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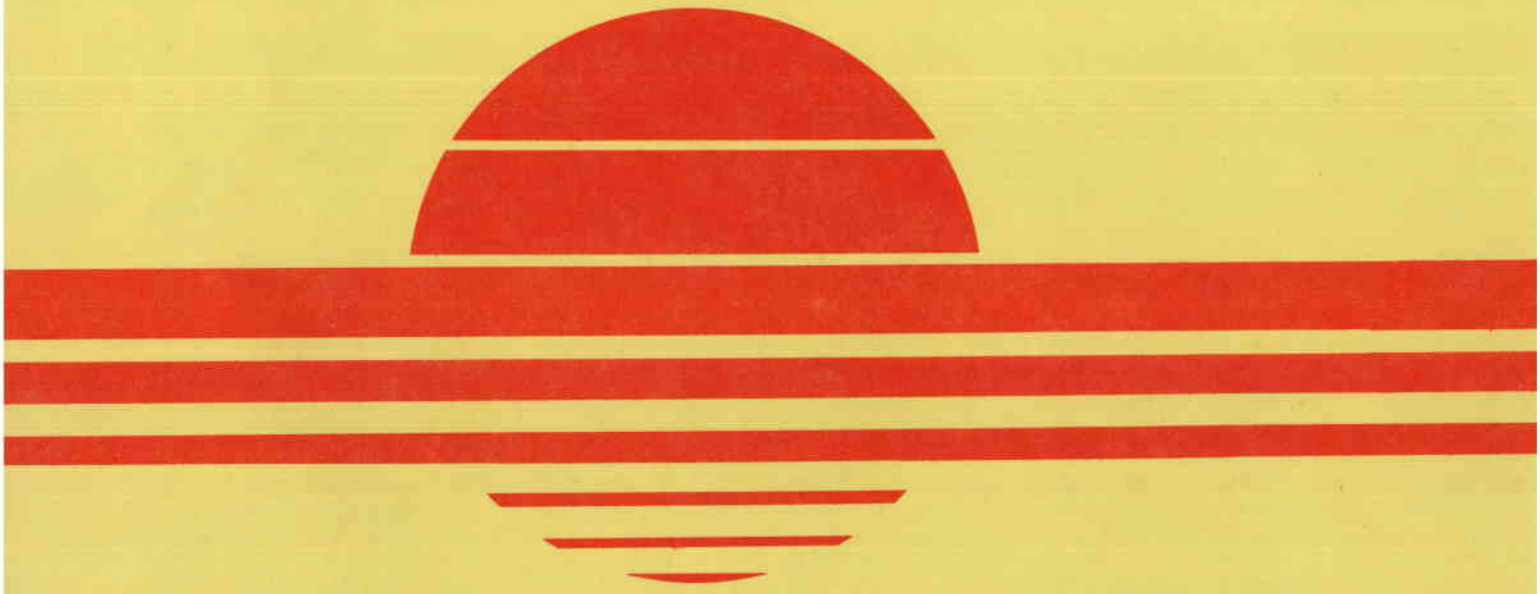
CONCEPTUAL DESIGN OF ADVANCED CENTRAL RECEIVER POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. FINAL REPORT

Volume 4, Commercial and Pilot Plant Cost Data

March 1979

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

Rockwell International
Energy Systems Group
Canoga Park, California



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OF
ADVANCED CENTRAL RECEIVER POWER SYSTEMS
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FINAL REPORT

VOLUME IV
COMMERCIAL AND PILOT PLANT COST DATA

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

University of Houston · Founded 1927

McDonnell Douglas Corporation

Salt River Project
Water ◆ Power

Stearns-Roger Engineering Co.

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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 "breakthroughs" 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						
	OM214 Thermal Storage Equipment	66			29		
	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

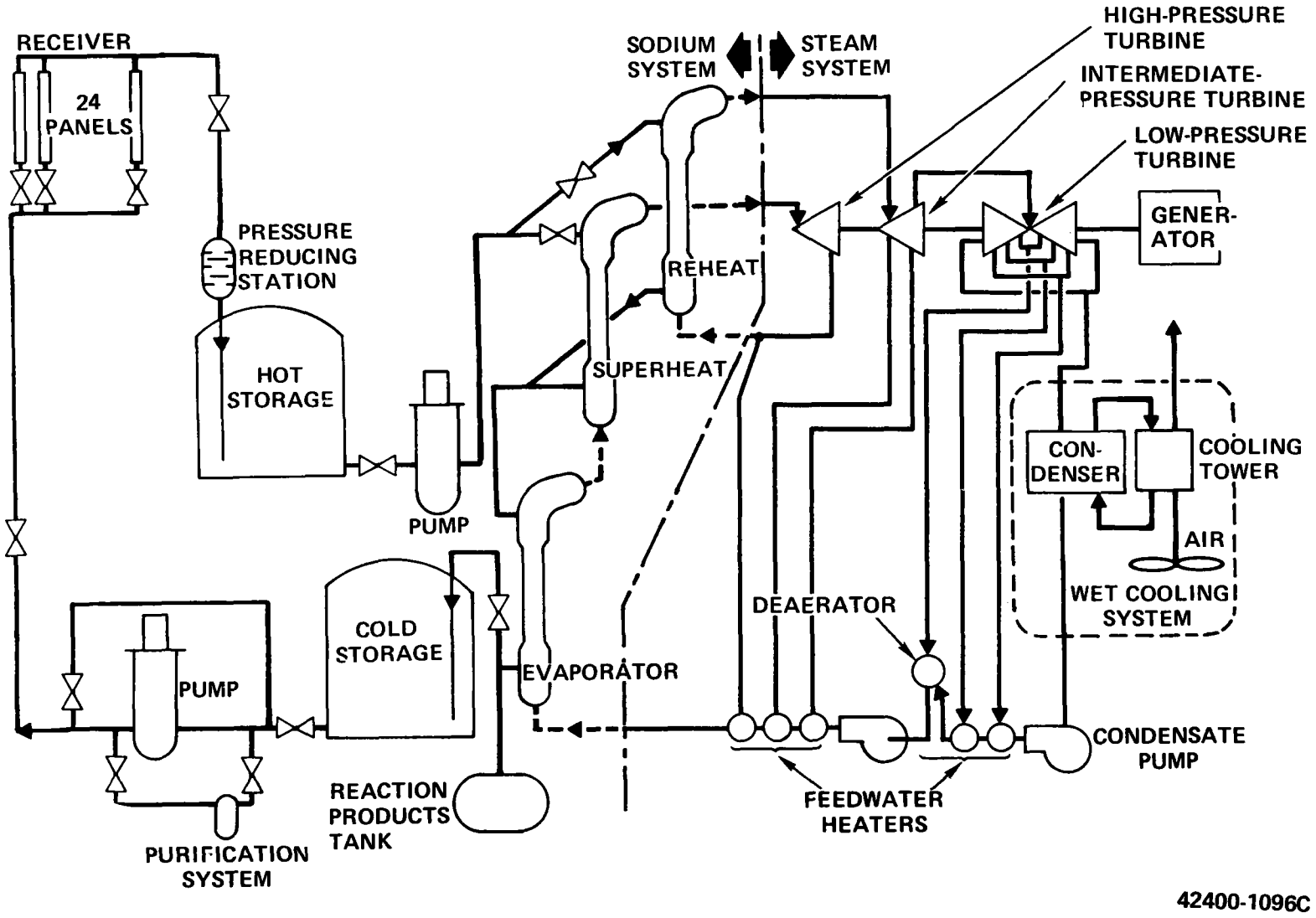

Figure 1. 100-MWe Baseline Concept With All-Sodium-Storage

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^o, 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 [^oC (^oF)]	288/593 (550/1100)
Receiver Sodium Flow Rate [kg/hr (lb/hr)]	3.66×10^6 (8.07×10^6)
Steam Generator Sodium Flow Rate (Direct Operation) [kg/hr (lb/hr)]	2.34×10^6 (5.29×10^6)

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, ^oC (psia, ^oF)]	
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 [^oC (^oF)]	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.

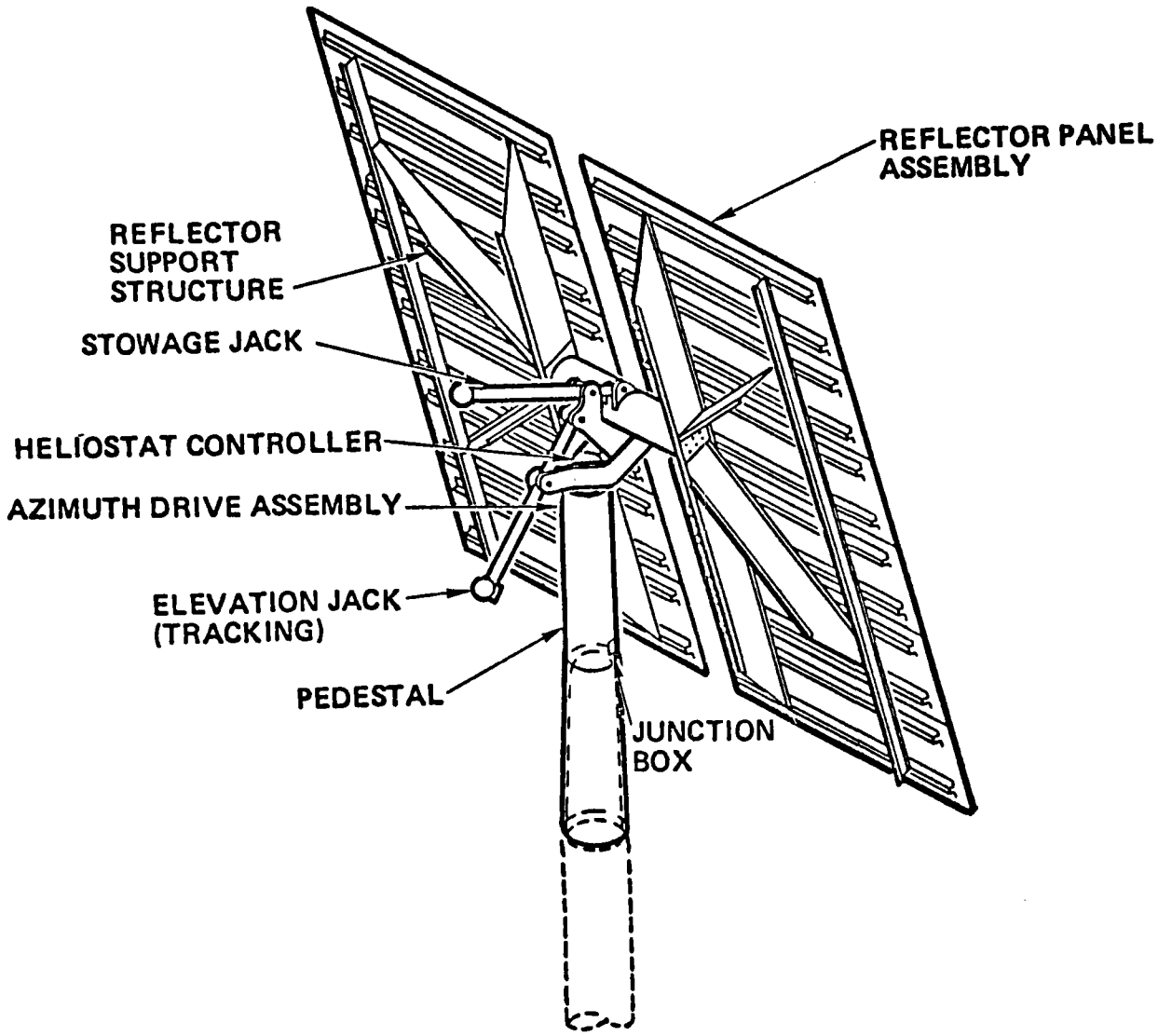

Figure 2. Prototype Heliostat Baseline

e. Baseline Scenarios

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

1) 25,000 units per year
2) 62,500 ft^2 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 diamete 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

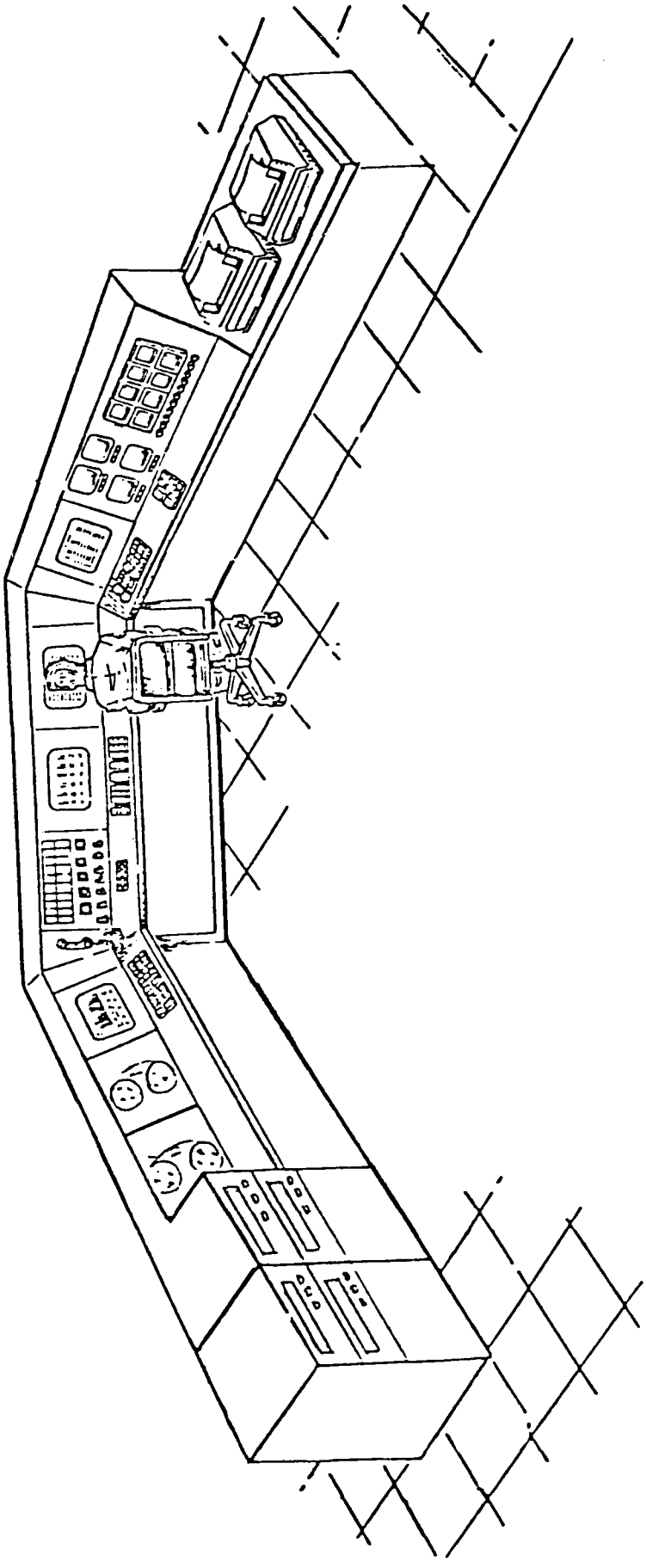

Figure 3. Master Control Unit

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

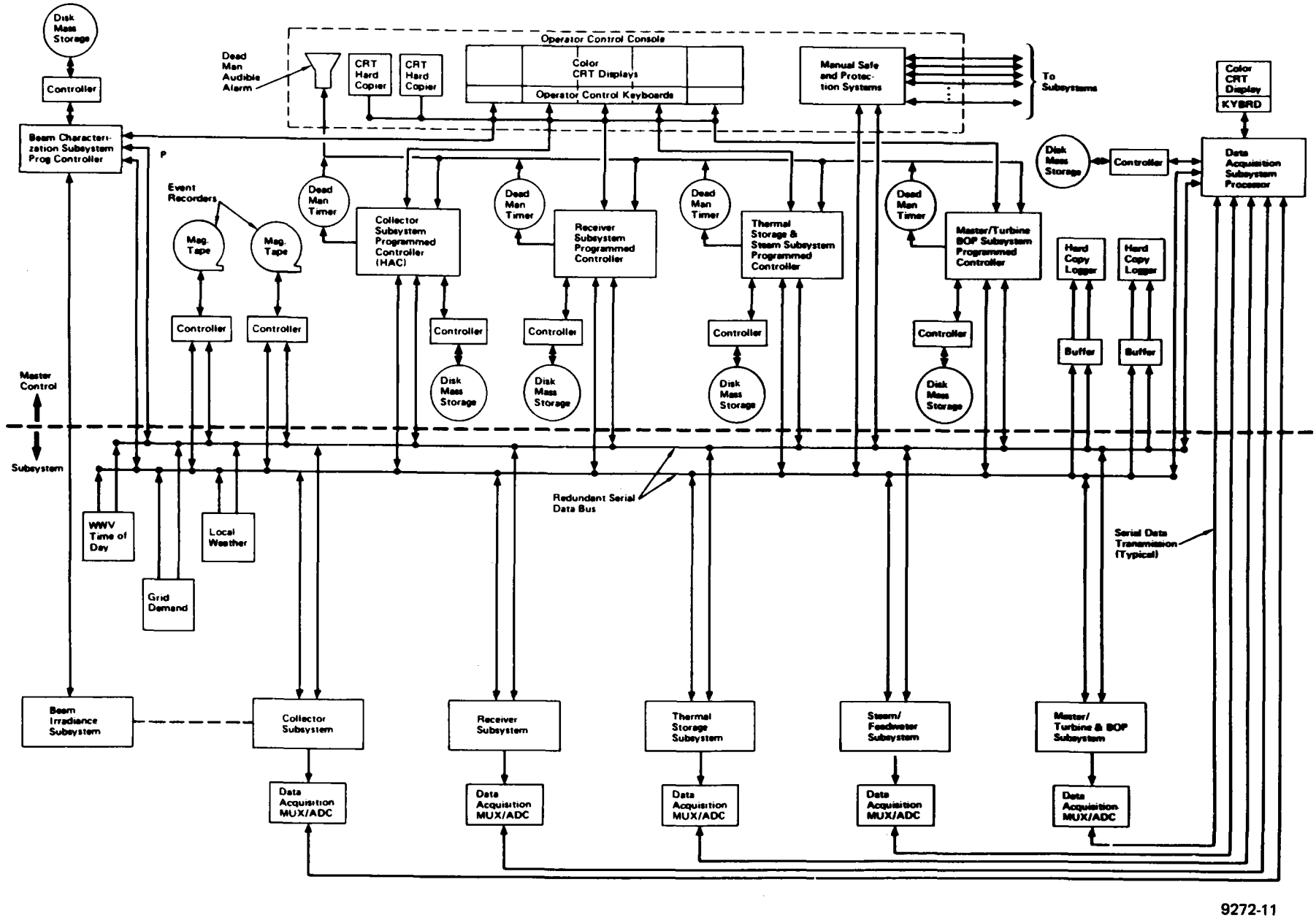

Figure 4. Pilot and First Plants — Master Control Subsystem — Block Diagram

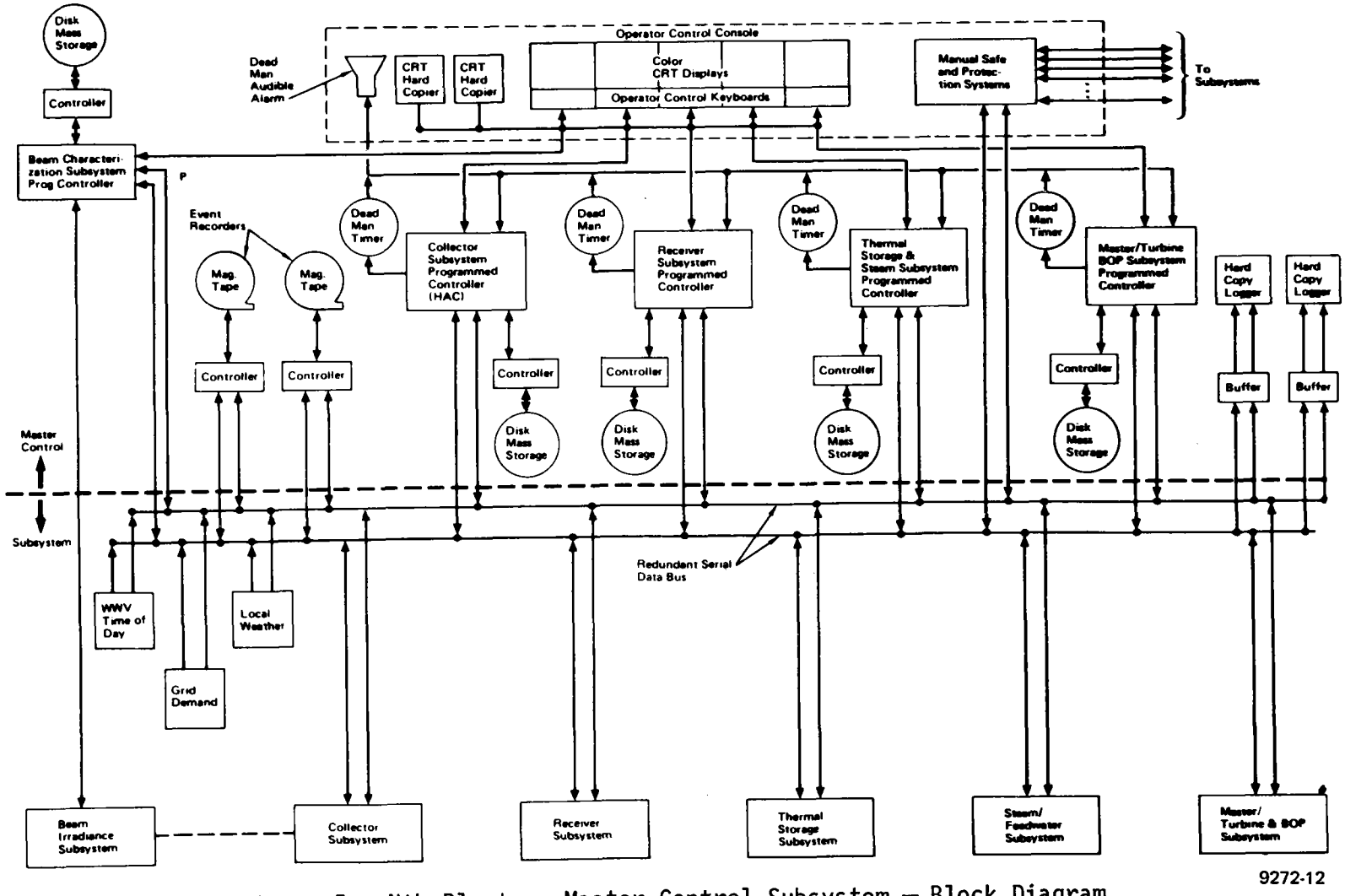

Figure 5. Nth Plants — Master Control Subsystem — Block Diagram

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 4550 Foundation		3,156				3,156	
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

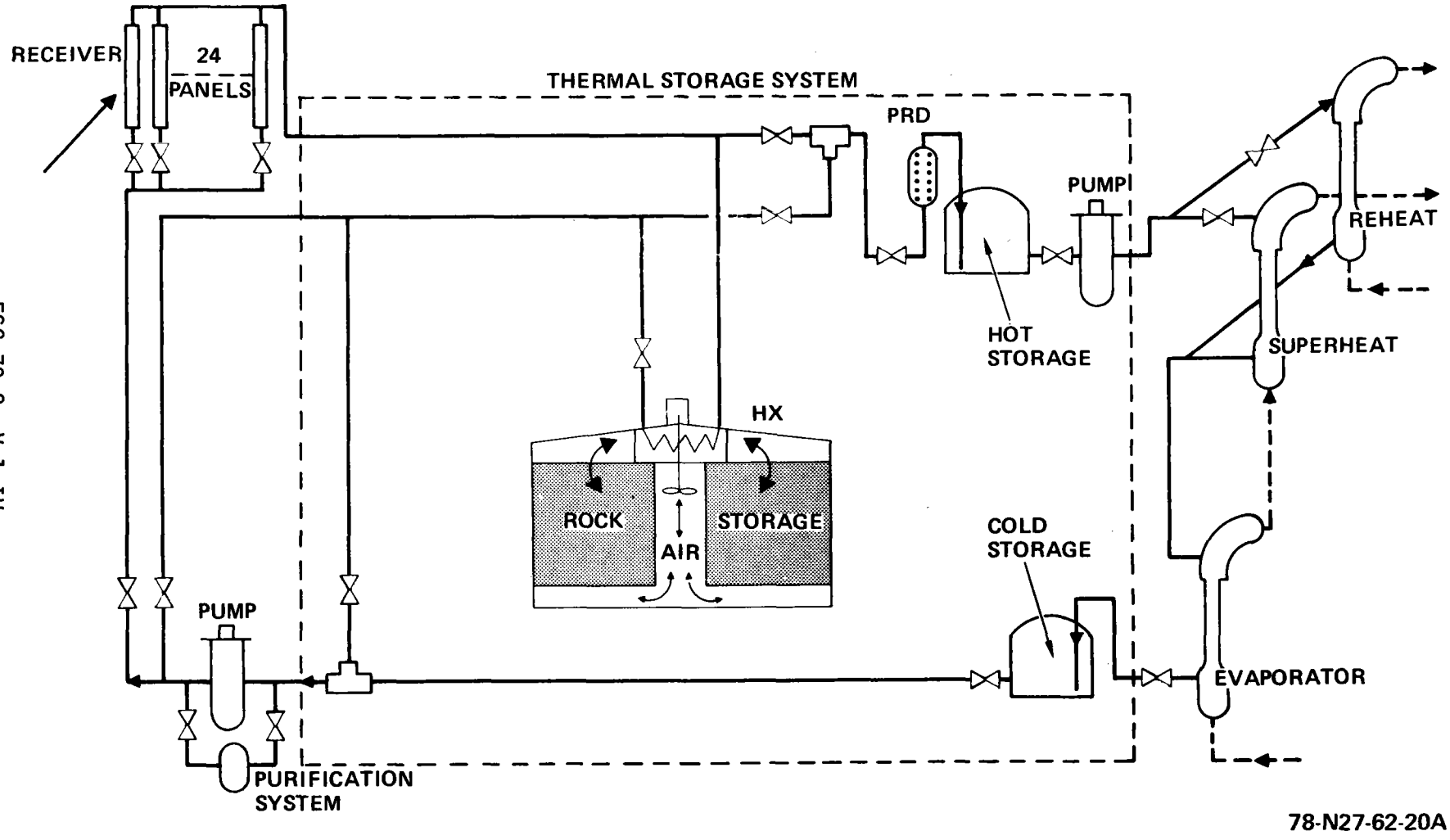

Figure 6. Advanced Central Receiver — Combined Air-Rock and All-Sodium Storage

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 Distribution 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 Installation	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	122			54		
	OM214 Thermal Storage Equipment						
	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

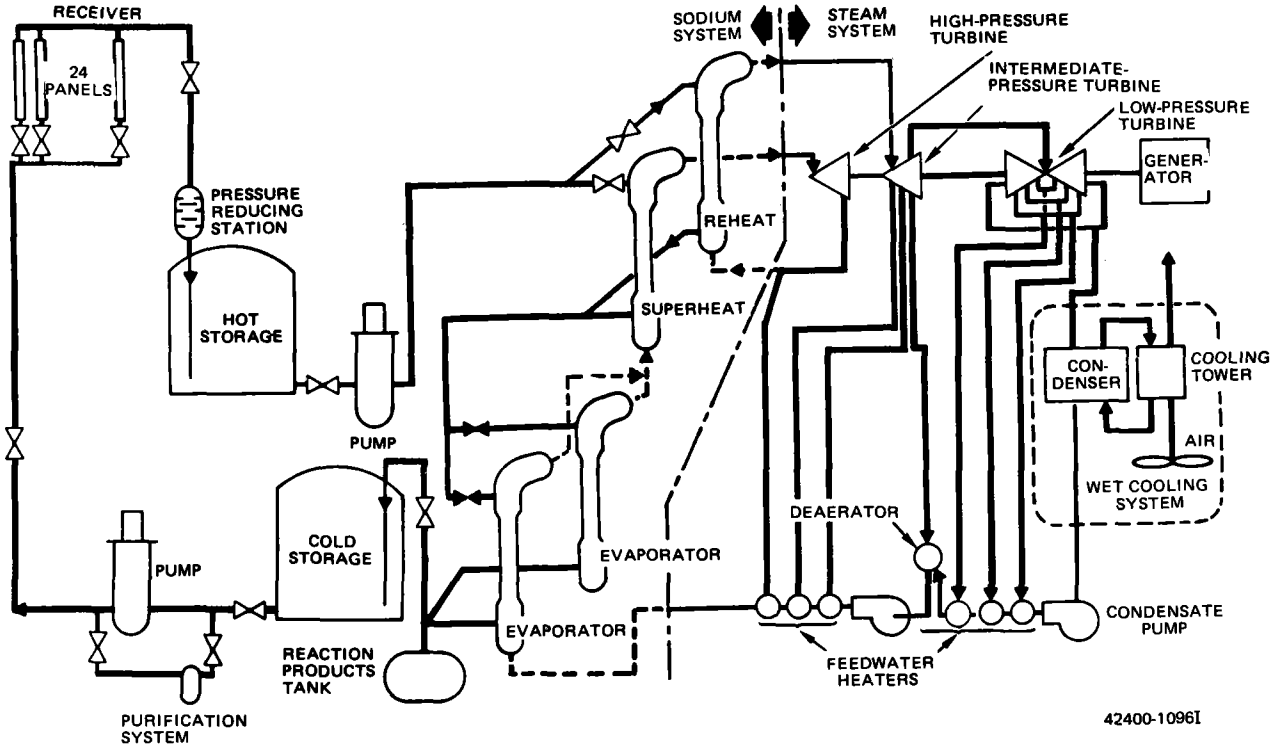

Figure 7. 281-MWe Commercial Plant With All Sodium Storage

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^o, 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 [^oC (^oF)]	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, °C (psia, °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 [°C (°F)]	242 (468)
Turbine Back Pressure [MN/m^2 (in. Hg)]	0.007 (2.0)
Heat Rejection [MW (Btu/hr)]	
Daytime	442 (1500×10^6)
Nighttime	420 (1430×10^6)

*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 1100^{o}F, 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 1000^{o}F will be provided for demonstration purposes, though the turbine may be limited to lower temperatures. An attemporator 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 Horizontal 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, Equipment, 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	

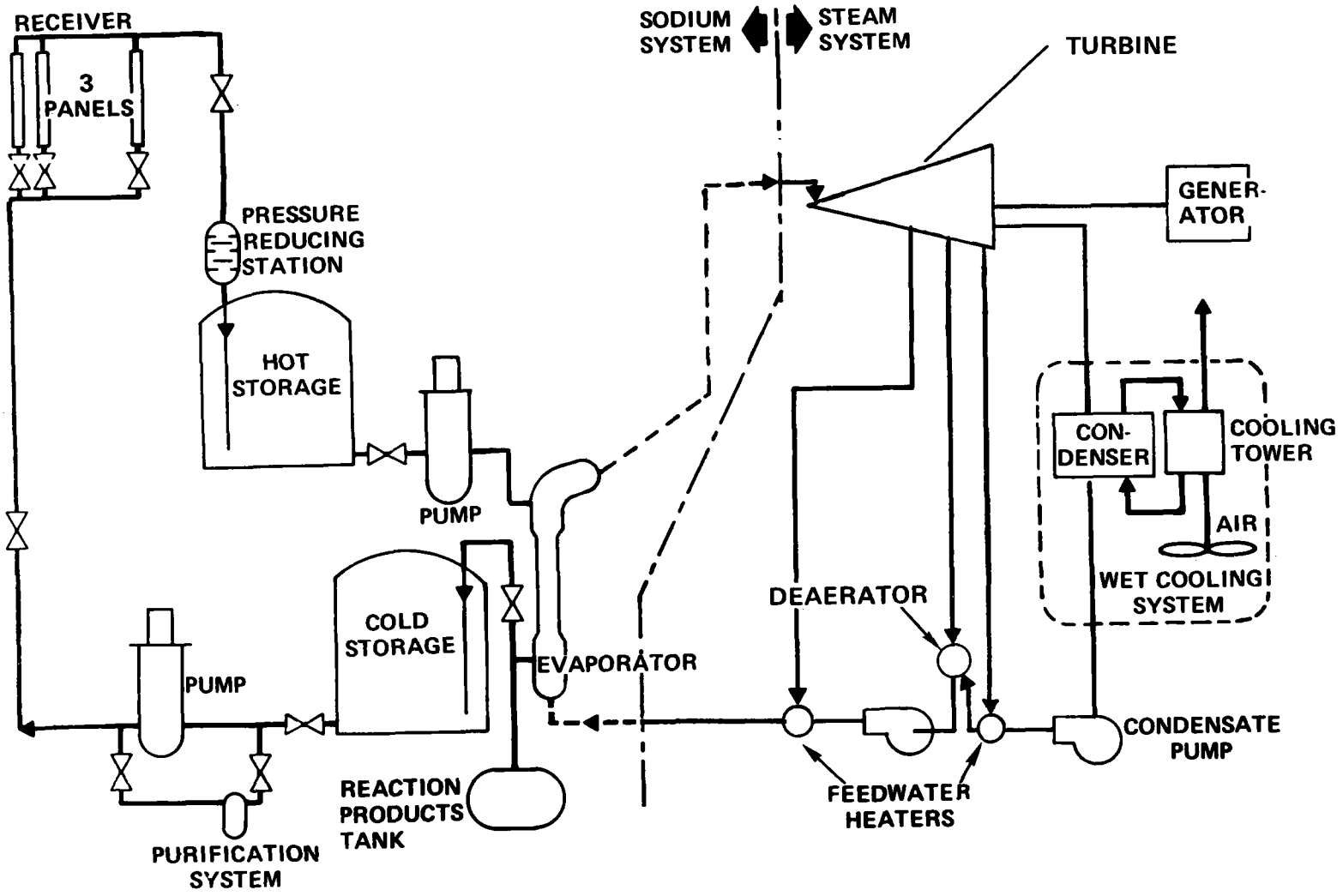

Figure 8. 10-MWe Pilot Plant With All-Sodium Storage

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 [^oC (^oF)]	288/593 (550/1100)
Receiver Sodium Flow Rate [kg/h (1b/h)]	0.337×10^6 (0.741×10^6)
Steam Generator Sodium Flow Rate (Direct Operation) [kg/h (1b/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, ^oC (psia, ^oF)]	
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 [^oC (^oF)]	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 1(shows the STEAEC block diagram, and Figure 11 shows the block diagram for BUCKS

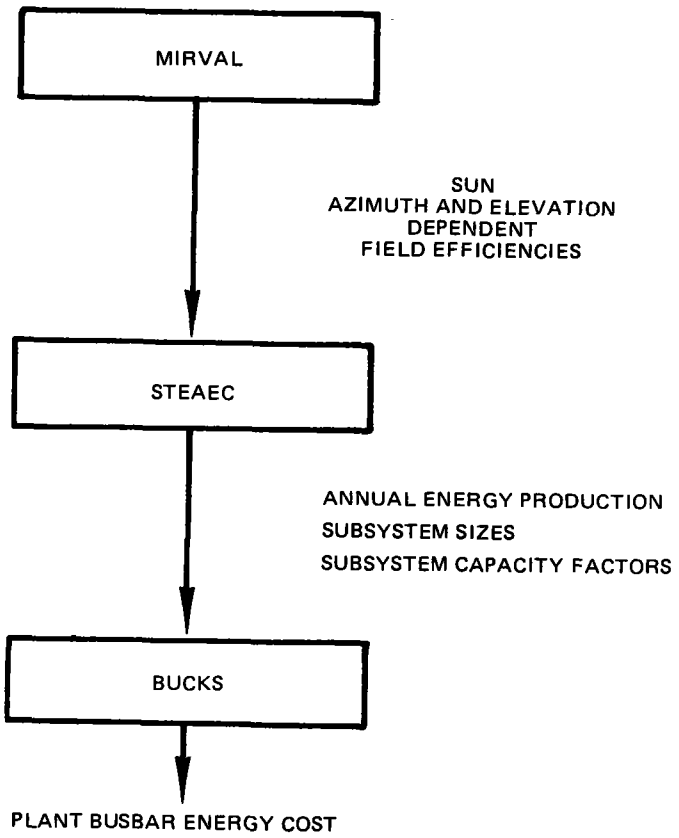

Figure 9. Solar Thermal Electric Power Plant Analysis Models

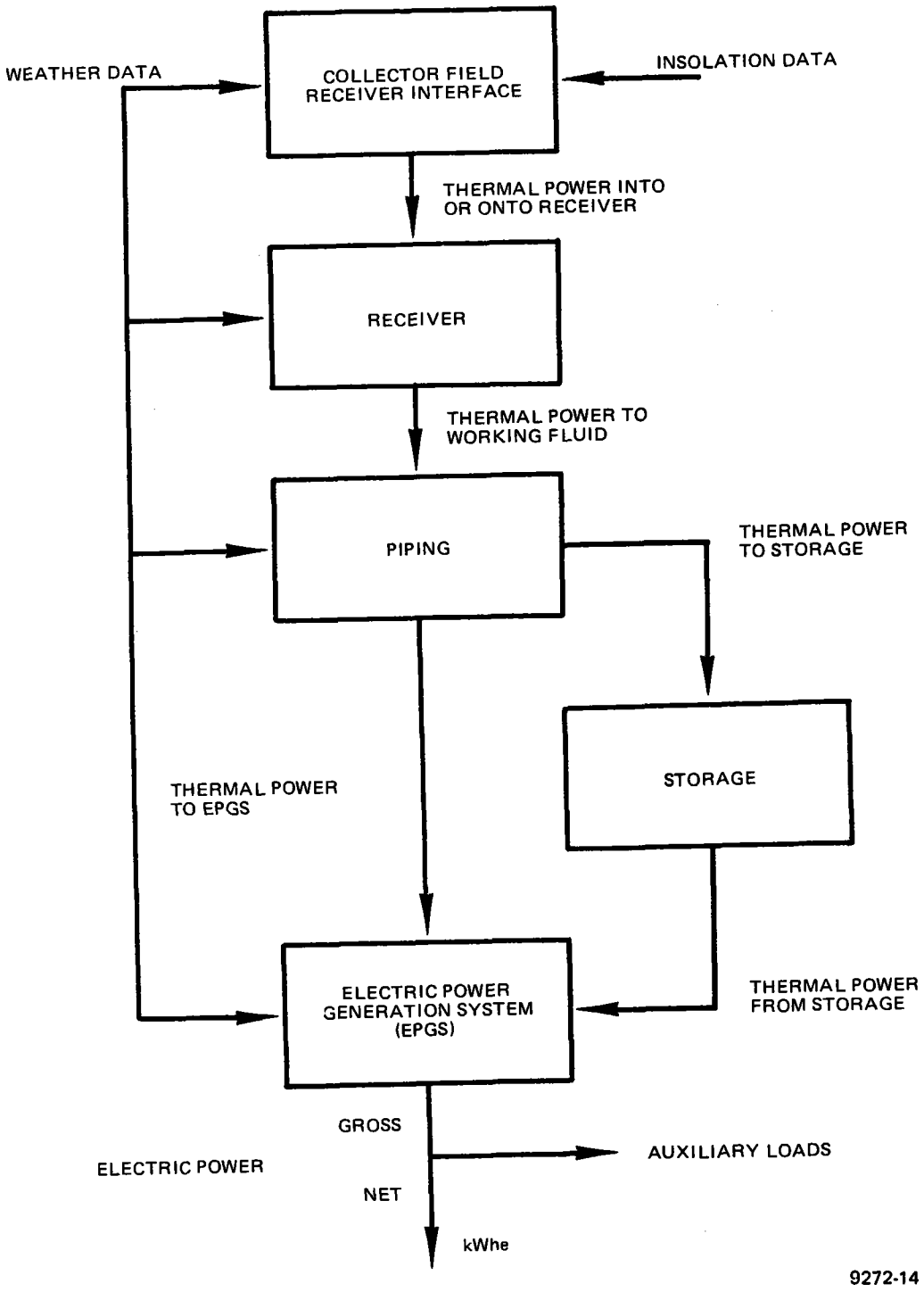

Figure 10. Solar Thermal Electric Annual Energy Calculator

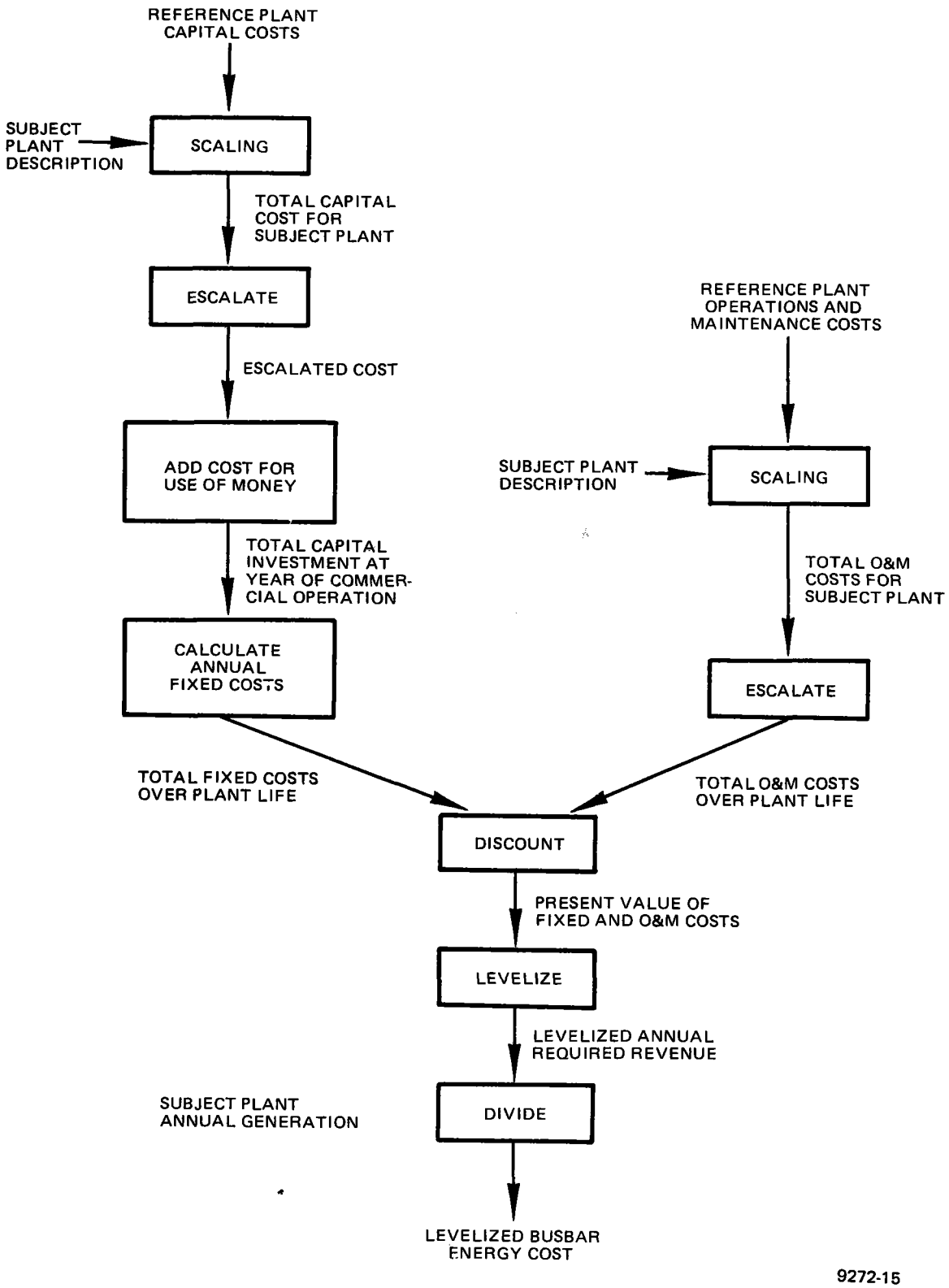

Figure 11. BUCKS

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 attentuation, 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

```
STEAEC.BLKDATA.FORT
      BLOCK DATA
      COMMON /DATA2/ PTWF, PWF, XT,          TR1, TR2, TR2A, TR3, PTS,
     1 PFS, PFT, PIT
      COMMON /STRGE/ SUPTS, UPFS, XES, XPFS, ESMAXP
      DATA PTWF /0./ , PWF /0./
      DATA SUPTS /0./ , UPFS /0./, XES /0./, XPFS /0./
      COMMON /COMCOE/ ELR(6), NX, AZR(7), NY, FR(6,7), COF(16,5,6),
     1 LCX, LCY
      COMMON /COMCOL/ FS, ASB, AOL, TLIML, TLIMU, ELIM, WSLIM, RELCTY
      COMMON /COMEFW/ NEFWS, WSX(8), WSEF(8)
      COMMON /COMRCV/ EPS , XHR, RS, ALPHAR, TCS, RMF, CAXP, DEPTF,
     1 MODPO, XTD, DTST
      COMMON /COMXLR/ NRXLR, NCXLR, RXLR(5), CXLR(6), FXLR(30)
      COMMON /COMXLP/ NXLP, TXLP(9), YXLP(9)
      COMMON /COMTRB/ ALPHA, BETA, TAUR, TAUS, ALPHR, ALPHS, TPFRL,
     1 TPFSL, AUXPC, TMFR, TMFS, SMFC, SMFD, TURBSS, MOPMF
      COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSR(6), FEPSR(24)
      COMMON /KOMEPS/ NREPSS, NCEPSS, REPSS(4), CEPSS(6), FEPSS(24)
      COMMON /COMSTR/ PTSMAX, PFSMAX, EMAX, EMIN, ES, XLL, A, B,
     1 ALPHC, ALPHD, ALPHL, C1, C2, C3, D1, D2, D3, LS
      COMMON /TSTATU/ ISBR, ISBT, ISUT, ISUS, IOFR, IOFS, IOFRPS,
     1 GCOPY4
      DATA AZR /0.,30.,60.,75.,90.,110.,130./ , NY /7/
      DATA ELR /5.,15.,25.,43.,65.,89.5/ , NX /6/
      DATA FR /
     1 .29150385, .56115821, .66819170, .72588351, .73519690, .72920901,
     1 .29079515, .54432693, .6653313., .71349580, .7450362, .72612763,
     1 .28273488, .53175144, .63130911, .71661620, .72234359, .72722612,
     1 .27557995, .51487068, .62427383, .69904697, .71418629, .72779114,
     1 .26982498, .50277789, .60764914, .68002701, .70804967, .72876434,
     1 .26387111, .47851924, .59189316, .66554903, .70130568, .73079122,
     1 .26016708, .47302487, .57601535, .65345907, .70355616, .74037288/
      DATA FS /889732./,
     1 ASB /3.934E-9/,
     1 AOL /3.934E-7/,
     1 TLIML /32.0/,
     1 TLIMU /104.0/,
     1 ELIM /0.0/,
     1 WSLIM /16.0/,
     1 RELCTY /0.857/
      DATA NEFWS /8/,
     1 WSX /0.0,2.0,4.0,6.0,8.0,10.0,12.0,13.4/,
     1 WSEF /1.0,0.9995,0.998,0.996,0.994,0.985,0.964,0.942/
      DATA EPS  /0.93677/,
     1 XHR /6.695E-2/,
     1 RS /560.0/,
     1 ALPHAR /0.5/,
     1 TCS /0.5/,
     1 RMF /0.10/,
     1 CAXP /3.824E-5/,
     1 DEPTF /0.15/,
     1 MODPO /2/,
     1 XTD /0.75/,
     1 DTST /0.75/
      DATA NCXLR /5/, RXLR /0.0,3.0,8.0,10.0,16.0/
      DATA NRXLR /5/, CXLR  /-4.0,32.0,68.0,104.0,140.0/
      DATA FXLR/
     1 2.446E-2,2.393E-2,2.339E-2,2.286E-2,2.232E-2,
     1 2.625E-2,2.571E-2,2.518E-2,2.464E-2,2.411E-2,
     1 2.857E-2,2.804E-2,2.750E-2,2.696E-2,2.643E-2,
     1 2.927E-2,2.873E-2,2.820E-2,2.766E-2,2.713E-2,
     1 3.059E-2,3.005E-2,2.952E-2,2.898E-2,2.845E-2/
      DATA NXLP /9/, TXLP /-22.,-4.,14.,32.,50.,68.,86.,104.,122./,
     1 YXLP /3.473E-4,3.393E-4,3.313E-4,3.232E-4,3.152E-4,3.071E-4,
     1 2.991E-4,2.911E-4,2.830E-4/
      DATA ALPHA /0.01158/,
     1 BETA /0.06417/,
     1 TAUR /1.5/,
     1 TAUS /21.5/,
     1 ALPHR /2.641E-2/,
     1 ALPHS /2.137E-2/,
     1 TPFRL /296.50/,
     1 TPFSL /285.00/,
     1 AUXPC /6.542E-3/,
     1 TMFR /0.25/,
     1 TMFS /0.26/,
     1 SMFC /0.05/,
     1 SMFD /0.109/,
     1 TURBSS /0.42238/,
     1 MOPMF /1/
      DATA NCEPSR /4/,  REPSR /0.25,0.50,0.75,1.00/
      DATA NREPSR /6/,  CEPSR /30.0,40.0,50.0,60.0,70.0,80.0/
      DATA FEPSR/
     1 .3450,.3440,.3430,.3415,.3310,.3230,
     1 .3760,.3755,.3745,.3725,.3685,.3615,
     1 .3843,.3835,.3830,.3820,.3730,.3720,
     1 .3860,.3855,.3850,.3840,.3800,.3740/
      DATA NCEPSS /4/,  REPSS /0.25,0.50,0.75,1.00/
      DATA NREPSS /6/,  CEPSS /30.0,40.0,50.0,60.0,70.0,80.0/
      DATA FEPSS/
     1 .213,.212,.212,.210,.207,.202,
     1 .254,.254,.253,.252,.249,.244,
     1 .267,.267,.266,.265,.262,.257,
     1 .284,.283,.282,.280,.277,.270/
      DATA PTSMAX /255.0/,
     1 PFSMAX /285.1/,
     1 EMAX  /1800.0/,
     1 EMIN  /70.0/,
     1 ES    /62.0/,
     1 XLL   /0.0025/,
     1 A   /0.003/,
     1 B   /0.00326/,
     1 ALPHC  /0.98/,
     1 ALPHD  /0.98/,
     1 ALPHL  /0.99970/,
     1 C1   /0.90570/,
     1 C2  /1.0390E-4/,
     1 C3  /-5.784E-8/,
     1 D1  /0.95220/,
     1 D2 /-6.025E-4/,
     1 D3  /2.448E-6/,
     1 LS /2/
      DATA ISBR /1/
      DATA ISBT /1/, ISUS /0/, IOFR /0/, IOFS /0/, IOFRPS/0/, ISUT /0/
      COMMON /MLBLK0/ NF,NI
      DATA NF/-1/,NI/0/
      END
```

TABLE 12

SALIENT ITEMS FOR ACR STEAEC INPUTS

```
ANARG.BLKDATA.FOR1
00030       BLOCK DATA
00040       COMMON /DATA2/ PTWF, PWF, XT,          TR1, TR2, TR2A, TR3, PTS,
00050      1 PFS, PFT, PTI
00060       COMMON /STRGE/ SUPTS, UPFS, XES, XPFS, ESMAXP
00070       DATA PTWF /0./ , PWF /0./
00080       DATA SUPTS /0./ , UPFS /0./, XES /0./, XPFS /0./
00090       COMMON /COMCOE/ ELR(6), NX, AZR(7), NY, FR(6,7), COF(16,5,6),
00100      1 LCX, LCY
00110       COMMON /COMCOE/ FS, ASB, AOL, TLIML, TLIMU, ELIM, WSLIM, RFLCTY
00120       COMMON /COMEFW/ NEFWS, WSX(8), WSEF(8)
00130       COMMON /COMRCV/ EPS , XHR, RS, ALPHAR, TCS, RMF, CAXP, DEPTF,
00140      1 MODPO, XID, DTST
00150       COMMON /COMXLR/ NRXLR, NCXLR, RXLR(5), CXLR(6), FXLR(30)
00160       COMMON /COMXLP/ NXLP, TXLP(9), YXLP(9)
00170       COMMON /COMTRB/ ALPHA, BETA, TAUR, TAUS, ALPHR, ALPHS, TPFRL,
00180      1 TPFSL, AUXPC, TMFR, TMFS, SMFC, SMFD, TURBSS, MOPMF
00190       COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSR(6), FEPSR(24)
00200       COMMON /COMEPS/ NREPSS, NCEPSS, REPSS(4), CEPSS(6), FEPSS(24)
00210       COMMON /COMSTR/ PTSMAX, PFSMAX, EMAX, EMIN, ES, XLL, 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 GCOP74
00250       DATA AZR /0.,30.,60.,75.,90.,110.,130./ , NY /7/
00260       DATA ELR /3.,15.,25.,45.,65.,89.5/ , NX /5/
00270       DATA FR /
00280      1 .0001,     .0001,     .0001,     .662,      .672,      .678,
00290      1 .0001,     .0001,     .592,      .640,      .667,      .0001,
00300      1 .300       .472,      .578,      .657,      .660,      .0001,
00310      1 .290,      .462,      .570,      .644,      .0001,     .0001,
00320      1 .288,      .463,      .561,      .631,      .0001,     .0001,
00330      1 .289,      .0001,     .0001,     .0001,     .0001,     .0001,
00340      1 .0001,     .0001,     .0001,     .0001,     .0001,     .0001/
00350       DATA FS /692000./,
00360      1 ASB /6.12E-7/,
00370      1 AOL /8.97E-7/,
00380      1 TLIML /32.0/,
00390      1 TLIMU /122.0/,
00400      1 ELIM /0.0/,
00410      1 WSLIM /16.0/,
00420      1 RFLCTY /1.0/
00430       DATA NEFWS /5/,
00440      1 WSX /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 /1.5/,
00510      1 RMF /0.02/,
00520      1 CAXP /0.0/,
00530      1 DEPTF /0.10/,
00540      1 MODPO /2/,
00550      1 XID /0.10/,
00560      1 DTST /0.55/
00570       DATA NCXLR /4/, RXLR /0.0,5.7,11.0,16.28/
00580       DATA NRXLR /5/, CXLR  /-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/
00650       DATA NXLP /9/, TXLP /-22.,-4.,14.,32.,50.,68.,86.,104.,122./,
00660      1 YXLP /8.287E-4,8.134E-4,7.982E-4,7.829E-4,7.677E-4,7.525E-4,
00670      1 7.372E-4,7.220E-4,7.067E-4/
00680       DATA ALPHA /0.0216/,
00690      1 BETA /0.00571/,
00700      1 TAUR /0./,
00710      1 TAUS /0./,
00720      1 ALPHR /2.7069E-2/,
00730      1 ALPHS /1.745E-2/,
00740      1 TPFRL /260.00/,
00750      1 TPFSL /250.00/,
00760      1 AUXPC /4.595E-3/,
00770      1 TMFR /0.14/,
00780      1 TMFS /0.14/,
00790      1 SMFC /0.02/,
00800      1 SMFD /0.10/,
00810      1 TURBSS /0.381/,
00820      1 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      1 .404,.401,.396,.388,.378,.367,
00870      1 .433,.433,.430,.424,.418,.410,
00880      1 .437,.437,.436,.434,.431,.424,
00890      1 .435,.435,.435,.435,.434,.430/
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 FEPSS/
00930      1 .404,.401,.396,.388,.378,.367,
00940      1 .433,.433,.430,.424,.418,.410,
00950      1 .437,.437,.436,.434,.431,.424,
00960      1 .435,.435,.435,.435,.434,.430/
00970       DATA PTSMAX /390.0/,
00980      1 PFSMAX /260.0/,
00990      1 EMAX  /812.5/,
01000      1 EMIN  /60.0/,
01010      1 ES    /60.0/,
01020      1 XLL   /0.00021/,
01030      1 A   /0.0082/,
01040      1 B   /0.00196/,
01050      1 ALPHC  /1.0/,
01060      1 ALPHD  /1.0/,
01070      1 ALPHL  /0.9973/,
01080      1 C1 /1.0/,
01090      1 C2 /0.0/,
01100      1 C3 /0.0/,
01110      1 D1 /1.0/,
01120      1 D2 /0.0/,
01130      1 D3 /0.0/,
01140      1 LS /1/
01150       DATA ISBR /1/
01160       DATA ISBT /1/, ISUS /0/, IOFR /0/, IOFS /0/, IOFRPS/0/, ISUT /0/
01170       COMMON /MLBLK0/ NF,NI
01180       DATA NF/-1/,NI/0/
01190       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, ^{O}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

```
ANABG.BLKDATA.FORT
00030       BLOCK DATA
00040       COMMON /DATA2/ PTWF, PWF, XT,        TR1, TR2, TR2A, TR3, PTS,
00050      1 PFS, PFT, PTT
00060       COMMON /STRGE/ SUPTS, UPFS, XES, XPFS, ESMAXP
00070       DATA PTWF /0./ , PWF /0./
00080       DATA SUPTS /0./ , UPFS /0./, XES /0./, XPFS /0./
00090       COMMON /COMCOE/ ELR(6), RX, AZR(7), NY, FR(6,7), COF(16,5,6),
00100      1 LCX, LCY
00110       COMMON /COMCOL/ FS, ASB, AOL, TLIML, TLIMU, ELIM, WSLIM, RFLCTY
00120       COMMON /COMEFW/ NEFWS, WSX(8), WSEF(8)
00130       COMMON /COMRCV/ EPS , XHR, RS, ALPHAR, TCS, RMF, CAXP, DEPTF,
00140      1 MODFO, XTD, DTST
00150       COMMON /COMXLR/ NRXLR, NCXLR, RXLR(5), CXLR(6), FXLR(30)
00160       COMMON /COMXLP/ NXLP, TXLP(9), YXLP(9)
00170       COMMON /CONTRB/ ALPHA, BETA, TAUR, TAUS, ALPHR, ALPHS, TPFRL,
00180      1 TPFSL, AUXPC, TMFR, TMFS, SMFC, SMFD, TURBSS, MOPMF
00190       COMMON /COMEPS/ NREPSR, NCEPSR, REPSR(4), CEPSR(6), FEPSR(24)
00200       COMMON /KOMEPS/ NREPSS, NCEPSS, REPSS(4), CEPSS(6), FEPSS(24)
00210       COMMON /COMSTR/ PTSMAX, PFSMAX, EMAX, EMIN, ES, XLL, 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 GCOF74
00250       DATA AZR /0.,30.,60.,75.,90.,110.,130./ , NY /7/
00260       DATA ELR /5.,15.,25.,45.,65.,89.5/ , 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 FS /692000./,
00360      1 ASB /6.12E-7/,
00370      1 AOL /8.97E-7/,
00380      1 TLIML /32.0/,
00390      1 TLIMU /122.0/,
00400      1 ELIM /0.0/,
00410      1 WSLIM /16.0/,
00420      1 RFLCTY /1.0/
00430       DATA NEFWS /5/,
00440      1 WSX /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 /0.02/,
00520      1 CAXP /0.0/,
00530      1 DEPTF /0.0/,
00540      1 MODFO /1/,
00550      1 XTD /1.0/,
00560      1 DTST /0.55/
00570       DATA NCXLR /4/, RXLR /0.0,5.7,11.0,16.28/
00580       DATA NRXLR /5/, CXLR  /-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-2,4.548E-2,
00610      1 4.548E-2,4.548E-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-2,5.230E-2,
00630      1 5.932E-2,5.932E-2,5.932E-2,5.932E-2,5.932E-2,5.932E-2/
00650       DATA NXLP /9/, TXLP /-22.,-4.,14.,32.,50.,68.,86.,104.,122./,
00660      1 YXLP /8.287E-4,8.134E-4,7.982E-4,7.829E-4,7.677E-4,7.525E-4,
00670      1 7.372E-4,7.220E-4,7.067E-4/
00680       DATA ALPHA /0.3216/,
00690      1 BETA /0.00571/,
00700      1 TAUR /0./,
00710      1 TAUS /0./,
00720      1 ALPHR /2.7069E-2/,
00730      1 ALPHS /1.765E-2/,
00740      1 TPFRL /260.00/,
00750      1 TPFSL /250.00/,
00760      1 AUXPC /4.595E-3/,
00770      1 TMFR /0.0/,
00780      1 TMFS /0.0/,
00790      1 SMFC /0.0/,
00800      1 SMFD /0.0/,
00810      1 TURBSS /0.381/,
00820      1 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      1 .404,.401,.396,.388,.378,.367,
00870      1 .433,.433,.430,.424,.418,.410,
00880      1 .437,.437,.436,.434,.431,.424,
00890      1 .435,.435,.435,.435,.434,.430/
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 FEPSS/
00930      1 .404,.401,.396,.388,.378,.367,
00940      1 .433,.433,.430,.424,.418,.410,
00950      1 .437,.437,.436,.434,.431,.424,
00960      1 .435,.435,.435,.435,.434,.430/
00970       DATA PTSMAX /390.0/,
00980      1 PFSMAX /260.0/,
00990      1 EMAX  /812.5/,
01000      1 EMIN  /60.0/,
01010      1 ES    /60.0/,
01020      1 XLL   /0.00021/,
01030      1 A  /0.0/,
01040      1 B  /0.0/,
01050      1 ALPHC  /1.0/,
01060      1 ALPHD  /1.0/,
01070      1 ALPHL  /0.9973/,
01080      1 C1 /1.0/,
01090      1 C2 /0.0/,
01100      1 C3 /0.0/,
01110      1 D1 /1.0/,
01120      1 D2 /0.0/,
01130      1 D3 /0.0/,
01140      1 LS /1/
01150       DATA ISBR /1/
01160       DATA ISBT /1/, ISUS /0/, IOFR /0/, IOFS /0/, IOFRPS/0/, ISUT /0/
01170       COMMON /MLBLK0/ NF,NT
01180       DATA NF/-17,NT/0/
01190       END
READY
```

TABLE 15

STEAEC 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
Base Sizes		
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	
Maintenance — Annual		
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 MWTH 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 YEAR$

		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 YEAR$

		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 YEAR$

		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 YEAR$

		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 YEAR$

		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 YEAR$	
		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 YEAR$	
		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 YEAR$	
		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

Atomics International Division

JOB NO 133-4 PROJECT 100 MW LOCATION CLIENT

DATE 9-1-78 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
					ACCOUNT				
LAND "FURNISHED BY USER"					4111				
SITE INCLUDING FENCING, UTILITIES & INPUT FROM MDAC UNDER ACCOUNT #4400					4112				1500000
CODE 4110 SITE									1500000

Form 702-D Rev. 11-73

ESG-79-2, Vol IV
A-2

Atomics International Division

JOB NO 133-026802 PROJECT 100 MW LOCATION CLIENT

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
BUILDINGS ACCOUNT SUPPLIED BY S. TEARNS - ROGER									
CODE 4120 BUILDINGS									

Form 702-D Rev. 11-73

Atomics International Division

JOB NO 133-02GR01 PROJECT 100 MW LOCATION _____ CLIENT _____

DATE 4-17-78 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
					ACCOUNT				
TRANSPORTATION & LIFTING EQUIP.					4131	STEARNS-ROGER			181000
COMMUNICATION EQUIPMENT					4132	"	"		110000
OTHERS					4133	"	"		850000
MDAC COLLECTOR SYSTEM					4131	MDAC			540000
"EXTRAPOLATED FROM STEARNS-ROGER ESTIMATE FOR 300 MW PLANT"									
CODE 4130 MISCELLANEOUS EQUIPMENT									1681000

Form 702-D Rev. 11-75

Atomics International
D/798 Correspondence

ACTION

REPLY 17

REPLY DUE

REMARKS

ANDERSON, S. H.
ASHWORTH
ASQUITH
BALENT
BAUMASH
BOTTS
BRINDLEY
CARDENAS
COCHRAN, J.C.
CRAWFORD
DE LOS PRADOS
DETTERMAN
FEILER
GYLFE
HARTZLER
HILLIG
HOLBROOK
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JACOBSON, J.
JONES, R.G.
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LULOVICS
MARTIN, A.B.
McCOURT X
McDERMOTT
McDONALD, J.S.
McKENZIE, D.E.
MEYERS, G.W.
MOREWITZ
MOSS
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PARKINS
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T.S. WILLIAMS
Orean X
Springer X
Katz X
Wiegow X
Thornton
D. Johnson
Granger
T. Bates

FORM NO. 21-1 REV. 12-77

Stearns-Roger
ENGINEERING CO.

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/ESG

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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.

AWM'Kenzie
A. W. McKenzie
Project Engineer

AWM:vr

cc: Steve Chalmers - SRP

Ator / Roc — rnational Division / national

JOB NO. 133-02GR01 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-17-78 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
TRANSPORTATION & LIFTING EQUIP.									181,000
COMMUNICATION EQUIPMENT									110,000
OTHERS									850,000
"EXTRAPOLATED FROM STEARNS-ROGER ESTIMATE FOR 300 MWe PLANT"									
CODE 4130 MISCELLANEOUS EQUIPMENT									1,141,000

Form 702-D Rev. 11-73

Atomic Rockwe onal Division onal

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

DATE 7-30-78 TAKE-OFF _____ PRICED _____ CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL

J. Chauvet

Telcon with Al McKenzie 5/31/78 2:30 p. m.

ACCOUNT: 4200 TURBINE PLANT EQUIPMENT

Subaccount No.	Description	Cost
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	2,378,000
TOTAL		$19,424,000

CODE 4200 TURBINE PLANT EQUIPMENT

Form 702-D Rev. 11-73

Atomic :national Division
Rockw :national

JOB NO 133-026R02 PROJECT 1000 MW LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ELECTRIC PLANT EQUIPMENT SUPPLIED BY "STEARNS-ROGERS & MDAC"									3553000 1281000
CODE 4300 ELECTRIC PLANT EQUIPMENT									4834000

Table A

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

1978 DOLLARS AND HOURS IN THOUSANDS

CBS	COST ELEMENT	LABOR HOURS	LABOR DOLLARS	NON-LABOR	TOTAL
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	6.48	217.74	13.51	231.25
	Subtotal	8.85	$301.34	$279.03	$580.37
	Visibility		60.66	55.97	116.63
	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

1978 DOLLARS AND HOURS IN THOUSANDS

CBS	COST ELEMENT	LABOR HOURS	LABOR DOLLARS	NON-LABOR	TOTAL
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	5.07	170.04	10.37	180.41
	Subtotal	7.44	$236.23	$169.38	$405.61
	Visibility		47.77	33.62	81.39
	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)

WBS NUMBER AND TITLE		CAPITAL INVESTMENT — LABOR HOURS (THOU)	LABOR DOLL ($M)	MATL $ ($M)	TOTAL ($M)
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

WBS NUMBER AND TITLE		CAPITAL INVESTMENT			
		LABOR		MATL $	TOTAL
		HOURS (THOU)	DOLL ($M)	($M)	($M)
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	39.50	.55	.01	.56
	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			
		LABOR		MATL $	TOTAL
	WBS NUMBER AND TITLE	HOURS (THOU)	DOLL ($M)	($M)	($M)
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	40.17	.60	0	.60
	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)

WBS NUMBER AND TITLE		CAPITAL INVESTMENT			
		LABOR		MATL $	TOTAL
		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

		CAPITAL INVESTMENT			
		LABOR		MATL $	TOTAL
	WBS NUMBER AND TITLE	HOURS (THOU)	DOLL ($M)	($M)	($M)
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	Heliostat	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 Heliostats	11.28	.25	0	.25
4465	Field Support	15.51	.35	0	.35
4466	Pack & Transp	32.46	.46	.01	.47
	Subtotal - Heliostat	556.91	10.54	35.27	45.82
	Visibility	-	2.11	3.52	5.63
	TOTAL HELIOSTAT		12.65	38.79	51.45

Table 4-3

NTH COMMERCIAL HELIOSTAT INVESTMENT COST - 100 MWe

WBS NUMBER AND TITLE		CAPITAL INVESTMENT			
		LABOR		MATL $	TOTAL
		HOURS (THOU)	DOLL ($M)	($M)	($M)
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	40.17	.60	0	.60
	TOTAL O&M	40.17	.60	.17	.77
Ongoing O&M		20.70	.31	.14	.45

Atomic Rockwell tional Division ional

JOB NO. 33-026-R02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-27-78 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
4511									4,022,000
4512									2,364,000
4513									1,526,000
4514									1,452,000
4515									1,316,000
CODE 4510 RECEIVER SUMMARY									85,510,000

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Rockwell

JOB NO 33-026R02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-27-78 TAKE-OFF JC/JW PRICED JC/J.W CALC. CHKD _____ APPROVED _____ SHEET 1 OF 7

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEET # 2									1608000
3									1128000
4									87000
5									172000
6									107000
7									2497553
									3351553
MANAGEMENT RESERVE @ 20%									670351
									4022104
CODE 4511 ABSORBER UNIT SUMMARY								ROUND TO	4022000

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International Division, Atomics International, Rockwell

JOB NO 133,026,R07 PROJECT ABSORBER PANEL LOCATION ______ CLIENT ______

DATE 4-4-78 TAKE-OFF JMW PRICED JMW CALC. CHKD ______ APPROVED ______ SHEET 2 OF ______

		ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
		REF: TABLES 5-6 + 5K 24 PANELS REQD 1-SHOWN									
2400	(1)	TUBING 110 3/4 OD x .049 x 62' 13668 304H	6820	FT	1.73		2502	11799			
240	(2)	HEADER 1-6-STD IPS x 14.25' (at 2) .28 1697 "	14.25	"	31.00'		270	442			
13	(3)	" ENDS 6-STD CAP "	2	ea	72.00 ea		13	144			
49	(4)	" FTG 6-90° L.BELL "	2	ea	192.00 ea		49	384			
30	(5)	TUBEHEADER 2 PL 3/4 x 2 1/2" x 7.1' "	14.25	FT	1.50		91	137			
800	(6)	SUP 13 L 1/4 x 3 x 3 x 7' 4.9 "	169	"	1.23		828	1018			
		WEL .049 BW TUBE TO HEADER A/T.A "	220	ea	4.50		2	9			
		HEADER BW .28 V .357 A.T.A "	29	FT	4.50		11	50			
		SUPPORT 1/4 FW .1 TIG HAND "	50	"	"		5	22			
		TUBE BENDS 110° "	220	ea		15.00 ea		-		3300	
		WELD TUBES V .049 .102 " A.T.A "	5500	FT	4.50		110	495			
		FTG B.W 6-40 .28 V	4	ea	"		2.5	11			
50	(7)	HEADER LS 1 L 3/8 x 6 x 6 x 4' (at 4)	4	FT	1.50		60	90			
20	(8)	PYROMARK 600#	.4	GAL	50.00		32				
	(9)	TUBE TO HEADER JIG (24000)	1/24							1000	
	(10)	MISC MATL	L.S					500			
		WELD DEVELOPMENT								1000	
3602		SUB-TOTAL					3974	15101		5300	20401
		MATL O.H ~10%									2039
		FABRICATION LABOR	985	HR		31.06			30594		30594
		SUB-TOTAL									53034
		VENDOR G+A ~10%									5366
		SUB-TOTAL									58400
		VENDOR PROFIT ~15%									8600
		ESTIMATED PRICE 1-UNIT CURRENT DOLLARS									67000
		X 24									1608000
	CODE 4511	ABSORBER UNIT									

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Atomic International Division
Rockwell International

JOB NO 133.026 RW PROJECT ABSORBER PANEL PIPING LOCATION CLIENT

DATE 4-5-78 TAKE-OFF JHW PRICED JHW CALC. CHK'D APPROVED SHEET 3 OF

	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
NET WT	REF TABLE 5-5 ISK 24 REQD 1-	SHOWN		SHOP		FABR WT				
(1)	OUTLET PIPE 26-STD IPS X 20' T304	40	FT	31.00		760	1240			
(2)	INLET " 12- DO X 20' "	40	FT	"		760	1240			
(3)	~~INLET FOOT HANGERS~~									
	BENDS 6-STD #7½ MH1	6	ea		267.00				1602	
	" DO #7	2	ea		267.00				534	
SHOP	WELD, 280 V 5 sch .64 HAND T304	9	FT	4.50		6	27			
FIELD	" DO 4 sch .64 " "	7	"	"		5	23			
(4)	PIPE HANGERS SIMILAR	10	ea	100.00	10	500	1000			
(5)	CONTROL VALVE 6"	1	"	600.00		400	6000			
(6)	BLOCK VALVE 6"	1	"	3000.00		300	3000			
(7)	SNUBBER 40 MHR EA	2	"	1200.00		400	2400			
	MISC MATL	L.S				300	500			
3000	SUB-TOTAL MATL					3431	14940		2136	17076
	MATL OH ~10%									1724
	SHOP LABOR	60	MH		30.00			1800		1800
	FIELD LABOR 5M2D = 80 X L PIPE	160	"		30.00			4800		4800
	HANGERS	50	"		30.00			1500		1500
	SNUBBERS	80	"		"			2400		2400
	FIELD EFFICIENCY 60% 5700									5220
	SUB-TOTAL									34520
	SHOP G+A ~10% 2060									2060
	FIELD OH & BOND OF 13,920									4220
	SUB-TOTAL									40800
	VENDOR PROFIT ~15%									6200
	ESTIMATED PRICE INSTALLED UNIT CURRENT DOLLARS									47000
	TOTAL 24 UNITS									1128000
CODE 4511	ABSORBER UNIT									

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Atlantic Richfield International Division

JOB NO 133,046 B07 PROJECT ABSORBER INLET PIPE LOCATION _____ CLIENT _____

DATE 4-5-78 TAKE-OFF [signature] PRICED [signature] CALC. CHKD _____ APPROVED _____ SHEET 4 OF _____

		ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
		REF: TABLE 5.5 9SK INLET LINE 1 - REQD									
5500	(D)	PIPE 3-20"ODX 3/8WX 23.2' 78.6# T304	71.25	FT	2.30#		5600	12880			
8260	(E)	" 3-20"ODX 3/8WX 23.1' 121# "	69.3	FT	2.30#		8385	19286			
155	(3)	" - HD 1-30" 2:1 SE HD 1-R 3/8X3.25 R3.25 "	11.6	#	1.25		197	246		100	
46	(4)	" - BOT 1-R 1/2 V 2.5'X 2.5' "	6.25	"	1.35		144	194			
150	(5)	NOZZLE 1-200DX 3/8W X 2' "	2	FT	2.30		157	361			
	SHOP	WELD 3/8 V .66 HAN "	40	"	4.50		34	152			
15	(6)	SPACERS 3/8X5X2' (Cut 4) "	2	"	1.74		17	30			
200	(7)	REL LINE 8 1/2-40 IPS X 20' 2.718 "	180	"	10.00		2.15	1800			
	(8)	PIPE BENDS 1 1/2-40 "	32	ea		1/4.00				1408	
	SHOP	WELD .145 V 1 1/2 IPS 82 EA .15 HANG	6	"	4.50		3	14			
		FIELD WELD 2-20" V .36 HANG	14	"	4.50		10	45			
		" " 8-1 1/2 V .145	4	"	"		4	18			
120		MISC MATL				1/2.50	200	300			
1438		PIPE HANGERS	12	ea	5.00		25	60			
		SUB-TOTAL					14991	34386		1508	35894
		SHOP LABOR	420	HR		3/00			12400		12400
		FIELD LABOR VESSEL SMLNS	200	"		30.00			6000		6000
		" LABOR 1 1/2 IPS 3M 2D X 4	100	"		30.00			3000		3000
		" LABOR EFFICIENCY 60% OF 9000							5400		5400
		MATL OH N/C TO OF 35894									3586
		SUB-TOTAL									66280
		SHOP G+A N/C TO OF 5/880									5120
		FIELD OVER HEAD 30% OF 14,400									4300
		SUB-TOTAL									75700
		VENDOR PROFIT N/5%									11300
		ESTIMATED COST INSTALLED CURRENT DOLLARS									87000
	CODE										
	4511	ABSORBER UNIT									

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Atomics International Division
Rockwell International

JOB NO. 33026.R02 PROJECT ABSORBER EXPANSION TANKS LOCATION CLIENT

DATE 4-5-78 TAKE-OFF JMW PRICED JMW CALC. CHK'D APPROVED SHEET 5 OF

NET WT		ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
		TABLE 5.5 SK 4-6'Ø X 14.5' ST SHELL VERT	TANKS	1 - SHOWN			FABR WT				
1308	(1)	HEADS 2 PL 3/8 X 7' V7' T304	98	#	1.20		1666	1999			
4864	(2)	SHELL 2 PL 3/8 X 7.6' X 19' "	289	"			4913	5896		200	
2338	(3)	SKIRT 1 PL 3/8 X 7' X 19' "	133	"			2261	2713			
240	(4)	" BASE 1 L 4 X 4 X 4 X 21' "	21	FT	1.30		269	350		100	
150	(5)	BOTNOZ 8-STD PIPE X 5.34' 304SS "	5.34	"	BATCH		152	427			
50	(6)	" " FTG 1-8-STD 90° L. RED "	1	ea	450.00		50	450			
55	(7)	LIFT BRKT 1 PL 3/4 X .83 X 7.5" (cut 2) "	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 "	L.S		4.		150	300			
		WELDS S.S 3/8 V .156 S/A "	21	FT	4.50		12	54			
		" R.S DO .56 " "	38	"			22	99			
26		" SKIRT 3/8 FW .54 .34 " "	76	"			41	185			
5	(10)	VENTNOZ 1-1½-40 X 2' (cut 4	2	FT	10.00		55	20			
9086		SUB-TOTAL					9686	12485		300	12985
		MATL OH ~10%									1315
		SHOP LABOR	400	MH		31.00			12400		12400
		FIELD INSTALLATION 3 da	120	"		30.00			3600		3600
		EFFICIENCY 60%	72	"		30.00			2160		2160
		SUB-TOTAL									32370
		FIELD OVERHEAD 30% 5760									1730
		SUB-TOTAL BASE COST									34100
		VENDOR G+A ~10%									3400
		SUB-TOTAL									37500
		VENDOR PROFIT ~15%									5500
											43000
		X-4									
	CODE										172000
	4511	ABSORBER UNIT									

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Ato … national Division
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JOB NO/ 33026.R02 PROJECT ABSORBER OUTLET & EXPANSION TR PIPING LOCATION _____ CLIENT _____

DATE 4-6-78 TAKE-OFF JAW PRICED JAW CALC. CHKD _____ APPROVED _____ SHEET 6 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 PL 3/8 X 6' X 6' T304	72	#	1.20		1152	1382		200	
245	(2)	SHELL " 1 PL 3/8 X 1' X 15.75' "	15.75	"	1.20		252	302			
225	(3)	" NO 2 24-6-STD IPS X 5' "	12	FT	31.00		228	372			
55	(4)	EXP " 4-8-STD IPS X 5' "	2	"	80.00		57	160			
3480	(5)	LEG 3-17.00 X 3/8 W X 17.75' 75° "	53.25	"	2.75#		3994	10984			
	(6)	EXP. TR PIPING FIG 8-90° LR ELL "	12	ea	450.00		600	5400			
	(7)	" " " 1-8-STD IPS X 75' (cut 12) "	75	FT	80.00		2141	6000			
		WELD 3/8 V (1)(2)(6) 188 .56 HAND "	42	FT	4.50		37	167			
		" (5)(6) 3/8 V .65 " V	51	"			33	148			
17		" (3)(7) 3/8 FW .54 .34 " "	51	"			28	126			
		" PIPE (5) 3/8 V .88 " "	63	"			55	248			
300	(8)	SNUBBERS	4	ea	120.00		400	480			
150	(9)	PIPE HANGER	4	"	100.00		200	400			
600		MISC MATL	L.S				800	1000			
5971		SUB-TOTAL					9977	31117		200	31317
		MATL O.N N1090									133
		SHOP FABRICATION	340	Hr		31.00			10540		10540
		FIELD INST LEG SM-3D	120	"		30.00			3600		3600
		" " " EXP PIPE SM-2D=80 X 4	320	"		"			9600		9600
		" HANGERS 4 X 10	40	"		"			1200		1200
		" SNUBBERS 4 X 40	160	"		"			4800		4800
		FIELD EFFICIENCY 60% OF 19200							11520		11526
		" O.N 3090 OF 30,720									9216
		SUB-TOTAL BASE COST									84926
		VENDOR GNR N1090									8474
		SUB-TOTAL									93400
		VENDOR PROFIT N 1590									13600
CODE 4511		ESTIMATED PRICE INSTALLED CURRENT DOLLARS ABSORBER UNIT									107000

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Ato[illegible] [illegible]ernational Division
Ro[illegible] [illegible]national

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

DATE 4-10-78 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET 7 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
					S.S OVEN				
3" THERMOBESTOS BLOCK INSULATION									
RECEIVER	9540	S.F	4.20	.2	4.26	40068	1908 @	40640	
EXPANSION TANKS (4)	1550	S.F	4.20	.2	4.26	6510	310 @	6603	
6" THERMO-12 PIPE INSUL. 30	70	LF	68	3.68	29	4760	258 @	2030	
5½ 18	60		44	2.67	22	2640	160 @	1320	
4 6	336		14	.89	8	4704	299 @	2688	
3 2	40		6	.39	3	240	16 @	120	
3 1½	180		6	.37	3	1080	67 @	540	
							3918 @	M.H @ 30	
							90540		
ADD FOR LABOR HEIGHT PRODUCTIVITY ~ 50%							45270		
						60092	135810	53941	249753
CODE 4511 INSULATION ABSORBER	UNIT								

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Atlantic Richfield International Division

JOB NO. 1331-61 ROV PROJECT ABSORBER PANEL TRUSS LOCATION _____ CLIENT _____

DATE 4-4-78 TAKE-OFF JAW PRICED JAW CALC. CHK'D _____ APPROVED _____ SHEET 1 OF 1

	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
	REF: TABLE 5-5 & 3R 24 REQD	1-SHOWN				[illegible]				
NET WT	① COIL FACE LEGS 2 L 3 3/8 X 6 X 6 X 5'8" 14.9 A36	104	FT	22		1550	341			
	② TUNSIDE " 2 DO X 54' "	108	"	|		1609	354			
	③ SIDE STRUSS 1 DO X 60' (cut 8) "	60	"	|		894	197			
	④ COMP MEMB 4 DO X 40' (cut 16) "	160	"	|		2384	524			
	⑤ DET BRACE DIAGONALS - DO X 53' (cut 20) "	265	"	|		3949	869			
	⑥ GUIDE 2 1/2 X 4 X 4 X 46' "	92	"	V		405	89			
	WELD 3/E FW .58 .34 HAND "	350	FT	.60		182	104			
	" 1/2 V 1.33 .86 " "	10	"	"		13	8			
	" 1/4 FW 1.25 1.15 " "	30	"	"		8	5			
	PAINT NU TEMP	10	GAL	25.00		100	250			
10500	SUB-TOTAL					11094	2746			2746
	MATL O/H N10%									274
	LABOR	110	HR		31.54			3465		3465
	BASE COST									6485
	VENDOR G+A N10%									648
	SUB. TOTAL									7130
	VENDOR PROFIT N15%									1070
	ESTIMATED VENDOR PRICE CURRENT DOLLARS									8200
	X-24									19680
	MANAGEMENT RESERVE @ 20%									3936
										23616
CODE 4512	SUPPORT STRUCTURE SUMMARY							ROUND TO		23600

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

DATE 7-20-78 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
P-1 RECEIVER PUMP · 4500 H.P 20,000 GPM @ 844' TDH SECT. VIII FAB		EA			60 TON	12000000	1500000		13500000
INSULATION	520	S.F						155000	155000
TRACE HEATERS	173	L.F						20760	20760
DRIVE & SPEED CONTROL WITH FLUID COUPLING (FROM 4514)									600000
CODE 4513 RECEIVER PUMP P-1									21257760
								ROUND TO	21260000

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UPDATE -

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

DATA FOR PRICING PUMPS

550°F

P-1 PUMP. (RECEIVER PUMP

TYPE - SIMILAR TO CRBRP

SINGLE STAGE

DOUBLE SUCTION - NPSH(REQ.) 30 FT

MATERIAL - A-285

CODE - ASME B&PV - SECTION ~~VIII~~ VIII - DIV. 1

TDH ~~6447~~ FT 722 FT

FLOW 20,000 G.P.M. Nd - 600°F

CASE DIAM. 6.4 ~~X~~ FT

CASE LENGTH 11.4 ~~12~~ FT

INLET NOZZLE 30 IN

OUTLET NOZZLE ~~X~~ 24 IN

DRY WT (46,667) ~~57,000~~ LBS .84

SPEED ~~1160~~ 1130 RPM

MOTOR - SQUIRREL CAGE - VERTICAL

60HZ 3φ - SINGLE SPEED - ~~1160~~ 1130 RPM

4160 VOLTS

4,500 H.P. OR

(OPERATING H.P. = 4022)

PRODUCTION - 1ST IN A SERIES OF 7

ENGINEERING - FINAL ONLY

SUGGEST A 1.15 FACTOR

L. S. Glasgow

4/7/78

P.B. ACTUAL 4 OF 4

A[illegible] R[illegible] International Division [illegible]national

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

DATE 5-4-78 TAKE-OFF J.G PRICED J.G CALC. CHKD JC APPROVED _____ SHEET 1 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEET # 2									312100
3									399500
4									189000
CODE 4514 INSTRUMENTATION SUMMARY							ROUND TO		851600
									852000

Form 702-D Rev. 11-73

Atc ternational Division
Ro national

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

DATE 4-26-78 TAKE-OFF I.G PRICED I.G CALC. CHKD J.C APPROVED _____ SHEET 3 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
RECEIVER									
TEMPERATURE CONTROLS	24	EA			1,250				30000
PRESS. INDICATORS	2				2500				5000
TEMP. INDICATORS	26				2500				65000
LEVEL CONTROLS	2				2500				5000
PURIFICATION SYSTEM	1	L.S							25000
PUMP P-1									
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				75,000				75000
700 MCM FEEDER	200	LF			128.50				25700
PUMP P-2									
TEMPERATURE	1	EA.			2500				2500
PRESS.	1				2500				2500
PRESS. DIFF.	1				3500				3500
POWER, CURRENT, SPEED	1				6000				6000
CIRCUIT BREAKER	1				20,000				20000
SPEED CONTROLLER	1				2,000				2000
FLOW CONTROLLER	1				1500				1500
SPEED CHANGER	1				25,000				25000
#1 FEEDER	200	LF			22.00				4400
CODE 4514 INSTRUMENTATION & CONTROLS									312100

Form 702-D Rev. 11-73

Ato Rox ternational Division national

JOB NO 133-026802 PROJECT _____ LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TANK-T-1									
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
TANK-T-2									
TEMPERATURE	1				2500				2500
PRESSURE	1				2500				2500
LEVEL	1				2500				2500
PRESS. RELIEF	1				3500				3500
GAS BALANCE VALVE	1				2500				2500
LINE #103									
DRAG VALVE	1				250,000				250000
PRESS. DIFF.	1				3500				3500
TEMPERATURE	1				2500				2500
LINE #105									
TEMPERATURE	1				2500				2500
PRESSURE	1				2500				2500
REHEATER									
TEMPERATURE	1				2500				2500
SUPER HEATER									
TEMPERATURE	1				2500				2500
FLOWMETER	1				8500				8500
CONTROLLER	1				1500				1500
LOW FLOW CONTROLS	1				43,500				43500
CODE 4514 INSTRUMENTATION & CONTROL									300500

Form 702-D Rev. 11-73

Ato... ...rnational Division ...national

JOB NO! 33-026R03 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-27-78 TAKE-OFF L.G PRICED L.G CALC. CHK'D JC APPROVED _____ SHEET 4 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
~~EVAPORATOR~~									
LEVEL	1	EA			1500				1500
PRESSURE	1				1500				1500
TEMPERATURE	1				1500				1500
FLOWMETER	1				12,000				12000
TEMPERATURE	1				2500				2500
PREHEATING	1	L.S			INCL. w/ COMPONENTS				-0-
MISCELLANEOUS	1	L.S			60,000				60000
DATA AQUISITION	100	EA			600				60000
COMPUTER INTERFACE	1	L.S			25,000				25000
FLOWMETER 18"	1	EA.			25,000				25000
DRIVES & SPEED CONTROL FOR PUMP P-1 - MOTOR GENERATOR SET WITH FLUID COUPLER DRIVES	1	L.S			60,000	MAY BE 1513			60000
CODE 4514 INSTRUMENTATION & CONTROLS									189000

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Atomics International Division
Rockwell International

JOB NO/ 33-026R02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-27-78 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
ABSORBER PANELS	24	EA		416[e]			9984[e]		
P&H OVERHEAD CRANE	1	EA.	596K	50[e]		596000	50000[e]		
							14984[e]	M. HE 30%[e]	
						596000	449520		
FIELD OVERHEAD							90000		
Q.A							60000		
MANAGEMENT RESERVE							119904		
						596000	719424		1315424
CODE 4515 FIELD ERECTION, TRANSPORTATION & INSTALLATION							ROUND TO		1315000

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Atlantic Richfield International Division

JOB NO. 33-026R02 PROJECT ADVANCED CENTRAL RECEIVER LOCATION _____ CLIENT _____

DATE 4-17-78 TAKE-OFF JC PRICED JC CALC. CHK'D _____ APPROVED _____ SHEET 1 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEET #2 PURIFICATION & GAS SYSTEM						761000	392460		
3 HORIZ. PIPING						403844	162360		
4 DOWNCOMMER & RISER						469442	426030		
5 INSULATION								686608	
6 THRU 9 PIPE SUPPORTS								50500	
FIELD OVERHEAD 30% x D.L							294255		
SHEET #10 TRACE HEATERS								749700	
						1634286	1275105		
ADD FOR AREA PRODUCTIVITY x 60% OF D.L							545310		
						1634286	1820415	1486808	4941509
CODE 4520 RISER, DOWNCOMER & HORIZ. PIPING SUMMARY							ROUND TO		4942500

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Atc rnational Division
Flo rnational

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

DATE 4-6-78 TAKE-OFF JC PRICED JC 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/4.3"						266000	3400		
COVER GAS SYSTEM "REF. PCTF USE .6 POWER"						150000	7582		
SODIUM REACTION TANK "REF LLTR"						240000	1000		
							13082	M.H. @ 30	
CODE 4520 PURIFICATION & GAS SYSTEM						761000	39246		

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Ato … national Division
… rnational

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. RED.	18x12	3		285	9.0		855	27		
C.S SODIUM VALVE	20	1		90K	212.0		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	6.5		5060	26		
45° ELL	12	2		797	6.5		1594	13		
TEE	18	1		4211	12.0		4211	12		
	12	4		2100	8.6		8400	34		
S.S SODIUM VALVE	12	2		40K	90.0		80000	180		
	18	1		70K	150.0		70000	150		
BURST FIKE 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	1.5		168	18		
								5412	M.H.@ 30.00	
CODE 4520 HORIZ. PIPING							403844	162360		

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Atc rnational Division
Ro rnational

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.
C.S A-53 Pipe x 3/8" WALL 20"	1000	LF	47	3.5	
90° ell 20"	28	EA	733	11.°	
BUTTWELDS 20	88			5.4	
S.S - T-304 Pipe x 3/8" WALL 18	1000	LF	190	3.4	
90° ell 18	28	EA.	2600	9.°	
BUTTWELDS 18	88			2.°	
SUPPORT HANGERS HORIZ. #45 20"	28	EA.	1314	60.°	
#46 18"	28		1355	60.°	
VERT. 20	43		52	3.°	
18	43		50	3.°	
SNUBBERS #200 w/ Pipe CLAMP	20		3000	40.°	
CODE 4520 DOWN COMMER & RISER					

MATERIAL	LABOR	SUB-CONTRACT	TOTAL
47000	3500.°		
20524	308.°		
	475.°		
190000	3400.°		
72800	252.°		
	1848.°		
367992	1680.°		
379440	1680.°		
22236	129.°		
21550	129.°		
600000	800.°		
469442	426030		

1420 1.° M.H. @ 30.°°

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Ato / Rox national Division national

JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
J.M. THERMO-12 W/.010 S.S OVEN					S.S. OVEN				
EQUIV. LIN. FOOTAGE 3" 30	16000	LF	24	2.88	24.00	38400	46088	38400	
5½" 18	1700		44	2.67	23.00	7480	4539	3910	
5" 12	250		30	1.79	15.00	75	448	37	
2½ 6	25		10	.89	7.65	2	22	1	
ALUMINUM WEATHER PROOFING 20"	150	LF	1.00	.10		150	15		
18"	300	LF	1.00	.10		300	30		
							9662	M.H.@ 23	
							2222226		
ADD FOR AREA LABOR PRODUCTIVITY	x 60%						1333336		
						121400	355562	81441	
CONTRACTORS O.H & PROFIT @	15%					18210	53334	12216	
FIELD OVERHEAD							44445		
CODE 4520 INSULATION						139610	453341	93657	686608

Form 702-D Rev. 11-73

Atlantic Richfield Company — National Division

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

DATE 4-6-78 TAKE-OFF _____ PRICED _____ CALC. CHKD _____ APPROVED _____ SHEET 16 OF _____

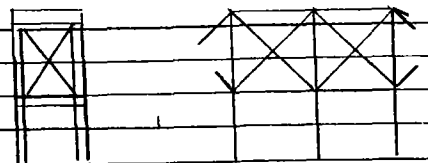
ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEET # 7								16500	
# 8								6500	
# 9								27500	
									50500
CODE 4520 STRUCTURAL STEEL PIPE SUPPORTS									50500

Form 702-D Rev. 11-73

Atlantic Richfield International Division

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' ÷ 7 = 6.4 USE 6.5									
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	LBS	1 00					14000	
EXCAV									
(2 X 3 X 6 X 7) ÷ 27 + MISC	10	CY	40 00					400	
CONCRETE	10	CY	80 00					800	
REBAR	1000	LBS	0 75					750	
FORM AND MISC	1	LS						550	
									
6.5' X 144 ÷ 44 = 21.3 6.5 X 48 / 4 = 78 ÷ 20: 4									
CODE 4520								16500	

7 @ $ 2357 EA

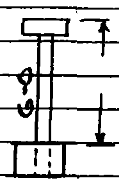
Form 702-D Rev. 11-73

Atlantic Research International Division
Rockwell International

JOB NO. 133.026 PROJECT ______ LOCATION ______ CLIENT ______

DATE 4/6/78 TAKE-OFF FIERER PRICED FIERER CALC. CHKD ______ APPROVED ______ SHEET 8 OF ______

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
6'0" HIGH SUPPORTS									
$30^k \div 8 = 4^k$ $13^k \div 4 = 3.25^k$									
$28^k \div 6 = 4.67^k$ USE 5^k LOAD									
STEEL									
W8x24 @ 24# (6'+2'+2) 20 = 4800									
MISC BASE PL ETC 500									
TOTAL 5300	5300	LBS	0.95					5000	
EXCAV									
EARTH (1' x 2 x 4 x 20) ÷ 7	6	YDS	41.50					250	
CONCRETE	6	YDS	83.33					500	
REBAR	600	LBS	0.75					450	
FORM & MISC	1	LS	—					300	
CODE 4520								6500	



$5^k \times 72 = 360^k \div 22 = 16.2$

Form 702-D Rev. 11-73

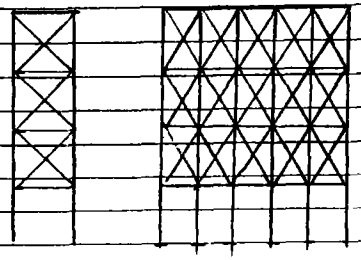
20 @ $325 EA

A[illegible] B[illegible] International Division

JOB NO. 133.022 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4/6/78 TAKE-OFF FIERER PRICED FIERER CALC. CHK'D _____ APPROVED _____ SHEET 9 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
45' HIGH									
20K ÷ 6 = 3.33 use 3.5K									
STEEL W 10X21									
(50'x2 + 6'x4) 6 15624									
L 3x3x1/4 @ 4.9 (8x10S 4116									
MISC BRACING ETC 4260									
	24000	LBS	1					24000	
EXCAV									
(2x4x8x6) ÷ 27 + MISC	15	CY	40	=				600	
CONCRETE	15	CY	80	=				1200	
REBAR	1500	LBS	0	75				1125	
FORM & MISC	1	LS						500	
3.5x72 ÷ 4 ÷ 20 = 3+									
CODE 4520								27500	



6 @ $4667

Form 702-D Rev. 11-73

International Division

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

DATE 4-17-78 TAKE-OFF JK PRICED JK CALC. CHK'D _____ APPROVED _____ SHEET 10 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

Atomic Rockwe ional Division ional

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

DATE 7-27-78 TAKE-OFF JS PRICED JS CALC. CHKD _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SODIUM	457,500	#@	40¢/LB.						183XXXX
CODE 4530 WORKING MEDIUM									183000

Form 702-D Rev. 11-73

Atomics International
O/798 Correspondence

ACTION

REPLY DUE

REMARKS

ANDERSON, S. H.
ASHWORTH
ASQUITH
BALENT
BAUMGASH
BOTTS
BRINDLEY
CARDENAS
COCHRAN, J.C.
CRAWFORD
DE LOS PRADOS
DETTERMAN
FEILER
GYLFE
HARTZLER
HILLIG
HOLBROOK
IACOBELLIS
JACOBSON, J.
JONES, R.G.
E. Ash
LULOVICS
MARTIN, A.B.
McCOURT
McDERMOTT
McDONALD, J.S.
McKENZIE, D.L.
MEYERS, G.W.
MORLWITZ
T. Bates
J. MURPHY
OLDENKAMP
PARKER, T.
PARKINS
Crean
REMLEY
REINECKER
SANDERS
Perkins
L. STONE
W. TOMEN
H.A. WARD
WHEELER
WIESENECK
J.S. WILLIAMS
Springer
Katz
Gibson
Thomas
Shaw

Stearns-Roger
ENGINEERING

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
Project Engineer

AWM:vr

10486ESG

PERRY CREEK DRIVE • P.O. BOX 5888 • DENVER, COLORADO 80217 • PHONE (303) 758-1122 • TWX 910-931-0451 TELEX 045-540

Stearns-Roger INC CORPORATION

ESTIMATE SUMMARY

CUSTOMER ATOMICS INTERNATIONAL — PROP NO.

LOCATION — JOB NO. C-20325

PROJECT ADVANCED CENTRAL RECEIVER — DATE 5-31-78

159 METER TOWER - 500 KIP RECVR — 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					
						112 202
Y	FEE		5%			
						2 356 245
	TOTAL					

FORM 62 · 11D REV. 10-76

Stearns-Roger
INCORPORATED

CLIENT ATOMICS INTERNATIONAL
ORDER NO 620325 LOCATION
SHEET NO. 1
BY A.L.
DATE 5·31·78

159 METER TOWER - 500 KIP RECVR.

ACCOUNT	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L UNIT COST	MANHOURS UNIT	MANHOURS 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	208920		616,314
	TOWER	3347	C.Y.	40	11	36817	13.00	478,621	133880		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

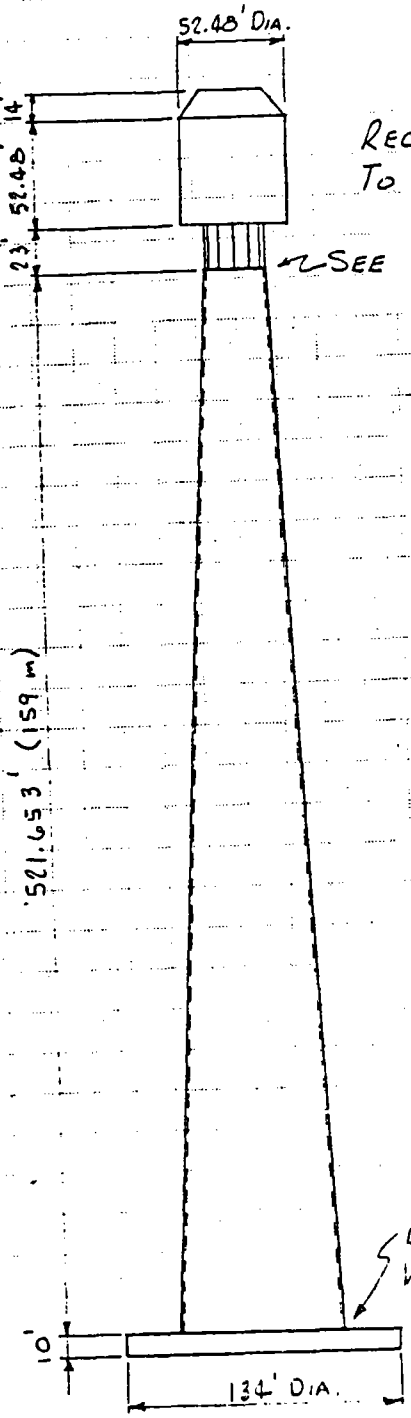
FORM 62.114
REV. 4-75

PAGE 1

JOB NO. C20325 DATE 5/25/78 BY RJC CH'K.

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 KSI ; E = 3640 KSI ; V = .15
2) REBAR f_y = 60 KSI
3) ALLOW. SOIL BRG. PRESS. = 10 KSF (ALLOW 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.

BASE O.D. = 82'
WALL THK = 15"

FORM 62.114
REV. 4-75

Stearns-Roger

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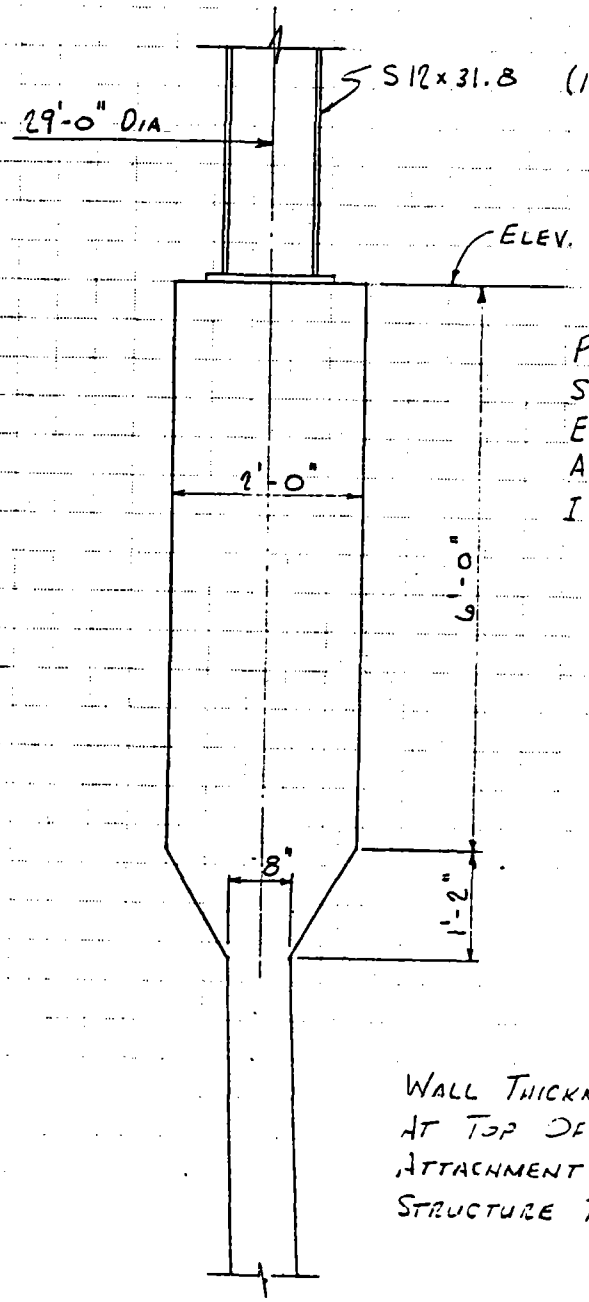
JOB NO. C 20325 DATE 5/25/78 BY RJC CH'K.

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER



PROPERTIES OF RECEIVER SUPPORT STRUCTURE:

$E = 29000$ ksi ; $\nu = .3$

$A = 12 \times 9.35 / 144 = .779$ ft^2

$I = \frac{9.35}{144} \cdot 14.5^2 [4(.5^2 + .866^2) + 2(1)^2]$

$= 81.91$ ft^4

WALL THICKNESS MUST BE INCREASED AT TOP OF TOWER TO ACCOMMODATE ATTACHMENT OF RECEIVER SUPPORT STRUCTURE TO CONCRETE TOWER.

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Stearns-Roger

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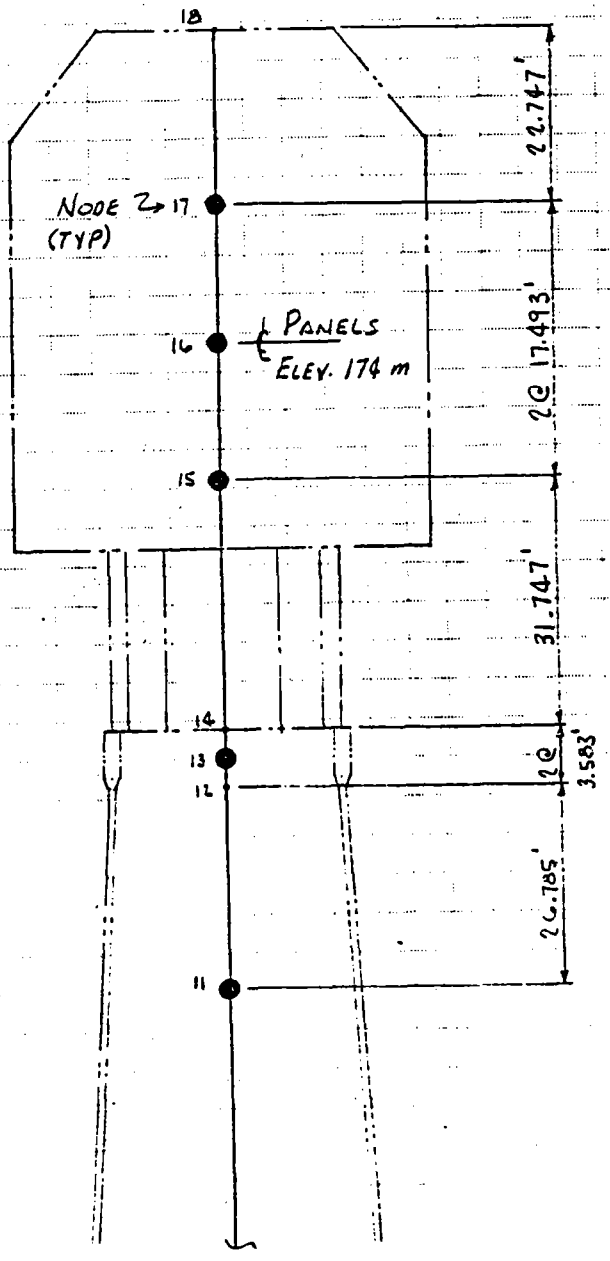
JOB NO. C20325 DATE 5/25/78 BY RJC CH'K.

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER

STRUCTURAL MODEL AT TOP:



FORM 62.114
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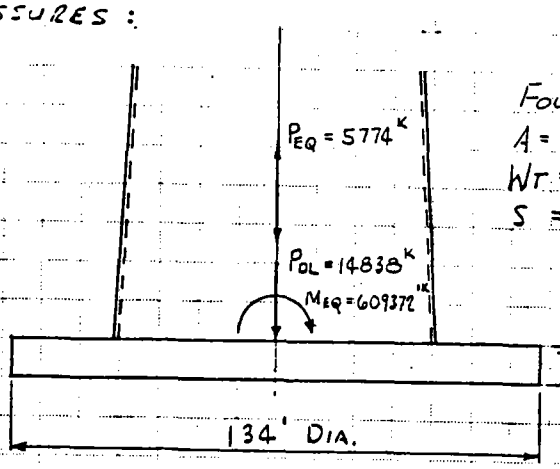
JOB NO. C20325 DATE 5/26/78 BY RJC CH'K

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER

SOIL PRESSURES:

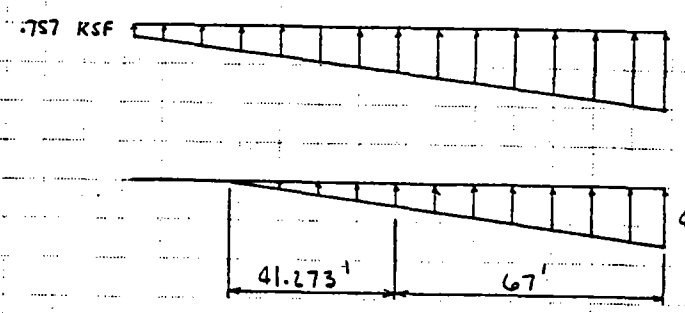


FOUNDATION PROP.:

$A = \pi \times 67^2 = 14103\ ft^2$

$Wt = 14103 \times 10 \times .15 = 21154^K$

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



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}):

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

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

SOIL BEARING PRESSURES ARE LOW.

FORM 62-114
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JOB NO C20325 DATE 5/30/78 BY RJC CH'K

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER

TOWER CONCRETE & REBAR

WT. OF TOWER CONCRETE

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

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

VERTICAL REBAR QUANTITIES

MEMBER	LENGTH (FT)	STEEL AREA (IN^2)	STEEL VOL. ($FT\text{-}IN^2$)
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	224.27	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	87.45	313
13	3.584	87.45	313
TOTAL			116929

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

Stearns-Roger

JOB NO. C20325 DATE 5/30/78 BY RJC CH'K

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER

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TOTAL			116929

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Stearns-Roger

JOB NO. C20325 DATE 5/30/78 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"

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

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 TONS

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JOB NO C20325 DATE 5/30/78 BY RJC CH'K

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER

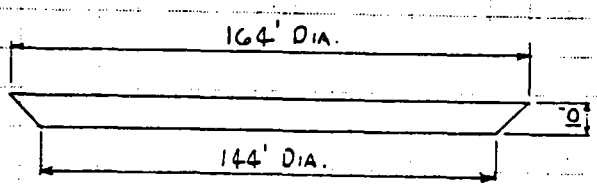
FOUNDATION QUANTITIES

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

ESTIMATE REBAR @ 110 #/CY

WT. REBAR = 110 × 5223 / 2000 = 287.3 TONS

SOIL EXCAVATION



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

SUMMARY

TOWER CONCRETE	=	3347	CY	300, 1004,1000
TOWER REBAR	=	243.2	TONS	97,280
MAT CONCRETE	=	5223	CY	750 914,025
MAT REBAR	=	287.3	TONS	400 114920
SOIL EXCAVATION	=	6908	CY	29,

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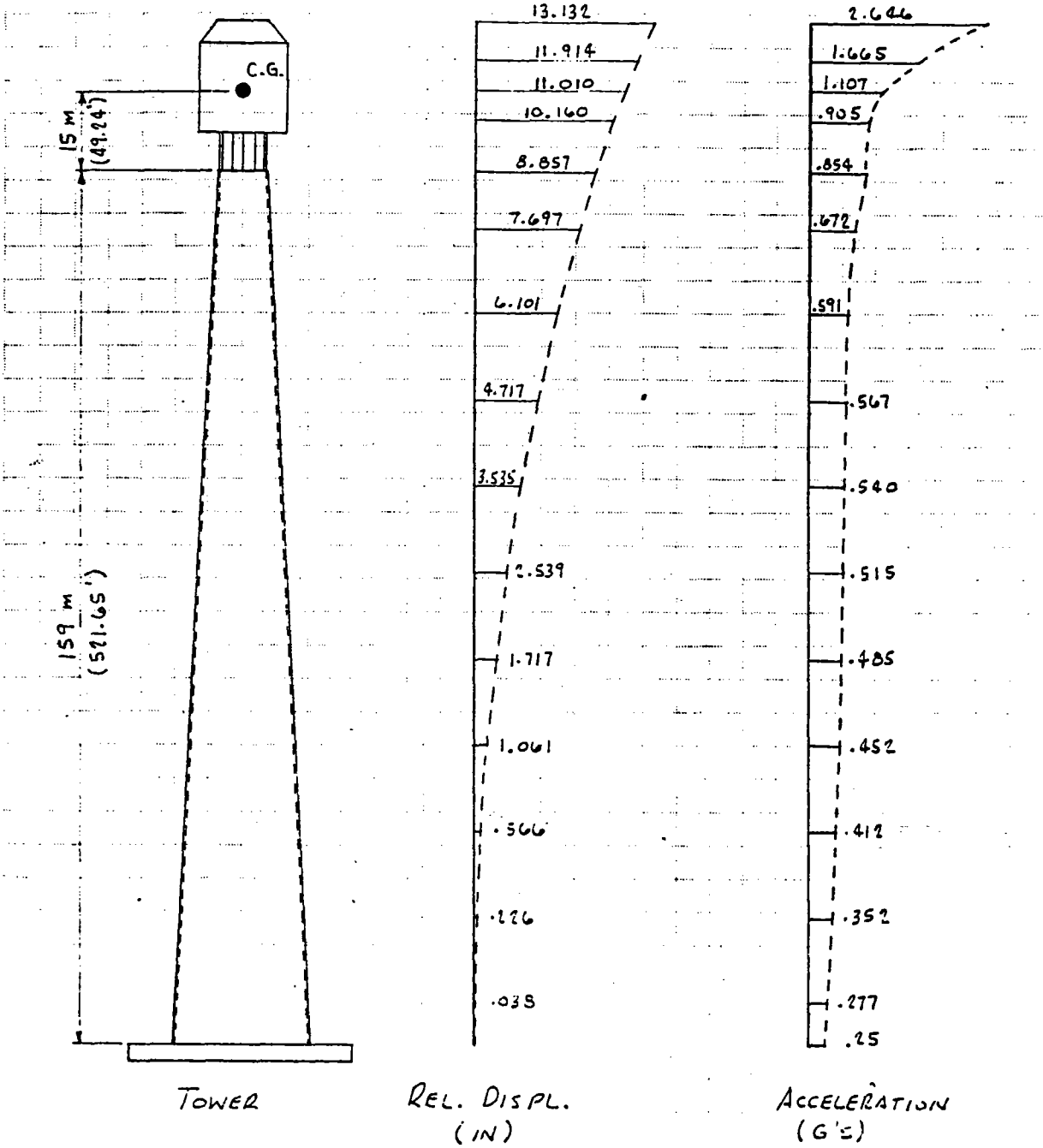
JOB NO. C20325 DATE 5/30/78 BY RJC CH'K.

CUSTOMER ATOMICS INTERNATIONAL PROJECT

SUBJECT ADVANCED CENTRAL RECEIVER

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



At ... International Division

JOB NO. 133-02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-10-78 TAKE-OFF JC PRICED JC CALC. CHK'D _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
				.6					
EVAPORATOR - 4'φ x 95' 1100 5/8" φ TUBES - 2¼ CR/1MO.	1	EA		2.1K	64 TON	2967000	3509		
SUPERHEATER - 30"φ x 91' 283 - ¾φ TUBES - 304 S.S	1	EA		2.10K	20 TON	927500	1609		
REHEAT - 32"φ x 66' 163 - 1½φ TUBES - 304 S.S	1	EA		2.10K	22 TON	1022000	1609		
CRANE TIME (75 TON)	400	HRS.			150/HR.			60000	
COST REF. A-1 CRBRP STEAM GENERATORS LESS SECT. III/CL. 1&2 REQUIREMENTS FAB. TO SECTION VIII									
INSULATION	2100	S.F			21.00			44100	
TRACE HEATERS	700	L.F			150.00			105000	
							6709	M.H. @ 30.00	
CODE 4560 STEAM GENERATORS						4914500	20100	209100	5143766

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ROUND TO $5144.000

Atomics International Division
Rocketdyne

JOB NO 133-026R02 PROJECT 100 MW LOCATION CLIENT

DATE 9-1-78 TAKE-OFF PRICED CALC. CHK'D APPROVED SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ENGINEERING TITLE III									
ESTIMATED @ 6% OF CONSTRUCTION (21,986)									1319(00)
CODE 4570 ENGINEERING									

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Atomic International Division

JOB NO 133-0126R02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-10-78 TAKE-OFF JC PRICED JC 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. OVEN & ALUM. COVER									
INSULATION HOT TANK 12"	22776	S.F			43.00/ft³			979368	
INSULATION COLD TANK 6"	21520	S.F			24.00/ft²			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 4610 HOT & COLD TANK SUMMARY									4356310
							TRANSFER TO		$4356000

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Atomics International Division

JOB 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	ft²			14,000#				
STIFFENER RING 1"x6 S.S	160	ft²			6,626#				
OUTER TANK BASE 1" S.S. PL.	330	ft²			13,665#				
SLIDE PL 2'x1" W 2" SLOT S.S	20	ft²			828#				
2x2x1/4 L BRACES S.S	135	L.F			435#				
2"ϕ x 15' ANCHOR BOLTS C.S	8	EA	150	150				1200	
2" NUTS & WASHER	8	EA.	25	30				240	
INSULATION @ 9.00/ft²	1510	ft²						13600	
CONCRETE @ 200.00/C.Y	24	C.Y						4800	
					35,554#	@ 3.00/LB.		106662	
									126202
COLD TANK									
SAME AS HOT TANK USING									91xxxx
CARBON STEEL INLIEU OF	S.S								
CODE									
4610 SODIUM SAFETY REQ.									

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ESG-79-2, Vol IV
A-61

A F International Division
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JOB NO. 33-0-6R02 PROJECT 120'd x 45' SHELL 1100°F API STORAGE TANK HOT LOCATION _____ CLIENT _____

DATE 3-29-78 TAKE-OFF JMW PRICED JMW CALC. CHKD _____ APPROVED _____ SHEET 2 OF _____

	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
NET LIST	REF: SK FRANGOS SK 3-22-78 100MW ACR					FAB & LIST				
①	COURSE #1 10R 1/4 x 9.0833 x 31.34' T304	2847	#	1.10		32370	35607			
	" #2 10R 7/16 x " x 31.4' "	2854	"	1.12		56345	63106			
	" #3 10R 5/8 x " x 31.42' "	2854	"	1.10		78485	86334			
	" #4 10R 13/16 x " x 31.5' "	2861	"	1.05		101437	106508			
	" #5 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 DO x 14' "	1127	"			1444	1588			
	" 1PL 1/4 x 6' x 7' "	42	"			478	526			
	" 1PL 1/4 x 10.6' x 30' "	318	"			3616	3978			
③	ROOF RS 28R 3/16 x 9.0833 x 30' "	7630	#	1.20		63863	76636			
	" " 1 " DO x 9.1' "	82.6	"			691	829			
	" " 2 3/16 x 6' x 30' "	360	"			3013	3616			
	" " 2 3/16 x 4' x 10' "	80	"			670	804			
④	PURLINS 32 PL 1/2 x 1' x 30.34' "	971	#	1.10		21721	23893			
	" 4 PL 1/2 x 1' x 25.1 "	100.4	"	"		2246	2471			
⑤	COLUMNS 1600 x 1/2 W x 230' 82.77 "	230	FT	245#		19037	46641			
⑥	BEAM PLGS 1 PR 1 1/8 x 10' x 36' (cut 8) 48.68 "	860	#	1.05		17523	18399			
	" WEB 1 PR 3/4 x 8.34' x 36' (cut 8) 57 "	300	"	1.05		9861	10354			
⑦	COL BASE & TOP 1 PR 1 1/2" x 2' x 10' (cut 5) "	20	"	1.15		1340	1541			
⑧	" " CTR " 1 PR 2" x 4' x 4' "	16	"	1.15		1360	1564			
⑨	PURLIN CLIP 1L 1/2 x 8 x 6 x 18' (cut 36) 23 "	18	FT	1.50		414	621			
⑩	SHELL RIM 10L 3/8 x 4 x 4 x 30.5' 9.8 "	325	"	1.130		3185	4141			
⑪	CTR PURLIN 1 PR 3/8 x 4' x 23' (cut 4) "	92	#	1.12		1472	1649			
⑫	" " 1 PL 3/8 x 4' x 15' (cut 4) "	60	"	1.12		960	1075			
⑬	" " 1 PL 3/8 x 8' x 17' (cut 8) "	136	"	1.12		2176	2437			
⑭	NOZZLE 1-18" x 24" OD x 100# SADDLE "	1	ea	800#		252	2016			
⑮	INLET 1-1800 x 1/2 W x 50' 93.4 "	50	FT	2.45#		4671	11464			
620,100	CODE 4610					639865	727688			

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International Division

JOB NO. 33,026,R02 PROJECT 100'D x 45'S TSHELL API TYPE 5 TORGE 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 100MWe ACR									
WELD SHELL 1" SS V 4.18 HAND T304	90	FT	4.25		376	1598			
" " 13/16 " V 2.94 " "	90	"			265	1126			
" " 5/8 " V 1.86 " "	90	"			167	710			
" " 7/16 " V 1.11 " "	90	"			104	442			
" " 1/4 " V .43 " "	90	"			39	166			
WELD COURSE 5 R.S 1/2 FW .62 S/A "	1257	"			781	3319			
" " 4 " 13/16 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 LONGSM .28 " "	872	"			244	1037			
" " 1/4 V CROSSM .28 " "	315	"			88	374			
WELD ROOF 3/16 FW LONGSM 1.06 SEMI A HAND "	892	"			946	4021			
" SSM DO 1.06 " "	350	"			371	1577			
" " TUBML 3/16 FW 1.06 " "	320	"			339	1441			
WELD COL 1/2 V 1.33 HAND "	42	"			56	238			
WELD RIM 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 .25 .15 " "	48	"			12	51			
14" BEAM 3/4 FW WEB TO FLG 1.4 S/A "	576	"			806	3426			
" " TO COL 3/4 FW 2.15 1.4 HAND "	24	"			52	221			
" GUSSET CLIP 1/4 FW .25 .15 " "	81	"			20	85			
" PURLIN TO COURSE #1 .25 .15 " "	84	"			21	89			
" PURLINS 1/4 FW .25 .15 " "	350	"			88	374			
" BEAMS TO COL 3/4 FW 2.15 1.44 " "	48	"			103	438			
" NO 2 (14) 1" V 4.18 " "	6.25	"			26	110			
CODE 4610 WELD NO 2 (15) 1/4 FW .25 .15 " "	9	"	↓		2	9			
					6358	27097			

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International Division

JOB NO. 6330.0202-Y PROJECT 100MW EACR COLD NA API STORAGE TANK LOCATION _____ CLIENT _____

DATE 3-31-78 TAKE-OFF JAM PRICED JAM CALC. CHKD _____ APPROVED _____ SHEET 1 OF _____

NET WT		ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
		REFSK. FRANCOS 3-22-78					FABR W.T				
463321		MATERIAL (SEE BILL PG-2)	L.S				482624	119371			
3100		" (" " PG3)					3954	8245			
466421		SUB-TOTAL					486580	127586			127586
		MAT'L ON ~10%									12714
		ENGINEERING DESIGN	160	HR		30.00			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	"		19.75			7406		
		SUB-TOTAL							76419		76419
		SHOP OVERHEAD	600	HR		20.75			12450		
		FIELD O.H 50% of 71469							35735		
		SUB-TOTAL O.H							48185		48185
		CRANE RENTAL								15000	15000
		SUB-TOTAL BASE COST									284704
		VENDOR G+A ~10%									28296
		SUB-TOTAL									313000
		VENDOR PROFIT ~15%									31000
		ESTIMATED VENDOR PRICE	CURRENT DOLLARS								344000
		.73753/LB									
		SHELL BI-WELD 100%	V-R								
	CODE										
	4610	COLD TANK									

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International Division

JOB NO. 133-026-R02-2 PROJECT 100MW e ACR CORONA API STORAGE TANK LOCATION ______ CLIENT ______

DATE 3-31-78 TAKE-OFF [illegible] PRICED [illegible] CALC. CHKD ______ APPROVED ______ SHEET 2 OF ______

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
REF: SK FRANGOS 3-22-78									
(1) COURSE #1 10 PL 1/4 x 9.0833 x 31.34 516-70	2847	#	.242		31317	7579			
" #2 " 5/16 8.0833 x 31.42 "	2540	"	.2341		34925	8190			
" #3 " 7/16 " x 31.42 "	2540	"	.231		48895	11295			
" #4 " 9/16 " x 31.5 "	2546	"	.227		63014	14304			
" 5 " 11/16 " x 31.5 "	2546	"	.227		76380	17338			
(2) BOT PL [illegible] 1/4 PL " "	8117	"	.242		89287	21607			
(3) ROOF PL " 3/16 PL "	8153	"	.251		66855	16781			
(4) PURLINS 6 [13 (cut 36 A36	1072	FT	.2405		13936	3352			
(5) COLUMN C1 1-12 WF 79# x 45' "	45	"	.276		3555	981			
(6) #C2-5 4 DO x 42' "	168	"	"		13193	3641			
(7) BEAMS 4-24 WF 160 x 36' "	144	"	"		23040	6359			
(8) COL BASE/TOP 1 PL 1 1/2 x 2' x 10' (cut 6) 516-70	20	#	.30		1275	383			
(9) " " C1/2 1 PL 2" x 4 [illegible] "	16	"	.30		1360	408			
(10) PURLIN CLIPS 1 L 1/2 x 6 x 6 x 18' (cut 36) A36	18	FT	.229		414	95			
(11) STIFFENER 10 L 3/8 x 4 x 4 x 32.5' "	325	"	.225		3185	717			
(12) CTR PURLINS 6 [13 x 288' (cut 16 "	288	"	.2405		3744	900			
(13) NOZZLES 24" [illegible]	1	ea	2.00		260	520			
(14) INLET 1-24 x 1/2 W x 50 A106	50	FT	77.86		6275	3893			
WELD SHELL #1 S.S 1/4 V .43 HORIZ 516-70	91		.60		39	23			
" " #2 " 5/16 V .64 " "	80				51	31			
" " #3 " 7/16 V 1.15 " "	80				92	55			
" " #4 " 9/16 V 1.59 " "	80				127	76			
" " #5 " 11/16 V 2.28 " "	80				182	109			
" 1 R.S 1/4 V .28 S/A "	315				88	53			
" 2 5/16 V .42 " "	315				132	79			
" 3 7/16 V .75 " "	315				236	142			
" 4 9/16 V 1.03 " "	315				325	195			
" 5 3/8 FW .35 " "	1259				441	265			
CODE 4610					482626	119371			

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International Division

JOB NO. 133.0-0.R02-2 PROJECT 100MWe ACR COLONA APE STORAGE TANK LOCATION _____ CLIENT _____

DATE 3-31-78 TAKE-OFF JRM PRICED JRM 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 1/4V .28 S/A 5/16-70	1187	FT	60		332	199			
WELD ROOF 3/16FW .1 .06 " .1	1242	"			124	74			
" RING 3/16FW .1 .06 " "	320	"			32	19			
" RING 3/8V .88 MAIN "	7	"			6	4			
" " TO SHELL 1/4FW .15 S/A "	640	"			32	19			
" COL TO BOOT TOP 1/4FW 1.6 HAND "	42	"			42	25			
" BASE TO BOT 1/4FW .25 .15 " "	48	"			12	7			
" BEAM TO COL 3/4FW 2.15 1.4 " "	24	"			52	31			
" GUSS TO CLIP 1/4FW .25 .15 " "	81	"			20	12			
" PURLIN SUP TO SHELL #1 1/4FW .25 .15 " "	84	"			21	12			
" PURLINS 1/4FW .25 .15 " "	350	"			88	53			
" BEAMS TO COL 3/4FW 2.15 1.4 " "	48	"			103	62			
" NOZ TO SHELL 11/16V 2.5 228 " "	8	"			28	17			
" NOZZLE TO ROOF 1/4FW .25 .15 " "	6	"			2	1			
WELD FLUX	2100	LBS	180			1680			
MISC MATL MH'D, STAIRSETS	L.S				3000	6000			
SUB-TOTAL					3954	8215			
CODE 4610									

Form 702-D Rev. 11-73

Ato... ional Division
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JOB NO 133-026R1 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-20-78 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
STEAM GENERATOR PUMP P-2 706 H.P - 15,000 GPM @ 250' TDH COMPLETE W/ DRIVES, SPEED CONTROL MOTOR GENERATOR.	1	EA			14 TON	5000000	75000		5750000
INSULATION	438	S.F						131000	131000
TRACE HEATERS	146	L.F						17520	17520
									7235200
								ROUND TO	7240000

CODE 4630 STEAM GENERATOR PUMP P-2

Form 702-D Rev. 11-73

Atc ational Division
Rock ational

JOB NO. 133-92&102 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-27-78 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
CONCRETE FOUNDATIONS	200	C.Y			$150/C.Y				30,000.00
CODE 4660 FOUNDATIONS									30,000.00

Form 702 D Rev. 11-73

Atomics International Division

JOB NO. [illegible] PROJECT 100 MW LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ENGINEERING TITLE III ESTIMATED @ 6% OF CONSTRUCTION									
CODE 4670 ENGINEERING									

Form 702-D Rev. 11-73

Atomic International Division
Rockwell International

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

DATE 7-27-78 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
SODIUM	16×10^6	LBS	.40						64000000
CODE 4680 WORKING MEDIA.									64000000

Form 702-D Rev. 11-73

JOB NO. 133-__-16 PROJECT _____ LOCATION _____ CLIENT _____

DATE 5-3-79 TAKE-OFF JC PRICED JC CALC. CHK'D _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
"MECHANICAL"									
TEMPORARY CONSTRUCTION									
OFFICE TRAILER									17000
TOILETS									9000
FAB. SHELTER & WAREHOUSE									20000
RENTAL EQUIPMENT									
CRANES & HOISTING EQUIPT.									92000
PICKUP TRUCKS									28000
FLATBED TRUCKS									20000
WELDING MACHINES									30000
PIPE MACHINES									3000
GAS RIGS									4000
~~TEST PUMPS~~ SMALL TOOLS									10000
SCAFFOLDING ALLOWANCE									10000
JOB OVERHEAD									
SUPERINTENDENT									218000
ENGINEERS									167000
~~OFFICE MANAGER~~ GENERAL FOREMAN									175000
~~CLERKS~~ WAREHOUSEMAN									125000
UNALLOCABLE LABOR @ 6% OF DEL X $	2,282,000								136000
CONSUMABLES @ 6% OF DEL X $	2,282,000								136000
CODE 4810-5400 CONTRACTORS FIELD OVERHEAD									1200000

Form 702-D Rev. 11-73

PREPARED BY: J. Wilcof
CHECKED BY:
DATE: 9/06/78

Rockwell International
Atomics International Division

100 MWe oil sodium 1 ST plant

PAGE NO. OF
REPORT NO. Draft final
MODEL NO.

CBS	4820 Spare Parts	4830 A&E	4840 CM	4860	
4100		5,381	5,381		5,381
4200	19,424	19,424	19,424		19,424
4300	4,834	4,834	4,834		4,834
4400	60,596				60,596
4440			10,918		
50			2,525		
60			3,399		
4500	23,305			23,305	
14			1,452		
15			1,315		
20			4,942		
40			3,166		
50			0		
60			5,144		
4600	12,086			12,086	
10			4,356		
20			0		
30			724		
40			0		
50			0		
60			300		
FACTOR	x.005	x .05	x .05	x.29	x.10
10^6	601	1482	3394	10288	9023
				19311	

N 152-8-2 REV. 2-76

PREPARED BY: W. WILLCOX	Rockwell International	PAGE NO. OF
CHECKED BY:	Atomics International Division	REPORT NO.
DATE: 09/06/78	NTH PLANT MODULE alt 1a	MODEL NO.

CBS	4820 Space Parts	4830 A&E	4840 C M	4860
4100		5,271	5271	5271
4200	19,424	19,424	19,424	19,424
4300	4301	4301	4,301	4301
4400	45,820			45,820
4470			8590	
50			1,910	
60			2,720	
4500	19,852			19,852
14			1,452	
15			1,315	
20			4,942	
40			3,166	
50			4,110	
60			0	
4600	11,400			11,400
10			4,072	
20			0	
30			688	
40			0	
50			0	
60			300	
FACTOR	X.005	X .05	X .105	X .129 X.10
10^6 $	503	1450	3113	4017 7482
				11499

M 147-8-2 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 occuring 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) Instrumant 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

Atomics International Division
Rockwell International

JOB NO. 133-D26R02 PROJECT _____ LOCATION _____ CLIENT _____

DATE 7-28-78 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
ALL SODIUM INSTRUMENTATION									1452000
ADD FOLLOWING FOR AIR ROCK: SWITCH GEAR FOR FANS, TANK HEAT EXCHANGERS ETC.									837000
CODE 4514 AIR/ROCK INSTRUMENTATION									2289000

Atomic International Division
Rockwell International

JOB NO. 133-026R02 PROJECT ADVANCED CENTRAL RECEIVER LOCATION _____ CLIENT _____

DATE 4-21-78 TAKE-OFF JC PRICED JC CALC. CHK'D _____ APPROVED _____ SHEET 1 OF 4

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEET # 2- PURIFICATION & GAS SYSTEM						761000	292460		
3&4- HORIZ. PIPING						1055997	233370	11200	
5- DOWNCOMMER & RISER						469442	426030		
6- INSULATION								670037	
7- TRACE HEATERS								769860	
FIELD OVERHEAD 30% x D.L							318558		
							136718		
ADD FOR AERA LABOR PRODUCTIVITY, 60% x 426030							255618		
						2288377	1623036	1451097	
CODE 4520 HOT ROCKS- RISER, DOWNCOMIER & HORIZ. SUMMARY									5362513

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Atomic [illegible] Division

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

DATE 4-6-78 TAKE-OFF JC PRICED JC CALC. CHK'D _____ 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/CL.3"						266000	3400		
COVER GAS SYSTEM "REF PCTF USE .6 POWER"						150000	7582		
SODIUM REACTION TANK "REF LLTR"						240000	100		
							13082 M.H. @ 30.29		
CODE 4-520 HOT ROCKS PURIFICATION & GAS SYSTEM						761000	396460		

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

DATE 4-20-78 TAKE-OFF JC PRICED JC CALC. CHK'D _____ 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"	140	LF	47	3.5		6580	490		
	18	460		42	3.4		19320	1564		
	6	20		11	1.0		220	20		
90° ELL	20	1	EA	733	11.0		733	11		
	18	5		569	9.0		2845	45		
TEE	20x18	1		1410	15.0		1410	15		
	18	1		926	12.0		926	12		
CONC. RED.	18x12	3		285	9.0		855	27		
3000# F.S WELD-O-LET	6	2		58	9.2		116	18		
SODIUM VALVES	20	1		90K	212.0		90000	212		
	18	6		70K	150.0		420000	900		
	12	2		40K	90.0		80000	180		
MIXING TEE	20x18	1		140K	80.0		140000	80		
	18	1		126K	60.0		126000	60		
S.S T-304 x 3/8 WALL PIPE	18	525	L.F	190	3.4		99750	1785		
	12	168	L.F	170	2.3		28560	386		
90° ELL	18	3	EA	2600	9.0		7800	27		
	12	4		1265	6.5		5060	26		
TEE	18	2		4211	12.0		8422	24		
	12	4		2100	8.6		8400	34		
FIKE BURST DISC. ASSEMBLY 600#	12	3		3000	12.0		9000	36		
STD. C.S BUTTWELDS	20	13			5.4			70		
	18	40			4.7			188		
	6	4			2.3			9		
S.S	18	42			21.0			882		
	12	37			15.0			555		
								7656	M.H. @ 30.00	
CODE 4520	HOT ROCKS HORIZ. PIPING						1055997	229680		

Atomics Int ional Division
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JOB NO. 133-02602 PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-20-78 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
SPRING HANGERS & SUPPORTS 20"	10	EA	52	3.0		520	30.00		
18	25		50	3.0		1250	75.00		
12	12		14	1.5		168	18.00		
STRUCTURAL PIPE SUPPORTS	32	EA			350			11200	
							123.00	M.H. @ 30.00	
CODE 4520 HOT ROCKS HORIZ. PIPING						1938	3690	11200	

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Atomic[illegible]tional Division
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JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

DATE 4-3-78 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET 4=5 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		
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		
#46 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		
							14201	M.H 30	
CODE 4-520 DOWN COMMER & RISER	HOT Rocks					469442	426030		

Atomic[illegible] onal Division
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JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
					S.S. OVER				
EQUIV. LIN. FOOTAGE 3" 20	1250	LF	24	2.88	24.00	30000	3600	30000	
5½ 18	1700		44	2.67	23.00	74800	4539	39100	
5 12	220		30	1.79	15.00	6600	394	3300	
2½ 6	20		10	.89	7.65	200	18	153	
3" 18	480		22	1.30	23.00	10560	624	11040	
ALUM. WEATHER PROOFING 20	100	L.F	1.00	.10		100	10		
18	1040	L.F	1.00	.10		1040	104		
							9289	N.I.H.E 23.00	
						123300	213647	83593	
ADD FOR AREA LABOR PRODUCTIVITY x 60%							128188		
						123300	341835	83593	
CONTRACTORS O.H. & PROFIT @ 15%						18495	51275	12539	
FIELD OVERHEAD							39000		
CODE 4520 1-HOT ROCKS PIPING INSULATION						141795	432110	96132	670237

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

DATE 4-21-78 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET 7 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
				↓					
ELECT. TRACE HEATERS 20"	1250	L.F	50	160		62500	200000		
18"	2180		50	160		109000	348800		
12"	220		50	160		11000	35200		
6"	20	↓	40	128		800	2560		
CODE 4520 HOT ROCKS ELECT. TRACE HEATERS						183300	586560		769860

Atomics International Division
Rockwell International

JOB NO. 133-038 PROJECT _____ LOCATION _____ CLIENT _____

DATE 8-10-78 TAKE-OFF JC PRICED JC CALC. CHKD _____ APPROVED _____ SHEET 1 OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SHEET #2 #3									

CODE 4600 IR/Rocks Summary

Form 702-D Rev. 11-73

Atomics International Division
Rockwell International

JOB NO. 133-038 PROJECT 100 MW LOCATION ______ CLIENT ______

DATE 8·2·78 TAKE-OFF JC PRICED JC CALC. CHKD ______ APPROVED ______ SHEET 2 OF ______

	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR #	SUB-CONT.	MATERIAL	LABOR $	SUB-CONTRACT	TOTAL $000
60	EXCAVATION & BACKFILL	80,000	C.Y			3.00/C.Y			240000	240
80	INSULATING ROCKS	124 ~~76,000~~	TON	4.20	.66		~~304000~~	~~50000~~		601
10	RIVERBED SAND	34,000	TON	4.00	.65		136000	22100		158
40	FORMED CONCRETE HOUSING	54	C.Y			$200.00			16200	16
10	CONCRETE SERVICE ROADS 6"	380	C.Y			$150.00			57000	57
10	.032 GALV. CORR. SHEETING	70,000	ft²	.60	.30		42000	21000		63
10	CONCRETE ROOF SEAL 6"	2300	C.Y			$200/C.Y			230000 ~~460000~~	230
10	GUNITE EXTERIOR WALL 1"	74,000	ft²			.41			30000	30
30	CONCRETE PIPE COL. 12'6 WITH FOOTINGS INSTALLED	1	L.S						149000	149
30	HOT DUCT PIPING	324	EA	525	3.00		170100	21384	20000	395
	COOL DUCT PIPING	324	EA	495	3.25		160380	23166		

CODE 46XX AIR-ROCKS STORAGE 1939

ESG-79-2, Vol IV
B-11

Atomics International Division
Rockwell International

JOB NO. 22-038 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
					$					
30	100 H.P FANS w/ VARI-SPEED MOTOR, & COOLED BEARNINGS & 60" FAN	54	EA.	11,000	2000		594000	108000		702
40	HEAT EXCHANGERS 2'-9"x8'x8' 1"ODx.049 2¼ cr/IMD. 10,519 ft² SURFACE	54	EA.	170K	1200		918000	64800		982
40	SHEET METAL HOUSING (450#)	54	EA	600	200		32400	10800		43
30	12" THERMO FIBERGLASS @ UNIT	3456	ft²	↓	↓	30.00			103680	
	2" FIBERGLASS @ UNIT (ERT)	3456	ft²			3.90			13478	
	12" THERMO BESTOS @ WALLS	2160	ft²			37.00			79920	116
	2" FIBERGLASS @ WALLS (ERT)	2160	ft²			4.50			9720	
	CERIFELT 3# DENSITY	1	L.S			100			100	
40	FAN & HEAT EXCHANGER STRUCTURES	54	EA	1200	1300		64800	70200		135
40	SUPPLY & RETURN PIPING @ UNITS	54	EA	515	575		27810	31050		
	PIPE INSULATION @ UNITS 3"	1840	L.F	↓	↓	20			36800	316
	TRACE HEATERS @ UNITS	1840	L.F			120			220800	
30	COOLING SYSTEM FOR FANS	54	EA.	613	412		33102	22248		55
40	S.S FOR HX & FAN STRUCTURE	16,200	LBS	↓	↓	2.50/LB			40500	41
CODE										
46xx	FANS & HOUSING									6882

Rockw national

JOB NO. 133-026R02 PROJECT AIR/Rock LOCATION CLIENT

DATE 9-5-78 TAKE-OFF JC PRICED JC CALC. CHK'D APPROVED SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
20 P-2 Pump Ref 100 Nominal ALL Sodium									724000
Tanks - Hot 15 min									646
x " Cold									
(1/16 size ALL Sodium # 4610 & 4680)									
20 SODIUM		T.4/16							530
CODE 4620 HALF HOUR ALL SODIUM BUFFER									1900000

Form 702-D Rev. 11-73

PREPARED BY: TLJ	Rockwell International Atomics International Division	PAGE NO. OF
CHECKED BY:		REPORT NO.
DATE: 12/2/78	Air Locks	MODEL NO.

CBS	4820 Space Parts .5%	4830 A&E 5%	4840 C/M 5%	4860 30%	10%
4100		5,321	3321		
4200					
4300					
4400					
4470					
50					
60					
4500	24568			24568	
14			2289		
15			1315		
20			5362		
40			3156		
50					
60			5144		
4600	10721			10721	
10			538		
20			1900		
30			1391		
40			6051		
50			—		
60			240		
	120163		73687	35309	
	X.005	X .05	X .05	X.29	X.10
	600	1982	3693	10240	9024
				19264	

N 152-8-2 REV. 2-76

PREPARED BY: TLJ
CHECKED BY:
DATE: 12/2/78

Rockwell International
Atomics International Division

AIR Racks Nth Plant

PAGE NO. OF
REPORT NO.
MODEL NO.

CBS	4820 Spare Parts	4830 A&E	4840 C M	4860 Contingency	
4100		5381	5381		5381
4200	K424	19424	19424		19424
4300	4301	4301	4301		4301
4400	45820				45820
4470			6540		
50			1910		
60			2720		
4500	21397			21397	
14			2289		
15			1315		
20			5362		
40			3156		
50			—		
60			5144		
4600	9978			9978	
10			538		
20			1900		
30			1250		
40			5450		
50			—		
60			240		
	100920	29106	68970	31375	74926
	X.005	X .05	X .05	X.13	X.10
	505	455	3449	4079	7493
					11572

APPENDIX C

COST SUBSTANTIATION DATA FOR THE 281-MWe COMMERCIAL PLANT

Atomics International Division

JOB NO 33-026R02 PROJECT 300 MW LOCATION _____ CLIENT _____

DATE 9-1-78 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
LAND FURNISHED BY USER									
SITE INCLUDING FENCING, UTILITIES									1329000
MDAC "REF ACCOUNT #4400									1500000
CODE									
4100 SITE									2829000

FORM [illegible] Rev. 11-77

Atomics International Division
Rockwell International

JOB NO. 133- R&D PROJECT 300 NW LOCATION CLIENT

DATE 9-1-78 TAKE-OFF JC PRICED JC CALC. CHK'D APPROVED SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
					ACCOUNT				
LAND "FURNISHED BY USER"					4111				
SITE INCLUDING FENCING, UTILITIES & INPUT FROM MDAC UNDER ACCOUNT #4400					4112				2829000
CODE 4110 SITE									2829000

Form 702-D Rev. 11-73

Atomics International Division
Rockwell International

JOB NO 133-0 202 PROJECT 300 MWe LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
BUILDINGS ACCOUNT SUPPLIED BY STEARNS-ROGER									
CODE 4120 BUILDINGS									

Form 702-D Rev. 11-73

Atomics International
Correspondence

ACTION

REPLY

REPLY DUE

REMARKS

DERSON, S. H.
WORTH
DUITH
ENT
JRMASH
TTS
NDLEY
ROENAS
CHRAN, J.C.
AWFORD
LOS PRADOS
TTERMAN
LER
LFE
RTZLER
IG
LBROOK
COBELLIS
COBSON, J.
IES, R.G.
IAN, M.
ATEN
TINGER
LUCAS
RTIN, A.B.
COURT X
DERMOTT
DONALD, J.S.
KENZIE, D.E.
YERS, G.W.
REWITZ
Creeth X
MURPHY
DENKAMP
RKER, T.
RKINS
CRUL
MLEY
INECKER
NDERS
HIRM
STONE
TOHER
A. WARD
IEELER
ESENECK
WILLIAMS

M N77-H-1 REV. 12-77

Stearns-Roger
INCORPORATED

ENGINEERING • CONSTRUCTION

RECEIVED
JUN 20 1978
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 ^{o}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

0214

700 SOUTH ASH • P.O. BOX 5888 • DENVER, COLORADO 80217 • PHONE (303) 758-1122 • TWX 910-931-0453 TELEX 045-540

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	
			8410,000	

(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.

AWMcKenzie

A. W. McKenzie
Project Engineer

AWM:vr

Enclosure

Atomics International Division
Rockwell International

JOB NO 133-01-02 PROJECT 300 MW LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TURBINE PLANT SUPPLIED BY STEARNS-ROGERS									
CODE 42(X) TURBINE PLANT EQUIPTMENT									

Form 702-D Rev. 12-73

Fluor International

JOB NO 33-01 22 PROJECT 300 MW _____ LOCATION _____ CLIENT _____ _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ELECTRIC PLANT EQUIPMENT									
SUPPLIED BY STEARNS-ROGERS									
CODE 4300 ELECTRIC PLANT EQUIPMENT									

Form 702-D Rev. 11-73

Atomics International
D/79C Correspondence

ACTION

REPLY

REPLY DUE

REMARKS

Stearns-Roger
ENGINEERING

RECEIVED
AUG 25 1978
Correspondence Dept.

August 22, 1978

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.

10507ESG

4200
4300

...RRY CREEK DRIVE • P.O. BOX 5888 • DENVER, COLORADO 80217 • PHONE (303) 758 1122 • TWX 910 931 0453 TELEX 045 54

C-20325
6/13/78
Rev. 1 - 8/21/78

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
4200 TURBINE PLANT EQUIPMENT			
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.	2,378,000	3,544,000
	TOTAL 4200	$19,424,000	$38,759,000 (1)
4300 ELECTRIC PLANT EQUIPMENT			
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	938,000	2,231,000
	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

ADVANCED CONCEPT NTH COMMERCIAL PLANT - ~~300~~ 251 MWe

BREAKDOWN OF MASTER CONTROL COSTS BY CBS

1978 DOLLARS AND HOURS IN THOUSANDS

CBS	COST ELEMENT	LABOR HOURS	LABOR DOLLARS	NON-LABOR	TOTAL
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	5.07	169.94	10.37	180.31
	Subtotal	7.44	$236.13	$171.87	$408.00
	Visibility		47.87	34.13	82.00
	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 - ~~300~~ 281 MWe

WBS NUMBER	TITLE	CAPITAL INVESTMENT LABOR HOURS (THOU)	LABOR DOLL ($M)	MATL $ ($M)	TOTAL ($M)
4410	Reflective Unit	174.52	2.42	33.41	35.83
4420	Drive Unit	316.96	4.46	48.57	53.03
4430	Control/Instrumentation Equipment	99.76	1.47	3.42	4.89
4440	Foundation/Site Preparation	588.55	13.61	11.11	24.72
4450	Helio Spt St/Pr En	44.63	0.60	4.95	5.55
4460	Field Assembly and Checkout	373.42	7.77	0.03	7.80
	Subtotal - Heliostat	1597.84	30.33	101.49	131.82
	Visibility	-	6.07	10.13	16.20
	Total Heliostat		36.40	111.62	148.02
4100	Site, Struc, Misc Equip.	8.14	0.12	1.41	1.53
4800	Dist. and Indir. (Init. Sprs)	0.00	0.00	0.06	0.06
OM100	OPERATION	0.00	0.00	0.00	0.00
OM200	MAINT MATERIAL	0.00	0.00	0.49	0.49
OM300	MAINTENANCE LABOR	115.59	1.73	0.00	1.73
	TOTAL O&M	115.59	1.73	0.49	2.22
ONGOING O&M		59.57	0.89	0.40	1.29

Atomics I... ...ial Division

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

DATE 8-11-78 TAKE-OFF SC PRICED S.R CALC. CHK'D _____ 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	EA.				4637628	2900000		49276628
INSULATION	1056	S.F			298.00				323628
TRACE HEATERS	362	L.F			120.00				43440
1ST COMMERICAL									52950000
NTH PLANT ~ 18% LEARNING CURVE									43420000
CODE 4513 PUMP P-1									43420000

Form 102-D Rev. 11-73

ESG-79-2, Vol IV
C-13

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.

BY

ACT	DESCRIPTION	CRAFT HOURS	LABOR	MATERIAL	OTHER	TOTAL
A	EARTHWORK	1930	23160	11600	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	179149	2703685	1010725	7370	3721780
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 7½% OF TOTAL FIELD COST PLUS SALES TAX MINUS SUBCONTRACT					418600
	SUB TOTAL					6073390
Y	FEE 5% OF SUBTOTAL					303670
	TOTAL				200 M	6377060
	(31,885.00/METER x 240 METER 7				240 M	7652000

Atlantic International Division

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

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ENGINEERING TITLE III									
ESTIMATED @ 6% OF CONSTRUCTION									
1570 ENGINEERING									

Atomics I[illegible]nal Division

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

DATE 8-11-78 TAKE-OFF JC PRICED JC CALC. CHK'D _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
Pump P-2	1	EA				620400	144750		765150
Insulation	220	SF			298⁰⁰				65560
Trace Heaters	73	L.F			120⁰⁰				8760
1ST Commerical									839470
NTH Plant 2 20% Learning Curve									672000
CODE									
4630 Pump P-2									839470
							Round To		840000

Atomics International Division

PROJECT 300 MW LOCATION CLIENT

DATE 9-1-78 TAKE-OFF PRICED CALC. CHK'D APPROVED SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ENGINEERING TITLE III									
ESTIMATED @ 6% OF CONSTRUCTION									
4670 ENGINEERING									

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	122		54	
OM214 Thermal Storage Equipment				
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

717

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 $\left(\frac{281}{100}\right)^{.6} = 1.8$

OM 300 Use MDAC estimate Heliostats Increase BOP by 50%

PREPARED BY: W. Willcox

CHECKED BY:

DATE: 09/26/71

Rockwell International
Atomics International Division

300 MWe All Storage (1/4)

PAGE NO. OF

REPORT NO.

MODEL NO.

CAS	4820 Spare Parts .5%	4830 A&E 5%	4840 CM 5%	4860 30%	10%
4100		11,239	11,239		11,239
4200	38,759	38,751	38,751		38,751
4300	6,865	6,865	6,865		6865
4400	131,820				131,820
4470			24,720		
50			5,550		
60			7,653		
4500	42,077			42,077	
14			2,272		
15			2,538		
20			9,538		
40			7,652		
50			—		
60			7,272		
4600	30,470			30,470	
10			8,025		
20			~~0~~		
30			1,666		
40			~~0~~		
50			~~0~~		
60			579		
	X.005	X .05	X .05	X .15	X.10
	1250.	2843	6795	10865	18868
				29753	

N 152-8-2 REV. 2-76

APPENDIX D

COST SUBSTANTIATION DATA FOR THE PILOT PLANT

JOB NO 133- R&D PROJECT 10 MW LOCATION CLIENT

DATE 9-1-78 TAKE-OFF JC PRICED JC CALC. CHK'D APPROVED SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
					Account				
LAND "FURNISHED BY USER"	"				4111				
SITE INCLUDING FENCING, UTILITIES & INPUT FROM MDAC UNDER ACCOUNT # 4400					4112				300000
CODE 4110 SITE									300000

Form 702-D Rev. 11-73

Rockwell International

JOB NO 133-0 702 PROJECT 10 MWe LOCATION CLIENT

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
BUILDINGS ACCOUNT SUPPLIED BY STEARNS-ROGER									
CODE 4120 BUILDINGS									

Form 702-D Rev. 11-73

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. Turbine Bldg.	-	$ 300,000
2. Administration Bldg.	-	20,000
3. Warehouse-Maintenance	-	50,000
4. Controll Bldg.	-	100,000
5. Other Bldgs.	-	90,000
Total		560,000

Will confirm by mail

Jerry

4100

Atomics International Division

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

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TRANSPORTATION & LIFTING EQUIP.					4131				560000
COMMUNICATION					4132				110000
OTHERS					4133				260000
MDAC COLLECTION SYSTEM					4131				2400000
CODE 4130 MISC. EQUIPMENT									5670000

Form 7010 Rev. 11-77

Atomics International Division
Rockwell International

JOB NO 133-02-203 PROJECT 10 MW LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
TURBINE PLANT SUPPLIED BY STEARNS-ROGERS									
CODE 1									
2.0 TURBINE PLANT EQUIPMENT									

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	$2,600,000
4210 Turbine Generator & Access	740,000
4220 Heat Rejection System	95,000
4230 Condensing Systems	440,000
4240 Feed Heating Systems	1,000,000
4250 Work Fluid Circulating, Treatment, Etc	
TOTAL 4200	$4,875,000
4300 Electric Plant Equipment	$ 290,000
4310 Switchgear	410,000
4320 Station Service Equipment	170,000
4330 Protective Equipment	170,000
4340 Power Wiring, Electrical Structure & Wiring Containers	
TOTAL 4300	$1,040,000

JOB NO 33-23 02 PROJECT 10 MW LOCATION CLIENT

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
					Account				
ELECTRIC PLANT EQUIPMENT					4310.20	30 [illegible]			
SUPPLIED BY STEARNS-ROGER & MDAC									1 0 4 0 0 0 0
					4350				2 1 1 4 0 0 0
CODE 4300 ELECTRIC PLANT EQUIPMENT									3 1 5 4 0 0 0

Form 702-D Rev. 11-73

Table

ADVANCED CONCEPT PILOT PLANT

BREAKDOWN OF MASTER CONTROL COSTS BY CBS

1978 DOLLARS AND HOURS IN THOUSANDS

CBS	COST ELEMENT	LABOR HOURS	LABOR DOLLARS	NON-LABOR	TOTAL
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				
	Assy, Trans., Install & C/O	7.13	242.17	18.30	260.47
	Subtotal	10.12	$325.77	$397.69	$723.46
	Visibility		65.23	79.31	144.54
	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.

	1978 DOLLARS IN MILLIONS			
COST ELEMENT	PILOT	1ST COMM (Equipped)	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)

WBS NUMBER AND TITLE		CAPITAL INVESTMENT — LABOR — NON RECUR ($K)	LABOR HOURS (THOU)	LABOR DOLL ($M)	MATL $ ($M)	TOTAL ($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	

Table D-1

ADVANCED CONCEPT PILOT PLANT - HELIOSTAT COST (1065)

(Sheet 2 of 4)

WBS NUMBER AND TITLE	CAPITAL INVESTMENT — LABOR — NON RECUR ($K)	LABOR HOURS (THOU)	LABOR DOLL ($M)	MATL $ ($M)	TOTAL ($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)

WBS NUMBER AND TITLE		CAPITAL INVESTMENT				
		LABOR			MATL $	TOTAL
		NON RECUR ($K)	HOURS (THOU)	DOLL ($M)	($M)	($M)
4465	Field Support	1	.60	.01	0	.01
4466	Pack & Transp	1	.97	.03	0	.03
→ 4470	Design/Engineering	2534	13.94	.57	0	.57 ←
4471	Design	1575	0	0	0	0
4472	Sustaining Engr	580	13.94	.57	0	.57
4473	Pre Prod Unit	170	0	0	0	0
4474	Site Activation	510	0	0	0	0
	TOTAL HELIOSTAT	4700	140.72	4.48	6.07	10.55
→ 4100	Site, Struct, Misc Equip	0	1.22	.02	.22	.24
→ 4130	Misc Equipment	0	1.22	.02	.22	.24
→ 4800	Dist and Indir	0	0	0	.01	.01

Table -1

ADVANCED CONCEPT PILOT PLANT - HELIOSTAT COST (1065)

WBS NUMBER AND TITLE		CAPITAL INVESTMENT — LABOR — NON RECUR ($K)	LABOR — HOURS (THOU)	LABOR — DOLL ($M)	MATL $ ($M)	TOTAL ($M)
4840	Initial Spares	0	0	0	.01	.01
OM100	Operations	0	0	0	0	0
OM200	Maint Material	0	0	0	.03	.03
OM300	Maintenance Labor	0	4.09	.06	0	.06
	TOTAL O&M	0	4.09	.06	.03	.09
Ongoing O&M		0	1.80	.04	.02	.06

Atomics International Division
Rockwell International

JOB NO. _____ PROJECT 10 MWe 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
					Account				
Receiver Panels (115,107 lbs)	3	EA			4511	"Ref 100 MW"		345321	345321
Support Structure (8200 lbs)					4512	"	"	24600	24600
Receiver Pump (Rework) P-5 SCT					4513	31000	5000	44000	80000
Instrumentation & Controls (Ref 100 MW)					4514			798000	798000
Transportation, Field Erection (Ref 100 MW)					4515		54000		54000
Piping Systems					4520	709810	768510	948002	2426322
Sodium	69,100	LB.	.40		4530			27640	27640
Tower & Foundations Stears-Rodger					4540			1595500	1595500
Steam Generator A-1 MSG (Less Nuclear Codes)					4560			9000000	9000000
Design & Engineering	(See Backup)				4570				

CODE 4500 RECEIVER EQUIPMENT

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Atomics International Division
Rockwell International

JOB NO. _____ PROJECT _____ LOCATION _____ CLIENT _____

DATE _____ TAKE-OFF _____ PRICED _____ CALC. CHK'D _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION		QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
SCH. 40 C.S PIPE A-53	8"	1500	LF	210	3.7		315000	13050		
S.S	6"	1600	↓	158	6.54		252800	10464		
SODIUM VALVES C.S	8	3	EA	19K	50		57000	150		
S.S	6	2		14K	17		28000	34		
	4	1		9100	10		9100	10		
	3	1		7000	8		7000	8		
	2	3		4660	2		13980	6		
	1	1		2330	1		2330	1		
DRAG VALVE	6	1		18K	17		18000	17		
BURST DISC	6	1		1500	3		1500	3		
PIPE SUPPORTS	8	150		18	1.3		2700	180		
	6	160		15	1		2400	160		
SCH. 40 C.S BUTTWELDS	8	81			7.3			591		
S.S	6	87			10			870		
	4	2			8			16		
	3	2			7			14		
	2	6			5.5			33		
	1	2			5			10		
SODIUM REACTION TANK		1	L.S	REF	100 MW ÷.6	POWER			60301	
" PURIFICATION SYSTEM		1	L.S	"	"		"		92462	
INSULATION	4½" 8	1500	L.F			62			93000	
"	4" 6	1600	L.F			44			70400	
TRACE HEATERS		3100	L.F			120/LF			372000	
SODIUM HEATING & UNLOADING		1	L.S	REF	100 MW PLANT				165000	
COVER GAS SYSTEM		1	L.S	"	"	÷.6 POWER			94839	
								17	M.H. @ 37	
CODE 4520	PIPING SYSTEMS BACKUP						709810	76851	948002	2426322

Form 702-D Rev. 11-73

Stearns-Roger

ESTIMATE SUMMARY

CUSTOMER ATOMIC INTERNATIONAL — PROP NO.

LOCATION — JOB NO. 20325

PROJECT ADVANCED CENTRAL RECEIVER — DATE 2-6-78

(100 METERS HEIGH / NONE KIPS) — BY J.W.F.

REV. NO. — REV. DATE — BY

ACT	DESCRIPTION	CRAFT HOURS	LABOR	MATERIAL	SUBCONTRACT	TOTAL
A	EARTHWORK	462	5 540	2 800	1 770	10 110
B	CONCRETE	29 037	438 540	163 090		601 630
C	BUILDINGS & STRUCTURES					
D	PROCESS EQUIPMENT					
E	PIPING					
F	ELECTRICAL					
G	PAINTING					
L	PLANT ITEMS					
N	INSTRUMENTS & CONTROLS					
P	INSULATION					
	DIRECT FIELD COST	29 499	444 080	165 890	1 770	611 740
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			310 655
	TOTAL FIELD COST					922 595
J	ENGINEERING BY OTHERS					
	TOTAL FIELD & ENG COST					
Q	SALES TAX 4 % OF MAT'L COST					6 635
R	PREMIUM PAY NONE					
	ESCALATION CURRENT PRICES AND LABOR RATES					
	CONTINGENCY 7½ % OF TOTAL FIELD COST PLUS SALES TAX MINUS SUBCONTRACT					69 560
	SUB TOTAL					998 790
Y	FEE 5 % OF SUBTOTAL					49 945
	TOTAL					1 048 730

4540

Stearns-Roger
INCORPORATED

SHEET NO. 1
BY J. W. F.
DATE 2-10-78

CLIENT ATOMIC INTERNATIONAL
ORDER NO. 20325 LOCATION

ACCOUNT	ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L UNIT COST	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS $/MH	LABOR	MATERIAL	OTHER	TOTA
	TOWER:										
	HEIGHT 100 METERS										
	RECV. WT NONE KIPS										
A	SOIL EXCAVATION	2,719	CY	—	.08	217	12.00	2,600	—	1,070	3,67
A	BACK-FILL (COMPACTED STRUCT.)	700	CY	[illegible]	.35	245	12.00	2,940	[illegible]	[illegible]	6.[illegible]
B	TOWER CONCRETE — f'_c = 4000psi	1,058	CY	30.[illegible]	10	10,580	15.00	158,700	31,740		190,4
B	TOWER STEEL — f_y = GR.60	66	TONS	440.00	10	660	17.00	11,220	29,040		[illegible]
B	MAT CONCRETE — f'_c = 4000psi	1,885	CY	[illegible]	9	16,965	15.00	254,475	56,550		311,0
B	MAT STEEL — f_y = GR.60	104	TONS	440.00	8	832	17.00	14,145	45,760		59,9
	TOTAL					29,499		444,080	165,890	1,770	611,7

FORM 22-233 REV 1

ESG-79-2, Vol IV
D-18

Atomics International Division

JOB NO 133-22-06 PROJECT 10 MW LOCATION _____ CLIENT _____

DATE 9-1-78 TAKE-OFF _____ PRICED _____ CALC. CHK'D _____ APPROVED _____ SHEET _____ OF _____

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ENGINEERING TITLE III									
ESTIMATED @ 6% OF CONSTRUCTION									
CODE									
4570 ENGINEERING									

JOB NO. PROJECT 100 MWe LOCATION CLIENT

DATE TAKE OFF JC PRICED JC CALC. CHKD APPROVED SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	ACC. SUB CONT.	MATERIAL	LABOR	SUB CONTRACT	TOTAL
Hot Tank 35'Ø x 11' S.S (3,476ft²)	1	EA			4610	158300		*164321	
Cold Tank 35'Ø x 11' C.S (3,476ft²)	1	EA			4610	40000		*114823	
Circulation Pump Rework	1	EA			4620	15000	5000		
Foundations (1710ft²)	1	L.S			4660			13500	
Design & Engineering	1	L.S			4610				
Sodium	620K	LBS	.40		4680	248000			
* Insulation & Trace Heating									

CODE	
4600	THERMAL STORAGE EQUIPMENT

Form 702-D Rev. 11-73

133- PROJECT 10 MW LOCATION _____ CLIENT _____

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

ITEM AND DESCRIPTION	QUANTITY	UNIT	MAT'L	LABOR	SUB-CONT.	MATERIAL	LABOR	SUB-CONTRACT	TOTAL
ENGINEERING TITLE III									
ESTIMATED @ 6% OF CONSTRUCTION									
4670 ENGINEERING									

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 [illegible] & S-R
15% of ESG.

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