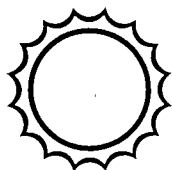


1182

1.3.1



Sandia Laboratories  
Solar Energy



San Francisco  
Operations  
Office

## SOLAR THERMAL POWER

**Large  
Power  
Systems  
Applications**

**STATUS LETTER FOR  
SEPTEMBER 1979**

C. W. MOORE, EDITOR  
LARGE POWER SYSTEMS DIVISION  
SANDIA LABORATORIES, LIVERMORE

*Robert W. Hughey*

ROBERT W. HUGHEY, DIRECTOR  
SOLAR ENERGY DIVISION  
SAN FRANCISCO OPERATIONS

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## PROGRAM ELEMENT SUMMARY

### LARGE POWER SYSTEMS APPLICATIONS

This report, issued monthly, covers the portion of the Solar Thermal Power Systems Program which is directed toward large-scale systems applications -- primarily Central Receiver system applications to electrical power generation at 10 MWe and above, but also with consideration of direct, high temperature thermal applications and of alternative collector configurations. The Central Receiver concept employs a field of individually guided mirrors called heliostats that redirect the sun's energy to a receiver mounted on top of a tower. In the receiver, the radiant solar energy is absorbed in a circulating fluid and is then transported to an electrical power generation subsystem or to an industrial thermal process; excess thermal energy may be stored for later use, if operationally desirable and economically justifiable. Alternative systems for large-scale energy collection, such as linear central receivers with single-axis heliostats and individual, distributed collectors in manifolded arrays, are also under study.

Responsibility for managing the development and assessment of large solar thermal power systems for various applications has been delegated by DOE Headquarters to the San Francisco Operations Office. Technical management is drawn from Sandia Laboratories, Livermore, the Aerospace Corporation, and other public and private organizations. The Large Power Systems Applications program element is organized according to a work breakdown structure which includes: Overall planning and coordination activities; storage-coupled systems; utility repowering/industrial retrofit systems; solar/non-solar hybrid systems; and programmatic support to the 10-MWe Solar Thermal Pilot Plant construction project.

## HIGHLIGHTS

### Major Accomplishments

- Solar Central Receiver Semiannual review was held (page 3).
- Midprogram review of SRI mesoscale weather study was held (page 3).
- Energy Foundation of Texas awarded follow-on optimization study (page 3).
- The three Line Focus System Studies received final reviews (page 4).
- The Repowering/Industrial Retrofit Systems contracts have been negotiated (page 4).
- Bechtel, Foster-Wheeler, and Dynatherm to study heat pipes for gas receivers (page 5).

## MAJOR ACCOMPLISHMENTS

### Semi Annual Review Meeting (WBS 01.01.01)

The Solar Central Receiver Semiannual review meeting was held in Williamsburg, Virginia on September 11 and 12, 1979. There was a total of 173 people in attendance with the following representation:

Contractor/Supplier	122
Utility	12
Sandia Labs	14
University	6
Foreign	3
DOE	8
Other Federal Agencies	8

### SRI Mesoscale Weather Program Reviewed (WBS 01.01.02)

On September 5, a mid-program review of the SRI mesoscale weather study was held at Sandia Livermore. Chandrakant Bhumralkar and Art Slemmons presented the SRI work. In attendance were Doug Elliott (DOE/SAN), Robert Lindberg (LNMRB/UCLA), Jim Hunig (JPL), and a number of Sandia personnel.

Results of preliminary runs for June conditions at Barstow with and without the solar plant were reported. Qualitatively the model responds in a physically consistent manner. Quantitative confidence in the model's predictions requires further sensitivity testing and additional scenario runs.

The project duration has been extended to December 31, 1979. This no-cost extension should allow sufficient time to complete the project in a thorough fashion.

### Energy Foundation of Texas Optimization Study (WBS 01.01.02)

EFT (a consortium of the University of Houston and Texas Tech University) was awarded a contract by SAN to continue the development and dissemination of heliostat field optimization codes. During FY 80, the University of Houston team will: update and generate a Users' Guide for the N-S cellwise Performance code; provide Programers' and Users' Guides and a background

Theory Manual for the RC Optimization Code; develop and archive the Individual Heliostat (IH) Code, which will be capable of treating novel and unusual heliostat configurations, and provide a general description of the code for potential users; and continue general code development, archiving and dissemination activities in support of the Central Receiver Program.

Line Focus 100 MW Conceptual Designs  
(WBS 01.02.04)

General Atomic - The General Atomic final review was conducted at SAN on September 14. The GA conceptual design utilizes their fixed mirror collector with a 1060°F salt receiver for an overall plant efficiency of 24% peak. The first plant cost, at 100MWe, 49% capacity factor, is estimated to be \$287 M. GA proposed a contract extension to provide for final report preparation. Detailed review of contract financial status is necessary prior to authorization of any contract extension.

SRI International - The SRI final review was held at Menlo Park on September 18. The SRI conceptual design utilizes a north field of 24 rows of linear parabolic collectors to focus energy on the tower-mounted linear salt receiver (1050°F). This configuration results in an overall plant peak efficiency of 25%. The first plant cost, at 100 MWe, 60% capacity factor, is estimated to be \$193 M, which is based on a high volume heliostat cost of \$5/ft<sup>2</sup> and the application of 95% learning curves. SRI proposes a two month extension to finish work on the final report. They are also preparing a detailed wind tunnel test proposal for their receiver design. Neither item will be acted upon until a detailed cost review of their contract financial data is completed by DOE. This accounting requires a DOE audit, which has been requested.

BDM Corporation - The BDM final review was conducted at SAN on September 28. The BDM conceptual design utilizes a tracking, 21 foot aperture, parabolic trough with an oil receiver (two fields-one at 590°F and one at 740°F). The overall peak efficiency is 19%. The first plant cost at 165 MWe peak, 38% capacity factor, is estimated to be \$188 M. BDM has been authorized a one month contract extension at a \$6 K contract cost increase to provide extra detail on the 21 foot aperture trough.

Repowering/Industrial Retrofit Systems  
(WBS 01.03.00)

As of September 25, 1979, twelve repowering/retrofit contracts have been negotiated and contractors have been given authorization to proceed. A schedule of contract kick-off meeting dates has been finalized. The first meeting is on October 11, 1979 and the final meeting date is scheduled for November 16, 1979. Effective dates of contracts are as follows:

<u>EDC</u>	<u>CONTRACTOR</u>
9/24	Black & Veatch
9/24	MDAC/Sierra Pacific

9/17	Northrup, Inc.
9/30	PFR Engineering
9/28	Martin Marietta/Exxon
9/24	MDAC/Gulf
9/24	Arizona Public Service
9/30	El Paso Electric
9/30	Boeing
9/20	Rockwell Int'l.
9/30	Foster Wheeler
9/28	General Electric

Bechtel, Foster-Wheeler, and Dynatherm Heat Pipe Receiver Study  
(WBS 01.04.02)

Previous conceptual studies and individual heat pipe experimentation by Dynatherm (with Foster Wheeler as a subcontractor) under the Advanced Thermal Technology Program identified liquid-metal (sodium and potassium) heat pipes as offering an efficient and effective method for introducing the heat from concentrated solar radiation into an air or gas stream. During their Hybrid Combined Cycle concept study, Bechtel selected the Dynatherm concept for their air-cooled 1500°F receiver. Before further design can be undertaken, however, performance and lifetime of the heat pipes must be verified. During the next nine months, two series of tests will be planned, conducted and evaluated; one test series will involve life-cycle testing a statistically-significant number (at least six) of heat pipes; the second series will involve testing of two or more heat pipes using different shell materials and/or working fluids throughout the anticipated operating range to determine performance parameters. All failures will be carefully documented and analyzed. The heat pipes will incorporate details of fabrication and configuration (diffuser finning, assembly flanges, etc.) representative of those specified for use in the conceptual receiver design. Successful results in this stage will permit consideration of a follow-on study involving an array of heat pipes in a simulated section of a receiver panel.

## MILESTONE SCHEDULE AND STATUS REPORT

ID-- LARGE POWER SYSTEMS		WBS- 1.0 SYSTEM APPLIC START 10/01/78 END 09/30/79												REPORTING PERIOD 09/01/79 THRU 09/30/79													
		FY 79 O N D J F M A M J J A S												FY 80 O N D Q2 Q3 Q4				FY 81 Q1 Q2 Q3 Q4				82	PL	AC			
01.01.00	GENERAL ACTIVITIES																										
01.01.01	---PLANNING AND AD-HOC TASKS																									20	20
01.01.02	---UNSOLICITED PROPOSALS																									20	20
01.02.00	STORAGE COUPLED SYSTEMS																										
01.02.01	---SYSTEMS ANALYSIS/PLANNING																									33	33
01.02.02	---RECEIVER TESTING																									100	100
01.02.03	---ALT CENTRAL RECEIVER SYSTEM																									33	33
01.02.04	---LINE FOCUS SYSTEM STUDIES																									44	44
01.03.00	REPOWERING/INDUSTRIAL RETROFIT																										
01.03.01	---SYSTEMS ANALYSIS/PLANNING																									25	25
01.03.02	---REPOWERING/RETROFIT CONCEPT																									61	61
01.03.03	---W SYN EPRI UTILITY-E STUDY																									100	100
01.04.00	HYBRID POWER SYSTEMS																										
01.04.01	---SYSTEMS ANALYSIS/PLANNING																									33	33
01.04.02	---HYBRID PWR SYSTEMS STUDIES																									46	46
01.04.03	---UTILITY COOPERATIVE PROGRAM																									20	20
01.04.04	---DOE/BU-REC HYB NETWK STUDY																									62	62
01.04.05	---W UTIL/TECH SENS ANALYSIS																									80	80
01.05.00	10MWE PILOT PLANT																										
01.05.01	---STMPO OPERATIONS																									25	25
01.05.02	---PP OPERATIONAL TESTING																									25	25

IDENT	DESCRIPTION
01.01.00.A	GENERAL ACTIVITIES
01.01.01.A	---PLANNING AND AD-HOC TASKS
01.01.01.B	B MIRVAL CODE ISSUE
01.01.01.C	C TECHNOLOGY DOCUMENT DRAFT
01.01.01.D	D UTILITY DOCUMENT DRAFT
01.01.01.E	E UTIL DOC DRAFT RESCHEDULED
01.01.01.F	F AOP/APP DRAFT
01.01.01.G	G TECHNOLOGY COMPARISON
01.01.02.A	---UNSOLICITED PROPOSALS
01.01.02.B	B START SRI MESOSCALE STUDY
01.01.02.C	C SRI STUDY COMPLETE
01.02.00.A	STORAGE COUPLED SYSTEMS
01.02.01.A	---SYSTEMS ANALYSIS/PLANNING
01.02.01.B	B TECHNOLOGY COMPARISON
01.02.01.C	C TECHNOLOGY COMPARISON
01.02.02.A	---RECEIVER TESTING
01.02.02.B	B ROEING TEST START
01.02.02.C	C ROEING TEST COMPLETE
01.02.03.A	---ALT CENTRAL RECEIVER SYSTEM
01.02.03.B	B SELECT PHASE 2 CONTRACTORS
01.02.03.C	C START PHASE 2 ACTIVITIES
01.02.03.D	D PHASE 2 STATUS REVIEW
01.02.03.E	E DECISION TO CONT PHASE 3
01.02.03.F	F PHASE 2 COMPLETE
01.02.04.A	---LINE FOCUS SYSTEM STUDIES
01.02.04.B	B START PHASE 1 ACTIVITIES
01.02.04.C	C DECISION TO CANCEL PHASE 2
01.02.04.D	D PHASE 1 COMPLETE
01.03.00.A	REPOWERING/INDUSTRIAL RETROFIT
01.03.01.A	---SYSTEMS ANALYSIS/PLANNING
01.03.01.B	B SRI STRATEGY ANALYSIS COMP
01.03.01.C	C TECHNOLOGY COMPARISON
01.03.01.D	D TECHNOLOGY COMPARISON
01.03.02.A	---REPOWERING/RETROFIT CONCEPT
01.03.02.B	B PNM STUDY COMPLETE
01.03.02.C	C RELEASE CONCEPT STUDY REP
01.03.02.D	D START CONCEPT STUDIES
01.03.02.E	E CONCEPT STUDIES COMPLETE
01.03.03.A	---W SYN EPRI UTILITY-E STUDY
01.03.03.B	B UTILITY SELECTION
01.03.03.C	C START WORK
01.03.03.D	D STUDY COMPLETE
01.04.00.A	HYBRID POWER SYSTEMS
01.04.01.A	---SYSTEMS ANALYSIS/PLANNING
01.04.01.B	B TECHNOLOGY COMPARISON
01.04.01.C	C TECHNOLOGY COMPARISON
01.04.02.A	---HYBRID PWR SYSTEMS STUDIES
01.04.02.B	B START PHASE 1 ACTIVITIES
01.04.02.C	C DECISION TO CANCEL PHASE 2
01.04.02.D	D PHASE 1 COMPLETE
01.04.02.E	E PHASE I EVALUATION
01.04.02.F	F START PHASE IA ACTIVITIES
01.04.02.G	G PHASE IA COMPLETE
01.04.03.A	---UTILITY COOPERATIVE PROGRAM
01.04.03.B	B EPRI/W MKT SURVEY COMPLETE
01.04.03.F	F DOE/EPRI PP DECISION
01.04.04.A	---DOE/BU-REC HYB NETWK STUDY
01.04.04.B	B START NETWORK STUDY
01.04.04.C	C COMPLETE NETWORK STUDY
01.04.04.D	D STUDY COMPLETION RESCHEDULE
01.04.04.E	E FINAL REPORT
01.04.05.A	---W UTIL/TECH SENS ANALYSIS
01.04.05.B	B SCOPE OF WORK DEFINED
01.04.05.C	C START WORK
01.04.05.D	D STUDY COMPLETE
01.05.00.A	10MWE PILOT PLANT
01.05.01.A	---STMPD OPERATIONS
01.05.01.B	B START COLLECTOR CONTRACTS
01.05.01.C	C START FACILITY DESIGN
01.05.01.D	D START HELIOSTAT WORK
01.05.01.E	E TURBINE ROLL
01.05.01.F	F END ACCEPTANCE TEST
01.05.02.A	---PP OPERATIONAL TESTING
01.05.02.B	B TEST PLAN
01.05.02.C	C TEST PLAN RESCHEDULED
01.05.02.D	D TEST REQUIREMENTS
01.05.02.E	E TEST PROCEDURES
01.05.02.F	F BEGIN OPERATIONAL TESTING

OF PLOTS



## FISCAL STATUS

Obligations (B/A): The SAN Financial Plan for September remained unchanged at \$7,810K in operating funding and \$1,650K in PE&D funding obligation authority. With inclusion of the \$2,940K in operating funding transferred during the course of the year to SLL, the total FY79 obligational authority allocated to (or through) the Large Power Systems Applications Program Element stands at \$12,400K. (Of the funds transferred to SLL, \$600K are for Technology Development and \$100K for International Energy Agency project support-see SLL Central Receiver Technology Report for September; the balance is for technical support to LPSA.)

Obligations for September were \$2,775K vs. a planning figure of zero. (Obligations for August should be corrected to \$2,142K, vs. a previously-reported \$1,834K and a planned \$2,771K.) Cumulative obligations for September and the Fiscal Year are \$11,588K. The difference between this figure and that above is made up of (a) \$800K of PE&D funds carried over to FY80 for the Cogeneration preliminary design solicitation and (b) approximately \$12K for miscellaneous purchase orders and final adjustments in negotiation.

Cost Status (B/O): The SAN Financial Plan for September remained unchanged at \$11,360K in operating fund and \$1,650K in PE&D fund costing authority; the total FY79 cost authority allocated to the Large Power Systems Applications Program Element thus stands at \$13,010K.

Current status for SLL (LPSA) through September 31, 1979 is \$2,090K BA authorized. Year to date costs are \$2,062K.

# OVERALL LPSA OBLIGATION STATUS

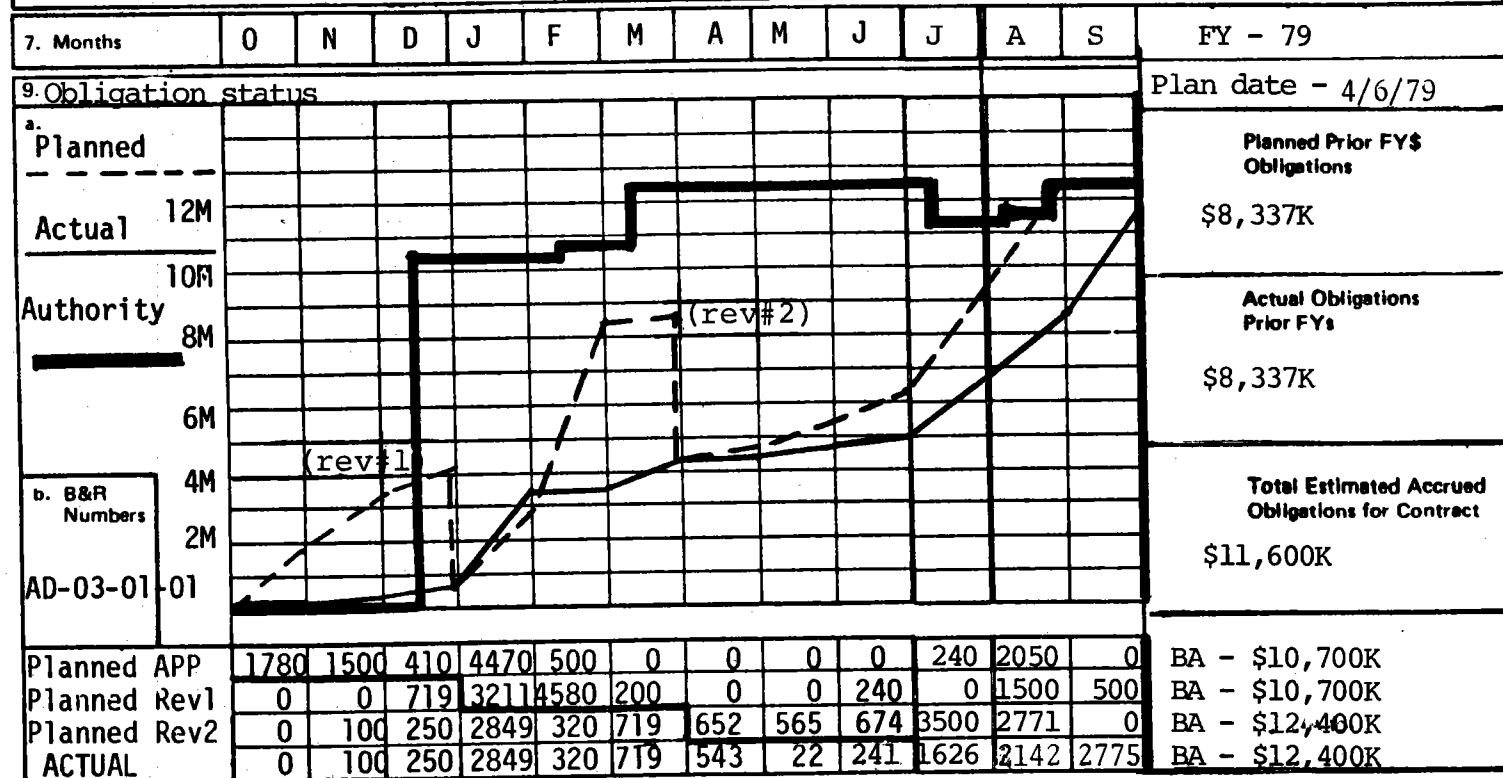
U.S. DEPARTMENT OF ENERGY

FORM DOE 536  
(1/78)

## CONTRACT MANAGEMENT SUMMARY REPORT

FORM APPROVED  
OMB NO. 38R-0190

<b>1. Contract Identification</b> LARGE POWER SYSTEMS APPLICATIONS (WBS 1.0)	<b>2. Reporting Period</b> 1 Sept through 30 Sept	<b>3. Contract Number</b> AD-03-01-01
<b>4. Contractor (Name and Address)</b> SAN FRANCISCO OPERATIONS OFFICE		<b>5. Contract Start Date</b> N/A
		<b>6. Contract Completion Date</b> N/A



NOTE: Revision #2 to the LPSA FY 79 Annual Procurement Plan, submitted to HQ April 13, was approved on June 22, and serves as the basis for this and following Obligation Status Reports. Each APP revision shows actual obligations below and to left of the heavy line on the data block, and planned obligations above and to the right. Differences between Rev. #1 and Rev. #2 actual obligations reflect a change to the actual date of contract execution vs. the date of reservation of funds for a given contract action.

# SAN COST STATUS

U.S. DEPARTMENT OF ENERGY

FORM DOE 536  
(1/78)

## CONTRACT MANAGEMENT SUMMARY REPORT

FORM APPROVED  
OMB NO. 38R-0190

1. Contract Identification LARGE POWER SYSTEMS APPLICATIONS (WBS-1.0)										2. Reporting Period 1 Sep through 30 Sep					3. Contract Number N/A				
4. Contractor (Name and Address) SAN FRANCISCO OPERATIONS OFFICE															5. Contract Start Date N/A				
															6. Contract Completion Date N/A				
7. Months		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	8. FY 79		
9. Cost Status Dollars in Thousands																			
a. Planned																			
b. B&R Numbers AD - 03 01 - 01																			
g. Cost Plan Date		24 Jan. 79																	
h. Planned Costs Prior FYs		4,345 K																	
i. Actual Costs Prior FYs		2,650 K																	
j. Total Estimated Costs for Contract		N/A																	
k. Total Contract Value		N/A																	
l. Unfilled Orders Outstanding		N/A																	
m. Estimate for Subsequent Reporting Period		N/A																	
Accrued Costs		c. Planned	364	508	544	575	550	555	658	686	694	656	786	4070					
		d. Actual	230	697	550	548	618	448	811	332	434	348	758						
		e. Variance	134	(189)	(6)	27	(68)	107	(153)	354	260	308	26						
		f. Cum. Variance	134	(55)	(61)	(34)	(102)	5	(148)	206	466	774	800						

NOTE: Costing authority is total for Large Power Systems Applications program element. Cost Plan does not include the \$2,240K transferred to SLL for LPST Technical Management/Support (see next chart), or \$700K transferred to SLL for Technology Development or International (IEA) Program Support (see Sept. Central Receiver Technology Report). Actual cost figures for the month of September were not available at the time of printing of this report due to a computer malfunction.

## CONTRACT MANAGEMENT SUMMARY REPORT

FORM APPROVED  
OMB NO. 38R-0190

1. Contract Identification <b>SOLAR LARGE POWER SYSTEMS APPLICATIONS</b>													2. Reporting Period <b>1 Sept</b> through <b>30 Sept</b>				3. Contract Number <b>AD 03 01 837</b>					
4. Contractor (Name and Address) <b>SANDIA LABORATORIES, LIVERMORE, CALIF.</b>																	5. Contract Start Date <b>FY-75</b>					
																	6. Contract Completion Date <b>N/A</b>					
7. Months		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	8. FY 79					
9. Cost Status		Dollars in Thousands															g. Cost Plan Date <b>1 Oct 78</b>					
a.																	h. Planned Costs Prior FYs <b>6,753K</b>					
																	i. Actual Costs Prior FYs <b>6,695K</b>					
																	j. Total Estimated Costs for Contract <b>N/A</b>					
b. B&R Numbers <b>AD 03 01</b>																	k. Total Contract Value <b>N/A</b>					
																	l. Unfilled Orders Outstanding <b>N/A</b>					
Accrued Costs		c. Planned	160	160	150	150	160	150	150	140	200	207	145	188					m. Estimate for Subsequent Reporting Period <b>N/A</b>			
		d. Actual	158	123	202	110	231	205	222	223	193	177	129	80								
		e. Variance	2	37	(52)	40	(71)	(55)	(72)	(83)	7	30	(16)	108								
		f. Cum. Variance	2	39	(13)	27	(44)	(99)	(171)	(254)	(247)	(217)	(201)	(93)								

**Comments:**

There was \$93K more in costs than predicted for FY79, however, this did not exceed the allocated BA.

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