4620	Media Circulation Equipment		1,886	
4630	Working Fluid Circulation Equipment		0	
4640	Discharging Heat Exchangers		0	
4650	Charging Heat Exchangers		0	
4660	Foundation		579	
4670	Design and Engineering			
4680	Media		20,000	
4800	Distributables and Indirect Costs			44,784
4810	Temporary Facilities, Equipment, etc.		2,143	
4820	Spare Parts		1,250	
4830	Architectural Engineering Services		2,843	
4840	Construction Management		6,795	
4850	Plant Startup and Checkout		2,000	
4860	Contingency		29,753	
Subtotal				117,351

TABLE 4
281-MWe COMMERCIAL PLANT WITH ALL-SODIUM STORAGE
(Sheet 4 of 4)

		O&M Costs (\$1,000/year)					
		First Commercial			Nth Plant		
OM100	Operations Supervision			843			376
OM200	Maintenance Materials			1,078			469
	OM210 Spare Parts		1,078			469	
	OM211 Turbine and Electric Plant	593			258		
	OM212 Collector Equipment	363			158		
	OM213 Receiver Equipment				54		
	OM214 Thermal Storage Equipment	122					
	OM220 Material for Repair						
	OM230 Other						
OM300	Maintenance Labor			2,539			1,800
	OM310 Scheduled Maintenance	2,539			1,800		
	OM320 Corrective Maintenance						
Total				4,460			2,645

Figure 7. 281-MWe Commercial Plant With All Sodium Storage

TABLE 5
ADVANCED CENTRAL RECEIVER SYSTEM —
281-MWe COMMERCIAL PLANT
SUMMARY DATA
(Sheet 1 of 2)

Net Electrical Power MWe)	281
Parasitic Power (MWe)	
Daytime	31
Nighttime	16
Insolation (W/m^2)	950
Maximum Solar Power Absorbed (MWt)	1084
Nominal Solar Power Absorbed for Direct Operating (MWt)	723
Plant Net Efficiency (%)	25
Collector Field Configuration	Single 360° , North Biased
Solar Multiple, Equinox Noon	1.5
Number of Heliostats	40,591
Heliostat Shape and Size [m (ft)]	Square, 7.38 x 7.42 (24.2 x 24.3)
Number of Towers/Receivers	1
Land Area (acre)	2220
Receiver Mid-Point Elevation [m (ft)]	268 (879)
Receiver Configuration	External Cylinder
Number of Receiver Panels	24
Receiver Height and Diameter [m (ft)]	22.8 x 22.8 (74.8 x 74.8)
Receiver Maximum Heat Flux (MW/m^2)	1.94
Sodium Temperatures [$^\circ\text{C}$ ($^\circ\text{F}$)]	288/593 (550/1100)
Receiver Sodium Flow Rate [kg/hr (lb/hr)]	10.2×10^6 (22.6×10^6)
Steam Generator Sodium Flow Rate (Direct Operation) [kg/hr (lb/hr)]	6.82×10^6 (15.0×10^6)

TABLE 5
ADVANCED CENTRAL RECEIVER SYSTEM —
281-MWe COMMERCIAL PLANT
SUMMARY DATA
(Sheet 2 of 2)

Thermal Storage Capacity (MWth)	2350*
Total Sodium Inventory [kg (lb)]	23×10^6 (50.4×10^6)
Steam Generator and Reheater Type	Modular Steam Generator
Steam Conditions [MN/m^2 , $^{\circ}\text{C}$ (psia, $^{\circ}\text{F}$)]	
Initial	16.6, 538 (2400, 1000)
Reheated	538 (1000)
Steam Flow Rate [kg/hr (lb/hr)]	
Daytime	9.3×10^5 (20.5×10^5)
Nighttime	8.80×10^5 (19.5×10^5)
TSS Sodium Flow Rate [kg/hr (lb/hr)]	6.82×10^6 (15.0×10^6)
Feedwater Temperature [$^{\circ}\text{C}$ ($^{\circ}\text{F}$)]	242 (468)
Turbine Back Pressure [MN/m^2 (in. Hg)]	0.007 (2.0)
Heat Rejection [MW (Btu/hr)]	
Daytime	$442 (1500 \times 10^6)$
Nighttime	$420 (1430 \times 10^6)$

*Includes 180 MWt for startup/shutdown

IV. PILOT PLANT COST

Pilot Plant cost summary data are presented in Table 6. The cost backup data are given in Appendix D.

The Pilot Plant is designed to produce 10-MW net electrical power and to provide a test of the full-scale 100-MWe size receiver panels.

The receiver consists of three full-size receiver panels arranged as a cylindrical segment to give ~38 MW thermal power. The plant schematic is shown in Figure 8, with performance parameters as given in Table 7.

The Solar Multiplier (SM) is estimated to be 1.2 in order to supply a 1-h storage capability. The 1 h of storage capability was selected to provide demonstration of the buffering capability of the all-sodium storage system and yet demonstrate significant nighttime operation from storage without the cost of a longer duration storage capacity.

The receiver outlet temperature will be 1100⁰F, the same as for the 100-MWe plant, in order to demonstrate sodium system capability and operation at this temperature condition. Since reheat turbines are not available in the small 10-MWe size, reheat capability will not be provided. The steam generator will be a once-through unit of the MSG design. A once-through unit will be of sufficient size to represent the commercial-scale units. Steam outlet temperatures up to 1000⁰F will be provided for demonstration purposes, though the turbine may be limited to lower temperatures. An attemperator will be used to reduce steam temperatures. The steam generator unit is expected to be nearly identical to the ESG MSG in physical size and design.

TABLE 6
10-MWe PILOT PLANT
(Sheet 1 of 3)

		Solar Plant Capital Investment Cost (\$000)		
4000	Solar Plant Cost			39,306
4100	Site, Structures and Miscellaneous Equipment		1,427	
4110	Site	300		
4111	Land			
4112	Yard Work			
4120	Buildings	560		
4121	Turbine Building	300		
4122	Administration Buildings	20		
4123	Warehouse-Maintenance Buildings	50		
4124	Control Building	100		
4125	Other	90		
4130	Miscellaneous Equipment	567		
4131	Transportation and Lifting Equipment	296		
4132	Communication Equipment	11		
4133	Other	260		
4200	Turbine Plant Equipment		4,880	
4210	Turbine Generators and Accessories			
4220	Heat Rejection System			
4230	Condensing Systems			
4240	Feed-Heating or Recuperator System			
4250	Working Fluid Circulation, Treatment, and Auxiliary Inventory Containment Equipment			
Subtotal			6,307	

TABLE 6
10-MWe PILOT PLANT
(Sheet 2 of 3)

		Solar Plant Capital Investment Cost (\$000)		
4300	Electric Plant Equipment			3,154
	4310 Switchgear		}	1,040
	4320 Station Service Equipment			
	4330 Protective Equipment			
	4340 Power Wiring, Electrical Structures, and Wiring Containers			
	4350 Master Control Equipment			2,114
	4351 Hardware	868		
	4352 Hardware Design and Engineering	790		
	4353 Software Design, Development, and Test	456		
4400	Collector Equipment			7,090
	4410 Reflective Unit			2,630
	4420 Drive Unit			4,460
	4421 Azimuth or Horizontal Drive			
	4422 Elevation or Vertical Drive			
	4423 Motors			
	4424 Position Indicators or Encoders			
	4425 Power Distribution and Emergency Supply			
4430	Control and Instrumentation			990
	4431 Sensor or Calibration Equipment			
	4432 Field Control Elect Electronics			
	4433 Control Signal Distribution Equipment			
4440	Foundation and Site			960
4450	Heliostat Support and Protection			390
	4451 Heliostat Support Structure			
	4452 Heliostat Protective Enclosure			
	4453 Lightning Protection			
4460	Field Assembly and Check Out			550
4470	Design and Engineering			570
Subtotal				13,704

TABLE 6
10-MWe PILOT PLANT
(Sheet 3 of 3)

		Solar Plant Capital Investment Cost (\$000)		
4500	Receiver Equipment			8,063
4510	Receiver Unit		1,523	
4511	Absorber Unit	345		
4512	Support Structure	246		
4513	Receiver Circulation Equipment	80		
4514	Instrumentation and Control	798		
4515	Transportation, Field Erection, and Installation	54		
4520	Riser, Downcomer, and Hori- zontal Piping		2,426	
4530	Working Media Cost		28	
4540	Tower		1,049	
4550	Foundation			
4560	Steam Generator or Working Media Heat Transfer Equipment		900	
4570	Design and Engineering		2,137	
4600	Thermal Storage Equipment			1,471
4610	Media Containment Equipment		478	
4620	Media Circulation Equipment		20	
4630	Working Fluid Circulation Equipment		0	
4640	Discharging Heat Exchangers		0	
4650	Charging Heat Exchangers		0	
4660	Foundation		14	
4670	Design and Engineering		711	
4680	Media		248	
4800	Distributables and Indirect Costs			9,761
4810	Temporary Facilities, Equip- ment, etc.		2,594	
4820	Spare Parts		47	
4830	Architectural Engineering Services		473	
4840	Construction Management		1,287	
4850	Plant Startup and Checkout		500	
4860	Contingency		4,860	
Subtotal				19,295

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Figure 8. 10-MWe Pilot Plant With All-Sodium Storage

TABLE 7
ADVANCED CENTRAL RECEIVER
SYSTEM SUMMARY DATA —
PILOT PLANT
(Sheet 1 of 2)

Net Electrical Power (MWe)	10
Parasitic Power (MWe)	
Daytime	1.2
Nighttime	0.6
Isolation (W/m^2)	950
Maximum Solar Power Absorbed (MWt)	36.2
Nominal Solar Power Absorbed for Direct Operating (MWt)	30.2
Plant Net Efficiency (%)	
Collector Field Configuration	North
Solar Multiple, Equinox Noon	1.2
Number of Heliostats	1065 (Inverted)
Heliostat Shape and Size [m (ft)]	Square, 6.4 x 6.4 (24.2 x 24.3)
Number of Towers and Receivers	1
Receiver Mid-Point Elevation [m (ft)]	104 (341)
Receiver Configuration	External Cylinder
Number of Receiver Panels	3
Receiver Height and Diameter [m (ft)]	16.1 x 6.3 (52.8 x 20.7)
Receiver Maximum Heat Flux (MW/m^2)	1.53
Sodium Temperatures [$^{\circ}\text{C}$ ($^{\circ}\text{F}$)]	288/593 (550/1100)
Receiver Sodium Flow Rate [kg/h (lb/h)]	0.337×10^6 (0.741×10^6)
Steam Generator Sodium Flow Rate (Direct Operation) [kg/h (lb/h)]	0.281×10^6 (0.018×10^6)

TABLE 7
ADVANCED CENTRAL RECEIVER
SYSTEM SUMMARY DATA —
PILOT PLANT
(Sheet 2 of 2)

Thermal Storage Capacity (MWth)	30.2
Total Sodium Inventory [kg (lb)]	0.352×10^6 (0.775×10^6)
Steam Generator and Reheater Type	Modular Steam Generator
Steam Conditions [MN/m^2 , $^{\circ}\text{C}$ (psia, $^{\circ}\text{F}$)]	
Initial	10.10, 538 (1465, 1000)
Steam Flow Rate [kg/h (lb/h)]	
Daytime	0.42×10^5 (0.929×10^5)
Nighttime	0.405×10^5 (0.893×10^5)
TSS Sodium Flow Rate [kg/h (lb/h)]	0.281×10^6 (0.618×10^6)
Feedwater Temperature [$^{\circ}\text{C}$ ($^{\circ}\text{F}$)]	234 (453)
Turbine Back Pressure [MN/m^2 (in. Hg)]	0.007 (2.0
Heat Rejection [MW (Btu/h)]	
Daytime	22 (75×10^6)
Nighttime	21.2 (72×10^6)

V. SOLAR THERMAL ELECTRIC ANNUAL ENERGY CALCULATED AND BUCKS INPUT DATA

The Solar Thermal Electric Annual Energy Calculator (STEAEC) is a quasi-steady state computer model which estimates the annual performance of a solar thermal electric power plant. BUCKS is a computer model developed for economic analysis of solar electric power plants. The model calculates the levelized busbar energy costs which is the constant revenue per unit output required over the lifetime of the plant to compensate for its fixed and variable costs, pay interest to stockholders, and provide return to shareholders.

Both STEAEC and BUCKS were developed at Sandia Laboratories for use as part of the Central Receiver Solar Thermal Electric Program. MIRVAL is another program developed at Sandia to provide field efficiencies as a function of sun azimuth and elevation. These three programs are used in conjunction with each other (although they may be used independently) as shown in Figure 9. Figure 10 shows the STEAEC block diagram, and Figure 11 shows the block diagram for BUCKS

Figure 9. Solar Thermal Electric Power Plant Analysis Models

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Figure 10. Solar Thermal Electric Annual Energy Calculator

9272-15

Figure 11. BUCKS

The block diagrams show the general logic and information input and output for both these programs. More detailed information is contained in the Sandia reports for these programs.

A. COMMENTS

1. STEAEC

a. Collector Field Efficiency Data, F

The effects of reflectivity, atmospheric attenuation, blocking, shading, cosine, tower shadow, tracking errors, alignment errors, receiver interception, and heliostat reliability are all included in the function, F. In the STEAEC program, F is represented by a bicubic spline fit to a rectangular array of elevation and azimuth angles (θ_e , θ_a). The data provided for the ACR collector field are shown in Table 8. The dot (.) entries indicate nonexistent values for any one of several reasons. Since STEAEC uses a bicubic spline fit for these data, Sandia has suggested using F values scaled from the STEAEC sample problem data in lieu of "zeros" to preclude spurious STEAEC output resulting from the bicubic spline fit methodology. The scaling factors are shown in Table 9. The "adjusted" values for use in the STEAEC input data are shown in Table 10.

2. BUCKS

BUCKS inputs are taken primarily from the cost breakdown of Section II. Other inputs such as capital cost escalation rates, income tax, and construction time and year of commercial operation are assumed values. ACR plant sizes are those resulting from the baseline design. STEAEC inputs are discussed in the next section.

B. INPUT DATA

1. STEAEC

Table 11 shows the STEAEC sample problem inputs provided by Sandia and are included for reference purposes only. Table 12 shows the data developed for the

TABLE 8
FIELD EFFICIENCY MATRIX, F, PROVIDED BY MDAC

Elevation	Azimuth						
	0	30	60	75	90	110	130
5	.	.	0.300	0.290	0.288	0.289	.
15	.	.	0.472	0.462	0.463	.	.
25	.	0.592	0.578	0.570	0.561	.	.
45	0.662	0.660	0.657	0.644	0.631	.	.
65	0.672	0.667	0.660	.	.	.	.
89.5	0.678	.	.	.	.	.	.

TABLE 9
SCALING FACTORS USED WITH SAMPLE DATA

Elevation	Azimuth						
	0	30	60	75	90	110	130
5	.	.	1.240	1.229	1.247	1.279	.
15	.	.	1.035	1.048	1.074	.	.
25	.	1.039	1.068	1.065	1.077	.	.
45	1.064	1.078	1.070	1.075	1.082	.	.
65	1.067	1.044	1.066	.	.	.	.
89.5	1.085	.	.	.	.	.	.

TABLE 10
FIELD EFFICIENCY MATRIX, F, WITH "ADJUSTED" DOT VALUES

Elevation	Azimuth						
	0	30	60	75	90	110	130
5	0.311	0.310	0.300	0.290	0.288	0.289	0.278
15	0.506	0.491	0.472	0.462	0.463	0.431	0.427
25	0.609	0.592	0.578	0.570	0.561	0.539	0.525
45	0.662	0.660	0.657	0.644	0.631	0.613	0.601
65	0.672	0.667	0.660	0.648	0.643	0.636	0.639
89.5	0.678	0.675	0.676	0.677	0.678	0.679	0.689

TABLE 11
SAMPLE PROBLEM STEAEC INPUTS

STEAC.BKDATA.FORT		
00030	BLOCK DATA	
00040	COMMON /DATA2/ PTWF, PWF, XT, TR1, TR2, TR2A, TR3, PYS,	
00050	I PFS, PFT, PTT	
00060	COMMON /STRCK/ SUPIS, UPFS, XES, XPFS, ESMAXP	
00070	DATA PTWF /0./, PWF /0./	
00080	DATA SUPIS /0./, UPFS /0./, XES /0./, XPFS /0./	
00090	COMMON /COMCOE/ ELR(6), NX, AZR(7), NY, FR(6,7), COF(16,5,6).	
00100	I LCK, LCY	
00110	COMMON /COMCOL/ FS, ASB, AOL, TL1M, TL1M, EL1M, WSL1M, RFLCTY	
00120	COMMON /COMEFM/ NEFWS, WSX(8), WSEF(8)	
00130	COMMON /COMRCV/ EPS, XHR, RS, ALPHAR, TCS, RMF, CAXP, DEPTF,	
00140	I MODPO, XTD, DTST	
00150	COMMON /COMXLR/ MXLR, NXLR, RXLR(5), CXLR(6), FXLR(10)	
00160	COMMON /COMXLP/ NXLP, TXLP(9), YXLP(9)	
00170	COMMON /COMTRB/ ALPHA, BETA, TAUR, TAUS, ALPHR, ALPHS, TPFR,	
00180	I TPFR, AUXPC, TMFR, TMFS, SMFC, SMFO, TURBSS, MOPMF	
00190	COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSR(6), FEPSR(24)	
00200	COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSR(6), FEPSR(24)	
00210	COMMON /COMSTW/ PTSMAX, PFSMAX, EMAX, EMIN, ES, XLL, A, R,	
00220	I ALPHC, ALPHD, ALPHL, C1, C2, C3, D1, D2, D3, LS	
00230	COMMON /TSTATU/ ISBR, ISBT, ISUT, ISUS, IOFR, IOFS, IOFRPS,	
00240	I GCOPZA	
00250	DATA AZR /0.,30.,60.,75.,90.,110.,130./, NY 77	
00260	DATA ELR /5.,15.,25.,45.,65.,89.5/, NX 76	
00270	DATA FR /	
00280	I .29150385, .56115821, .66819170, .72588351, .73519690, .72920901,	
00290	I .29077515, .54432693, .6453313., .71349580, .74503362, .72612763,	
00300	I .78273488, .53175144, .63130911, .71661620, .72234359, .72722612,	
00310	I .27557995, .51487068, .62427393, .69904697, .71418629, .72779114,	
00320	I .26982498, .50277789, .60764914, .68002701, .70804967, .72876434,	
00330	I .26387111, .47851924, .59189314, .66554903, .70130568, .73079122,	
00340	I .26016708, .47302487, .57601355, .65345907, .70355616, .74037288/	
00350	DATA FS /889732./,	
00360	I ASR /1.934E-9/.	
00370	I AOL /3.934E-7/.	
00380	I TL1M /32.0/.	
00390	I TL1M /104.0/.	
00400	I EL1M /0.0/.	
00410	I WSL1M /16.0/.	
00420	I RFLCTY /0.857/	
00430	DATA NEFWS /8/.	
00440	I WSX /0.0,2.0,4.0,6.0,8.0,10.0,12.0,13.4/.	
00450	I WSEF /1.0,0.9995,0.998,0.996,0.994,0.985,0.964,0.942/	
00460	DATA EPS /0.93677/.	
00470	I XHR /6.695E-2/.	
00480	I RS /560.0/.	
00490	I ALPHAR /0.5/.	
00500	I TCS /0.5/.	
00510	I RMF /0.10/.	
00520	I CAXP /3.824E-5/.	
00530	I DEPTF /0.15/.	
00540	I MODPO /2/.	
00550	I XTD /0.75/.	
00560	I DTST /0.75/.	
00570	DATA MXLR /5/., RXLR /0.0,1.0,8.0,10.0,16.0/	
00580	DATA MXLR /5/., CXLR /-4.0,32.0,68.0,104.0,140.0/	
00590	DATA FXLR /	
00600	I 2.446E-2,2.193E-2,2.319E-2,2.286E-2,2.232E-2,	
00610	I 2.625E-2,2.571E-2,2.518E-2,2.464E-2,2.411E-2,	
00620	I 2.857E-2,2.804E-2,2.750E-2,2.696E-2,2.643E-2,	
00630	I 2.927E-2,2.873E-2,2.820E-2,2.766E-2,2.713E-2,	
00640	I 3.059E-2,3.005E-2,2.952E-2,2.898E-2,2.845E-2/	
00650	DATA MXLP /9/., TXLP /-22.,-4.,14.,32.,50.,68.,86.,104.,122./,	
00660	I YXLP /3.473E-4,3.393E-4,3.313E-4,3.232E-4,3.152E-4,3.071E-4,	
00670	I 2.991E-4,2.911E-4,2.830E-4/	
00680	DATA ALPHA /0.01158/.	
00690	I BETA /0.06417/.	
00700	I TAUR /1.5/.	
00710	I TAUS /21.5/.	
00720	I ALPHR /2.641E-2/.	
00730	I ALPHS /2.137E-2/.	
00740	I TPFR /298.50/.	
00750	I TPFR /285.00/.	
00760	I AUXPC /6.342E-3/.	
00770	I TMFR /0.25/.	
00780	I TMFS /0.26/.	
00790	I SMTC /0.05/.	
00800	I SMFD /0.109/.	
00810	I TURBSS /0.42238/.	
00820	I MOPMF /1/	
00830	DATA NCEPSR /4/., REPSR /0.25,0.50,0.75,1.00/	
00840	DATA NREPSR /6/., CEPSR /30.0,40.0,50.0,60.0,70.0,80.0/	
00850	DATA FEPSR /	
00860	I .3450, .3440, .3430, .3415, .3310, .3230,	
00870	I .3760, .3755, .3745, .3725, .3685, .3615,	
00880	I .3843, .3835, .3830, .3820, .3790, .3720,	
00890	I .3860, .3855, .3850, .3840, .3830, .3740/	
00900	DATA NCEPSS /4/., REPSS /0.25,0.50,0.75,1.00/	
00910	DATA NREPSS /6/., CEPSS /30.0,40.0,50.0,60.0,70.0,80.0/	
00920	DATA FEPSR /	
00930	I .213, .212, .212, .210, .207, .202,	
00940	I .254, .254, .253, .252, .249, .244,	
00950	I .267, .267, .266, .265, .262, .257,	
00960	I .284, .283, .282, .280, .277, .270/	
00970	DATA PTSMAX /255.0/.	
00980	I PFSMAX /285.1/.	
00990	I EMAX /1800.0/.	
01000	I EM1M /70.0/.	
01010	I ES /62.0/.	
01020	I XLL /0.0025/.	
01030	I A /0.0037/.	
01040	I B /0.00326/.	
01050	I ALPHC /0.98/.	
01060	I ALPHD /0.98/.	
01070	I ALPHL /0.99970/.	
01080	I C1 /0.90570/.	
01090	I C2 /1.0390E-4/.	
01100	I C3 /-5.784E-8/.	
01110	I D1 /0.95220/.	
01120	I D2 /-6.025E-4/.	
01130	I D3 /2.448E-6/.	
01140	I LS /2/.	
01150	DATA ISBR /1/	
01160	DATA ISBT /1/., ISUS /0/., IOFR /0/., IOFS /0/., IOFRPS /0/., ISUT /0/	
01170	COMMON /MLBLKO/ NF,NT	
01180	DATA NF/-1/.,NT/0/	
01190	END	

TABLE 12
SALIENT ITEMS FOR ACR STEAEC INPUTS

```

AWKRC-BLKDATA.FORT
00030 BLOCK DATA
00040 COMMON /DATA2/ PTWF, PMF, XT, TR1, TR2, TR2A, TR3, PTS,
00050 I PFS, PFT, PTT
00060 COMMON /STRCE/ SUPTS, UPFS, XES, XPPS, ESMAXP
00070 DATA PTWF /0./, PMF /0./
00080 DATA SUPTS /0./, UPFS /0./, XES /0./, XPPS /0./
00090 COMMON /COMCOE/ ELR(6), NX, AZR(7), NY, FR(6,7), COF(16,5,6),
00100 I LCX, LCY
00110 COMMON /COMCOE/ FS, ASB, AOL, TLIM, TLIMU, ELIM, WSLIM, RFLCTY
00120 COMMON /COMCFW/ NEFWS, WSX(8), WSEF(8)
00130 COMMON /COMRCV/ EPS, XHR, RS, ALPHAR, TCS, RMF, CAXP, DEPTF,
00140 I MODPO, XTD, DIST
00150 COMMON /COMXLR/ NRXL, NCXLR, RXLR(5), CXLR(6), FXLR(30)
00160 COMMON /COMXLP/ NXLP, TXLP(9), YXLP(9)
00170 COMMON /COMTRS/ ALPHA, BETA, TAUR, TALS, ALPHR, ALPHS, TPFRL,
00180 I TPFSL, AUXPC, TMFR, TMFS, SMFC, SMFD, TRSSS, MOPMF
00190 COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSS(6), FEPSR(24)
00200 COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSS(6), FEPSR(24)
00210 COMMON /COMSTR/ PTSMAX, PFSMAX, ENAX, EMIV, ES, XLL, A, B,
00220 I ALPHC, ALPHD, ALPHL, C1, C2, C3, D1, D2, D3, LS
00230 COMMON /TSTATU/ ISBR, ISBT, ISUT, ISLS, IOFR, IOFS, IOFRPS,
00240 I GCOP74
00250 DATA AZR /0.,30.,60.,75.,90.,110.,130./, SY /7/
00260 DATA ELR /5.,15.,25.,45.,65.,89.5/, NX /5/
00270 DATA FR /
00280 I .0001, .0001, .0001, .662, .672, .678,
00290 I .0001, .0001, .592, .660, .667, .0001,
00300 I .300, .472, .578, .657, .660, .0001,
00310 I .290, .462, .570, .644, .0001, .0001,
00320 I .288, .463, .561, .631, .0001, .0001,
00330 I .289, .0001, .0001, .0001, .0001, .0001,
00340 I .0001, .0001, .0001, .0001, .0001, .0001/
00350 DATA FS /692000./,
00360 I ASB /6.12E-7/,
00370 I AOL /8.97E-7/,
00380 I TLIM /32.0/,
00390 I TLIMU /122.0/,
00400 I ELIM /0.0/,
00410 I WSLIM /16.0/,
00420 I RFLCTY /1.0/,
00430 DATA NEFWS /5/,
00440 I WSX /0.0,3.0,7.0,11.0,16.0/,
00450 I WSEF /1.005,1.004,1.003,0.998,0.966/
00460 DATA EPS /0.950/,
00470 I XHR /1.6E-2/,
00480 I RS /390.0/,
00490 I ALPHAR /0.5/,
00500 I TCS /1.5/,
00510 I RMF /0.02/,
00520 I CAXP /0.0/,
00530 I DEPTF /0.10/,
00540 I MODPO /2/,
00550 I XTD /0.10/,
00560 I DIST /0.55/
00570 DATA NCXLR /4/, RXLR /0.0,5.7,11.0,16.2/,
00580 DATA NRXL /5/, CXLR /-4.0,32.0,68.0,134.0/
00590 DATA FXLR/

```

```

0600 I 4.548E-2,4.548E-2,4.548E-2,4.548E-2,4.548E-2,
0610 I 4.548E-2,4.548E-2,4.548E-2,4.548E-2,4.548E-2,
0620 I 5.230E-2,5.230E-2,5.230E-2,5.230E-2,5.230E-2,
0630 I 5.932E-2,5.932E-2,5.932E-2,5.932E-2,5.932E-2,
0650 DATA NXLP /9/, TXLP /-22.,-4.,14.,32.,50.,56.,104.,122./,
0660 I YXLP /8.287E-4,8.134E-4,7.982E-4,7.829E-4,7.577E-4,7.325E-4,
0670 I 7.372E-4,7.220E-4,7.067E-4/
0680 DATA ALPHA /0.0216/,
0690 I BETA /0.0037/,
0700 I TAUR /0./,
0710 I TAUS /0./,
0720 I ALPHR /2.7069E-2/,
0730 I ALPHS /1.745E-2/,
0740 I TPFRL /260.00/,
0750 I TPFSL /250.00/,
0760 I AUXPC /4.595E-3/,
0770 I TMFR /0.14/,
0780 I TMFS /0.14/,
0790 I SMFC /0.02/,
0800 I SMFD /0.10/,
0810 I TURBSS /0.381/,
0820 I MOPMF /1/
0830 DATA NCEPSR /4/, REPSR /0.25,0.50,0.75,1.00/
0840 DATA NREPSR /6/, CEPSS /30.0,40.0,50.0,60.0,70.0,80.0/
0850 DATA FEPSR/
0860 I .404,.401,.396,.388,.378,.367,
0870 I .433,.433,.430,.424,.418,.410,
0880 I .437,.437,.436,.434,.431,.424,
0890 I .435,.435,.435,.435,.434,.430/
0900 DATA NCEPSR /4/, REPSR /0.25,0.50,0.75,1.00/
0910 DATA NREPSR /6/, CEPSS /30.0,40.0,50.0,60.0,70.0,80.0/
0920 DATA FEPSR/
0930 I .404,.401,.396,.388,.378,.367,
0940 I .433,.433,.430,.424,.418,.410,
0950 I .437,.437,.436,.434,.431,.424,
0960 I .435,.435,.435,.435,.434,.430/
0970 DATA PTSMAX /390.0/,
0980 I PFSMAX /260.0/,
0990 I EMAX /812.5/,
1000 I EMIV /60.0/,
1010 I ES /60.0/,
1020 I XLL /0.00021/,
1030 I A /0.0082/,
1040 I B /0.00196/,
1050 I ALPHC /1.0/,
1060 I ALPHD /1.0/,
1070 I ALPHL /0.9973/,
1080 I C1 /1.0/,
1090 I C2 /0.0/,
1100 I C3 /0.0/,
1110 I D1 /1.0/,
1120 I D2 /0.0/,
1130 I D3 /0.0/,
1140 I LS /1/
1150 DATA ISBR /1/
1160 DATA ISBT /1/, ISUT /0/, IOFR /0/, IOFS /0/, IOFRPS /0/, ISUT /0/
1170 COMMON /HOLEK0/ NF,NT
1180 DATA NF /-1/,NT /0/
1190 END

```

all-sodium baseline ACR STEAEC inputs. The shaded areas are the salient items relating to the all-sodium ACR in particular. It should be noted that the input data reflect the choice of "derated" operation capability which is not applicable to the all-sodium ACR. The STEAEC computer output based on the "derated" operation is shown in Table 13 using 10 hypothetical days of Barstow insolation data.

TABLE 13
PLANT CHARACTERISTICS — DERATED OPERATION CAPABILITY
(Minimum Flow Options — Turbine Priority)

Hypothetical Insolation and Weather Data (Year 1976)	
Yearly Energy From Turbine (MWh)	6346.55
Collector Field Size (m ²)	692000.00
Receiver Size — Maximum Thermal Input (MW)	390.00
Gross Maximum Electrical Output of EPGS at 74 Degs. (Wet Bulb, °F) (MW)	112.50
Yearly Electrical Auxiliary Power Drawn From Net (MWh)	307.25
Maximum Storage Charge Rate (MW)	390.00
Maximum Storage Discharge Rate (MW)	260.00
Maximum Storage Capacity (MWh)	812.50
Number of Hours in Year	87.84
Yearly Integral of Energy Storage	20426.56

Table 14 shows the revised ACR all-sodium baseline STEAEC inputs incorporating the "adjusted" field efficiencies and the "no derated" operation option. These are the input data which will be used in subsequent STEAEC computer runs.

Table 15 shows the STEAEC output used for the input to BUCKS. The values from the sample problem are shown along with those for the all-sodium ACR using 36.5 times the STEAEC output for 10 days of Barstow data. The alternate input to BUCKS uses 400,000 MWe-h for the plant electrical generation derived from independent integration of the University of Houston solar insolation data and collector field efficiencies.

2. BUCKS

Table 16 presents the miscellaneous inputs required by BUCKS. The entries are noted and are self-explanatory. Base costs, both solar-related and nonsolar-related, are provided in Tables 17 and 18, respectively.

TABLE 14

REVISED ALL-SODIUM BASELINE STEAEC INPUTS WITH "ADJUSTED"
FIELD EFFICIENCIES AND "NO DERATED" OPERATION

ANARC.BLDATA.FORT

```

00030 BLOCK DATA
00040 COMMON /DATA2/ PTWF, PWF, XT, TR1, TR2, TR2A, TR3, PIS,
00050 1 PFS, PFI, PIT
00060 COMMON /STRGE/ SUPTS, UPFS, XES, XPPS, ESMAXP
00070 DATA PTWF /0./, PWF /0./
00080 DATA SUPTS /0./, UPFS /0./, XES /0./, XPPS /0./
00090 COMMON /CONCOE/ ELN(6), RX, AZR(7), NY, FR(6,7), COP(16,5,6),
00100 1 LCL, LCT
00110 COMMON /CONCOL/ FS, ASB, AOL, TLIML, TLINU, ELEM, WSLIN, RFLCTY
00120 COMMON /COMEPG/ NEFUS, WSK(8), WSEF(8)
00130 COMMON /COMRCV/ EPS, XHR, RS, ALPHAR, TCS, RMF, CAXP, DEPTV,
00140 1 MOOPO, XTD, DTST
00150 COMMON /COMCLR/ NXLN, NXLN, RXLR(5), CRLN(6), FXLR(30)
00160 COMMON /COMXLP/ NXLP, TXLP(9), YXI P(9)
00170 COMMON /CONTRB/ ALPHA, BETA, TAUR, TAUS, ALPHR, ALPHS, TPFR,
00180 1 TPFS, AUXPC, THPR, THPS, SHPC, SHPD, TURBSS, WOPMF
00190 COMMON /COMEPS/ YREPSR, NCEPSR, RFPSS(4), CEPSS(6), FEPSS(24)
00200 COMMON /KOMFPS/ NRFPSS, NCEPSS, RFPSS(4), CEPSS(6), FEPSS(24)
00210 COMMON /COMSTR/ PYSMAX, PFSMAX, EMAX, EMIV, FS, XLC, A, B,
00220 1 ALPHC, ALPHD, ALPHL, C1, C2, C3, D1, D2, D3, LS
00230 COMMON /TSTATU/ ISBR, ISBT, ISUT, ISUS, IOFR, IOFS, IOFRPS,
00240 1 CCOP74
00250 DATA AZR /0.,30.,60.,75.,90.,110.,130./, NY /7/
00260 DATA ELR /5.,15.,25.,45.,65.,85./, NX /6/
00270 DATA FR /
00280 1 .311, .506, .609, .662, .672, .678,
00290 1 .310, .491, .592, .660, .667, .675,
00300 1 .300, .472, .578, .657, .660, .676,
00310 1 .290, .462, .570, .644, .648, .677,
00320 1 .288, .463, .561, .631, .643, .678,
00330 1 .289, .431, .539, .613, .636, .679,
00340 1 .278, .427, .525, .601, .639, .689/
00350 DATA PS /692000./,
00360 1 ASB /6.12E-7/,
00370 1 AOL /8.97E-7/,
00380 1 TLIML /32.0/,
00390 1 TLINU /122.0/,
00400 1 ELIA /0.0/,
00410 1 WSLIN /16.0/,
00420 1 RFLCTY /1.0/,
00430 DATA NEFUS /5/,
00440 1 WSK /0.0,3.0,7.0,11.0,16.0/,
00450 1 WSEF /1.005,1.004,1.003,0.998,0.966/
00460 DATA EPS /0.950/,
00470 1 XHR /1.6E-2/,
00480 1 RS /390.0/,
00490 1 ALPHAR /0.5/,
00500 1 TCS /0.5/,
00510 1 RMF /0.027/,
00520 1 CAXP /0.0/,
00530 1 DEPTV /0.0/,
00540 1 MOOPO /1/,
00550 1 XTD /1.0/,
00560 1 DTST /0.55/
00570 DATA NXLR /4/, RXLR /0.0,5.7,11.0,16.28/
00580 DATA NRXLN /5/, CRLN /-4.0,32.0,68.0,104.0,140.0/
00590 DATA FXLR/

```

```

00600 1 4.548E-2,4.548E-2,4.548E-2,4.548E-2,4.548E-2,
00610 1 4.548E-2,4.548E-2,4.548E-2,4.548E-2,4.548E-2,
00620 1 5.230E-2,5.230E-2,5.230E-2,5.230E-2,5.230E-2,
00630 1 5.932E-2,5.932E-2,5.932E-2,5.932E-2,5.932E-2/
00640 DATA NXLP /9/, TXLP /-22.,-4.,14.,32.,50.,68.,86.,104.,122./,
00650 1 TXLP /8.287E-4,8.134E-4,7.982E-4,7.829E-4,7.677E-4,7.525E-4,
00660 1 7.372E-4,7.220E-4,7.067E-4/
00670 DATA ALPHA /0.321E/,
00680 1 BETA /0.00571/,
00690 1 TAUR /0./,
00700 1 TAUS /0./,
00710 1 ALPHR /2.7069E-2/,
00720 1 ALPHS /1.745E-2/,
00730 1 TPFR /260.00/,
00740 1 TPFS /250.00/,
00750 1 AUXPC /4.595E-3/,
00760 1 THPR /0.0/,
00770 1 THPS /0.0/,
00780 1 SHPC /0.07/,
00790 1 SHPD /0.0/,
00800 1 TURBSS /0.381/,
00810 1 WOPMF /1/
00820 DATA NCEPSR /4/, REPSR /0.25,0.50,0.75,1.00/
00830 DATA NRFPSS /6/, CEPSS /30.0,40.0,50.0,60.0,70.0,80.0/
00840 DATA FEPSS/
00850 1 .404,.401,.396,.388,.378,.367,
00860 1 .433,.433,.430,.424,.418,.410,
00870 1 .437,.437,.436,.434,.431,.424,
00880 1 .435,.435,.435,.433,.434,.430,
00890 DATA NCEPSS /4/, REPSS /0.25,0.50,0.75,1.00/
00900 DATA NRFPSS /6/, CEPSS /30.0,40.0,50.0,60.0,70.0,80.0/
00910 DATA FEPSS/
00920 1 .404,.401,.396,.388,.378,.367,
00930 1 .433,.433,.430,.424,.418,.410,
00940 1 .437,.437,.436,.434,.431,.424,
00950 1 .435,.435,.435,.433,.434,.430,
00960 DATA PYSMAX /390.0/,
00970 1 PFSMAX /260.0/,
00980 1 EMAX /812.5/,
00990 1 EMIV /60.0/,
01000 1 ES /60.0/,
01010 1 XLL /0.00021/,
01020 1 A /0.0/,
01030 1 B /0.0/,
01040 1 ALPHC /1.0/,
01050 1 ALPHD /1.0/,
01060 1 ALPHL /0.9973/,
01070 1 C1 /1.0/,
01080 1 C2 /0.0/,
01090 1 C3 /0.0/,
01100 1 D1 /1.0/,
01110 1 D2 /0.0/,
01120 1 D3 /0.0/,
01130 1 LS /1/
01140 DATA ISBR /1/
01150 DATA ISBT /1/, ISUS /0/, IOFR /0/, IOFS /0/, IOFRPS /0/, ISUT /0/
01160 COMMON /MLALGO/ NF,NT
01170 DATA NF /-17,NT/
01180 END
01190
01200 READY

```

TABLE 15
STEAEAC OUTPUT → BUCKS INPUT
(Plant Performance and Size Information)

	Sample	ACR (36.5 x 10 Days Barstow Data)	Alternate
PHR Annual Net Electrical Generation From Plant (MWe-h)	400,000	231,649.07	400,000
SQM Collector Field Reflective Surface Area (m ²)	1,000,000	692,000.00	No Change ↓
SMWTH Receiver Peak Input Capacity (MWt)	650	390.00	
PMX Peak Gross Electrical Capacity of Plant (MWe)	100	112.50	
SOLOAD Annual Electrical Energy Required by Plant From Utility Network (MWe-h)	0	11,214.63	
CHGRT Thermal Storage Peak Charging Rate (MWt)	350	390.00	
DCHGRT Thermal Storage Peak Discharge Rate (MWt)	250	260.00	
SMWHR Thermal Storage Capacity (MWt-h)	2,500	812.50	↓
IYHR Number of Hours in Year	8,760	8,784.00	
XMWH2 Number of Hours in Year That Each MWt-h of Storage Capacity is Charged (MWt-h-h)	5,000,000	745,549.00	
			1,322,000

The resulting BUCKS output based on 400,000 MWe-h solar plant generation annually is shown in Table 19. It should again be pointed out that the indicated cost of 105.88 mills/kWh represents a levelized busbar cost over the 30-year life of the plant assumed in this BUCKS case to be the years 1988 to 2018. It is the cost per unit of energy which must be charged over the plant lifetime to compensate for all fixed and variable costs, pay interest to bondholders, and provide return to shareholders. Feed pump costs are shown as zero since pump costs were lumped in the receiver and thermal storage systems.

There is an approximate method to obtain estimated BBEC translated to base year dollars. Multiply the BUCKS BBEC by the ratio of total plant base years cost per MWe to the total cost per MWe installed. For this case, the ratio is $1481041/2355204 = 0.6288$. The approximate BBEC in 1978 dollars is 66.58 mill/kWh.

TABLE 16
BUCKS INPUT
(Miscellaneous)

	Sample	ACR
Capital Cost Escalation Rate	0	6.0
Cost Estimate Base Year	1977	1978
Composite Income Tax Rate	0.50	0.40
Construction Time for Plant	5.5	4.0
Fraction of Capitalization — Stock	0.50	0.50
Fraction of Capitalization — Debt	0.50	0.50
Rate of Return — Stock	0.11	0.10
Rate of Interest — Debt	0.08	0.08
Year of Plant Operation	1977	1988
Depreciation Method DDB	Yes	Yes
<u>Base Sizes</u>		
Collector Size (M ² Mirrors)	880,000	692,000
Storage Capacity (MWt-h)	1,600	812.5
Charge-Discharge Rate (MWt)	240/300	390/260
Gross Output (MWe)	110	112.5
Receiver Capacity (MWt)	640	390
Base-Solar Related Costs	See Tables	
Base-Nonsolar Related Costs	See Tables	
<u>Maintenance — Annual</u>		
Fixed per Plant	1,050,000	70,000
Receiver	500	308
Storage	50	66.5
Collectors	1	1.15
EPGS		1,422
Contingency Fraction	0.15	0.129
Insurance and Property Tax	0.0045	0.0225
Operations and Maintenance Escalation Rate	0.05	0.08
Thermal Storage Media Replacement Fraction	0.5; 0; 0	0; 0; 0
Plant Life	30	30

TABLE 17
BASE SOLAR-RELATED COST ESTIMATES

Cost Item	Sample Problem Value (10 ³)	ACR Value (10 ³)
Thermal Storage Shed	0.0	0.
Thermal Storage Media Only With Storage Requirements	3,600.	0.
Heliostat Reflective Unit	70,000.	12,460.
Drive Unit	60,000.	18,420.
Sensor-Calibration	1,000.	51.
Field Control	20,000.	1,669.
(Blank — Array Position Unused)	0.	0.
Foundation and Site	7,500.	8,590.
Design-Engineering	2,000.	0.
(Blank)	0.	0.
Packing and Shipping	900.	410.
Assembly and Installation	9,500.	2,720.
Lightning Protection	1,000.	1,500.
Receiver Unit	50,000.	11,744.
Receiver Feed and Return Piping	10,000.	4,942.
Design-Receiver, Piping, Tower	3,000.	0.
Tower and Platform	20,000.	1,356.
Tower Foundation and Site	9,500.	1,000.
(Blank)	0.	0.
Thermal Storage Tank Equipment	10,000.	4,000.
Circulation Equipment	5,500.	688.
(Blank)	0.	0.
Piping From Receiver	300.	0.
Piping to Turbine	600.	0.
(Blank)	0.	0.
Discharging Equipment	5,000.	0.
Charging Equipment	4,000.	0.
Instrumentation and Control	500.	0.
Foundation and Site	700.	300.
Design	2,000.	0.
Storage Material	7,000.	6,400.
Receiver Feed Pumps	1,000.	0.0
Master Control Equipment	2,000.	367.

TABLE 18
BASE NONSOLAR-RELATED COST ESTIMATES

Cost Item	Sample Problem Value (10 ³)	ACR Value (10 ³)
Land and Yard Work	2,000.	1,500.
Turbine Building	1,000.	1,386.
Administration Building	700.	180.
Miscellaneous Buildings	50.	118.
Warehouse	0.	150.
Maintenance Building	700.	150.
Water Treatment Building	300.	0.
Sewage Treatment Building	0.	0.
Control Building	0.	216.
Turbine Generator	15,000.	10,856.
Heat Rejection Equipment	3,000.	4,215.
Condensing System	300.	320.
Feedwater Heating Equipment	1,000.	1,655.
Water Treatment Equipment	1,000.	2,378.
Electrical Plant	4,000.	2,415.
Maintenance and Handling Equipment	1,000.	1,141.
Miscellaneous Equipment	2,000.	1,200.
Transmission Plant	500.	938.
Distributables	5,000.	16,422.
Spare Parts	2,000.	422.
A&E Services	6,000.	1,399.
Construction Manager	4,000.	3,004.
Solar Integrator	1,500.	0.
Solar Design	0.	0.
Master Control Design	0.	0.
Startup and Checkout	2,000.	500.
(Blank)	0.	0.

TABLE 19
 ADVANCED CENTRAL RECEIVER — BUCKS OUTPUT
 (BBEC — Levelized Bus Bar Electrical Costs Over Life of Plant)
 (Sheet 1 of 3)

PLANT SIZES
 0.692000E+06 SQ METERS OF MIRRORS 0.812500E+03 MWHR OF STORAGE 0.390000E+03 MWH FOR RECEIVER
 0.390000E+03 MW(T) CHARGE RATE 0.260000E+03 MW(T) DISCHARGE RATE 112.500 MWE GROSS PEAK OUTPUT

PLANT PERFORMANCE
 SOLAR GENERATION 0.400000E+06 ANNUAL STORED ENERGY 0.132200E+07

ECONOMIC ASSUMPTIONS
 YEAR OF FIRST COMMERCIAL OPERATION 1988.
 DEPRECIATION METHOD DD BALANCE
 EFFECTIVE COST OF MONEY 0.074

LAND/SITE 0.150000E+07
 BUILDINGS 0.220000E+07
 COLLECTOR 0.458199E+08
 RECEIVER 0.166860E+08
 TOWER 0.235600E+07
 THERMAL STORAGE 0.113880E+08
 CAPACITY 0.107000E+08
 CHARGE/DISCHARGE 0.688000E+06
 DESIGN 0.0
 FEED PUMPS 0.0
 MASTER CONTROL 0.367000E+06
 EPGS 0.218390E+08
 OTHER EQUIP 0.327900E+07
 DISTRIB/INDIRECTS 0.217470E+08
 CONTINGENCY 0.164064E+08
 TOTAL PLANT 0.143588E+09
 XMED 0.0

TOTAL PLANT
 \$ 2355204.00 PER GROSS MWE INSTALLED \$ 1481041.00 PER GROSS MWE, BASE YEARS

	AMVAL	BBEC
INVEST-TAX	\$ 0.329130E+06	0.925679E+02 MILLS
DEPTAX	\$ 0.642897E+05	0.180815E+02 MILLS
INS	\$ 0.529921E+05	0.149040E+02 MILLS
FIX O-M	\$ 0.586315E+05	0.164901E+02 MILLS
VAR O-M	\$ 0.0	0.0 MILLS
TOTAL	\$ 0.376464E+06	0.105881E+03 MILLS

TABLE 19

ADVANCED CENTRAL RECEIVER — BUCKS OUTPUT
(BBEC — Levelized Bus Bar Electrical Costs Over Life of Plant)
(Sheet 2 of 3)

COLLECTOR			
\$ 751562.62 PER GROSS MWE INSTALLED		\$ 472610.37 PER GROSS MWE, BASE YEARS	
	AMVAL		BBEC
INVEST-TAX	\$ 0.105028E+06	0.295391E+02	MILLS
DEPTAX	\$ 0.205153E+05	0.576992E+01	MILLS
INS	\$ 0.169102E+05	0.475598E+01	MILLS
FIX O=M	\$ 0.389238E+05	0.109473E+02	MILLS
VAR O=M	\$ 0.0	0.0	MILLS
TOTAL	\$ 0.140346E+06	0.394724E+02	MILLS
RECEIVER			
\$ 273692.56 PER GROSS MWE INSTALLED		\$ 172108.06 PER GROSS MWE, BASE YEARS	
	AMVAL		BBEC
INVEST-TAX	\$ 0.382474E+05	0.107571E+02	MILLS
DEPTAX	\$ 0.747091E+04	0.210119E+01	MILLS
INS	\$ 0.615808E+04	0.173196E+01	MILLS
FIX O=M	\$ 0.585425E+04	0.164651E+01	MILLS
VAR O=M	\$ 0.0	0.0	MILLS
TOTAL	\$ 0.427889E+05	0.120344E+02	MILLS
TOWER			
\$ 38644.35 PER GROSS MWE INSTALLED		\$ 24301.00 PER GROSS MWE, BASE YEARS	
	AMVAL		BBEC
INVEST-TAX	\$ 0.540039E+04	0.151886E+01	MILLS
DEPTAX	\$ 0.105487E+04	0.296681E+00	MILLS
INS	\$ 0.869498E+03	0.244546E+00	MILLS
FIX O=M	\$ 0.0	0.0	MILLS
VAR O=M	\$ 0.0	0.0	MILLS
TOTAL	\$ 0.521502E+04	0.146673E+01	MILLS
THERMAL ST			
\$ 186791.81 PER GROSS MWE INSTALLED		\$ 117461.69 PER GROSS MWE, BASE YEARS	
	AMVAL		BBEC
INVEST-TAX	\$ 0.261034E+05	0.734158E+01	MILLS
DEPTAX	\$ 0.509883E+04	0.143405E+01	MILLS
INS	\$ 0.420281E+04	0.118204E+01	MILLS
FIX O=M	\$ 0.263429E+04	0.740894E+00	MILLS
VAR O=M	\$ 0.0	0.0	MILLS
TOTAL	\$ 0.278417E+05	0.783047E+01	MILLS

TABLE 19
ADVANCED CENTRAL RECEIVER — BUCKS OUTPUT
(BBEC — Levelized Bus Bar Electrical Costs Over Life of Plant)
(Sheet 3 of 3)

FEED PUMPS					
\$	0.0	PER GROSS MWE INSTALLED	\$	0.0	PER GROSS MWE, BASE YEARS
		AMVAL		BBEC	
INVEST-TAX	\$	0.0	0.0		MILLS
DEPTAX	\$	0.0	0.0		MILLS
INS	\$	0.0	0.0		MILLS
FIX O-M	\$	0.0	0.0		MILLS
VAR O-M	\$	0.0	0.0		MILLS
TOTAL	\$	0.0	0.0		MILLS
MASTER CTL					
\$	6019.72	PER GROSS MWE INSTALLED	\$	3785.43	PER GROSS MWE, BASE YEARS
		AMVAL		BBEC	
INVEST-TAX	\$	0.841232E+03	0.236596E+00		MILLS
DEPTAX	\$	0.164319E+03	0.462148E-01		MILLS
INS	\$	0.135444E+03	0.380936E-01		MILLS
FIX O-M	\$	0.0	0.0		MILLS
VAR O-M	\$	0.0	0.0		MILLS
TOTAL	\$	0.812356E+03	0.228475E+00		MILLS
ALL OTHERS					
\$	1098496.00	PER GROSS MWE INSTALLED	\$	690775.31	PER GROSS MWE, BASE YEARS
		AMVAL		BBEC	
INVEST-TAX	\$	0.153510E+06	0.431748E+02		MILLS
DEPTAX	\$	0.299854E+05	0.843341E+01		MILLS
INS	\$	0.247162E+05	0.695142E+01		MILLS
FIX O-M	\$	0.112191E+05	0.315538E+01		MILLS
VAR O-M	\$	0.0	0.0		MILLS
TOTAL	\$	0.159460E+06	0.448482E+02		MILLS

0

APPENDIX A
COST SUBSTANTIATION DATA
FOR THE 100-MWe COMMERCIAL PLANT

ALL SODIUM STORAGE

DATE 9-1-78 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

ESG-79-2, Vol IV
A-2

DATE 9-1-78 TAKE-OFF _____ PRICED _____ CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

Form 702-D Rev. 11-75

ESG-79-2, Vol IV
A-3

JOS NO 133-026001 PROJECT 100 MW

LOCATION

CLIENT

DATE 4-17-78

TAKE-OFF LC

PRICED 15

_ CALC CHKD

APPROVED

~~SECRET~~

OF

[illegible]

11-75

[illegible]

August 8, 1978

Atomics International Division
Rockwell International
8900 DeSota Avenue
Canoga Park, CA 91304

Re: C-20325-34

Attention: Mr. T. H. Springer

Subject: 100 MWe Commercial Plant Building
Costs and O & M Costs
Advanced Central Receiver Power System

Reference: AI Contract N311-002FX
DOE Contract EG-77-C-03-1483

Dear Tom:

Confirming out telecopier transmittal of July 19, 1978, we are pleased to advise the following:

Commercial Plant Building Cost Estimates
4120 Buildings

- 4121 Turbine Building (20m x 30m x 10m)
198,000 c.f. x \$7/c.f. = \$1,386,000
- 4122 Administration Building (15m x 15m x 8m)
60,000 c.f. x \$3/c.f. = 180,000
- 4123 Warehouse/Maintenance Building (25m x 25m x 8m)
150,000 c.f. x \$2/c.f. = \$300,000
- 4124 Control Building (12m x 12m x 14m)
72,000 c.f. x \$3/c.f. = \$216,000
- 4125 Other Buildings
- 1 Water Treatment Building (15m x 15m x 6m)
50,000 c.f. x \$2/c.f. = \$100,000
 - 2 Steam Generator & Sodium Heat Transport
Pad (20m x 20m)
400 s.y. x \$45/s.y. = \$18,000

9904/256

Stearns-Roger

PAGE 2

Atomics International Division
Rockwell International
Canoga Park, CA 91304

August 8, 1978

100 MWe O & M Costs (EPGS & BOP only)

OM100 Operations

1. Operations/Shift:

- 1 Shift Supervisor
- 1 Station Operator (Relief for all classes)
- 1 Control Operator
- 1 Turbine Operator
- 2 Auxiliary Operators
- 6 per shift x 3 shifts = 18 per 24 hr. day

Additional on Day Shift:

- 1 Senior Results Engineer
- 2 Results Technicians
- 1 Chemist
- 1 Chemist Technician
- 1 Electrical Foreman
- 1 Electrical Specialist
- 2 Electrical Apprentice
- 1 Electrical Helper
- 10 per day

2. Administrative:

- 1 Plant Superintendent
- 1 Assistant Plant Superintendent
- 2 Secretaries
- 2 File Clerks
- 6 per day

3. Stores:

- 2 Storepersons

4. Schedulers:

- 2 Schedulers

5. Guards:

- 3 Guards

Atomics International Division
Rockwell International
Canoga Park, CA 91304

August 8, 1978

100 MWe O & M Costs (EPGS & BOP only) - (Cont'd)

6. Total EPGS Operations - 41 Employees on Payroll

Operations Cost, including Administrative (excluding Maintenance):

41 people x \$21,000/yr. x 1.05 overtime = \$904,000/year

OM200 Maintenance Materials

OM210 Spare Parts

OM211 Turbine and Electric Plant - Est. Spare Parts \$150,000

OM220 Materials for Repairs

Maintenance Materials & Supplies

Est. 50% of O & M Labor

0.50 x \$1,188,000/yr. = \$594,000/yr.

OM300 Maintenance Labor

Maintenance:

1 Maintenance Supervisor

1 Work Foreman

3 Classified Mechanics

3 Plant Mechanics

5 Helpers

15 per day

15 people x \$18,000/yr. x 1.05 overtime = \$284,000/year

Very truly yours,

STEARNS-ROGER ENGINEERING CO.

A. W. McKenzie

A. W. McKenzie
Project Engineer

AWM:vr

cc: Steve Chalmers - SRP

LOCATION _____ CLIENT _____

SHEET _____ **C**

[illegible]

Form 702-D Rev. 11-73

ESG-79-2, Vol IV
A-8

JOB NO 133-026-R1 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-20-78 TAKE-OFF _____ PRICED _____ CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
Telcon with Al McKenzie 5/31/78 2:30 p. m. <i>J. Chavetz</i>									
ACCOUNT: 4200 TURBINE PLANT EQUIPMENT									
<u>Subaccount No.</u>	<u>Description</u>								<u>Cost</u>
4210	Turbine generator & accessories								\$10,856,000
4220	Heat rejection system								4,215,000
4230	Condensing system								320,000
4240	Feed heating system								1,655,000
4250	Working fluid circ., treatment								<u>2,378,000</u>
TOTAL									<u>\$19,424,000</u>
CODE									
4200	TURBINE PLANT EQUIPMENT

national Division
national

LOCATION

CLIENT

TAKE-OFF

PRICED

CALC CHKD

— APPROVED

— SHEET

 OF

[illegible]

Table A

ADVANCED CONCEPT 1ST COMMERCIAL PLANT - 100 MWe
BREAKDOWN OF MASTER CONTROL COSTS BY CBS

1978 DOLLARS AND HOURS IN THOUSANDS					
<u>CBS</u>	<u>COST ELEMENT</u>	<u>HOURS</u>	<u>LABOR</u>		<u>TOTAL</u>
			<u>DOLLARS</u>	<u>NON-LABOR</u>	
4351	Hardware				
	LSI-11 Processor			\$ 14.94	\$ 14.94
	RX11 BA Disc Drive and Control			27.22	27.22
	TA11 AB Recorder			9.52	9.52
	LAV11 DA Printers			8.55	8.55
	Terminal			49.65	49.65
	Cabinet	2.99	\$ 83.60	29.43	113.03
	Cables			10.50	10.50
	Data Acquisition			91.11	91.11
	Time			3.83	3.83
	Weather			18.37	18.37
	Timers			2.40	2.40
	Assy, Trans., Install. & C/O	<u>6.48</u>	<u>217.74</u>	<u>13.51</u>	<u>231.25</u>
	Subtotal	8.85	\$301.34	\$279.03	\$580.37
	Visibility		<u>60.66</u>	<u>55.97</u>	<u>116.63</u>
	Total 4351		\$362.00	\$335.00	\$697.00
4352	Hardware Design & Engr	6.65	\$313.00	\$ 19.00	\$332.00
4353	Software Design, Develop & Test	5.04	\$237.00	\$ 15.00	\$252.00
OM300	Maintenance Labor (Subcontract)			\$ 0.05	\$ 0.05

Table, A
 ADVANCED CONCEPT NTH COMMERCIAL PLANT - 100 MWe
 BREAKDOWN OF MASTER CONTROL COSTS BY CBS

<u>1978 DOLLARS AND HOURS IN THOUSANDS</u>					
<u>CBS</u>	<u>COST ELEMENT</u>	<u>LABOR</u>		<u>NON-LABOR</u>	<u>TOTAL</u>
		<u>HOURS</u>	<u>DOLLARS</u>		
4351	Hardware				
	LSI-11 Processor			\$ 12.45	\$ 12.45
	RX11 BA Disc Drive & Control			22.68	22.68
	TA11 AB Recorder			9.52	9.52
	LAV11 DA Printers			8.55	8.55
	Terminal			41.28	41.28
	Cabinet	2.37	\$ 66.19	29.43	95.62
	Cable			10.50	10.50
	Data Acquisition			0	0
	Time			3.83	3.83
	Weather			18.37	18.37
	Timers			2.40	2.40
	Assy, Trans, Install & C/O	<u>5.07</u>	<u>170.04</u>	<u>10.37</u>	<u>180.41</u>
	Subtotal	7.44	\$236.23	\$169.38	\$405.61
	Visibility		<u>47.77</u>	<u>33.62</u>	<u>81.39</u>
	TOTAL 4351		\$284.00	\$203.00	\$487.00
4352	Hardware Design & Engr	3.70	\$174.00	\$ 11.00	\$185.00
4353	Software Design, Develop & Test	1.53	\$ 72.00	\$ 4.00	\$ 76.00
OM300	Maintenance Labor (Subcontract)			\$ 0.05	\$ 0.05

Table A -2

1ST ADVANCED CONCEPT PLANT - HELIOSTAT COST - 100 MWe

(Sheet 1 of 3)

		CAPITAL INVESTMENT			
		<u>LABOR</u>		<u>MATL \$</u>	<u>TOTAL</u>
<u>WBS NUMBER AND TITLE</u>		<u>HOURS</u> <u>(THOU)</u>	<u>DOLL</u> <u>(\$M)</u>	<u>(\$M)</u>	<u>(\$M)</u>
4410	Reflective Unit	101.56	1.43	15.53	16.96
4411	Reflective Surface	31.03	.42	8.87	9.29
4412	Mirror Back Struct	36.68	.52	6.11	6.63
4413	Assy & Bond	33.85	.49	.55	1.04
4420	Drive Unit	183.38	2.58	21.60	24.18
4421	Azimuth	93.10	1.31	5.34	6.65
4422	Elevation	59.25	.83	10.50	11.33
4423	Motor Total	0	0	2.93	2.93
4424	Pos/Limit Indicators	19.74	.28	.32	.60
4425	Power Sply/Dist	0	0	2.50	2.50
4426	Assy Dr/Ped/Elect	11.29	.16	.01	.17
4430	Control/Instrmt Equip	58.92	.84	1.78	2.62
4431	Sensor/Calib Equip	0	0	.02	.02
4432	Field Control	0	0	.01	.01
4433	Cntrl/Sig Equip	56.42	.79	1.47	2.26
44320101	Collector Control	2.50	.05	.28	.33

Table *A* -2

1ST ADVANCED CONCEPT PLANT - HELIOSTAT COST - 100 MWe

(Sheet 2 of 3)

		CAPITAL INVESTMENT			
		<u>LABOR</u>		<u>MATL \$</u>	<u>TOTAL</u>
<u>WBS NUMBER AND TITLE</u>	<u>HOURS</u> <u>(THOU)</u>	<u>DOLL</u> <u>(\$M)</u>	<u>(\$M)</u>	<u>(\$M)</u>	<u>(\$M)</u>
4440 Found/Site Prep	259.55	6.01	4.91	10.92	
4441 Foundation	187.61	4.35	4.91	9.26	
4442 Site Preparation	71.94	1.66	0	1.66	
4450 Heliostat Spt St/Pr En	25.39	.35	2.17	2.52	
4451 Helio Suppt Struct	25.39	.35	2.17	2.52	
4452 Protection Encl	0	0	0	0	
4453 Lightning Protect	0	0	0	0	
4460 Field Assy and C/O	162.22	3.39	.01	3.40	
4461 Heliostat	57.83	1.34	0	1.34	
4462 Sensor/Calib Equip	0	0	0	0	
4463 Electrical/Distrib	32.44	.76	0	.76	
4464 Align Heliostats	14.11	.32	0	.32	
4465 Field Support	18.34	.42	0	.42	
4466 Pack & Transp	<u>39.50</u>	<u>.55</u>	<u>.01</u>	<u>.56</u>	
TOTAL HELIOSTAT	791.02	14.60	46.00	60.60	

Table *A* -2

1ST ADVANCED CONCEPT PLANT - HELIOSTAT COST - 100 MWe

(Sheet 3 of 3)

		CAPITAL INVESTMENT			
		<u>LABOR</u>		<u>MATL \$</u>	<u>TOTAL</u>
<u>WBS NUMBER AND TITLE</u>	<u>HOURS (THOU)</u>	<u>DOLL (\$M)</u>		<u>(\$M)</u>	<u>(\$M)</u>
4100 Site, Struct, Misc Equip	2.82	.04		.49	.54
4130 Misc Equipment	2.82	.04		.49	.54
4800 Dist and Indir	0	0		.04	.04
4840 Initial Spares	0	0		.04	.04
OM100 Operations	0	0		0	0
OM200 Maint Material	0	0		.20	.20
OM300 Maintenance Labor	<u>40.17</u>	<u>.60</u>		<u>0</u>	<u>.60</u>
TOTAL O&M	40.17	.60		.20	.80
Ongoing O&M	21.13	.31		.15	.46

Table A -3

NTH COMMERCIAL HELIOSTAT INVESTMENT COST - 100 MWe

(Sheet 1 of 3)

		CAPITAL INVESTMENT			
		LABOR		MATL \$	TOTAL
WBS NUMBER AND TITLE		HOURS (THOU)	DOLL (\$M)	(\$M)	(\$M)
4410	Reflective Unit	60.65	.85	11.61	12.46
4411	Reflective Surface	18.33	.25	6.39	6.64
4412	Mirror Back Struct	21.16	.31	4.81	5.12
4413	Assy & Bond	21.16	.29	.41	.70
4420	Drive Unit	110.15	1.53	16.89	18.42
4421	Azimuth	56.42	.78	4.21	4.99
4422	Elevation	35.61	.50	8.25	8.75
4423	Motor Total	0	0	2.31	2.31
4424	Pos/Limit Indicators	11.28	.16	.24	.40
4425	Pwr Sply/Dist	0	0	1.84	1.84
4426	Assy Dr/Ped/Elect	6.84	.09	.04	.13
4430	Control/Instrmt Equip	36.30	.51	1.19	1.72
4431	Sensor/Calib Equip	0	0	.03	.03
4432	Field Control	0	0	.01	.01
4433	Cntrl/Sig Equip	33.80	.46	.95	1.43
44320101	Collector Control	2.50	.05	.20	.25
4440	Found/Site Prep	204.53	4.73	3.86	8.59

Table A -3

NTH COMMERCIAL HELIOSTAT INVESTMENT COST - 100 MWe

(Sheet 2 of 3)

		CAPITAL INVESTMENT			
		<u>LABOR</u>		<u>MATL \$</u>	<u>TOTAL</u>
<u>WBS NUMBER AND TITLE</u>		<u>HOURS</u> <u>(THOU)</u>	<u>DOLL</u> <u>(\$M)</u>	<u>(\$M)</u>	<u>(\$M)</u>
4441	Foundation	148.11	3.42	3.86	7.28
4442	Site Preparation	56.42	1.31	0	1.31
4450	Helio Spt St/Pr En	15.51	.21	1.72	1.91
4451	Helio Supp Struct	15.51	.21	1.72	1.91
4452	Protection Encl	0	0	0	0
4453	Lightning Protection	0	0	0	0
4460	Field Assy & C/O	129.77	2.71	.01	2.72
4461	Helio stat	45.13	1.04	0	1.04
4462	Sensor/Calib Equip	0	0	0	0
4463	Electrical/Distrib	25.39	.61	0	.61
4464	Align Helio stats	11.28	.25	0	.25
4465	Field Support	15.51	.35	0	.35
4466	Pack & Transp	<u>32.46</u>	<u>.46</u>	<u>.01</u>	<u>.47</u>
	Subtotal - Helio stat	556.91	10.54	35.27	45.82
	Visibility	-	<u>2.11</u>	<u>3.52</u>	<u>5.63</u>
	TOTAL HELIOSTAT		12.65	38.79	51.45

Table *f* -3

NTH COMMERCIAL HELIOSTAT INVESTMENT COST - 100 MWe

(Sheet 3 of 3)

		<u>CAPITAL INVESTMENT</u>			
		<u>LABOR</u>		<u>MATL \$</u>	<u>TOTAL</u>
<u>WBS NUMBER AND TITLE</u>		<u>HOURS</u> <u>(THOU)</u>	<u>DOLL</u> <u>(\$M)</u>	<u>(\$M)</u>	<u>(\$M)</u>
4100	Site, Struc, Misc Equip	2.83	.04	.49	.53
4130	Misc Equipment	2.83	.04	.49	.53
4800	Dist and Indir	0	0	.02	.02
	Initial Spares	0	0	.02	.02
OM100	Operation	0	0	0	0
OM200	Maint Material	0	0	.17	.17
OM300	Maintenance Labor	<u>40.17</u>	<u>.60</u>	<u>0</u>	<u>.60</u>
	TOTAL O&M	40.17	.60	.17	.77
	Ongoing O&M	20.70	.31	.14	.45

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PROJECT

LOCATION

CLIENT

TAKE-OFF JC/JW

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Form 702-D Rev 11-73

ESG-79-2, Vol 1 IW
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JOB NO 133026R02 PROJECT ABSORBER PANEL

LOCATION

CLIENT

DATE 4-4-78

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2

OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
REF. TABLES - 5 - 5/8 24 PANELS REQ'D 1 - SHOWN									
2400 ① TUBING 110 3/4" O.D. X .049 X L2' 13.668 304H	6820	FT	1.73		2502	11799			
240 ② HEADER 1 - 6-STD IPS X 1/4" (6" L) "	14.25	"	31.00		270	441			
13 ③ " ENDS 6-STD CAP "	2	"	72.00		13	144			
49 ④ " F76 6-90° L-BELL "	2	"	192.00		49	384			
30 ⑤ TUBE HOOK 2 R 3/4" X 2 1/8" X 7 1/2"	14.25	FT	1.50		91	137			
800 ⑥ SUP 13 L 1/4" X 3/8" X 7' 4.9	169	"	1.23		828	1018			
WEL 1049BW TUBE TO HEADER AKA "	220	EA	4.50		2	9			
HEADER BW 28V .357 ATA "	29	FT	4.50		11	50			
SUPPORT 1/2 LFW 1 TIG WELD "	50	"	"		5	22			
TUBE BENDS 110° "	220	EA	15.00					3300	
WELV TUBES V1049 102 1/2" ATA "	5500	FT	4.50		110	495			
F76 BW 6-40 28V	4	EA	"		2.5	11			
50 ⑦ HEADERS 1 L 3/8" X 6 X 6 X 4' (at 4)	4	FT	1.50		60	90			
20 ⑧ PYLON MARK 600 #	4	EA	5.00		32				
⑨ TUBE TO HEADER JIG (24000)	1/24							1000	
⑩ MISC MAT'L	L.S					500			
WELD DEVELOPMENT								1000	
360 SUB-TOTAL					3974	15101		5300	20401
MAT'L @ 110°									2089
FABRICATION LABOR	985	HR		31.06			30594		30594
SUB-TOTAL									53034
VENDOR G & A @ 1090									5366
SUB-TOTAL									58400
VENDOR PROFIT @ 1590									8600
ESTIMATED PRICE 1-UNIT CURRENT DOLLARS									67000
X 2 ✓									1608000
CODE									
4511									
ABSORBER UNIT

JOB NO/33026R PROJECT ABSORBER PANEL PIPING

LOCATION

CLIENT

DATE 4-5-78

TAKE OFF

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SHEET 3

OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
REF TABLE 5-5 4SK 24 REOD 1- SHOWN SHUP FABR									
(1) OUTLET PIPE 26-STD IPS X 20' 7304	40	FT	3/16"		760	1240			
(2) INLET 12 DO 120'	40	FT	"		760	1240			
(3) INLET FOOT HANGERS									
BENDS 6-STD 4 1/2" NH 1	6	ea		267				1602	
" DO #7	2	ea		267				534	
SHUP WELD, 280' 5/8" 6" HAND 7304	9	FT	4/16"		6	27			
FIELD " DO 4/8" 6" " "	7	"	"		5	23			
(4) PIPE HANGERS 1/2" 1/2"	10	ea	100		500	1000			
(5) CONTROL VALVE 6"	1	"	600		400	6000			
(6) BLUIC VALVE 6"	1	"	300		300	3000			
(7) SNUGGER 40MM H2A	2	"	1200		400	2400			
MISC MATL	L.S				300	500			
3000 SUB-TOTAL MATL					3431	14940		2136	17076
MATL ON HAND 1070									1724
SHUP LABOR	60	HR		300			1800		1800
FIELD LABOR 5M2D 80X PIPE	160	"		3000			4800		4800
HANGERS	50	"		390			1500		1500
SNUGGER	80	"					2400		2400
FIELD EFFICIENCY 60% 5700									5220
SUB-TOTAL									34520
SHUP G + HAND 1070 2060									2060
FIELD ON HAND 1070 4820									4820
SUB TOTAL									40800
VENDOR PRICE 7 1570									4100
ESTIMATED PRICE INSTALLED UNIT CURRENT DOLLAR									47000
TOTAL 24 UNITS									1128000
CODE									
4511	ABSORBER UNIT

International Division
of the American Petroleum Institute

JOB NO. 133046202 PROJECT ABSORBER INLET PIPE

LOCATION

CLIENT

DATE

4-5-78

TAKE-OFF

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SHEET

4

OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
REF. TABLE 5.545K INLET LINE 1-RECORD									
9500 (1) IN PIPE 3-20" O.D. X 3/8" W X 23.75' 78.6" T304 71.25' FT 2.30"					5600	12880			
8260 (2) OUT " 3-20" O.D. X 3/8" W X 23.75' 121" " 69.3' FT 2.30"					8385	19286			
155 (3) " 40 1-30" 2:1 SE, 401-R 3/8" X 3.25' 3.25' 11.6' # 1.25					197	246		100	
46 (4) " 40 1-R 1/2" X 2.5' X 2.5' " 6.25' # 1.35					144	194			
150 (5) NOZZLE 1-200" X 3/8" W X 2' " 2' FT 2.30"					157	361			
SHOP WELD 3/8" V 186 HANK " 40 " 4.50					34	152			
15 (6) SPACERS 3/8" X 5" X 2' (cut 4) " 2 " 1.74					17	30			
200 (7) RELINE 8 1/2" 40 IPS X 20' 2.718 " 180 " 10.01					2.45	1800			
(8) PIPE BENDS 1" 40 " 32 ea 44.00								1408	
SHOP WELD 1/4" V 1 1/2" IPS 822EA 54 HANK " 6 " 4.50					3	14			
FIELD WELD 220" V 186 HANK " 1 # " 4.50					10	45			
" " 8-1 1/2" V 145 " 4 " "					4	18			
120 MISC MATL 12.59 200 300									
14386 PIPE HANGERS 12 ea 5.00 25 60									
SUB-TOTAL					14991	34386		1508	35894
SHOP LABOR	420	HR		31.00			12400		12400
FIELD LABOR VESSEL SM/WK	200	"		30.00			6000		6000
" LABOR 1 1/2" IPS 342D X 4	100	"		30.00			3000		3000
11 LABOR EFFICIENCY 60% OF 9000							5400		5400
MATL ON HAND 1070 OF 35894									3586
SUB-TOTAL									66280
SHOP G + A 110% OF 51880									5120
FIELD OVER HEAD 30% OF 14,400									4300
SUB-TOTAL									75700
VENDOR PROFIT 15%									11300
ESTIMATED COST INSTALLED CURRENT DOLLARS									87000
CODE									
4511	ABSORBER UNIT

International Division
national

JOB NO. 133,026,002 PROJECT ABSORBER EXPANSION TANKS

LOCATION _____ CLIENT _____

DATE 4-5-78 TAKE-OFF JAW PRICED JAW CALC CHKD _____ APPROVED _____ SHEET 5 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TABLE SK 4-6'4"X14.5'S SHELL VERT TANKS	1	SHOWN							
1308 (1) HEADS 2 PL 3/8 X 7' V7'	98	#	1.20		1666	1999		200	
4864 (2) SHELL 2 PL 3/8 X 7.6' X 19'	289	"			4913	5896			
2238 (3) SKIRT 1 PL 3/8 X 7' X 19'	133	"			2261	2713			
240 (4) " BASE 1 L 1/2 X 4 X 4 X 21'	2	FT	1.30		269	350		100	
150 (5) BOND 8-STD IPS X 5.34' 2655	5.34	"	8.10		152	427			
50 (6) " " FTL 1-8-STD 90° L-RFL	1	EA	450.00		50	450			
55 (7) LIK 1 BKT 1 PL 3/4 X .83 X 8.5' (cont'd)	2.9	#	1.40		96	134			
45 (8) " " PAD 1 PL 3/8 X 1' X 3'	3	"	1.20		48	58			
100 (9) MISC MATL	6.5	#			150	300			
WELDS 5/8 X	56	9A		2.1	FT	4.50	12		54
" RIS DO	56	"		38	"		22		99
26 " SKIRT 3/8 FW .54 .34	76	"			41	185			
5 (10) VENT NOZ 1-1/2-40 X 2' (cont'd)	2	FT	10.00		35	20			
9086 SUB-TOTAL					9686	12685		300	12985
MAT'L OH ~1070									1315
SHUP LABOR	4100	HR		31.00			12400		12400
FIELD INSTALL 5M 3da	120	"		30.00			3600		3600
EFFICIENCY 6090	72	"		30.00			2160		2160
SUB-TOTAL									32370
FIELD OVERHEAD 30% 5760									1730
SUB-TOTAL BASE COST									34100
VENDOR GTA ~1070									3400
SUB-TOTAL									37500
VENDOR PROFIT ~1570									5500
									43000
X-4									172000
CODE									
4511	ABSORBER UNIT

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National Division
national

JOB NO. 133026.R02 PROJECT ABSORBER OUTLET EXPANSION TR. PIPING

LOCATION

CLIENT

DATE 4-6-78

TAKE-OFF

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OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TABLE 5-5 SK									
905 (1) OUTHEADER NO. 2 FL 3/8 X 6' X 6' T904	72	#	1.20		1152	1382		200	
245 (2) SHELL " 1 FL 3/8 X 1' X 15.75'	15.75	"	1.20		252	302			
225 (3) " NO. 2 24-6 STD IPS X 15'	12	FT	31.00		228	372			
55 (4) EXP " 4-8 STD IPS X 15'	2	"	80.00		57	160			
3480 (5) LEG 3-1700 X 3/4" X 17.75' 70'	53.25	"	2.75		3994	10984			
(6) EXP. TR. PIPE F16 8-90 LBL	1	EA	450.00		600	5400			
(7) " " 1-8 STD IPS X 7.5' (cut 12)	7.5	FT	80.00		2141	6000			
FIELD 3/8 V (100) 188	56	HAND				167			
" (100) 3/8 V 165	51	"			33	148			
" (100) 3/8 FW 154	34	"			28	126			
" PIPE (100) 3/8 V 188	63	"			55	248			
300 (8) SNUBBERS	4	EA	120.00		400	4800			
150 (9) PIPE HANGERS	4	"	100.00		200	4000			
600 MISC. MATH	6.5				800	1000			
5971 SUB-TOTAL					9977	31117		200	31317
MAT'L O.N. 1070									2133
SHIP FABRICATION	340	HA		31.00			10540		10540
FIELD INST. LEG 5M-30	120	"		30.00			3600		3600
" " EXP. PIPE 5M-20-80 X 4	320	"		"			9600		9600
" HANGERS 4 X 10	40	"		"			1200		1200
" SNUBBERS 4 X 40	160	"		"			4800		4800
FIELD EFFICIENCY 6070 OF 19200							11520		11520
" O.N. 3070 OF 30720									9216
SUB-TOTAL BASE COST									84926
VENDOR G.T.A. 1070									8474
SUB-TOTAL									93400
VENDOR PROFIT 15%									13600
CODE 4511 ESTIMATED PRICE INSTALLED CURRENT DOLLARS									107000
4511 ABSORBER UNIT									

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LOCATION

CLIENT

TAKE-OFF JK

PRICED 25

CALC CHKD

APPROVED

SHEET 7 OF 7

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A-26

LOCATION

CLIENT

DATE 4-4-78 TAKE-OFF JSW PRICED JSW CALC CKD _____ APPROVED _____ SHEET 1 OF 1

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A-27

LOCATION

CLIENT

TAKE-OFF JK

PRICED 25

CALC CHKD

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Of

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
P.I RECEIVER Pump. 4500 H.P 29,000 GPM @ 84' TDH SECT. VIII FAB			EA			60 Tm	1,700,000	150,000		1,850,000
INSULATION		520	S.F						155,000	155,000
TRACE HEATERS		173	L.F						20,760	20,760
DRIVE & SPEED CONTROL WITH FLUID COUPLING (FROM 4514)										600,000
										2,125,760
CODE										
4513	RECEIVER Pump P.I									Bound It 2,126,000

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A-28

UPDATE -

C-2, 1

PREPARED BY: L. GLASGOW	Rockwell International Atomics International Division	SUMMARY
CHECKED BY:		PAGE NO. 1 OF 2
DATE: 7/17/78 4/7/78		REPORT NO.
		MODEL NO.

DATA FOR PRICING PUMPS

550°F

P-1 PUMP. (RECEIVER PUMPTYPE - SIMILAR TO CRBRPSINGLE STAGEDOUBLE SUCTION - NPSH(REQ.) 30 FTMATERIAL - A - 285CODE - ASME B&PV - SECTION VIII - DIV. 1

	<u>T D H</u>	<u>844 FT</u>	<u>722 FT</u>
FLOW	20,000 G.P.M.	Nd - .6000 F	
	CASE DIAM.	6.4 X FT	
	CASE LENGTH	11.4 X FT	
	INLET NOZZLE	36 IN	
	OUTLET NOZZLE	24 IN	
	DRY WT	46,667	57,000 LBS .82
	SPEED	1130	1160 RPM

MOTOR - SQUIRREL CAGE - VERTICAL

60HZ 3 ϕ - SINGLE SPEED - 1130 RPM

4160 VOLTS

4,500 H.P. OK

(OPERATING H.P. = 4022)

PRODUCTION - 1ST IN A SERIES
OF 7ENGINEERING - FINAL ONLY
SUGGEST A 1.15 FACTORL. S. Glasgow
4/7/78

H.W. BATHURST 4/12/78

JOB NO/33-026-R02 PROJECT

LOCATION

CLIENT

DATE 5-4-78

TAKE-OFF 1.6

PRICED 1.60

CALC. CHKD JS

APPROVED

— SHEET 1 OF

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International Division
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JOB NO. 133-026-R02 PROJECT

LOCATION

CLIENT

DATE 4-26-78

TAKE-OFF 1. G

PRICED 1. G

CALC CHKD J.C

APPROVED

SHEET 2 OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
<u>RECEIVER</u>									
TEMPERATURE CONTROLS	24	EA			1250				30000
PRESS. INDICATORS	2				2500				5000
TEMP. INDICATORS	26				2500				65000
LEVEL CONTROLS	2				2500				5000
<u>PURIFICATION SYSTEM</u>									
	1	LS							25000
<u>Pump P-1</u>									
TEMPERATURE	1	EA			2500				2500
PRESS.	1				2500				2500
PRESS. DIFF	1				3000				3000
POWER, CURRENT, SPEED	1				6000				6000
RED VOLTAGE. CIRCUIT BREAKER	1				75000				75000
700 MCM FEEDER	200	LF			128.50				25700
<u>Pump P-2</u>									
TEMPERATURE	1	EA			2500				2500
PRESS.	1				2500				2500
PRESS. DIFF	1				3500				3500
POWER, CURRENT, SPEED	1				6000				6000
CIRCUIT BREAKER	1				20000				20000
SPEED CONTROLLER	1				2000				2000
FLOW CONTROLLER	1				1500				1500
SPEED CHANGING	1				25000				25000
#1 FEEDER	200	LF			22.00				4400
<u>INSTRUMENTATION & CONTROLS</u>									
4-514									312100

JOB NO. 133-026R02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-27-78 TAKE-OFF 1 G PRICED 1 G CALC CHKD J C APPROVED _____ SHEET 3 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
<u>TANK-T-1</u>									
TEMPERATURE	1	EA			2500				2500
PRESSURE	1				2500				2500
LEVEL	1				2500				2500
PRESS. RELIEF	1				5000				5000
GAS BALANCE VALVE	1				2500				2500
FILL VALVE	1				2500				2500
<u>TANK-T-2</u>									
TEMPERATURE	1				2500				2500
PRESSURE	1				2500				2500
LEVEL	1				2500				2500
PRESS. RELIEF	1				3500				3500
GAS BALANCE VALVE	1				2500				2500
<u>LINE #103</u>									
DRAG VALVE	1				250,000				250,000
PRESS. DIFF.	1				3500				3500
TEMPERATURE	1				2500				2500
<u>LINE #105</u>									
TEMPERATURE	1				2500				2500
PRESSURE	1				2500				2500
<u>REHEATER</u>									
TEMPERATURE	1				2500				2500
<u>SUPER HEATER</u>									
TEMPERATURE	1				2500				2500
FLOWMETER	1				8500				8500
CONTROLLER	1				1500				1500
LOW FLOW CONTROLS	1				43,500				43,500
CODE									
4514	INSTRUMENTATION & CONTROL								
									300,500

LOCATION

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TAKE-OFF L.G.

PRICED 1.60

CALC CHKD LC

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JOB NO/ 33-726 R02 PROJECT

LOCATION

CLIENT

DATE 7-27-78

TAKE-OFF JS

PRICED JS

CALC CHKD

APPROVED

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LOCATION

CLIENT

TAKE-OFF 10

PRICED 116

CALC CHKD

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DATE 4-6-78 TAKE-OFF JS PRICED JS CALC CHKD _____ APPROVED _____ SHEET 2 OF _____

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SODIUM HEATING & UNLOADING SYSTEM INCLUDING 100 GPM EM PUMP							105000	2000°		
PURIFICATION SYSTEM "REF PCTF USE .6 POWER & DROP SEC III/CL3"							266000	3400°		
COVER GAS SYSTEM "REF PCTF USE .6 POWER"							150000	7582°		
SODIUM REACTION TANK "REF LLTR"							240000	100°		
CODE										
4520		PURIFICATION & GAS SYSTEM					761000	392460	130828 M.N.C. 30°PS	

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International Division
National

JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

DATE 3-31-78 TAKE-OFF JC PRICED JC CALC CHKD _____ APPROVED _____ SHEET 3 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
C.S. A-53 x 3/8 WALL PIPE	20	189	LF	47	3.5	8883	662°		
C.S.	18	189	LF	42	3.4	7938	643°		
C.S.	6	20	LF	11	1.0	220	20°		
90° ELL	20	4	EA	733	11.0	2932	44°		
	18	5		569	9.0	2845	45°		
TEE	18	2		926	12.0	1852	24°		
WELD-O-LET	6	2		58	9.2	116	18°		
CONC. REQ. 18x12	3			285	9.0	855	27°		
C.S. SODIUM VALVE	20	1		90K	212°	90000	212°		
C.S. BUTTWELDS	20	18			5.4		97°		
	18	18			4.7		85°		
	6	6			2.3		14°		
S.S. T-304 x 3/8 WALL PIPE	18	336	LF	190	3.4	63840	1142°		
	12	168		170	2.3	28560	386°		
90° ELL	18	6	EA	2600	9.0	15600	54°		
	12	4		1265	6.0	5060	26°		
45° ELL	12	2		797	6.0	1594	13°		
TEE	18	1		4211	12.0	4211	12°		
	12	4		2100	8.0	8400	34°		
S.S. SODIUM VALVE	12	2		40K	90°	80000	180°		
FLKE	18	1		7016	150°	70000	150°		
BURST DISC. 600# FLG.	12	3		3000	12.0	9000	36°		
S.S. BUTTWELDS	18	40			21.0		840°		
	12	35			15.0		525°		
SPRING HANGERS & SUPPORTS	20	10		52	3.0	520	30°		
	18	25		50	3.0	1250	75°		
	12	12		14	1.0	168	18°		
CODE									
4520	HORIZ. PIPING								
						403844	1162360	M.H.C. 30°	

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A-37

National Division
International

JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-3-78 TAKE-OFF JC PRICED JC CALC CHKD _____ APPROVED _____ SHEET 4 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
C.S. A-53 Pipe x 3/8" WALL 20"	1000	LF	47	3.5		47000	3500°		
20" ell 20"	28	EA	733	11°		20524	308°		
BUTTWELDS	20	88		5.4			475°		
S.S. T-304 Pipe x 3/8" WALL 18	1000	LF	190	3.4		19000	3400°		
20" ell 18	28	EA	2600	9°		72800	252°		
BUTTWELDS	18	88		21°			1848°		
SUPPORT HANGERS HORIZ. #45 20"	28	EA	1314	60°		36792	1680°		
#46 18"	28		1355	60°		37940	1680°		
VERT. 20	43		52	3.2		2236	129°		
18	43		50	3.2		2150	129°		
SNUBBERS #200 w/ Pipe CLAMP	20		3000	40°		60000	800°		
CODE	4520	DOWN COMMER & RISER				469442	14201°	M.H.C. 30°	
						426030			

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ESG-79-2, Vol I IV
A-38

DATE 4-3-78 TAKE-OFF JC PRICED JC CALC CHKD APPROVED SHEET 5 OF

[illegible]

Form 702-D Rev. 11-73

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A-39

International Division
International

LOCATION

CLIENT

TAKE-OFF

PRICED

CALC CHKD

— APPROVED

— SHEET

— Of .

[illegible]

Form 702-D Rev. 11-73

ESG-79-2, Vol IV
A-40

National Division
national

JOB NO 133.026 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4/6/78 TAKE-OFF FIERER PRICED FIERER CALC CHKD _____ APPROVED _____ SHEET 7 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
24' HIGH									
$32' \div 7 = 6.4$ USE C.S.									
STEEL W10 X 21									
(27+4) 2 X 7	9114								
L 3 X 3 @ 4.9 (4 X 120)	2352								
MISC BRACING ETC	2534								
TOTAL	14000	LB	1.00					14000	
EXCAV									
(2 X 3 X 6 K 7) $\div$ 27 + MISC	10	CY	40.00					400	
CONCRETE	10	CY	80.00					800	
REBAR	1000	LB	0.75					750	
FORM AND MISC	1	LS						550

CODE									
4520								16500	

Form 702-D Rev. 11-73

702 $\pm$ 2357 EA

ESG-79-2, Vol IV
A-11

International Division
national

JOB NO. 133,026

PROJECT

LOCATION

CLIENT

DATE 4/6/78

TAKE-OFF FIERER

PRICED FIERER

CALC CHKD

APPROVED

— SHEET 8 OF

[illegible]

Form 702-D Rev. 11-73

20 @ \$325 EA

ESG-79-2, Vol IV
A-42

LOCATION

CLIENT

TAKE-OFF JK

PRICED JK

CALC CHKD

APPROVED

 SHEET 102

OF

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
					\$					
ELECT TRACE HEATERS	20"	1600	LF	50	160		80000	256000		
	18"	1700		50	160		85000	272000		
	12"	250		50	160		12500	40000		
	6"	25		40	128		1000	3200		
							178500	571200		749700
COST INCLUDES THERMOCOUPLES										
& ALL MATERIAL INCLUDING										
SCR'S & PANEL & LABOR										
PRODUCTIVITY.										
CODE										
4520		ELECT TRACE HEATERS								
										749700

Form 702-D Rev. 11-73

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Regional Division
normal

JOB NO 133-026R02 PROJECT

LOCATION

CLIENT

DATE 7-27-18

TAKE-OFF 15

PRICED 15

_ CALC CHKD

— APPROVED

→ SHEET

Of

[illegible]

Form 702-D Rev 11-73

ESG-79-2, Vol IV
A-45

Atomics International
D/798 Correspondence

ACTION

REPLY DUE

REMARKS

ANDERSON S H

ANDERSON S H

ANDERSON S H

BALINT

BAUMANN

BOTIS

BRINDLEY

CARDNAS

COCHRAN J C

CRAWFORD

DE LOS PRADOS

DETERMAN

FEILER

GYLFE

HARTZLER

HILLIG

HOLBROOK

IACOBELLIS

JACOBSON J

JONES R G

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August 22, 1978

RECEIVED

AUG 24 1978

Correspondence Dept

Atomics International Division
Rockwell International
8900 DeSota Avenue
Canoga Park, CA 91304

Re: C-20325-37

Attention: Mr. T. H. Springer
Project Manager

Subject: 100 MWe Receiver Tower Cost
Advanced Central Receiver Power System

Reference: AI Contract N311-0002-FX
DOE Contract EG-77-C-03-1483

Dear Tom:

Please be advised that the 100 MW 159m receiver tower cost presented at the third quarterly review meeting on August 15, 1978 did not include ancillary equipment (see our letter C-20325-27, dated June 9, 1978). The following preliminary equipment and material cost should be added to the tower and foundation cost previously presented:

Caged Ladder 159m	\$ 30,000
Service Platforms, incl. H.R.	125,000
Aircraft Warning Lights	50,000
Lightning Protection & Grounding	15,000
Misc. Electrical & Lighting	20,000
Elevator 159m (Subcontract)	500,000
Direct Field Cost	740,000
Indirect Field Cost	70,000
TOTAL FIELD COST	\$810,000

If you have any questions concerning these additional costs, please advise.

Very truly yours,

STEARNS-ROGER ENGINEERING CO.

A. W. McKenzie
A. W. McKenzie
Project Engineer

10486ESG

AWM:vr

FORM 79-1 REV 12/77

FERRY CREEK DRIVE • P.O. BOX 5888 • DENVER, COLORADO 80212 • PHONE (303) 751-1122 • TWX (303) 411-0411 • TELETYPE 440

ESTIMATE SUMMARY

CUSTOMER		ATOMICS INTERNATIONAL				PROP NO.	
LOCATION						JOB NO. 6-20325	
PROJECT		ADVANCED CENTRAL RECEIVER				DATE 5-31-78	
		159 METER TOWER - 500 KIP RECUR				BY A.L.	
REV. NO.		REV. DATE				BY	

ACT	DESCRIPTION	CRAFT HOURS	LABOR	MATERIAL	OTHER	TOTAL
A	EARTHWORK		15 492	—		15 492
B	CONCRETE		886 615	554 920		1 440 935
C	BUILDINGS & STRUCTURES					
D	PROCESS EQUIPMENT					
E	PIPING					
F	ELECTRICAL					
G	PAINTING					
L	PLANT ITEMS					
N	INSTRUMENTS & CONTROLS					
P	INSULATION					
	DIRECT FIELD COST		901 507	554 920		1 456 427
H	FIELD EXPENSE					
H	ALL RISK, PR TAX, BOND					
K	CONSTRUCTION SUPPLIES					
M	STARTUP					
S	TEMPORARY FACILITIES					
V	CRAFT BENEFITS					
V	CONSTRUCTION CAMP.					
W	CONSTRUCTION EQUIP.					
	INDIRECT FIELD COST		70 % OF DIRECT LABOR			631 055
	TOTAL FIELD COST					2 087 482
J	ENGINEERING		BY OTHERS			
						2 087 482
	TOTAL FIELD & ENG. COST					
Q	SALES TAX		INCLUDED			
R	PREMIUM PAY					
	ESCALATION					
	CONTINGENCY		7.5%			156 561
	SUB TOTAL					
Y	FEE		5%			112 202
	TOTAL					2 356 245

INCORPORATED

ORDER NO 620325 LOCATION _____

BY Δ. L.

DATE 5.31.78

159 METER TOWER - 500 KIP RECVR.

159 METER TOWER - 500 KIP RECV.					MANHOURS						
ACCOUNT	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L UNIT COST	UNIT	TOTAL	\$/MH	LABOR	MATERIAL	OTHER	TOTAL
	ADVANCED CENTRAL RECEIVER										
	EARTHWORK: EXCAVATION	6908	C.Y.	-	.1	691	12.00	8292	-		8292
	BACKFILL	1500	C.Y.	-	.4	600	12.00	7200	-		7200
	CONCRETE: MAT	5223	C.Y.	40	6	31338	13.00	407,394	208,920		616,314
	TOWER	3347	C.Y.	40	11	36817	13.00	478,621	133,880		612,501
	REINFORCING: MAT	287.3	TON	400	-	-	15.00	-	114,920		114,920
	TOWER	243.	TON	400	-	-	15.00	-	97,200		97,200
	TOTAL :					69446		901,507	554,920		1,456,427

Stearns-Roger

PAGE 1

JOB NO. C20325

DATE 5/25/78

BY

RJC

CHK

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER 100MWe COMMERCIAL PLANT

RECEIVER WT = 500^K (FOR FURTHER DETAILS REFER TO SKETCH BY ATOMICS INTERNATIONAL)

SEE PG. 2 FOR DETAILS AT TOP

NOTES:

- 1) CONCRETE $f'_c = 4 \text{ KSI}$; $E = 3640 \text{ KSI}$; $\nu = .15$
- 2) REBAR $f_y = 60 \text{ KSI}$
- 3) ALLOW. SOIL BRG. PRESS. = 10 KSF (ALLOW $\frac{1}{3}$ INCREASE FOR SEISMIC)
- 4) ESTIMATED WT. OF PIPING AND ELEVATOR = 1.5^K/1.
- 5) TOWER DESIGN BASED ON .25 G MAX. GROUND ACCELERATION IN BOTH VERTICAL AND HORIZONTAL DIRECTIONS W/ 7% DAMPING. RESPONSE SPECTRA FROM NRC REG. GUIDE 1.60 ARE EMPLOYED.
- 6) REFER TO COMPUTER OUTPUT FOR ANALYSIS AND DESIGN RESULTS.

Stearns-Roger

JOB NO. C 20325 DATE 5/25/78 PAGE 2
BY RJC CHK.
CUSTOMER ATOMICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

Stearns-Roger

JOB NO. C20325 DATE 5/25/78 PAGE 3
BY RJC CHK.
CUSTOMER ATOMICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

STRUCTURAL MODEL AT TOP:

Stearns-Roger

JOB NO. C20325 DATE 5/26/78 BY RJC CH'K
CUSTOMER ATONICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

PAGE 4

SOIL PRESSURES :

FOUNDATION PROP.:

$$A = \pi \times 67^2 = 14103 \text{ ft}^2$$

$$WT = 14103 \times 10 \times .15 = 21154^k$$

$$S = \pi \times 67^3 / 4 = 236219 \text{ ft}^3$$

VERTICAL LOADS:

$$P_{MAX} = 14838 + 5774 + 1.25 \times 21154 = 47055^k$$

$$P_{MIN} = 14838 - 5774 + .75 \times 21154 = 24930^k$$

% CONTACT AREA FOR UPLIFT CONDITION (P_{MIN}):

$$\% \text{ AREA} = 100 \left[1 - \frac{2\alpha - \sin 2\alpha}{2\pi} \right] \text{ Where } \alpha = \cos^{-1} (41.273/67) = 51.974^\circ$$

$$= 100 \left[1 - \frac{2 \times .90712 - \sin(2 \times 51.974)}{2\pi} \right] = 86.6\% \quad \text{OK}$$

SOIL BEARING PRESSURES ARE LOW.

Stearns-Roger

PAGE 5
JOB NO. C20325 DATE 5/30/78 BY RJC CHK
CUSTOMER ATOMICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

TOWER CONCRETE & REBAR

WT. OF TOWER CONCRETE

$$= 14838 - 500 - 1.5 \times 521.653 = 13556 \text{ K}$$

$$\text{VOLUME OF CONCRETE} = \frac{13556}{15 \times 27} = 3347 \text{ CY}$$

VERTICAL REBAR QUANTITIES

MEMBER	LENGTH (FT)	STEEL AREA (IN ²)	STEEL VOL. (FT-IN ³)
1	15.236	339.28	8562
2	51.418	327.31	16830
3	51.414	299.96	15422
4	51.409	271.79	13972
5	51.403	246.18	12654
6	51.395	224.27	11527
7	51.384	205.91	10580
8	51.370	185.76	9542
9	51.351	160.57	8245
10	51.322	128.13	6576
11	26.785	89.35	2393
12	3.584	57.45	313
13	3.584	57.45	313
TOTAL			116929

$$\text{WT.} = \frac{116929 \times 490}{144 \times 2000} = 198.94 \text{ TONS}$$

Stearns-Roger

PAGE 5

JOB NO. C20325 DATE 5/30/78 BY RJC CHK.
CUSTOMER ATOMICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

TOWER CONCRETE & REBAR

WT. OF TOWER CONCRETE

$$= 14838 - 500 - 1.5 \times 521.653 = 13556^K$$

$$\text{VOLUME OF CONCRETE} = \frac{13556}{.15 \times 27} = 3347 \text{ CY}$$

VERTICAL REBAR QUANTITIES

MEMBER	LENGTH (FT)	STEEL AREA (IN ²)	STEEL VOL. (FT-IN ³)
1	25.236	339.28	8562
2	51.418	327.31	16830
3	51.414	299.96	15422
4	51.409	271.79	13972
5	51.403	246.18	12654
6	51.395	224.29	11527
7	51.384	205.91	10580
8	51.370	185.76	9542
9	51.351	160.57	8245
10	51.322	128.13	6576
11	26.785	89.35	2393
12	3.534	57.45	313
13	3.534	57.45	313
TOTAL			116929

$$\text{WT.} = \frac{116929 \times 490}{144 \times 2000} = 198.94 \text{ TONS}$$

Stearns-Roger

JOB NO. C20325 DATE 5/30/78 PAGE 6
BY RJC CH'K _____
CUSTOMER ATOMICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

TOWER CIRCUMFERENTIAL REBAR

REF. TO ACI 307-67, SECTION 4.7

USE $p = .002$

VOLUME OF REBAR IN A HEIGHT "h"

$$V = \frac{\pi p h}{3} (2t_b r_{mb} + 2t_t r_{mt} + t_b r_{mt} + t_t r_{mb})$$

WHERE

t_b = WALL THICKNESS AT BOTTOM

t_t = " " " TOP

r_{mb} = MEAN RADIUS AT BOTTOM

r_{mt} = " " " TOP

FOR $h = 6173.832'$, $t_b = 15''$, $t_t = 8''$, $r_{mb} = 484.5'$, $r_{mt} = 174''$

$$V = \pi \times .002 \times 6173.832 (2 \times 15 \times 484.5 + 2 \times 8 \times 174 + 15 \times 174 + 8 \times 484.5) / 3$$

$$= 307809 \text{ in}^3$$

FOR $h = 86''$, $t_b = t_t = 24''$, $r_{mb} = r_{mt} = 174''$

$$V = \pi \times .002 \times 86 \times 2 \times 24 \times 174 = 4513 \text{ in}^3$$

$$V_{TOT} = 307809 + 4513 = 312322 \text{ in}^3$$

$$WT = \frac{312322 \times 490}{1728 \times 2000} = 44.28 \text{ TONS}$$

TOTAL REBAR IN TOWER = $198.94 + 44.28 = 243.2 \text{ TONS}$

Stearns-Roger

JOB NO. C10325 DATE 5/30/78 PAGE 7
BY RJC CH'K. _____
CUSTOMER ATOMICS INTERNATIONAL PROJECT _____
SUBJECT ADVANCED CENTRAL RECEIVER

FOUNDATION QUANTITIES

$$\text{VOLUME OF CONCRETE} = \frac{\pi \times 67^2 \times 10}{27} = 5223 \text{ CY}$$

$$\text{ESTIMATE REBAR @ } 110 \#/\text{CY}$$

$$\text{WT. REBAR} = 110 \times 5223 / 2000 = 287.3 \text{ TONS}$$

SOIL EXCAVATION

$$\text{VOL.} = \pi \times 10 [72^2 + 10 \times (72 + 10/3)] / 27 = 6908 \text{ CY}$$

SUMMARY

TOWER CONCRETE	= 3347 CY	37', 1004, 1000
TOWER REBAR	= 243.2 TONS	4 97,280
MAT CONCRETE	= 5223 CY	750 914,025
MAT REBAR	= 287.3 TONS	400 114,920
SOIL EXCAVATION	= 6908 CY	29,

Stearns-Roger

PAGE 8

JOB NO. C20325 DATE 5/30/78 BY RJC CHK.
CUSTOMER ATOMICS INTERNATIONAL PROJECT
SUBJECT ADVANCED CENTRAL RECEIVER

RESPONSE TO LATERAL E.Q. (.25 G MAX. GROUND ACCEL.)

JOB NO 133-026 PROJECT

LOCATION

CLIENT

DATE 4-10-78

TAKE-OFF JC

PRICED JK

- CALC CHKD

— APPROVED

 SWEET

OF

[illegible]

Form 702-D Rev. 11-73

ROUND IN \$5144.000

DATE 9-1-78 TAKE-OFF _____ PRICED _____ CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

Form 702-D Rev. 11-75

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A-59

Atomic Energy International Division

JOB NO. 33-026R02 PROJECT _____

LOCATION _____

CLIENT _____

DATE 4-10-78TAKE-OFF JSPRICED JS

CALC CHKD _____

APPROVED _____

SHEET A

OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEETS 1 THRU 3 HOT TANK						1360000			
SHEETS 1 THRU 3 COLD TANK						344000			
J.M. CALCIUM SILICATE W/S.S. OVER ALUM. COVER									
INSULATION HOT TANK 12"	22776	S.F.			43.2°/ft ³			979368	
INSULATION COLD TANK 6"	21520	S.F.			24.4°/ft ³			516480	
TRACE HEATERS	3796	L.F.			120/LF			455520	
	3587	L.F.			120/LF			430440	
HOT TANK CONCRETE SLAB	"SEE 4660 ACCOUNT"								
COLD TANK CONCRETE SLAB									
TOTAL COST HOT TANK									2794888
TOTAL COST COLD TANK									1290920
DRIP PANS FOR THE FOLLOWING:	SEE BACKUP SHEET "A-1"								
HOT & COLD TANKS									217502
PUMPS									8000
MAIN VALVES									4000
BOTTOM OF TOWER PIPE RUNS									6000
MISC.									35000
CODE									4356310
4610	HOT & COLD TANK SUMMARY								4356000

Form 702-D Rev. 11-73

ESG-79-2, Vol IV
A-60

IGN NO 133-26 PROJECT 100 MW LOCATION _____ CLIENT _____

DATE 9-1-78 TAKE OFF JC PRICED JC CALC CHKD _____ APPROVED _____ SHEET A-1 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
HOT TANK									
OUTER TANK 1/4 S.S PL	1360	ft ²			14,000 [#]				
STIFFENER RING 1"X16 S.S	160	ft ²			4626 [#]				
OUTER TANK BASE 1" S.S PL	330	ft ²			13,665 [#]				
SLIDE PL 2'X1" W 2" SLOT S.S	20	ft ²			828 [#]				
2X2X 1/4 L BRACES S.S	135	L.F			435 [#]				
2"Ø X 15' ANCHOR BOLTS C.S	8	EA	150	150				1200	
2" NUTS & WASHER	8	EA	25	30				240	
INSULATION @ 9" / ft ²	1510	ft ²						136000	
CONCRETE @ 200" / C.Y	24	C.Y						4800	
					35,554 [#]	@ 3" / LB.		106662	
									126502
COLD TANK									
SAME AS HOT TANK USING									911000
CARBON STEEL INSTEAD OF S.S									
</

International Division
of the American Society of Mechanical Engineers

JOB NO 133-D-6202 PROJECT 100' DIAMETER 110' FAPI STORAGE TANK HOT LOCATION _____ CLIENT _____

DATE 3-29-78 TAKE-OFF John PRICED John CALC CKD _____ APPROVED _____ SHEET 2 OF _____

Net
Wt

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
REF: SK FRAMES SK 3-22-28 100MMW ACR						FADE WY			
(1) COURSE 1 10R 1/4 X 9.0833 X 31.34' T304	2847	#	1.10		32370	35607			
" 1 10R 1/4 X " X 31.42'	2854	"	1.12		56345	1173			
" 4 10R 3/8 X " X 31.42'	2854	"	1.10		78485	86334			
" 4 10R 1/2 X " X 31.5'	2861	"	1.05		101437	126508			
" 4 10R 1' X " X 31.5'	2861	"	1.00		124482	124482			
(2) BOT 28R 1/4 X 9.0833 X 30'	7630	"	1.10		86753	95428			
" 1R 50 X 14'	127	"			1444	1588			
" 1R 1/4 X 6' X 7'	42	"			478	526			
" 1R 1/4 X 10.6' X 30'	318	"			3616	3978			
(3) ROOF RS 28R 3/4 X 9.0833 X 30'	7630	"	1.20		63863	76636			
" 1 50 X 9.1'	826	"			691	829			
" 2 3/4 X 6' X 30'	360	"			3013	3616			
" 2 3/4 X 4' X 10'	80	"			670	804			
(4) PURLINS 32R 1/2 X 1' X 30.34'	971	"	1.10		21721	23893			
" 41R 1/2 X 1' X 25.1	1044	"			2246	2471			
(5) COLUMNS 1600 X 1/4 W X 220' 82.77	220	F7	2.45		19037	42641			
(6) GENDR LGS 1R 1 1/8 X 10' X 36' (cut 8) 46.8	860	#	1.05		17523	18394			
" WEB 1R 3/4 X 8.25' X 36' (cut 8)	300	"	1.05		9861	10354			
(7) COL BASE TOP 1R 1 1/2 X 2' X 10' (cut 5)	20	"	1.15		1340	1541			
(8) " " CTR " 1R 2" X 4' X 4'	16	"	1.15		1360	1564			
(9) PURLIN CLIP 1/2 X 5 X 6 X 18' (cut 36) 25	18	F7	1.50		414	621			
(10) SHELL RIM 10L 3/8 X 4 X 4 X 30.5' 9.8	325	"	1.30		3185	4141			
(11) CTR PURLIN 1R 3/8 X 4' X 23' (cut 4)	92	#	1.12		1472	1649			
(12) " " 1R 3/8 X 4' X 15' (cut 4)	60	"	1.12		960	1075			
(13) " " 1R 3/8 X 8' X 17' (cut 5)	136	"	1.12		2176	2437			
(14) NOZZLE 1-18" X 24" OD X 100' SADDLE	1	LN	8.00		252	2016			
(15) INLET 1-1800 X 1/4 W X 50' 93.40	50	F7	2.45		4671	11444			
20, 100 CODE					639865	727688			
4610

International Division
ational

JOB NO 31026R02 PROJECT 100' X 45' ST SHELL API TYPE STORAGE TANK

LOCATION _____

CLIENT _____

DATE 3-30-78

TAKE-OFF JRW

PRICED JRW

CALC CHKD _____

APPROVED _____

SHEET 3 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
REF' SK. FRANGOS 3-22-78 100 MW P.A.C.R.									
WELD SHELL 1" S/S V 4.18 HAND T804	90	F1	425		376	1598			
" " 1 3/16 " V 2.94 " "	90	"			265	1126			
" " 5/8 " V 1.86 " "	90	"			167	712			
" " 7/16 " V 1.15 " "	90	"			104	412			
" " 1/4 " V .63 " "	90	"			39	161			
WELD COURSE 5 R/S 1/2 FW .62 S/A "	1257	"			781	8319			
" " 4 " 1 3/16 V 1.91 " "	315	"			604	2567			
" " 3 " 5/8 V 1.21 " "	315	"			381	1619			
" " 2 " 7/16 V .75 " "	315	"			236	1003			
" " 1 " 1/4 V .28 " "	315	"			88	374			
WELD BOT 1/4 V LONG SN .28 " "	872	"			244	1037			
" " 1/4 V CRACK SN .28 " "	315	"			88	374			
WELD ROOF 3/16 FW LONG SN 1.06 SEMI A HAND "	892	"			946	4021			
" " 5.57 DO 1.06 " "	350	"			371	1577			
" " TUBING 3/16 FW 1.06 " "	320	"			339	1441			
WELD COL 1/2 V 1.33 HAND "	42	"			56	238			
WELD LIM 3/8 V .88 " "	7	"			6	26			
" " TO 1/4 SHELL 1/4 FW .15 S/A "	640	"			96	408			
" " COL TO BASE 1/2 FW 1 .62 HAND "	42	"			42	178			
" " BASE TO BOT 1/4 FW .15 .15 " "	48	"			12	51			
14 BEAM 3/4 FW WEAT FLS 1.4 S/A "	576	"			806	3426			
" " TO COL 3/4 FW 2.15 1.4 HAND "	24	"			62	221			
" " GUSSET CLIP 1/4 FW .25 .15 " "	84	"			20	85			
" " PURS 1/2 COURSE #1 .25 .15 " "	84	"			21	89			
" " PURS 1/4 FW .25 .15 " "	350	"			88	374			
" " BEAMS TO COL 3/4 FW 2.15 HAND " "	48	"			103	438			
" " NO 2 (4) 1" V 4.18 " "	625	"			26	110			
CODE WELD NO 2 (12) 1/4 FW .25 .15 " "	9	"	✓		2	9			
4610					6358	27027			

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International Division
National

JOB NO. 13310 202-2 PROJECT 100MW EACR COLD NA API STORAGE TANK LOCATION CLIENT

DATE 2-21-78 TAKE OFF JAW PRICED JAW CALC CHKD APPROVED SHEET 1 OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
REFSK FRANGOS 3-22-78					FAIR				
46321 MATERIAL (SEE BIL PG 2)	LS				48264	119371			
3100 " " " PG 3)					3954	8245			
46421 SUB-TOTAL					486580	127586			127586
MATL ON ~100%									12714
ENGINEERING DESIGN	160	HR		39.25			4800		4800
FABRICATION LABOR									
SHOP FABR	600	HR		8.25			4950		
FIELD FABR LABOR	2500	"		16.75			41875		
" INSPECTION	1500	"		17.75			22188		
SUPERVISION	375	"		19.25			7406		
SUB-TOTAL							76419		76419
SHOP OVERHEAD	600	HR		20.75			12450		
FIELD O.H 50% 71469							35735		
SUB TOTAL O.H							78185		48185
CRANE RENTAL								15000	15000
SUB-TOTAL BASIC COST									284704
VENDOR GTA ~100%									28296
SUB-TOTAL									313000
VENDOR PROFIT ~15%									31000
ESTIMATED VENDOR PRICE CURRENT DOLLARS									344000
173753/LB									
SHELL B.W.F.L.D 100% V-R									
CODE									
4610									
COLD TANK									

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A-64

International Division
National

JOB NO 133-026-202-2 PROJECT 100MW LACR COLD NA API STORAGE TANK

LOCATION _____

CLIENT _____

DATE 3-31-78

TAKE-OFF John

PRICED John

CALC CHKD _____

APPROVED _____

SHEET 2 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
REF: SK FRAMGUS 3-22-78									
(1) CURSEMENT 10PL 4x9.0833x31.34	2847	★	.242		31317	7579			
" 4L " 5/16 8.0833x31.34	2540	"	.2345		34925	8190			
" 43 " 7/16 " x 31.42	2540	"	.231		48895	11295			
" 41 " 9/16 " x 31.5	2546	"	.227		63014	14304			
" 5 " 11/16 " x 31.5	2546	"	.227		76380	17338			
(2) BOLT PL FROM-1 1/4H	8117	"	.24V		89287	21607			
(3) BOLT PL " 3/16H	8153	"	.251		66855	16781			
(4) PURLINS 6E13 Cut 36 A36	1072	FT	.2405		13936	3352			
(5) COLUMN C1 1-12x579" x 45'	45	"	.276		3555	981			
(6) #C2-5 41 DO x 42'	168	"	"		13193	3641			
(7) BEAMS 4-24x160 x 36'	144	"	"		23040	6359			
(8) CUL BARS 10P 12 1/4 x 2' x 10' (cut 6) 516-70	20	#	.30		1275	383			
(9) " C12 14L 2" x 4' 4"	16	"	.30		1360	408			
(10) PURLIN CLIPS 12 1/4 x 6 x 18' (cut 36) A36	18	FT	.229		414	95			
(11) SHELTER 10L 7/8 x 44 x 32.5' 9.5	325	"	.225		3185	717			
(12) CTCL PURLIN 6E13 x 288' (cut 16)	288	"	.2405		3744	900			
(13) NO. 24 24" LAG 12" x 5' 7" 10.3' 4.25'	1	LC	.205		260	520			
(14) INLET 1 x 4 x 1/2 W x 50' 12.5	50	FT	.7786		6275	3893			
WELD SHELL M1 S.S 1/4V .43 NAMS 51670	91		.160		39	23			
" 4 42 5/16V .64 " "	80				51	31			
" 4 43 7/16V 1.15 " "	80				92	55			
" 4 44 9/16V 1.59 " "	80				127	76			
" 4 45 11/16V 2.28 " "	80				182	109			
" 1 R.S 1/4V .28 S/A "	315				88	53			
" 2 5/16V .42 " "	315				132	79			
" 3 7/16V .75 " "	315				236	142			
" 4 9/16V 1.03 " "	315				325	195			
CODE " 5 3/8FW .35 " "	1259				441	265			
4610					482626	119371			

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A-65

International Division
National

JOB NO. 133,000-02-2 PROJECT 100MW ACR COLONIA API STORAGE TANK LOCATION _____ CLIENT _____

DATE 3-31-78 TAKE-OFF JAN PRICED JAN CALC CHKD _____ APPROVED _____ SHEET 3 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
REF SK FRANGOS 3-22-78									
WELD BOT 1/4" .28 5/16 70	1187	FT	60		332	199			
WELD ROOF 3/16 FW .1 106 " .1	1242	"			124	74			
" RIM L 3/16 FW .1 106 " "	320	"			32	19			
" RIM L 3/8 V .82 HAIN "	7	"			6	4			
" TISHALL 1/4 FW .15 9/A "	640	"			32	19			
" COL TO ROOF TOP 1/4 FW 1.6 HAND "	42	"			42	25			
" BASE TO BOT 1/4 FW .25 .15 " "	48	"			12	7			
" BEAM TO COL 3/4 FW 2.5 1.4 " "	24	"			52	31			
" GUS TO CLIP 1/4 FW .25 .15 " "	81	"			20	12			
" PURLINS SUP TOSHALL 1/4 FW .25 .15 " "	84	"			21	12			
" PURLINS 1/4 FW .25 .15 " "	350	"			88	53			
" BEAMS TO COL 3/4 FW 2.5 1.4 " "	48	"			103	62			
" NOZZLE SHCL 1/16 V 2.5 228 " "	8	"			28	17			
" NOZZLE TO ROOF 1/4 FW .25 .15 " "	6	"			2	1			
WELD FLUV	2100	FT	180			1680			
MIC MAT LMD, STAIRSETS	1.5				3000	6000			
SUB-TOTAL					3954	8215			
CODE									
4610

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JOB NO 133-024R1 PROJECT

LOCATION

CLIENT

DATE 7-20-78

TAKE-OFF JK

PRICED 25

__ CALC CHKD

— APPROVED

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→ **Of**

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DATE 7-27-78 TAKE-OFF JK PRICED JK CALC CKD _____ APPROVED _____ SWEET _____ OF _____

[illegible]

Form 700 R Dec 11 77

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JCS NO 12-1146 PROJECT

DATE 2-1-78

TAKE-OFF

PRICED

CALC CHKD

- APPROVED

- SHEET

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CODE	
4670	ENGINEERING

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LOCATION

CLIENT

TAKE-OFF JK

PRICED 5

CALC CHKD

APPROVED

SWEET

OF

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A-70

JOB NO. 133-46 PROJECT _____ LOCATION _____ CLIENT _____

DATE 5-3-79 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

PREPARED BY: <u>J. W. Wilcox</u> CHECKED BY: DATE: <u>9/06/78</u>	Rockwell International Atomic International Division <u>100 MWE at sodium 1st plant</u>	PAGE NO. _____ OF _____ REPORT NO. <u>Dropit final</u> MODEL NO. _____
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	<u>4820</u> <u>Space Parts</u>	<u>4830</u> <u>A & E</u>	<u>4840</u> <u>C M</u>	<u>4860</u>	
CBS					
4100		<u>5,381</u>	<u>5,381</u>	<u>5,381</u>	
4200	<u>19,424</u>	<u>19,424</u>	<u>19,424</u>	<u>19,424</u>	
4300	<u>4,834</u>	<u>4,834</u>	<u>4,834</u>	<u>4,834</u>	
4400	<u>60,596</u>			<u>60,596</u>	
4440			<u>10,918</u>		
50			<u>2,525</u>		
60			<u>3,399</u>		
4520	<u>23,305</u>			<u>23,305</u>	
14			<u>1,452</u>		
15			<u>1,315</u>		
20			<u>4,242</u>		
40			<u>3,166</u>		
50			<u>0</u>		
60			<u>5,144</u>		
4600	<u>12,086</u>			<u>12,086</u>	
10			<u>4,356</u>		
20			<u>0</u>		
30			<u>724</u>		
40			<u>0</u>		
50			<u>0</u>		
60			<u>300</u>		
<hr/>					
FACTOR	x .005	x .05	x .05	x .29	x .10
10 ⁶ \$	601	1482	3394	10288	9023
				<u>19311</u>	

M 159-B-2 REV. 2-76

PREPARED BY: <u>W. WILCOX</u>	Rockwell International Atomics International Division	PAGE NO. <u> </u> OF <u> </u>
CHECKED BY: <u> </u>		REPORT NO. <u> </u>
DATE: <u>09/06/78</u>		MODEL NO. <u> </u>

	4820 Spare Parts	4830 A & E	4840 C M	4860	
CBS	_____	_____	_____	_____	
4100		<u>5,271</u>	<u>5,271</u>	<u>5,271</u>	
4200	<u>19,424</u>	<u>14-7</u>	<u>19,424</u>	<u>19,424</u>	
4300	<u>4,301</u>	<u>4,301</u>	<u>4,301</u>	<u>4,301</u>	
4400	<u>45,820</u>			<u>45,820</u>	
4440			<u>8,570</u>		
50			<u>1,910</u>		
60			<u>2,720</u>		
4500	<u>19,852</u>			<u>19,852</u>	
14			<u>1,452</u>		
15			<u>1,315</u>		
20			<u>4,942</u>		
40			<u>3,166</u>		
50			<u>4,110</u>		
60			<u>0</u>		
4600	<u>11,400</u>			<u>11,400</u>	
10			<u>4,072</u>		
20			<u>0</u>		
30			<u>688</u>		
40			<u>0</u>		
50			<u>0</u>		
60			<u>300</u>		
FACTOR	X.005	X.05	X.05	X.129	X.10
10 ⁶ \$	503	1450	3113	4017	7482
				11490	

W 142-B-2 REV. 2-76

THREE YEAR O&M COSTS AGUA FRIA STATION

COSTS FOR SINGLE 100 MW UNIT IN SIX UNIT PLANT, \$'s

ACCOUNT	1975	1976	1977	AVERAGE
Operations	232,521	272,798	313,610	272,976
Maintenance	265,535	296,540	527,903	363,325
TOTAL	498,056	569,338	841,513	636,301

COSTS FOR SINGLE 100 MW UNIT IN ONE UNIT PLANT, \$'s

ACCOUNT	1975	1976	1977	AVERAGE
Operations	534,798	627,435	721,303	627,845
Maintenance	610,731	682,042	1,214,177	835,648
TOTAL	1,145,529	1,309,477	1,935,480	1,463,493

NOTES:

1. The above costs are based on removing boiler and fuel related costs from total O&M.
2. The three year period reflects a cycle of O&M events.
3. There is some escalation (6% - 8%/yr) that is occurring over the three year period.
4. Costs are based on actual and of course do not include requirements for sodium or solar systems.

**MINIMUM MANNING TABLE RECOMMENDED BY SRP
FOR 100 MW SOLAR PLANT
(Excludes Collector & Sodium Systems Maintenance)**

ADMINISTRATIVE & OFFICE TOTAL: 10

- (1) Superintendent
- (1) Asst. Superintendent
- (1) Clerk
- (1) Statistician
- (1) Warehouseman
- (5) Guards

ENGINEERING, RESULTS & CONTROLS TOTAL: 10

- (1) Plant Engineer
- (1) Engineer (Controls/Computer)
- (2) Computer Technicians
- (2) Chemists
- (2) Instrument Technicians
- (1) Helper
- (1) Apprentice

OPERATION TOTAL: 20

- (5) Shift Foremen
- (5) Control Room Operators
- (5) Asst Control Room Operators
- (5) Auxiliary Operators

MAINTENANCE TOTAL: 13

- (1) Maintenance Supervisor
- (2) Working Foremen
- (1) Electrician
- (3) Mechanics
- (1) Machinist/Mechanic
- (1) Welder/Mechanic
- (3) Apprentices
- (1) Janitor

PLANT TOTAL: 53

APPENDIX B
COST SUBSTANTIATION DATA
FOR THE 100 MWe COMMERCIAL PLANT
AIR-ROCKS STORAGE

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LOCATION

CLIENT

TAKE-OFF 25

PRICED 25

__ CALC. CHKD

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ESG-79-2, Vol IV
B-2

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JOB NO. 133-026802 PROJECT

LOCATION

CLIENT

DATE 4-6-78

TAKE-OFF 25

PRICED 15

CALC. CHKD

APPROVED

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B-4

JOB NO 133-026R02 PROJECT LOCATION CLIENT

DATE 4-20-78 TAKE-OFF JC PRICED JC CALC CHKD APPROVED SHEET 3 OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
C.S. A-53x 3/8" WALL PIPE 20"	140	LF	47	3.5		6580	4900		
	18		47	3.4		19320	15640		
	6	20	11	1.0		220	200		
90° ELL 20	1	EA	733	11.0		733	110		
	18	5	569	9.0		2845	450		
TEE 20x18	1		1410	15.0		1410	150		
	18	1	926	12.0		926	120		
CONC. RED. 18x17	3		285	9.0		855	270		
3000# F.S. WELD-O-LET	6	2	58	9.2		116	180		
SODIUM VALVES	20	1	90K	212.0		90000	2120		
	18	6	70K	150.0		420000	9000		
	12	2	40K	90.0		80000	1800		
MIXING TEE 20x18	1		140K	80.0		140000	800		
	18	1	126K	60.0		126000	600		
S.S. T-304x 3/8" WALL PIPE	18	525	LF	190	3.4	99750	17850		
	12	168	LF	170	2.3	28560	3860		
90° ELL	18	3	EA	2600	9.0	7800	270		
	12	4		1265	6.5	5060	260		
TEE	18	2		4211	12.0	8422	240		
	12	4		2100	8.6	8400	340		
FIKE BURST DISC. ASSEMBLY 6x12	3		3000	12.0		9000	360		
STD. C.S. BUTTWELDS	20	13		5.4			700		
	18	40		4.7			1880		
	6	4		2.3			90		
S.S.	18	42		21.0			8820		
	12	37		15.0			5550		
CODE									
4520	H.O.T. ROCKS HORIZ. PIPING					1055997	229620	M.H. 2300	

ESG-79-2, Vol IV
B-5

DATE 4-20-78 TAKE-OFF JC PRICED JC CALC CKD _____ APPROVED _____ SHEET 4 OF _____

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Wagon 700-D Row 11-73

ESG-79-2, Vol IV
B-6

DATE 4-3-78 TAKE-OFF JK PRICED JK CALC. CHKD _____ APPROVED _____ SHEET 4 OF 5

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
C.S.	A-53 Pipe x 3/8" WALL 20"	1000	LF	47	3.5		47000	3500°		
	90° ell 20"	28	EA	733	11.°		20524	308°		
	BUTTWELDS 20	88			5.4			475°		
S.S.	T-304 Pipe x 3/8" WALL 18	1000	LF	190	3.4		190000	3400°		
	90° ell 18	28	EA	2600	9.°		72800	252°		
	BUTTWELDS 18	88			21.°			1848°		
	SUPPORT HANGERS HORIZ. #45 20"	28	EA	1314	60°		36792	1680°		
	#16 18	28		1355	60°		37940	1680°		
	VERT. 20	43		52	3.°		2236	129°		
	18	43		50	3.°		2150	129°		
	SNUBBERS #200 w/ Pipe CLAMP	20		3000	40°		60000	800°		
CODE										
4-520	DOWN COMMER & RISER	HOT Rocks					469442	14201°	M.H.C. 30°	
							426030			

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B-7

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DATE 4-20-78 TAKE-OFF JC PRICED JC CALC CHKD _____ APPROVED _____ SHEET 6 OF _____

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ESG-79-2, Vol IV
B-8

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LOCATION

CLIENT

TAKE OFF 25

PRICED JS

__ CALC CHKD

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ESG-79-2, Vol IV
B-9

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LOCATION

CLIENT

TAKE-OFF JS

PRICED 25

CALC. CHKD

— APPROVED

SHEET

— OF

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR \$	SUB-CONTRACT	TOTAL
60	EXCAVATION & BACKFILL	89,000	C.Y		\$	3 ⁰⁰ /C.Y			240000	240
80	INSULATING ROCKS	¹²⁴ 76,000	TON	4.2 ⁰	.66		504000	50000		601
10	RIVERBED SAND	34,000	TON	4.2 ⁰	.65		136000	22100		158
40	FORMED CONCRETE HOUSING	54	C.Y		1	\$200 ⁰⁰			16200	16
10	CONCRETE SERVICE ROADS 6"	380	C.Y		1	\$150 ⁰⁰			57000	57
10	.032 GALV. CORR. SHEETING	70,000	FT ²	.60	.30		420000	21000		63
10	CONCRETE ROOF SEAL 4"	2300	C.Y		1	\$200/C.Y			230000 460000	230
10	GUNITE EXTERIOR WALL 1"	74,000	FT ²		1	.41			30000	30
30	CONCRETE PIPE COL. 12'Ø WITH FOOTINGS INSTALLED	1	L.S		1				147000	147
30	HOT DUST PIPING	324	EA	525	3.0		170100	21384	20000	395
	COLD DUST PIPING	324	EA	495	3.25		160380	23166		
CODE										
46XX		AIR-ROCKS STORAGE								
		1939								

ESG-79-2, Vol IV
B-11

JOB NO: 12-038 PROJECT LOCATION CLIENT

DATE 6-28-78 TAKE-OFF JC PRICED JC CALC CHKD APPROVED SHEET 3 OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB CONTRACT	TOTAL
				\$					FREE
30 100 H.P FANS w/ VARI-SPEED MOTOR & COOLED BEARINGS & 60" FAN	54	EA	16,000	2000		5940.00	1080.00		164
40 HEAT EXCHANGERS 2'-9" x 8' x 8' 10' L x .049 2 1/4" / 1" ID 10,519 ft ² SURFACE	54	EA	170K	1200		48,720.00 9180.00	6480.00		2500
40 SHEET METAL HOUSING (450#)	54	EA	600	200		3240.00	1080.00		43
30 12" THERMO THERMO @ UNIT	3456	ft ²			30.00			103680	
24" FIBERGLASS @ UNIT (ERT)	3456	ft ²			3.90			13478.4	
12" THERMO BESTUS @ WALLS	2160	ft ²			37.00			79920	11
24" FIBERGLASS @ 1 1/2" INS (ERT)	2160	ft ²			4.50			9720	
CERIFELT 3# DENSITY	1	L.S.			100			100	
40 FAN & HEAT EXCHANGER STRUCTURES	54	EA	1200	1300		6480.00	7020.00		135
40 SUPPLY & RETURN PIPING @ UNITS	54	L.F.	5/5	575		2781.00	3105.00		
PIPE INSULATION @ UNITS 3"	1840	L.F.			20			3680.00	316
TRACE HEATERS @ UNITS	1840	L.F.			1.20			2208.00	
30 COOLING SYSTEM FOR FANS	54	EA	613	412		3310.20	2224.80		55
40 S.S. FOR HX & FAN STRUCTURE	16,200	LBS			2.50/LB			40500	41
CODE									
46x x	FANS & HOUSING								
	6882								

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PREPARED BY: <u>TLJ</u>	Rockwell International Atomic International Division		PAGE NO. <u> </u> OF <u> </u>
CHECKED BY: <u> </u>			REPORT NO. <u> </u>
DATE: <u>12/2/78</u>	<u>4.12 100CS</u>		MODEL NO. <u> </u>

	4820 Space Parts 1.5%	4830 A8E 5%	4840 C14 5%	4860 30% 10%
CBS	<u> </u>	<u> </u>	<u> </u>	<u> </u>
4100		<u>5.21</u>	<u>5321</u>	
4200	<u>4.17</u>	<u>3.2</u>	<u> </u>	<u> </u>
4300	<u>4.2</u>	<u>5.1</u>	<u> </u>	<u>4.2</u>
4400	<u> </u>			<u> </u>
4440			<u>10.2</u>	
50			<u>23.5</u>	
60			<u>3.5</u>	
4520	<u>24588</u>			<u>24588</u>
14			<u>2289</u>	
15			<u>1315</u>	
20			<u>5362</u>	
40			<u>3156</u>	
50			<u> </u>	
60			<u>5144</u>	
4600	<u>10721</u>			<u>10721</u>
10			<u>536</u>	
20			<u>1900</u>	
30			<u>1341</u>	
40			<u>6051</u>	
50			<u> </u>	
60			<u>2.10</u>	
	<u>120163</u>		<u>73207</u>	<u>35204</u>
	X.005	X.05	X.05	X.29 X.10
	600	1982	3693	10.2 9024
				<u>11204</u>

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PREPARED BY: <u>RLJ</u>	Rockwell International Atomic International Division		PAGE NO. <u> </u> OF <u> </u>
CHECKED BY: <u> </u>			REPORT NO. <u> </u>
DATE: <u>12/2/78</u>	<u>AIR RACKS Nth Plant</u>		MODEL NO. <u> </u>

	<u>4820</u> Space Units	<u>4830</u> A & E	<u>4840</u> C M	<u>4860</u> contingency
CBS	_____	_____	_____	_____
4100		<u>5381</u>	<u>5381</u>	<u>5381</u>
4200	<u>19424</u>	<u>19424</u>	<u>19424</u>	<u>19424</u>
4300	<u>4301</u>	<u>4301</u>	<u>4301</u>	<u>4301</u>
4400	<u>45820</u>			<u>45820</u>
4440			<u>8590</u>	
50			<u>1910</u>	
60			<u>2720</u>	
4500	<u>= 397</u>			<u>21397</u>
14			<u>2289</u>	
15			<u>1315</u>	
20			<u>5362</u>	
40			<u>3156</u>	
50			<u>—</u>	
60			<u>5144</u>	
4600	<u>9978</u>			<u>9978</u>
10			<u>538</u>	
20			<u>1900</u>	
30			<u>1250</u>	
40			<u>5450</u>	
50			<u>—</u>	
60			<u>240</u>	
	<u>100920</u>	<u>29106</u>	<u>68970</u>	<u>31375</u> <u>74926</u>
	<u>X .005</u>	<u>X .05</u>	<u>X .05</u>	<u>X .13</u> <u>X .10</u>
	<u>505</u>	<u>1455</u>	<u>3449</u>	<u>4079</u> <u>7493</u>
				<u>11572</u>

APPENDIX C

COST SUBSTANTIATION DATA
FOR THE 281-MWe COMMERCIAL PLANT

CLIENT

OF

[illegible]

-75

JOB NO 133 PROJECT 300 MW LOCATION _____ CLIENT _____

DATE 9-1-78 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

Form 702-D Rev. 11-73

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C-3

109 NO/33-0 702 PROJECT 300 MW LOCATION CLIENT

DATE 9-1-78 TAKE-OFF _____ PRICED _____ CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

Form 702-D Rev. 11-73

ESG-79-2, Vol IV
C-4

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MARKS

PERSON S H

WORTH

JURTH

ENT

JRMASH

ITS

NOLLEY

ODENAS

CHRAN JC

AWFORD

LOS PRADOS

TERMAN

LER

LFE

RTZLER

IG

LBROOK

OBELLIS

OBSON J

ES R G

IAN M

ATEN

T" EP

LL LS

RTIN A B

COURT

DERMOTT

DONALD JS

KENZIE DE

YERS GW

REWITZ

Clear

MURPHY

DENKAMP

RKER T

RKINS

RUL

MLEY

INECKER

NDERS

HIRM

STONE

TOHER

A WARD

HEELER

SENECK

WILLIAMS

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JUN 20 1978

ENGINEERING • CONSTRUCTION

Correspondence Dept.

June 14, 1978

Atomics International Division
Rockwell International
8900 DeSota Avenue
Canoga Park, California 91304

Re: C-20325-29

Attention: Mr. T. H. Springer
Project Manager

Subject: 300 MWe Plant Cost
Advanced Central Receiver Power System

Reference: AI Contract N311-002FX

Dear Tom:

In accordance with discussions held at the midterm review on June 6, 1978, we have prepared preliminary turbine selection and cost data for a 300 MWe (net) EPGS. Enclosed herewith are 300 MWe turbine-generator cost and performance data for 1800 psig and 2400 psig reheat turbines dated June 7, 1978. It appears that either the TC2F-33.5" or the TC4F-26" machines at 2400 psig, 1000/1000 °F, 2" HgA would be the best choice in a seven heater cycle, based on cycle efficiency.

Also enclosed is a preliminary cost estimate dated June 13, 1978 showing direct costs for account 4200 Turbine Plant Equipment and account 4300 Electric Plant Equipment for both 100 MW and 300 MW plants. Please note that the 100 MW Electric Plant Equipment costs have been revised since the midterm review. A review of the 100 MW cost estimate revealed that the cost of heliostat power distribution and trenching had inadvertently been included under account 4300 and has been deleted in the revised estimate. Also the costs under 4300 have been redistributed to reflect the proper charges in the various sub-accounts.

Other cost estimates for the 300 MW Balance of Plant include the following:

7680 AT

4120

Stearns-Roger

PAGE 2

Atomics International Division
Canoga Park, California 91304

June 14, 1978

4121	Turbine Building	\$ 5,500,000	}	7,100,000
4122	Administration Building	)		
4123	Warehouse/Maintenance Building	) Lot 1,600,000		
4123	Control Building	)		
4131	Transportation and Lifting Equipment	350,000	}	1,310,000
4132	Communication Equipment	110,000		
4133	Other	850,000		
		<u>840,000</u>		

(Included are service air and instrument air compressor equipment, and miscellaneous building piping: service water, sanitary, heating, floor drains, roof drains, potable water, fire protection, etc.)

If you have any questions regarding the cost estimates or turbine data, please advise.

Very truly yours,

STEARNS-ROGER ENGINEERING CO.

A. W. McKenzie
A. W. McKenzie
Project Engineer

AWM:vr

Enclosure

American International Division
RUCAL International

JOB NO. 133-0 02 PROJECT 300 MW LOCATION _____ CLIENT _____

DATE 9-1-78 TAKE-OFF _____ PRICED _____ CALC CKD _____ APPROVED _____ SHEET _____ OF _____

[illegible]

Form 702-D Rev. 11-73

ESG-79-2, Vol IV
C-7

Atomics International
D/79C Correspondence

ACTION

REPLY

REPLY DUE

REMARKS

ANDERSON S H

ASINWORTH

ASQUITH

BALENT

BAURMASH

BOTIS

BRINDLEY

CARDFNAS

COCHRAN JC

CRAWFORD

DE LOS PHADOS

DETERMAN

L. C. C.

FEILER

GYLFE

HARTZLER

HILLIG

HOLBROOK

JACOBELLIS

JACOBSON J

JONES RG

JULIAN M

KLEIN

KLINGER

L. B. C.

LULOVICS

MARTIN A B

MCCOURT

MCDERMOTT

MCDONALD JS

MCKENZIE DE

MEYERS GW

MORVITZ

M. Frazer

J MURPHY

OLDENAMP

PARKER T

PARKINS

E. Ash

REIMLEY

REINICKER

SANDERS

SCHIRM

LE STONE

W TISHEN

H A WAHID

WHEELER

WHISTENCK

J S WILLIAMS

Springer

Katz

G. S. G.

A. Thomas

L. E. Johnson

Bouber

P. Klaus

RECEIVED

AUG 25 1978

August 22, 1978

Correspondence Dept.

Atomics International Division
Rockwell International
8900 DeSota Avenue
Canoga Park, CA 91304

Re: C-20325-38

Attention: Mr. T. H. Springer
Project Manager

Subject: 300 MWe Plant Cost (Revised)
Advanced Central Receiver Power System

Reference: AI Contract N311-0002-FX
DOE Contract EG-77-C-03-1483

Dear Tom:

Enclosed please find revised preliminary cost estimate dated 8/21/78 (Rev. 1) comparing 100 MWe vs 300 MWe Turbine Plant Equipment and Electric Plant Equipment. This estimate supersedes the previous estimate dated 6/13/78.

Revision 1 changes the 300 MWe turbine-generator cost (account 4210, reflecting the use of a TC2F-33.5" turbine in lieu of a TC4F-26" turbine originally assumed. Also account 4220 (heat rejection system) revised to add an 80 acre evaporation pond (\$3,600,000) to the 300 MWe plant. A 30 acre evaporation pond was already included in this account for the 100 MWe plant at a cost of \$1,500,000.

If you have any questions concerning this revised cost estimate, please let us know.

Very truly yours,

STEARNS-ROGER ENGINEERING CO.

A. W. McKenzie
A. W. McKenzie
Project Engineer

AWM:vr
Encl.

10507ESS

4200
4300

CONCEPTUAL DESIGN OF ADVANCED CENTRAL RECEIVER POWER SYSTEM
ELECTRIC POWER GENERATION SUBSYSTEM (STEARNS-ROGER)

PRELIMINARY COST ESTIMATE

PLANT SIZE (NET OUTPUT)	100 MWe	300 MWe
<u>4200 TURBINE PLANT EQUIPMENT</u>		
4210 TURBINE-GEN. AND ACCESS.	\$10,856,000	\$21,560,000 ¹
4220 HEAT REJECTION SYSTEM	4,215,000	9,875,000 ¹
4230 CONDENSING SYSTEMS	320,000	577,000
4240 FEED HEATING SYSTEMS	1,655,000	3,203,000
4250 WORKING FLUID CIRC., TREAT., ETC.	<u>2,378,000</u>	<u>3,544,000</u>
TOTAL 4200	\$19,424,000	\$38,759,000 ¹
<u>4300 ELECTRIC PLANT EQUIPMENT</u>		
4310 SWITCHGEAR	\$ 860,000	\$ 1,502,000
4320 STATION SERVICE EQUIP.	1,302,000	2,163,000
4330 PROTECTIVE EQUIPMENT	253,000	300,000
4340 POWER WIRING, ELECT. STRUCTURES AND WIRING CONTAINERS	<u>938,000</u>	<u>2,231,000</u>
TOTAL 4300	\$ 3,353,000	\$ 6,196,000

NOTE:

- 1) Costs are current direct costs, no indirect costs included.
- 2) Heliostat power distribution not included.

4200
4300

Table C

251
ADVANCED CONCEPT NTH COMMERCIAL PLANT - ~~300~~ MWe
BREAKDOWN OF MASTER CONTROL COSTS BY CBS

1978 DOLLARS AND HOURS IN THOUSANDS

<u>CBS</u>	<u>COST ELEMENT</u>	<u>LABOR</u>		<u>NON-LABOR</u>	<u>TOTAL</u>
		<u>HOURS</u>	<u>DOLLARS</u>		
4351	Hardware				
	LSI-11 Processor			\$ 14.94	\$ 14.94
	RX11 BA Disc Drive & Control			22.68	22.68
	TA11 AB Recorder			9.52	9.52
	LAV11 DA Printers			8.55	8.55
	Terminal			41.28	41.28
	Cabinet	2.37	\$ 66.19	29.43	95.62
	Cable			10.50	10.50
	Data Acquisition			0	0
	Time			3.83	3.83
	Weather			18.37	18.37
	Timers			2.40	2.40
	Assy, Trans, Install & C/O	<u>5.07</u>	<u>169.94</u>	<u>10.37</u>	<u>180.31</u>
	Subtotal	7.44	\$236.13	\$171.87	\$408.00
	Visibility		<u>47.87</u>	<u>34.13</u>	<u>82.00</u>
	TOTAL 4351		\$284.00	\$206.00	\$490.00
4352	Hardware Design & Engr	3.70	\$174.00	\$ 11.00	\$185.00
4353	Software Design, Develop & Test	1.53	\$ 72.00	\$ 4.00	\$ 76.00
OM300	Maintenance Labor (Subcontract)			\$ 0.50	\$ 0.50

Table C -4

NTH COMMERCIAL HELIOSTAT INVESTMENT COST - ²⁸¹300 MWe

WBS NUMBER AND TITLE		CAPITAL INVESTMENT		
		LABOR		TOTAL (\$M)
		HOURS (THOU)	DOLL (\$M)	
4410	Reflective Unit	174.52	2.42	33.41
4420	Drive Unit	316.96	4.46	48.57
4430	Control/Instrumentation Equipment	99.76	1.47	3.42
4440	Foundation/Site Preparation	588.55	13.61	11.11
4450	Helio Spt St/Pr En	44.63	0.60	4.95
4460	Field Assembly and Checkout	<u>373.42</u>	<u>7.77</u>	<u>0.03</u>
	Subtotal - Heliostat	1597.84	30.33	101.49
	Visibility	-	<u>6.07</u>	<u>10.13</u>
	Total Heliostat		36.40	111.62
4100	Site, Struc, Misc Equip.	8.14	0.12	1.41
4800	Dist. and Indir. (Init. Sprs)	0.00	0.00	0.06
OM100	OPERATION	0.00	0.00	0.00
OM200	MAINT MATERIAL	0.00	0.00	0.49
OM300	MAINTENANCE LABOR	<u>115.59</u>	<u>1.73</u>	<u>0.00</u>
	TOTAL O&M	115.59	1.73	0.49
ONGOING O&M		59.57	0.89	0.40

JOB NO 133-037 PROJECT 300 MW LOCATION _____ CLIENT _____

DATE 8-11-78 TAKE-OFF SC PRICED S.R CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
Pump P-1 60,000 GPM @ 1066 TDH, 18,000 H.P	1	E.A.				4637628	2906000		4927628
INSULATION	1056	S.F			298 ⁰⁰				323628
TRACE HEATERS	362	L.F			120 ⁰⁰				43440
1 ST COMMERCIAL									5295000
NTH PLANT ~ 18% LEAKING CURVE									4342000
CODE	4513	Pump P-1							4342000

133-037 Rev. 11-78

Stearns-Roger

ESTIMATE SUMMARY

CUSTOMER		ATOMIC INTERNATIONAL				PROP NO.		
LOCATION						JOB NO.		20325
PROJECT		ADVANCED CENTRAL RECEIVER (200 METERS HEIGHT / 1,500 KIPS)				DATE		2-13-78
REV NO		REV DATE				BY		J.W.P.

ACTI	DESCRIPTION	CRAFT UNITS	LABOR	MATERIAL	OTHER	TOTAL		
A	EARTHWORK	11930	23160	111600	7370	42130		
B	CONCRETE	177219	2680525	999125		3679650		
C	BUILDINGS & STRUCTURES							
D	PROCESS EQUIPMENT							
E	PIPING							
F	ELECTRICAL							
G	PAINTING							
L	PLANT ITEMS							
N	INSTRUMENTS & CONTROLS							
P	INSULATION							
	DIRECT FIELD COST	1791149	21703685	110101725	7370	31721780		
H	FIELD EXPENSE							
H	ALL RISK, PR TAX, BOND							
K	CONSTRUCTION SUPPLIES							
M	STARTUP							
S	TEMPORARY FACILITIES							
V	CRAFT BENEFITS							
V	CONSTRUCTION CAMP							
W	CONSTRUCTION EQUIP.							
	INDIRECT FIELD COST		70% OF DIRECT LABOR			1892580		
	TOTAL FIELD COST					5614360		
J	ENGINEERING BY OTHERS							
	TOTAL FIELD & ENG. COST							
Q	SALES TAX 4% OF MAT'L COST					40430		
R	PREMIUM PAY NONE							
	ESCALATION CURRENT PRICES AND LABOR RATES							
	CONTINGENCY 7 1/2% OF TOTAL FIELD COST PLUS SALES TAX MINUS SUBCONTRACT					418600		
	SUB TOTAL					6073390		
Y	FEE 5% OF SUBTOTAL					303670		
	TOTAL			200 M		6377060		
	(31.85\$/METER X 240 METER 7'							
				240 M		7652000		

NO. 133-0 02 PROJECT 300 MW LOCATION _____ CLIENT _____

DATE 9-1-78 TAKE OFF PRICED CALC CHKD APPROVED SHEET OF

[illegible]

PROJECT 300 MW LOCATION _____ CLIENT _____

[illegible]

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C-17

TABLE 9.1-5
ADVANCED CENTRAL RECEIVER
281 MWe O&M COSTS

O&M Items	First Commercial \$1,000/yr		Nth Plant	
OM100 Operations Supervision		843		376
OM200 Maintenance Materials		1,078		469
OM210 Spare Parts		1,078		469
OM211 Turbine and Electric Plant	593		258	
OM212 Collector Equipment	363		158	
OM212 Receiver Equipment				
OM214 Thermal Storage Equipment	122		54	
OM220 Material for Repair				
OM230 Other				
OM300 Maintenance Labor		2,539		1,103
OM310 Scheduled Maintenance	2,539		1,103	
OM320 Corrective Maintenance				
Total		4,460		1,948

Rockwell International
Energy Systems Group

281 MWe O & M Costs

update 100 MWe O & M costs
as follows.

OM 100 Increase operating staff
by 1 per shift 3 men 150K

OM 200 Increase maintenance materials
by $\left(\frac{2.81}{100}\right)^{.6} = 1.8$

OM 300 Use MADAC estimate Heliostats
Increase BOP by 50%

PREPARED BY: <u>W.W. Wilcox</u>	Rockwell International Atomics International Division	PAGE NO. <u> </u> OF <u> </u>
CHECKED BY: <u> </u>		REPORT NO. <u> </u>
DATE: <u>09/10/1</u>		MODEL NO. <u> </u>

	4820 Space Parts 1.5%	4830 48E 5%	4840 C.M. 5%	4860 30%	10%
CBS					
4100		<u>11,239</u>	<u>11,239</u>		<u>11,239</u>
4200	<u>38,759</u>	<u>38,751</u>	<u>38,751</u>		<u>38,751</u>
4300	<u>6,865</u>	<u>6,865</u>	<u>6,865</u>		<u>6,865</u>
4400	<u>131,820</u>				<u>131,820</u>
4470			<u>24,707</u>		
50			<u>5,550</u>		
60			<u>7,600</u>		
4500	<u>12,217</u>			<u>42,077</u>	
14			<u>2,100</u>		
15			<u>4,538</u>		
20			<u>9,500</u>		
40			<u>1,600</u>		
50			<u> </u>		
60			<u>1,100</u>		
4600	<u>50,100</u>			<u>30,400</u>	
10			<u>8,025</u>		
20			<u>0</u>		
30			<u>1,600</u>		
40			<u>0</u>		
50			<u>0</u>		
60			<u>579</u>		
<hr/>					
	X.005	X.05	X.05	X.15	X.10
	1-50.	2843	6795	10885	18868
				<u>29753</u>	

N 152-B-2 REV 2-76

APPENDIX D
COST SUBSTANTIATION DATA
FOR THE PILOT PLANT

8-30-78 - 2:20 p.m.

Tom Springer

Jack Dubberly from Stern Rogers
Advanced Concept - Pilot Plant.

Estimated Costs for 10 megawatt
Pilot Plant

1. Jurbin Bldg.	\$ 300,000
2. Administration Bldg.	20,000
3. Warehouse - maintenance	50,000
4. Control Bldg.	100,000
5. Other Bldgs	<u>90,000</u>
Total	560,000

Will confirm by mail

Jaunty

4100

JOB NO 133-026/202 PROJECT 10 MW LOCATION _____ CLIENT _____

DATE 9-1-78 TAKE OFF _____ PRICED _____ CALC CMKD _____ APPROVED _____ SWEET _____ OF _____

[illegible]

C-20325
8-29-78

CONCEPTUAL DESIGN OF ADVANCED CENTRAL
RECEIVER POWER SYSTEM
ELECTRIC POWER GENERATION SUBSYSTEM (S-R)

Preliminary Cost Estimate

Plant Size (Net Output)

10 MWe

4200 Turbine Equipment

4210 Turbine Generator & Access.....	\$2,600,000
4220 Heat Rejection System.....	740,000
4230 Condensing Systems.....	95,000
4240 Feed Heating Systems.....	440,000
4250 Work Fluid Circulating, Treatment, Etc.....	<u>1,000,000</u>

TOTAL 4200.....\$4,875,000

4300 Electric Plant Equipment

4310 Switchgear.....	\$ 290,000
4320 Station Service Equipment.....	410,000
4330 Protective Equipment.....	170,000
4340 Power Wiring, Electrical Structure & Wiring Containers...	<u>170,000</u>

TOTAL 4300.....\$1,040,000

Table
ADVANCED CONCEPT PILOT PLANT
BREAKDOWN OF MASTER CONTROL COSTS BY CBS

<u>1978 DOLLARS AND HOURS IN THOUSANDS</u>					
<u>CBS</u>	<u>COST ELEMENT</u>	<u>HOURS</u>	<u>LABOR</u>		<u>TOTAL</u>
			<u>DOLLARS</u>	<u>NON-LABOR</u>	
4351	Hardware			\$ 33.78	\$ 33.78
	LSI-11 Processor			27.22	27.22
	RX11 BA Disc Drive and Control			9.52	9.52
	TA11 AB Recorder			8.55	8.55
	LAV11 DA Printers			49.65	49.65
	Terminal	2.99	\$ 83.60	29.43	113.03
	Cabinet			10.50	10.50
	Cables			186.14	186.14
	Data Acquisition			3.83	3.83
	Time			18.37	18.37
	Weather			2.40	2.40
	Timers			18.30	260.47
	Assy, Trans., Install & C/O	<u>7.13</u>	<u>242.17</u>		
	Subtotal	10.12	\$325.77	\$397.69	\$723.46
	Visibility		<u>65.23</u>	<u>79.31</u>	<u>144.54</u>
	Total 4351		\$391.00	\$477.00	\$868.00
4352	Hardware Design & Engr	15.84	\$745.00	\$ 45.00	\$790.00
4353	Software Design, Develop & Test	9.14	\$430.00	\$ 26.00	\$456.00
OM300	Maintenance Labor (Subcontract)			\$ 0.05	\$ 0.05

Section
COLLECTOR COST ANALYSIS

4400

Costing Results

Summarized costing results relating to the Collector Equipment subsystem are shown for Pilot, First and Nth Commercial power plants that employ liquid sodium as a coolant in the receiver.

COST ELEMENT	1978 DOLLARS IN MILLIONS			
	PILOT	1ST COMM	NTH 100 MWe	300 MWe
Non-Recurring	\$ 4.70	-	-	-
Transport & Lift Equip	\$.24	\$ 0.54	\$ 0.53	\$ 1.53
Collectors	\$10.55	\$60.60	\$ 45.82	\$ 131.82
Visibility	-	-	\$ 5.63	\$ 16.20
TOTAL Collect	\$10.55	\$60.60	\$ 51.45	\$ 149.55
Initial Spares	\$.01	\$ 0.04	\$ 0.02	\$ 0.06
1st Year O&M	\$.09	\$ 0.80	\$ 0.77	\$ 2.22
Follow-On O&M	\$.06	\$ 0.46	\$ 0.45	\$ 1.29

These costs are based on data developed in association with the Prototype Heliostat study. Tables -1 thru -4 provide further breakdown of these costs. Non-recurring costs for Commercial Plants are shown as nil because those costs that are not already paid for in prior development are allocated over all production and included in the overhead. Visibility is buried in the Pilot and First Commercial costs but has been listed separately for Nth Commercial because of the likelihood of compensating

Table -1

ADVANCED CONCEPT PILOT PLANT - HELIOSTAT COST (1065)

(Sheet 1 of 4)

		CAPITAL INVESTMENT				
		LABOR		MATL \$	TOTAL	
WBS NUMBER AND TITLE		NON RECUR (\$K)	HOURS (THOU)	DOLL (\$M)	(\$M)	(\$M)
→ 4410	Reflective Unit	311	21.94	.77	1.86	2.63 ←
4411	Reflective Surface	88	6.67	.24	1.16	1.40
4412	Mirror Back Struct	124	7.87	.27	.63	.90
4413	Assy & Bond	99	7.40	.26	.07	.33
→ 4420	Drive Unit	542	39.75	1.42	3.04	4.46 ←
4421	Azimuth	280	20.24	.72	.59	1.31
4422	Elevation	175	12.97	.46	1.57	2.03
4423	Motor Total	0	0	0	.50	.50
4424	Pos/Limit Indicators	54	4.12	.15	.03	.18
4425	Power Sply/Dist	0	0	0	.35	.35
4426	Assy Dr/Ped/Elect	33	2.42	.09	0	.09
→ 4430	Control/Instrmt Equip	171	12.85	.45	.54	.99 ←
4431	Sensor/Calib Equip	0	0	0	.01	.01
4432	Field Control	1	.13	0	0	0
4433	Cntrl/Sig Equip	161	12.12	.43	.48	.91

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Table D - 1

ADVANCED CONCEPT PILOT PLANT - HELIOSTAT COST (1065)

(Sheet 2 of 4)

CAPITAL INVESTMENT					
WBS NUMBER AND TITLE	LABOR			MATL \$	TOTAL
	NON RECUR (\$K)	HOURS (THOU)	DOLL (\$M)	(\$M)	(\$M)
44320101 Collector Control	9	.60	.02	.05	.07
4440 Found/Site Prep	134	22.54	.53	.43	.96
4441 Foundation	122	16.36	.38	.43	.81
4442 Site Preparation	12	6.18	.15	0	.15
4450 Heliostat Spt St/Pr En	71	5.34	.19	.20	.39
4451 Helio Suppt Struct	71	5.34	.19	.20	.39
4452 Protection Encl	0	0	0	0	0
4453 Lightning Protect	0	0	0	0	0
4460 Field Assy and C/O	636	24.36	.55	0	.55
4461 Heliostat	593	12.48	.28	0	.28
4462 Sensor/Calib Equip	1	.13	0	0	0
4463 Electrical/Distrib	37	7.03	.16	0	.16
4464 Align Heliostats	3	3.15	.07	0	.07

Table 1

ADVANCED CONCEPT PILOT PLANT - HELIOSTAT COST (1065)

(Sheet 3 of 4)

CAPITAL INVESTMENT

WBS NUMBER AND TITLE		LABOR		MATL \$	TOTAL
		NON RECUR (\$K)	HOURS (THOU)	DOLL (\$M)	(\$M)
4465	Field Support	1	.60	.01	0
4466	Pack & Transp	1	.97	.03	0
→ 4470	Design/Engineering	2534	13.94	.57	0
4471	Design	1575	0	0	0
4472	Sustaining Engr	580	13.94	.57	0
4473	Pre Prod Unit	170	0	0	0
4474	Site Activation	510	0	0	0
	TOTAL HELIOSTAT	4700	140.72	4.48	6.07
→ 4100	Site, Struct, Misc Equip	0	1.22	.02	.22
→ 4130	Misc Equipment	0	1.22	.02	.22
→ 4300	Dist and Indir	0	0	0	.01

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Table -1

ADVANCED CONCEPT PILOT PLANT - HELIOSTAT COST (1065)

(Sheet 4 of 4)

CAPITAL INVESTMENT					
WBS NUMBER AND TITLE		LABOR		MATL \$	TOTAL
		NON RECUR (\$K)	HOURS (THOU)	DOLL (\$M)	
4840	Initial Spares	0	0	0	.01
OM100	Operations	0	0	0	0
OM200	Maint Material	0	0	0	.03
OM300	Maintenance Labor	0	4.09	.06	0
	TOTAL O&M	0	4.09	.06	.03
Ongoing O&M		0	1.80	.04	.02

JOB NO _____ PROJECT 10 MW LOCATION _____ CLIENT _____

DATE _____ TAKE-OFF JC PRICED JC CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR \$	SUB-CONTRACT	TOTAL
RECEIVER PANELS (115,107 EA)	3	EA			ACCOUNT				
SUPPORT STRUCTURE (8200 EA)					4511	"REF 100 MW"		345321	345321
RECEIVER PUMP (REWORK) P-5 SCT					4512	" "		24600	24600
INSTRUMENTATION & CONTROLS (REF 100 MW)					4513	31000	5000	44000	80000
TRANSPORTATION, FIELD ERECTION (REF 100 MW)					4514			798000	798000
					4515		54000		54000
PIPING SYSTEMS					4520	709810	768510	948002	2426322
SODIUM	69,100	LB.	.40		4530			27640	27640
TOWER & FOUNDATIONS STEARNS-RODGER					4540			159500	159500
STEAM GENERATOR A-1 MCG (LESS NUCLEAR CODES)					4560			900000	900000
DESIGN & ENGINEERING (SEE BACKUP)					4570				
CODE	4500	RECEIVER EQUIPMENT							

JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

DATE _____ TAKE OFF _____ PRICED _____ CALC CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT L	LABOR	SUB CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SCH. 40 S.S. PIPE A-53	8"	1500	LF	210	6.7	315000	130500		
S.S.	6"	1600	LF	158	6.54	252800	104640		
SODIUM VALVES C.S.	8	3	1A	19K	50°	57000	1500		
S.S.	6	2		14K	17.0	28000	340		
	4	1		9100	10.0	9100	100		
	3	1		7000	8.0	7000	80		
	2	3		4660	2.0	13980	60		
	1	1		2330	1.0	2330	10		
DRAG VALVE	6	1		18K	17.0	18000	170		
BURST DISC	6	1		1500	3.0	1500	30		
PIPE SUPPLIES	8	150		18	1.0	2700	1800		
	6	160		15	1.0	2400	1600		
SCH. 40 C.S. FITTINGS	8	81			7.0		5910		
S.S.	6	87			10.0		8700		
	4	2			8.0		160		
	3	2			7.0		140		
	2	6			5.0		330		
	1	2			5.0		100		
SODIUM REACTION TANK	1	L.S.	REF	100 MW ÷ 6	POWER			60301	
" PURIFICATION SYSTEM	1	L.S.	"	"	"			92462	
INSULATION 4 1/2"	8	1500	LF		62°			93000	
" 4"	6	1600	LF		44°			70400	
TRACE HEATERS	3100	LF			120/LF			372000	
SODIUM HEATING & UNLOADING	1	L.S.	REF	100 MW PLANT				165000	
COVER GAS SYSTEM	1	L.S.	"	"	÷ 6 POWER			94839	
CODE	4520	Piping Systems Backup				709810	768510	948002	2426322

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Stearns-Roger

ESTIMATE SUMMARY

[illegible]

INCORPORATED

ORDER NO. 20325 LOCATION.

BY J. W. J.

DATE 2-10-78

TOTAL

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DISCUSSION

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	TEMP	AIR	EQUIP	FUEL	MATERIALS	LABOR	SUB	TOTAL	%
HOT TANK - 2' x 8' = 16 sq ft)	1	L.S.		4600	158300		*164		
COLD TANK 2' x 8' = 16 sq ft)	1	L.S.		4600	90000		*114823		
CIRCULATION PUMP NETWORK	1	L.S.		4600	157000		2500		
FOUNDATIONS (1700 sq')	1	L.S.		4600			13500		
DESIGN & ENGINEERING	1	L.S.		4600					
TOTAL		L.O.S.	40	4600	248000				
* INSULATION & TRAC HEATING									

CODE 4600 THERMAL STORAGE EQUIPMENT 11

Summary 4800

- 4810 - Temporary Facilities - See Breakdown Sheet
- 4820 - Spare Parts 1/2% of 4200 through 4600
- 4830 - A&E Services 5% of 4100 through 4300
- 4840 - Construction Management 5% of 4100 through 4300;
4400, 50, and 60; 4514, 15, 20, 40, 50, and 60;
4610 through 4660.
- 4850 - Startup and Checkout - 20 Man-Years at \$50K/yr
- 4860 - Contingency - 10% of 4100 through 4400
30% of 4500 and 4600
- 4860 - Contingency on Nth Plant
10% of FAC & S-R
15% of ESG.

Rockwell International
Energy Systems Group