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Sandia Laboratories
Solar Energy

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Cameron

SOLAR THERMAL DISTRIBUTED RECEIVER TECHNOLOGY DEVELOPMENT AND APPLICATIONS PROJECT

TECHNICAL STATUS REPORT

FEBRUARY-MARCH, 1984

SANDIA NATIONAL LABORATORIES
ALBUQUERQUE, NEW MEXICO
EDITED BY: J. A. LEONARD

February/March 1984

HIGHLIGHTS

Project Management

Eldon Boes has been appointed supervisor of the newly formed Distributed Receiver Technology Division, effective March 16. Responsibilities of this division include R & D of distributed concentrators and receivers, heliostats, energy transport systems, energy conversion, and controls. Eldon has most recently been responsible for the Photovoltaic Concentrator Project within DOE's Photovoltaic Program. He has also worked extensively on solar radiation resource assessment.

Distributed Receiver Technology Development

On February 10, 1984, a letter contract for about $1.15M was placed between Sanders Associates and Sandia. Negotiations were held March 22-23 to finalize this contract. Sanders' overhead has decreased somewhat, and with Sandia assembling the LaJet collector, extra controls, electric start, and engine burner can be obtained to allow the Sanders module to remain operational while Module #2 is being tested at Sandia. Negotiations were satisfactorily completed, but will not be finalized until a property inventory is available. JPL is assisting in the property inventory.

Phase A construction of the DRTF, which includes grading and the foundation for the test bed concentrator, TBC-1, was completed. Installation of TBC-1 is complete, and about twenty members of the management and technical staffs of Sandia and DOE/AL observed operation of the concentrator on March 15.

Distributed Receiver Evaluation

The final acceptance test of the upgrade work on the IPH system at Southern Union Refining was completed at the end of March. The test was supervised by ETEC.

The Shenandoah Test Operation Phase Plan (TOP) report written for the Electric Power Research Institute (EPRI) by the Energy Technology Engineering Center (ETEC) has been published as Document number EPRI-RP-2003-4.

Solar Concentrator Technology Development

The Laser Ray Trace (LRT) inspection system has been disassembled and moved from inside the tech area at Sandia to the DRTF for reinstallation there. The system should be operational in June for inspection of troughs utilizing the same programs and set-up previously used. New approaches to inspection of long focal-length dish sections are being investigated.

Sandia Livermore issued an RFP for Design and Fabrication of a Stressed Membrane Heliostat to 42 potential bidders on March 2. Issuance of this RFP met Solar Thermal Controlled Milestone for "Release RFP for stretched membrane heliostat Design and Fabrication". The proposal review panel will convene in May to evaluate the proposals.

PUBLICATIONS

"Modular Industrial Solar Retrofit Specifications: Prepared Foods, Santa Teresa, New Mexico; A. E. Staley, Inc., Monte Vista, Colorado," SAND83-7031. Contractor Report: The BDM Corporation, Albuquerque, New Mexico, February 1984.

PRESENTATIONS

Sandia Laboratories DISTRIBUTED RECEIVER TECHNOLOGY AND APPLICATIONS PROJECT

Solar Energy

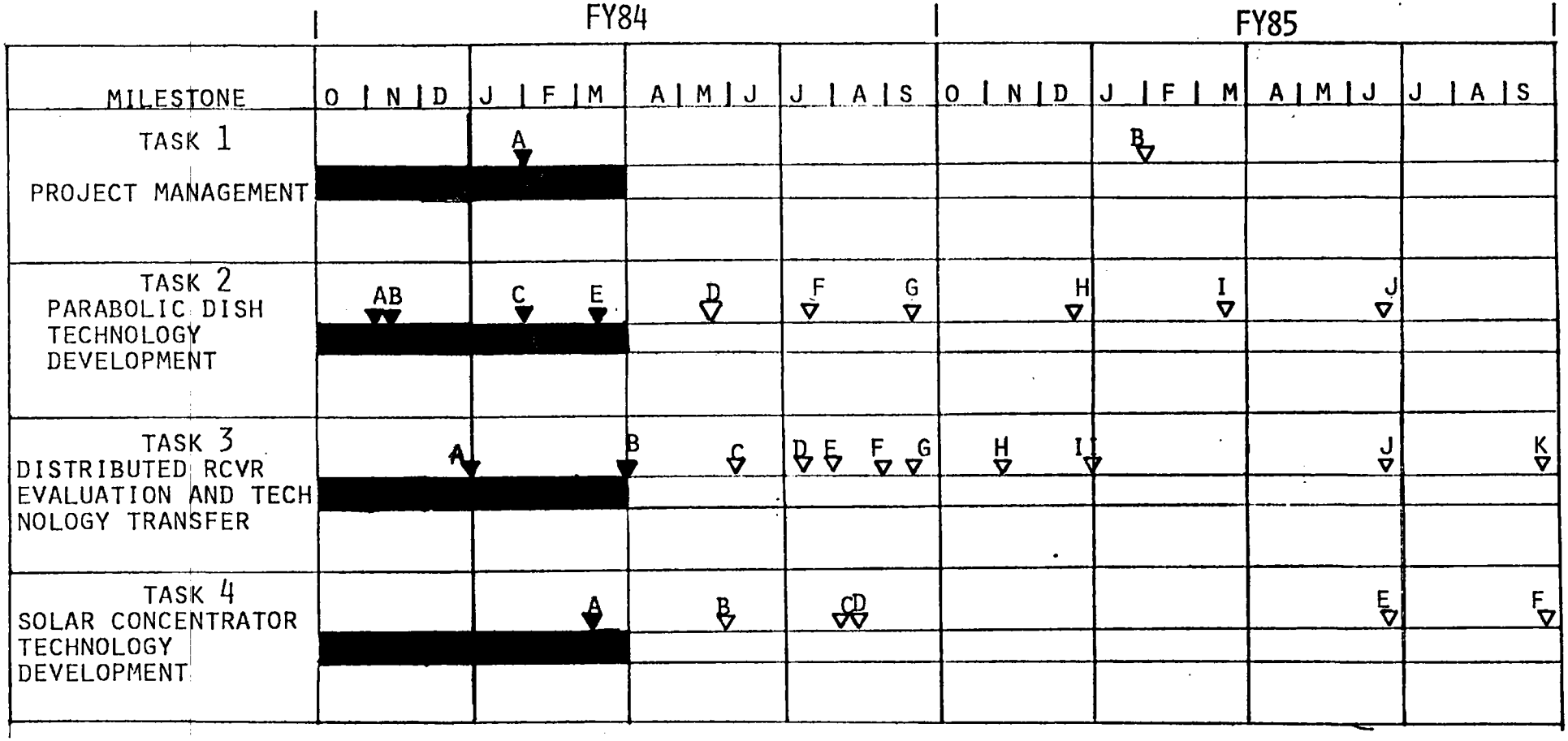

Figure 1

Sandia Laboratories
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TASK 1 - PROJECT MANAGEMENT

A. FY84 AOP (REVISED) PUBLISHED
B. FY85 AOP PUBLISHED

TASK 2 - PARABOLIC DISH TECHNOLOGY DEVELOPMENT

A. PDC-2 DESIGN REVIEW COMPLETED
B. ORC 100-HR TEST COMPLETED
*C. DRTF INTERIM CAPABILITY DESIGNED
D. CHARACTERIZE SABC DISH (LA JET)
*E. THERMAL TRANSPORT TECHNOLOGY REVIEW COMPLETED
F. VANGUARD/STIRLING PERFORMANCE EVALUATION
G. VANGUARD/STIRLING LIFE TESTS COMPLETED
*H. FIRST GENERATION BRAYTON MODULE ASSEMBLED
I. CONCEPTUAL DISH SYSTEM DESIGN FOR FUELS & CHEMICALS APPLICATION COMPLETED
J. INITIATE FABRICATION OF PROTOTYPE 550°C THERMAL RECEIV
K. PROOF OF CONCEPT TC ENERGY TRANSPORT BASELINE LABORATO EXPERIMENT COMPLETED.

TASK 3 - DISTRIBUTED REVEIVER EVALUATION & TECHNOLOGY TRANSFER

A. ISSUE SCSE PON
*B. SHENANDOAH DOCUMENTATION COMPLETED
C. CROSBYTON DESIGN REVIEW
D. SCSE CONTRACTS AWARDED
*E. FY83 IPH ANNUAL REPORT
F. MISR TEST & EVALUATION REPORT
*G. MODIFIED MISR INITIAL QUALIFICATION TEST COMPLETED
*H. IPH FIELD TESTS COMPLETED
I. TRANSFER SHENANDOAH STEP TO GEORGIA POWER
J. SHENANDOAH OPERATIONAL REPORT
K. FY84 IPH ANNUAL REPORT

TASK 4 - SOLAR CONCENTRATOR TECHNOLOGY DEVELOPMENT

*A. HELIOSTAT RFP RELEASED
B. CASSEGRAINIAN DISH DESIGN REPORT
*C. HELIOSTAT CONTRACT AWARDED
D. INNOVATIVE CONCENTRATOR CONTRACTS AWARDED
E. INNOVATIVE CONCENTRATOR HARDWARE TESTS INITIATED
F. FABRICATION OF INNOVATIVE HELIOSTAT STARTED

*Controlled Milestone

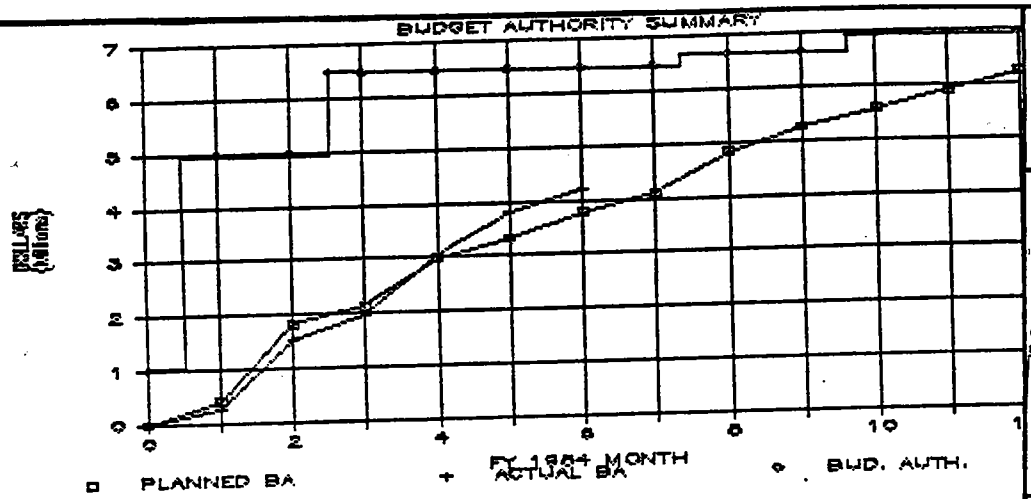
CONTRACT MANAGEMENT SUMMARY REPORT

1. Contract Identification	Distributed Receiver Technology and Applications Project	2. Reporting Period 2/1 through 3/31	3. Contract Number
4. Contractor (name and address)	Sandia National Laboratories Box 5800 Albuquerque, NM 87185		5. Contract Start Date 10/83 6. Contract Completion Date continuing

7. Months													8. FY
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	

9.

a.



e. Actual Costs Prior FYs: N/A

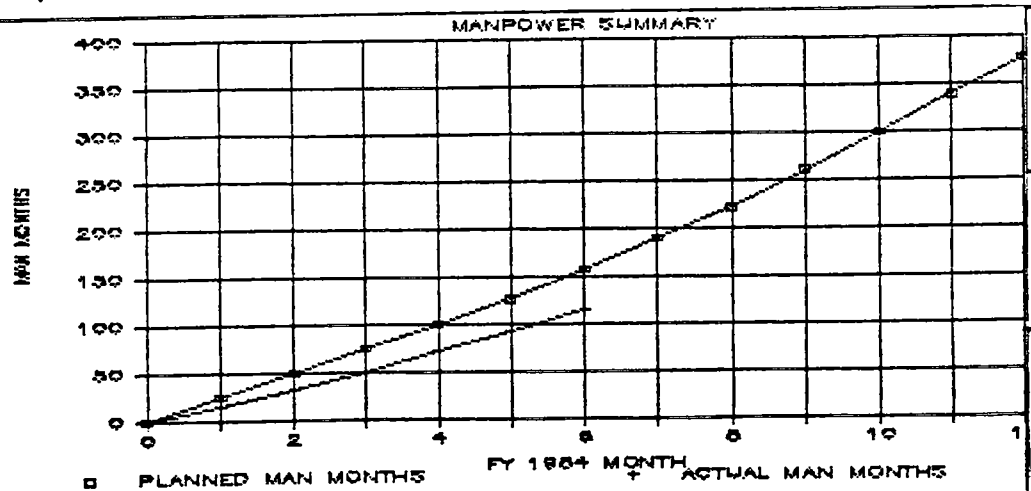
f. Planned Costs Prior FYs: N/A

g. Total Estimated Accrued Costs for Contract: N/A

h. Total Contract Value: continuing

Accrued Costs		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	b. Planned	412	1413	308	848	347	453	323	724	429	324	323	326
	c. Actual	282	1270	404	1118	721	426	0	0	0	0	0	0
	d. Variance	-130	-143	96	270	374	-27	-323	-724	-429	-324	-323	-326

10. Manpower Status



e. Actual Manpower Prior FYs: N/A

f. Planned Manpower Prior FYs: N/A

g. Total Estimated Manpower for Contract: continuing

h. Total Contract Manpower

Manpower		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	b. Planned	25	25	25	25	27	31	32	32	39	39	39	39
	c. Actual	15	17	20	21	20	22	0	0	0	0	0	0
	d. Variance	-10	-8	-6	-4	-7	-9	-32	-32	-39	-39	-39	-39

11. Remarks

12. Signature

Number:	3
Date:	April, 1984
Period:	02/1/84 - 3/31/84
B & R Code:	EB-02-01
Project:	Distributed Receiver Technology Development and Applications Project
Title:	Project Management (AOP Task 1)
Contractor:	Sandia National Laboratories, Albuquerque, New Mexico 87185

ACOMPLISHMENTS

1.0 Project management - Resources will be budgeted to meet the work plan outlined in the AOP. Activities required to meet the project objectives will be identified and progress toward these objectives will be monitored. Budget allocations, manpower needs and milestone monitoring will be administered. Liaison with appropriate DOE offices, laboratories, and other agencies will be maintained to assure that a well integrated, balanced Distributed Receiver Project is conducted.

1.1 Project Report

The Quarterly Project Review was held in Washington on March 27, 28, and 29, 1984. The Distributed Receiver presentations featured the following Technical Special Topics Reports:

Reflector Materials, Gordon Gross, SERI
Stretched Membrane Heliostat, Bill Wilson, SNLL
Dish-Electric Module Development, John Lucas, JPL
Shenandoah/IPH, Ed Harley, SNLA
MISR, Chris Cameron, SNLA
Thermochemical Transport, Jesus Martinez and Jim Fish, SNLA

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Al Heckes has joined the Distributed Receiver Project staff. Al will be primarily involved with technical and analytical support to the Shenandoah Project. Al is a chemical engineer with substantial project engineering experience.

1.2 Project Planning

Work in support of the Solar Thermal Five-Year Research Plan has been initiated.

TECHNICAL APPROACH OR WORK PLAN CHANGES

The budget and manpower graphs have been changed slightly since the last report. The planned BA commitment line has been depressed by about $50 per month to more realistically indicate our plans to underrun the FY84 budget by about a half million which will provide some cushion in early FY85. This has been our budget plan all along, but previous graphs did not display it accurately. The manpower planned expenditure rate has been smoothed, but the total predicted expenditure has not yet been changed.

VARIANCES

None

OPEN ITEMS

$190K in withheld funds are still outstanding pending DOE/HW efforts to have capital equipment funds reprogrammed to operating funds

Planning for the use of $3M in reprogrammed FY83 funds is lagging. Commitment before the end of FY84 could be a problem.

Replacement of the $300K reduction in DRTF funding is needed if the DRTF development is to stay on schedule.

FORECAST FOR NEXT REPORTING PERIOD

FY85 AOP planning will begin.

Allocation of the $3M discussed above should be completed by DOE/HQ, AL, and SNLA.

Number:	3
Date:	April, 1984
Period:	02/1/84 - 3/31/84
B & R Code:	EB-02-01
Project:	Distributed Receiver Technology Development and Applications Project
Title:	Distributed Receiver Technology Development (AOP Task 2)
Contractor:	Sandia National Laboratories, Albuquerque, New Mexico 87185

Accomplishments

2.0 DISTRIBUTED RECEIVER TECHNOLOGY DEVELOPMENT - The parabolic dish potentially has the highest energy collection capability of any distributed receiver system. The high concentration ratio reduces receiver area and thermal losses and two-axis tracking eliminates the cosine effect losses and provides a constant all day efficiency. This task seeks in the long term to provide a parabolic dish solar thermal capability in excess of 1200°C for process heat applications and with emphasis on industrial process heat, including fuels and chemicals production, electrical power, and cogeneration.

2.1 Systems Engineering and Analysis

Calculations were conducted for the performance of Brayton engines - Parabolic dish as a function of concentration ratio. The results indicate the high temperature high performance capability of the SAGT requires dishes with concentration ratios of 2000 or greater.

Calculations were performed on heat engine/dish system performance and hybrid modes. The results indicate that hybrid systems, those which ca augment insolation with fossil fuel, are desirable for improved performance, as well as providing reliability and a high capacity facto

Calculations indicate the optimum concentration ratio as a function of operating temperature. For instance, at 1500°F a concentration ratio of 1000 is sufficient. At 2500°F, a concentration of greater than 2000 is required so that the aperture of a cavity receiver will be smal enough to keep reradiation losses reasonable..

2.2 Energy Transport and Storage

Progress made on the SO_3 experimental setup at NMSU included the installation of both reactors (dissociator and synthesizer) packed with 0.3% Pt on alumina and connection of the SO_2 line including teflon lined piston pump. Negotiations were made for a preliminary run of the loop using a temporary teflon synthesis line in order to uncover any potential problems associated with initial experiments. Safety issues on handling of the sulfur gases were reviewed and discussed.

J. Martinez participated in a workshop at SERI on March 21-22 on the use of direct flux in solar applications. Specifically, the use of direct solar flux to promote chemical processes that may be useful in thermochemical transport, as well as fuels and chemicals production or possibly, in toxic waste disposal. The purpose of the workshop was to assess the state-of-the-art in direct flux materials, phenomena, and processes to define research opportunities and potential applications. An overview of Sandia's approach to thermochemical transport, as well as progress on the SO_3 dissociation experiments at NMSU was presented, alongside a supplementary presentation of the CLEA project.

J. Martinez and J. F. Muir of the Distributed Receiver Research Division and L. J. Weirick of the Corrosion Division, visited the New Mexico State University Physical Science Laboratory on February 14, 1984 to review the thermochemical transport research being performed by Jim and Gloria McCrary under contract to Sandia. The McCrary's described their activities in setting up a laboratory-scale, closed loop, SO_3 dissociation/recombination thermochemical transport system. Most of the loop components, including the dissociator and synthesizer furnaces, their power supplies, a compressor and teflon tubing and fittings for the synthesis line, along with an SO_2 analyzer , have been assembled in a specially-fabricated hood. They are awaiting delivery of two specially designed quartz reactors (dissociator and synthesizer) and the quartz tubing connecting them.

A workshop was held in Albuquerque on March 6 to address various problems and issues affecting thermochemical transport. The workshop was well attended with 22 persons from Sandia Laboratories, four from DOE, seven university representatives; two from industry, three from other R&D laboratories, and one student attending. This constitutes completion of Controlled Milestone No. 26, "Complete Thermal Transport Technology Review." A letter report is in preparation to summarize the insights and issues of the workshop and which includes copies of the visual material used in the presentations. This document will be distributed during the next report period.

On March 13-14, J. F. Muir and J. I. Martinez attended a presentation by Dr. Prengle of the University of Houston on his new proposal for a modified AHS thermochemical transport cycle. This has a higher exothermic output, but has bee primarily designed for central receiver application. The question of applicability to distributed receivers was raised and discussed. Sandia recommended that distributed receivers be kept in mind on this project. DOE and SERI gave support to this request and discussions were held with the principals involved in this project.

The data acquisition system and system controller for the SNLA Closed Loop Efficiency Analysis experiment have been received. Software development is currently underway. The stainless steel tube-in-tube spiral heat exchanges have been fabricated. These heat exchangers, the salt-bath preheater, and the circulation pump are being plumbed for installation in the test station. A search was initiated for computer models applicable to distributed receiver solar thermal transport and storage including component and system performance and system performance/cost optimization being plumbed for installation in the test station. A search was initiated for computer models applicable to distributed receiver solar thermal transport and storage including component and system performance and system performance/cost optimization odes. Results to date have been only partially successful. Although some codes were found that model various aspects of sensible heat transport, only one was found that specifically addresses an aspect of thermochemical energy transport. The codes are: (1) SOLTES, a modular heat and mass balance code that simulates the quasi-transient response of thermal energy systems using a single heat transfer fluid to time-varying boundary conditions. (2) HEAP, which models the transient or steady state performance of a solar receiver under varying solar flux, ambient temperature, and local heat transfer ratio. It is also capable of detecting the location of hot spots and metallurgical problems and predicting the performance sensitivity to neighboring component parameters. (3) ETRANS - a performance/cost optimization code for thermal transport piping systems for distributed fields of solar collectors; and (4) SOLTHERM, a two dimensional, steady-state, pseudo homogeneous model of an endothermic catalytic chemical reaction in an annular packed bed. Available documentation of these codes has been obtained. In light of the paucity of existing codes for modelling thermochemical energy transport systems, the question of how best to obtain/develop a suitable model was addressed. An initial evaluation suggests that modification of SOLTES to include multi-component gas mixture, catalytic reactions, and capital and operating costs would probably provide a suitable steady-state model for full scale systems. A greatly simplified, single-loop version of this would be appropriate for modelling the CLEA and NMSU laboratory experiments.

2.3 Receiver Development

SNLA Evacuated Receiver Tubes

Bellows-flange subassemblies have been completed and leak tested. Graded kovar to Pyrex glazing sub-assemblies have been completed, using Sol-Gel AR treated Pyrex tubing. A final assembly fixture has been completed. The radio frequency induction heating generator was repaired, and additional brazed bellows/flange subassemblies were fabricated

The new higher capacity vacuum pump arrived in March. Unfortunately, it was supplied with an ANSI flange where a Conflat flange was required, and had to be returned to the vendor for installation of the proper type flange.

Acurex Evacuated Annulus Receiver

Acurex received the Inconel bellow and all other long lead items. They successfully fabricated glazing subassemblies which included graded seals from Pyrex tubing to metallized ceramic cuffs. However, when they brazed Inconel rings to metallized ceramic cuffs to test the butt joint design, they had problems with ceramic breakage from overstress.

Acurex is investigating three possible solutions to the problem:

a. They have successfully made brazing closures with intermediate copper rings between the Inconel and ceramic; however, they are concerned about the fatigue life of copper in this configuration.

b. They are thinning the Inconel ring to limit the force it can transmit to the braze joint, thus lowering the stress in the ceramic.

c. They have awarded a subcontract to a local (California) company which claims to be able to make a direct Pyrex-to-Inconel seal.

2.4 Controls development

No specific activities are scheduled in FY84.

2.5 Distributed Receiver Test Facilities

Phase A construction of the DRTF, which includes grading and the foundation for the test bed concentrator, TBC-1, was completed. Installation of TBC-1 is complete, and about twenty members of the management and technical staffs of Sandia and DOE/AL observed operation of the concentrator on March 15.

The design of Phase B of the test site has been completed and drawings were printed on February 27. This meets controlled milestone, D4, "Design of an Interim Capability Test Facility." Bids for Phase B of the DRTF construction have been received, and a contractor was selected. The cost is well within the "shotgun" estimated by Black and Veatch. Phase B includes the foundations for the LaJet and Shenandoah collectors, the modifications to building 9981 to create control room space, the circulating water system, electric power, and instrumentation cable trays.

An informal inventory of DOE-purchased equipment at the PDTS has been conducted by Sandia personnel. The list of equipment has been reviewed to eliminate equipment which will not be needed at the DRTF and it has been submitted to DOE so that the transfer of the equipment from JPL to SNLA may be made. Preparations to transfer the equipment are underway, and removal of the mirrors from TBC-2 has been completed.

A visit was made to Barber-Nichols Engineering in Denver to observe the start of a 200-hour hot test on the organic Rankine cycle turbine alternator pump and to discuss instrumentation required during testing in preparation for possible testing of the engine on TBC-1 A visit was also made to the Advanco Vanguard/Stirling engine test site at Rancho Mirage. The system was in full automatic operation and automatic startup and shutdown were observed. Advanco and United Stirling, Inc. personnel provided a thorough briefing on the design and operation of the system.

2.6 Engine Development for Dish-Electric

ORC

Barber-Nichols completed the additional 200 hours of hot bench testing on their Organic Rankine Cycle (ORC) engine on April 3, under Sandia contract. After one and two-hundred hours of operation the ORC was dismantled for inspection of bearings and internal conditions. Except for normal glazing of the bearings, all remaining rotating surfaces appeared as their original installed condition. These results indicate that the material bonding problems which plagued the bearing shoes were solved by Sandia's Metallurgy Division. Completion of this testing indicates the ORC Engine shows promise as a candidate for near term dish-electric installation.

Direct Conversion Devices

A literature search has uncovered two direct heat-to-electric conversion devices which might be used together in a system in a topping/bottoming cycle arrangement.

The Sodium Heat Engine (SHE), under research by Ford Motor Company and others, accepts heat from any external source at 800 to 1000°C and rejects heat at 300°C. We have been in contact with Ford and will visit there in early April to learn more about the SHE.

The Lithium/Iodine thermochemical engine/storage battery combination accepts heat at 300°C and rejects heat as low as 25°C, making it a bottoming candidate for the SHE. Guy R. B. Elliott, LANL (retired) who worked on the device at LANL in the mid-1970's made a presentation February 17, 1984 to an audience comprised of several interested Sandia organizations.

A combination of two such devices operating between 1000°C and 25°C would have a Carnot efficiency limit of about 77%. So far, the SHE has demonstrated efficiency approximately onethird its Carnot limit, with 45% Carnot expected near term and 62% Carnot for term. No efficiency measurement was available for the Lithium/Iodine device, but it has been project as 50% of Carnot.

The distributed receiver project staff are sharing shared information and ideas concerning this subject with appropriate individuals in Sandia Electromechanical Subsystems, Power Sources, and Space Nuclear Power Safety organizations, as well as the Chemistry and Ceramics Department and their consultants in the area of conversion devices for space power application.

SAGT

Sandia participated in the Automotive Gas Turbine status review at Garrett Turbine, Phoenix, in February. The engine has been successfully operated with all ceramic hot parts except the compressor/turbine wheel. The bearing stability problem appears to have been solved as no problems were encountered up to 80,000 rpm. The SAGT will be the designation for the Solarized Automotive Gas Turbine. The metal version SAGT is scheduled for shipment to SNLA by November 1, 1984.

SABC

Sandia participated in the Subatmospheric Brayton Cycle Engine (SABC) design review at Garrett AiResearch in February, 1984. The acceptance was accomplished and the power conversion assembly was shipped to Sanders. However, the estimated production cost is approximately three to five times more than originally estimated. This could take the SABC out of consideration. Pressurizing the engine can result in 18 kW vs. 9. The alternator is believed capable of this power output by adding extra cooling. The design change to a pressurized 18 kW system is being studied.

On February 10, 1984, a letter contract for about $1.15M was placed between Sanders Associates and Sandia. Negotiations were held March 22-23 to finalize this contract. Sanders' overhead has decreased somewhat, and with Sandia assembling the LaJet collector, extra controls, electric start, and engine burner can be obtained to allow the Sanders module to remain operational while Module #2 is being tested at Sandia. Negotiations were satisfactorily completed, but will not be finalized until a property inventory is available. JPL is assisting in the property inventory.

TECHNICAL APPROACH OR WORK PLAN CHANGES

Addition of a task to perform a parametric systems analysis comparing the performance/cost characteristics of sensible heat and thermochemical transport from a field of dish collectors. A stronger emphasis will be placed on the economic feasibility study of thermochemical transport in order to encourage stronger support for thermochemical transport for the dish program.

The move of TBC-2 and PDC-1 from the PDTS to the DRTF, while generally consistent with the FY84 AOP, were not specifically described.

Variances

The Sanders Associates-Sandia contract was not placed by February 1 as planned. The Sanders reduced rates allowed the JPL contract to continue funding until February 10. Sandia had a letter contract in place. Final award is being delayed until a property inventory is completed.

Based on technical and economic information, the SABC is losing strength as a contender for solar application. Testing as planned at Sanders and DRTF will provide additional information.

Open Items

None

FORECAST FOR NEXT REPORTING PERIOD

The literature search, as well as analytical investigation, for other possible element/electrolyte combinations which may have advantageous direct conversion characteristics will be continued.

We will continue a dialogue with Ford Motor Company, inventors of the SHE, along with a visit to Ford to observe the devices in operation. We will discuss with Ford the areas needing engineering development and/or further research.

We will attempt to formulate a recommendation for a reasonable development program for promising candidate systems, possibly in a synergistic dual support arrangement between the solar and space power programs.

Evacuated receivers will be assembled and deployed for test on a Custom Engineering MISR drive group (six receivers plus spares) and testing begun. Additional receivers will be assembled for accelerated mechanical life tests and for experiment with an integral vacuum indicator.

Acurex will pursue the three investigations identified to attempt to resolve the sealing problem. When they are able to demonstrate a seal of good integrity, they will deliver the test devices under contract 52-9909.

In an effort to evaluate the cost competitiveness of thermochemical energy transport, we will perform a parametric systems analysis of the cost/performance of thermochemical transport as compared with sensible heat transport from a field of dish collectors to a nearby user. Thermochemical transport model development activities during the next report period will concentrate on obtaining a tape of the ETRANS code, making it operational on the Sandia computers, and performing calculations in support of the thermal transport systems cost/performance study.

The results of Sandia thermochemical literature review will be documented with some discussion on the rational for proceeding with research on thermochemical transport. The experiments to close the loop on the SO_3 dissociation/recombination will be performed at NMSU. Experiments on initial SO_3 metal compatibility will be performed.

Critical design review for the SABC/LaJet module is scheduled for May 15, 1984.

The ORC, with new controls, should be shipped to Sandia for testing on TBC-1 by June 1, 1984. The advisability of undertaking the contract modification (about $75K) will be determined through discussions with DOE. Sandia strongly recommends this step be taken.

PROBLEM AREAS

None

Number:	3
Date:	April, 1984
Period:	02/1/84 - 3/31/84
B & R Code:	EB-02-01
Project:	Distributed Receiver Technology Development and Applications Project
Title:	Distributed Receiver Evaluation and Technology Transfer (AOP Task 3)
Contractor:	Sandia National Laboratories, Albuquerque, New Mexico 87185

ACCOMPLISHMENTS

3.0 DISTRIBUTED RECEIVER EVALUATION AND TECHNOLOGY TRANSFER - This activity includes the technical management support and long term evaluation of existing field projects including the Shenandoah Solar Total Energy Project (STEP) and the Industrial Process Heat Projects; the completion of the MISR project and its follow-on system improvement developments; the Small Community Solar Experiments; the continued testing of privately-developed line-focus R & D in high-risk, high-payoff areas of technology, and the availability of a cadre of knowledgable personnel in line-focus technology to provide continuing technical advisory support to private sector developers.

3.1 Shenandoah Evaluation

The new year-to-date monthly operating summary for the Shenandoah Solar Total Energy Project (STEP) is shown in Table 3.1-I.

The Test Operation Plan has been reviewed by the STEP staff and consultants Dick Cummings of EPRI and Bob Thompson, a private consultant recently of Westinghouse. The tests have been placed in chronological order according to complexity of the operation. The essential test variables have been identified and data lists prepared. This has pointed out a need for some data to be collected by hand. Another requirement is the upgrading of the computer program to provide a proper listing of information collected by the Control and Instrumentation Subsystem (CAIS). The computer program is being reworked.

The STEP electrical generator was successfully brought on line with the Georgia Power Co. grid. This was a test of the turbine synchronizer scope and switching subsystem.

TABLE 3.1.I

Shenandoah STEP Year-to-Date Monthly Summary

Month	Electrical Power kWh	Refrigeration Ton Hours	Process Steam Lbs.	Natural Gas Consumed 10^6 Btu
JAN	3142	0	12388	158
FEB	1378	0	11417	260
MAR	4162	18	20034	319

The STEP emergency power generator was found to have a reversed phase direction. It was changed to be compatible with the power grid. The emergency system was subsequently tested and operated properly in that regard. Some transient voltage spikes were observed during the switchover which cause concern over compatibility with the CAIS.

The STEP staff has been upgrading, repairing and calibrating the various components, instruments and meters to be used for data gathering in the upcoming evaluation tests. A number of RTD's, potentiometers, and fiber optics have been changed or repaired on the solar field. Insulation was installed on the high temperature fluid lines which had previously been replaced due to corrosion problems.

3.2 Industrial Process heat

See attached report.

3.3 Modular Industrial Solar Retrofit (MISR)

During the MISR project, components of the various systems have failed, operated intermittently, or have adversely affected system performance because they were not within specifications. A summary has been prepared in tabular form qualitatively describing the adequacy of the various components in the various systems based upon the operating history to date. This information was presented at the DOE quarterly review.

Acurex

Three engineers from Acurex, John Schaefer, Don Duffy, and Eric Nearing visited the MISR site to review our operating and maintenance experience with their system. Acurex hopes to begin production of the 3011 trough soon.

BDM/Acurex

A flexible hose which is part of a rotary joint assembly installed by BDM on the Acurex QTS has failed. This flexible hose connects the rotary joint to the stationary piping manifold and allows for differential expansion of the collector structure relative to the manifold. It also causes the stationary side of the rotary joint to remain stationary relative to he rotating portion of the joint which is fastened to the collector. The hose that failed was mounted with an Aeroquip joint and, since there is considerable friction in the joint, the hose must absorb the resultant stress. However, we also observed that there is insufficient clearance between the bolts in the rotary joint mount and the collector pylon at very cold temperatures. This caused the joint to be forced out of alignment and may have caused the failure of the hose.

When the flexible hose was replaced, a mechanical restraint was installed to transfer the rotational force and thus minimize the stress in the flexible hose fromthe friction in the rotary joint. Clearance between the mounting flangesand the collector was improved by installing the mounting bolts with the head towards the collector rather than away from it. The assembly is now functioning satisfactorily.

Solar Kinetics/BDM

Solar Kinetics has installed a 10-foot drive group of T-700 mirrors with glass reflective surfaces in the BDM QTS. The system includes a Winsmith gearbox, center of gravity rotation (no counterweights), non-drive pylons similar to those used in the T-800 collectors, and flexible hoses with stripwound covers. Installation of the new flexible hoses required that the piping be modified appropriately. As installed by SKI, the hose is very tightly bent to its minimum radius when the collector is rotated to its rotational limits. Since the stress is on the cover, not the inner bellows, this may have no effect on hose life, and SKI has experienced no failures in testing at their plant.

Performance testing of the Solar Kinetics T-700 collectors in the BDM system continues. Four of the drive groups have reflective surfaces of FEK-244 aluminized acrylic. One has ECP-300X, a silvered acrylic, and the other has thin-glass steel laminate mirrors. The performance of the collectors was measured with water as a heat transfer fluid so that the collectors were operating at approximately ambient temperature, yielding optical efficiency. The optical efficiency of the collectors were ECP-300X, 78%; FEK-244, 69%; and glass, 77%. All measurements were made using pyrex receiver glazings without anti-reflective treatment. The measured reflectivities are ECP-300X, 98%; FEK-244, 84%; and glass 95%.

Several months ago the measured efficiency of the FEK-244 mirrors was about 74%, which is consistent with collector module tests performed on the rotating platforms at the CMTF in 1981. A module equipped with glass reflective surfaces was also tested on the rotating platform and was determined to have an optical efficiency of 78%. The reflectivity of the FEK-244 reflective film in the BDM system has not changed and all instrumentation has been checked. A receiver was removed for measurement of the black chrome reflectivity and the measured result was 95.3%, which is very good. The cause of the change in performance is still under investigation; none of the other systems have been observed to change.

Custom Engineering

Ten sol-gel treated receiver glazings were removed from the CEI collectors and will be used in fabricating evacuated receivers. Laboratory tests of the transmissivity of these anti-reflective glazings showed no degradation in the more than three months they were installed.

CEI engineers installed several modifications to their qualification test system. The control system was modified to incorporate an FSK transmitter for sending tracking data to the local control units over the AC power lines. The FM carrier signal previously used has been eliminated. A new local controller was installed which detects the FSK signal with better error rejection than the previous FM receiver and incorporates a DC motor controller with a soft start capability. In addition, a new filter was added which is switched in-line when overtemperature is detected by the outlet drive group in a delta-temperature string. It then filters out the tracking signal to all of the drive groups in the string and causes them to stow. Overtemperature protection of the outlet drive group thus protects the entire string. A new field light switch was also installed. All of these modifications were demonstrated to function properly after installation; however, since that time, the local controller has failed.

After less than a month of operation, the new local control system began to experience intermittent failures. On one occasion a fuse blew; after the fuse was replaced, the controller worked normally. Subsequently, the drain wire on the power feed was observed to have been destroyed by high current, although the controller was still functional. It then blew a fuse again and was found to be completely inoperative.

A failed solid state relay was replaced in the motor controller and new capacitors were installed at CEI's direction to increase the time before changing direction from one to seven seconds. However, after another day of operation, the unit failed again. We continue to consult with CEI about possible repairs. The controller was designed to replace the Hampton motor controllers originally installed on the system. The Hampton controller experienced a number of problems early in their operation, mostly failed SCR's, but have been operating without failure for several months now.

In the process of repairing the motor controller, we discovered that CEI had included a manual reset which must be actuated following a power outage. This is undesirable in production units since it would require that an operator actuate a reset on every drive in a field of collectors following a power outage. Without being reset, the collectors will go to and remain in stow position.

MAINTENANCE HOURS SUMMARY

	BDM		ACUREX		SKI **		CEI	
	SKID	COLL*	SKID	COLL*	SKID	COLL*	SKID	COLL*
FEBRUARY	1	0	0	0	-	-	0	1
MARCH	0	0	0	0	-	-	5	1

* Average hours of maintenance normalized to one drive group. Manufacturer supplied parts unless otherwise noted.

** SKI was not operated during February and March

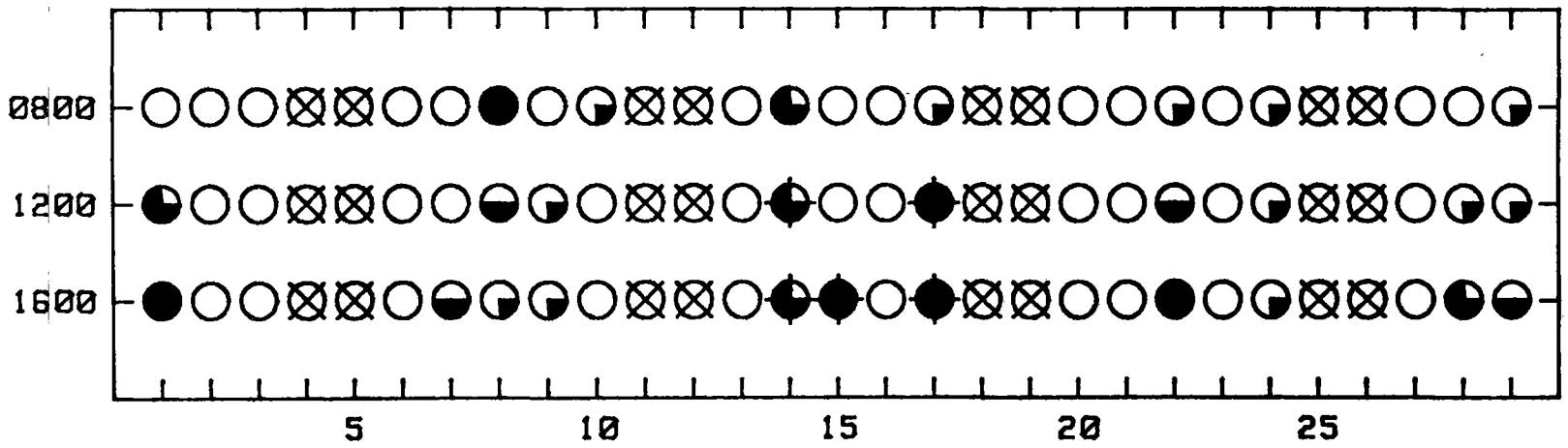
LIFE CYCLE SUMMARY

	BDM	ACUREX		SKI	CEI	FOSTER WHEELER		
		HOSES	ROT JNTS			ROT JNTS	HOSES	COLL
PRIOR MONTHS	875*	3697	1699	0	707	1161**	339	1500
FEBRUARY	0	205	205	0	93	0	0	0
MARCHR	0	529	529	0	888	0	0	0
TOTAL	875	4431	2433	0	1687	1161	339	1500

* Life cycling suspended due to flexible hose failures

** Life cycling suspended pending installation of new rotary joints; at that time, it will be continued with two rotary joints and two flexible hoses.

MISR SITE WEATHER DATA
FEBRUARY, 1984

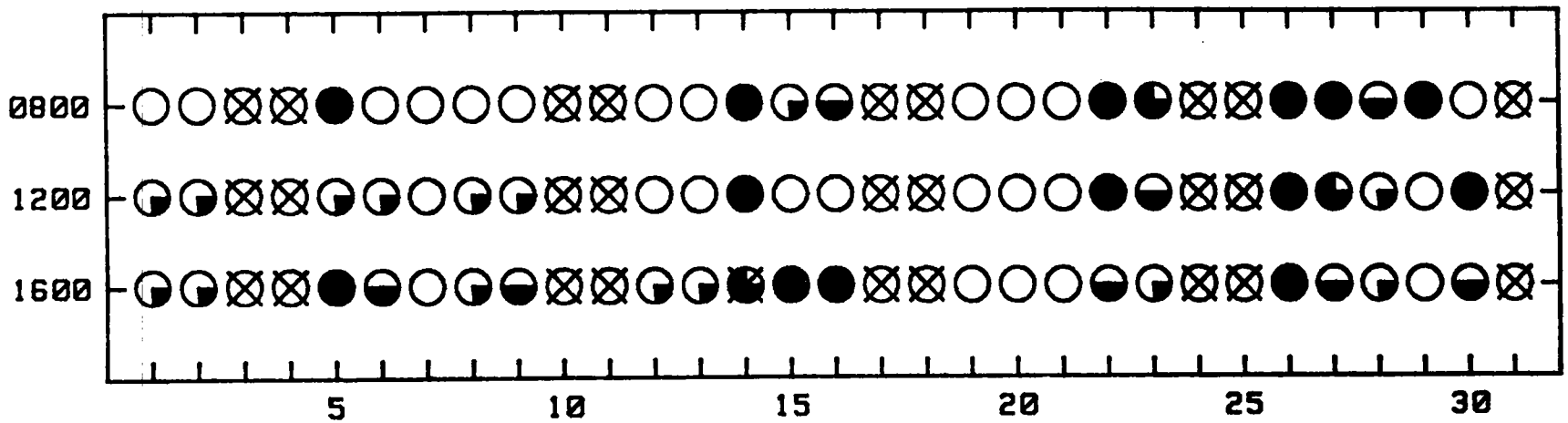


KEY

○ CLEAR	◕ MOSTLY CLOUDY
◔ MOSTLY CLEAR	● CLOUDY
◒ PARTLY CLOUDY	⊕ HIGH WINDS

⊠ TEST SITE NOT MANNED

MISR SITE WEATHER DATA
MARCH, 1984



KEY

○ CLEAR	◕ MOSTLY CLOUDY
◔ MOSTLY CLEAR	● CLOUDY
◒ PARTLY CLOUDY	⊕ HIGH WINDS

⊠ TEST SITE NOT MANNED

The steam generator level control on the CEI QTS has failed. It was determined that the differential pressure transducer which senses the level had failed. It was replaced with a similar unit and normal operation was verified; however, the next morning this unit had also failed. Investigation of the problem continues.

The master control computer for the CEI QTS has occasionally displayed incorrect time or date and other locations in RAM have also changed. The backup battery has been checked and is functioning normally.

Foster Wheeler

Submittal drawings were received from Foster Wheeler for a rotary joint for pressurized water applications. The joint that they have selected is the Aeroquip joint, but with 600 pound flanges and a grease fitting and vent hole in the bearing body. The latter are to minimize corrosion should water leak into the bearing area. Foster Wheeler will install two of these in their MISR system at SERI. Following a brief hot test, life cycling of the system will resume.

3.4 Dish Electric Field Experiment Support - Two Small Community Solar Experiments (SCSE's) are planned for evaluation of solar electric 100 kWe plants in a small community environment. The DOE has selected Osage City, Kansas and Molokai Island, Hawaii as sites for these experiments. Each SCSE will use point-focus concentrators and heat engines. New development of components and subsystems is not envisioned as part of the SCSE's. A competitive solicitation for proposals was issued for the DOE/AL in FY1984. SNLA will provide technical and management support to DOE/AL for these projects.

Osage City, Kansas - A meeting was held with representatives of Osage City to discuss and to define the technical work scope for the project. The work scope was defined and provided to DOE and to Osage City for the preparation of costs to be submitted to the DOE. A SNLA contract was let to provide topographical data, survey, and subsurface exploration of the site. This work has been completed and preliminary data has been provided to DOE/AL. Final data and a report will be provided in the next report period. The southwest corner of the site proposed by Acurex and Ford is covered by fill and refuse to a depth up to 16 feet. The northeast corner of the ten acres is undisturbed, with limestone at a depth of 5 to 6 feet, making it suitable for the SCSE. Soil characterization samples were taken in this area.

Molokai Island, Hawaii - Insolation data based on available measurements through February 1984, satellite photos and meteorological observations resulting from a SNLA contract with the Hawaiian Natural Energy Institute, were received in the form of a map with insolation lines. These data indicate the direct normal available energy day is less that previously estimated. Daily values of 3.0 kWe per square meter are indicated at the Molokai Electric proposed site. Discussions were held with the Molokai Electric Company and the Molokai Ranch and Cattle Company general manager relative to sites on the island. Other sites are available that are equally or better suited for the purposes of the experiment.

SCSE Program Opportunity Notice (PON)

Technical evaluation of the proposals received by the DOE has been completed. In addition to the planned technical evaluation, a separate SNLA team reviewed the costs proposed for the SCSE by the various proposers in support of DOE/AL.

3.5 Technology Transfer

Formal responses to requests for information or technical data were sent to five domestic and four foreign correspondents during this reporting period. Similar requests by telephone or visits probably exceed this total by a factor of ten.

TECHNICAL APPROACH OR WORK PLAN CHANGES

The activities associated with solar resource assessment on Molokai were not described in the FY84 AOP and have been added by agreement with DOE. Good insolation does not abound on Molokai and it is imperative that a quality site be selected.

All activities in support of the resolicitation of SCSE #1 at Osage City were not contemplated in the FY84 AOP and have been added within the original budget agreement with DOE and by adjusting other programmatic responsibilities.

VARIANCES

The review of the Shenandoah Test Operation Plan pointed out that the efficiency of the steam turbine could not be determined unless the output steam, flow rate, temperature, and pressure are known. The flow rate into the turbine is known, but some steam is removed to be used in the refrigerated water system. The balance flows to the condenser. Georgia Power intends to install a venturi meter, thermocouple, and pressure gauge as soon as practical.

Open items

None

FORECAST FOR NEXT REPORTING PERIOD

A request from transfer of the meteorological instruments purchased by JPL for the SCSE projects to SNLA has been made. When received, a set of instruments will be installed on Molokai to measure the climatological parameters at a southern shore site near the town of Kuanakakai and one or two installations may also be made at attractive alternate sites.

Four season weeks of typical insolation data for a site near Kuanakakai, Molokai, will be prepared by the HNEI for SNLA's use in a performance model for the Molokai SCSE.

Life cycle testing of the Acurex and Custom Engineering qualification test systems will continue.

Performance measurements at operating temperatures will continue for the FEK-244, ECP-300X, and glass reflective surfaces.

Foster Wheeler will install two rotary joints in there qualification test system at SERI.

Efficiency measurements on Solar Kinetics' 160 ft. drive group will be initiated.

Transfer of equipment from the PDTs to the DRTF will be completed and Phase B of the DRTF construction should be about 50% complete.

Contract negotiations are underway for SERI to perform theoretical computations and compare these results to those actually obtained in the Shenandoah STEP operation. This contract should be placed late in April.

The STEP evaluation tests should be well underway.

Number: 3
Date: April 1984
Period: 02/01/84 - 03/31/84
BR Code: EB 0201

PROJECT

Title: Solar IPH Projects (AOP Task 3)

CONTRACT
Number: --
Start Date: 1977
Completion Date: Continuing
Contractor: Sandia National Laboratories, Albuquerque, NM 87185

ACCOMPLISHMENTS

3.0 Solar IPH Project

Objective--The objective of the solar IPH project is to evaluate the technical feasibility of solar thermal energy for industrial process heat applications. For this project, Sandia provides technical and administrative support to DOE/ALO who manages a group of experiments that are currently in the operational phase. The task provides a focal point for reporting system performance and operation and maintenance (O&M) data for the IPH experiments.

- Project summaries reporting physical characteristics, system performance, and O&M data are included with this report. Four DOE supported Phase III projects are operational and are routinely producing energy for their respective industrial participants. One project, Lone Star Brewery, is non-operational while it is being converted from a high-temperature system using an organic heat transfer fluid to a low-temperature water system. A summary of activities at each site during February 1984 and March 1984 follows, along with information concerning owner operated systems formerly supported by DOE under the solar IPH program.

- Site Activities (DOE Supported)

  Caterpillar Tractor Co., San Leandro, CA (SWRI)

  The IPH system at Caterpillar Tractor Co., continued to operate through February and March with no significant problems. A study by SWRI showed that reflectivity of the T-700 collectors degraded from 84% to less than 35%. When part of the field was rinsed (rather than washed) the reflectivity was improved to 70%. The collector field is allowed to degrade that much because the IPH system still produces more energy than the plant can use.

Dow Chemical Co., Dalton, GA (Foster-Wheeler Development Co.)

The solar IPH system at Dow Chemical Company has been operating reliably since the re-insulation upgrade was completed in October, 1983. The system was down for a week in February, however, while a seal was replaced in the main circulating pump. The solar tracker for the pyrheliometer also failed and was returned to the manufacturer for repair.

The DOE contract with Foster Wheeler for operation of the DOW IPH experiment was extended to July 1984 to provide time for preparation of the final report. Foster Wheeler will continue to report performance data.

Lone Star Brewery, San Antonio, TX (SWRI)

Conversion of the IPH system at the Lone Star Brewery from a steam system operating with high-temperature heat-transfer fluid to a hot-water system continued during this reporting period. Solar steam equipment that will not be incorporated in the water preheat system has been removed. Other tasks underway include (1) instrument recalibration and preparation for reinstallation, (2) reconstruction of the collector field header piping to accommodate new receiver tube flex hoses, and (3) work on piping in the equipment room. Most of the mechanical equipment has been delivered, and construction is scheduled to be completed by mid-May 1984. A preliminary review of the design modifications was conducted at the Lone Star Brewery in mid-March 1984.

Southern Union Oil Refining Co., Lovington, NM (Energetics)

Search mode tracking systems were installed and hydraulic drives were modified at the Solar IPH system at Southern Union Refining Company by Solar Kinetics Inc., the manufacturers of the SKI T-700 collector. The system was put back into operation and checked out in automatic operating mode. Energetics Corporation reported that operation of the system was better in February than in any other month since it began operating two years ago. The improved performance is attributed to the upgrade activity completed early in this reporting period. During February, the system availability was 86.2% (some upgrade work was still in process), utilization was 100%, and the fuel savings were $458.

The final acceptance test of the upgrade work on the IPH system at Southern Union Refining was completed at the end of March. The test was supervised by ETEC.

The contract with Energetics Corporation for Phase III operation of the IPH system at Southern Union Refining Company was extended to June 1984 to provide time for preparation of the final report.

U.S.S. Chemical Co., Haverhill, OH (Columbia Gas Service)

The solar IPH system at U.S.S. Chemical Company continues to operate well and was in service during February and March. The contract has been modified to permit procurement of spare parts and new flex hoses.

o Site Acitivities (Owner Systems)

Campbell Soup, Sacramento, CA (Acurex)

Final approval for participation in the monitoring and reporting program has been cleared through the Campbell Soup Company main office in New Jersey. Preparation of reports and purchase of spare parts will be performed by Acurex Corporation.

The Auto 10 On-Site Data Acquisition System was replaced with another unit during the report period. Erratic operation and response was observed in the new unit. Acurex now suspects the problems are the result of excursions in the voltage level at the site. An isolation transformer will be installed to eliminate the voltage spikes. The solar system itself continues to perform well.

Capitol Concrete Products, Topeka, KS

The controller for the solar IPH system at Capitol Concrete was returned from Power Kinetics, Inc., the collector manufacturer, and was installed. The system was checked out before returning it to normal operation. Subsequently, the system was taken out of service because of a worn jack screw in the PKI point-focus Fresnel concentrator. The future of the system is being reevaluated because the plant superintendent, who operates the IPH system, left Capitol Concrete at the end of March.

Georgia Power, Atlanta, GA (Herry/Jacobs Engineering)

Approximately 5/6 of the 24,000 ft^2 parabolic reflector array has been returned to operational status following damage from freezing during the winter. The remaining damaged receiver tubes and flex hoses will be repaired during the next report period. A thorough inspection and check-out will be performed once the entire system is back on line.

Home Laundry, Pasadena, CA (Jacobs Engineering)

The final report on the IPH system at Home Laundry is being prepared by Jacobs Engineering for publication. The system has been dismantled.

Johnson & Johnson, Sherman, TX

The solar system was filled and restarted on March 29 with only minor operational problems encountered after having been shut down for the winter. Steam was produced the remaining two days of the month. Proposals for upgrading the J&J project are being prepared by Acurex and will be submitted to ETEC for review during the next report period.

Lamanuzzi and Pantaleo, Fresno, CA (California Polytechnic State University)

The roof over the heat storage tank has been repaired and plans for start-up and check-out of the system prior to the 1984 drying season are being developed. The drying season begins in August. A spare parts kit is being ordered and installation details are being prepared and are to be included with the materials in the kit.

During the report period, the project was visited by a group of six Japanese agricultural specialists interested in alternate energy systems. The group toured the facility and conversed with the owner about the operation and problems which have been encountered with the system during the past five years.

Ore-Ida Foods, Inc., Ontario, OR, (TRW)

Ore-Ida Foods is negotiating to sell their Solar IPH system to the U.S. Army for a site in Yuma, AZ, where Suntec collectors are used. The negotiation is being handled by the former TRW project manager for the system. The system is not being operated at Ore-Ida.

Riegel Textile Corp., La France, SC (SWRI)

ETEC visited the Riegal Solar Facility the week of March 6, 1984 to varify that the acceptance test punch list items were satisfactorily completed and to hold discussions with CARRE Inc., SWRI, and Riegel personnel during the final turnover to Riegel. CARRE Inc. will be performing the monitoring and preparing the reports on facility operation.

The punch list items were successfully completed except for some wet insulation which needs replacement. In a meeting with the Riegal assistant plant manager and chief engineer, ETEC stressed the need to develop and maintain personnel who would be familiar with and understand the solar energy system so that it could be operated continuously and successfully. SWRI has submitted their final report for the facility, and when the insulation repair is completed, ETEC will formally turn over the solar facility to Riegel.

Veterans Administration Medical Center, Albuquerque, NM (Jacobs Engineering)

Jacobs Engineering has conducted their final presentation of the V.A. Medical Center solar program. Future plans for the solar system are being assessed in light of a large expansion program now being proposed for the medical facility.

York Building Products, Middletown, PA (AAI)

The plant was non-operational for part of the report period for scheduled maintenance, and new flow meters were installed at that time. A feasibility study is being performed to determine the desireability of installing a new, more efficient heat exchanger. Repair and modification of on-site electronic equipment is being considered to provide data for reporting.

OPEN ITEMS

Open IPH project activities include completing the final reports for the Home Laundry IPH experiment by Jacobs Engineering, scheduled for May 1984, Dow Chemical Co. for July 1984, and Southern Union Refining Co. for June 1984.

PROJECT DESCRIPTION AND STATUS

Table 1 provides a physical description of each project and Table 2 the current status.

PERFORMANCE

Performance of solar IPH projects is summarized in this section for those projects that are currently operating under DOE funding. For these projects, data is collected and reported monthly to DOE in accordance with contractual requirements that specify a special SERI format.* Monthly totals from the contractors reports are reported in this section so that readers may follow current energy production from the projects. Both long-term performance (Tables 3 and 4) and short-term (Clear-day, Table 5) performance are summarized. Reliability of the solar energy equipment and the operational efficiency of a particular application are determined by the portion of available solar energy that is converted to useful thermal energy over the long term. Hence, long-term energy production is of prime interest.

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* SERI/MR-632-714, "Monthly Reporting Requirements for Solar Industrial Process Heat Field Tests", C. f. Kutscher and R. L. Davenport, September 1980.

TABLE 1

PHYSICAL CHARACTERISTICS
IPH SOLAR PROJECTS SUMMARY

PROJECT	COLLECTOR TYPE	COLLECTOR AREA m^2	HEAT TRANSFER FLUID	COLLECTOR FLUID TEMPERATURE	STEAM PRESSURE PSI	RATED CAPACITY, STEAM PRODUCTION LB/HR	PERCENT OF TOTAL PLANT LOAD	DESIGN ENERGY DELIVERY MBTU/YR
CAPITOL CONCRETE TOPEKA, KS	Power Kinetics Point focus	80.4	Water	300°F	45	174.5	3.0	100
CATERPILLAR TRACTOR SAN LEANDRO, CA	Solar Kinetics T-700 Parabolic Trough	4682.2	Water	235°F	--	--	60.0	14,000
DOW CHEMICAL CO. DALTON, GA	Suntec/Hexcel Parabolic Trough	922.5	Dowtherm LF	510°F	150	1,500	2.5	2,536
HOME LAUNDRY CO. PASADENA, CA	Jacobs/Del Parabolic Trough	603.5	Water	420°F	110	900	15.0	1,200
LONE STAR BREWERY SAN ANTONIO, TX	Solar Kinetics T-700 Parabolic Trough	877.9	Therminol T-55	425°F	125	1,200	3.4	3,200
ORE-IDA FOODS ONTARIO, OR	Suntec-SH1655/ Hexcell Parabolic Trough	884.4	Water	486°F	300	1,930	1.9	2,700
SOUTHERN UNION REFINING CO. LOVINGTON, NM	Solar Kinetics T-700 Parabolic Trough	936.5	Texatherm	375°F	170	1,800	9.0	3,300
USS CHEMICALS CO. HAVERHILL, OH	Solar Kinetics T-700 Parabolic Trough	4682.3	Therminol 60	425°F	52	10,430	0.5	12,000
CAMPBELL SOUP CO. SACRAMENTO, CA	Western Solar Develop., Flat Plate, Acurex Parabolic Trough (Upgrade)	371.6 278.7	Water	195°F				180
GILROY FOODS GILROY, CA	GE TC-100 Evacuated tube (Upgrade)	552.8	Water	194°F				2,400
JOHNSON & JOHNSON SHERMAN, TX	Acurex 3001-03 (Coilmak) Parabolic Trough	1068.0	Water	375°F	160	1,200	2.0	1,500
LA COUR KILN CO. CANTON, MS	Flat plate, Chamberlain (Upgrade)	234.1	Water/Air	200°F				
RIEGEL TEXTILE CO. LA FRANCE, SC	Flat plate, Hyperion (Upgrade)	620.6	Water/glycol	100°F			2.0	
YORK BUILDING PRODUCTS CO, INC. MIDDLETOWN, PA	Linear, concentrating single-axis tracking, fixed receiver	836.0	Water	200°F			33.0	
LAMANUZZI AND PANTALEO FOODS, FRESNO, CA	Flat plate, site built	2006.7	Air	185°F			7.0	3,672

TABLE 2

IPH PROGRAM STATUS

PROJECT	PHASE I STARTED	PHASE I COMPLETE	PHASE II COMPLETE	UPGRADE COMPLETE	ACCEPTANCE TEST	END OF CONTRACT	ACTIONS PENDING
CAMPBELL SOUP CO. SACRAMENTO, CA				6/82	7/82	9/82	
CAPITOL CONCRETE TOPEKA, KS	1/81	9/81	5/82		8/82	12/82	
CATERPILLAR TRACTOR SAN LEANDRO, CA	9/79	7/80	11/82		2/83	9/84	
DOW CHEMICAL CO. DALTON, GA	9/78	9/79	1/82		11/81	7/84	FINAL REPORT
GILROY FOODS GILROY, CA				10/81		9/81	
HOME LAUNDRY CO. PASADENA, CA	9/77	1/81	4/82		4/82	5/84	FINAL REPORT
JOHNSON & JOHNSON SHERMAN, TX	7/77	12/78	12/79	---	2/80	3/81	
LA COUR KILN CO. CANTON, MS				5/82	5/82	3/82	
LAMANUZZI AND PANTALEO FOODS FRESNO, CA	5/76	4/77	5/77	6/82	4/77	6/82	
LONE STAR BREWERY SAN ANTONIO, TX	9/78	9/79	12/81		1/82	11/84	CONVERSION FROM OIL TO WATER
ORE-IDA FOODS ONTARIO, OR	9/78	7/80	8/81		6/81	3/83	
RIEGEL TEXTILE CO. LA FRANCE, SC				6/83	10/83	8/83	
SOUTHERN UNION REFINING CO. LOVINGTON, NM	9/78	9/79	1/82		1/82	6/84	FINAL REPORT
USS CHEMICALS CO. HAVERHILL, OH	9/79	11/80	3/82		5/82	9/84	FLEX HOSE REPLACEMENT, AND SPARE PARTS PROCUREMENT

TABLE 3

IPH MONTHLY PERFORMANCE STATUS
FOR JANUARY 1984

PROJECT	COLLECTOR ARRAY SIZE M^2	INSOLATION IN PLANE OF COLLECTOR GJ	ENERGY DELIVERED GJ	SYSTEM THERMAL EFFICIENCY %	COMMENTS
CATERPILLAR TRACTOR SAN LEANDRO, CA	4,682.3				SYSTEM AVAILABLE FOR OPERATION ON 29 DAYS AND USED 21 DAYS; SYSTEM DOWN 2 DAYS FOR DAS MAINTENANCE
Current Month		615	60	9.8	
Cumulative, 15 Months		6057	1678	27.7	
DOW CHEMICAL CO. DALTON, GA	922.5				SYSTEM OPERATIONAL ALL MONTH, BUT SOLAR TRACKER FAILURE PRECLUDED INSOLATION DATA COLLECTION
Current Month		--	--	--	
Cumulative 6 Months		1633	247	15.1	
SOUTHERN UNION REFINING CO. LOVINGTON, NM	936.5				SYSTEM OPERATED 11 DAYS BUT DATA LOST IN 7 DAYS; NO OPERATOR 5 DAYS; SYSTEM DOWN 15 DAYS DUE TO FEED WATER FREEZE/ REPAIR
Current Month		37	6	16.2	
Cumulative, 22 Months		3071	584	19.0	
USS CHEMICAL CO. HAVERHILL, OH	4682.3				SYSTEM OPERATED ALL MONTH WITH 22 HOURS OF LOST COLLECTOR OPERATION TIME
Current Month		678	32	4.7	
Cumulative 12 months		15718	3572	22.7	

TABLE 4

IPH MONTHLY PERFORMANCE STATUS
FOR FEBRUARY 1984

PROJECT	COLLECTOR ARRAY SIZE M^2	INSOLATION IN PLANE OF COLLECTOR GJ	ENERGY DELIVERED GJ	SYSTEM THERMAL EFFICIENCY %	COMMENTS
CATERPILLAR TRACTOR SAN LEANDRO, CA	4,682.3				DATA NOT AVAILABLE
Current Month					
Cumulative, 15 Months		6057	1678	27.7	
DOW CHEMICAL CO. DALTON, GA	922.5				DATA NOT AVAILABLE
Current Month					
Cumulative 6 Months		1633	247	15.1	
SOUTHERN UNION REFINING CO. LOVINGTON, NM	936.5				SYSTEM OPERATED 25 DAYS; DOWN 4 DAYS FOR UPGRADE
Current Month		259	84	32.4	
Cumulative, 23 Months		3330	668	20.1	
USS CHEMICAL CO. HAVERHILL, OH	4682.3				SYSTEM OPERATED ALL MONTH WITH 4 HOURS
Current Month		937	190	20.3	OF LOST COLLECTOR
Cumulative 13 months		16655	3762	22.6	OPERATION TIME

Table 5

Clear Day Performance

Project	Energy Incident in Plane of Collector (GJ)	Energy Delivered To Process (GJ)	System Thermal Efficiency (%)
	JANUARY		
Caterpillar Tractor Co.	32.4	5.9	18.2
Dow Chemical Co.	--	12.5	--
Southern Union Refining Co.	7.5	2.6	34.7
	FEBRUARY		
Southern Union Refining Co.	19.7	7.9	40.1

TABLE 6

COMPARISON OF ENERGY PRODUCTION WITH THEORETICAL - JANUARY 1984

Project	Energy in Plane of Collector (GJ)	Energy Delivered To Process (GJ)	Comments
Caterpillar Tractor Co.			
Theoretical:	748	290	SYSTEM AVAILABLE FOR OPERATION ON
Adjusted Theoretical:	615	238	29 DAYS AND USED 21 DAYS; SYSTEM
Actual:	615	60	DOWN 2 DAYS FOR DAS MAINTENANCE
Southern Union Refining Co.			
Theoretical:	496	157	SYSTEM OPERATED 11 DAYS-NO OPERA-
Adjusted Theoretical:	37	12	TOR 5 DAYS; DAS FAILED TO RECORD
Actual:	37	6	DATA ON 7 DAYS; SYSTEM DOWN 15 DAYS DUE TO FEED WATER LINE FREEZE/ REPAIR
USS Chemical Co.			
Theoretical:	474	94	SYSTEM OPERATED ALL MONTH WITH
Adjusted Theoretical:	678	135	22 HOURS OF LOST COLLECTOR
Actual:	678	32	OPERATION TIME

NOTES: (1) Data not reported for Dow Chemical Co.

(2) The theoretical value for energy delivered has been adjusted for the difference between TMY and measured data by multiplying by the ratio of the measured energy in the plane of the collector to the theoretical energy in the plane of the collector.

TABLE 7

COMPARISON OF ENERGY PRODUCTION WITH THEORETICAL - FEBRUARY 1984

Project	Energy in Plane of Collector (GJ)	Energy Delivered To Process (GJ)	Comments
Southern Union Refining Co.			
Theoretical:	471	148	SYSTEM OPERATED 25 DAYS; DOWN
Adjusted Theoretical:	259	81	4 DAYS FOR UPGRADE
Actual:	259	84	
USS Chemical Co.			
Theoretical:	605	143	SYSTEM OPERATED ALL MONTH WITH
Adjusted Theoretical:	937	237	4 HOURS OF LOST COLLECTOR
Actual:	937	190	OPERATION TIME

NOTES: (1) Data not reported for Dow Chemical Co. and Caterpillar Tractor Co.
(2) The theoretical values for energy delivered has been adjusted for the difference between TMY and measured data by multiplying by the ratio of the measured energy in the plane of the collector to the theoretical energy in the plane of the collector.

Long-term performance is compared with theoretical performance (Tables 6 and 7) to give the reader a better understanding of what might be expected in the way of energy production at each location. Theoretcal performance was calculated by SERI using their SOLIPH code and Typical Meteorological Year (TMY) weather data. Actual weather conditions might vary plus or minus 10% from the TMY data on a yearly basis. To compensate for this variation, the theoretical values used in this report for energy delivered have been adjusted by multiplying them by the ratio of the measured energy in the plane of the collector to the theoretical energy in the plane of the collector. (Efficiencies are based on energy in the plane of the collector.) Another variation between measured and theoretical insolation results from the location of the instrumentation. At some of the sites, insolation in the plane of the collector is measured by pyranometers mounted on the collectors and is measured only when the collectors are in focus. TMY data provides statistically derived insolation from sunrise to sunset. This is one reason why the theoretical values are, in general, significantly greater than the measured values. Comparison of measured energy production with theoretical energy production is not a requirement of the SERI reporting format.

In addition to the energy production summaries, "availability" and "utilization" for each of the projects is reported (Table 8). Availability is the measure of mechanical reliability of the solar energy system. Utilization is an indication of the extent to which the industrial plant makes use of the solar energy system when it is available.

OPERATION AND MAINTENANCE SUMMARY

An O&M summary (Table 9) is included with this report.

Table 8

Availability and Utilization

Project	Availability (%)	Utilization
	JANUARY	
Caterpillar Tractor	94	72
Dow Chemical Co.	100	100
Southern Union Refining Co.	52	69
	FEBRUARY	
Southern Union Refining Co.	86	100

TABLE 9

IPH MONTHLY SUMMARY
OPERATION AND MAINTENANCE DATA
THRU FEBRUARY 1984

PROJECT	O&M ACTIVITY ($) ROUTINE	NON-ROUTINE	O&M TOTAL	TAXES (PROPERTY) OR INSURANCE	PARASITICS	TOTAL COSTS	FOSSIL FUEL SAVINGS
CATERPILLAR TRACTOR							
SAN LEANDRO, CA							
Current Month			834.25			834.25	
Cumulative, 12 Months			6,987.41			6,987.41	
DOW CHEMICAL							
DALTON, GA							
Current Month					21.00	21.00	81.00
Cumulative, 9 Months			7,825.00		188.00	8,013.00	2,073.00
SOUTHERN UNION							
REFINING CO.							
LOVINGTON, NM							
Current Month				154.92	71.96	226.88	458.33
Cumulative, 17 Months	1145.00	396.00	1,571.76	2,633.64	545.89	4,751.29	3,033.09

Number:	3
Date:	April, 1984
Period:	02/1/84 - 3/31/84
B & R Code:	EB-02-01
Project:	Distributed Receiver Technology and Applications Project
Title:	Solar Concentrator Technology Development (AOP Task 4)
Contractor:	Sandia National Laboratories, Albuquerque, New Mexico 87185

ACCOMPLISHMENTS

4.0 SOLAR CONCENTRATOR TECHNOLOGY DEVELOPMENT - A major issue affecting the growth and application of central and distributed solar thermal technology is the cost of the concentrator field. A major breakthrough in concentrator technology to reduce costs by a large factor is needed. The objective of this task is to determine the feasibility and potential cost effectiveness of innovative type concentrators for use in solar systems for electrical systems or process heat applications.

4.1 Dish Concentrators

Silvered Sheet Steel

Optical properties of machine polished stainless steel were measured against those of hand polished specimens, both before and after coating with silver, to determine if the production polishing method carried any quality penalty. Both types had specular reflectance of about 93% at apertures greater than 6 mrad. This represents a 4% scattering loss and a sigma value of 2 mrad.

A competitive contract was placed (with a small business establishment) for sputtered silver deposition on test coupons, and the first experimental batch of coated coupons has been received. Optical properties of these coupons are being measured at the time of this report.

A patent disclosure was made on a new type of point focus concentrator. The idea was the result of principal stress analysis indicating that tangential stress is approximately twice that of radial stress. This indicates that circumferential rings may be more effective than "petals". Therefore, the concept is designated Para-ring.

The Laser Ray Trace (LRT) inspection system has been disassembled and moved from inside the tech area at Sandia to the DRTF for reinstallation there. The system should be operational in June for inspection of troughs utilizing the same programs and set-up previously used. New approaches to inspection of long focal-length dish sections are being investigated.

Custody of the master tooling for three reflector sections of the PDC-1 plus the associated tooling and fixtures have been transferred from NASA/JPL to DOE/Sandia. These items were shipped to Sandia and stored pending further development work on dishes which could utilize them.

Samples of silvered film reflector materials which had been in environmental test chambers for three months were removed for inspection and measurement of specular reflectance. The samples, on aluminum substrates, were subjected to accelerated thermal cycling with alternate weeks of summer (+55^{o}F to +130^{o}F) and winter (-20^{o}F to 55^{o}) cycling extremes. Reflectance measurements will be reported when available.

Representatives of Texas Tech University visited Sandia on March 28 to review the status and process of evaluation of the proposals received for fabrication of replacement mirrors for the Crosbyton FMDF project. Proposals for development of reflector panels for the large diameter FMDF bowl) had not been received by the date of their visit. The results of their review of those proposals will be presented during a trip to SNLA/DOE or by phone.

4.2 Central Receiver Heliostats

Sandia Livermore issued an RFP for Design and Fabrication of a Stressed Membrane Heliostat to 42 potential bidders on March 2. Issuance of this RFP met Solar Thermal Controlled Milestone for "Release RFP for stretched membrane heliostat Design and Fabrication". The proposal review panel will convene in May to evaluate the proposals.

TECHNICAL APPROACH OR WORK PLAN CHANGES

The proposal receipt date for the Innovative Concentrator PON issued in January has been extended to April 16, 1984. The proposal evaluation panel from JPL, SERI, SNLL, and SNLA will convene in early May.

VARIANCES

None

Open items

None

FORECAST FOR NEXT REPORTING PERIOD

A contract will be initiated for ion plating of coupons to support matrix of process investigations in the Metallurgy Department

Silver coated coupons will be coated with various formulations of Sol-Gel glass solutions and processed according to a planned matrix of process variables. They will then be subjected to environmental exposure, with optical property measurements at appropriate points in the entire process, to determine a coating composition and process which will provide long term silver protection.

The Solar Central Receiver Meeting will be held in San Diego on April 24, 25, and 26, 1984. A presentation will be made on the Heliostat Development Program by SNLA, followed by presentations by SERI and SNLL on reflective polymer and membrane heliostat development efforts.

PROBLEM AREAS

None.

SOLAR THERMAL DISTRIBUTED RECEIVER TECHNOLOGY DEVELOPMENT AND APPLICATIONS PROJECT MONTHLY TECHNICAL STATUS REPORT

February and March, 1984

JPL	A. Marriott
SERI	B. L. Butler
SERI	B. Gupta
SERI	J. Thornton
DOE/HQ	M. R. Scheve
DOE/HQ	J. Greyerbiehl
DOE/HQ	C. Carwile
DOE/HQ	C. Mangold
DOE HQ	K. O'Kelley
DOE/HQ	F. Wilkins
DOE/AL	D. Graves
DOE/AL	J. Hanson
DOE/AL	D. L. Krenz
DOE/AL	G. N. Pappas
DOE/AL	J. Weisiger
DFVLR	C. Selvage

0143	H. A. Romme
0400	R. P. Stromberg
1513	D. W. Larson
1810	T. G. Kepler
1820	R. E. Whan
1830	M. J. Davis
1840	R. J. Eagan
2540	K. Gillespie
3160	J. E. Mitchell
6200	V. L. Dugan
6220	D. G. Schueler
6220	J. Hanna
6221	E. L. Burgess
6222	J. V. Otts
6222	C. P. Cameron
6224	E. C.Boes
6225	R. H. Braasch
6228	J. F. Banas
6246	B. Granoff
8450	J. B. Wright
8454	J. B. Woodard
6227	J. A. Leonard (3)