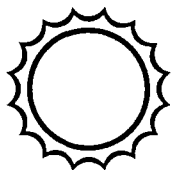


1180



Sandia Laboratories  
Solar Energy



San Francisco  
Operations  
Office

# SOLAR THERMAL POWER

**Large  
Power  
Systems  
Applications**

**STATUS LETTER FOR  
JUNE 1979**

J.D. FISH, EDITOR  
LARGE POWER SYSTEMS DIVISION  
SANDIA LABORATORIES, LIVERMORE

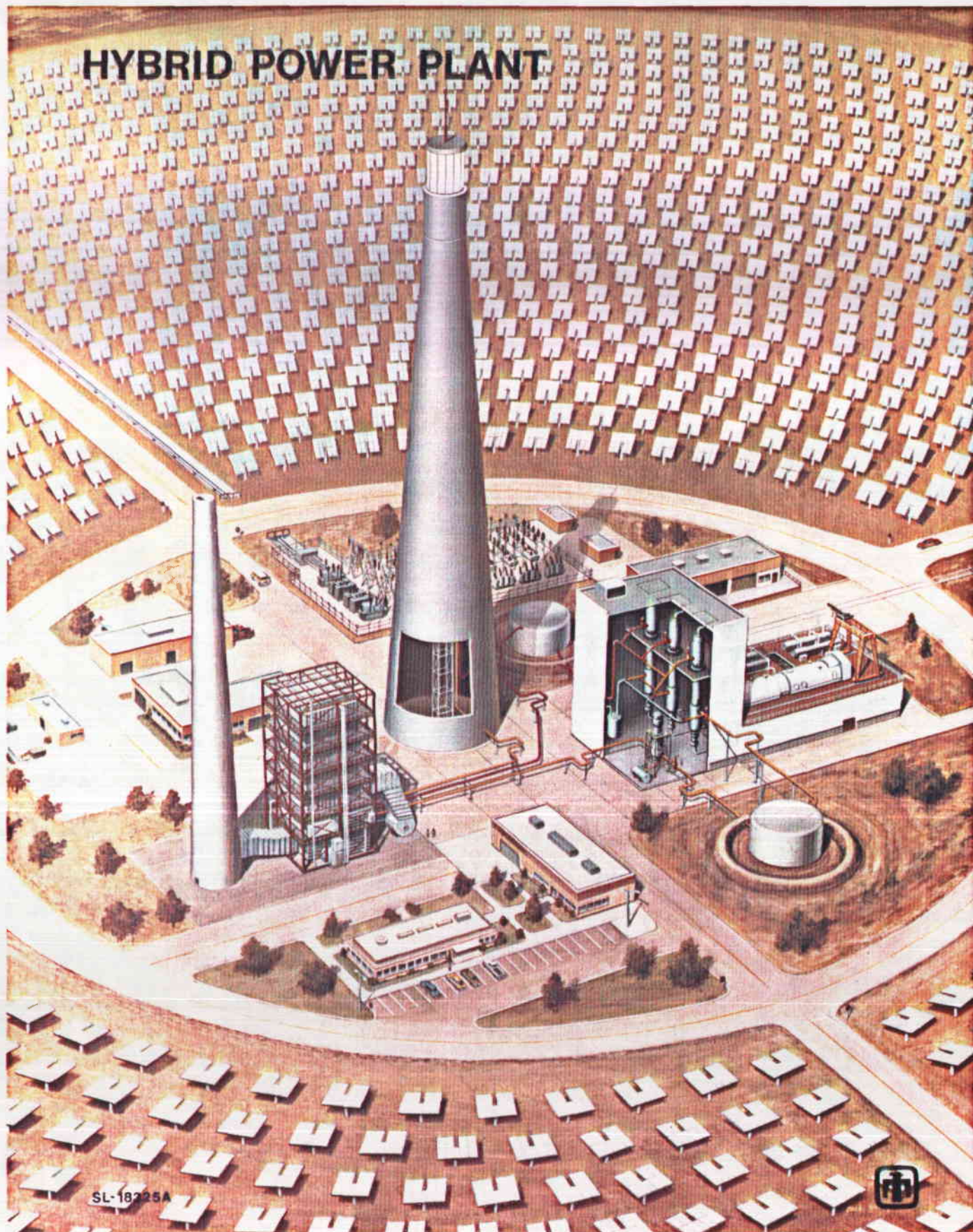
ROBERT W. HUGHEY, DIRECTOR  
SOLAR ENERGY DIVISION  
SAN FRANCISCO OPERATIONS

The Photograph --

Artist's concept of a Solar Central Receiver Hybrid Power System

A Solar Central Receiver Hybrid Power System is a system for electrical power generation consisting of a solar Central Receiver energy source and a non-solar energy source at a single, common site, operated such that the output is essentially independent of variations in insolation.

# HYBRID POWER PLANT



SL-18225A





## PROGRAM ELEMENT SUMMARY

### LARGE POWER SYSTEMS APPLICATIONS

This report, issued monthly, covers the portion of the Solar Thermal Power Systems 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

- Initial review of Solar Repowering/Industrial Retrofit Systems proposals complete, and competitive-range Offerors' "best & finals" under review; selection due in July (see page )
- The Westinghouse utility technology sensitivity analysis originally scheduled to start May 1, was initiated under an advance agreement at the end of June. (see page )
- Mid-project reviews for the three solar fossil hybrid contractors were held in June. (see page )
- A rough draft of the first year's testing plan has been sent to STMPO for review. (see page )



IDENT	DESCRIPTION	-----DATES-----			
		START	PROGRESS	PLAN COMP	ACT COMP
01.01.00.A	GENERAL ACTIVITIES				
01.01.01.A	---PLANNING AND AD-HOC TASKS	10/01/78	06/30/79	09/30/83	
01.01.01.B	3 MIRVAL CODE ISSUE			12/15/78	03/10/79
01.01.01.C	3 TECHNOLOGY DOCUMENT DRAFT			03/15/79	03/15/79
01.01.01.D	3 UTILITY DOCUMENT DRAFT			04/10/79	
01.01.01.E	3 AOP/APP DRAFT			07/15/79	
01.01.01.F	3 TECHNOLOGY COMPARISON			11/30/79	
01.01.01.G	3 TECHNOLOGY COMPARISON			11/30/80	
01.01.02.A	---UNSOLICITED PROPOSALS	10/01/78	06/30/79	09/30/83	
01.01.02.B	3 START SRI MESOSCALE STUDY			10/01/78	10/01/78
01.01.02.C	3 SRI STUDY COMPLETE			09/29/79	
01.02.00.A	STORAGE COUPLED SYSTEMS				
01.02.01.A	---SYSTEMS ANALYSIS/PLANNING	10/01/78	06/30/79	09/30/81	
01.02.01.B	3 TECHNOLOGY COMPARISON			11/30/79	
01.02.01.C	3 TECHNOLOGY COMPARISON			11/30/80	
01.02.02.A	---RECEIVER TESTING	10/01/78	02/01/79	02/01/79	02/01/79
01.02.02.B	3 ROEING TEST START			10/16/78	10/16/78
01.02.02.C	3 ROEING TEST COMPLETE		02/01/79	02/01/79	02/01/79
01.02.03.A	---ALT CENTRAL RECEIVER SYSTEM	10/01/78	06/30/79	09/30/81	
01.02.03.B	3 SELECT PHASE 2 CONTRACTORS			02/01/79	02/21/79
01.02.03.C	3 START PHASE 2 ACTIVITIES			03/01/79	
01.02.03.D	3 PHASE 2 STATUS REVIEW			11/01/79	04/09/79
01.02.03.E	3 PHASE 2 COMPLETE			09/30/80	
01.02.03.F	3 DECISION TO CONT PHASE 3			11/30/80	
01.02.04.A	---LINE FOCUS SYSTEM STUDIES	10/01/78	06/30/79	12/30/80	
01.02.04.B	3 START PHASE 1 ACTIVITIES			10/01/78	10/01/78
01.02.04.C	3 PHASE 1 COMPLETE			09/28/79	
01.03.00.A	REPOWERING/INDUSTRIAL RETROFIT				
01.03.01.A	---SYSTEMS ANALYSIS/PLANNING	10/01/78	06/30/79	09/30/82	
01.03.01.B	3 SRI STRATEGY ANALYSIS COMP			07/30/79	
01.03.01.C	3 TECHNOLOGY COMPARISON			11/30/79	
01.03.01.D	3 TECHNOLOGY COMPARISON			11/30/80	
01.03.02.A	---REPOWERING/RETROFIT CONCEPT	10/01/78	06/30/79	05/15/80	
01.03.02.B	3 PNM STUDY COMPLETE			10/01/78	10/01/78
01.03.02.C	3 RELEASE CONCEPT STUDY RFP			03/01/79	03/01/79
01.03.02.D	3 START CONCEPT STUDIES			08/15/79	
01.03.02.E	3 CONCEPT STUDIES COMPLETE			05/15/80	
01.03.03.A	---W SYN EPRI UTILITY-E STUDY	01/15/79	06/30/79	09/15/79	
01.03.03.B	3 START WORK			08/15/79	
01.03.03.C	3 UTILITY SELECTION			07/01/79	
01.03.03.D	3 STUDY COMPLETE			09/15/79	
01.04.00.A	HYBRID POWER SYSTEMS				
01.04.01.A	---SYSTEMS ANALYSIS/PLANNING	10/01/78	06/30/79	09/30/81	
01.04.01.B	3 TECHNOLOGY COMPARISON			11/30/79	
01.04.01.C	3 TECHNOLOGY COMPARISON			11/30/80	
01.04.02.A	---HYBRID PWR SYSTEMS STUDIES	10/01/78	06/30/79	11/30/80	
01.04.02.B	3 START PHASE 1 ACTIVITIES			10/01/78	10/01/78
01.04.02.C	3 DEVELOPMENT PLANS DUE			08/30/79	
01.04.02.D	3 PHASE 1 COMPLETE			09/28/79	
01.04.02.E	3 PHASE I EVALUATION			10/30/79	
01.04.02.F	3 START PHASE 1A ACTIVITIES			11/30/79	
01.04.02.G	3 PHASE 1A COMPLETE			09/15/80	
01.04.03.A	---UTILITY COOPERATIVE PROGRAM	10/01/78	06/30/79	09/30/83	
01.04.03.B	3 EPRI/W MGT SURVEY COMPLETE			02/28/79	02/28/79
01.04.03.C	3 DOE/EPRI PP DECISION			03/15/80	
01.04.04.A	---DOE/DO-REC HYR NETWK STUDY	12/01/78	06/30/79	04/01/80	
01.04.04.B	3 START NETWORK STUDY			01/15/79	02/09/79
01.04.04.C	3 COMPLETE NETWORK STUDY			11/30/79	
01.04.04.D	3 STUDY COMPLETION RESCHEDULE			02/01/80	
01.04.04.E	3 FINAL REPORT			04/01/80	
01.04.05.A	---W UTIL/TECH SENS ANALYSIS	10/01/78	06/30/79	12/30/79	
01.04.05.B	3 SCOPE OF WORK DEFINED			03/01/79	03/01/79
01.04.05.C	3 START WORK			05/01/79	06/30/79
01.04.05.D	3 STUDY COMPLETE			02/28/80	
01.05.00.A	13MWE PILOT PLANT				
01.05.01.A	---STMPD OPERATIONS	10/01/78	06/30/79	09/30/82	
01.05.01.B	3 START COLLECTOR CONTRACTS				
01.05.01.C	3 START FACILITY DESIGN				
01.05.01.D	3 START HELIOSTAT WORK			12/01/79	
01.05.01.E	3 TURBINE ROLL			12/30/81	
01.05.01.F	3 END ACCEPTANCE TEST			06/30/82	
01.05.02.A	---PP OPERATIONAL TESTING	10/01/78	06/30/79	09/30/82	
01.05.02.B	3 TEST PLAN			04/30/79	
01.05.02.C	3 TEST PLAN RESCHEDULED			05/31/79	05/31/79
01.05.02.D	3 TEST REQUIREMENTS			09/30/79	
01.05.02.E	3 TEST PROCEDURES			03/30/81	
01.05.02.F	3 BEGIN OPERATIONAL TESTING			07/01/82	

END OF PLOTS

## MAJOR ACCOMPLISHMENTS

### Large Solar Power Systems Technology Document (WBS 01.01.01-Planning and Ad-hoc Tasks)

Sandia is preparing a document summarizing the systems being developed by the Department of Energy's Large Solar Thermal Central Power System Program. Included are the technical concepts upon which the systems are based and, to the extent possible, estimated cost, performance, and Sandia assessment of the concepts. The document will provide potential users with an overview of present technologies and those technologies that will be available within the next few years. The document was released in draft form to prospective bidders on the Repowering/Retrofit RFP. Comments in response to the draft document have been received and are being incorporated. Final release is scheduled for July.

### Large Power Systems Applications AOP for FY80 (WBS 01.01.01 - Planning and Ad-hoc Tasks)

A first draft AOP for FY80 has been compiled.

### CESA-I (WBS 01.01.01 - Planning and Ad-hoc Tasks)

Funding has been received for CESA-I activities carried out in FY79.

### Repowering/Industrial Retrofit Procurement (WBS 01.03.02 - Repowering/Retrofit Concept)

Initial evaluation of proposals submitted in response to RFP DE-RP03-79SF10506, "Solar Repowering/Industrial Retrofit Systems", was concluded June 14, and questions requiring clarification of proposal content were sent to those Offerors determined to be in the competitive range, with a response date of June 26. Responses were received from all competitive Offerors in timely fashion, and final review by the Contractor Evaluation Board is underway. The CEB's findings will be presented to the Source Selection Official July 6. Tentative arrangements have been made for announcement of selections in conjunction with a press' conference by the Undersecretary, Dr. Deutch, in mid-July. Due to the high political and media interest in this procurement, a review of DOE policy on dissemination of information on ongoing competitive procurements was requested from the General Counsel. The DOE position continues to be that: "After receipt of proposals, no information regarding the number or identity of the offerors or any information contained in their proposals will be made available to the public or to anyone whose official duties do not require such knowledge."



Westinghouse Analyses Efforts  
(WBS 01.03.03 and 01.04.05 - Synthetic EPRI Utility - E  
Study and Westinghouse Utility/Technology Sensitivity  
Analysis, respectively)

The Westinghouse study of repowering in a "real" West Texas utility context originally scheduled to start May 1, has been deferred pending resolution of contractual issues. Award is expected in late July or early August.

The Westinghouse utility technology sensitivity analysis originally scheduled to start May 1, was initiated under an advance agreement at the end of June.

Solar Hybrid Mid-Project Reviews Completed  
(WBS 01.04.02 - Hybrid Power System Studies)

Mid-project reviews were held for the three solar fossil hybrid contractors: Energy Systems Group (Rockwell) June 6 and 7, Martin Marietta June 12 and 13 and Bechtel Nationals June 14 and 15. Each contractor supplied the mid-project report by month end.

The ESG system uses coal as the fossil energy source. The optimum configuration of the system (amount of thermal energy storage) is a function of the cost of coal; the higher the coal cost the more the storage is justified. Consequently, two systems have been evaluated, one with buffer storage only, the other with three hours of storage (and a correspondingly larger receiver and heliostat field). Large (~80%) capacity factors at relatively low cost are achieved by burning coal whenever solar energy is not available.

Change over from coal to other fossil alternates is possible throughout plant life with minimum capital cost.

The Martin hybrid has low cost molten salt thermal energy storage which permits their system to have a solar capacity factor (77%) comparable to the capacity factors of current coal and nuclear plants. The fossil portion of this plant is included as a back-up energy source for periods of inclement weather; this provides high plant availability and therefore a large capacity credit.

The Bechtel system uses solar heated compressed air as an input to an oil-fired combustion chamber followed by a combustion turbine. The exhaust heat of this turbine is used to generate steam which operates a turbine in a conventional Rankine cycle. There is no thermal energy storage; this with the high temperature limitations on the containment materials of the sodium heat pipes (used to transfer the solar energy to the air) constrains the system to the use of a significant amount of oil in order to achieve high thermal to electric conversion efficiencies. The result is a relatively low solar capacity factor. A ceramic receiver offers the possibility of a high solar capacity but current cost estimates do not indicate it to be cost effective. Bechtel has been directed to evaluate designs and operational scenarios which might increase the solar capacity and decrease the dependence on oil fuel.

Of the three systems the ESG (liquid sodium) system is the most ready for commercial implementation due to the sodium handling experience in the nuclear reactor industry. The Martin (molten salt) system is desirable because of its low cost thermal storage potential but requires additional salt containment materials characterization to guarantee long life; programs to accomplish this are in progress and in planning. The ESG and Martin systems appear to have life cycle costs competitive with fossil plants with realistic choices of economic parameters. The Bechtel (sodium heat pipe) life time system costs are greater than those projected for similar size salt and liquid sodium systems, and it appears it would have difficulty in making a significant market penetration unless unusual economic parameters were assumed.

The final technical presentations of the hybrid contractors are scheduled as follows Bechtel, August 27-28; ESG, August 29-30; Martin, September 6-7; at Sandia Livermore. The final reports are due at the end of September.

Pilot Plant System Test and Evaluation Plant  
(WBS 01.05.02 - Pilot Plant Operational Testing)

As reported last month, the publication of the complete plan slipped due mostly to underestimation of the effort required to incorporate all the comments and changes to the Dec 78 draft. A rough draft of the first year's testing has been sent to STMPO for review and comment; and the second year's testing is now being defined.

## FISCAL STATUS

**Obligations (B/A):** The SAN Financial Plan was reduced in June by \$160K in operating fund obligation authority transferred to SLL, to a new value of \$8160K. With inclusion of the new total of \$2940K transferred to SLL (of which \$600K will actually be obligated under WBS 2.0 and \$100K under WBS 4.0), and \$850K of PE&D funding added in February, total obligation authority for Large Power Systems Applications stands at \$12,400K (\$11,700 to be obligated under WBS 1.0).

Obligations for June were \$138K vs. a planned \$674K. Cumulative obligations, at \$4961K, are low by \$1168 (19%) with respect to the current approved Annual Procurement Plan.\* The indicated variance results from delays in definitization of a number of contracts currently in negotiation (of which the principal ones are those with Westinghouse - \$335K - and Aerospace - \$355K).

\* Revision #2 to the FY 79 APP, submitted to HQ April 13, was approved on June 22, and serves as the current basis for reporting obligation status.

**Cost Status (B/O):** The SAN Financial Plant was reduced in June by \$160K in operating fund costing authority transferred to SLL, to a new a value of \$12,700K. With inclusion of the \$850K in PE&D costing authority added in February, SAN's costing authority for Large Power Systems Applications stands at \$13,550.

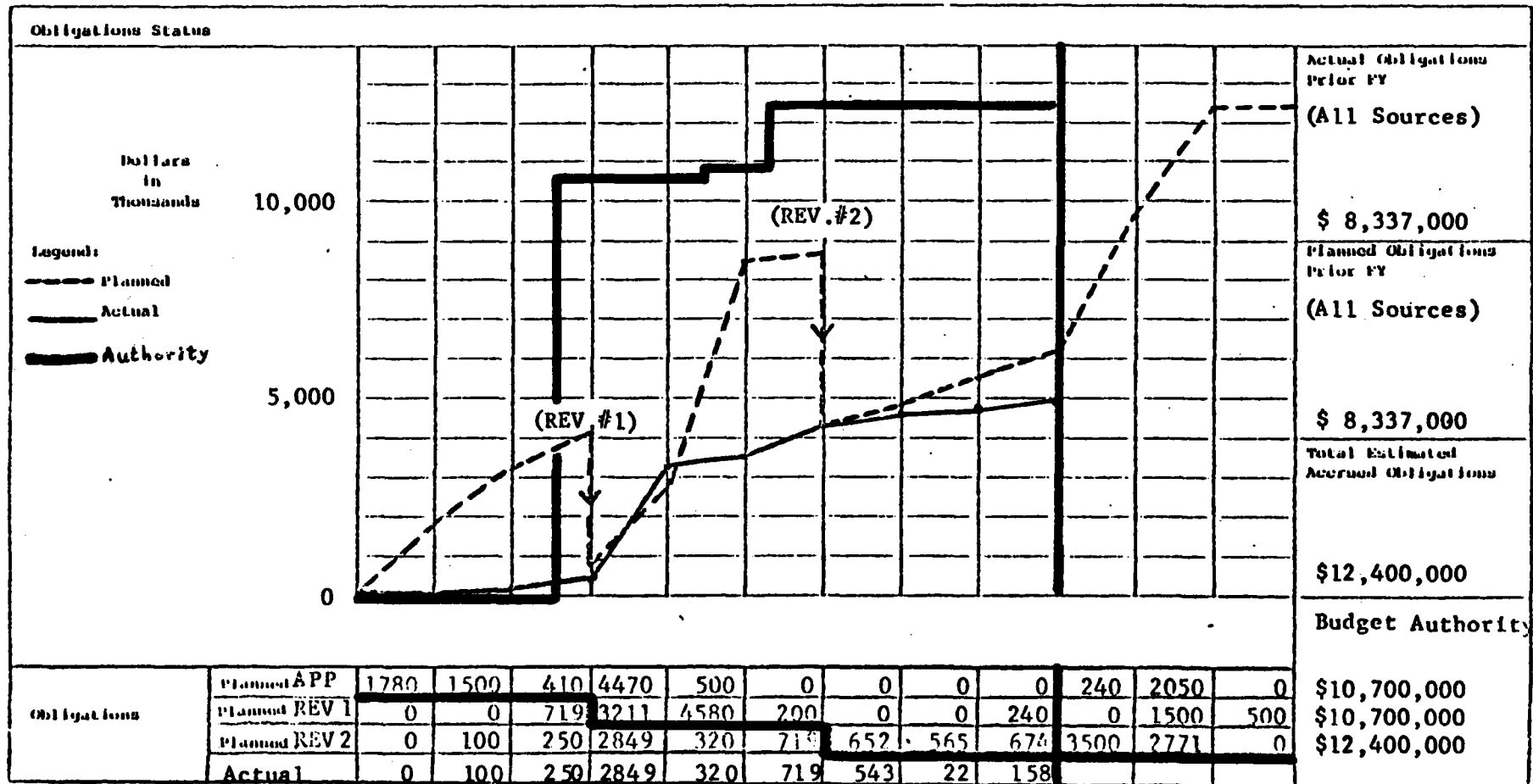
Costs accrued by SAN for June were \$434 vs. a planned \$694K. Cumulative costs through June, at \$4668K, are low by \$466K (9%) with respect to planned costs.

Current Status for SLL (LPSA) through June 30, 1979 is \$1,780 BA authorized. Year to date costs are \$1,657; reserved for salaries, internal support and other commitments is \$405K, for a total of \$2,062K. As noted in the previous report a transfer of funds is going to rectify this over-commitment, but as of this date, the additional funds have not appeared on the Sandia Financial Plan.

# OVERALL LPSA OBLIGATION STATUS

PROGRAM ELEMENT TITLE: LARGE POWER SYSTEMS APPLICATIONS (WBS 1.0) SAN FRANCISCO OPERATIONS OFFICE BR: AD-03-01-01

Months: O N D J F M A M J J A S FY 1979



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.

U.S. DEPARTMENT OF ENERGY

FORM DOE 536  
(1/78)

**CONTRACT MANAGEMENT SUMMARY REPORT**

FORM APPROVED  
OMB NO. 38R-0190

1. Contract Identification <b>LARGE POWER SYSTEMS APPLICATIONS (WBS-1.0)</b>										2. Reporting Period <b>1 June</b> through <b>30 June</b>					3. Contract Number <b>N/A</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</b>				
7. Months		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	8. FY 79		

9. Cost Status <b>Dollars in Thousands</b>																		g. Cost Plan Date <b>24 Jan. 79</b>	
a. Planned																		h. Planned Costs Prior FYs <b>4,345 K</b>	
Actual																		i. Actual Costs Prior FYs <b>2,650 K</b>	
Authorized																		j. Total Estimated Costs for Contract <b>N/A</b>	
b. B&R Numbers AD - 03 01 - 01																			
Accrued Costs																		l. Unfilled Orders Outstanding <b>N/A</b>	
c. Planned																		m. Estimate for Subsequent Reporting Period <b>N/A</b>	
d. Actual																			
e. Variance																			
f. Cum. Variance																			

NOTE: Costing authority is total for Large Power Systems Applications program element. Cost Plan does not include the \$2,240K transferred to SLL for LPSA Technical Management/Support (see next chart), or \$700K transferred to SLL for Technology Development or International (IEA) Program Support (see June Central Receiver Technology Report).

SAN COST STATUS

U.S. DEPARTMENT OF ENERGY

FORM DOE 538  
(1/78)

**CONTRACT MANAGEMENT SUMMARY REPORT**

FORM APPROVED  
OMB NO. 38R-0190

1. Contract Identification <b>SOLAR LARGE POWER SYSTEMS APPLICATIONS</b>										2. Reporting Period <u>1 June</u> through <u>30 June</u>					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 <u>Dollars in Thousands</u>																		g. Cost Plan Date <b>1 Oct 78</b>		
a.     b. B&R Numbers <b>AD 03 01</b>		2100																h. Planned Costs Prior FYs <b>6,753K</b>		
		1800																	i. Actual Costs Prior FYs <b>6,695K</b>	
		1500																	j. Total Estimated Costs for Contract <b>N/A</b>	
		1200																	k. Total Contract Value <b>N/A</b>	
		900																	l. Unfilled Orders Outstanding <b>N/A</b>	
Accrued Costs		600																m. Estimate for Subsequent Reporting Period <b>N/A</b>		
		300																		
		c. Planned	160	160	150	150	160	150	150	140	200	207	145	148						
		d. Actual	158	123	202	110	231	205	222	223	193									
		e. Variance	2	37	(52)	40	(71)	(55)	(72)	(83)	7									
		f. Cum. Variance	2	39	(13)	27	(44)	(99)	(171)	(254)	247									



DISTRIBUTION

DOE/HQ

H. Coleman  
G. W. Braun  
G. M. Kaplan  
J. Weisiger, Jr. (3)  
L. Melamed  
J. E. Rannels  
M. U. Gutstein  
D. Campbell  
S. M. Hansen  
R. A. Miller  
R. H. Annon  
J. Flynn  
F. Goldner  
R. L. Bigham

DOE/SAN

R. A. Du Val  
R. W. Hughey  
S. D. Elliott (3)  
L. E. Prince  
S. M. O'Brien  
R. N. Schweinberg (STMP0)

DOE/ALO

D. K. Nowlin

SERI

J. C. Grosskreutz  
J. Doane  
K. Touryan

JPL

V. C. Truscello

Aerospace Corporation

E. L. Katz

SLL

T. B. Cook, 8000  
A. N. Blackwell, 8200  
P. J. Eicker, 8326  
L. Gutierrez, 8400  
R. C. Wayne, 8450  
J. F. Genoni, 8450  
D. N. Tanner, 8450A  
W. G. Wilson, 8451  
A. C. Skinrood, 8452  
J. D. Gilson, 8452

SLA

J. H. Scott, 4700  
G. E. Brandvold, 4710  
B. W. Marshall, 4713  
V. L. Dugan, 4720

PRC

R. Edelstein