SAN-1604-3

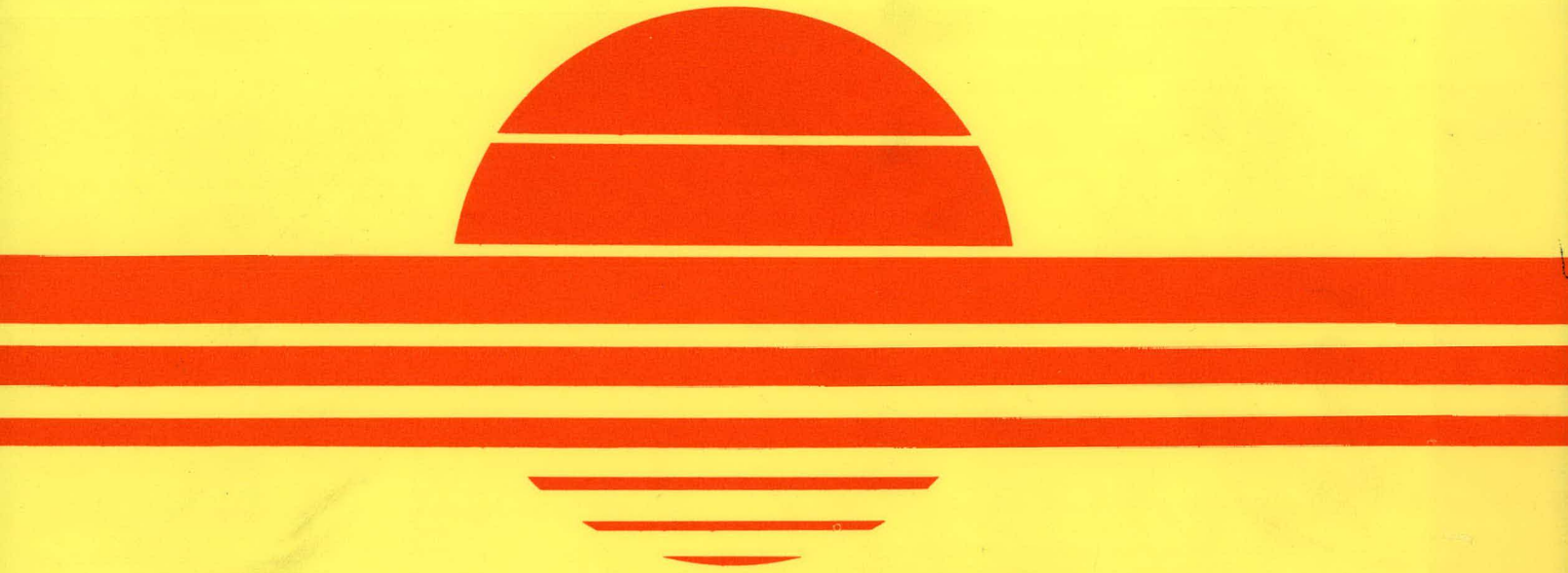
SOLAR CENTRAL RECEIVER ~~PROTOTYPE HELIOSTAT~~

Volume III: Cost Estimates

June 1, 1978

Work Performed Under Contract No. EG-77-C-03-1604

Boeing Engineering and Construction
Seattle, Washington



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VOLUME III
COST ESTIMATES

SOLAR CENTRAL RECEIVER PROTOTYPE HELIOSTAT

1 June, 1978

Prepared For
UNITED STATES
DEPARTMENT OF ENERGY

Under Contract EG-77-C-03-1604

BY

Boeing Engineering and Construction
A Division of The Boeing Company
Seattle, Washington

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FOREWORD

This document (Vol III) contains cost estimates for heliostats. This work was performed under DOE Contract EG-77-C-03-1604, "Solar Central Receiver Prototype Heliostats". Companion documents are the Final Technical Report (Vol I) and the Phase II Program Plan (Vol II). The primary objective of this study was to develop a preliminary design and cost estimate of heliostats which is consistent with production quantities and rates projected for future commercial utilization of solar energy. Work under this Phase I contract was initiated on October 1, 1977, and is scheduled for completion on June 30, 1978. Program management was performed by the DOE office in Oakland, California, and technical performance was monitored by Sandia Laboratories in Livermore, California. This report complies with the Contract Reporting Requirements Checklist.

Volume III

Table of Contents

1.0 SUMMARY

The Boeing heliostat design can be produced and installed for a Capital Cost of $42 per square meter at high commercial plant quantities and rates. This is 14 percent less than the DOE cost target. Even at a low commercial plant production rate of 25,000 heliostats per year the Capital Cost of $48 per square meter is 2 percent less than the cost goal established by the DOE.

Boeing Engineering and Construction submits herein the projected capital costs and 30 year maintenance costs for three scenarios of production and installation:

1) Commercial rate production of 25,000, 250,000, and 1,000,000 heliostats per year.
2) A one-time only production quantity of 2500 heliostats.
3) Commercial rate production of 25,000 heliostats per year with each plant (25,000 heliostats) installed at widely dispersed sites throughout the Southwestern United States.

These three scenarios for solar plant locations and the manufacturing/installation processes are fully described in Sections 3.1, 3.2 and 3.3 respectively. Detail cost breakdowns for the three scenarios are provided in Sections 5.1, 5.2 and 5.3 respectively.

The first scenario of commercial rate production utilizes highly automated on-site manufacturing/assembly facilities at each of the plant sites. At the rate of 25,000 heliostats per year, all annual productions are assembled and installed at one location. At the rates of 250,000 and 1,000,000 per year the annual productions are assembled and installed at 10 and 20 southwestern locations respectively. The resulting capital costs are approximately 48, 43, and 42 dollars per square meter for the three production rates. With 30 year maintenance cost included, the total cost is approximately 59, 53, and 52 dollar per square meter.

The second scenario of the one-time production of 2500 heliostats results in a Capital cost estimate of $84 per square meter.

The third scenario is similar to the first scenario, except that at the annual production rate of 25,000 per year, the annual installations are at widely dispersed locations. The configuration is amenable to widely dispersed plant sites. A penalty of approximately 10 percent in life cycle cost is incurred compared to the centralized concept of the first scenario. The resulting total 30 year cost is $64.50 per square meter.

The Boeing concept of an environmentally protected heliostat has the design features to achieve the low-cost goals compatible with commercial utilization of solar energy. The primary features which minimize the cost/performance ratio are:

1) The protective enclosure allows a lightweight reflector utilizing a metalized membrane.
2) The lightweight reflector allows the use of a small two-axis gimbal/actuator assembly and a lightweight support structure.
3) The reflector, protected from wind loading, is cost optimized at a relatively large area of 65.7 square meters.
4) The gravity focusing capability of the tensioned membrane maximizes energy on the receiver.
5) Each component has been designed from the standpoint of highly automated manufacturing and assembly processes.
6) The heliostat is completely assembled in the factory environment using assembly line facilities. There is no labor intensive assembly in the field.
7) The heliostat foundation concept of auger cast concrete piles is highly automated.
8) The installation concept utilizes simple welds to the piling cap plates at the pedestal and three stanchions. Electrical connections complete the installation.
9) Alignment and checkout is an automated procedure utilizing an optical detector array on the receiver tower to achieve the pointing inputs to the computer software and to record image intensity profiles of heliostat groups.

10) Maintenance requirements have been minimized by the pressurized protective enclosure requiring a very low input of highly filtered air. This environment eliminates the need for mirror cleaning for at least 15 years. Placement of electronic parts on the base shell eliminates the need for access into the heliostat for electronic component replacement.

11) The concept for cleaning the protective enclosure (dome) includes spray rinsing from sprinklers, plus an occasional cleaning with a special mobile automated washing machine using high pressure water sprays.

12) Because commercial rate production is highly automated, heliostat materials - rather than labor - become the dominate cost factor. The protective dome concept allows the lightweight structure and results in a minimum usage of materials. Table 1.0-1 shows a break out of the quantities of materials for the proposed heliostat design. Excluding the concrete foundation piling, the material usage totals only 36 LB/m^2.

The DOE capital cost goal for commercial solar heliostats has been established at \$70/m^2-Reflectivity (63.7/m^2) of reflective surface. The equivalent value for the protective enclosure concept with a dome transmissivity of 0.88 is \$54.20/m^2-R, or \$49.30/m^2. Figure 1.0-1 shows how the BEC target goal was distributed and compares the target costs with the costs identified as a result of this study. The thermoforming of the weatherized polyester enclosure results in costs considerably below the initial target established for fabricating by gore seaming. In total, the identified costs are 2 to 14 percent below the DOE target cost for production rates varying from 25,000 to 1,000,000/year.

Table 1.0-2 provides a summary of costs per square meter by the Cost Breakdown Structure (CBS) items.

Table 1.0-3 provides the distribution of cost to categories of heliostat capital costs of materials, labor, and facilities; and the maintenance cost for the specified 30 year plant life. It is seen that the "Economies

TABLE 1.0-1
WEIGHT BREAKDOWN

CBS	ITEM	LB	LB/m^2
4410	Reflector	301	4.6
4420	Drive Unit	65	1.0
4430	Control	30	0.5
4451	Support Structure	1940	29.5
4452	Enclosure	54	0.8
	Subtotal	2390	36.4
4440	Foundation	4370	66.5
	TOTAL	6760	102.9
	Steel:		
	Sheet	685	10.4
	Pipe	1145	17.4
	Machined Castings/Forgings	70	1.1
	Extrusions	45	0.7
	Rebar	70	1.1
	Other	60	0.9
	Aluminum:		
	Tubing	200	3.0
	Castings	90	1.4
	Plastic:		
	Polyester Sheet	61	0.9
	Extrusions	4	0.1
	Electronics:		
	Controller	20	0.3
	Wiring	10	0.2
	Concrete	4300	65.4
	TOTAL	6760	102.9

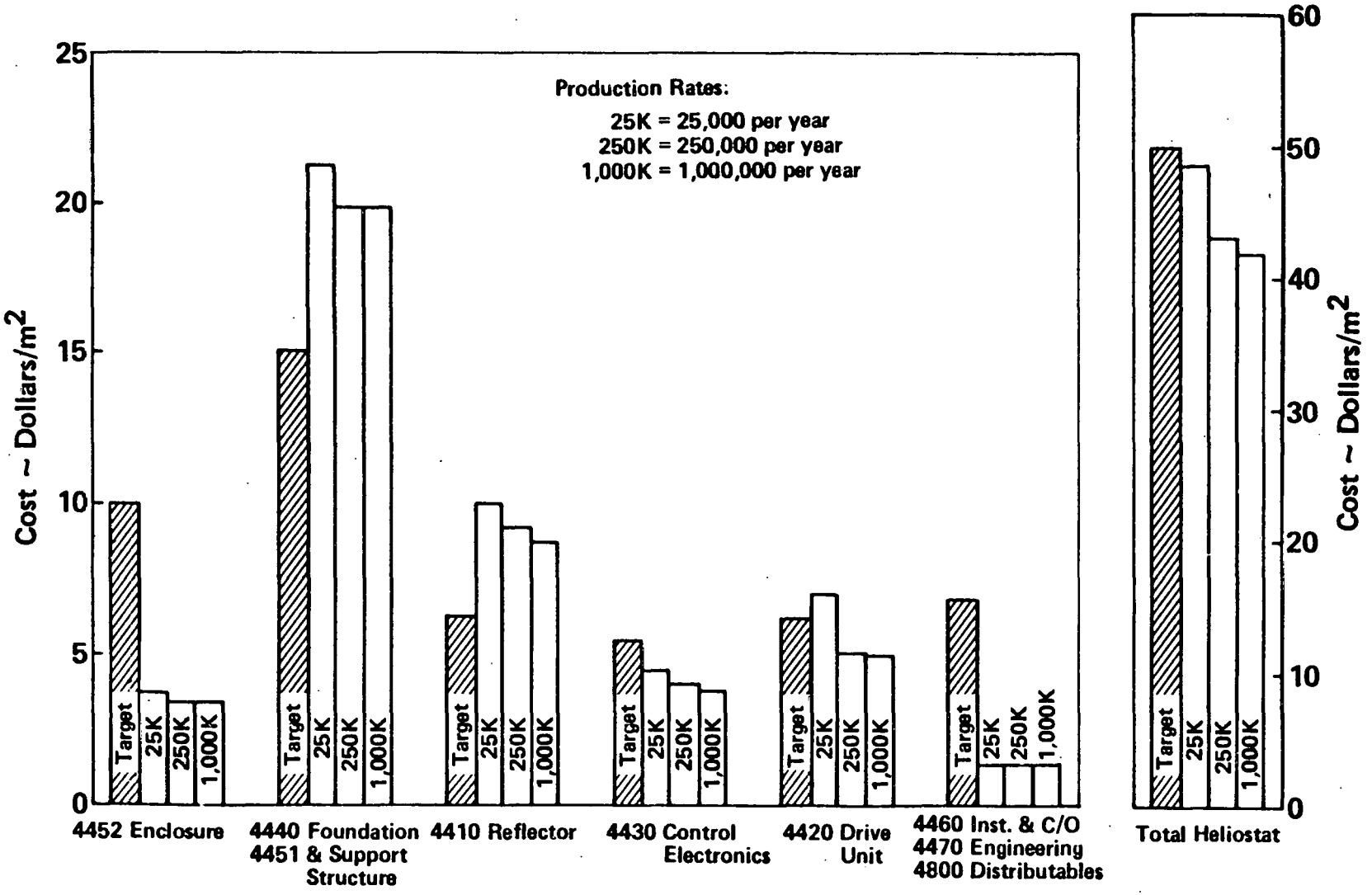

Figure 1.0-1 HELIOSTAT CAPITAL COST SUMMARY - SCENARIO 1

TABLE 1.0-2 SUMMARY - Dollars Per Square Meter
(Reflector Area = 65.7 Square Meters)

CBS	ITEM	ANNUAL PRODUCTION RATE 25,000 [1]	25,000 [2]	250,000	1,000,000	BEC TARGET
4410	Reflector	10.37	10.20	9.18	8.86	6.30
4420	Drive Unit	7.09	7.07	5.11	5.04	6.30
4430	Control & Instrumentation	4.64	4.63	4.14	3.86	5.40
4440	Foundation & Site	5.36	5.10	5.10	5.10	15.20
4451	Support Structure	16.83	16.13	14.39	14.39	
4452	Enclosure	4.21	3.68	3.37	3.37	10.00
	Subtotal	(48.50)	(46.81)	(41.29)	(40.62)	(43.20)
4460	Field Assy & C/O	1.22	1.10	1.10	1.10	6.8
4470	Engineering Liaison	.18	.06	.06	.06	
4810	Temporary Facilities, etc.	1.91	.48	.45	.42	
4850	Plant Startup & C/O	.11	.10	.10	.10	
	CAPITAL COST	(51.92)	(48.55)	(43.00)	(42.30)	(50.00)
OM210	Spare Parts	.30	.15	.14	.13	
OM220	Materials for Repairs	Neg.	Neg.	Neg.	Neg.	
OM230	Other - Special Equip	2.53	2.53	2.38	2.26	
OM231	Other - Maint. Mtls.	4.36	4.36	4.07	4.00	
OM310	Scheduled Maint (Labor)	2.63	2.39	2.39	2.39	
OM320	Corrective Maint (Labor)	2.78	1.39	1.39	1.39	
	Subtotal	(12.60)	(10.82)	(10.37)	(10.17)	
	TOTAL COST	64.52	59.37	53.37	52.47	

[1] Third Scenario for dispersed solar plant sites.

[2] First Scenario for centralized concentration of solar plants at one site.

TABLE 1.0-3 COST SUMMARY - Dollars Per Heliostat

	ANNUAL PRODUCTION RATE			
	[1] 25,000	[2] 25,000	250,000	1,000,000
Raw Material	1813.69	1775.69	1576.36	1555.30
Purchased Equipment	1111.48	1094.48	933.32	909.90
Total Material	2925.17	2870.17	2509.68	2465.20
Fabrication Labor	230.51	202.06	202.06	202.06
Installation & C/O Labor	90.12	80.33	80.33	80.33
Total Labor	320.63	282.39	282.39	282.39
Special Maintenance Equipment	166.12	166.12	156.64	148.34
Maintenance Materials	305.70	295.95	276.54	272.08
Maintenance Labor	355.49	248.38	248.38	248.38
Total Maintenance	827.31	710.45	681.56	668.80
Facility, Tooling, & Special Equipment	165.52	38.59	33.76	31.35
	4238.63	3901.60	3507.40	3447.75

[1] Third Scenario for dispersed solar plant sites.

[2] First Scenario for centralized concentration of solar plants at one site.

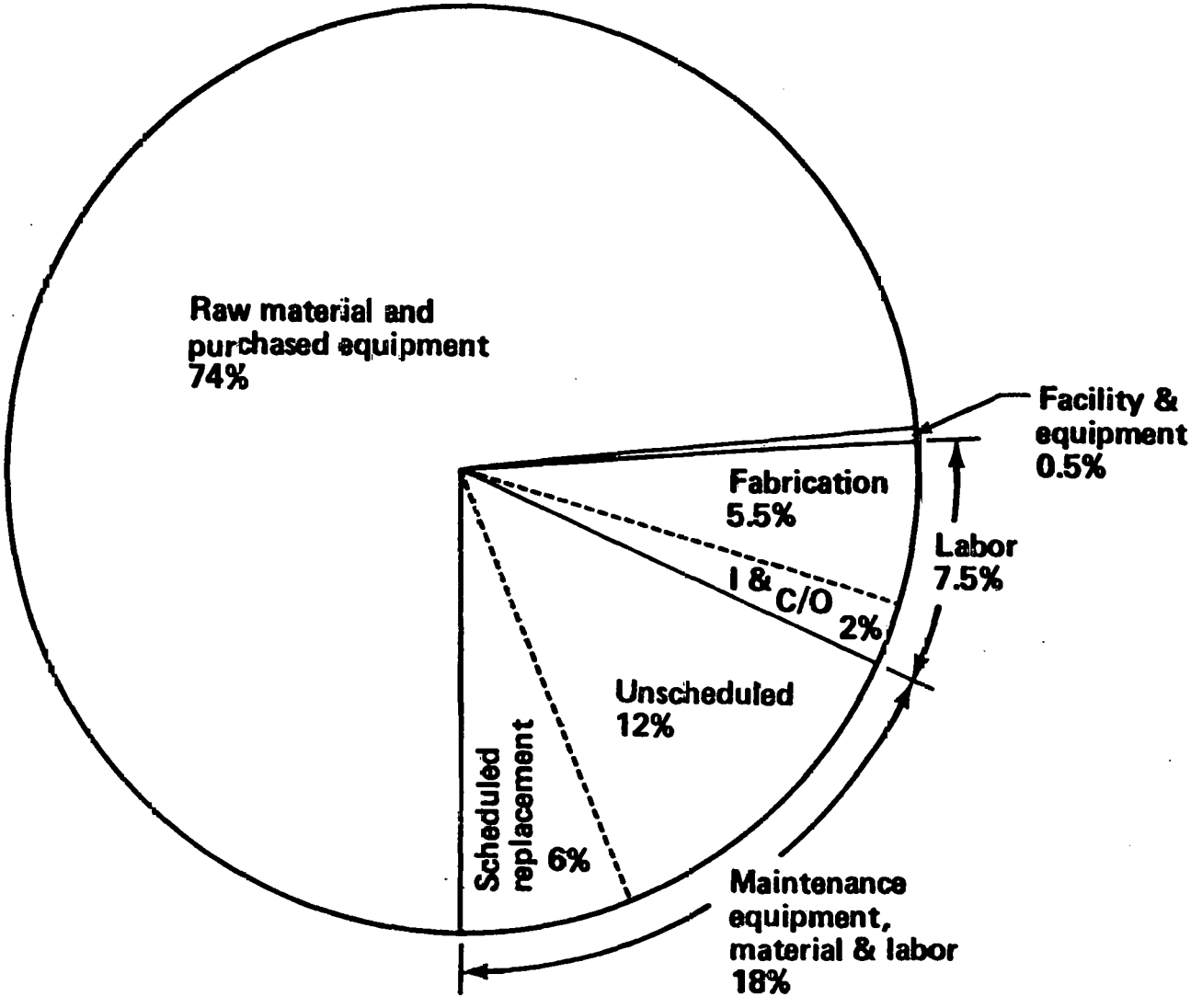

Figure 1.0-2 COST DISTRIBUTION - SCENARIO 1

of Production Rate" are related primarily to materials rather than to labor. The labor does have an improvement factor with time or with units produced per each on-site manufacturing/assembly facility; but no labor improvement factor has been credited when increasing the production rate from 25,000 per year to 1,000,000 per year. This is because the higher rates of production are achieved by simultaneous multiple site production using identical automated tooling and facilities.

The cost distribution illustrated by Figure 1.0-2 shows that heliostat materials is the dominant cost. Manufacturing/installation labor are not the large cost drivers. Low life-cycle cost will only be achieved with a design concept which minimizes the usage of materials and which utilizes low-cost materials and material forms which are currently in the large volume market. Steel sheet and steel pipe as utilized in the base design are examples of current high production items. The plastics industries currently produce polyester film in quantity for a multitude of applications. The air supply blower and filter components, and the gimbal actuators utilize components which have many applications in the commercial market. The heliostat controller electronics are current state-of-the art in applications using high rate automated production.

In this cost analysis, emphasis has been placed on the detailed definition to provide visibility of the cost accounts (CBS) and the methodology utilized in the cost estimates. These data are provided in Sections 3.0, 4.0 and 5.0.

In reviewing the cost estimates it is seen that several items are worthy of further analysis and have the potential for significant reduction. One example appears to be the reflector structural design where the three tee-shaped castings and the hub casting are significant cost items. Further trade-study and design definition should have potential for reducing cost. Replacement of the steel base dish with an impregnated fabric design may reduce cost. These and other prospects for cost reduction are discussed in Section 7.0.

2.0 REQUIREMENTS

2.1 COST ESTIMATE

Capital cost estimates are required for an initial production of 2500 heliostats and for heliostat steady state production/installation rates of 25,000, 250,000, and 1,000,000 heliostats per year plus the operations and maintenance cost for an assumed 30 year plant life. The power plant locations are defined as being in the region of the eight southwestern states. Costs are provided to the DOE specified Cost Breakdown Structure. Costs are recurring costs only of items identified with the heliostat. Costs exclude the interface with plant control and therefore exclude the power and signal distribution wiring in the collector field. Costs, defined in Section 5.0, are generated for a power plant field of 25,000 heliostats with operations and maintenance for an assumed 30 year life. The resulting plant cost is reduced to a cost per heliostat and a cost per square meter of reflective surface to allow comparison with competitive design concepts.

2.2 PERFORMANCE ESTIMATE

Optical performance at the receiver is required for each of three specified heliostats on each of four specified days. These data are documented in Section 2.3 of Volume I, Technical Report and are summarized in this Volume III Section 6.0. These data allow the DOE to calculate the Cost Performance Ratio (CPR). The CPR is the quotient of Total Annual Cost (TAC) and the Net Reflected Power (NRP) for a complete single heliostat as installed and maintained for a 30 year life.

3.0 MANUFACTURING/INSTALLATION SCENARIO

3.1 SCENARIO 1 - COMMERCIAL RATE PRODUCTION

To estimate costs for commercial utilization of solar electric power, the following scenario for heliostat production and installation was established.

1) A solar central receiver power plant has 25,000 heliostats.

2) Relatively small land areas are dedicated to high density installation of solar power "parks." A solar power "park" is some multiple of individual solar plants, as defined in Item 6.

3) Solar parks are located in the reasonable vicinity of population centers to assure local availability of manufacturing, assembly and site installation labor. The number of solar power "parks" is a function of the specified production rates as defined in Item 6.

4) For the purpose of costing the delivery of materials, Phoenix, Arizona has been assumed as an average location for sites.

5) Transport over dedicated roads is utilized within the boundaries of the solar park. Solar parks are widely separated in the eight southwestern states, precluding dedicated roads between solar parks.

6) A separate scenario is assumed for each of the three specified production rates as discussed in the following and summarized in Table 3.0-1.

   25,000 Heliostats Per Year

   A solar park will contain thirty power plants (750,000 heliostats). The park will be completed in thirty years. Each plant within the park will be installed sequentially such that one plant installation is complete each year.

TABLE 3.0-1

SOLAR PLANT INSTALLATION ASSUMPTIONS

(SCENARIO 1)

	Annual Production Rate		
	25,000	250,000	1,000,000
Heliostats Per Plant	25,000	25,000	25,000
Total Plants in 30 Years	30	300	1,200
Number of Solar Parks	1	10	20
Plants Per Park	30	30	60
Years to Complete a Park	30	30	30
Plants Complete Per Year Per Park	1	1	2
Number of Parks in Simultaneous Construction	1	10	20
Plants Complete Per Year	1	10	40

250,000 Heliostats Per Year

A solar park will contain 30 power plants (750,000 heliostats). Each power park is completed in 30 years at a rate of one plant per year. Ten parks are in simultaneous construction.

1,000,000 Heliostats Per Year

A solar park will contain 60 power plants (1,500,000 heliostats). Each power park will be completed in 30 years at a rate of two plants per year. Twenty parks are in simultaneous construction.

The scenario as described above provides a distribution of plants throughout the Southwestern states while retaining the efficiency of dedicating an on-site high rate production facility to a 30 year production life at each southwestern site (solar park). The manufacturing/assembly facility is modularized. The module with its automated tooling has the capability to fabricate, assemble, and install 25,000 heliostats per year. At the highest production rate of 1,000,000 heliostats per year, two factory modules are required to meet the production rate at each of twenty parks. With this scenario a factory module of 208,000 square feet was defined with automated tooling and equipment to produce 100 heliostats per day on a two shift/day basis. The cost for this scenario is summarized in Section 5.1 and detail estimating work sheets are provided in Appendix A.

3.2 SCENARIO 2 - 2500 HELIOSTATS

This scenario is for the one time only production of 2500 heliostats as may be desired for an initial demonstration plant. The configuration and the manufacturing/installation scenario is the same as for commercial rate production except that the prototype tooling and handling equipment is not highly automated. The cost for this scenario is summarized in Section 5.2 and detail cost estimating worksheets are provided in Appendix B.

3.3 SCENARIO 3 - 25,000 HELIOSTATS PER YEAR AT DISPERSED SITES

At the low commercial production rate (25,000 per year) as described in Section 3.1, all heliostats would be installed at one site location. This is the most cost-effective approach requiring capital investment in only one assembly facility.

The following describes an alternate scenario in which individual plants of 25,000 heliostats would be installed at widely separated sites in the Southwestern United States. For this scenario, all heliostat components, including the protective enclosure and the base dish are fabricated off-site and transported to the site assembly facility. The assembly facility size is thereby reduced from 208,000 square feet to 160,000 square feet. An assembly facility building is required at each site to support the yearly production rate. At the end of the year's production, 40,000 square feet are retained for maintenance purposes and the remaining 120,000 square feet are sold or leased. Initial tooling is provided for the first two assembly facilities. Subsequent assembly site tooling is provided by moving tools in leap frog fashion (No. 1 to No. 3, No. 2 to No. 4, etc.)

The heliostat configuration for this scenario is the same as defined in Section 3.1 with the exception that the large steel base dish, fabricated off-site, would be transported in two halves with weld assembly at the site.

The cost for this scenario is summarized in Section 5.3 and detail cost estimating worksheets are provided in Appendix C.

4.0 COST ESTIMATING APPROACH

Table 4.0-1 lists the major elements of heliostat recurring costs and shows the general methodology of cost estimation. Raw material costs using supplier quotes were generated from detailed parts lists considering gross material requirements. Purchased equipment and components are defined by the Make/Buy plan of Table 4.0-2. The plan is to purchase all small components which could be shipped from off-site suppliers. Only those components too large for shipment are produced in the on-site manufacturing/assembly facility. Supplier quotes were utilized for the gimbal/actuator assembly and for the heliostat control electronics. Other purchased components from off-site manufacturing were estimated by a detailed analysis of material and man-hour estimates times burdened labor rates.

4.1 LEARNING CURVE FACTOR

The appropriate "Learning Factor" is very difficult to establish for a highly automated high production rate factory. It is well documented that productivity improvement or reduction in man-hours per unit of production does occur. The Aerospace industry experiences an improvement as described by an 85% learning curve where:

$$\text{COST Nth Unit} = (\text{1st Unit Cost})\ (N)^{\frac{\log .85}{\log 2}}$$

The Aerospace experience is for low quantity production using relatively labor intensive fabrication and assembly procedures. Industries with a long history of high rate automated production also show very significant improvements in productivity with time. Figures 4.2-1, 4.2-2, and 4.2-3 illustrate productivity improvements which have been achieved.

Table 4.0-1

COST ESTIMATE METHODOLOGY

ELEMENT	METHOD
Heliostat Raw Material	Qty x Unit Cost Supplier Quotes
Purchased Equipment	Supplier Quotes
Purchased Components - Material	Supplier Quotes Plus Transportation Per Pound.
- Labor	Man-hour Estimate x Rates & Factors
On-Site Mfg/Assy Labor	Man-loading x Rates & Factors
Mfg/Assy Facility	Facility Design & Cost Estimate
Production Tooling	Material Plus Hours x Rates & Factors
Special Equipment	Similarity to Existing Equipment
Auger Cast Foundations	Subcontractor Estimate
Installation & Functional Check	Man-loading x Rates and Factors
Align & Checkout	Man-loading x Rates and Factors
Maintenance	Man-laoding x Rates and Factors

Table 4.0-2

MAKE/BUY PLAN

Item	Make (M) Buy (B)	Drawing Number
Support ring - segments	B	277-10048-41
Stanchions	B	277-10048-5
Pedestal	B	277-10048-6
Enclosure attach ring	B	277-10048-X
Reflector structural components	B	277-10051-7
	B	277-10051-8
	B	277-10051-9
Hatch assy	B	277-10048-10
Flanges - hatch	B	277-10048-13 & -14
Gimbal/actuator assy & harness wire	B	
Air Supply assy	B	277-10052-1
Relief Valve assy	B	277-10052-2
Electronics equipment	B	
Piling installation	B	277-10050-1
Hub	B	277-10054-1
Tee's	B	277-10053-1, -2
Base Dish	M	277-10048-3
Enclosure	M	277-10049-1
Heliostat Assy & instl	M	277-10048-1
Reflector assy	M	277-10051-1 & -2

NOTE: M = On-site manufacture or assembly
B = Off-site manufacture

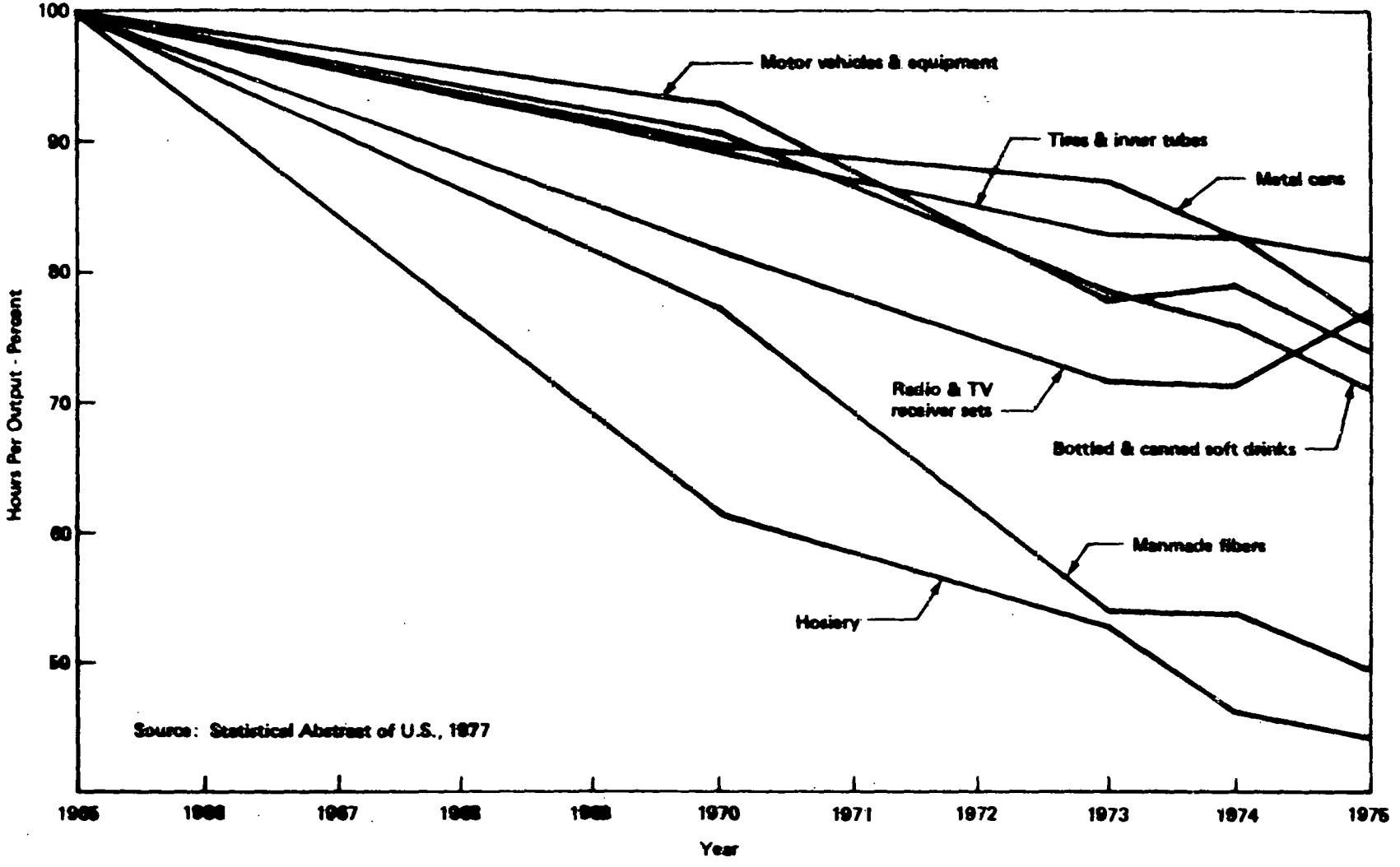

Figure 4.1-1. Production Worker Hours Per Output - Automated Industries

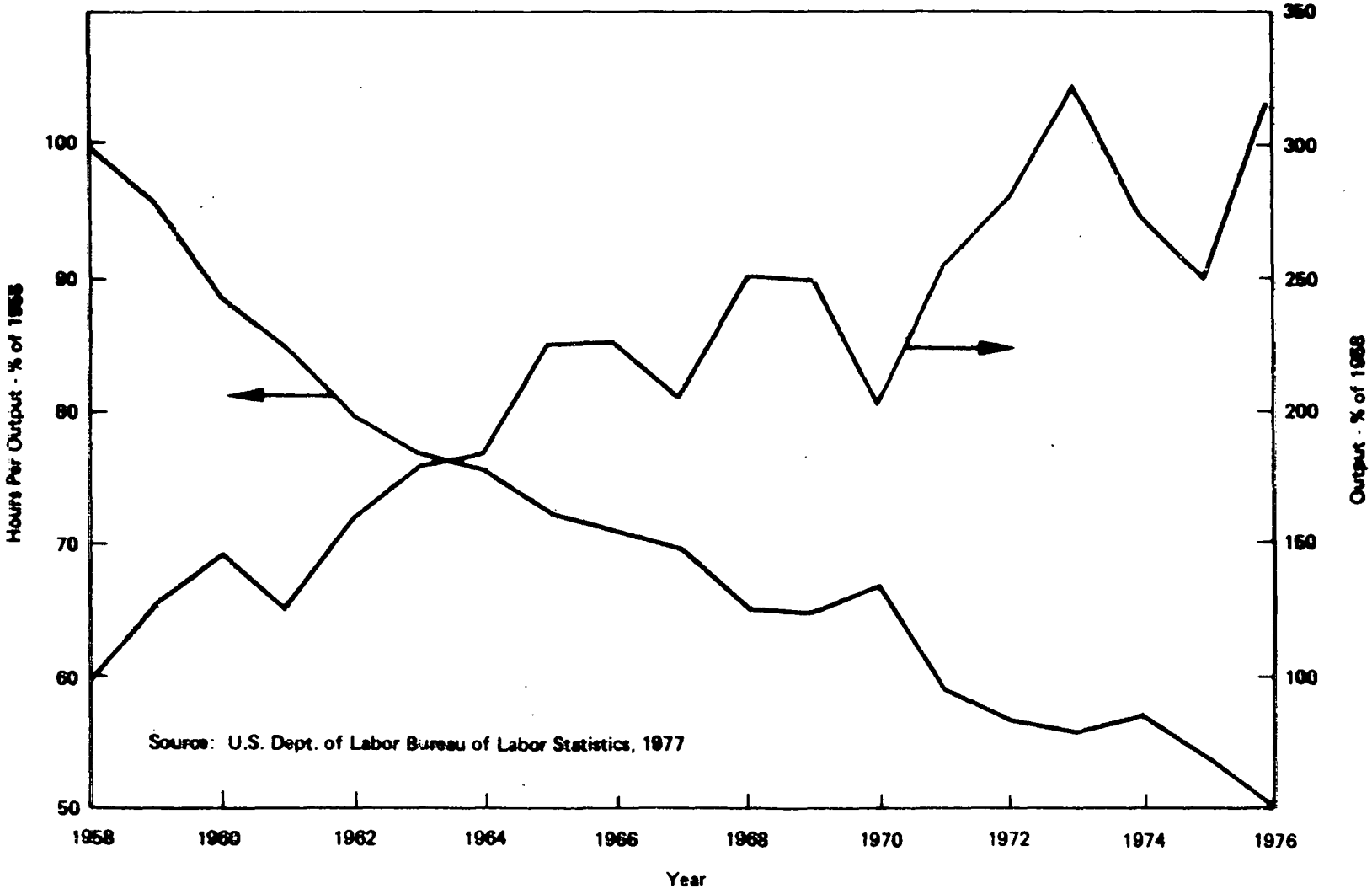

Figure 4.1-2. Production Workers - Motor Vehicles and Equipment

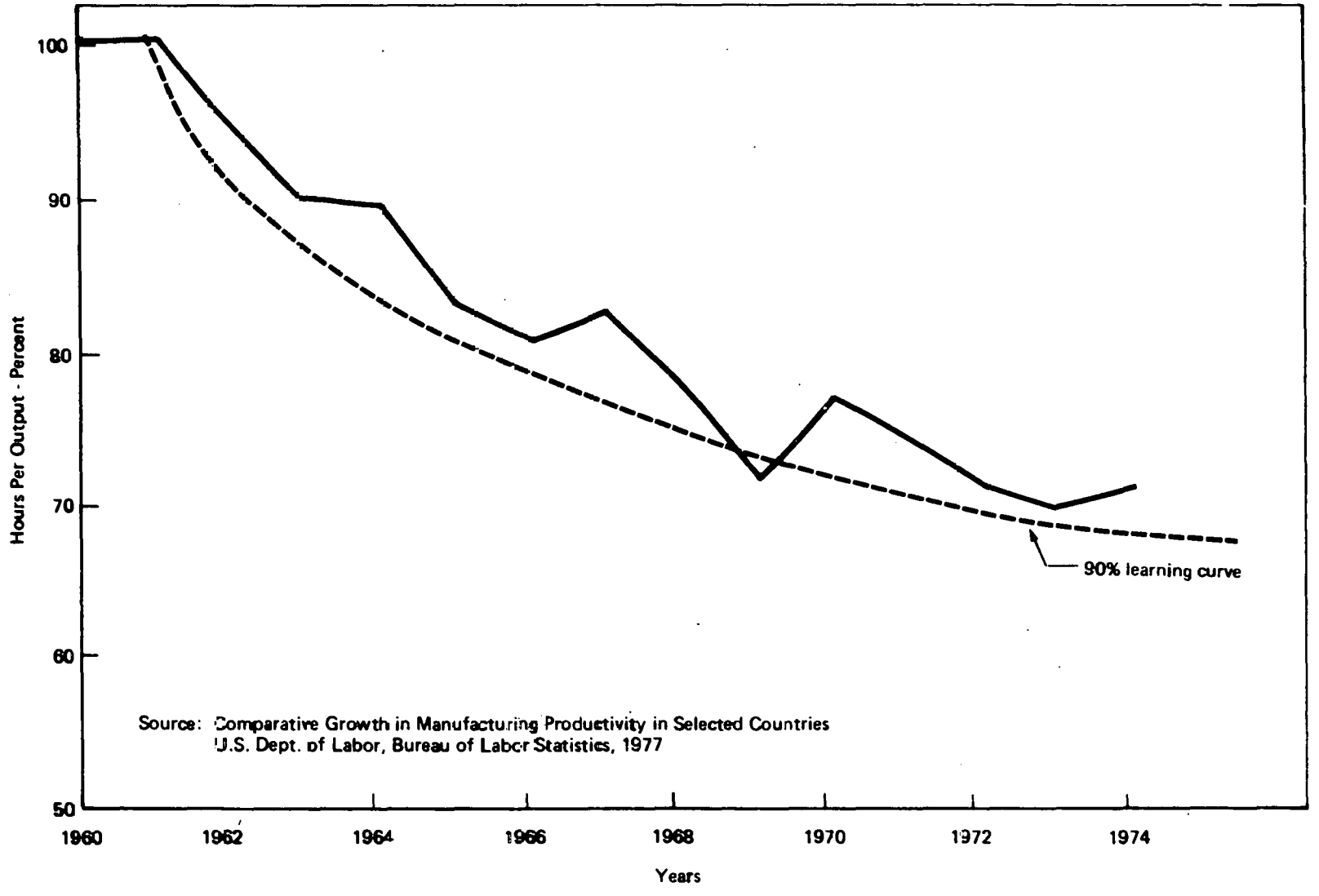

Figure 4.1-3. Fabricate Metal Products - United States

These data would indicate that "learning" or improvement continues over the many years of production without apparently leveling off at an ultimate achievement. These data do not indicate however, the amount of capital investment in new tooling that may have been required to achieve and maintain the indicated levels of productivity improvement.

For this cost estimate, a conservative estimate of the "learning curve" has been chosen to represent the commercial heliostat production scenario. This scenario has assumed that the plant startup period has been completed. The tooling and processes have been developed and debugged. The learning process has reached the point of steady state continuous production. This point is estimated to be about 18 months and approximately 25,000 heliostats (an initial plant) has been produced. The man-loading estimates have been based on this initial production level. Heliostat costs are based on the steady-state continuous production following this start up period. It is then estimated that productivity improvement would be described by a 95% learning curve which continues over the next 20 years followed by no improvement for the next 10 years. The application of this improvement makes the first unit be the 25,000th unit on the learning curve. This "Learning Curve" is illustrated in Figure 4.1-5.

$$\frac{\text{COST } (25{,}000 + N)}{\text{COST } (25{,}000)} = \frac{(\text{1st Unit Cost})\ (25{,}000 + N)^{\frac{\log .95}{\log 2}}}{(\text{1st Unit Cost})\ (25{,}000)^{\frac{\log .95}{\log 2}}}$$

This approach results in an average unit labor learning factor of 0.834 over the 30 years of steady state production and installation. This value is probably conservative, especially in the area of maintenance labor where experience is likely to solve probelms such as part failures or develop improved cleaning processes.

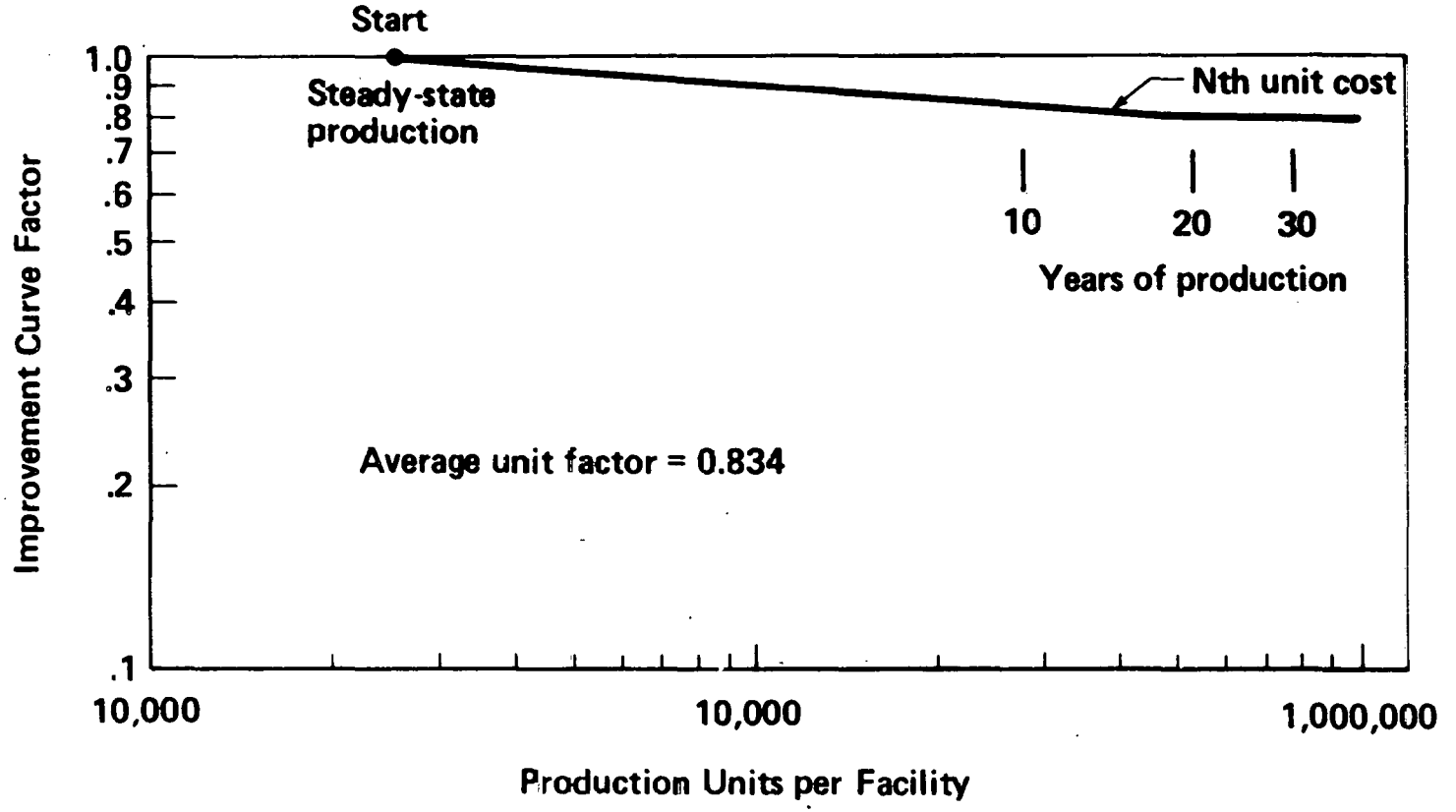

Figure 4.1-5 LABOR PRODUCTIVITY CURVE

4.2 COST BREAKDOWN STRUCTURE DEFINITION

The following definition of the cost elements included in each item of the CBS are provided for understanding and clarity.

4410 Reflective Unit

The reflective unit includes the aluminized membrane, the structural ring and spoke assembly with the hub casting which interfaces with the Drive Unit. Structural components costs are estimated as off-site fabrication. The structural assembly and the bonding of the membrane is accomplished in the on-site assembly facility. Labor cost includes the final assembly of the reflector to the gimbal mounting plate. Tooling cost for off-site component fabrication and for on-site assembly are separately identified. Transportation cost for the off-site fabricated components is included as an item of material.

4420 Drive Unit

The Drive Unit consists of a two-axis gimbal with identical azimuth and elevation drive actuators. The unit includes limit switches, encoders, and the wiring and connectors which interface with the heliostat controller. The structural interface is at the mounting plate at the top of the pedestal. The on-dock cost of this total unit has been obtained by a budgetary competitive bid to a Boeing specification. It is accounted for as Purchased Equipment (material) in this CBS. The labor cost is that of functional checkout and installation on the pedestal at the final assembly position of the on-site facility.

4430 Control and Instrumentation

The heliostat controller is estimated as a subcontract item. The subcontract estimate includes cost of facilities, materials, and labor. Transportation cost and the installation labor at the final assembly position in the on-site assembly facility has been added.

4431 Sensor or Calibration Equipment

Heliostat tracking sensors are not required. Calibration Equipment is not included in the heliostat cost. The equipment which would be located on the receiver tower is very low cost per heliostat for calibration of 25,000 heliostats.

4432 Field Control Electronics

Heliostat Controllers are included in CBS 4430. Field Controllers located at the plant central control are not included in the heliostat cost.

4433 Control Signal Distribution Equipment

CBS 4420 includes heliostat wiring. Field cabling is not included in heliostat cost.

4440 Foundation and Site

The foundation consists of four auger cast steel reinforced piling with steel cap plates. The Truzillo Company supported the cost estimate with design of the automated equipment and performed the cost analysis for foundation installation. The cost quotation of $335 per heliostat included equipment development cost, equipment cost including maintenance and replacement for 30 years, grout cost, reinforcing steel cost, labor and fee.

4450 Heliostat Support and Protection

4451 Heliostat Support Structure

The support structure consists of the base structure and the reflector support pedestal. The base structure consists of a dish, a structural ring and three support stanchions. The dish provides an interface attachment for the protective enclosure. The stanchions interface

with three of the foundation piles. The pedestal interfaces with the gimbal mount plate and with the center foundation pile. The base dish includes an access hatch with mounting provisions for the heliostat controller. The air supply assembly is included in this CBS.

All components, with the exception of the base dish, are made off-site and have been cost estimated by detailed material and fabrication labor estimates. The initial cost of tooling and the transportation cost to the on-site assembly facility is included. The base dish, due to its size, is fabricated in the on-site assembly facility. The cost includes raw material, labor, and the cost of tooling. All assembly labor including material handling, sandblasting, painting, etc. has been included.

4452 Protective Enclosure

The protective enclosure is a one-piece dome thermoformed in the on-site manufacturing/assembly facility. The cost includes raw material and the cost of the tooling. Labor is based on man-loading all functions of material handling and the final assembly to complete the heliostat.

4453 Lightning Protection

Protection is included in the heliostat control. The provisions for grounding to a field installed protective grid is negligible.

4460 Field Assembly and Checkout

This item includes the cost of all special equipment and the labor from the time that the completed heliostat leaves the assembly facility until it is attached to its foundation piles, field power is applied and it has been verified that mirror control properly functions, and that the air supply is maintaining design pressure. The heliostat is now ready for alignment and plant startup as described in CBS 4850.

Time-line analysis has defined the quantity of transporters and defined the crew mix and number of crews to support the rate of 25,000 heliostats per year per plant module. Field labor rates are based on a Union trades skill mix and include the factors defined in Section 4.1.

4470 Design and Engineering

The contract statement of work requires only recurring costs. This item therefore includes only the cost of engineering liaison to manufacturing and installation. After initial plant startup the requirement for engineering liaison will become very small. The average man-loading for the thirty years of production assumes one man for factory and one man for field.

4800 Distributables and Indirect Costs

4810 Temporary Facilities, Equipment, Etc.

This item is a fabrication/assembly facility building. It has been designed to accommodate all the tooling and processes for the production of 25,000 heliostats per year. This facility includes material storage, tool rooms, office space, lunch room, lavatories, etc., for a factory force of approximately 80 people on each of two shifts. The building has 208,000 square feet of floor space with high bay requirements, large doors, overhead crane facilities, etc. This building with its services is typical of aerospace factories and has been estimated by the Boeing Facility Design Organization. The cost includes A and E, site preparation, paint and sandblast facility, automated handling equipment, and miscellaneous vehicles. It does not include the installed tooling and equipment which have been costed against the appropriate CBS items.

At the production rate of 250,000 heliostats per year, a facility is required at each of ten southwestern sites. For the production rate of 1,000,000 heliostats per year, two facilities are required at each of 20 southwestern sites. Costs are appropriately factored for the multiple facilities.

4820 Spare Parts

All spare parts are included in CBS item OM210.

4830 Architectural Engineering Services

Included in CBS item 4810.

4840 Construction Management

Facility construction management is included in CBS item 4810. CBS items 4440 and 4460 include management of field installation. This includes factory and field superintendents for each shift. In addition 2 shop foreman are costed in each of CBS items 4410, 4451, and 4452. Overhead rates account for the plant manager and other indirect management functions.

4850 Plant Startup and Checkout

Startup and checkout includes the man-loaded labor to accomplish alignment and to scan for image signature, power centroid and total power. Control operating modes are verified. The collector subsystem is gradually powered up by groups, followed by one month of full operation for system verification.

4860 Contingency

No specific cost allowance is included. The field installation and checkout rate can achieve the required rates with a five percent time loss due to inclement weather.

OM10 Operations

Operations is considered a total plant function and is not included in heliostat cost. The cost of parasitic heliostat power requirement is not included because it has been deducted from the heliostat thermal performance at the receiver.

OM200 Maintenance Materials

OM210 Spare Parts

Spare parts requirements were generated from analysis of component failures and maintenance repair procedures. Procedures include on-site repair of some failed components and return to supplier for repair of other components. Costs are the initial on-site spare part inventory which will keep the plant operational while component repairs are being made. Included in spares inventories are those items (enclosures and reflectors) which may suffer inadvertent accidental damage or vandalism. The full quantity of spares for replacement of failed components is in CBS 231.

OM220 Materials for Repair

This CBS includes only those items of minor repair which are performed in the field such as repair of holes in enclosure or access hatch seals.

OM230 Other - Special Maintenance Equipment

The special equipment items for maintenance, cleaning and dome replacement have been estimated from conceptual equipment designs by modification to or similarity to other equipment of comparable complexity. The major cost item is a sprinkler system installed throughout the field. This was estimated on a subcontract basis using a detailed analysis of materials and labor. The unit cost of special equipment is factored when purchasing multiple units for the higher production rates.

OM231 Other - Replacement Parts

This CBS was added to define costs of those components which will be replaced in the thirty year plant life. Some replacement parts are for random failures. The planned replacement is for the enclosure. The life of the enclosure is 15 to 24 years depending on location

within the field. The average replacement time is 18 years. The enclosure replacement cost is therefore factored by 12/18 or 0.67.

OM300 Maintenance Labor

OM310 Scheduled Maintenance

This CBS collects the labor for all scheduled maintenance of:

Alignment checks
Enclosure washing
Air pre-filter replacement
Enclosure replacement

The costs are based on man-hour and man-loading for each function. Alignment checks are performed annually. Enclosure washing conservatively assumes a weekly spray rinse plus an annual washing. Air prefilters are replaced at 5 year intervals. The labor cost for enclosure replacement occurs between the 15th and 24th years at an average time of 18 years. Enclosure labor is therefore factored by 12/18 or 0.67.

OM320 Corrective Maintenance

This CBS collects the labor cost for all corrective maintenance. This CBS refers to the maintenance of those items of spare parts costed in CBS OM210. The analysis of man-hours includes replacement in the field, removing to the on-site repair shop, the repair time; and the repair cost of those items, such as electronic components, which are returned for supplier repair.

5.0 HELIOSTAT COSTS

5.1 SCENARIO 1 - COMMERCIAL RATE PRODUCTION

A summary cost per heliostat breakdown for each of the three production rates is provided in Table 5.1-1. These costs are for the heliostat defined in D277-10105-1, Volume I, Technical Report. The configuration has 65.7 square meters of reflector. The heliostat cost per square meter is summarized in Table 1.0-2. A cost summary by materials, labor, facilities, and maintenance is provided in Table 1.0-3.

From examination of these data, it is seen that:

1) The heliostat support structure (CBS 4451) is the most costly item.
2) The protective enclosure (CBS 4552), thermoformed from weatherized polyester is not the significant cost item.
3) Heliostat materials (including the replacement parts for 30 years maintenance) is approximately 80 percent of the total heliostat cost, and labor is nearly the remaining 20 percent.
4) The capital investment in facilities, tooling, and special equipment is insignificant cost per heliostat when producing the quantity of heliostats for 30 years.
5) Only slight "Economics of Production Rate" are achieved above a basic production rate of 250,000 heliostats per year.

Detailed cost breakdown sheets for each CBS item are provided in Appendix A. These detail data for each production rate are organized to show cost by elements of material, fabrication labor, installation labor, facilities and special equipment. The maintenance cost for 30 years is organized by elements of material, labor, and special equipment. Each element of each CBS is defined in detail by material parts lists or labor function. The estimation by quantities, unit costs and factors are self explanatory.

TABLE 5.1-1 COST SUMMARY - SCENARIO 1

(COMMERCIAL RATE PRODUCTION - Dollars per Heliostat)

CBS	ITEM	ANNUAL PRODUCTION RATE 25,000	250,000	1,000,000
4410	Reflector	670.30	603.04	581.86
4420	Drive Unit	464.65	335.75	331.23
4430	Control and Instrumentation	304.50	272.24	253.34
4440	Foundation and Site	335.00	335.00	335.00
4451	Support Structure	1059.98	945.43	945.24
4452	Enclosure	241.78	221.70	221.61
	Subtotal	(3076.21)	2713.16	2668.28
4460	Field Assy and C/O	72.27	72.13	72.06
4470	Engineering Liaison	4.00	4.00	4.00
4810	Temporary Facilities, Etc.	31.83	29.71	27.77
4850	Plant Startup and Checkout	6.84	6.84	6.84
	CAPITAL COST	(3191.15)	2825.84	2778.95
OM210	Spare Parts	9.72	8.92	8.66
OM220	Materials For Repairs	.02	.02	.02
OM230	Other - Special Equipment	166.12	156.64	148.34
OM231	Other - Maintenance Materials	286.21	267.60	263.40
OM310	Scheduled Maintenance (Labor)	156.90	156.90	156.90
OM320	Corrective Maintenance (Labor)	91.48	91.48	91.48
	O & M COST	(710.45)	(681.56)	(668.80)
	TOTAL HELIOSTAT	3901.60	3507.40	3447.75

5.2 SCENARIO 2 - 2500 HELIOSTATS

5.2.1 Summary

Table 5.2-1 summarizes a budgetary capital cost estimate for an initial one-time production quantity of 2500 heliostats. The installed capital cost is $5,515 or $84 per square meter. Table 5.2-2 summarizes the capital cost elements of material, labor, and facilities. This breakdown is illustrated in Figure 5.2-1. As expected, labor and the facilities become significant cost elements for an initial one-time production of a small demonstration plant.

Detailed cost estimation worksheets are provided in Appendix B.

5.2.2 Ground Rules and Assumptions

The following ground rules and assumptions are pertinent to this estimate:

1) The configuration is the same as described for the commercial heliostats in D277-10105-1, Final Technical Report.
2) The site is assumed to be near Phoenix, Arizona.
3) The period of fabrication/installation is approximately 18 months following a 6 month period of facility and tooling installation.
4) The Make/Buy plan is the same as Table 4.0-2.
5) The basic tooling is prototype units of the future automated high production rate tooling. Development cost of the tooling is not included.
6) An on-site facility of approximately 100,000 square feet is costed for assembly of heliostats.

TABLE 5.2-1 CAPITAL COST SUMMARY - SCENARIO 2
(2500 HELIOSTATS)

CBS	ITEM	$/HELIOSTAT	$/SQ. METER
4410	Reflector	987	15.00
4420	Drive Unit	654	10.00
4430	Control and Instrumentation	461	7.00
4440	Foundation and Site	500	7.60
4451	Support Structure	1509	23.00
4452	Protective Enclosure	328	5.00
4460	Field Assy and Checkout	191	2.90
4470	Design and Engineering	100	1.50
4471	Program Management	171	2.60
4810	Facilities	590	9.00
4850	Plant Startup and Checkout	24	0.40
	TOTAL CAPITAL COST	5515	84.00

TABLE 5.2-2 CAPITAL COST SUMMARY - SCENARIO 2
(2500 HELIOSTATS)

Raw Material	2108	32.00
Purchased Equipment	1599	24.40
TOTAL MATERIAL	3707	56.40
Fabrication Labor	485	7.40
Installation & Checkout Labor	280	4.30
Program Management	171	2.60
	936	14.30
Facility, Tooling & Special Equipment	872	13.50
TOTAL CAPITAL COST	5515	84.00

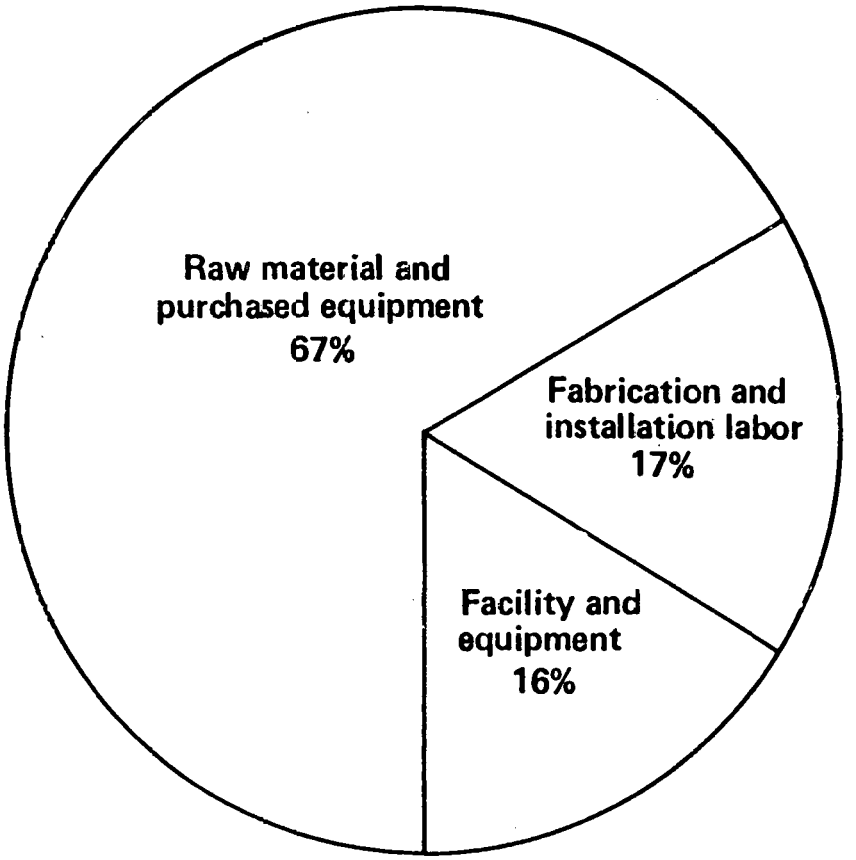

Figure 5.2-1 CAPITAL COST DISTRIBUTION
(2500 HELIOSTAT PRODUCTION)

7) Basic tools, i.e. dish forming and enclosure thermoforming, are provided. The highly automated materials handling equipment is not provided. Fabrication is therefore more labor intensive than commercial production.

8) The basic tools could be utilized in future heliostat production. Residual value is assigned to the facility building and to the tooling.

9) The heliostat would be fully assembled in the on-site facility. Transport to the field and field installation is the same as described for the commercial high production rate quantities.

10) Costs are recurring capital cost only (R & D excluded) and no costs are included for extended testing or maintenance.

5.2.3 Cost Estimating Approach

The material costs were developed from detail parts lists considering the gross material requirements. Supplier quotes were utilized for the Drive Unit and the Control System.

Facility and tooling costs reflect those portions of the highly automated commercial production rate tooling which were both cost effective for 2500 units and which would be important in the development and demonstration of the commercial rate processes.

The on-site manufacturing/assembly labor was not estimated by man-loading of functions as was done for the highly automated commercial rate production. Instead, the conventional Boeing estimating approach was utilized. This approach analyzes each manufacturing function to establish the required manufacturing hours for the 100th unit of production. This value has been adjusted to the average unit cost of 2500 units based on an 85 percent learning curve where:

$$\text{COST Nth Unit} = (\text{1st Unit Cost})\ (N)^{\frac{\log .85}{\log 2}}$$

The average unit cost is therefore 21 percent of the first unit cost.

5.2.4 Cost Breakdown Structure Definition

The definition of all capital CBS items is the same as provided in Section 4.3 with the following exceptions and clarifications.

4471 Program Management

This item was added to the DOE Cost Breakdown Structure to collect cost of the direct management functions. Included is the cost of travel and per diem from Seattle to the site. All other personnel are on permanent assignment to the site or are from the local labor source.

4810 Temporary Facilities, Equipment, Etc.

A fabrication/assembly facility building has been costed. This 100,000 square foot building will accommodate the assembly of 2500 units in an 18 month period. It is assumed that the building would have a residual value of two-thirds its cost. Possible alternatives, depending on location, could be lease of existing buildings or rental of temporary facilities such as an air-supported structure.

5.3 SCENARIO 3 - 25,000 HELIOSTATS PER YEAR AT DISPERSED SITES

The cost summarized in Table 5.3-1 is for the alternate scenario defined in Section 3.3. These costs are for individual plants (25,000 heliostats) widely dispersed in the Southwestern United States. By comparison of Table 5.3-1 with 5.1-1 (also summarized in Table 1.0-2), it is seen that dispersing the plant sites incurs a cost penalty of less than ten percent as compared to the annual assembly and installation at one centralized site. Approximately three percent penalty is associated with component production; partly due to packaging and transportation, and partly due to loss in the assembly labor learning curve factor. An additional three percent penalty is associated in the capital cost primarily due to the need for an assembly facility at each of the sites.

The remaining four percent is due to the maintenance inefficiency associated with decentralization.

Detailed cost estimating worksheets for this scenario are provided in Appendix C. Note on the Appendix C worksheets that the estimates are explained by similarity and difference to Appendix A worksheets. In both the centralized and dispersed scenarios it has been assumed that costs are based on 30 years of production and installation.

TABLE 5.3-1 COST SUMMARY - SCENARIO 3
(25,000 per Year at Dispersed Sites)

CBS	ITEM	$/HELIOSTAT	$/m^2
4410	Reflector	681.28	10.37
4420	Drive Unit	465.51	7.09
4430	Control and Instrumentation	304.60	4.64
4440	Foundation and Site	352.00	5.36
4451	Support Structure	1105.62	16.83
4452	Enclosure	276.91	4.21
	Subtotal	(3185.92)	(48.50)
4460	Field Assy and Checkout	80.09	1.22
4470	Engineering Liaison	12.00	0.18
4810	Temporary Facilities, etc.	125.79	1.91
4850	Plant Start Up and Checkout	7.52	0.11
	CAPITAL COST	(3421.32)	(51.92)
OM210	Spare Parts	19.45	0.30
OM220	Materials for Repairs	.04	Negl.
OM230	Other - Special Equipment	166.12	2.53
OM231	Other - Maintenance Materials	286.21	4.36
OM310	Scheduled Maintenance (Labor)	172.53	2.63
OM320	Corrective Maintenance (Labor)	182.96	2.78
	O&M COST	(827.31)	(12.60)
	TOTAL HELIOSTAT	4238.63	64.52

6.0 HELIOSTAT OPTICAL PERFORMANCE

The Net Radiated Power (NRP) at the receiver is provided in Table 6.0-1 for each of the three specified heliostats for each of the four specified days. The derivation of this performance is discussed in D277-10105-1 Volume I, Section 2.3.1.

TABLE 6.0-1 NET DAILY INCIDENT ENERGY ON RECEIVER (KW-HR)

	HELIOSTAT		
PERIOD	A	B	C
Spring & Fall Equinox	285	277	231
Summer Solstice	363	362	393
Winter Solstice	230	220	146

These data may be combined with the cost data provided in this Volume III to derive the Cost Performance Ratio (CPR). The CPR is defined as the Total Annualized Cost (TAC) divided by the NRP. The TAC values for each production rate are tabulated below:

	ANNUAL PRODUCTION RATE		
	25,000	250,000	1,000,000
HELIOSTAT COST (30 YEARS)	3902	3507	3448
ANNUALIZED COST (TAC)	130	117	115

7.C POTENTIAL COST REDUCTION

The detailed cost analysis performed for this study was very useful in gaining an understanding of the cost drivers and the cost uncertainties. This understanding will provide guidance for further study in Phase II. The following paragraphs discuss potential cost reductions that need to be verified by further analysis and test.

CBS 4451 Heliostat Support Structure

The current base ring is conservatively designed to limit deflections due to 90 mph wind loads from the most adverse direction. The allowable deflection was established to assure no possible interference between the protective enclosure and the reflector. It is believed that the preliminary deflection analysis was conservative in selecting a schedule 40 pipe with 4.0 inch nominal diameter and 0.237 inch wall thickness. The material for this ring costs $318 per heliostat. Further analysis which should be verified by test is expected to reduce the required pipe size to 3.0 inch nominal diameter by 0.216 wall thickness. The cost saving would be at least $100 per heliostat or $1.50 per square meter.

CBS 4410 Reflector

The three reflector ring sections and spokes are joined by electromagnetic swaging the aluminum tubing to three tee fittings. The current design of these tee castings has an estimated cost of $250 per heliostat. It is believed that further design studies could reduce the cost of these electromagnetic swaging fittings. The result may be a revised joint concept or a simplification of the casting. A possible cost saving of $100 or $1.50 per square meter is feasible.

The above two items alone show a potential of reducing the cost by 5 percent. Further design and development effort should uncover additional increments of cost saving.

APPENDIX A

DETAILED COST ESTIMATES

FOR

COMMERCIAL RATE PRODUCTION

This Appendix contains detail cost estimating worksheets. These data are summarized in Section 5.1 of D277-10105-3, Volume III, "Cost Estimate".

LABOR RATES

Labor rates were established for each of the following categories:

On-Site Fabrication/Assembly Labor	Factor	Rate
Average Base Rate		$7.00/hr
Fringe Benefits		2.45/hr
Subtotal		9.45/hr
G & A Factor	1.138	1.30/hr
Subtotal		10.75/hr
Overhead Factor	1.330	3.55/hr
Subtotal		14.30/hr
Quality Control Factor	1.066	.95/hr
Total Burdened Rate		$15.25/hr

This overhead rate is based on a man-loaded manufacturing operation of approximately 300 employees at Phoenix, Arizona. It does not include factors for the facility buildings and tooling which are separately priced. It does include:

Indirect Salaries & Fringe Benefits
Use and Occupancy
Equipment Maintenance
Miscellaneous Non-labor

Off-Site Component Fabrication Labor	
Total Burdened Rate	$25.00/hr

This rate is typical of relatively small steel fabrication companies. This rate is probably conservatively high for a plant which could dedicate itself to a 30 year large volume production of a single component or class of simple components such as cutting, forming and welding of pipe.

Field Installation Labor	Factor	Rate
Average Base Rate		$9.00/hr
Fringe Benefits		2.45/hr
Subtotal		11.45/hr
G & A Factor	1.114	1.30/hr
Subtotal		12.75/hr
Overhead Factor	1.278	3.55/hr
Subtotal		16.30/hr
Quality Control Factor	1.068	.95/hr
Total Burdened Rate		$17.25/hr

This rate was derived using a mix of Union Trade skills including truck drivers, metal workers, electricians and laborers at Bureau of Labor rate data for Phoenix, Arizona.

Maintenance Labor

It is assumed that the Union trade skills involved are similar to the installation labor resulting in the same rates and factors.

Total Burdened Rate $17.25/hr

Alignment and Checkout Labor	Factor	Rate
Average Base Rate		$11.00/hr
Fringe Benefit		2.45/hr
Subtotal		13.45/hr
G & A Factor	1.097	1.30/hr
Subtotal		14.75/hr
Overhead	1.241	3.55/hr
Subtotal		18.30/hr
Quality Control	1.052	.95/hr
Total Burdened Rate		19.25/hr

This assumed a higher base rate for the skills involved.

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4410 TITLE REFLECTIVE UNIT ELEMENT MATERIAL - TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
MATERIAL												
Ring - Tubing	4,270,000	FT	1.33	$/FT	$5,679,000						$ 5,679,000	1227.16
Hub - Casting	25,000	EA	72.00	EA	1,800,000						1,800,000	72.00
Tees - Casting	75,000	EA	83.33	EA	6,250,000						6,250,000	250.00
Metalized Polyester	24,125,000	FT^2	.05	$/$FT^2$	1,206,205						1,206,250	48.25
Reflective Patch	8,340	FT	.21	$/FT	1,750						1,750	.07
Refl. - Adhesive	4,825,000	FT	.027	$/FT	131,250						131,250	5.25
Refl. - Adhesive	2,394,250	FT	.055	$/FT	131,250						131,250	5.25
Transportation	7,500,000	lbs	.014	$/lb	105,000						105,000	4.20
MATERIAL SUB TOTAL											(15,394,500)	(616.18)
TOOLING												
Tooling - Off Site	3,480	HRS	25.00	$/HR	87,000		INCLUDED			30	2,900	.11
* Tool Mat'l - Off Site	3,480	HRS	4.00	$/HR	13,920					30	464	.02
Tooling - On Site - Buy					65,000					30	2,167	.09
Tooling - On Site - Fab	15,647	HR	25.00	$/HR	391,175					30	13,039	.52
* Tool Matl - On Site - Fab	15,647	HR	4.00	$/HR	62,588					30	2,086	.08
TOOLING SUB TOTAL											(20,656)	(.82)

NOTES: *Tool material is based on tool fab. hours.

PAGE TOTAL (15,394,500) (616.18)

CBS TOTAL

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4410 TITLE REFLECTIVE UNIT ELEMENT MANUFACTURING LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
OFF SITE MFG												
Ring Segment	8,230	HRS	25.00	$/HR	205,750	.834	I N C L U D E D				171,595	6.86
Spoke	960	HRS	25.00	$/HR	24,000	.834	I N C L U D E D				20,016	.80
Spoke	1,920	HRS	25.00	$/HR	48,000	.834	I N C L U D E D				40,032	1.60
Reflective Film Assy	10,631	HRS	25.00	$/HR	265,775	.834	I N C L U D E D				221,656	8.87
OFF SITE SUBTOTAL											(453,300)	(18.13)
ON SITE MFG												
Reflector Fab & Assy	40,000	HRS	9.45	$/HR	378,000	.834	1.138	1.330	1.066		508,638	20.35
Store & Handling	12,000	HRS	9.45	$/HR	113,400	.834	1.138	1.330	1.066		152,591	6.10
Final Assy	25,000	HRS	9.45	$/HR	236,250	.834	1.138	1.330	1.066		317,899	12.72
ON SITE SUBTOTAL											(979,128)	(39.17)

NOTES:

PAGE TOTAL $1,432,428 $57.30

CBS TOTAL $14,757,939 $590.32

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4410 TITLE REFLECTIVE UNIT ELEMENT MATERIAL & TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
MATERIAL												
Ring - Tubing	42,700,000	FT	1.26	$/FT	53,802,000						53,802,000	215.21
Hub - Casting	250,000	EA	70.00	$/EA	17,500,000						17,500,000	70.00
Tees - Casting	750,000	EA	66.67	$/EA	50,000,000						50,000,000	200.00
Metalized Polyester	241,250,000	FT^2	.047	$/$FT^2$	11,427,500						11,427,500	45.71
Reflective Patch	83,400	FT	.180	$/FT	15,000						15,000	.06
Refl - Adhesive	48,250,000	FT	.026	$/FT	1,237,500						1,237,500	4.95
Refl - Adhesive	23,942,500	FT	.052	$/FT	1,237,500						1,237,500	4.95
Transportation	75,000,000	lbs	.014	$/lb	1,050,000						1,050,000	4.20
MATERIAL SUBTOTAL											(136,269,500)	(545.08)
TOOLING												
Tooling - Off Site	34,800	HRS	25.00	$/HR	870,000		I N C L U D E D			30	29,000	.12
* Tool Mat'l - Off Site	34,800	HRS	4.00	$/HR	139,200					30	4,640	.02
Tooling - On Site - Bay					120,000					30	4,000	.02
Tooling - On Site - Fab	120,454	HRS	25.00	$/HR	3,011,350		I N C L U D E D			30	100,378	.44
* Tool Mat'l - On Site - Fab	120,454	HRS	4.00	$/HR	481,816					30	16,061	.06
TOOLING SUBTOTAL											(154,079)	(.66)

NOTES: *Tool material is based on tool fab. hours.

PAGE TOTAL $136,423,600 $545.74

CBS TOTAL

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4410 TITLE REFLECTIVE UNIT ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
OFF SITE MFG												
Ring Segment	82,301	HRS	25.00	$/HR	2,057,525	.834	I N C L U D E D				1,715,976	6.86
Spoke	9,602	HRS	25.00	$/HR	240,056	.834	I N C L U D E D				200,202	.80
Spoke	19,204	HRS	25.00	$/HR	480,100	.834	I N C L U D E D				400,402	1.60
Reflective Film Assy	106,306	HRS	25.00	$/HR	2,657,650	.834	I N C L U D E D				2,216,460	8.87
OFF SITE SUBTOTAL											(4,533,061)	(18.13)
ON SITE MFG												
Reflector Fab & Assy	400,000	HRS	9.45	$/HR	3,780,000	.834	1.138	1.330	1.066		5,386,382	21.55
Store & Handling	120,000	HRS	9.45	$/HR	1,134,000	.834	1.138	1.330	1.066		1,615,914	6.46
Final Assy	250,000	HRS	9.45	$/HR	2,362,500	.834	1.138	1.330	1.066		3,178,989	12.72
ON SITE SUBTOTAL											(9,791,285)	(39.17)

NOTES:

PAGE TOTAL $14,324,346 $57.30

CBS TOTAL $150,748,000 $603.00

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4410 TITLE REFLECTIVE UNIT ELEMENT MATERIAL & TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
MATERIAL												
Ring - Tubing	170,800,000	FT	1.26	$/FT	215,208,000						215,208,000	215.21
Hub - Casting	1,000,000	EA	65.00	$/EA	65,000,000						65,000,000	65.00
Tees - Casting	3,000,000	EA	61.67	$/EA	185,000,000						185,000,000	185.00
Metalized Polyester	965,000,000	FT	.047	$/FT	43,355,000						43,355,000	43.36
Reflective Patch	333,600	FT^2	.180	$/$FT^2$	60,000						60,000	.06
Refl. - Adhesive	193,000,000	FT	.024	$/FT	4,600,000						4,600,000	4.60
Refl. - Adhesive	95,770,000	FT	.048	$/FT	4,600,000						4,600,000	4.60
Transportation	300,000,000	lbs	.014	$/lbs	4,200,000						4,200,000	4.20
MATERIAL SUBTOTAL											(524,023,000)	(524.02)
TOOLING												
Tool - Off Site	139,200	HRS	25.00	$/HR	3,480,000			INCLUDED		30	116,000	.12
* Tool Mat'l - Off Site	139,200	HRS	4.00	$/HR	556,800					30	18,560	.02
Tooling - On Site Buy					480,000					30	16,000	.02
Tooling - On Site Fab	396,692	HRS	25.00	$/HR	9,917,300			INCLUDED		30	330,577	.33
* Tool Mat'l - On Site	396,692	HRS	4.00	$/HR	1,586,768					30	52,892	.05
TOOLING SUBTOTAL											(534,029)	(.54)

NOTES: *Tool Material is based on tool fab. hours.

PAGE TOTAL $524,557,000 $524.56

CBS TOTAL

PRODUCTION RATE 1,000,000

CBS NO. 4410 TITLE REFLECTIVE UNIT ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
OFF SITE MFG												
Ring Segment	329,205	HRS	25.00	$/HR	8,230,125	.834		I N C L U D E D			6,863,964	6.86
Spoke	38,407	HRS	25.00	$/HR	960,175	.834		I N C L U D E D			800,786	.80
Spoke	76,815	HRS	25.00	$/HR	1,920,375	.834		I N C L U D E D			1,601,593	1.60
Reflective Film Assy	425,224	HRS	25.00	$/HR	10,630,600	.834		I N C L U D E D			8,865,960	8.87
OFF SITE SUBTOTAL											(18,132,283)	(18.13)
ON SITE MFG												
Reflector Fab & Assy	1,600,000	HRS	9.45	$/HR	15,120,000	.834	1.138	1.330	1.066		20,245,526	20.25
Store & Handling	480,000	HRS	9.45	$/HR	4,536,000	.834	1.138	1.330	1.066		6,073,658	6.07
Final Assy	1,000,000	HRS	9.45	$/HR	9,450,000	.834	1.138	1.330	1.066		12,715,953	12.72
ON SITE SUBTOTAL											(39,035,137)	(39.04)

NOTES:

PAGE TOTAL $57,297,360 $57.30

C3S TOTAL $581,854,400 $581.86

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4420 TITLE DRIVE UNIT ELEMENT MATERIAL & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Gimbal/Actuator Assy	25,000	EA	456.00	$/EA	11,400,000	I N C L U D E D					11,400,000	456.00
MATERIAL SUBTOTAL											(11,400,000)	(4.56)
Store and Handling	2,000	HRS	9.45	$/HR	18,900	.834	1.138	1.330	1.066		25,430	1.02
Final Assy	15,000	HRS	9.45	$/HR	141,750	.834	1.138	1.330	1.066		190,740	7.63
LABOR SUBTOTAL											(216,170)	(8.65)

NOTES:

PAGE TOTAL

CBS TOTAL $11,616,000 $464.65

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4420 TITLE DRIVE UNIT ELEMENT MATERIAL AND LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Gimbal/Actuator Assy	250,000	EA	327.10	$/EA	81,775,000	I N C L U D E D					81,775,000	327.10
MATERIAL SUBTOTAL											(81,775,000)	(327.10)
Store and Handling	20,000	HRS	9.45	$/HR	189,000	.834	1.138	1.330	1.066		254,200	1.02
Final Assy	150,000	HRS	9.45	$/HR	1,417,500	.834	1.138	1.330	1.066		1,907,400	7.63
LABOR SUBTOTAL											(2,161,700)	(8.65)

NOTES:

PAGE TOTAL

CBS TOTAL $83,936,700 $335.75

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4420 TITLE DRIVE UNIT ELEMENT MATERIAL AND LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Gimbal/Actuator Assy	1,000,000	EA	322.58	$/EA	322,580,000		I N C L U D E D				322,580,000	322.58
MATERIAL SUBTOTAL											(322,580,000)	(322.58)
Store and Handling	80,000	HRS	9.45	$/HR	756,000	.834	1.138	1.330	1.066		1,017,200	1.02
Final Assy	600,000	HRS	9.45	$/HR	5,670,000	.834	1.138	1.330	1.066		7,629,600	7.63
LABOR SUBTOTAL											(8,646,800)	(8.65)

NOTES:

PAGE TOTAL

CBS TOTAL $331,236,800 $331.23

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4439 TITLE CONTROL AND INSTRUMENTATION ELEMENT MATERIAL & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Contrl	Prorate Years		
HELIOSTAT CONTROLLER												
Subcontract	25,000	EA	299.28	$/EA	7,482,000						7,482,000	299.28
Transportation	750,000	lb/yr	0.14	$/lb	105,000						105,000	4.20
MATERIAL TOTAL					7,587,000						7,587,000	303.48
Final Assy Labor	2,000	HR	9.45	$/HR	18,900	.834	1.138	1.330	1.066		25,400	1.02

NOTES:

PAGE TOTAL $7,612,400 $304.50

CBS TOTAL $7,612,400 $304.50

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4430 TITLE CONTROL AND INSTRUMENTATION ELEMENT MATERIAL & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
HELIOSTAT CONTROLLER												
Subcontract	250,000	EA	267.02	$/EA	74,820,000						74,820,000	267.02
Transportation	7,500,000	lb/yr	0.14		1,050,000						1,050,000	4.20
MATERIAL SUBTOTAL					(75,870,000)						(75,870,000)	(271.22)
Final Assy Labor	20,000	HR	9.45	$/HR	189,000	.834	1.138	1.330	1.066		254,000	1.02

NOTES:

PAGE TOTAL

CBS TOTAL $76,124,000 $271.24

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4430 TITLE CONTROL AND INSTRUMENTATION ELEMENT MATERIAL & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
HELIOSTAT CONTROLLER												
Subcontract	1,000,000	EA	248.12	$/EA	248,120,000						248,120,000	248.12
Transportation	30,000,000	lb	0.14	$/lb	4,200,000						4,200,000	4.20
MATERIAL SUBTOTAL											(252,320,000)	(252.32)
Final Assy Labor	80,000	HR	9.45	$/HR	756,000	.834	1.138	1.330	1.066		1,016,000	1.02

NOTES:

PAGE TOTAL

CBS TOTAL $253,336,000 $253.34

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4440 TITLE FOUNDATION AND SITE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
FOUNDATION - PILING CONCRETE	25,000	EA	355.00	$/EA	$8,875,000						$8,875,000	$355.00

NOTES:

PAGE TOTAL $8,875,000 $355.00

CBS TOTAL $8,875,000 $355.00

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4440 TITLE FOUNDATION AND SITE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Contrl	Prorate Years		
Foundation - Piling Concrete	250,000	EA	$335.00	$/EA	$83,750,000						$83,750,000	$335.00

NOTES:

PAGE TOTAL $83,750,000 $335.00

CBS TOTAL $83,750,000 $335.00

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4440 TITLE FOUNDATION AND SITE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Foundation - Piling Concrete	1,000,000	EA	$335.00	$/EA	$335,000,000						$335,000,000	$335.00

NOTES:

PAGE TOTAL $335,000,000 $335.00

CBS TOTAL $335,000,000 $335.00

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Dish	22,340,000	lb	.266	$/lb	5,942,000						5,942,000	237.68
Ring Support	1,968,800	FT	4.0375	$/FT	7,948,800						7,948,800	317.95
Stanchion Pipe	393,750	FT	2.85	$/FT	1,122,500						1,122,500	44.90
Pedestal Post	393,750	FT	5.75	$/FT	2,264,000						2,264,000	90.56
Stanchion Plate	6,250	FT^2	6.200	$/$FT^2$	38,750						38,750	1.55
Hatch Access	769,500	lbs	.2755	$/lb	212,000						212,000	8.48
Handle	50,000	FT	.175	$/FT	8,750						8,750	.35
Hatch	6,250	FT^2	1.200	$/$FT^2$	7,500						7,500	.30
Hatch Flange Inside	287,800	lbs	.304	$/lb	87,500						87,500	3.50
Pedestal	25,000	FT^2	.100	$/$FT^2$	2,500						2,500	.10
Seal Hatch	250,000	FT	.19	$/FT	47,500						47,500	1.90
Fiberglass	225,000	FT^2	.780	$/$FT^2$	175,500						175,500	7.02
1 Primer	150,000	GAL	1.058	$/GAL	158,750						158,750	6.35
1 White Paint	150,000	GAL	1.625	$/GAL	243,750						243,750	9.75
Ring Stud - Weld	100,000	EA	.013	$/EA	1,300						1,300	.05
Hatch Toggle Clamp	100,000	EA	.96	$/EA	96,000						96,000	3.84
Concentric Reducer	25,000	EA	9.00	$/EA	225,000						225,000	9.00
Marmon Clamp	25,000	EA	4.50	$/EA	112,500						112,500	4.50
Rivets	1,100,000	EA	.01	$/EA	11,000						11,000	.44
Cap Screws	75,000	EA	.027	$/EA	2,000						2,000	.08
Wing Nut	100,000	EA	.013	$/EA	1,300						1,300	.05
Lock Nut	50,000	EA	.005	$/EA	250						250	.01

NOTES: 1. Small error not corrected in totals.

PAGE TOTAL $20,440,750 $817.63

CBS TOTAL

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Air Supply System	25,000	EA	102.00	$/EA	2,550,000						2,550,000	102.00
Notch Flange Outside	713,500	lb	.304	$/lb	216,900						21[illegible],900	[illegible].[illegible]
Transportation	32,500,600	lb	.014	$/lb	455,000						455,000	18.20
MATERIAL SUBTOTAL											(23,[illegible]2,[illegible]10)	(2[illegible].1)

NOTES:

PAGE TOTAL $3,221,900 $128.88

CBS TOTAL

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
TOOLING - OFF SITE	3,480	HRS	25.00	$/HR	87,000		I N C L U D E D			30	2,900	.11
* TOOL MAT'L - OFF SITE	3,480	HRS	4.00	$/HR	13,920					30	464	.02
TOOLING - ON SITE FAB	55,994	HRS	25.00	$/HR	1,399,850		I N C L U D E D			30	46,662	1.87
TOOLING - ON SITE BUY			1,870,000	$	1,870,000					30	62,333	2.49
* TOOL MAT'L - ON SITE FAB	55,994	HRS	4.00	$/HR	223,976					30	7,466	.30

NOTES: *Tool material is based on tool fab. hours.

PAGE TOTAL $119,225 4.79

CBS TOTAL

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 1451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT OFF SITE MANUFACTURING LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Match Flange - Outside	7,681	HRS	25.00	$/HR	192,025	.834	INCLUDED				160,149	6.41
Strap	2,537	HRS	25.00	$/HR	63,435	.834	INCLUDED				52,894	2.12
Stanchion	8,024	HRS	25.00	$/HR	200,600	.834	INCLUDED				167,300	6.69
Pedestal Assy	4,732	HRS	25.00	$/HR	118,300	.834	INCLUDED				98,662	3.95
Flange	6,173	HRS	25.00	$/HR	154,325	.834	INCLUDED				128,707	5.15
Pedestal	686	HRS	25.00	$/HR	17,150	.834	INCLUDED				14,303	.57
Bell	686	HRS	25.00	$/HR	17,150	.834	INCLUDED				14,303	.57
Match Flange - Inside	6,996	HRS	25.00	$/HR	174,900	.834	INCLUDED				145,867	5.83
Match Ass.	3,292	HRS	25.00	$/HR	82,300	.834	INCLUDED				68,638	2.75
Hatch	960	HRS	25.00	$/HR	24,000	.834	INCLUDED				20,016	.80
Handle	3,429	HRS	25.00	$/HR	85,725	.834	INCLUDED				71,496	2.86
Hatch Seal	1,509	HRS	25.00	$/HR	37,725	.834	INCLUDED				31,463	1.26
Pedestal Seal	1,784	HRS	25.00	$/HR	44,600	.834	INCLUDED				37,196	1.49
Retention Seal	2,098	HRS	25.00	$/HR	51,450	.834	INCLUDED				42,909	1.72
Doubler	1,646	HRS	25.00	$/HR	41,150	.834	INCLUDED				34,319	1.37
Flange - Pedestal Seal	4,938	HRS	25.00	$/HR	123,450	.834	INCLUDED				102,957	4.12

NOTES:

PAGE TOTAL $1,191,180 $47.65

CBS TOTAL

PRODUCTION RATE 85,000 PER YEAR

CBS NO. 6451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT ON SITE MANUFACTURING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Dish	16,000	HRS	9.45	$/HR	151,200	.834	1.138	1.339	1.066		803,455	8.14
Ring + Support	16,000	HRS	9.45	$/HR	151,200	.834	1.138	1.339	1.066		803,455	8.14
Painting	16,000	HRS	9.45	$/HR	151,200	.834	1.138	1.339	1.066		803,455	8.14
Disk/Ring Assy	8,000	HRS	9.45	$/HR	75,600	.834	1.138	1.339	1.066		401,728	4.07
Pedestal Assy	8,000	HRS	9.45	$/HR	75,600	.834	1.138	1.339	1.066		401,728	4.07
Stores & Handling	16,000	HRS	9.45	$/HR	151,200	.834	1.138	1.339	1.066		803,455	8.14
Final Assy	40,000	HRS	9.45	$/HR	378,000	.834	1.138	1.339	1.066		506,638	89.34

NOTES:

PAGE TOTAL $1,565,914 $61.93

CBS TOTAL $86,499,569 $1,959.99

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
	Dish	223,400,000	lbs	.252	$/lb	56,296,800						56,296,800	225.19
	Ring Support	19,688,000	FT	3.825	$/FT	75,306,600						75,306,600	301.23
	Stanchion Pipe	3,937,500	FT	2.700	$/FT	10,631,250						10,631,250	42.53
	Pedestal Post	3,937,500	FT	5.45	$/FT	21,459,375						21,459,375	85.84
	Stanchion Plate	62,500	FT^2	5.800	$/$FT^2$	362,500						362,500	1.45
	Hatch Access	7,695,000	lbs	.261	$/lb	2,008,395						2,008,395	8.03
	Handle	500,000	FT	.150	$/FT	75,000						75,000	.30
	Hatch	62,500	FT^2	1.200	$/$FT^2$	75,000						75,000	.30
	Hatch Flange Inside	2,878,000	lbs	.288	$/lb	828,864						828,864	3.32
	Pedestal	250,000	FT^2	.100	$/$FT^2$	25,000						25,000	.10
	Seal Hatch	2,500,000	FT	.19	$/FT	475,000						475,000	1.90
	Fiberglass	2,250,000	FT^2	.78	$/$FT^2$	1,755,000						1,755,000	7.01
1	Primer	1,500,000	GAL	1.058	$/GAL	1,587,500						1,587,000	6.35
1	White Paint	1,500,000	GAL	1.625	$/GAL	2,437,500						2,437,500	9.75
	Ring Stud-Weld	1,000,000	EA	.012	$/EA	12,000						12,000	.05
	Hatch Toggle Clamp	1,000,000	EA	.950	$/EA	950,000						950,000	3.80
	Concentric Reducer	250,000	EA	9.00	$/EA	2,250,000						2,250,000	9.00
	Marmon Clamp	250,000	EA	4.50	$/EA	1,125,000						1,125,000	4.50
	Rivets	11,000,000	EA	.01	$/EA	110,000						110,000	.44
	Cap Screws	750,000	EA	.027	$/EA	20,000						20,000	.08
	Wing Nut	1,000,000	EA	.012	$/EA	12,000						12,000	.05
	Lock Nut	500,000	EA	.005	$/EA	2,500						2,500	.01

NOTES: 1. Small error not corrected in totals.

PAGE TOTAL $177,805,284 $711.23

CBS TOTAL

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Hatch Plane Outside	7,135,000	lbs	.288	$/lb	2,054,880						2,054,880	8.22
Air Supply System	250,000	EA	96.63	$/EA	24,157,500						24,157,500	96.63
Transportation	325,000,000	lbs	.014	$/lb	4,550,000						4,550,000	18.20
MATERIAL SUBTOTAL											(228,567,664)	(914.27)

NOTES:

PAGE TOTAL $30,762,380 $123.05

CBS TOTAL

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Tooling - Off Site	34,600	HRS	25.00	$/HR	870,000		I N C L U D E D			30	29,000	.12
* Tool Mat'l - Off Site	34,600	HRS	4.00	$/HR	139,200					30	4,640	.02
Tooling On Site Buy					15,305,000					30	510,167	2.04
* Tool Mat'l On Site Fab	73,195	HRS	4.00	$/HR	292,780					30	19,759	.08
Tooling On Site Fab	73,195	HRS	25.00	$/HR	1,829,875		I N C L U D E D			30	60,996	.24

NOTES: *Tool material is based on the tool fab. hours.
Tooling labor hours benefit on 90% learning curve.

PAGE TOTAL $614,562 $2.46

CBS TOTAL

PRODUCTION RATE 850,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT OFF SITE MANUFACTURING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Hatch Flange - Outside	76,815	HR	25.00	$/HR	1,920,375	.834	INCLUDED				1,601,593	6.40
Strap	25,376	HR	25.00	$/HR	634,400	.834	INCLUDED				529,090	2.12
Stanchion	80,244	HR	25.00	$/HR	2,006,100	.834	INCLUDED				1,673,027	6.69
Pedestal Assy	47,323	HR	25.00	$/HR	1,183,075	.834	INCLUDED				986,685	3.95
Flange	61,726	HR	25.00	$/HR	1,543,150	.834	INCLUDED				1,286,967	5.15
Pedestal	6,858	HR	25.00	$/HR	171,450	.834	INCLUDED				142,969	.57
Bell	6,858	HR	25.00	$/HR	171,450	.834	INCLUDED				142,969	.57
Hatch Flange - Inside	69,956	HR	25.00	$/HR	1,748,900	.834	INCLUDED				1,458,583	5.83
Hatch Assy	38,921	HR	25.00	$/HR	623,025	.834	INCLUDED				686,403	2.75
Hatch	9,602	HR	25.00	$/HR	240,050	.834	INCLUDED				200,202	.80
Handle	34,292	HR	25.00	$/HR	857,300	.834	INCLUDED				714,988	2.86
Hatch Seal	15,089	HR	25.00	$/HR	377,225	.834	INCLUDED				314,606	1.26
Pedestal Seal	17,832	HR	25.00	$/HR	445,800	.834	INCLUDED				371,737	1.49
Retention Seal	20,575	HR	25.00	$/HR	514,375	.834	INCLUDED				429,069	1.72
Doubler	16,460	HR	25.00	$/HR	411,500	.834	INCLUDED				343,191	1.37
Flange - Pedestal Seal	49,381	HR	25.00	$/HR	1,234,525	.834	INCLUDED				1,029,534	4.12

NOTES:

PAGE TOTAL $11,911,773 $47.65

CBS TOTAL

PRODUCTION RATE 850,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT ON SITE MANUFACTURING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Dish	160,000	HRS	9.45	$/HR	1,512,000	.834	1.138	1.330	1.066		2,034,553	8.14
Ring Support	160,000	HRS	9.45	$/HR	1,512,000	.834	1.138	1.330	1.066		2,034,553	8.14
Painting	160,000	HRS	9.45	$/HR	1,512,000	.834	1.138	1.330	1.066		2,034,553	8.14
Dish/Ring Assy	80,000	HRS	9.45	$/HR	756,000	.834	1.138	1.330	1.066		1,017,276	4.07
Pedestal Assy	80,000	HRS	9.45	$/HR	756,000	.834	1.138	1.330	1.066		1,017,276	4.07
Stores & Handling	160,000	HRS	9.45	$/HR	1,512,000	.834	1.138	1.330	1.066		2,034,553	8.14
Final Assy	400,000	HRS	9.45	$/HR	3,780,000	.834	1.138	1.330	1.066		5,086,382	20.35

NOTES:

PAGE TOTAL $15,259,145 $61.[illegible]

CBS TOTAL $236,353,144 $945.[illegible]

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Program Years		
	Dish	893,600,000	lbs	.252	$/lb	225,187,200						225,187,200	225.19
	Ring Support	78,752,000	FT	3.825	$/FT	301,226,400						301,226,400	301.23
	Stanchion Pipe	15,750,000	FT	2.700	$/FT	42,525,000						42,525,000	42.53
	Pedestal Post	15,750,000	FT	5.45	$/FT	85,837,500						85,837,500	85.84
	Stanchion Plate	250,000	FT^2	5.800	$/FT^2	1,450,000						1,450,000	1.45
	Hatch Access	30,780,000	lbs	.261	$/lb	8,033,580						8,033,580	8.03
	Handle	2,000,000	FT	.150	$/FT	300,000						300,000	.30
	Hatch	250,000	FT^2	1.200	$/FT^2	300,000						300,000	.30
	Hatch Flange Inside	11,512,200	lbs	.288	$/lb	3,315,456						3,315,456	3.32
	Pedestal	1,000,000	FT^2	.100	$/FT^2	100,000						100,000	.10
	Seal Hatch	10,000,000	FT	.19	$/FT	1,900,000						1,900,000	1.90
	Fiberglass	9,000,000	FT^2	.78	$/FT^2	7,020,000						7,020,000	7.02
1	Primer	6,000,000	GAL	1.058	$/GAL	6,350,000						6,350,000	6.35
1	White Paint	6,000,000	GAL	1.625	$/GAL	9,750,000						9,750,000	9.75
	Ring Stud - Weld	4,000,000	EA	.012	$/EA	50,000						50,000	.05
	Hatch Toggle Clamp	4,000,000	EA	.950	$/EA	3,800,000						3,800,000	3.80
	Concentric Reducer	1,000,000	EA	9.00	$/EA	9,000,000						9,000,000	9.00
	Marmon Clamp	1,000,000	EA	4.50	$/EA	4,500,000						4,500,000	4.50
	Rivets	44,000,000	EA	.01	$/EA	440,000						440,000	.44
	Cap Screws	3,000,000	EA	.027	$/EA	80,000						80,000	.08
	Wing Nut	4,000,000	EA	.015	$/EA	50,000						50,000	.05
	Lock Nut	2,000,000	EA	.006	$/EA	10,000						10,000	.01

NOTES: 1. Small error not corrected in totals.

PAGE TOTAL $711,225,136 $711.23

CBS TOTAL

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Hatch Flange Outside	28,540,000	lbs	.288	$/lb	8,219,520						8,219,520	8.22
Air Supply System	1,000,000	EA	96.63	$/EA	96,630,000						96,630,000	96.63
Transportation	1,300,000,000	lbs	.014	$/lbs	18,200,000						18,200,000	18.20
MATERIAL SUBTOTAL											(834,274,656)	(834.28)

NOTES:

PAGE TOTAL $123,049,520 $123.05

CBS TOTAL

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Tooling - Off Site	139,200	HRS	25.00	$/HR	3,480,000		I N C L U D E D			30	116,000	.12
* Tool Mat'l - Off Site	139,200	HRS	4.00	$/HR	556,800					30	18,560	.02
Tooling - On Site Fab	256,159	HRS	25.00	$/HR	6,403,975		I N C L U D E D			30	213,466	.21
Tooling On Site Buy					56,686,578					30	1,889,553	1.89
Tool Mat'l On Site	256,159	HRS	4.00	$/HR	1,024,636					30	34,155	.03

NOTES: *Tool material is based on tool fab. hours.
Tooling labor hours benefit on 90% learning curve.

PAGE TOTAL $2,271,734 $2.27

CBS TOTAL

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT OFF SITE MANUFACTURING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Hatch Flange - Outside	307,260	HRS	25.00	$/HR	7,681,500	.834		INCL	UDED		6,406,371	6.40
Strap	101,505	HRS	25.00	$/HR	2,537,625	.834		INCL	UDED		2,116,379	2.12
Stanchion	320,975	HRS	25.00	$/HR	8,024,375	.834		INCL	UDED		6,692,329	6.69
Pedestal Assy	189,293	HRS	25.00	$/HR	4,732,325	.834		INCL	UDED		3,946,759	3.95
Flange	246,904	HRS	25.00	$/HR	6,172,600	.834		INCL	UDED		5,147,948	5.15
Pedestal	27,434	HRS	25.00	$/HR	685,850	.834		INCL	UDED		571,999	.57
Bell	27,434	HRS	25.00	$/HR	685,850	.834		INCL	UDED		571,999	.57
Hatch Flange Inside	279,824	HRS	25.00	$/HR	6,995,600	.834		INCL	UDED		5,834,330	5.83
Hatch Assy	131,682	HRS	25.00	$/HR	3,292,050	.834		INCL	UDED		2,745,570	2.75
Hatch	38,407	HRS	25.00	$/HR	960,175	.834		INCL	UDED		800,786	.80
Handle	137,165	HRS	25.00	$/HR	3,429,225	.834		INCL	UDED		2,859,974	2.86
Hatch Seal	60,354	HRS	25.00	$/HR	1,508,850	.834		INCL	UDED		1,258,381	1.26
Pedestal Seal	71,328	HRS	25.00	$/HR	1,783,200	.834		INCL	UDED		1,487,189	1.49
Retention Seal	82,301	HRS	25.00	$/HR	2,057,525	.834		INCL	UDED		1,715,976	1.72
Doubler	65,841	HRS	25.00	$/HR	1,646,025	.834		INCL	UDED		1,372,785	1.37
Flange - Pedestal Seal	197,523	HRS	25.00	$/HR	4,938,075	.834		INCL	UDED		4,118,355	4.12

NOTES:

PAGE TOTAL $47,647,130 $47.65

CBS TOTAL

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT ON SITE MANUFACTURING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Dish	640,000	HRS	9.45	$/HR	6,048,000	.834	1.138	1.330	1.066		8,138,211	8.14
Ring Support	640,000	HRS	9.45	$/HR	6,048,000	.834	1.138	1.330	1.066		8,138,211	8.14
Painting	640,000	HRS	9.45	$/HR	6,048,000	.834	1.138	1.330	1.066		8,138,211	8.14
Dish/Ring Assy	320,000	HRS	9.45	$/HR	3,024,000	.834	1.138	1.330	1.066		4,069,105	4.07
Pedestal Assy	320,000	HRS	9.45	$/HR	3,024,000	.834	1.138	1.330	1.066		4,069,105	4.07
Stores & Handling	640,000	HRS	9.45	$/HR	6,048,000	.834	1.138	1.330	1.066		8,138,211	8.13
Final Assy	1,600,000	HRS	9.45	$/HR	15,120,000	.834	1.138	1.330	1.066		20,345,526	20.35

NOTES:

PAGE TOTAL $61,036,580 $61.34

CBS TOTAL $945,230,100 $945.24

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4452 TITLE HELIOSTAT PROTECTIVE ENCLOSURE ELEMENT MATERIAL, TOOLING & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
MATERIAL												
Weatherized Polyester	16,439,400	FT^2	.330	$/FT^2	5,425,000						5,425,500	217.00
TOOLING												
Tooling - On Site Fab	9,630	HRS	25.00	$/HR	240,750			INCLUDED		30	8,025	.32
Tool Material	9,630	HRS	4.00	$/HR	38,520					30	1,284	.05
TOOLING SUBTOTAL											(9,309)	(.37)
ON SITE MFG												
Enclosure	16,000	HRS	9.45	$/HR	151,200	.834	1.138	1.330	1.066		203,455	8.14
Store & Handling	12,000	HRS	9.45	$/HR	113,400	.834	1.138	1.330	1.066		152,591	6.10
Final Assy	20,000	HRS	9.45	$/HR	189,000	.834	1.138	1.330	1.066		254,319	10.17
MFG SUBTOTAL											(610,365)	(24.41)

NOTES:

*Tool material is based on tool fab hours.

PAGE TOTAL $6,044,674 241.78

CBS TOTAL $6,044,674 241.78

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4452 TITLE HELIOSTAT PROTECTIVE ENCLOSURE ELEMENT MATERIAL, TOOLING, & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Profit & Risks		
MATERIAL												
Weatherized Polyester	156,250,000	FT^2	.315	$\$/FT^2$	49,250,000						49,250,000	197.00
TOOLING												
Tooling - On Site Mfg	74,107	HRS	25.00	\$/HR	1,852,675		INCLUDED			30	61,756	.25
Tool Mat'l	74,107	HRS	4.00	\$/HR	296,428					30	9,881	.04
TOOLING SUBTOTAL											(71,637)	(.29)
ON SITE MFG												
Enclosure	160,000	HRS	9.45	\$/HR	1,512,000	.834	1.138	1.330	1.066		2,034,353	8.14
Store & Handling	120,000	HRS	9.45	\$/HR	1,134,000	.834	1.138	1.330	1.066		1,525,914	6.10
Final Assy	200,000	HRS	9.45	\$/HR	1,890,000	.834	1.138	1.330	1.066		2,543,191	10.17
MFG SUBTOTAL											(6,103,658)	(24.41)

NOTES: *Tool material is based on tool fab. hours.

PAGE TOTAL $55,425,295 $221.70

CBS TOTAL $55,425,295 $221.70

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4452 TITLE HELIOSTAT PROTECTIVE ENCLOSURE ELEMENT MATERIAL, TOOLING & LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
MATERIAL												
Weatherized Polyester	625,000,000	FT^2	.3152	$/FT^2	197,000,000						197,000,000	197.00
TOOLING												
Tooling - On Site Mfg	205,198	HRS	25.00	$/HR	5,129,950			I N C L	U D E D	30	170,998	.17
* Tool Mat'l - On Site	205,198	HRS	4.00	$/HR	820,792						27,360	.03
TOOLING SUBTOTAL											(198,358)	(.20)
ON SITE MFG												
Enclosure	640,000	HRS	9.45	$/HR	6,048,000	.834	1.138	1.330	1.066		8,138,211	8.14
Store & Handling	480,000	HRS	9.45	$/HR	4,536,000	.834	1.138	1.330	1.066		6,103,658	6.10
Final Assy	800,000	HRS	9.45	$/HR	7,560,000	.834	1.138	1.330	1.066		10,172,763	10.17
MFG SUBTOTAL											(24,414,632)	(24.41)

NOTES: *Tool material is based on tool fab. hours.

PAGE TOTAL $221,612,990 $221.61

CBS TOTAL $221,612,990 $221.61

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4460 TITLE FIELD ASSY & CHECKOUT ELEMENT LABOR & EQUIPMENT

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Site Installation	120,000	HRS	11.45	$/HR	1,374,000	.834	1.114	1.278	1.058		1,726,054	69.04
Checkout	4,250	HRS	11.45	$/HR	48,660	.834	1.114	1.278	1.058		61,130	2.45
SUBTOTAL											(1,787,184)	(71.49)
TOOLING												
Tooling - Fab	12,800	HRS	25.00	$/HR	320,000			I N C L	U D E D	30	10,667	.43
Tooling - Buy	6	SETS	35,000	$/SET	210,000					30	7,000	.28
* Tool Mat'l	12,800	HRS	4.00	$/HR	51,200					30	1,707	.07
TOOLING SUBTOTAL											(19,374)	(.75)

NOTES: *Tool material is based on tool fab. hours.

PAGE TOTAL $1,806,558 $72.27

CBS TOTAL $1,806,558 $72.27

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4450 TITLE FIELD ASSY & CHECKOUT ELEMENT LABOR & EQUIPMENT

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Site Installation	1,200,000	HRS	11.45	$/HR	13,740,000	.834	1.114	1.278	1.058		17,260,584	69.04
Checkout	42,500	HRS	11.45	$/HR	486,625	.834	1.114	1.278	1.058		611,311	2.45
SUBTOTAL											(17,871,856)	(71.49)
TOOLING												
Tooling - Fab	92,119	HRS	25.00	$/HR	2,302,975		I N C L U D E D			30	76,766	.31
Tooling - Buy	60	SET	35,000	$/SET	2,100,000					30	70,000	.28
Tooling Mat'l	92,119	HRS	4.00	$/HR	368,476					30	12,283	.05
TOOLING SUBTOTAL											(159,049)	(.64)

NOTES:

PAGE TOTAL

CBS TOTAL $18,030,905 $72.13

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4460 TITLE FIELD ASSY & CHECKOUT ELEMENT LABOR & EQUIPMENT

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Meliostat
						Learning Curve	G & A	Overhead	Quality Control	Profit & Fees		
Site Installation	4,800,000	MHS	11.45	$/MH	54,960,000	.834	1.114	1.278	1.058		69,042,176	69.04
Checkout	170,000	MHS	11.45	$/MH	1,946,500	.834	1.114	1.278	1.058		2,445,244	2.45
SUBTOTAL											(71,487,420)	(71.49)
TOOLING												
Tooling - Fab	299,384	MHS	25.00	$/MH	7,484,600		I N C L U D E D			30	249,487	.25
* Tool Mat'l	299,384	MHS	4.00	$/MH	1,197,536					30	39,918	.04
Tooling - Buy	240	SET	35,000	$/SET	8,400,000					30	280,000	.28
TOOLING SUBTOTAL											(569,405)	(.57)

NOTES:

PAGE TOTAL $

CBS TOTAL $72,056,825 $72.06

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4470 TITLE DESIGN AND ENGINEERING ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Contrl	Prorate Years		
Factory Liaison	2,000	HRS	25.00	$/HR	50,000						50,000	2.00
Field Liaison	2,000	HRS	25.00	$/HR	50,000						50,000	2.00

NOTES: Engineering Liaison - recurring cost only.

PAGE TOTAL

CBS TOTAL $100,000 $4.00

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4470 TITLE DESIGN AND ENGINEERING ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Factory Liaison	20,000	HRS	25.00	$/HR	500,000						500,000	2.00
Field Liaison	20,000	HRS	25.00	$/HR	500,000						500,000	2.00

NOTES: Engineering Liaison - recurring cost only.

PAGE TOTAL

CBS TOTAL $1,000,000 $4.00

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4470 TITLE DESIGN AND ENGINEERING ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Factory Liaison	80,000	HRS	25.00	$/HR	2,000,000						2,000,000	2.00
Field Liaison	80,000	HRS	25.00	$/HR	2,000,000						2,000,000	2.00

NOTES: Engineering Liaison - recurring cost only.

PAGE TOTAL

CBS TOTAL $4,000,000 $4.00

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4810 TITLE TEMPORARY FACILITIES, EQUIPMENT, ETC. ELEMENT TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Assembly Bldg.	1	SET			8,000,000					30	266,667	10.67
Site Prep. Etc.	1	SET			1,500,000					30	50,000	2.00
A & E	1	SET			630,000					30	21,000	.84
Paint & Sandblast Fac.	1	SET			1,000,000					30	33,333	1.33
Automated Handling Equip.	1	SET			500,000					30	16,667	.67
Vehicles	6	EA	10,000	$/EA	60,000					30/5	360,000	14.40
Fork Lifts	3	EA	8,000	$/EA	24,000					30/15	48,000	1.92

NOTES:

PAGE TOTAL

CBS TOTAL $795,700 $31.83

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4810 TITLE TEMPORARY FACILITIES, EQUIPMENT, ETC. ELEMENT TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS: Learning Curve	G & A	Overhead	Quality Control	Prorate Years	Total	Total per Heliostat
Assembly Bldg.	10	SETS			80,000,000	0.95				30	2,533,000	10.13
Site Prep. Etc.	10	SETS			15,000,000	1.0				30	500,000	2.00
A & E	10	SETS			6,300,000	0.5				30	105,000	.42
Paint & Sandblast Fac.	8	SETS			7,600,000	0.95				30	240,700	.96
Automated Handling Equip.	10	SETS			4,750,000	0.95				30	150,400	.60
Vehicles	60	EA	10,000	$/EA	600,000	0.95				30/5	3,420,000	13.68
Fork Lifts	30	EA	8,000	$/EA	240,000	1.0				30/15	480,000	1.92

NOTES:

PAGE TOTAL

CBS TOTAL $7,429,100 $29.71

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4810 TITLE TEMPORARY FACILITIES EQUIPMENT, ETC. ELEMENT TOOLING

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Assembly Bldg.	40	SETS			320,000,000	.90				30	9,600,000	9.60
Site Prep. Etc.	40	SETS			60,000,000	.90				30	1,800,000	1.80
A & E	40	SETS			25,200,000	.25				30	210,000	.21
Paint & Sandblast Fac.	31	SETS			27,900,000	.90				30	837,000	.84
Automated Handling Equip.	40	SETS			18,000,000	.90				30	540,000	.54
Vehicles	240	EA	10,000	$/EA	2,400,000	.90				30/5	12,960,000	12.96
Fork Lifts	120	EA	8,000	$/EA	960,000	.95				30/15	1,824,000	1.82

NOTES:

PAGE TOTAL

CBS TOTAL $27,771,000 $27.77

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4850 TITLE PLANT STARTUP AND CHECKOUT ELEMENT LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Alignment and Scan	6,384	HRS	13.45	$/HR	85,865	.834	1.097	1.841	1.052		102,560	4.10
2	Collector Subsystem Power Up & Demonstrate	4,256	HRS	13.45	$/HR	57,845	.834	1.097	1.841	1.052		68,375	2.74

NOTES:
1. Each heliostat is aligned and scanned for image signature, power centroid and total power. Operating modes are verified. Requires two 3 man crews, 7 months on day shift.
2. Subsystem is gradually powered up using receiver as target. Final month at 100% operation. Requires 4 man crew, 7 months on day shift.

PAGE TOTAL

CBS TOTAL $170,935 $6.84

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 4850 TITLE PLANT STARTUP AND CHECKOUT ELEMENT LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Alignment and Scan	63,840	HRS	13.45	$/HR	858,650	.834	1.097	1.241	1.052		1,025,600	4.10
2	Collector Subsystem Power Up and Demonstrate	42,560	HRS	13.45	$/HR	858,650	.834	1.097	1.241	1.052		683,750	2.74

NOTES: 1. See notes for rate of 25,000 per year.
2. " " "

PAGE TOTAL

CBS TOTAL $1,709,350 $6.84

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 4850 TITLE PLANT STARTUP AND CHECKOUT ELEMENT LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Alignment and Scan	255,360	HRS	13.45	$/HR	3,434,600	.834	1.097	1.241	1.052		4,102,400	4.10
2	Collector Subsystem Power Up and Demonstrate	170,240	HRS	13.45	$/HR	2,289,700	.834	1.097	1.241	1.052		2,734,900	2.74

NOTES: 1. See notes for rate of 25,000 per year.
2. " " "

PAGE TOTAL

CBS TOTAL $6,837,300 $6.84

PRODUCTION RATE 25,000 PER YEAR

CBS NO. CA210 TITLE: SPARE PARTS (INVENTORY) ELEMENT MATERIAL

Item	Qty. per 30 yrs	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
ENCLOSURES	250	EA	241.78	$/EA	60,445						60,445	2.42
REFLECTORS	125	EA	670.30	$/EA	83,788						83,788	3.35
GIMBAL BEARINGS	100	EA	7.50	$/EA	750						750	.03
DRIVE MOTORS	400	EA	160.00	$/EA	64,000						64,000	2.56
GEARBOX BEARINGS	100	EA	5.50	$/EA	550						550	.02
HELIOSTAT CONTROLLER												
Power Cord	10	EA	1.17	$/EA	12						12	
Transformer	20	EA	9.50	$/EA	190						190	.01
Chassis	10	EA	2.17	$/EA	22						22	
P.C. Board	47	EA	290.00	$/EA	13,630						13,630	.55
AIR SUPPLY												
Compressor Vanes	300	EA	5.00	$/EA	1,500						1,500	.06
Prefilter	25,000	EA	0.50	$/EA	12,500						12,500	.50
Filter	250	EA	20.00	$/EA	5,000						5,000	.20
Compressor	10	EA	30.00	$/EA	300						300	.01
Check Valve	10	EA	5.00	$/EA	50						50	
Chassis	10	EA	35.00	$/EA	350						350	.01

NOTES:

PAGE TOTAL

CBS TOTAL $243,087 $9.72

PRODUCTION RATE 250,000 PER YEAR

CBS NO. CM210 TITLE SPARE PARTS (INVENTORY) ELEMENT MATERIAL

Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
ENCLOSURES	2,500	EA	221.70	$/EA	554,250						554,250	2.22
REFLECTORS	1,250	EA	590.03	$/EA	737,550						737,550	2.95
GIMBAL BEARINGS	1,000	EA	7.25	$/EA	7,250						7,250	.03
DRIVE MOTORS	4,000	EA	152.00	$/EA	608,000						608,000	2.43
GEARBOX BEARINGS	1,000	EA	5.25	$/EA	5,250						5,250	.02
HELIOSTAT CONTROLLER												
Power Cord	100	EA	1.10	$/EA	100						100	Neg.
Transformer	200	EA	9.00	$/EA	1,800						1,800	.01
Chassis	100	EA	2.05	$/EA	200						200	Neg.
P.C. Board	470	EA	260.00	$/EA	122,200						122,200	.49
AIR SUPPLY												
Compressor Vanes	3,000	EA	5.00	$/EA	15,000						15,000	.06
Prefilter	250,000	EA	.50	$/EA	125,000						125,000	.50
Filter	2,500	EA	19.00	$/EA	47,500						47,500	.19
Compressor	100	EA	28.50	$/EA	2,850						2,850	.01
Check Valve	100	EA	5.00	$/EA	500						500	Neg.
Chassis	100	EA	33.25	$/EA	3,325						3,325	.01

NOTES:

PAGE TOTAL

CBS TOTAL $2,830,775 $8.92

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 04210 TITLE SPARE PARTS (INVENTORY) ELEMENT MATERIAL

Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
ENCLOSURES	10,000	EA	221.61	$/EA	2,216,100						2,216,100	2.22
REFLECTORS	5,000	EA	568.85	$/EA	2,844,250						2,844,250	2.84
GIMBAL BEARINGS	4,000	EA	7.00	$/EA	28,000						28,000	.03
DRIVE MOTORS	16,000	EA	144.00	$/EA	2,304,000						2,304,000	2.30
GEARBOX BEARINGS	4,000	EA	5.00	$/EA	20,000						20,000	.02
HELIOSTAT CONTROLLER												
Power Cord	400	EA	1.05	$/EA	400						400	Neg.
Transformer	800	EA	8.75	$/EA	7,000						7,000	.01
Chassis	400	EA	2.00	$/EA	800						800	Neg.
P.C. Board	1,880	EA	245.00	$/EA	460,600						460,600	.46
AIR SUPPLY												
Compressor Vanes	12,000	EA	5.00	$/EA	60,000						60,000	.06
Prefilter	1,000,000	EA	.50	$/EA	500,000						500,000	.50
Filter	10,000	EA	19.00	$/EA	190,000						190,000	.19
Compressor	400	EA	28.50	$/EA	11,400						11,400	.01
Check Valve	400	EA	5.00	$/EA	2,000						2,000	Neg.
Chassis	400	EA	33.25	$/EA	13,300						13,300	.01

NOTES:

PAGE TOTAL

CBS TOTAL $8,657,850 $8.66

PRODUCTION RATE 25,000 PER YEAR

CBS NO. CM220 TITLE MATERIALS FOR REPAIRS ELEMENT MATERIAL

	Item	Qty. Per 30 Yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Malfostat
							Learning Curve	G & A	Overhead	Quality Control	Profits Yours		
1	Polyester Tape	30	Roll	10.00	$/Roll	300.00						300.00	.01
2	Access Hatch Gasket	30	Roll	10.00	$/Roll	300.00						300.00	.01

NOTES: 1. Dome patching - Assumes 1% suffer minor punctures in 30 years.
2. Assumes 1% replacement in 30 years.

PAGE TOTAL

CBS TOTAL $600.00 $.02

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 08220 TITLE MATERIALS FOR REPAIRS ELEMENT MATERIAL

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Helfostat
							Operating Crews	G & A	Overhead	Quality Control	Prorate Years		
1	Polyester Tape	300	Roll	10.00	$/EA	3,000						3,000	.01
2	Access Hatch Gasket	300	Roll	10.00	$/EA	3,000						3,000	.01

NOTES: 1. See notes for rate of 25,000 per year.
2. " " "

PAGE TOTAL

CBS TOTAL $6,000 $.02

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. CM220 TITLE MATERIALS FOR REPAIRS ELEMENT MATERIAL

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Polyester Tape	1,200	Roll	10.00	$/EA	12,000						12,000	.01
2	Access Hatch Gasket	1,200	Roll	10.00	$/EA	12,000						12,000	.01

NOTES: 1. See notes for rate of 25,000 per year.
2. " " "

PAGE TOTAL

CBS TOTAL $24,000 $.02

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 08230 TITLE MAINTENANCE MATERIALS - OTHER ELEMENT SPECIAL EQUIPMENT

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Heliostat Washer	1	EA	162,000	$/EA	162,000						162,000	6.48
Sprinkler System	1	EA	3,500,000	$/EA	3,500,000						3,500,000	140.00
Dome Replacement Machine	2	EA	211,000	$/EA	422,000						422,000	16.88
Maintenance Van	2	EA	34,500	$/EA	69,000						69,000	2.76

NOTES:

PAGE TOTAL

CBS TOTAL $4,153,000 $166.12

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 09230 TITLE MAINTENANCE MATERIALS - OTHER ELEMENT SPECIAL EQUIPMENT

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Profit & Years		
Heliostat Washer	10	EA	162,000	$/EA	1,620,000	.90					1,458,000	5.83
Sprinkler System	10	EA	3,500,000	$/EA	35,000,000	.95					33,250,000	133.00
Dome Replacement Machine	20	EA	211,000	$/EA	4,220,000	.90					3,798,000	15.19
Maintenance Van	20	EA	34,500	$/EA	690,000	.95					655,500	2.62

NOTES: Learning Curve Factor applied to Unit Cost of Equipment as estimated for the lower quantities for the production rate of 25,000 per year.

PAGE TOTAL

CBS TOTAL $39,161,500 $156.64

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 04230 TITLE MAINTENANCE MATERIALS - OTHER ELEMENT SPECIAL EQUIPMENT

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Heliostat Washer	40	EA	162,080	$/EA	6,480,000	.85					5,508,000	5.51
Sprinkler System	40	EA	3,500,080	$/EA	140,000,000	.90					126,000,000	126.00
Hose Replacement Machine	80	EA	211,000	$/EA	16,880,000	.85					14,348,000	14.35
Maintenance Van	80	EA	34,500	$/EA	2,760,000	.90					2,484,000	2.48

NOTES: Learning Curve Factor applied to Unit Cost of equipment as estimated for the lower quantities for the production rate of 25,000 per year.

PAGE TOTAL

CBS TOTAL $148,340,000 $148.34

PRODUCTION RATE 25,000 PER YEAR

CBS NO. C0231 TITLE MAINTENANCE MATERIALS - OTHER ELEMENT MATERIAL

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS: Learning Curve	FACTORS: G & A	FACTORS: Overhead	FACTORS: Quality Control	FACTORS: Prorate Years	Total	Total per Heliostat
1	ENCLOSURES	25,000	EA	241.78	$/EA	6,044,500					12/18	4,031,700	161.27
	GIMBAL BEARINGS	2,560	EA	7.50	$/EA	19,200						19,200	.77
	DRIVE MOTORS	12,800	EA	160.00	$/EA	2,048,000						2,048,000	81.92
	GEARBOX BEARINGS	2,560	EA	5.50	$/EA	14,080						14,080	.56
	H.C. POWER CORD	240	EA	1.17	$/EA	280						280	..01
	H.C. TRANSFORMER	638	EA	9.50	$/EA	6,060						6,060	.24
	H.C. CHASSIS	240	EA	2.17	$/EA	520						520	.02
	AIR SUPPLY.												
	Compressor Vanes	27,200	EA	5.00	$/EA	136,000						136,000	5.44
	Prefilter	125,000	EA	0.50	$/EA	62,500						62,500	2.50
	Filter	25,000	EA	20.00	$/EA	500,000						500,000	20.00
	Compressor	240	EA	30.00	$/EA	7,200						7,200	.29
	Check valve	240	EA	5.00	$/EA	1,200						1,200	.05
	Chassis	240	EA	35.00	$/EA	8,400						8,400	.34
	SPRINKLER SYSTEM												
	Heads	6,250	EA	50.00	$/EA	312,500						312,500	12.50
	Valves	250	EA	30.00	$/EA	7,500						7,500	.30

NOTES: 1. Scheduled replacement for an average life of 18 years.

PAGE TOTAL

CBS TOTAL $7,154,890 $286.21

PRODUCTION RATE 250,000 PER YEAR

CBS NO. CN231 TITLE MAINTENANCE MATERIAL - OTHER ELEMENT MATERIAL

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	ENCLOSURES	250,000	EA	221.70	$/EA	55,425,000					12/18	36,968,500	147.87
	GIMBAL BEARINGS	25,600	EA	7.25	$/EA	185,600						185,600	.74
	DRIVE MOTORS	128,000	EA	152.00	$/EA	19,456,000						19,456,000	77.82
	GEARBOX BEARINGS	25,600	EA	5.25	$/EA	134,400						134,400	.54
	H.C. POWER CORD	2,400	EA	1.10	$/EA	2,600						2,600	.01
	H.C. TRANSFORMER	6,380	EA	9.00	$/EA	57,400						57,400	.23
	H.C. CHASSIS	2,400	EA	2.05	$/EA	4,900						4,900	.02
	AIR SUPPLY												
	Compressor Vanes	272,000	EA	5.00	$/EA	1,360,000						1,360,000	5.44
	Prefilter	1,250,000	EA	.50	$/EA	625,000						625,000	2.50
	Filter	250,000	EA	19.00	$/EA	4,750,000						4,750,000	19.00
	Compressor	2,400	EA	28.50	$/EA	68,400						68,400	.27
	Check Valve	2,400	EA	5.00	$/EA	12,000						12,000	.05
	Chassis	2,400	EA	33.25	$/EA	79,800						79,800	.32
	SPRINKLER SYSTEM												
	Heads	62,500	EA	50.00	$/EA	3,125,000						3,125,000	12.50
	Valves	2,500	EA	30.00	$/EA	75,000						75,000	.30

NOTES: 1. Scheduled replacement for an average life of 18 years.

PAGE TOTAL

CBS TOTAL $66,904,600 $267.60

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. 09231 TITLE MAINTENANCE MATERIAL - OTHER ELEMENT MATERIAL

	Item	Qty. per 30 yrs	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	ENCLOSURES	1,000,000	EA	221.61	$/EA	221,610,000					12/18	147,814,000	147.81
	GIMBAL BEARINGS	102,400	EA	7.00	$/EA	716,800						716,800	.72
	DRIVE MOTORS	512,000	EA	144.00	$/EA	73,728,000						73,728,000	73.73
	GEARBOX BEARINGS	102,400	EA	5.00	$/EA	512,000						512,000	.51
	H.C. POWER CORD	9,600	EA	1.05	$/EA	10,100						10,100	.01
	H.C. TRANSFORMER	25,520	EA	8.75	$/EA	223,300						223,300	.22
	H.C. CHASSIS	9,600	EA	2.00	$/EA	19,200						19,200	.02
	AIR SUPPLY												
	Compressor Vanes	1,088,000	EA	5.00	$/EA	5,440,000						5,440,000	5.44
	Prefilter	5,000,000	EA	.50	$/EA	2,500,000						2,500,000	2.50
	Filter	1,000,000	EA	19.00	$/EA	19,000,000						19,000,000	19.00
	Compressor	9,600	EA	28.50	$/EA	273,600						273,600	.27
	Check Valve	9,600	EA	5.00	$/EA	48,000						48,000	.05
	Chassis	9,600	EA	33.25	$/EA	319,200						319,200	.32
	SPRINKLER SYSTEM												
	Heads	250,000	EA	50.00	$/EA	12,500,000						12,500,000	12.50
	Valves	10,000	EA	30.00	$/EA	300,000						300,000	.30

NOTES: 1. Scheduled replacement for an average life of 18 years.

PAGE TOTAL

CBS TOTAL $263,400,000 $263.40

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 0N310 TITLE SCHEDULED MAINTENANCE ELEMENT LABOR

	Item	Qty. per 30 yrs	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Enclosure Replacement	70,500	HRS	11.45	$/HR	807,225	.834	1.114	1.278	1.058	12/18	676,400	27.06
2	Enclosure Washing	179,730	HRS	11.45	$/HR	2,057,909	.834	1.114	1.278	1.058		2,585,200	103.41
3	Prefilter Replacement	21,000	HRS	11.45	$/HR	240,450	.834	1.114	1.278	1.058		302,100	12.08
4	Alignment Checks	24,960	HRS	11.45	$/HR	285,800	.834	1.114	1.278	1.058		359,000	14.36

NOTES:
1. Average enclosure replacement at 18th year.
2. Rinsed weekly, washed annually.
3. Replaced at five year intervals.
4. Alignment checked annually.

PAGE TOTAL

CBS TOTAL $3,922,700 $156.91

PRODUCTION RATE 250,000 PER YEAR

CBS NO. CM310 TITLE SCHEDULED MAINTENANCE ELEMENT LABOR

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Enclosure Replacement	705,000	HR	11.45	$/HR	8,072,250	.834	1.114	1.278	1.058	12/18	6,763,600	27.05
2	Enclosure Washing	1,797,300	HR	11.45	$/HR	20,579,000	.834	1.114	1.278	1.058		25,851,000	103.41
3	Prefilter Replacement	210,000	HR	11.45	$/HR	2,404,500	.834	1.114	1.278	1.058		3,020,500	12.08
4	Alignment Checks	249,600	HR	11.45	$/HR	2,858,000	.834	1.114	1.278	1.058		3,590,200	14.36

NOTES:
1. Average enclosure replacement at 18th year.
2. Rinsed weekly, washed annually.
3. Replaced at five year intervals.
4. Alignment checked annually.

PAGE TOTAL

CBS TOTAL $39,225,300 $156.90

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. OM310 TITLE SCHEDULED MAINTENANCE ELEMENT LABOR

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Enclosure Replacement	2,820,000	MR	11.45	$/MR	32,289,000	.834	1.114	1.278	1.058	12/18	27,054,500	27.05
2	Enclosure Washing	7,189,200	MR	11.45	$/MR	82,316,300	.834	1.114	1.278	1.058		103,406,000	103.41
3	Prefilter Replacement	840,000	MR	11.45	$/MR	9,618,000	.834	1.114	1.278	1.058		12,082,000	12.08
4	Alignment Checks	998,400	MR	11.45	$/MR	11,431,700	.834	1.114	1.278	1.058		14,360,500	14.36

NOTES:
1. Average enclosure replacement at 18th year.
2. Rinsed weekly, washed annually
3. Replaced at five year intervals.
4. Alignment checked annually.

PAGE TOTAL

CBS TOTAL $156,903,000 $156.90

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 06320 TITLE CORRECTIVE MAINTENANCE ELEMENT LABOR

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Heliostat Controller Repair	16,250	HRS	11.45	$/HR	186,060	.834	1.114	1.278	1.058		233,735	9.35
1	Drive Unit Repair	15,930	HRS	11.45	$/HR	182,400	.834	1.114	1.278	1.058		229,135	9.17
1	Air Supply Repair	16,667	HRS	11.45	$/HR	190,840	.834	1.114	1.278	1.058		239,740	9.59
1	Non-Scheduled Enclosure Replacement	720	HRS	11.45	$/HR	8,250	.834	1.114	1.278	1.058		10,365	.41
1	Non-Scheduled Reflector Replacement	720	HRS	11.45	$/HR	8,250	.834	1.114	1.278	1.058		10,365	.41
2	Heliostat Controller Repair	25,000	EA	75.00	$/EA	1,875,000	.834	-	-	-		1,563,750	62.55

NOTES: 1. Field crew and repair depot labor.
2. Vendor repair cost.

PAGE TOTAL

CBS TOTAL $2,287,100 $91.48

PRODUCTION RATE 250,000 PER YEAR

CBS NO. 0K320 TITLE CORRECTIVE MAINTENANCE ELEMENT LABOR

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Heliostat Controller Repair	162,500	MR	11.45	$/MR	1,860,600	.834	1.114	1.278	1.058		2,337,350	9.35
1	Drive Unit Repair	159,300	MR	11.45	$/MR	1,824,000	.834	1.114	1.278	1.058		2,291,350	9.17
1	Air Supply Repair	166,670	MR	11.45	$/MR	1,908,400	.834	1.114	1.278	1.058		2,397,400	9.59
1	Non-Scheduled Enclosure Replacement	7,200	MR	11.45	$/MR	82,500	.834	1.114	1.278	1.058		103,650	.41
1	Non-Scheduled Reflector Replacement	7,200	MR	11.45	$/MR	82,500	.834	1.114	1.278	1.058		103,650	.41
2	Heliostat Controller Repair	250,000	EA	75.00	$/EA	13,750,000	.834	-	-	-		15,637,500	62.55

NOTES: 1. Field crew and repair depot labor.
2. Vendor repair cost.

PAGE TOTAL

CBS TOTAL $22,870,900 $91.48

PRODUCTION RATE 1,000,000 PER YEAR

CBS NO. QN320 TITLE CORRECTIVE MAINTENANCE ELEMENT LABOR

	Item	Qty. per 30 yrs.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Heliostat Controller	650,000	HR	11.45	$/HR	7,442,500	.834	1.114	1.278	1.058		9,349,300	9.35
1	Drive Unit Repair	637,200	HR	11.45	$/HR	7,296,000	.834	1.114	1.278	1.058		9,165,200	9.17
1	Air Supply Repair	666,700	HR	11.45	$/HR	7,633,700	.834	1.114	1.278	1.058		9,589,500	9.59
1	Non-Scheduled Enclosure Replacement	28,800	HR	11.45	$/HR	329,800	.834	1.114	1.278	1.058		414,300	.41
1	Non-Scheduled Reflector Replacement	28,800	HR	11.45	$/HR	329,800	.834	1.114	1.278	1.058		414,300	.41
2	Heliostat Controller Repair	1,000,000	EA	75.00	$/EA	75,000,000	.834	-	-	-		62,550,000	62.55

NOTES: 1. Field crew and repair depot labor.
2. Vendor repair cost.

PAGE TOTAL

CBS TOTAL $91,482,600 $91.48

APPENDIX B

DETAILED COST ESTIMATES

FOR

2500 HELIOSTATS

This Appendix contains detail cost estimating worksheets. These data are summarized in Section 5.2 of D277-10105-3, Volume III, "Cost Estimate".

PRODUCTION 2500 HELIOSTATS

CBS NO. 4410 TITLE REFLECTOR ELEMENT MATERIAL AND TOOLING

	Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS: Learning Curve	G & A	Overhead	Quality Control	Residual Value	Total	Total per Heliostat
	MATERIAL												
	Ring - Tubing	498,200	FT	1.40	$/FT	697,500						697,500	279.00
	Hub - Casting	2,500	EA	78.50	$/EA	196,500						196,500	78.60
	Tees - Casting	2,500	EA	300.00	$/EA	750,000						750,000	300.00
	Metalized Polyester	2,558,000	FT^2	0.15	$/$FT^2$	383,800						383,800	153.52
	Reflective Patch	950	FT	.21	$/FT	200						200	.08
	Adhesive	500,000	FT	.028	$/FT	14,000						14,000	5.60
	Adhesive	250,000	FT	.06	$/FT	15,000						15,000	6.00
	Transportation	750,000	LB	.02	$/LB	15,000						15,000	6.00
	MATERIAL SUBTOTAL											(2,072,000)	(828.80)
	Tooling - Off Site	2,000	HR	25.00	$/HR	50,000					25,000	25,000	10.00
1	Tool Mtl - Off Site	2,000	HR	4.00	$/HR	8,000					4,000	4,000	1.60
	Tooling - On Site - Buy					65,000					40,000	25,000	10.00
	Tooling - On Site - Fab	10,000	HR	25.00	$/HR	250,000					200,000	50,000	20.00
1	Tool Mtl - On Site - Fab	10,000	HR	4.00	$/HR	40,000					30,000	10,000	4.00
	TOOLING SUBTOTAL											(114,000)	(45.60)

NOTES: 1. Tool material based on tool fab hours.

PAGE TOTAL $2,186,000 $874.28

CDS TOTAL

PRODUCTION 2500 HELIOSTATS

CBS NO. 4410 TITLE REFLECTOR ELEMENT LABOR

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
OFF - SITE MFG												
Ring	8,832	HR	25.00	$/HR	220,800	.21	I N C L U D E D				46,400	18.56
Spoke (1)	1,030	HR	25.00	$/HR	25,750	.21	I N C L U D E D				5,400	2.16
Spokes (2)	2,060	HR	25.00	$/HR	51,500	.21	I N C L U D E D				10,800	4.32
Reflective Film Assy	11,400	HR	25.00	$/HR	285,000	.21	I N C L U D E D				59,850	23.94
OFF - SITE SUBTOTAL											(122,450)	(48.98)
ON - SITE MFG												
Reflector Assy	25,500	HR	9.45	$/HR	241,000	.21	1.138	1.330	1.066		81,650	32.66
Store and Handling	8,000	HR	9.45	$/HR	75,600	.21	1.138	1.330	1.066		25,600	10.25
Final Assy	16,000	HR	9.45	$/HR	151,200	.21	1.138	1.330	1.066		51,200	20.50
ON - SITE SUBTOTAL											(158,450)	(63.41)

NOTES: Labor hours are 1st unit hours.
Learning curve factor is the average unit hours related to the first unit.

PAGE TOTAL $280,900 $112.39

CBS TOTAL $2,466,900 986.67

PRODUCTION 2500 HELIOSTATS

CBS NO. 4420 TITLE DRIVE UNIT ELEMENT MATERIAL AND LABOR

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Tooling Costs	G & A	Overhead	Quality Control	Profits Taxes		
Gimbal/Actuator Assy	2,500	EA	640.00	$/EA	1,600,000						1,600,000	640.00
MATERIAL SUBTOTAL											(1,600,000)	(640.00)
Store and Handling	1,950	HR	9.45	$/HR	18,450	.21	1.138	1.330	1.066		6,850	2.50
Final Assy	8,900	HR	9.45	$/HR	84,100	.21	1.138	1.330	1.066		28,500	11.40
LABOR SUBTOTAL											(34,750)	(13.90)

NOTES:

PAGE TOTAL

CBS TOTAL $1,634,750 $653.90

PRODUCTION 2500 HELIOSTATS

CBS NO. 4430 TITLE CONTROL AND INSTRUMENTATION ELEMENT MATERIAL AND LABOR

	Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
	HELIOSTAT CONTROLLER												
	Subcontract	2,500	EA	455.00	$/EA	1,137,500						1,137,500	455.00
1	Transportation	75,000	LB	0.14	$/LB	10,500						10,500	4.20
	MATERIAL TOTAL											1,148,000	(459.20)
2	FINAL ASSY LABOR	1,400		9.45		13,230	.21	1.118	1.330	1.066		4,500	1.80

NOTES: 1. Assumed 1500 miles.
2. Install controller in heliostat.

PAGE TOTAL

CBS TOTAL $1,152,500 $461.00

PRODUCTION 2500 HELIOSTATS

CBS NO. 4440 TITLE FOUNDATION AND SITE ELEMENT MATERIAL

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
FOUNDATION - Piling Concrete	2,500	EA	500.00	$/EA	1,250,000						1,250,000	500.00

NOTES:

PAGE TOTAL

CBS TOTAL $1,250,000 $500.00

PRODUCTION 2500 HELIOSTATS

CBS NO. 4451 TITLE SUPPORT STRUCTURE ELEMENT MATERIAL

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Dish	2,350,000	LB	.28	$/LB	658,000						658,000	263.20
Ring Support	206,700	FT	4.25	$/FT	878,500						878,500	351.39
Stanchion Pipe	41,250	FT	3.00	$/FT	123,750						123,750	49.50
Pedestal Pipe	41,350	FT	6.05	$/FT	250,150						250,150	100.06
Stanchion Plate	14,300	LB	0.30	$/LB	4,300						4,300	1.72
Hatch - Access	80,800	LB	0.29	$/LB	23,400						23,400	9.36
Hatch - Handle	5,000	FT	0.18	$/FT	900						900	0.36
Hatch	650	FT^2	1.25	$/$FT^2$	800						800	0.32
Hatch Flange - Inside	30,200	LB	0.32	$/LB	9,700						9,700	3.88
Pedestal	2,625	FT^2	0.10	$/FT	300						300	0.12
Hatch Seal	26,250	FT	0.20	$/FT	5,250						5,250	2.10
Fiberglas	23,600	FT^2	0.78	$/$FT^2$	18,400						18,400	7.36
Primer	10,000	GAL	7.75	$/GAL	77,500						77,500	31.00
White Paint	10,000	GAL	10.75	$/GAL	107,500						107,500	43.00
Stud	10,000	EA	0.013	$/EA	150						150	0.06
Hatch Toggle Clamp	10,000	EA	0.95	$/EA	9,500						9,500	3.80
Concentric Reducer	2,600	EA	9.00	$/EA	23,400						23,400	9.36
Marmon Clamp	2,600	EA	4.50	$/EA	11,700						11,700	4.68
Rivets	115,000	EA	0.01	$/EA	1,150						1,150	0.46
Cap Screws	7,900	EA	0.027	$/EA	200						200	0.08
Wing Nut	10,500	EA	0.013	$/EA	150						150	0.06
Lock Nut	5,200	EA	0.005	$/EA	Neg						Neg	Neg

NOTES:

PAGE TOTAL $2,204,700 $881.86

CBS TOTAL

CBS NO. 4451 TITLE SUPPORT STRUCTURE ELEMENT MATERIAL

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Air Supply System	2,550	EA	125.00	$/EA	318,750						318,750	127.50
Hatch Flange - Outside	75,000	LB	0.32	$/LB	24,000						24,000	9.60
Transportation	3,250,000	LB	0.014	$/LB	45,500						45,500	18.20
MATERIAL SUBTOTAL											(2,592,250)	(1,037.16)

NOTES:

PAGE TOTAL $388,250 $155.30

CBS TOTAL

PRODUCTION 2500 HELIOSTATS

CBS NO. 4451 TITLE SUPPORT STRUCTURE ELEMENT TOOLING

	Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
	Tooling - Off Site	2,000	HR	25.00	$/HR	50,000					30,000	20,000	8.00
1	Tool Mtl - Off Site	2,000	HR	4.00	$/HR	8,000					4,000	4,000	1.60
	Tooling - On Site - Fab	20,000	HR	25.00	$/HR	500,000					300,000	200,000	80.00
	Tooling - On Site - Buy			1,870,000		1,870,000					1,700,0	170,000	8.00
	Tool Mtl - On Site	20,000	HR	4.00	$/HR	80,000					40,000	40,000	16.00

NOTES: Tool material based on tool fab hours.

PAGE TOTAL $434,000 $173.60

CBS TOTAL

PRODUCTION [illegible]

CBS NO. 4451 TITLE SUPPORT STRUCTURE ELEMENT LABOR - OFF SITE MFG

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Helicopter
						Learning Curve	G & A	Overhead	Profit (Fee)	Escalation Factor		
Hatch Flange - Outside	8,843	HR	89.00	$/HR	806,100	.81	INCLUDED				43,350	17.34
Hatch - Strap	2,257	HR	89.00	$/HR	63,400	.81					13,192	5.28
Stanchions	8,084	HR	89.00	$/HR	800,600	.81					48,160	16.85
Pedestal Assy	4,738	HR	89.00	$/HR	118,300	.81					84,850	2.54
Flange	6,173	HR	89.00	$/HR	154,300	.81					38,409	18.56
Pedestal Plate	606	HR	89.00	$/HR	17,150	.81					3,650	1.44
Concentric Reducer	606	HR	89.00	$/HR	17,150	.81					3,650	1.44
Hatch Flange - Inside	6,996	HR	89.00	$/HR	174,900	.81					36,700	14.69
Hatch Assy	3,898	HR	89.00	$/HR	88,300	.81					17,360	6.91
Hatch	960	HR	89.00	$/HR	24,000	.81					5,250	2.58
Hatch Handle	3,489	HR	89.00	$/HR	85,700	.81					18,999	7.85
Hatch Seal	1,509	HR	89.00	$/HR	37,700	.81					7,900	3.16
Pedestal Seal	1,784	HR	89.00	$/HR	44,600	.81					9,350	3.75
Retention Seal	2,058	HR	89.00	$/HR	51,450	.81					10,800	4.38
Doubler	1,646	HR	89.00	$/HR	41,150	.81					8,650	3.46
Flange - Pedestal Seal	4,938	HR	89.00	$/HR	123,450	.81					25,900	10.37

NOTES: 1. Labor hours are 1st unit hours.
2. Learning curve factor is the average unit hours related to the first unit.

PAGE TOTAL 308,800 $121.16

CBS TOTAL

PRODUCTION 2500 HELIOSTATS

CBS NO. 4451 TITLE SUPPORT STRUCTURE ELEMENT LABOR - ON SITE MFG

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Dish	12,660	HR	9.45	$/HR	119,650	.21	1.138	1.330	1.066		40,500	16.21
Ring Support	12,070	HR	9.45	$/HR	114,000	.21	1.138	1.330	1.066		38,650	15.45
Painting	15,000	HR	9.45	$/HR	141,750	.21	1.138	1.330	1.066		48,000	19.21
Ring/Stanchion Assy	12,144	HR	9.45	$/HR	114,800	.21	1.138	1.330	1.066		38,900	15.55
Dish/Ring Assy	35,475	HR	9.45	$/HR	335,200	.21	1.138	1.330	1.066		113,600	45.44
Pedestal Assy	8,000	HR	9.45	$/HR	75,600	.21	1.138	1.330	1.066		25,600	10.25
Stores and Handling	12,000	HR	9.45	$/HR	113,400	.21	1.138	1.330	1.066		38,400	15.37
Final Assy	31,000	HR	9.45	$/HR	293,000	.21	1.138	1.330	1.066		99,250	39.70

NOTES: 1. Labor hours are 1st unit hours.
2. Learning curve factor is the average unit hours related to the first unit.

PAGE TOTAL $442,900 $177.17

CBS TOTAL $3,772,650 $1,509.06

PRODUCTION 2500 HELIOSTATS

CBS NO. 4452 TITLE PROTECTIVE ENCLOSURE ELEMENT MATERIAL, TOOLING AND LABOR

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Residual Value		
MATERIAL												
Weatherized Polyester	1,726,000	FT^2	0.35	$/FT^2	604,100						604,100	241.64
TOOLING												
Tooling - On Site - Fab	10,000	HR	25.00	$/HR	250,000					200,000	50,000	20.00
Tool Mtl	10,000	HR	4.00	$/HR	40,000					20,000	20,000	8.00
TOOLING SUBTOTAL											(70,000)	(28.00)
ON SITE MFG												
Enclosure	23,550	HR	9.45	$/HR	222,500	.21	1.138	1.330	1.066		75,400	30.15
Store & Handling	9,500	HR	9.45	$/HR	89,800	.21	1.138	1.330	1.066		30,400	12.17
Final Assy	12,500	HR	9.45	$/HR	118,100	.21	1.138	1.330	1.066		40,000	16.00
LABOR SUBTOTAL											(145,800)	(58.32)

NOTES:

PAGE TOTAL

CBS TOTAL $819,900 $327.96

PRODUCTION 2500 HELIOSTATS

CBS NO. 4460 TITLE FIELD ASSY AND CHECKOUT ELEMENT LABOR AND EQUIPMENT

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Residual Value		
Site Installation	115,000	HR	11.45	$/HR	1,316,800	.21	1.114	1.278	1.058		375,800	150.32
Checkout	4,000	HR	11.45	$/HR	45,800	.21	1.114	1.278	1.058		13,100	5.24
LABOR SUBTOTAL											(388,900)	(155.56)
EQUIPMENT												
Tooling - Fab	6,000	HR	25.00	$/HR	150,000					100,000	50,000	20.00
Equip - Buy	2	SETS	40,000	$	80,000					50,000	30,000	12.00
1 Tool Mtl	6,000	HR	4.00	$/HR	24,000					15,000	9,000	3.60
											(87,000)	(34.80)

NOTES: 1. Tool material is based on tool fab. hours.

PAGE TOTAL

CBS TOTAL $477,900 $191.16

PRODUCTION 2500 HELIOSTATE

CBS NO. 4470 TITLE DESIGN AND ENGINEERING ELEMENT LABOR

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
FACTORY LIAISON	5,000	HR	25.00	$/HR	125,000		I N C L U D E D				125,000	50.00
FIELD LIAISON	5,000	HR	25.00	$/HR	125,000		I N C L U D E D				125,000	50.00

NOTES:

PAGE TOTAL

CBS TOTAL $250,000 $100.00

PRODUCTION 2500 HELIOSTATS

CBS NO. 4471 TITLE PROGRAM MANAGEMENT ELEMENT LABOR & TRAVEL

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Program Manager	2,750	HR										
Program Control Supervisor	2,750	HR										
Engineer	2,000	HR										
Secretary	2,750	HR										
SUBTOTAL	10,250	HR	40.00	$/HR	410,000			I N C L U D E D			410,000	164.00
Travel	24	Man-Trips	260.00	$/Trip	6,240			1.428			8,900	3.56
Per Diem	120	Man-Days	54.00	$/Day	6,480			1.428			9,200	3.68

NOTES: This CTG added to collect program management cost.

PAGE TOTAL

CBS TOTAL $428,100 $171.24

PRODUCTION [illegible]

CBS NO. 4810 TITLE TEMPORARY FACILITIES, EQUIP, ETC. ELEMENT FACILITY AND EQUIPMENT

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						[illegible]	G & A	Overhead	[illegible]	[illegible]		
Assembly Bldg					3,000,000					[illegible]	[illegible]	[illegible]
Site Preparation, etc.					300,000					-	[illegible]	[illegible]
A & E					150,000					-	150,000	[illegible]
Vehicles	3	EA			30,000					15,000	15,000	6.00
Fork Lifts	3	EA			24,000					15,000	9,000	[illegible]

NOTES:

PAGE TOTAL

CBS TOTAL $1,474,000 $589.60

PRODUCTION 2500 HELIOSTATS

CBS NO. 4850 TITLE PLANT STARTUP AND CHECKOUT ELEMENT LABOR

Item	Qty.	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorata Years		
	1					2						
Alignment and Scan	7,500	HR	13.45	$/HR	100,900	.21	1.097	1.241	1.052		30,300	12.13
Collector Subsystem Power Up and Demonstrate	7,500	HR	13.45	$/HR	100,900	.21	1.097	1.241	1.052		30,300	12.13

NOTES: 1. Total hours based on first unit.
2. Average value of 2500 units on 85% learning curve.

PAGE TOTAL

CBS TOTAL $60,600 24.26

APPENDIX C

DETAILED COST ESTIMATES

FOR

PRODUCING 25,000 HELIOSTATS PER YEAR

WITH

INSTALLATION AT WIDELY DISPERSED SITES

This appendix contains detail cost estimating worksheets. These data are summarized in Section 5.3 of D277-10105-3, Volume III, Cost Estimates.

These data define cost for producing heliostats at a rate of 25,000 per year with assembly and installation plus 30 year maintenance at widely dispersed locations in the Southwestern United States. The differences between these data and the data in Appendix A are discussed in Section 5.3 of D277-10105-3, Volume III, Cost Estimates.

PRODUCTION RATE 85,000 PER YEAR

CBS NO. 4410 TITLE [illegible] ELEMENT MATERIAL, TOOLING

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS: Learning Curve	G & A	Overhead	Quality Control	Program Years	Total	Total per Helicostat
1.	Material Subtotal											(15,304,500)	(616.18)
	Tooling												
	Tooling - off site	3480	Hr	85.00	$/Hr.	87,000					20	2999	.11
	Tooling Mtl - off site	3480	Hr	4.00	$/Hr.	13,920					20	464	.32
2.	Tooling - on site Buy					65,000						84,409	.90
2.	Tooling - on site Fab	15,647	Hr	85.00	$/Hr.	391,175						146,560	5.86
2.	Tool Mtl - on site Fab	15,647	Hr	4.00	$/Hr.	62,588						23,459	.94
	TOOLING SUBTOTAL											(197,774)	(7.91)

NOTES: 1. All details identical to Appendix A.

2. Two sets of assembly tools are moved to new sites on alternate years at a cost of 1/3 of producing new tools.
Calculation = [(subtotal)(2) + (subtotal)(1/3)(28)] [1/30] = Total per year

PAGE TOTAL 15,502,300 620.09

CBS TOTAL

PRODUCTION RATE 25,000 per Year

CBS NO. 4410 TITLE Reflective Unit ELEMENT Manufecturing Labor

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Contrl	Prorate Years		
1	Off Site Subtotal											(453,300)	(18.13)
	On Site Mfg												
2	Reflector Assy	40,000	Hr	9.45	$/Hr	378,000	.917	1.138	1.330	1.066		559,260	22.37
2	Store & Handling	12,000	Hr	9.45	$/Hr	113,400	.917	1.138	1.330	1.066		167,780	6.71
2	Final Assy	25,000	Hr	9.45	$/Hr	236,250	.917	1.138	1.330	1.066		349,550	13.98
	On Site Subtotal											(1,076,590)	(43.06)

NOTES:
1. All details identical to Appendix A.
2. Learning curve factor (.917) assumes 1/2 of Appendix A factor (.834) due to new crews when assy sites are dispersed rather than continuous assy at one site.

PAGE TOTAL 1,529,890 61.19

CBS TOTAL 17,032,190 681.28

PRODUCTION RATE 25,000 per Year

CBS NO. 4420 TITLE Drive Unit ELEMENT Material and Labor

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1	Material Subtotal											(11,400,000)	(456.00)
	Store and Handling	2000	Hr	9.45	$/Hr	18,900	.917	1.138	1.330	1.066		27,960	1.12
	Final Assy	15,000	Hr	9.45	$/Hr	141,750	.917	1.138	1.330	1.066		209,740	8.39
	Labor Subtotal											(237,700)	(9.51)

NOTES:
1. Purchased equipment identical to Appendix A.
2. Learning Curve factor (.917) assumes 1/2 of Appendix A factor (.834) due to new crews when assy sites are dispersed rather than continuous assy at one site.

PAGE TOTAL

CBS TOTAL 11,637,700 465.51

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4439 TITLE CONTROL & INSTRUMENTATION ELEMENT MATERIAL & LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1.	MATERIAL SUBTOTAL											(7,587,000)	(303.48)
	FINAL ASSY LABOR	2000	Hr	9.45	$/Hr	18,900	.917	1.138	1.330	1.066		(27,930)	(1.12)

NOTES: 1. Purchased equipment identical to Appendix A.

2. Learning curve factor (.917) assumes 1/2 of Appendix A factor (.834) due to new crews when assy sites are dispersed rather than continuous assy at one site.

PAGE TOTAL

CBS TOTAL 7,614,930 304.60

PRODUCTION RATE 25,000 per Year

CBS NO. 1440 TITLE FOUNDATION AND SITE ELEMENT MATERIAL

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1.	Foundation-Piling Concrete	25,000	Ea.	352.00	$/ea							8,800,000	352.00

NOTES: 1. Time payment greater than Appendix A due to moving equipment to new sites yearly

PAGE TOTAL

CBS TOTAL 8,800,000 352.00

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4451 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MATERIAL & TOOLING

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
	MATERIAL												
1.	Total from Appendix A											23,662,650	946.51
3.	Add Dish Transportation	25,000	EA	10.00	$/EA	250,000						250,000	10.00
	MATERIAL SUBTOTAL											23,912,650	(956.51)
	Tooling - off site	3480	Hr	25.00	$/Hr	87,000		included			30	2300	.11
	Tooling mtl - off site	3480	Hr	4.00	$/Hr	13,920					30	464	.02
	Tooling - off site - Buy	1	EA	1,870,000	$	1,870,000					30	62,333	2.49
2.	Tooling - on site Fab	55,994	Hr	25.00		1,399,850					30	524,482	20.98
2.	Tool mtl - on site Fab	55,994	Hr	4.00		223,976					30	83,920	3.36
	TOOLING SUBTOTAL											(674,100)	(26.96)
	FACILITY - off site												
	ELEC for Dish Fab	25,000	FT^2	50	$/$FT^2$	1,250,000					30	41,650	1.67

NOTES:
1. All details identical to Appendix A
2. Two sets of assy tooling are moved to new sites on alternate years at a cost of 1/3 of producing new tools.
   Calculation = [(subtotal)(2) + (subtotal)(1/3)(28)] [1/30] = Total per year
3. 48 Dishes per flatcar @ 350 miles ($460 per flatcar)

PAGE TOTAL 24,628,400 985.14

CBS TOTAL

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4491 TITLE HELIOSTAT SUPPORT STRUCTURE ELEMENT MANUFACTURING LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
	OFF-SITE LABOR												
1.	Total from Appendix A	57,131	Hr	25.00	$/Hr	1,428,270	.834	Included				1,191,180	47.65
2.	Dish Fabrication	16,000	Hr	9.45	$/Hr	151,200	.834	1.138	1.330	1.066		203,455	8.14
	Dish - cut in two pieces	2000	Hr	25.00	$/Hr	50,000	.834	1.138	1.330	1.066		67,330	2.69
	Dish - handling for transport	1000	Hr	25.00	$/Hr	25,000	.834	1.138	1.330	1.066		33,650	1.35
	OFF-SITE LABOR SUBTOTAL											(1,495,620)	(59.83)
	ON-SITE LABOR												
3.	Total from Appendix A	120,000	Hr	9.45	$/Hr	1,134,000	.917	1.138	1.330	1.066		1,677,800	67.11
	Less Dish Fab	-16,000	Hr	9.45	$/Hr	-151,200	.834	1.138	1.330	1.066		-203,455	-8.14
	Add weld Dish halves	2000	Hr	9.45	$/Hr	18,900	.917	1.138	1.330	1.066		27,960	1.12
	Add Dish handling	1000	Hr	9.45	$/Hr	9450	.917	1.138	1.330	1.066		13,980	.56
	ON-SITE LABOR SUBTOTAL											(1,516,285)	(60.65)

NOTES:
1. All details identical to Appendix A
2. The off site dish fabrication is at the lower labor rate because the capital investment in heating and building is costed separately rather than included in overhead.
3. Identical to Appendix A except learning curve factor increased due to new crews when assy sites are dispersed rather than continuous assy at one site.

PAGE TOTAL (3,011,685) 120.48

CBS TOTAL (27,598,635) (1105.62)

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4452 TITLE HELIOSTAT PROTECTIVE ENCLOSURE ELEMENT MATERIAL, TOOLING, & LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
	MATERIAL												
1.	Weatherized Polyester	16,439,400	FT^2	.330	$/FT^2	5,425,000						5,425,000	217.00
2.	Packaging Boxes	500	EA	400	$/EA	200,000						200,000	8.00
	Transportation	25,000	EA	20.00	$/EA	500,000						500,000	20.00
	MATERIAL SUBTOTAL											(6,125,000)	(245.00)
	TOOLING												
	Tooling - off site Fab	9630	Hr	25.00		240,750		Included			30	8,025	.32
	Tool mtl - off site	9630	Hr	4.00		38,520					30	1,284	.05
	TOOLING SUBTOTAL											(9,309)	(.37)
	FACILITY												
	Bldg for thermoform	20,000	FT^2	50	$/FT^2	1,000,000					30	(33,300)	(1.33)
3.	OFF-SITE LABOR	22,000	Hr	9.45	$/Hr	207,900	.834	1.138	1.330	1.066		270,750	11.19
4.	ON-SITE LABOR												
	Store & Handling	14,000	Hr	9.45	$/Hr	132,300	.917	1.138	1.330	1.066		195,700	7.83
	Final Assy	20,000	Hr	9.45	$/Hr	189,000	.917	1.138	1.330	1.066		279,600	11.19
	LABOR SUBTOTAL											(755,050)	(30.21)

NOTES:
1. Identical to Appendix A
2. Dimensions 2.5 ft x 3 ft x 36 ft; $400/Box; Use 50 times = 500 Boxes/year
3. 16,000 hours thermoform plus 6,000 hr packaging & handling. Use lower overhead because tooling and facility is estimated separately.
4. Same as Appendix A except add 2000 hr (1 man) for handling shipping boxes and change learning curve factor to .917 because of new crews at dispersed sites.

PAGE TOTAL

CBS TOTAL 6,922,659 276.91

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4460 TITLE FIELD ASSY & CHECKOUT ELEMENT LABOR & EQUIPMENT

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1.	Site Installation	120,000	Hr	11.45	$/Hr	1,374,000	.917	1.114	1.278	1.058		1,897,830	75.91
1.	Checkout	4250	Hr	11.45	$/Hr	48,660	.917	1.114	1.278	1.058		67,200	2.69
	LABOR SUBTOTAL											(1,965,030)	(78.60)
	TOOLING												
2.	Tooling - Fab	24,000	Hr	25.00	$/Hr	600,000		Included			30	20,000	.80
2.	Tooling - Buy	12	Sets	35,000	$/Set	420,000					30	14,000	.56
2.	Tool Material	24,000	Hr	4.00	$/Hr	96,000					30	3200	.13
	TOOLING SUBTOTAL											(37,200)	(1.49)

NOTES:
1. Same as Appendix A except change Learning Curve Factor to .917 because of more crews at dispersed sites.
2. Build and Purchase 12 sets (instead of 6 as in Appendix A) to accommodate potential overlap of time between site installations.

PAGE TOTAL

CBS TOTAL 2,002,230 80.09

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 1470 TITLE DESIGN AND ENGINEERING ELEMENT LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1.	FACTORY LIAISON	8000	Hr	25.00	$/Hr	200,000						200,000	8.00
2.	FIELD LIAISON	4000	Hr	25.00	$/Hr	100,000						100,000	4.00

NOTES:
1. Four times Appendix A because of starting new assy plant each year
2. Two times Appendix A because of new crews at dispersed sites.

PAGE TOTAL

CBS TOTAL 300,000 12.00

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 4810 TITLE TEMPORARY FACILITIES, EQUIPMENT, ETC. ELEMENT TOOLING

	Item	Qty. per 30 years	Units	First Unit Cost	Units	Sub-Total	FACTORS Learning Curve	G & A	Overhead	Residual Value Factor	Prorate Years	Total	Total per Heliostat
1.	Assembly Buildings	30	EA	6,900,000	$/EA	207,000,000	.90			.25	30	1,552,500	62.10
	Site Prep, etc	30	EA	1,300,000	$/EA	39,000,000	.90			.25	30	292,500	11.70
	A&E	30	EA	630,000	$/EA	18,900,000	.30			--	30	199,000	7.56
2.	Paint & Sandblast facility	1	EA	1,000,000	$/EA	1,000,000	--			--	30	377,750	15.11
2.	Automated handling equipment	1	EA	500,000	$/EA	1,000,000	--			--	30	188,875	7.56
	Vehicles	8	EA	10,000	$/EA	80,000	--				30/5	480,000	19.20
	Forklifts	4	EA	8000	$/EA	32,000	--				30/15	64,000	2.56

NOTES: 1. 160,000 sq. ft; 40,000 sq. ft retained for maintenance, 120,000 sq. ft sold or leased for 29 years.

2. Two sets of facility are built and then moved to new sites on alternate years at a cost of 1/3 of building new facilities.
Calculation = [(subtotal)(2) + (subtotal)(1/3)(28)][1/30]

PAGE TOTAL

CBS TOTAL 2,955,625 125.79

PRODUCTION RATE 25,000 PER YEAR

CBS NO. L850 TITLE PLANT STARTUP AND CHECKOUT ELEMENT LABOR

	Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
							Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
1.	Alignment & OCAM	6384	Hr	13.45	$/Hr	85,865	.917	1.097	1.241	1.052		112,770	4.51
1.	Collector Subsystem Power up & Demonstrate	4256	Hr	13.45	$/Hr	57,245	.917	1.097	1.241	1.052		75,180	3.01

NOTES: 1. Same as Appendix A except change learning curve factor to .917 due to new crews at dispersed sites.

PAGE TOTAL

CBS TOTAL 187,950 7.52

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 0[illegible]2.0 TITLE SPARE PARTS - INVENTORY ELEMENT MATERIAL

Item	Qty. over 30 years	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		

NOTES: 1. All items same as Appendix A except inventory twice as many spare parts due to the sites being dispersed.

PAGE TOTAL

CBS TOTAL 486,175 19.45

PRODUCTION RATE 25,000 PER YEAR

C3S NO. C3 220 TITLE MATERIALS FOR REPAIRS ELEMENT MATERIAL

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		

NOTES: Twice Appendix A due to inventory for dispersed sites.

PAGE TOTAL

CBS TOTAL 1200.00 .04

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 08 230 TITLE MAINTENANCE MATERIALS - OTHER ELEMENT SPECIAL EQUIPMENT

Item	Qty. per yea-	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Heliostat Washer	1	EA	162,000	$/EA	162,000						162,000	6.48
Sprinkler System	1	EA	3,500,000	$/EA	3,500,000						3,500,000	140.00
Dome Replacement Machine	2	EA	211,000	$/EA	422,000						422,000	16.88
Maintenance Van	2	EA	34,500	$/EA	69,000						69,000	2.76

NOTES:

PAGE TOTAL

CBS TOTAL 4,153,000 166.12

PRODUCTION RATE 25,000 PER YEAR

CBS NO. 04 231 TITLE MAINTENANCE MATERIALS - OTHER ELEMENT MATERIAL

Item	Qty. per 30 years	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		

NOTES: 1. All details identical to Appendix A

PAGE TOTAL

CBS TOTAL 7,154,890 286.21

PRODUCTION RATE 25,000 PER YEAR

CBS NO. C: 310 TITLE SCHEDULED MAINTENANCE ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		
Enclosure Replacement	70,500	Hr	11.45	$/Hr	807,225	.917	1.114	1.278	1.058	12.13	743,700	29.75
Enclosure Washing	179,730	Hr	11.45	$/Hr	2,057,909	.917	1.114	1.278	1.058		2,842,400	113.70
Prefilter Replacement	21,000	Hr	11.45	$/Hr	240,450	.917	1.114	1.278	1.058		332,160	13.29
Alignment Checks	24,960	Hr	11.45	$/Hr	285,800	.917	1.114	1.278	1.058		394,740	15.79

NOTES:

1. Same as Appendix A except change learning curve factor to .917 due to new crews at dispersed sites.

PAGE TOTAL

CBS TOTAL 4,313,000 172.53

PRODUCTION RATE 25,000 PER YEAR

CBS NO. CM 320 TITLE CORRECTIVE MAINTENANCE ELEMENT LABOR

Item	Qty. per year	Units	Unit Cost	Units	Sub-Total	FACTORS					Total	Total per Heliostat
						Learning Curve	G & A	Overhead	Quality Control	Prorate Years		

NOTES: Same as Appendix A except all labor doubled due to staffing at each dispersed site.

PAGE TOTAL

CBS TOTAL 4,574,200 182.96

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