DOE/ET-0078

SOLAR THERMAL POWER SYSTEMS

Program Summary

Prepared for the U.S. Department of Energy
Assistant Secretary for Energy Technology
Office of Solar, Geothermal, Electric and Storage Systems
Washington, D.C. 20545

December 1978

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Preface

On October 26, 1974, the Solar Energy Research, Development and Demonstration Act (Public Law 93-473) was signed into law, authorizing a vigorous Federal program of research, development, and demonstration. Its goal was to provide the nation with the option of using solar energy as a new source for meeting future requirements. In response to the mandates of this act, major efforts were made within the Division of Solar Energy of the Energy Research and Development Administration (ERDA) to expeditiously develop and introduce economically competitive and environmentally acceptable solar energy systems.

These responsibilities were transferred to the newly organized U.S. Department of Energy (DOE) on October 1, 1977. Presently DOE's solar energy activities are divided into three distinct organizational components:

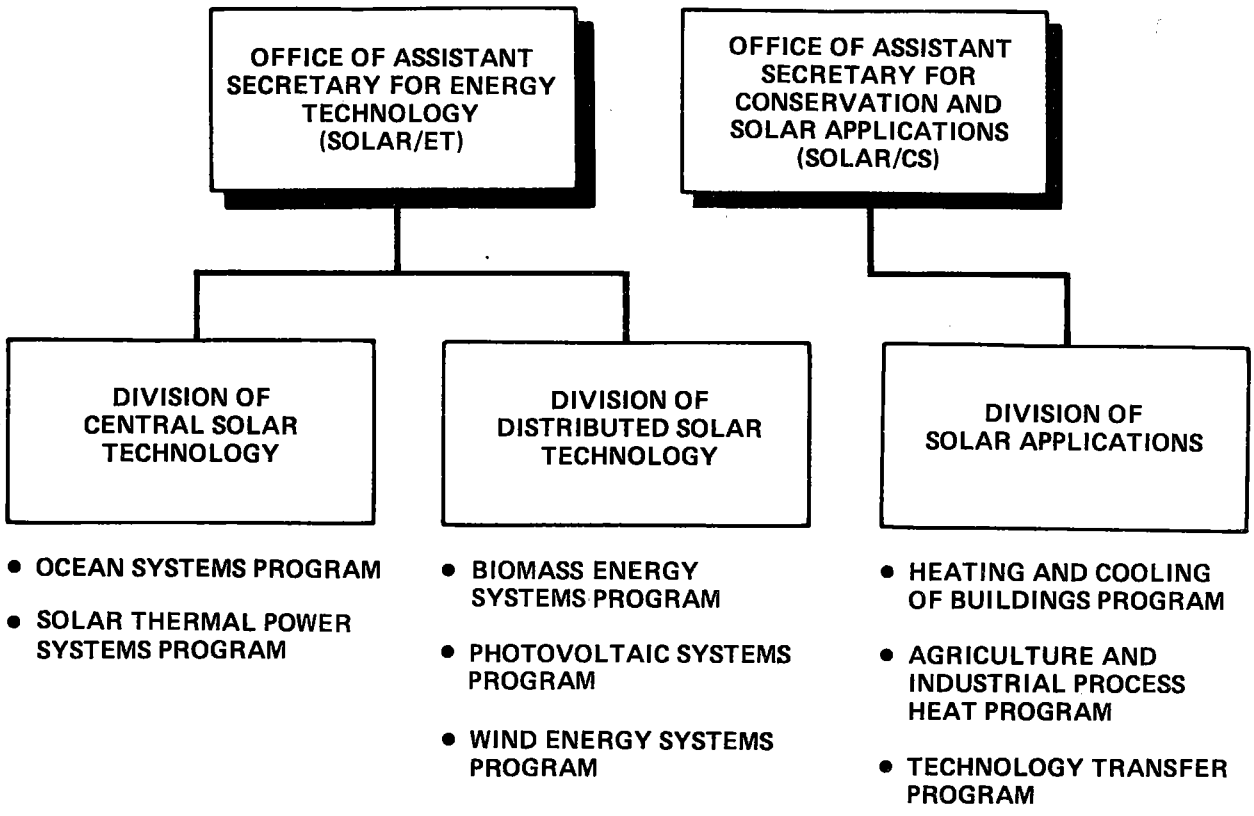
- Division of Central Solar Technology
  - Ocean Systems Program
  - Solar Thermal Power Systems Program
- Division of Distributed Solar Technology
  - Biomass Energy Systems Program
  - Photovoltaic Systems Program
  - Wind Energy Systems Program
- Division of Solar Applications
  - Heating and Cooling of Buildings Program
  - Agriculture and Industrial Process Heat Program
  - Technology Transfer Program

Both the Division of Central Solar Technology and the Division of Distributed Solar Technology come under the jurisdiction of the Office of Assistant Secretary for Energy Technology (SOLAR/ET), while the Division of Solar Applications comes under the jurisdiction of the Office of the Assistant Secretary for Conservation and Solar Applications (SOLAR/CS). An overview of the current DOE solar program organization is shown on page iv.

Program planning continues under the guidelines established by PL 93-473 and by three other legislative acts passed by the 93rd Congress: the Solar Heating and Cooling Demonstration Act of 1974 (PL 93-409), the Energy Reorganization Act of 1974 (PL 93-438), and the Federal Nonnuclear Energy Research and Development Act of 1974 (PL-577). Together these four laws grant DOE and other Federal agencies the authority to pursue a research program aimed at effective solar energy use. Under this authority, SOLAR/CS and SOLAR/ET are working to develop solar energy technologies and to complement efforts in the private sector to develop solar energy resources.

A program summary is issued for each solar program annually. Each summary provides an overview of the ongoing research, development, and demonstration efforts of the preceding fiscal year (FY).

This program summary describes each of the DOE's Solar Thermal Power Systems projects funded and/or in existence during FY 1978 (October 1, 1977 through September 30, 1978) and reflects their status as of September 30, 1978. This document is a follow-up to the FY 1977 Solar Thermal Power Systems Program Summary (DOE/ET0018/1 published in January 1978), which can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.



DOE Solar Program Organization

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Introduction

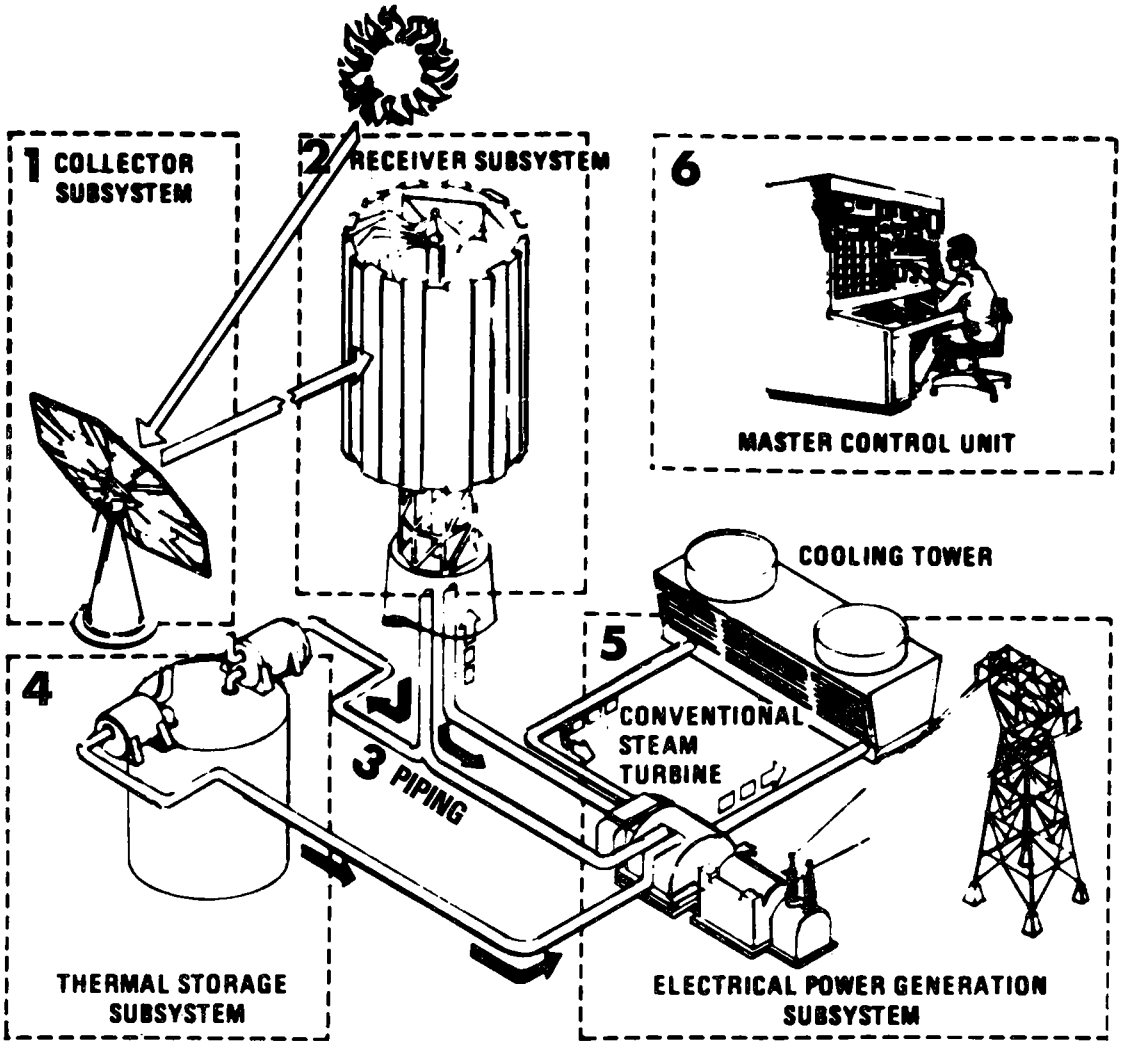
The Solar Thermal Power Systems Program is a key element in the overall national effort to establish solar conversion technologies within the major sectors of the national energy market.

The systems under development collect and concentrate the sun's radiant energy in order to heat or vaporize a fluid at high temperatures. The heat can then be converted to electrical or mechanical power or applied directly to high-temperature processes. Systems can be placed either at the point of energy use or at a central location from which energy is delivered to the user by the utility grid.

A SOLAR ENERGY CONVERSION SYSTEM

The figure below illustrates the major parts of a solar thermal energy conversion system. In general, these systems can be broken down into the following elements:

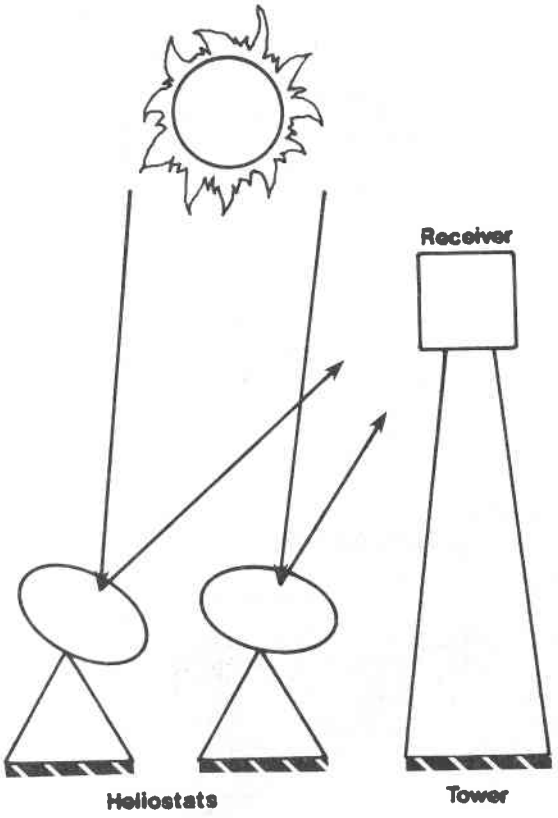
1. Lenses or mirrors to collect and concentrate sunlight.
2. Heat receivers to absorb the concentrated radiant energy.
3. Energy transport systems (piping) to couple the receivers with the conversion and storage elements.
4. Energy storage elements, e.g., tanks containing high-temperature fluid.
5. Heat engines to drive generators.
6. Control systems to integrate and coordinate the operation of the other elements.



TWO SYSTEM CONCEPTS

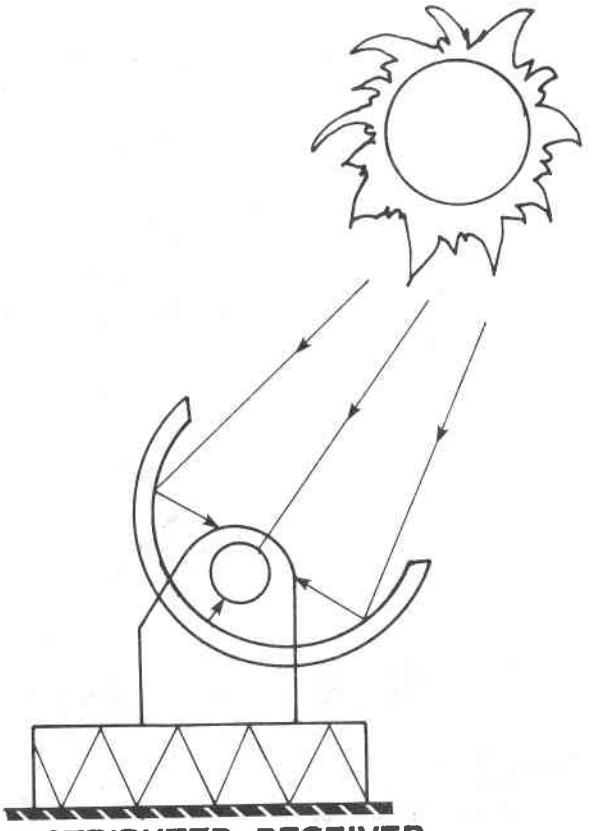
Two broad classes of concentrators exist that encompass the wide variety of possible system concepts.

In the central receiver approach, a large number of concentrating tracking elements called heliostats are controlled so that each delivers reflected sunlight to the same centrally located receiver. Because the receiver is atop a tower in most designs, this approach is often referred to as the "power tower."



CENTRAL RECEIVER

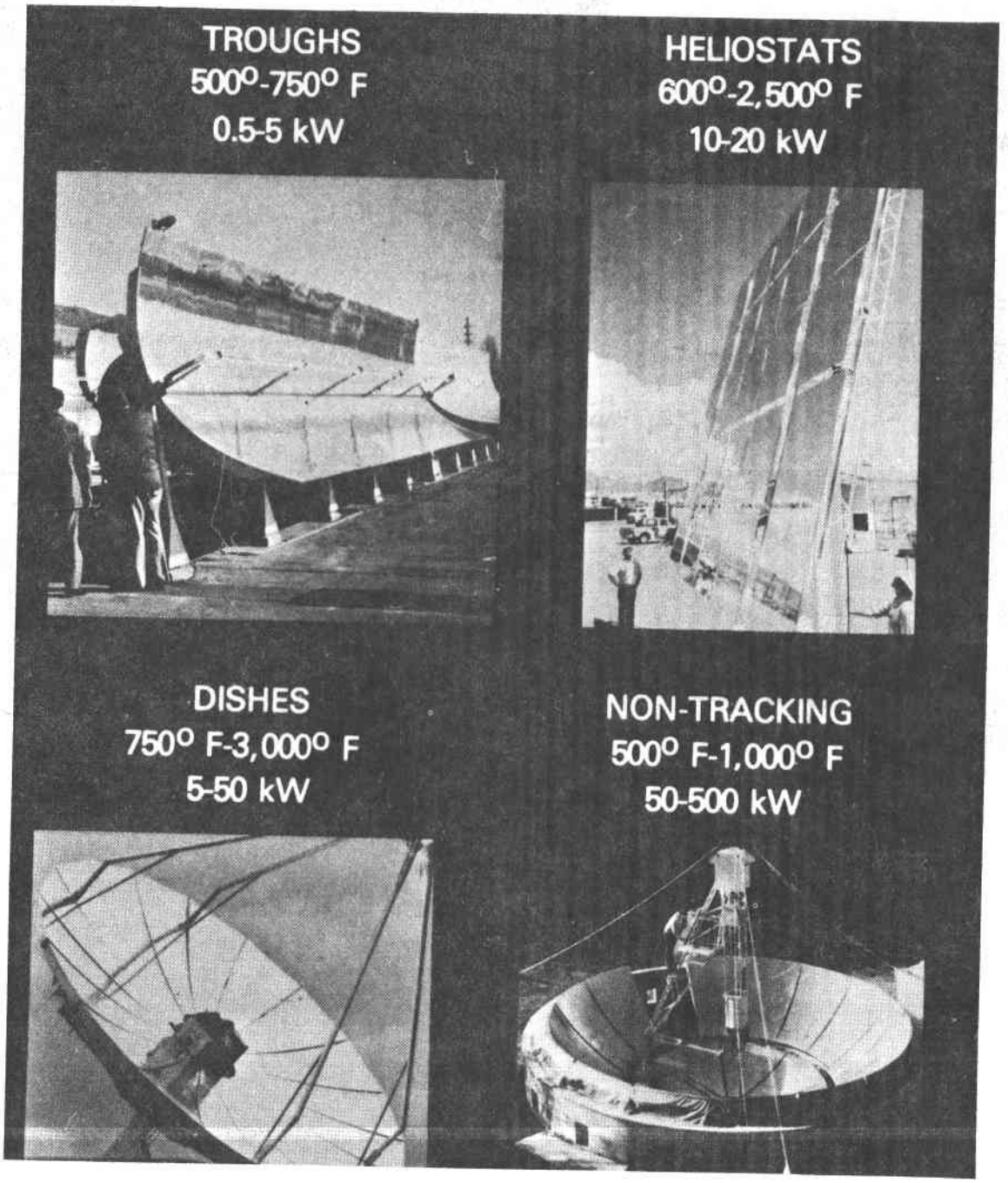
In the distributed receiver approach, the heat absorber is integral with the concentrating element.



DISTRIBUTED RECEIVER

CONCENTRATOR DESIGN CONCEPTS

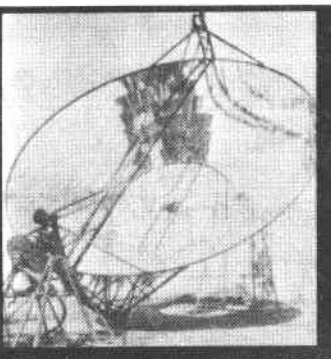
Numerous concentrator design concepts are under development. The basic element of all these concepts is an individual mirror assembly ranging in output from 500 watts to 500 kilowatts (kW). Because of the differences in concentrating capability, temperatures that can be produced efficiently vary between a few hundred degrees Fahrenheit to 3,000°F. Systems that can be assembled from the concentrator building blocks range in output from a few kW to a few hundred megawatts (MW).



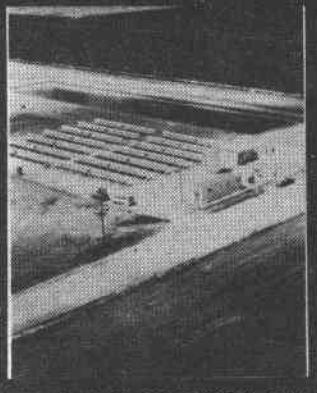
TECHNICAL FEASIBILITY HAS BEEN ESTABLISHED

The technical feasibility of concentrator systems has long been established. However, early systems were assembled in the days before the first assembly line had its impact on industrial development and before oil and natural gas had become mainstays of our energy economy. The technology development under way today attempts to apply modern design and manufacturing techniques to the concepts long known to be technically feasible.

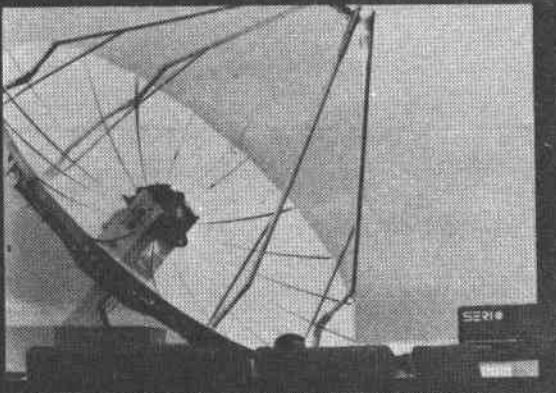
50-HP SOLAR IRRIGATION PUMP
AT MEADI, EGYPT—1913



33-FT PARABOLIC DISH, CAWSTON OSTRICH FARM
PASADENA, CALIFORNIA—1901



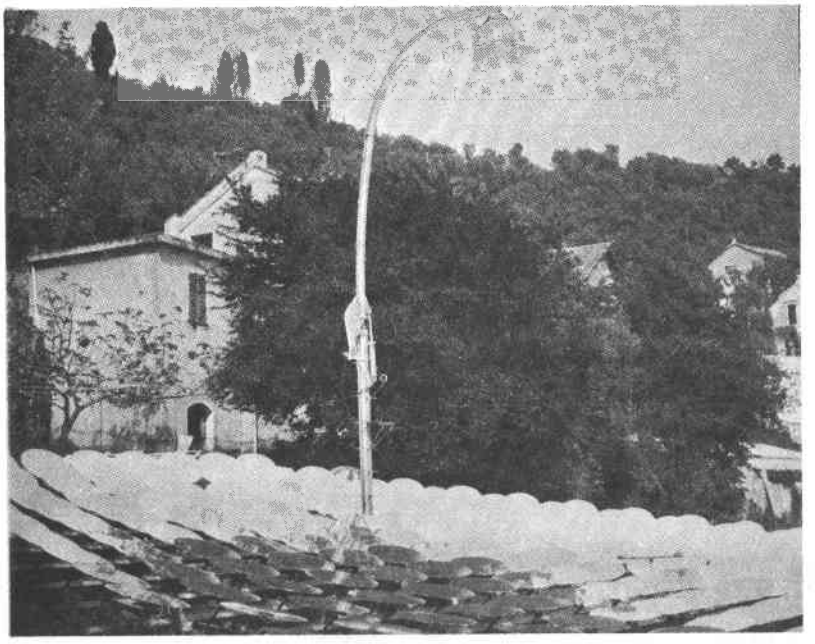
25-HP SHALLOW WELL PUMP
WILLARD, N.M.



37-FT PARABOLIC DISH "OMNIUM-G"
SERI—GOLDEN, COLORADO

Note the striking resemblance of the concentrator systems being tested today at Willard, New Mexico and Golden, Colorado to the systems built for the same purposes in the early 1900's.

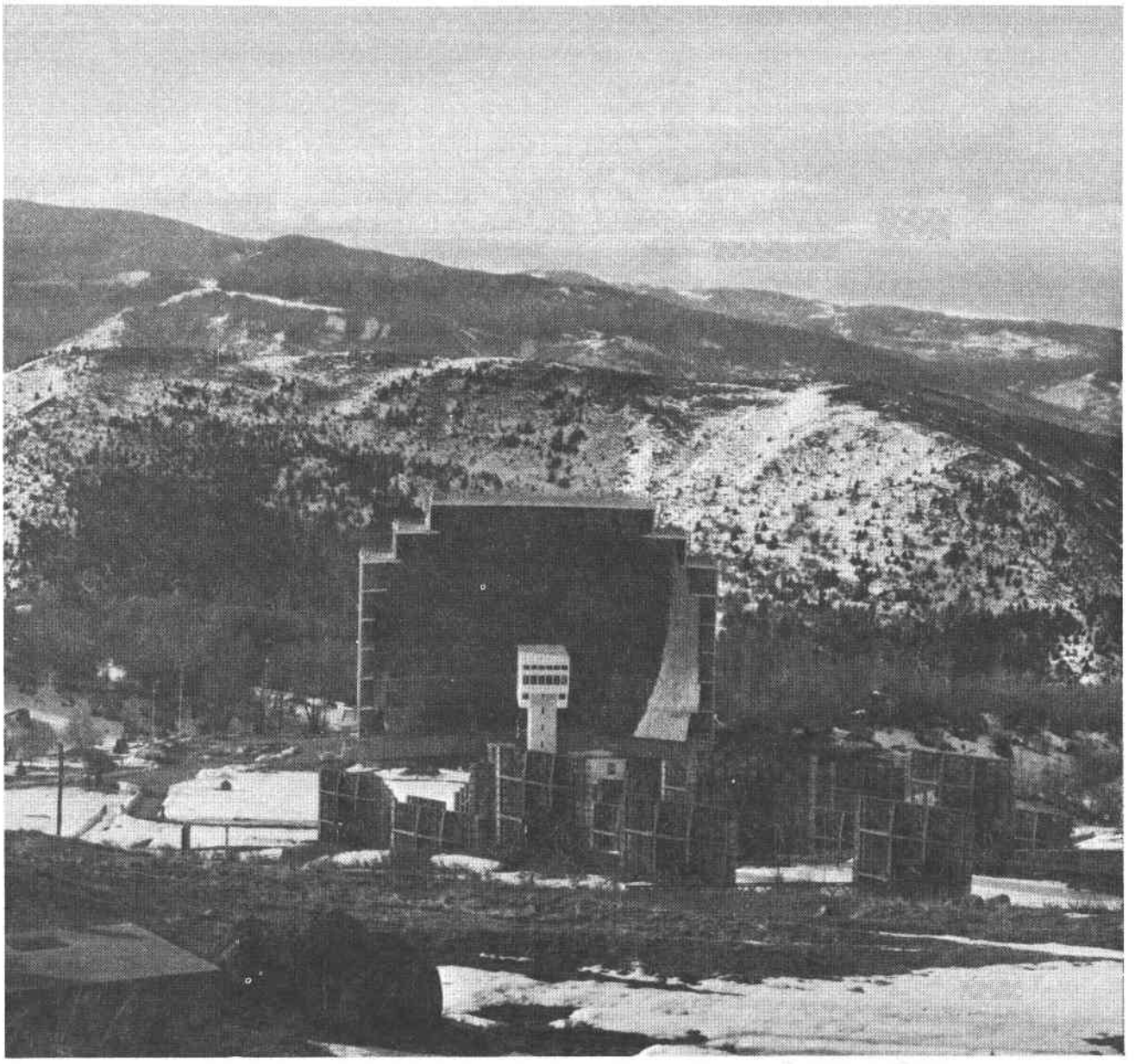
1978



CENTRAL RECEIVER
TEST FACILITY AT GENOA, ITALY

ADVANCED COMPONENTS TEST FACILITY
AT THE GEORGIA INSTITUTE OF TECHNOLOGY

The Advanced Components Test Facility now in operation at the Georgia Institute of Technology is patterned after a system that has been operating in Genoa, Italy for several years.

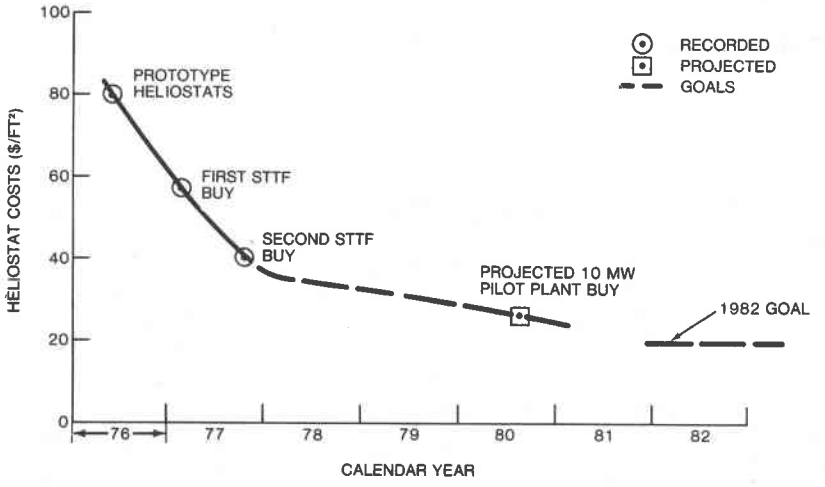


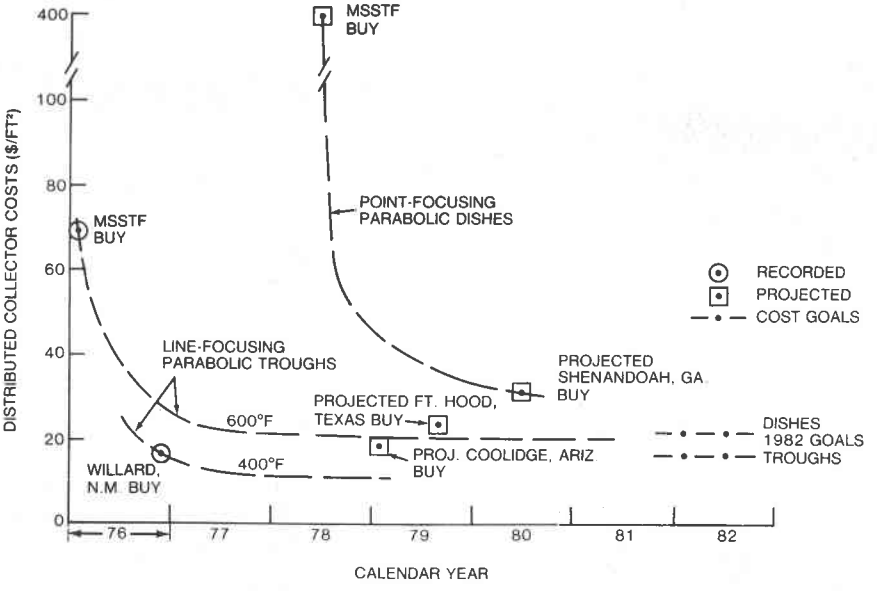
Central receiver technology has already been put to use by the French in their megawatt thermal (MWt) solar furnace in Odeillo, France. This furnace is used for materials production and metallurgy experiments.

SYSTEM COST GOALS

The Solar Thermal Power Systems Program objective is to establish the technical and operational readiness of full-scale central receiver and distributed receiver systems by the mid-1980's. System costs goals have been established, and efforts are under way to reduce costs to within a factor of two of the economic breakeven point by 1983 for small thermal power systems and by 1985 for large thermal power systems. Subsystem cost goals have also been established, and progress on critical items such as heliostats is being closely monitored (see figure below). Initial heliostat, trough, and dish concentrator cost experience has been encouraging and consistent with the plan.

HELIOSTAT PRODUCTION COSTS

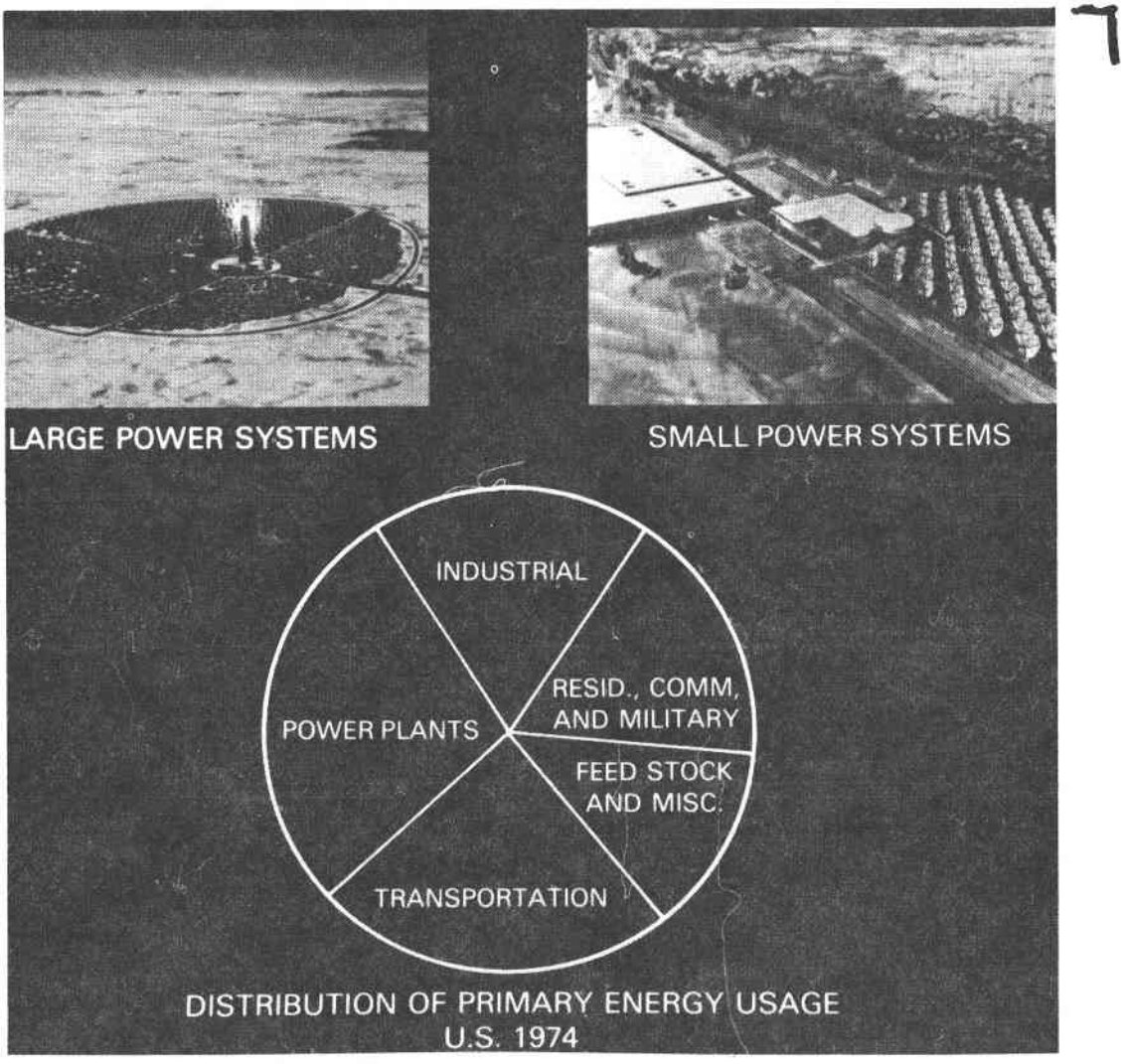




INSTALLED COSTS OF DISTRIBUTED COLLECTORS

SOLAR THERMAL POWER APPLICATIONS

As illustrated in the figure below, the thermal power systems effort is unique among the solar programs in providing technology to serve all major sectors of the national energy economy. The DOE Solar Thermal Power Systems Program is structured around large and small power applications. Both are expected to become commercially available in the 1980's. The large thermal power applications program element includes production of electricity in central receiver power plants larger than 10 MW and other applications of similar scale. The small thermal power applications program element deals with systems smaller than 10 MW as well as the industrial, commercial, residential, and institutional applications to which small systems based on distributed receiver collectors can be readily applied. Beyond the 1980's, the high-temperature capability of advanced design central receivers and parabolic dish distributed receiver concentrators should be able to be applied to processes for production of transportable fuels and essential chemicals. The advanced thermal technology program element addresses this opportunity directly with appropriate component and process development.



Strategy

To achieve these objectives and goals, the program strategy directs system design efforts toward applications having favorable conditions for early market penetration. For each key application, an orderly engineering development program is under way which includes the following:

- Concentrator and component evaluation and characterization.
- Subsystem design and performance verification.
- System integration experience via large- and small-scale experiments as appropriate.
- Industrialization and cost-reduction initiatives as appropriate.

The applications and engineering development programs are complemented and enhanced by a program of advanced development seeking performance improvements in the major subsystems and components.

Program Management

To streamline the development efforts and application programs, technical program management has been decentralized to DOE field offices, to major engineering laboratories (including Sandia and the Jet Propulsion Laboratory), and to the newly created Solar Energy Research Institute (SERI). DOE field offices are expected to carry forward the major applications programs with the support of the engineering laboratories. Advanced development responsibilities are rapidly being transferred to SERI. Major experiments are phased with go/no go decisions scheduled at key points. Intermediate cost goals have been established as a frame of reference for these decisions.

FUNDING

In FY 1978 (October 1, 1977-September 30, 1978) and 1979 (October 1, 1978-September 30,1979), the overall Solar Thermal Power Systems Program funding level amounts to roughly $100 million per year. The distribution of funding among the major program elements is indicated in the figure below.

BUDGET STATUS

	FISCAL YEAR 1978	FISCAL YEAR 1979
LARGE POWER	$ 21,800,000	$ 27,000,000
SMALL POWER	28,100,000	28,000,000
ADVANCED TECHNOLOGY	10,200,000	14,000,000
BARSTOW PILOT PLANT	41,000,000	28,000,000
CAPITAL EQUIPMENT	3,000,000	3,000,000
TOTAL	$104,100,000	$100,000,000

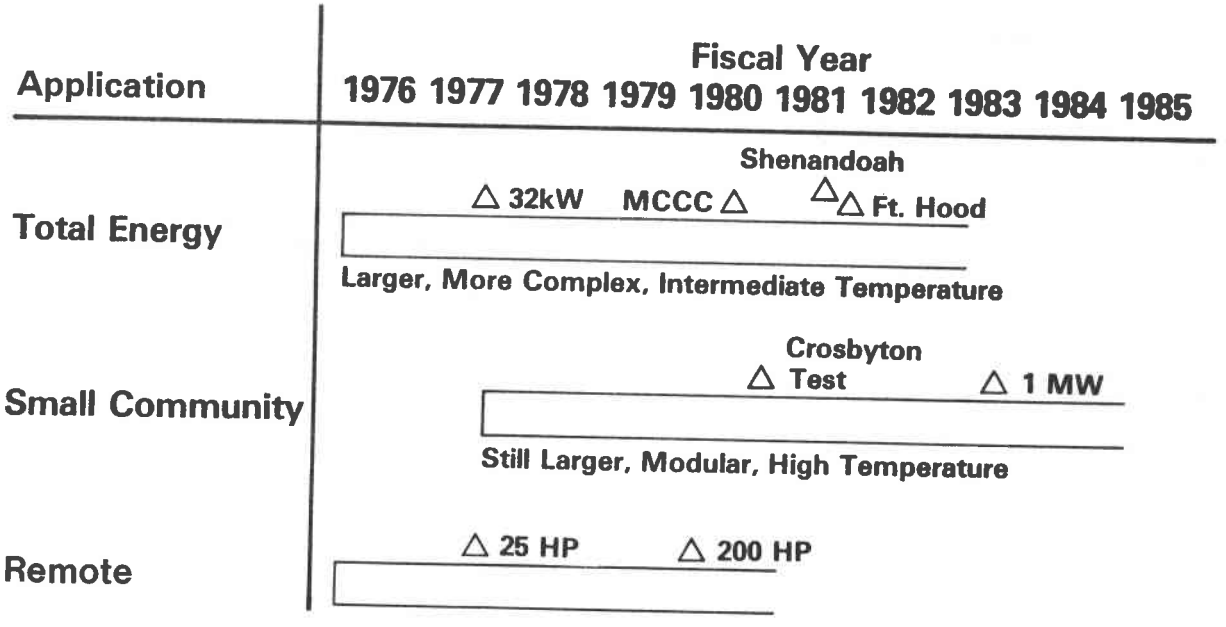
SMALL THERMAL POWER APPLICATIONS

As indicated in the milestone chart below, the small thermal power applications program element emphasizes system development for three applications:

- Total energy systems (onsite electric combined with heating and cooling).
- Small community systems (small electric power plants for small community or rural electric needs).
- Remote systems (irrigation pumping).

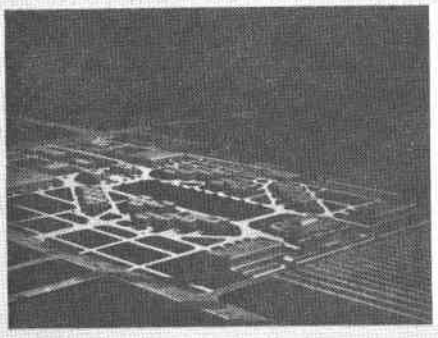
In addition, component and subsystem development efforts for three major categories of distributed receiver collectors are under way. They include:

- Mid-temperature and linear focusing collector development and operation of the Mid-temperature Solar Systems Test Facility.
- Point focusing dish concentrator development including component development at the NASA/JPL Edwards Air Force Base Test Site and at SERI.
- Development of the fixed dish concentrator technology via a project sited at Crosbyton, Texas and conducted by Texas Technical University.

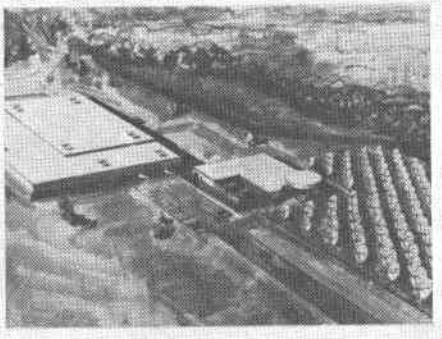


TOTAL ENERGY SYSTEMS

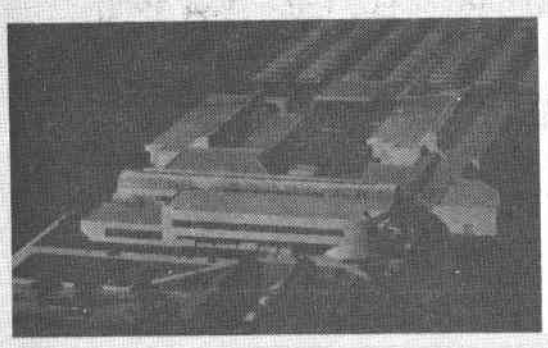
Preliminary designs for the Fort Hood and Shenandoah large-scale experiments have been completed and component and array characterization and evaluation in support of the Shenandoah project have been initiated at the Mid-temperature Solar Systems Test Facility in Albuquerque. Equipment suppliers have been selected for the photovoltaic total energy system experiment at Mississippi County Community College (MCCC) in Blytheville, Arkansas. The construction phase of the Fort Hood, Shenandoah, and MCCC projects, depicted below, is scheduled to begin in FY 1979.



MILITARY COMPLEX –
FORT HOOD, TEXAS



KNITWARE PLANT –
SHENANDOAH, GEORGIA

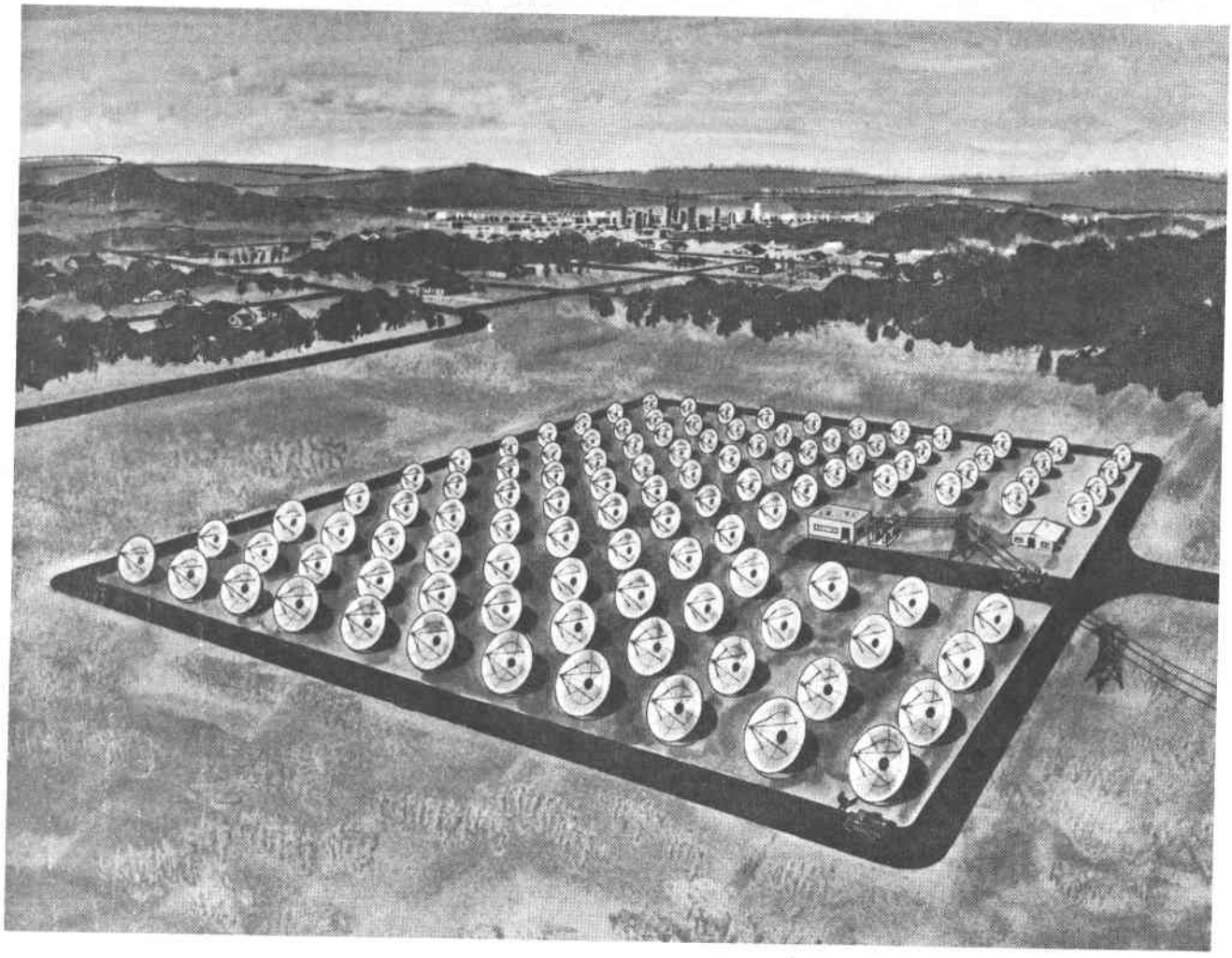


MISSISSIPPI COUNTY COMMUNITY
COLLEGE, ARKANSAS

MID-TEMPERATURE SOLAR
SYSTEMS TEST FACILITY

SMALL COMMUNITY SYSTEMS

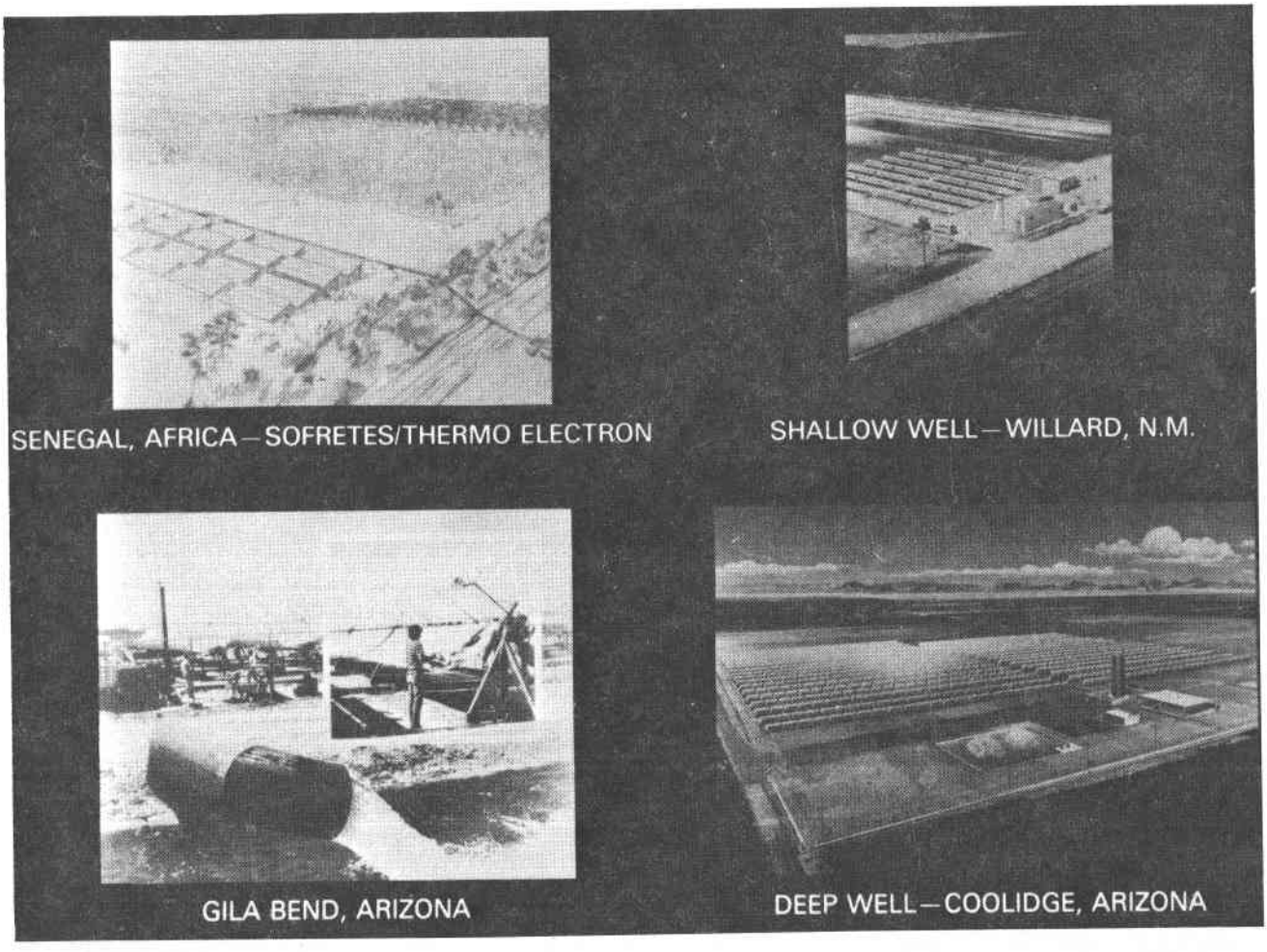
The figure below illustrates one of the concepts selected for development in the conceptual design phase of the program to build a 1 MW-scale small community solar thermal power system experiment. The concepts under development encompass the most promising system concepts for this scale of electric power production. They include a central receiver design (McDonnell Douglas) system based on point focusing dishes and a thermal energy transport (General Electric), and a concept involving a small Stirling engine coupled directly to high temperature and electrical energy transport to the busbar (Ford Aerospace). In addition, design and construction of a 65-ft. fixed dish concentrator test module has been initiated at Crosbyton, Texas by Texas Technical University as a basis for studies of a large-scale experiment to provide power for that community.



SYSTEM CONCEPT

REMOTE (IRRIGATION) SYSTEMS

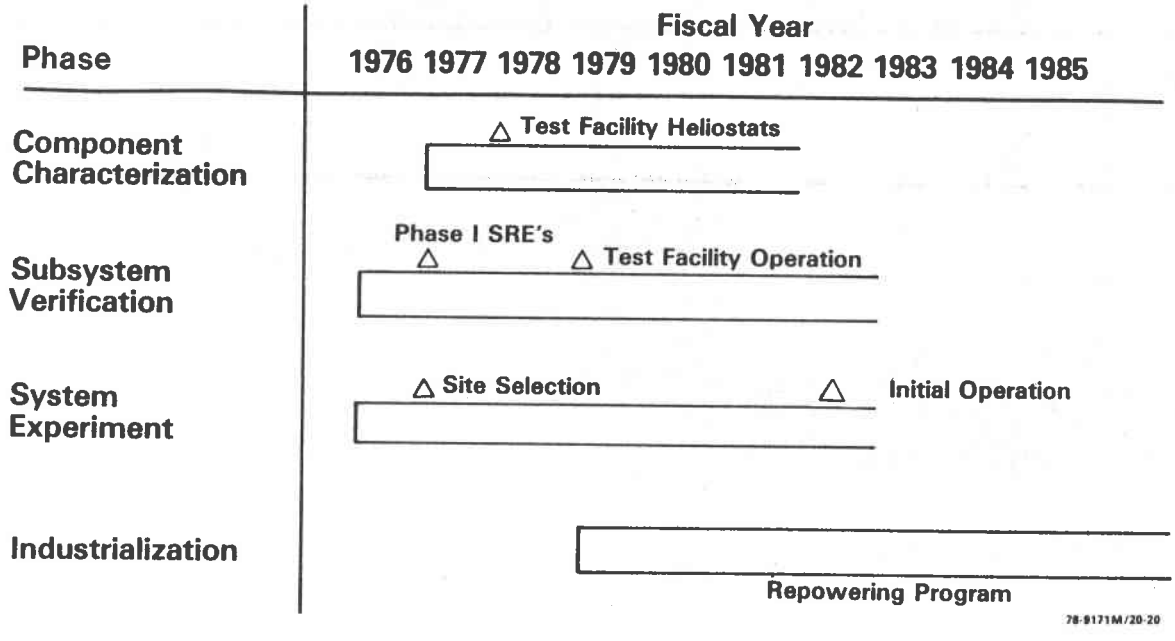
The shallow well irrigation pumping experiment at Willard, New Mexico has completed one year of successful operation. Construction has begun on the 200 hp deep-well experiment at Coolidge, Arizona. In addition, DOE has assumed responsibility for the existing privately funded irrigation pumping experiment at Gila Bend, Arizona to gain operating and maintenance experience and data from an additional major systems experiment. As illustrated in the upper left hand picture, use of solar thermal systems for irrigation is expanding to demonstration projects involving American companies in lesser developed countries. The DOE program is geared to provide a solid technology base for such activity.



LARGE THERMAL POWER APPLICATIONS

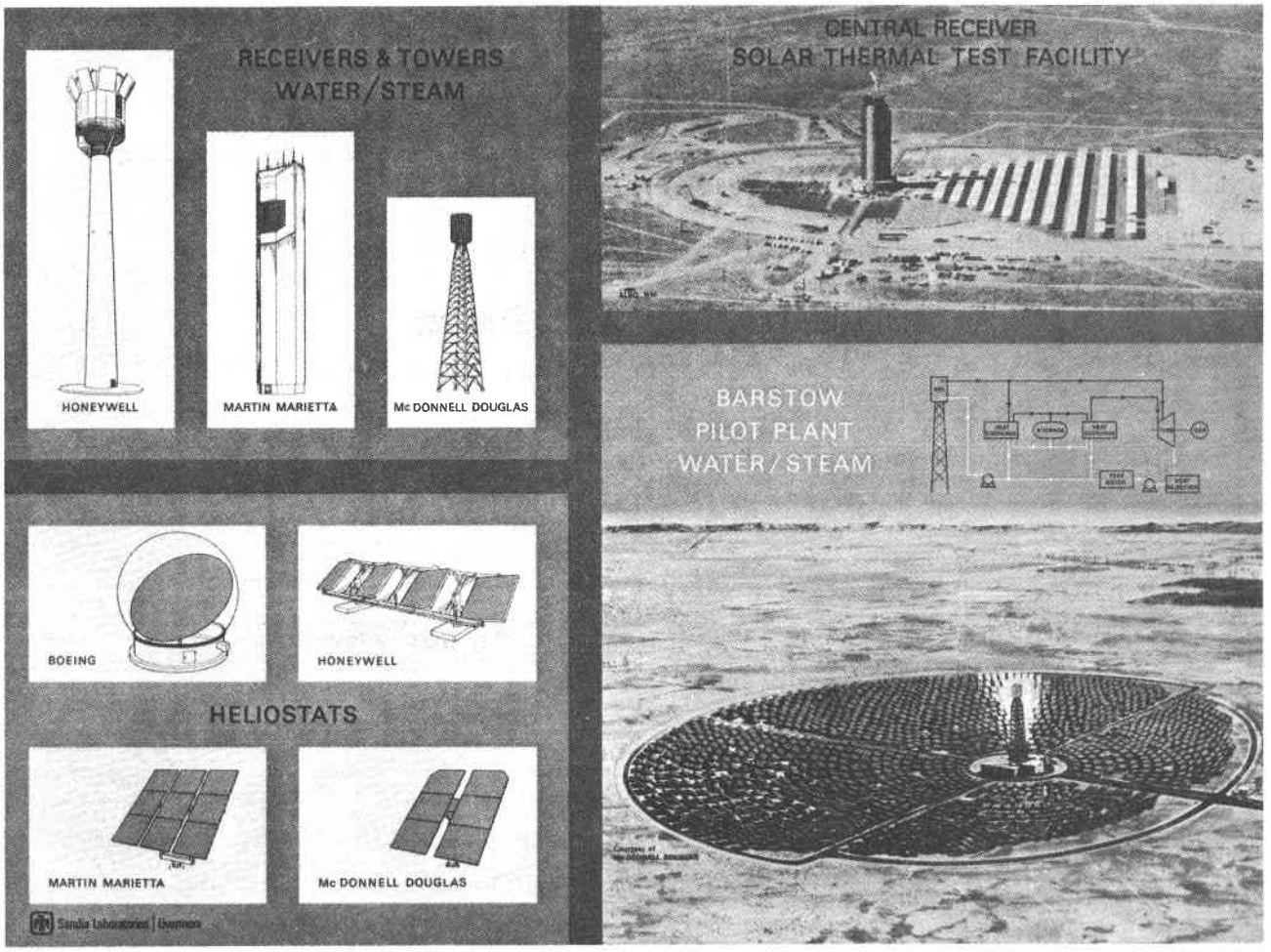
The major phases of the large thermal power applications program element are indicated in the figure below. The three activity areas under large power are:

- The large-scale central receiver system experiment (consisting of and utilizing a planned pilot plant to be located near Barstow, California).
- The development of systems for large-scale utility applications (emphasizing near-term applications, e.g., repowering of oil- and gas-fired power plants in the southwestern U.S.).
- The development of lower cost and higher performance central receiver subsystems and components (with particular emphasis on heliostats and advanced heat-receiver technology).



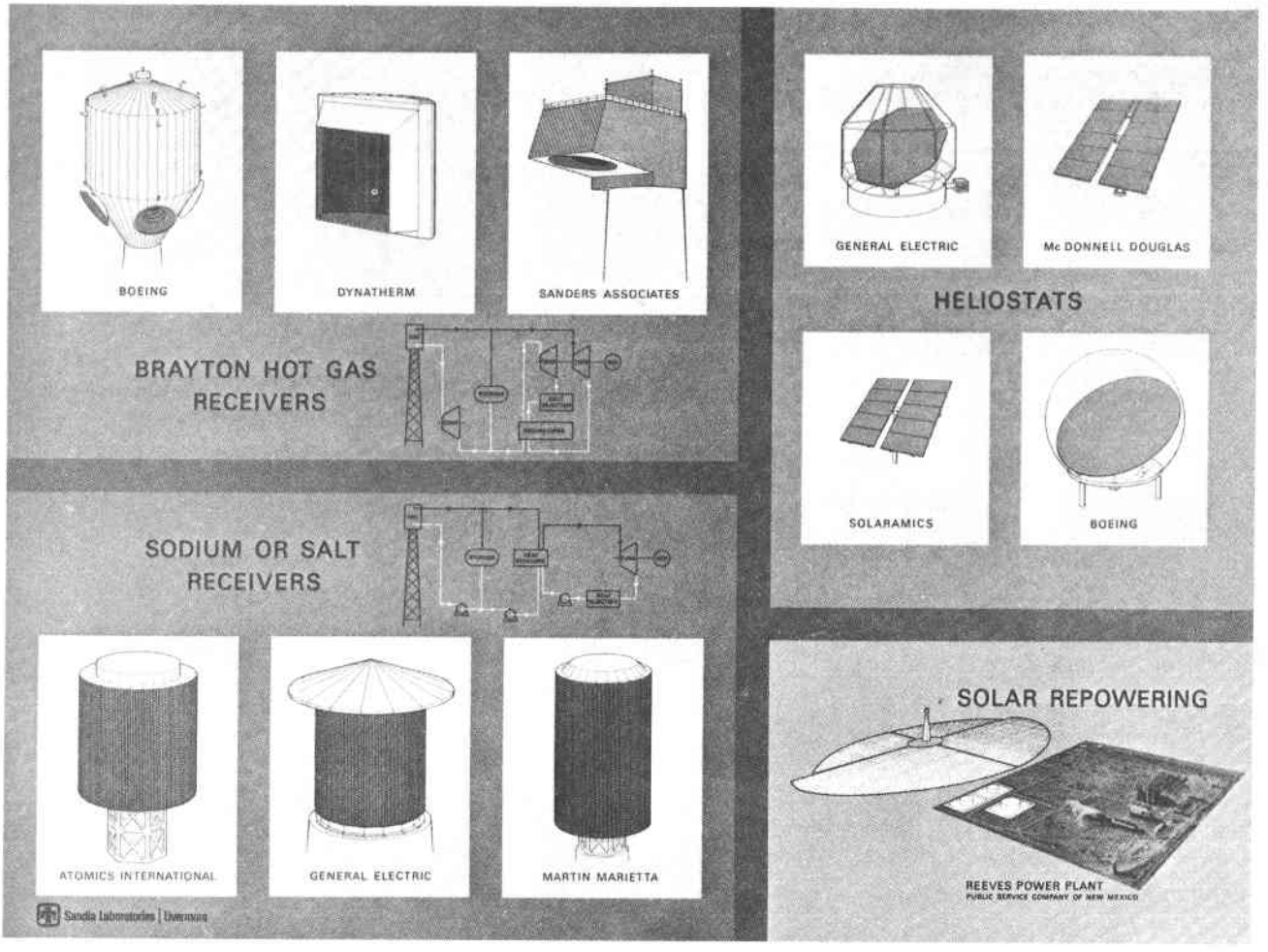
CENTRAL RECEIVER PILOT PLANT

Preliminary design efforts for the 10 MW central receiver pilot plant near Barstow, California have been initiated following selection of contractors for the major equipment. McDonnell Douglas Corporation has been selected as the system design integrator. Martin Marietta, along with McDonnell Douglas, will be engaged in parallel contracts to establish a technical and cost basis for procurement of 2,000 heliostats for the facility. The plant site, along with major cost sharing on the turbine plant and site-related items, is being provided by the Southern California Edison (SCE) Company and the City of Los Angeles Department of Water and Power. The figure shows the general configuration of the plant which will be connected to the SCE grid. Preproduction heliostats by Martin Marietta and McDonnell Douglas, as well as a single panel of the receiver design selected by DOE for the project, will be tested and evaluated at the large Central Receiver-Solar Thermal Test Facility (CR-STTF) operated for DOE at Sandia Laboratories in Albuquerque, New Mexico (also shown below).



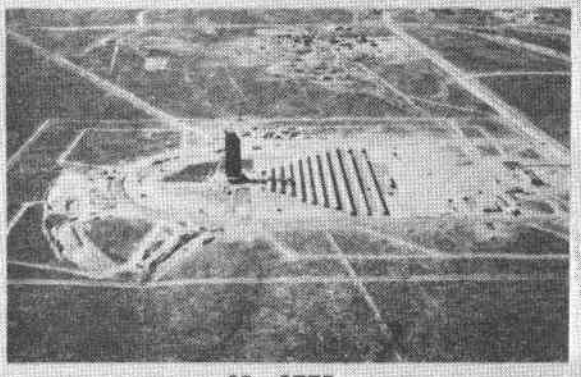
RELATED CENTRAL RECEIVER DEVELOPMENT

DOE is conducting studies and hardware development related to advanced and alternative system technology for large-scale central receiver applications. Specific hardware development programs for low-cost heliostats, advanced receivers, and other key components and subsystems illustrated below have also been initiated. In addition, a major study of solar repowering by the Public Service Company of New Mexico has been concluded and will serve as a basis for further DOE studies and activities related to this attractive application. A workshop on repowering, conducted in the summer of 1978, has led to consideration of a repowering initiative which will allow industry to initiate large-scale production of heliostats and gain the production experience necessary to achieve the $7-per-square-foot DOE goal. Studies completed in FY 1978 indicate the goal to be achievable based on second generation heliostat designs and high-production rates.

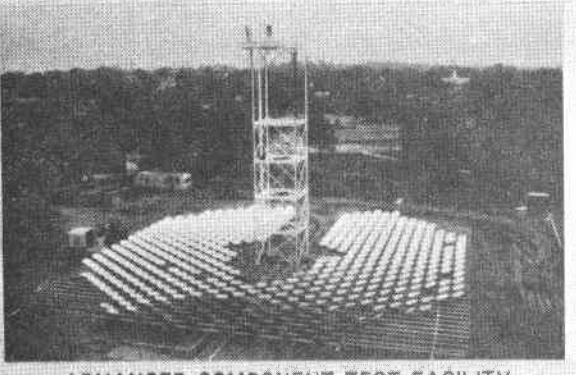


ADVANCED THERMAL TECHNOLOGY

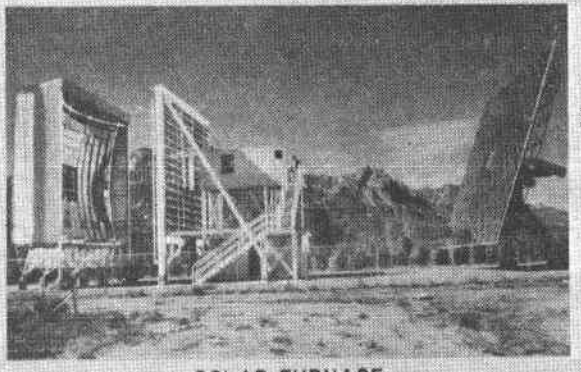
The advanced thermal technology program element emphasizes subsystem, component, and materials development that is not directly related to specific projects in the large and small power programs. The emphasis is on high-temperature, high-efficiency heat-transport and heat-receiver systems where advanced technology can lead to lower system costs as a result of more effective collector utilization. A major tool in support of this effort is the Advanced Component Test Facility at the Georgia Institute of Technology where testing of a high-temperature, air-cooled ceramic receiver has begun. This receiver can deliver heat at temperatures in the range 1,600°F to 2,000°F for Brayton cycle heat engines as well as high-temperature processes. As a part of the advanced technology program, a Users Association has been formed for coordinated use of the available solar high-temperature test facilities. The test facilities involved are shown below. Proposals are funded through the Users Association that allow the facilities to be used to support basic and applied research not directly related to program objectives.



CR–STTF
ALBUQUERQUE, N.M.



ADVANCED COMPONENT TEST FACILITY
GEORGIA INSTITUTE OF TECHNOLOGY



SOLAR FURNACE
WHITESANDS, N.M.

SOLAR FURNACE
ODEILLO, FRANCE

Fiscal Year 1978 — Project Summary Tables

Table 1

TOTAL ENERGY SYSTEMS PROJECTS (SMALL THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Sandia Laboratories	49	Mid-temperature Solar Systems Test Facility (MSSFT)	Operates and maintains a test facility for concentrating solar collectors. Characterizes performance and cost of solar energy components and subsystems.
Sandia Laboratories	51	Technical Management of Solar Total Energy Activities	Provides technical management of DOE's solar total energy activities at Sandia Laboratories.
Sandia Laboratories	53	Distributed Collector Systems Components and Subsystems Development Project	Develops components and subsystems and generates technical data in support of national solar programs utilizing distributed receiver collectors.
Solar Energy Research Institute	55	Concentrating Collector Technology Symposium	Coordinates a symposium to discuss the solar thermal concentrating collector technology developments and to identify the barriers that exist in achieving further cost reduction in the concentrating collector systems.
Oak Ridge National Laboratory	56	Solar Total Energy Systems (STES) Mission Analysis	Provides program planning and analytical support for implementation of the STES Program Plan.
Mississippi State University	58	Resource Assessment for an Alternative Total Energy System for Mississippi State University	Develops a design concept for a solar total energy system at institutional scale for application in the Midsouth. A specific case study of Mississippi State University is being made.
The Aerospace Corporation	59	Fort Hood Solar Total Energy Project Support	Provides DOE, through its Albuquerque Operations Office, with technical support during the design of the Large-Scale Experiment at Fort Hood being conducted by American Technological University.
Resource Planning Associates, Inc.	61	Institutional Application of Solar Total Energy Systems	Determines the compatibility and the applicability of solar total energy to the institutional sector.
Georgia Power Company	63	Solar Total Energy Large-Scale Experiment Shenandoah Site	Develops engineering experience for later commercial-size applications, acquires data to reduce risk in future cost and performance predictions, assesses interaction of technology in an industrial application with an electric utility system, and ensures dissemination of technical data.

Table 1

TOTAL ENERGY SYSTEMS PROJECTS (cont.) (SMALL THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
American Technological University	65	Ft. Hood Solar Total Energy Project	Develops the preliminary design of a solar total energy system that will supply a portion of the electrical and thermal energy for the Fort Hood 87,000 Troop Housing Complex.
Oak Ridge National Laboratory	67	Technical Support for Mississippi County Community College (MCCC) Project	Provides technical assistance to DOE in monitoring the work to be performed under the DOE grant to MCCC for development, design, and construction of a total energy solar photovoltaic conversion system for a new college facility.
Mississippi County Community College	69	Total Energy Solar Photovoltaic Conversion System	Designs and constructs a Solar Photovoltaic Conversion System to supply the major portion of the electrical and thermal energy requirements for an instructional facility at the main campus of the Mississippi County Community College.
General Electric Company	71	Design of a Solar Total Energy Large-Scale System (for Shenandoah, Georgia site)	Develops engineering experience for commercial size applications, acquires data to reduce risk in future cost and performance predictions, assesses interaction of technology in an industrial application with an electric utility system, and ensures dissemination of technical data.
Institute of Gas Technology	73	Application Analysis of Solar Total Energy for the Residential Sector	Determines the compatibility and the applicability of solar total energy to the residential sector.
Rockwell International Corporation	75	Commercial Applications of Solar Total Energy Systems	Identifies solar energy systems applicable to various commercial building types based upon technical and economic feasibility of the systems and market potential of the building types.

Table 2

SMALL COMMUNITY SYSTEMS PROJECTS (SMALL THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Jet Propulsion Laboratory	79	Small Community System Applications Project	Provides technical management for the Small Community Systems Application Program for DOE; defines/develops near- and far-term markets for 1 to 10 MWe power plants; defines/develops/installs a series of engineering experiments to test feasibility in a user environment; and develops strategies for accelerating commercialization, the required industrial infrastructure, and introduction into potential markets.
The Aerospace Corporation	81	Small Community Systems Applications Study	Provides small power application analysis.
Energy Services Consulting	82	Small Power Systems Application Workshop	Develops, evaluates, and documents small power systems applications.
Resource Planning Associates, Inc.	83	Barriers and Inventives to the Innovation of Small Power Systems	Identifies and describes the innovation process of new energy technologies and the barriers and incentives to the development and commercialization of small power systems.
Burns and McDonnell	85	Potential for SPS in Small Utilities	Determines the application of solar thermal small power systems to small utilities in the U.S. in the years 1985 to 2000.
Western Minnesota Municipal Power Agency	86	Detroit Lakes Energy Systems Study	Assesses renewable energy resources in the Detroit Lakes region; evaluates various alternative energy sources; and compares and evaluates various classes of solar thermal, solar photovoltaic, wind and biomass conversion systems for Detroit Lakes and the northern latitudes.
ESC Energy Corporation	87	The Effects of Ownership on Life-Cycle Costs	Develops a small power systems financial analysis computer program whose purpose is to compare the financial implications of constructing and operating alternative small power systems from the viewpoint of various ownership options.
McDonnell Douglas Corporation	88	Small Community Engineering Experiment #1	Performs system analyses of solar thermal electric power plants for a specific category in the 1 MWe size range and generates preferred system concepts for development, fabrication, and installation as initial experimental plants in the early 1980's.

Table 2

SMALL COMMUNITY SYSTEMS PROJECTS (cont.) (SMALL THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Ford Aerospace and Communications Corp.	89	Small Community Engineering Experiment #1	Performs system analyses of solar thermal electric power plants for a specific category in the 1 MWe size range and generates preferred system concepts for development, fabrication, and installation as initial experimental plants in the early 1980's.
General Electric Co.	90	Small Community Engineering Experiment #1	Performs systems analyses of solar thermal electric power plants for a specific category in the 1 MWe size range and generates preferred system concepts for development, fabrication, and installation as initial experimental plants in the early 1980's
Texas Technical University	91	Crosbyton Solar Power Project	Develops the Solar Gridiron, or Fixed Mirror Distributed Focus (FMDF), concept for the production of electricity in the context of the environment and electrical demand of the City of Crosbyton, Texas.
University of Oklahoma Center for Economic and Management Research	92	Develop and Analyze Costs and Implications of Integrating a Solar Energy System with an Existing Conventional Electric Utility System	Determines how the output of a solar energy system could be best integrated with a large existing electric utility and determines the economic impact of such an integration.
Jet Propulsion Laboratory	93	Point Focusing Distributed Receiver (PFDR) Technology	Provides technical management for the Point Focusing Distributed Receiver Technology Project for DOE, develops/matures point-focusing distributed receiver systems through module testing, and matures manufacturing process to enable low-cost mass production of key point-focusing distributed receiver subsystems.
Solar Energy Research Institute	95	Small Power Systems Study	Ranks the various solar thermal technologies regarding their applicability to power systems in the 1 to 10 MWe range.
E-Systems (Energy Technology Center)	97	Test-Bed Concentrator	Procures a test-bed concentrator to be used for point-focus concentrator development and testing at the subsystem and module level.

Table 2

SMALL COMMUNITY SYSTEMS PROJECTS (cont.) (SMALL THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Sanders Associates, Inc.	98	Gas (Brayton) Receiver Concepts	Develops the preliminary design of a receiver compatible with an open-cycle-air Brayton system.
Boeing Engineering and Construction Company	99	Gas (Brayton) Receiver Concepts	Develops the preliminary design of a receiver compatible with an open-cycle-air Brayton system.
Garrett Corporation	100	Gas (Brayton) Receiver Concepts	Develops the preliminary design of a receiver compatible with an open-cycle-air Brayton system.
Dynatherm Corporation	101	Gas (Brayton) Receiver Concepts	Develops the preliminary design of a receiver compatible with an open-cycle-air Brayton system.
Garrett Corporation	102	Steam (Rankine) Receiver Concepts	Develops the preliminary design of a steam Rankine receiver which is representative of the current industrial state-of-the-art in performance and low cost.
Fairchild Stratos	103	Steam (Rankine) Receiver Concepts	Develops the preliminary design of a steam Rankine receiver which is representative of the current industrial state-of-the-art in performance and low cost.
Acurex Corporation	104	Low-Cost Concentrator	Selects, studies, and performs preliminary design of a point-focusing concentrator which has the potential, when mass-produced, of attaining a cost/performance ratio of 0.004 to 0.012 kWt/$.
Boeing Engineering and Construction Company	105	Low-Cost Concentrator	Selects, studies, and performs preliminary design of a point-focusing concentrator which has the potential, when mass-produced, of attaining a cost/performance ratio of 0.004 to 0.012 kWt/$.
General Electric Company	106	Low-Cost Concentrator	Selects, studies, and performs preliminary design of a point-focusing concentrator which has the potential, when mass-produced, of attaining a cost/performance ratio of 0.004 to 0.012 kWt/$.

Table 3

REMOTE (IRRIGATION) SYSTEMS PROJECTS (SMALL THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Sandia Laboratories	**109**	Solar Irrigation Project	Analytically develops techniques and methods for assessing solar-powered irrigation feasibility on both a regional and a national basis; designs, fabricates, and field demonstrates solar-powered irrigation systems on working farms.
Acurex Corporation	111	150 kWe Solar-Powered Deep-Well Irrigation Facility	Designs, constructs, and operates solar-powered experimental facility to provide 150 kWe of electric power for the operation of deep-well irrigation pumps.
Bechtel Corporation	113	Technical and Economic Assessment of Solar Water Pumping for Remote Areas	Identifies the currently available solar energy technology and hardware that could be utilized to pump water in remote areas.
Bechtel Corporation	115	Technical and Economic Assessment of the Feasibility of Solar Distillation for Large-Scale Production of Fresh Water	Produces an assessment of the technical and economic feasibility of solar distillation for the large-scale production of fresh water.
Payne, Inc.	117	Investigation of Pulsejet Pump for Irrigation Systems	Develops novel solar pumping systems.
Thermo Electron Corporation	119	Directly Coupled Solar Thermal Water Pumping Concepts for Agriculture	Develops novel solar pumping systems.
University of New Mexico	120	Solar-Powered Liquid Piston Stirling-Cycle Irrigation Pump	Develops novel solar pumping systems.
Barber-Nichols Engineering	121	10-25 hp Solar-Powered Rankine Cycle Irrigation Pump	Develops novel solar pumping systems.
Transtech Corporation	122	Welge Solar-Powered Well Pump Engine	Develops novel solar pumping systems.
Systems Exploration, Inc.	123	Thermally-Driven Water Pumping Concepts for Solar System Applications in Agriculture	Develops novel solar pumping systems.
Foster Miller Associates, Inc.	124	Development of a Thermally-Driven Direct Action Organic Rankine Pump	Develops novel solar pumping systems.

Table 4

SYSTEMS AND APPLICATIONS PROJECTS (LARGE THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Sandia Laboratories	131	Solar Central Receiver Project Management	Provides technical support for the DOE Solar Thermal Central Receiver Program which aims at demonstrating the technical and economic feasibility of the thermal conversion of solar energy into electricity by means of large central, utility-type, power plants.
The Aerospace Corporation	133	Systems Engineering and Technical Management Support Advanced Central Power Project	Conducts system engineering studies to assess the technical and economic feasibility and risks for advanced central power concepts and provides the technical management of the Line Focus Receiver Phase I study concepts.
The Aerospace Corporation	135	Solar Thermal Power Technical and Management Support	Provides support in the planning, preparation, review, and documentation of the Solar Thermal Power Systems Program.
The Aerospace Corporation	136	Solar Thermal Power Systems Technical Support Services	Aggregates several separate and independent analysis, engineering, planning, and technical support activities.
Townsend and Bottum, Inc.	138	Phase I Construction Management Services	Assists DOE by providing construction management services for the solar portion of the 10 MWe Pilot Plant.
Martin Marietta Corporation	139	Collector Subsystem for the 10 MWe Pilot Plant	Designs and fabricates a collector subsystem for the 10 MWe Solar Thermal Central Receiver Pilot Plant.
McDonnell Douglas Corporation	140	Collector Subsystem for the 10 MWe Pilot Plant	Designs and fabricates a collector subsystem for the 10 MWe Solar Thermal Central Receiver Pilot Plant.
The Aerospace Corporation	141	Systems Engineering Support to Solar Ten Megawatt Project Office	Participates in the plant procurement activities at the STMPO.
Public Service of New Mexico	143	Technical and Economic Assessment of Solar Hybrid Repowering	Assesses the technical and economic viability of solar hybrid repowering as applied to the Southwest region and the Public Servce of New Mexico System.

Table 4

SYSTEMS AND APPLICATIONS PROJECTS (cont.) (LARGE THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Boeing Engineering and Construction Company	144	**10 MWe Central Receiver Solar Thermal Power System Phase I (Collector Subsystem Only)**	**Designs and develops a collector subsystem which can be integrated with other subsystems to demonstrate the technical feasibility and potential economic feasibility of solar thermal water/steam central-receiver-type power plants.**
Boeing Engineering and Construction Company	146	**Advanced Central Receiver Concept Design**	**Establishes the feasibility of developing a central receiver system that will significantly reduce the cost of electricity generated from solar central receivers.**
General Electric Company	147	**Advanced Central Receiver Concept Design**	**Establishes the feasibility of developing a central receiver system that will significantly reduce the cost of electricity generated from solar central receivers.**
Martin Marietta Corporation	148	**Advanced Central Receiver Power System Project**	**Conducts systems analyses and develops conceptual designs for Advanced Central Receiver Power Systems.**
Rockwell International Corporation	149	**Advanced Central Receiver Concept Design**	**Establishes the feasibility of developing a central receiver system that will significantly reduce the cost of electricity generated from solar central receivers.**

Table 5

SUBSYSTEMS AND COMPONENTS PROJECTS (LARGE THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Sandia Laboratories	153	Central Receiver Solar Thermal Test Facility	Provides design and planning support for construction of the Solar Thermal Test Facility.
Martin Marietta Corporation	154	One MWt Bench Model Solar Cavity Receiver Steam Generator: Build and Test	Fabricates and tests a 1 MWt cavity receiver steam generator suitable for the central receiver type of solar thermal conversions system for the generation of electricity.
Boeing Engineering and Construction Company	156	Solar Central Receiver Prototype Heliostat, Phase I	Establishes a heliostat design, which in quantity production, will yield significant reductions in capital and operating costs; stimulates broader industry participation in the DOE solar energy program; and identifies needs for near-term and future heliostat R&D.
Boeing Engineering and Construction Company	158	2nd Generation Heliostat Development (Phase II Prototype Heliostat)	Develops and demonstrates process for thermoforming a one-piece protective enclosure (domes) for heliostats.
General Electric Company	159	Solar Central Receiver Prototype Heliostat, Phase I	Establishes a heliostat design, which in quantity production, will yield significant reductions in capital and operating costs; stimulates broader industry participation in the DOE solar energy program; and identifies needs for near-term and future heliostat R&D.
General Electric Company	161	2nd Generation Heliostat Development (Phase II Prototype Heliostat)	Produces, characterizes, and tests protective heliostat enclosure and plastic reflector materials which will upgrade the performance of enclosed heliostat systems.
McDonnell Douglas Corporation	162	Solar Central Receiver Prototype Heliostat, Phase I	Establishes a heliostat design, which in quantity production, will yield significant reductions in capital and operating costs; stimulates broader industry participation in the DOE solar energy program; and identifies needs for near-term and future heliostat R&D.
McDonnell Douglas Corporation	164	2nd Generation Heliostat Development (Phase II Prototype Heliostat)	Develops the heliostat mirror modules, drive mechanism, and pedestal that was established by McDonnell Douglas in Phase I of DOE Contract ET-77-C-03-1605.

Table 5

SUBSYSTEMS AND COMPONENTS PROJECTS (cont.) (LARGE THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Solaramics, Incorporated	165	Solar Central Receiver Prototype Heliostat, Phase I	Establishes a heliostat design, which in quantity production, will yield significant reductions in capital and operating costs; stimulates broader industry participation in the DOE solar energy program; and identifies needs for near-term and future heliostat R&D.
Solaramics, Incorporated	167	2nd Generation Heliostat Development (Phase II Prototype Heliostat)	Develops the heliostat drive mechanism established by Solaramics in Phase I of DOE Contract ET-78-C-03-1745.
University of Illinois	168	Experimental Study of Convective Losses from Solar Receivers	Supports receiver design by establishing convective losses of both external and cavity receivers for various wind vectors.
Argonne National Laboratory	170	Mechanical Testing in Support of Structural Design of Solar Energy Central Receiver Power Plant Components	Provides testing and data surveys of candidate materials for receivers and ancillary components utilized by water/steam type receivers.
Foster Wheeler Development Corporation	171	An Interim Structural Design Standard for Solar Energy Applications	Develops structural design standards for solar central receivers and components.
Stearns-Roger Engineering Company	173	Receiver Tower Cost Study	Obtains tower cost data for use in current and future solar central receiver studies.
McDonnell Douglas Corporation	174	Extended Testing of Storage Fluids and Flow Loop Experiment	Provides data on fluid stability, compatibility, and surface fouling to permit fluid selection for thermal storage applications.
Martin Marietta Corporation	175	Modification and Test of SRE Receiver at CR-STTF - Phase II	Gathers performance data on the 5 MWt cavity receiver in the solar environment at the Central Receiver-Solar Thermal Test Facility.
Martin Marietta Corporation	176	Heliostat Wind Tunnel Test	Determines the mean wind velocity and relative drag loads within and over a 1/60-scale heliostat field, and evaluates the effect of the wind-induced loads on the heliostats to establish requirements consistent with these effects.
Martin Marietta Corporation	177	Storage Fluid Evaluation	Provides engineering and chemical data regarding the changes in hydro carbon oil with exposure to high temperature.

Table 5

SUBSYSTEMS AND COMPONENTS PROJECTS (cont.) (LARGE THERMAL POWER APPLICATIONS)

Organization	*Page*	*Title*	*Projected Contribution*
Beckman Instruments, Inc.	178	Portable Absolute Reflectometer	Obtains two prototype portable absolute reflectometers for evaluation.
Battelle Pacific Northwest Laboratories	179	Heliostat Glass and Foam Specification	Provides background information on the availability, quality, and cost of low-iron float and fusion glass for heliostats.
Battelle Pacific Northwest Laboratories	180	Heliostat Manufacturing Study	Assesses proposed heliostat manufacturing plans, heliostat cost estimates, and heliostat factory costs; studies options for developing a national heliostat manufacturing base. Collects a quantitative set of experimental data to evaluate a particular design concept for storage of thermal energy vs. heat of fusion in salts.
Honeywell, Inc. Energy Resources Center	181	Honeywell Latent Heat Thermal Storage Subsystem Research Experiment	Collects a quantitative set of experimental data to evaluate a particular design concept for storage of thermal energy vs. heat of fusion in salts.
McDonnell Douglas Corporation	182	Non-Inverting Heliostat Study	Investigates the implications of employing a non-inverting heliostat design where vertical stow is normally used and mirror-up stow is used to survive extreme winds.
University of Minnesota	183	Hydraulic Stability of Solar Boilers	Evaluates solar receivers relative to two-phase hydraulic stability.

Table 6
SUPPORTING TECHNOLOGY PROJECTS (ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
Solar Energy Research Institute	191	Materials Research and Development	Provides solar system designers with advanced materials which have lower life-cycle costs; provides long-range solar materials R&D.
Solar Energy Research Institute	193	Thermal Power Systems Workshop on Selective Absorber Coatings	Reviews progress of ongoing and recently completed Advanced Solar Thermal Technology research and development.
Exxon Research and Engineering Company	195	Optimization of Exxon's High Temperature Coating for Solar Applications	Develops a low-cost solar receiver coating that can be applied using conventional paint spraying techniques, that has a high solar absorptance, and that has optical and mechanical stability to 700°C.
Engelhard Minerals and Chemical Corporation	196	Improved Absorber Coatings for Thermal Utilization of Solar Energy	Develops selectively absorbing films prepared by the thermal decomposition of metallo-organic solutions for solar receivers at 300-700°C.
University of Arizona Optical Sciences Center	197	Chemical Vapor Deposition of Spectrally Selective Absorbers	Develops chemical vapor deposition techniques and produces optical multilayer stacks which are spectrally selective, stable at temperatures greater than 500°C, and economically attractive for large-scale manufacture.
University of Houston	199	Surface Morphologies of Efficient Solar Energy Absorbing Materials	Determines the role of surface morphology and microstructure in defining the optical absorption and emission of absorber coatings; compares the optical properties of laboratory and commercial gold, chrome, and nickel blacks.
University of Minnesota	201	Composition Profiling of Solar Coating and Materials with AES and ESCA	Provides Auger Electron Spectroscopy (AES) and Electron Spectroscopy for Chemical Analysis (ESCA) profile analyses of sample films submitted by DOE contractors engaged in coatings R&D.
Cornell University Laboratory of Atomic and Solid State Physics	203	Optical Properties of Metallic Surfaces, Small Particles, and Composite Coatings	Investigates the optical and physical properties of metals, alloys, and composite coatings.
RCA Laboratories David Sarnoff Research Center	204	Development of Granular Semiconductors As Selective Absorbers	Studies and develops selective absorbers comprised of dispersions of Si and Ge in a transparent matrix.

Table 6
SUPPORTING TECHNOLOGY PROJECTS (cont.)
(ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
University of Arizona Optical Sciences Center	205	High Temperature Optical Properties of Alloys for Central Receiver Solar Power Systems	Measures the absorption/emission characteristics of uncoated boiler tube steels at 500°C.
National Bureau of Standards	207	Thermal Radiation Property Measurements	Procures and calibrates standards of absorptance, reflectance, and emittance.
National Bureau of Standards	208	Review of Reflectance, Absorptance, and Emittance Measurement Techniques in Use by the Solar Community	Reconciles disparate measurements by the various laboratories presently studying emittance and solar absorptance of solar absorbers and solar reflectance of solar collectors.
Battelle-Pacific Northwest Laboratories	210	Research and Development in Solar Mirror and Quality Assurance Performance	Creates a materials-oriented program aimed at establishing Quality Assurance standards and developing measurement techniques for use throughout the entire solar industry.
Solar Energy Research Institute	212	Reflector Materials Workshop	Identifies current state-of-the-art of solar reflector technology with regard to material properties, material availability, reflector surface conditions, user experience, and characteristic technologies; defines mirror design requirements; and develops recommendations for DOE program goals and areas of future R&D support.
University of California Lawrence Berkeley Laboratory	214	Measurement of Circumsolar Radiation	Provides solar radiation measurements necessary for accurate prediction of the performance of solar energy conversion systems employing concentrating collectors.
Solar Energy Research Institute	216	Effects of Circumsolar Radiation on Collector Performance	Obtains quantitative information on the effect of circumsolar radiation on the thermal efficiency of various generic types of concentrators.
University of Texas	218	Studies of Solar Intensities in the United States	Evaluates procedures for accumulating historical measurements of global insolation; determines methods for handling errors made in accumulating past measurements; and develops a procedure for establishing model years to be used in computer simulation of solar energy systems design.

Table 6
SUPPORTING TECHNOLOGY PROJECTS (cont.)
(ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
Dow Corning Corporation	219	Reflective Surface Protective Coatings	Performs research and development of protective resins suitable for heliostats.
The Mitre Corporation	220	Atmospheric Considerations for a Central Receiver Power Plant	Determines the energy loss from the heliostat field to the central receiver due to scattering and absorption in the intervening atmosphere.
Energy Foundation of Texas	221	Solar Energy System Simulation and Analysis	Develops, improves, and documents mathematical simulations of various system components for a central receiver power plant; establishes a code center for central-receiver-related codes.
Energy Foundation of Texas	222	Analysis of Extreme Winds on Solar Tower Generators	Supports the 10 MWe Pilot Plant by analyzing and predicting the effects of extreme winds on the tower and on the heliostat field; advises and assists in methods of designing components that will be wind resistant.

Table 7
NEW CONCEPT DEMONSTRATIONS PROJECTS (ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
Sanders Associates, Inc.	225	One-Quarter Megawatt (Thermal) Solar Brayton Receiver Design, Construction, and Testing	Fabricates and tests a 250 kWt silicon carbide honeycomb receiver at atmospheric pressure and 2000°F.
Massachusetts Institute of Technology Lincoln Laboratories	227	Solar Heated-Air Cavity Receiver Development	Develops a novel approach for a solar heated-air cavity receiver.
Rockwell International Corp.	228	Characterization of Sodium Oxide Aerosols Released in a Natural Environment from a Heat Receiver	Characterizes the physical properties of the aerosols formed by the exposure of hot liquid sodium in jet and pool form from a heat receiver to air in a natural environment.
University of Chicago The Enrico Fermi Institute	230	Non-Imaging Concentrators for Wide-Angle Collection of Solar Energy	Develops non-imaging concentrators for wide angle collection using advanced concepts; performs basic collector research; collects compound parabolic concentrator performance data at a New Mexico Indian school.
University of Arizona Optical Science Center	231	Study of Small Fixed-Mirror Distributed-Focus Concentrator	Studies small module fixed spherical mirror distributed-focus concentrators.
Sun Power Corporation	232	Paravac Solar Collector	Demonstrates the feasibility of constructing a parabolic trough concentrator employing Fresnel reflectors on a vacuum-formed cylinder.
Mechanical Technology, Inc.	234	Concept Definition of Solar Stirling Engine for Advanced Dispersed Electric Power Systems	Designs a high-efficiency 15 kWe free-piston Stirling engine/alternator and a kinematic Stirling engine/alternator.
Garrett Corporation	235	Concept Definition Study of Small Brayton Engine for Solar Electric Power Systems	Establishes economically viable Brayton engines (10-20 kWe) for use with point focus distributed receiver solar thermal power systems.
BiPhase Engines, Inc.	236	Evaluation of a Two-Phase Turbine System for Solar Electric Power Generation	Analyzes, designs, fabricates, tests, and evaluates a two-phase turbine for operation at 600°F.
General Atomic Company	237	Solar Heat Transfer Test Loop	Designs and constructs a high-temperature liquid heat transfer test loop using a high-temperature eutectic salt and demonstrates its operation for use in Solar Thermal Power Plants.

Table 7

NEW CONCEPT DEMONSTRATIONS PROJECTS (cont.) (ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
Dynatech R/D Company	238	Combined Dry Cooling Tower and Thermal Storage Pond Waste Heat Rejection System for Solar Thermal Electric Power Stations	Conducts a preliminary evaluation of a dry cooling tower/thermal storage pond concept for integration with a solar thermal steam-electric plant.
Naval Research Laboratory	239	Development of Converter/Heat Receiver for Solar Thermochemical Energy Collection	Evaluates a converter/heat receiver design based on ceramic honeycomb extrusion technology.
General Electric Company	240	Conceptual Design Study on the Application of Liquid Metal Heat Transfer Technology to Solar Thermal Power	Investigates liquid metals applications to dispersed solar power systems. Emphasis is on the Stirling engine for power conversion.
Dynatherm Corporation	241	Heat Pipe for Central Solar Receiver	Investigates heat pipes as extended surfaces for a gas (Brayton cycle) heat exchanger for application to a central solar receiver.

Table 8

ADVANCED SYSTEMS PROJECTS (ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
Jet Propulsion Laboratory	245	Advanced Solar Thermal Technology	Performs technology assessment and planning, manages component development and feasibility experiments, defines advanced dispersed power system configurations, and develops components and subsystems for advanced dispersed power systems.
Industrial Research Institute Research Corporation	247	Survey of Industrial Input to R&D Planning for Use of High-Temperature Solar Energy in Chemicals and Fuels Processing	Establishes the potential for a research and development program which will enable the formation of collaborative and communicative ties between DOE and industrial organizations.
Oak Ridge National Laboratory	248	High-Temperature Solar Heat for Fuels and Chemicals	Outlines a suggested solar high-temperature fuels and chemicals program with a breakdown of tasks, milestones, and budgets for the 1979-1984 period.
Lawrence Livermore Laboratory	250	Solar Coal Gasification	Evaluates the technical and economical feasibility of utilizing solar energy to gasify coal, i.e., "scopes" the feasibility of a solar coal gasification plant and identifies critical parameters.

Table 9
TECHNOLOGY ASSESSMENT PROJECTS (ADVANCED THERMAL TECHNOLOGY)

Organization	*Page*	*Title*	*Projected Contribution*
Solar Energy Research Institute	253	Solar Thermal Test Facilities Users Association	Provides liaison among experimenters, solar thermal test facility operators, and DOE; acts as the point of contact for users of STTF's; solicits and reviews proposals for experiments to be performed on the STTF's; and provides funding for STTF and experiment information.
Georgia Institute of Technology	255	DOE-Advanced Components Test Facility	Transfers solar thermal/steam technology to the U.S. by building a 400 kWt Francia-type plant; supports the DOE Solar Thermal ACTF R&D.
New England Center for Continuing Education and The AETA Corporation	256	International Market Potential for Small Solar Thermal Systems	Develops a preliminary analysis of the international market potential for small solar thermal electric generators; identifies the existence and nature of such markets and recommends suitable approaches for U.S. manufacturers to reach them; and evaluates techniques and product types suitable for deployment to the less developed countries market.
OAO Corporation	258	Review and Analysis of Solar Thermal Component and Subsystems Technology	Performs review and analysis of solar thermal component and subsystem technology with the goals of establishing the state-of-the-art, defining areas requiring new or additional R&D, providing overviews of current R&D activities, and enhancing technical communication throughout the solar thermal power community.

SMALL THERMAL POWER APPLICATIONS

SMALL THERMAL POWER APPLICATIONS

INTRODUCTION

The small thermal power applications program element is designed to extend solar technologies to small communities, commercial/industrial users, and isolated applications such as farms.

Small thermal power applications focus upon the development of solar thermal technology for applications in which the energy supply system can be integrated at the point of use. Such "on-site" systems are typically much smaller than those required for utility power plant operation. Comparable conventional systems in current use rely heavily upon fuels such as natural gas, propane, and oil. The use of solar thermal power systems for these applications offers the potential for economically competitive energy production, reduced environmental intrusions, and reduced consumption of critical fossil fuels.

Efforts in the small thermal power applications area include:

- Total energy systems for industry, commercial building complexes, institutions, and small communities.
- Electric power systems for small communities.
- Remote systems for specialized applications in locations far from or inconvenient to an electrical grid.

These small thermal power applications complement the developmental effort pursued under the large thermal power applications effort.

SMALL THERMAL POWER APPLICATIONS PROGRAM ACTIVITIES

Status

Total Energy Systems. During 1978, substantial progress was made in the design of three total energy system experiments: one at Shenandoah, Georgia; a second at Fort Hood, Texas; and a third at Blytheville, Arkansas. The preliminary design phase of the Shenandoah and Fort Hood projects has been completed. A single contractor for each program has been selected and the detail design and laboratory testing of the critical portion of the design is underway. The detail design of the Blytheville project, funded as a grant to the Mississippi County Community College, has been completed and the construction phase has begun. Each total energy system experiment encompasses a separate application: one, industrial; one, military; and one, institutional.

The industrial application involves the energy requirements for a knitwear manufacturing facility in Shenandoah, Georgia, and uses distributed point focus technology. The General Electric Company has been selected to complete preliminary design and initiate detailed design during 1978. When completed, the system will supply electricity, process heat, thermal energy for space conditioning, and domestic hot water heating.

The military application involves the requirements for a troop housing complex at Fort Hood, Texas. The American Technological University, assisted by the Westinghouse Electric Corporation, has been selected to complete, during 1978, a preliminary design using distributed line focus technology. The system is to provide electricity, thermal energy for space conditioning, and domestic hot water heating.

The institutional application is tailored to supply the major portion of the electrical and thermal energy requirements for a 50,000 square foot instruction building on the main campus of the Mississippi County Community College (MCCC) in Blytheville, Arkansas. This project will consist of a total energy system using photovoltaic direct-conversion devices. Electricity will be produced and heat will be absorbed for other purposes at the focus of concentrating distributed line focus collectors.

Components for the three total energy experiments will be tested in DOE's Mid-temperature Solar Systems Test Facility (MSSTF) in Albuquerque, New Mexico. This facility is now operational. MSSTF consists of an 800 square meter collector field comprised of four different distributed concentrator concepts: (1) line focusing parabolic trough, (2) fixed mirror, (3) linear array concentrators, and (4) point focusing parabolic dish concentrator. The facility consists of a power conversion subsystem, thermal storage subsystems, and heat exchangers, all of which provide a capability to test a completely integrated total energy system.

The testing of a number of intermediate-temperature individual collector unit concepts, including a line focus concentrating collector for dispersed power systems, was conducted in FY 1977 by Sandia Laboratory using the Collector Module Test Facility, also located in Albuquerque, New Mexico.

Small Community Systems. In 1978 three contracts were awarded for the Phase-I conceptual design of an experimental system for the small community program. Only one concept will be selected for the detailed design, construction, and test portion of the program. This initial hardware effort is expected to be followed by the development of additional experimental systems as more cost-effective components become available. In parallel with this effort, studies were initiated during 1978 to determine the requirements of solar powered generating systems for specific communities.

Remote Systems. Two developmental solar irrigation experiments have been initiated as part of the remote system application program. Both experiments are intended to provide realistic performance and cost information of solar irrigation pumping applications. One system, installed at Willard, New Mexico through joint funding by DOE and the State of New Mexico, began operating in July 1977 and was upgraded during 1978 to operate with a center pivot sprinkler. This system uses a 1,200 square meter collector field, a 25-hp organic Rankine engine, an irrigation pump, controls, and a thermal storage subsystem to allow the system to operate 24 hours a day. The system is capable of irrigating 200 acres of crops and pumps 700 gallons of water per minute from a well 100 feet in depth. This operational system is currently providing a demonstrated capability for using small solar thermal systems for irrigation. It is also providing significant operational performance data that will be used in defining requirements for future experiments.

The preliminary design for the second experiment, a larger 200-hp irrigation system jointly sponsored by DOE and the State of Arizona, was completed during 1978. This larger system, to be located at Collidge, Arizona, will be operational during 1979. Lower systems costs through higher operating temperatures and higher efficiencies are sought in this experiment.

Future Effort

The detailed system engineering design efforts for the Shenandoah and Fort Hood total energy systems experiments are continuing and will be completed in the fall of 1979. Procurement of their major components and construction will commence thereafter, with the hardware procurement being finalized during 1980. Both the Shenandoah and Fort Hood projects will be operational in 1981; the MCC total energy system experiment will be operational in 1980.

MSSTF will continue to provide basic engineering performance data for the subsystems to be employed in the intermediate temperature range. Continuing experiments at MSSTF will offer the opportunity to prove feasibility of concepts at relatively low cost without the need for full-scale demonstration systems.

The Collector Module Test Facility will provide performance data for mid-temperature concentrating collector concepts during FY 1979. This data will be used to screen candidate new collector concepts for intermediate temperature dispersed power applications.

The site for a 1 MWe small community power system experiment will be selected early in 1979.

The operation of the Willard, New Mexico irrigation system will be continued through 1979 to accumulate operating experience. Construction of the Collidge, Arizona irrigation experiment will be completed in 1979, with full operation scheduled late that year.

SMALL THERMAL POWER APPLICATIONS
Total Energy Systems
Project Summaries

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Mid-temperature Solar Systems Test Facility (MSSTF)
	CONTRACT NO. AT(29-1)-0789
PRINCIPAL INVESTIGATOR Name: James A. Leonard	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $2,665,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING

PROJECT SUMMARY

Objective

To operate and maintain a test facility for concentrating solar collectors (as well as other subsystems). The project will (1) identify design and system integration considerations, (2) characterize performance and cost of solar energy components and subsystems, and (3) accumulate operational and maintenance experience applicable to a wide range of dispersed solar power systems application projects.

The MSSTF and the various research and development (R&D) projects within Solar Thermal Power together support the application projects. Components are developed in the R&D based on projected requirements of DOE or commercial application projects. The MSSTF is utilized as a test bed to evaluate these components and to identify, through operating experience, areas requiring additional research and development.

Approach

Pursue tasks in the following areas: (1) Program Management, (2) System Management, (3) Collector Subsystems, (4) Collector Subsystems Subcontracting, (5) High Temperature Storage Subsystems, (6) Prime Mover Subsystems, (7) Heat and Cooling Subsystems, and (8) Solar Collector Module Test Facility.

Status

a. The following subsystems have been put into operation: (1) the General Atomic Fixed Mirror Solar Collector subsystem, (2) the Suntec SLATS collector subsystem, (3) a 24,000 liter Multi-Tank High Temperature Thermal Energy Storage Subsystem, and (4) a seven meter parabolic dish, developed by Raytheon.

b. Test evaluations of collector modules are being completed at the rate of about one every five weeks.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Mid-temperature Solar Systems Test Facility (MSSTF)
	CONTRACT NO. AT(29-1)-0789
PRINCIPAL INVESTIGATOR Name: James A. Leonard	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $2,665, 000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING

PROJECT SUMMARY (continued)

c. All completed subsystems, i.e., collectors, storage, turbine/generator, and heating and cooling subsystems, have been operated as a completed solar total energy system.

d. The project is continuing (1) to produce numerous reports and presentations describing the evaluation of subsystems and the design and operation of the integrated system and (2) to host approximately 680 visitors each month.

Future Effort

Procurement and evaluation of candidate solar collectors and other subsystems for solar small (dispersed) power applications will continue. Completed subsystems will be removed and advanced subsystems installed in a continuously interactive mode. In addition to several new collector modules, the following subsystems are to be installed in the near future: a parabolic dish collector field, an advanced prime mover, and an advanced high-temperature thermal energy storage subsystem.

Bibliography Reference Number: 1

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Technical Management of Solar Total Energy Activities
	CONTRACT NO. AT(29-1)-0789
PRINCIPAL INVESTIGATOR Name: J.F. Banas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $1,300,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $2,480,000

PROJECT SUMMARY

Objective

To provide technical management of DOE's solar total energy activities at Sandia Laboratories.

Approach

a. Maintenance of a long-range Solar Total Energy Program Plan in cooperation with the Small Power Systems Branch of the DOE/Division of Central Solar Technology.

b. Preparation of annual operating plans based on the long range plan.

c. Technical management of existing DOE-issued contracts pertaining to Solar Total Energy.

Status

a. Preliminary design of a solar total energy system for the Shenandoah Large-Scale Experiment (LSE) was completed by General Electric.

b. Instrumentation system for the knitwear factory at the Shenandoah LSE was activated.

c. Site preparations at the Shenandoah LSE were begun.

d. The residential and institutional applications analyses were completed.

e. The SOLTES computer code has been documented and made available for remote terminal timeshare use.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87158	Technical Management of Solar Total Energy Activities
	CONTRACT NO. AT(29-1)-0789
PRINCIPAL INVESTIGATOR Name: J.F. Banas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $1,300,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $2,480,000

PROJECT SUMMARY (continued)

Future Effort

a. Detailed design of a solar total energy system for the Shenandoah LSE will be completed by General Electric.

b. A set of four parabolic dishes for the Shenandoah LSE will be tested at the MSSTF.

c. The Solar Total Energy Modularization Study will be completed by McDonnell Douglas Corporation.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Distributed Collector Systems Components and Subsystems Development Project
	CONTRACT NO. AT(29-1)-0789
PRINCIPAL INVESTIGATOR Name: J.F. Banas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $2,900,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING

PROJECT SUMMARY

Objective

To develop components and subsystems and to generate technical data in support of national solar programs utilizing distributed receiver collectors.

Approach

a. Determine project goals and guide the project toward those goals.

b. Promote development of sources for reflector structures, reflective materials, optical instruments, and selective coatings; evaluate environmental and technical capabilities of these items.

c. Utilize experience and technology to design and test improved collector field subsystems for the Solar Total Energy Test Facility.

d. Test and evaluate existing commercial collector systems.

e. Promote the design, development, and actual performance testing of new collectors system concepts.

f. Develop techniques and instruments for nondestructive testing and evaluation of the optical parameters of collector subsystems during production and/or after field installation.

g. Determine the prime mover and storage requirements for future dispersed power systems.

h. Promote development of subsystems to meet these requirements.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Distributed Collector Systems Components and Subsystems Development Project
	CONTRACT NO. AT(29-1)-0789
PRINCIPAL INVESTIGATOR Name: J.F. Banas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $2,900,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING

PROJECT SUMMARY (continued)

Status

a. Design has been completed by Mechanical Technology Incorporated (MTI) for an improved efficiency steam turbine for the Shenandoah Large-Scale Experiment (LSE).

b. A black chrome coating with improved thermal stability has been produced by Sandia; compilation of a process handbook has been initiated by Honeywell.

c. A collector cleaning technique investigation has been initiated by McDonnell Douglas Corporation.

d. Development of thin and sagged glass reflectors for parabolic troughs and dishes has been initiated.

e. A parabolic trough with advanced features has been designed; layouts of troughs based on three fabrication technologies have been initiated.

Future Effort

a. The improved steam turbine for the Shenandoah LSE will be fabricated by MTI.

b. The improved black chrome coating will be tested on the collectors for the Collidge Irrigation Experiment.

c. Design and fabrication of the advanced trough layouts will be procured from industry.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Blvd. Golden, Colorado 80401	Concentrating Collector Technology Symposium
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: B.P. Gupta, F. Kreith	PERIOD OF PERFORMANCE January 1978 to September 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $150,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $150,000

PROJECT SUMMARY

Objective

To coordinate a symposium to discuss the Solar Thermal Concentrating Collector Technology developments and to identify the barriers that exist in achieving further cost reduction in the concentrating collector systems.

Approach

Invite a group of speakers to speak on specific areas with emphasis on the state-of-the-art of the technology, applications, and potential problems. Working groups were set up to discuss sub-elements of concentrating collector technology and to identify areas that require further research and development.

Status

a. The symposium was held on June 14 and 15 at Denver, Colorado, with 175 people attending from industry, universities, and national laboratories.

b. Working group summaries were prepared by the leaders.

c. The proceedings were compiled, edited, and sent to print on August 15, 1978.

Future Effort

None.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Oak Ridge National Laboratory Nuclear Division P.O. Box X Oak Ridge, Tennessee 37830	Solar Total Energy Systems (STES) Mission Analysis
	CONTRACT NO. W-7405-eng-26
PRINCIPAL INVESTIGATOR Name: W.R. Mixon, C.G. Lawson	PERIOD OF PERFORMANCE January 1, 1978 to September 30, 1978
WORK LOCATION Oak Ridge, Tennessee	FISCAL YEAR 1978 FUNDING $300,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $300,000

PROJECT SUMMARY

Objective

To provide program planning and analytical support for implementation of the STES Program Plan. Specific objectives include identification of (1) appropriate market, (2) attractive STES configurations, (3) needed technology development, and (4) the technical, financial, institutional, and social factors that affect STES applications.

Approach

Planning and management support of DOE includes review and evaluation of applications and mission analyses, and support for technical demonstrations. Systems analysis is extended by comparing combinations of STES, conventional Total Energy (TE), and grid connections for industrial and residential applications. Of special interest are arrangements complementary to utilities, size effects, and community characteristics that favor use of STES.

Status

a. Project staffing and management, cost, and manpower plans were completed.

b. Staff familiarization with STES objectives, program plans, and activities of other contractors was essentially completed.

c. Recent applications and mission analysis work was reviewed and evaluated.

d. Initial comparisons of STES and other TE for industrial applications were completed.

e. A baseline community model was selected and analysis of TE system applications was initiated.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Oak Ridge National Laboratory Nuclear Division P.O. Box X Oak Ridge, Tennessee 37830	Solar Total Energy Systems (STES) Mission Analysis
	CONTRACT NO. W-7405-eng-26
PRINCIPAL INVESTIGATOR Name: W.R. Mixon, C.G. Lawson	PERIOD OF PERFORMANCE January 1, 1978 to September 30, 1978
WORK LOCATION Oak Ridge, Tennessee	FISCAL YEAR 1978 FUNDING $300,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $300,000

PROJECT SUMMARY (continued)

f. A direction was established for utility compatibility studies.

g. Site-specific data were collected on industries identified as prime candidates for market penetration and analysis is in progress.

h. The FY 1979 management plan was submitted to DOE in August 1978.

i. Comparative systems analyses for industrial applications was completed in FY 1978.

j. Analysis of specific industry data was completed in FY 1978.

Future Effort

a. User's guides for computer programs developed by Aerospace Corporation will be completed in the first quarter of FY 1979.

b. Progress in all tasks will be summarized in a FY 1978 annual report.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Mississippi State University Energy Research Center P.O. Drawer G Mississippi State, Mississippi 39762	Resource Assessment for an Alternative Total Energy System for Mississippi State University
	CONTRACT NO. ET-78-S-05-5868
PRINCIPAL INVESTIGATOR Name: Dr. C.W. Bouchillon	PERIOD OF PERFORMANCE May 1, 1978 to October 31, 1979
WORK LOCATION Mississippi State University	FISCAL YEAR 1978 FUNDING $125,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $125,000

PROJECT SUMMARY

Objective

To develop a design concept for a Solar Total Energy System at institutional scale for application in the Midsouth. A specific case study of Mississippi State University is being made.

Approach

Energy requirements (electrical, heating, cooling, and hot water) are being determined from historical experience and projected predictions into the 1990 time frame are being made. Solar insolation (direct and total) and meteorological conditions are being established.

An assessment of current state-of-the-art systems (solar thermal and photovoltaic) coupled with heat pump augmentation and cascade energy utilization are being used to establish a baseline design. Improved design concepts will then be recommended for a site specific Solar Total Energy System.

Status

The project is in early stages of load determination, literature review, state-of-the-art systems observation, and evaluation; early-on preliminary design concepts are being discussed.

Future Effort

Continuing efforts to achieve the objective of the project will be made by the team of professors and graduate students participating in this study.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation 2350 E. El Segundo Blvd. El Segundo, California 90004	Fort Hood Solar Total Energy Project Support
	CONTRACT NO. ET-78-C-04-4271
PRINCIPAL INVESTIGATOR Name: Dr. E. Katz	PERIOD OF PERFORMANCE May 1, 1978 to April 30, 1979
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $344,775
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $414,775

PROJECT SUMMARY

Objective

To provide DOE, through its Albuquerque Operations Office, with technical support during the design of the Large Scale Experiment (LSE) at Fort Hood being conducted by American Technological University (ATU). The technical support includes (1) performing independent design analyses, (2) monitoring and assessing ATU's performance, (3) participating in project review meetings, and (4) providing DOE with recommendations on technical and project control issues.

Approach

a. Establish a working relationship with other members of the Fort Hood project team.

b. Conduct independent studies on appropriate sizing of the LSE, thermal storage optimizations, and alternative energy dispatching strategies.

c. Make an assessment of the accuracy of load measurements at the site and of the relative value to the project of pilot collector array testing.

d. Provide assistance to the DOE/Albuquerque office on briefing reports, budget preparation, review of all ATU submittals, and planning of future project phases.

Status

a. Independent sizing analysis has been completed and reported.

b. An assessment of ATU's measurement of energy loads has been completed and a report has been issued.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation 2350 E. El Segundo Blvd. El Segundo, California 90004	Fort Hood Solar Total Energy Project Support
	CONTRACT NO. ET-78-C-04-4271
PRINCIPAL INVESTIGATOR Name: Dr. E. Katz	PERIOD OF PERFORMANCE May 1, 1978 to April 30, 1978
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $344,775
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $414,775

PROJECT SUMMARY (continued)

c. The ATU Model Year Weather/Solar task has been evaluated.

d. The Pilot Test Array plant has been evaluated and recommendations have been given to DOE.

Future Effort

Assistance will be given to DOE in reviewing ATU work statements and cost estimates for the Definitive Design Phase to begin in November 1979. An active technical role will be taken in reviewing system design, assisting in the design of some subsystems, and providing recommendations to DOE concerning design decisions and future project plans.

Bibliography Reference Number: 2

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Resource Planning Associates 1750 K Street, N.W. Washington, D.C. 20036	Institutional Application of Solar Total Energy Systems
	CONTRACT NO. EG-77-C-04-3786
PRINCIPAL INVESTIGATOR Name: H.C. Bailly	PERIOD OF PERFORMANCE March 7, 1977 to March 30, 1978
WORK LOCATION Washington, D.C.	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $357,772

PROJECT SUMMARY

Objective

To determine the compatibility and the applicability of Solar Total Energy (STE) to the institutional sector.

Approach

a. Establish energy requirements within the institutional sector.

b. Identify the segments of the institutional market having the highest potential for penetration by STE systems.

c. Develop conceptual designs to assess the technical and economic characteristics of representative systems.

d. Examine the institutional barriers faced by STE systems in these sectors.

e. Estimate the penetration of STE systems in these segments and assess the effects of Federal incentive policies.

f. Develop criteria to select demonstration projects to maximize the national market penetration of STE systems in the institutional market.

g. Assess the potential for demonstration projects in the recreational sector.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Resource Planning Associates 1750 K Street, N.W. Washington, D.C. 20036	Institutional Application of Solar Total Energy Systems
	CONTRACT NO. EG-77-C-04-3786
PRINCIPAL INVESTIGATOR Name: H.C. Bailly	PERIOD OF PERFORMANCE March 7, 1977 to March 30, 1978
WORK LOCATION Washington, D.C.	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $357,772

PROJECT SUMMARY (continued)

Status

This project is complete except for publication of the final report. Principal conclusions resulting from this effort are:

a. That some penetration will be possible by the year 2000 in the college campus and military installations sectors.

b. That initial penetration will occur in the southwestern U.S.

c. That time-of-day energy pricing strongly affects system design, with photovoltaic systems appearing more favorable than thermal systems in areas having high-peak electric rates.

d. That STE systems will pick up only part of an application's load and will operate best when integrated with the utility grid.

Future Effort

A final report should be available to the public through the National Technical Information Service by January, 1979.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Georgia Power Company P.O. Box 4545 Atlanta, Georgia 30302	Solar Total Energy Large-Scale Experiment, Shenandoah Site
	CONTRACT NO. EG-77-A-04-3994
PRINCIPAL INVESTIGATOR Name: W.R. Hensley	PERIOD OF PERFORMANCE June 14, 1977 to September 30, 1978
WORK LOCATION Atlanta, Georgia	FISCAL YEAR 1978 FUNDING $345,073
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $485,073

PROJECT SUMMARY

Objective

a. To develop engineering experience for later commercial-size applications.

b. To acquire data to reduce risk in future cost and performance predictions.

c. To assess interaction of technology in an industrial application with an electric utility system.

d. To ensure dissemination of technical data.

Approach

a. Analyze factory energy needs, utilization, conservation, and performance.

b. Instrument factory and provide data.

c. Provide engineering services.

d. Provide utilities.

e. Provide site data.

f. Provide interface documentation.

g. Operate meteorology station.

h. Provide materials, and services for pipes and wires from STES site to factory.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Georgia Power Company P.O. Box 4545 Atlanta, Georgia 30302	Solar Total Energy Large-Scale Experiment, Shenandoah Site
	CONTRACT NO. EG-77-A-04-3994
PRINCIPAL INVESTIGATOR Name: W.R. Hensley	PERIOD OF PERFORMANCE June 14, 1977 to September 30, 1978
WORK LOCATION Atlanta, Georgia	FISCAL YEAR 1978 FUNDING $345,073
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $485,073

PROJECT SUMMARY (continued)

i. Provide support in checkout, operation, training, and maintenance.

j. Assist DOE/SANDIA in information dissemination.

Status

The meteorology station is in operation. All milestones have been met. An annual report and a technical paper on conservation have been published.

Future Effort

Site grading will be initiated, building data will be collected, weather station operation and reporting will continue, and coordination with the design team will be provided.

Bibliography Reference Number: 3

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
American Technological University P.O. Box 1416 Killeen, Texas 76541	Fort Hood Solar Total Energy Project
	CONTRACT NO. EM-78-C-04-4231
PRINCIPAL INVESTIGATOR Name: B. Hale	PERIOD OF PERFORMANCE March 1, 1978 to October 31, 1978
WORK LOCATION Fort Hood, Texas	FISCAL YEAR 1978 FUNDING $2,000,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $4,104,725

PROJECT SUMMARY

Objective

To develop the preliminary design of a solar total energy system that will supply a substantial portion of the electrical and thermal energy for the Fort Hood 87,000 Troop Housing Complex. The preliminary design effort will finalize the baseline design which was selected during the conceptual design phase. The preliminary design will include: design specifications, interface requirements, process flow diagrams, heat balances, energy budgets, preliminary engineering drawings, reliability analyses, operation plans, and cost estimates. Each system, subsystem, and component will be characterized by specific design features required for this application.

Approach

Using the conceptual design as a baseline, the preliminary design of subsystems and components is being determined by a design process which is supported by selected trade-off analyses. Design calculations for loads and solar availability are being supplemented with site-specific data collection and analyses. A basis for future commercialization efforts is being established through economic and life cycle cost analyses.

Status

The system design is taking form as subsystem descriptions and preliminary specifications are developed. The RFP for the collector system will be issued soon and procurement packages for other long-lead items are being prepared.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
American Technological University P.O. Box 1416 Killeen, Texas 76541	Fort Hood Solar Total Energy Project
	CONTRACT NO. EM-78-C-04-4231
PRINCIPAL INVESTIGATOR Name: B. Hale	PERIOD OF PERFORMANCE March 1, 1978 to October 31, 1978
WORK LOCATION Fort Hood, Texas	FISCAL YEAR 1978 FUNDING $2,000,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $4,104,725

PROJECT SUMMARY (continued)

Future Effort

The preliminary design will be completed October 31, 1978. After a 12-month definitive design phase, construction is scheduled to start in October 1979. System start-up is planned in January 1981, followed by a two-year operational/experimental phase.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Oak Ridge National Laboratory P.O. Box X Oak Ridge, Tennessee 37830	Technical Support for Mississippi County Community College Project
	CONTRACT NO. W-7405-eng-26
PRINCIPAL INVESTIGATOR Name: Stephen I. Kaplan	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Oak Ridge, Tennessee	FISCAL YEAR 1978 FUNDING $234,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $244,000

PROJECT SUMMARY

Objective

To provide technical assisstance to DOE in monitoring the work to be performed under the DOE grant to Mississippi County Community College (MCCC) for development, design, and construction of a total energy solar photovoltaic conversion system for a new college facility. Technical assistance will also be provided to MCCC by making available observations, findings, and recommendations resulting from this activity.

Approach

The major activities in this project are (1) technical monitoring of MCCC progress in component development and construction of the campus and (2) the furnishing and coordinating of technical assistance to MCCC. The technical monitoring has included technical progress reporting and tracking project management events. Technical support has covered assistance in specifications review, bid evaluation, securing of calibration and component test data, and continuing periodic review of component development.

Status

Project accomplishments to date include:

a. Establishment of a PERT matrix for tracking MCCC progress.

b. Review of purchase specifications for the solar collectors, power conditioning systems, solar photovoltaic (PV) cells, and energy storage system.

c. Review of MCCC Energy Conservation Plan and conference with the architects on revisions to the plan.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Oak Ridge National Laboratory P.O. Box X Oak Ridge, Tennessee 37830	Technical Support for Mississippi County Community College Project
	CONTRACT NO. W-7405-eng-26
PRINCIPAL INVESTIGATOR Name: Stephen I. Kaplan	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Oak Ridge, Tennessee	FISCAL YEAR 1978 FUNDING $234,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $244,000

PROJECT SUMMARY (continued)

d. Critique of the storage battery development subproject.

e. Arranging for PV cell calibration at NASA-Lewis Research Center and Sandia Laboratories.

Future Effort

Evaluation of key aspects of the MCCC Project will be made as project progress permits. These include:

a. Capability of the solar energy system, to be completed in the fourth quarter of 1978.

b. The final design, to be completed in the first quarter of 1979.

c. The as-built system, to be completed in the fourth quarter of 1979.

Bibliography Reference Number: 4

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Mississippi County Community College Blytheville, Arkansas 72315	Total Energy Solar Photovoltaic Conversion System
	CONTRACT NO. EG-77-G-05-5565
PRINCIPAL INVESTIGATOR Name: Dr. Harry V. Smith	PERIOD OF PERFORMANCE July 1, 1977 to June 30, 1979
WORK LOCATION Blytheville, Arkansas	FISCAL YEAR 1978 FUNDING $3,800,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $5,903,000

PROJECT SUMMARY

Objective

To design and construct a Solar Photovoltaic Conversion System (SPCS) to supply the major portion of the electrical and thermal energy requirements for an instructional facility of approximately 50,000 sq. ft. at the main campus of the Mississippi County Community College.

Approach

Demonstrate the technical, economic, and institutional feasibility of the total energy concept; also, promote within an appropriate industrial sector a technology which offers the prospect of being economically competitive with other energy sources. Further, this program is expected to demonstrate the advanced technologies employed in the SPCS by making use of well characterized but perhaps commercially unproven components, subsystems, and systems.

Status

a. Selection of components, subsystems, and systems is being made on the basis of cost effectiveness and design tradeoff studies conducted to ensure the highest probability of success for the program.

b. An engineering model of the prototype collector was tested.

c. An engineering model (1 kW) of the prototype (10 kW) battery system was assembled and tested.

d. Acurex, Inc. was selected on the basis of a competitive solicitation to supply the photovoltaic collector subsystem.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Mississippi County Community College Blytheville, Arkansas 72315	Total Energy Solar Photovoltaic Conversion System
	CONTRACT NO. EG-77-G-05-5565
PRINCIPAL INVESTIGATOR Name: Dr. Harry V. Smith	PERIOD OF PERFORMANCE July 1, 1977 to June 30, 1979
WORK LOCATION Blytheville, Arkansas	FISCAL YEAR 1978 FUNDING $3,800,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $5,903,000

PROJECT SUMMARY (continued)

e. Solarex, Inc. was selected on the basis of a competitive solicitation to supply the photovoltaic cells.

f. The construction bid package was prepared and a competitive solicitation was conducted.

g. The design is 90 percent complete and construction of the project is under way.

Future Effort

The project should be completed and operations started in the spring of 1980. The total DOE contribution to this project will be $6.3 million.

Bibliography Reference Number: 5

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
General Electric Company Advanced Energy Programs P.O. Box 8661 Philadelphia, Pennsylvania 19101	Design of a Solar Total Energy Large-Scale System (for Shenandoah, Georgia Site)
	CONTRACT NO. EG-77-C-04-3985
PRINCIPAL INVESTIGATOR Name: A.J. Poche	PERIOD OF PERFORMANCE September 1, 1977 to August 30, 1978
WORK LOCATION King of Prussia, Pennsylvania	FISCAL YEAR 1978 FUNDING $2,475,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $4,127,600

PROJECT SUMMARY

Objective

a. To develop engineering experience for later commercial-size applications.

b. To acquire data to reduce risk in future cost and performance predictions.

c. To assess interaction of technology in an industrial application with an electric utility system.

d. To ensure dissemination of technical data.

Approach

The solar total energy large-scale system is being designed for a knitwear plant in Shenandoah, Georgia. It will supply over 60 percent of the energy requirements for the selected plant, including electric power, process steam, and space heating and cooling. Trade-off studies have resulted in selection of a distributed collection/central generation solar total energy system configuration, using parabolic dish solar collectors, trickle oil thermal energy storage, and a steam Rankine power conversion subsystem with extraction turbine prime mover for the Shenandoah application.

Status

Preliminary design of the solar total energy system has been completed. An engineering prototype parabolic dish solar collector, 5 meters in diameter, was tested in the Mid-temperature Test Facility at Sandia-Albuquerque. A small-scale column experiment was performed to obtain basic data on (1) trickle oil thermal energy storage system parameters and (2) performance characteristics during charge and discharge. Preliminary plans were formulated for subsequent project installation and operation phases. Detailed plans were developed for the definitive design phase.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
General Electric Company Advanced Energy Programs P.O. Box 8661 Philadelphia, Pennsylvania 19101	Design of a Solar Total Energy Large-Scale System (for Shenandoah, Georgia Site)
	CONTRACT NO. EG-77-C-04-3985
PRINCIPAL INVESTIGATOR Name: A.J. Poche	PERIOD OF PERFORMANCE September 1, 1977 to August 30, 1978
WORK LOCATION King of Prussia, Pennsylvania	FISCAL YEAR 1978 FUNDING $2,475,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $4,127,6000

PROJECT SUMMARY (continued)

Future Effort

Definitive design of the solar total energy system will be completed during FY 1979. Development testing of four full-scale 7 meter prototype parabolic dish solar collectors will be performed during the spring of 1979. Development testing of an extended-length column will be performed during the fall of 1978 to obtain additional experimental data on the trickle oil thermal energy storage system. Plans will be further developed for the system installation and operation phases. Fabrication and procurement of pacing long lead-time hardware will be initiated.

Bibliography Reference Number: 6

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Institute of Gas Technology 3424 South State St. Chicago, Illinois 60616	Application Analysis of Solar Total Energy for the Residential Sector
	CONTRACT NO. EG-77-C-04-3707
PRINCIPAL INVESTIGATOR Name: T.P. Whaley	PERIOD OF PERFORMANCE April 1, 1977 to April 1, 1978
WORK LOCATION Chicago, Illinois	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $385,228

PROJECT SUMMARY

Objective

To determine the compatibility and the applicability of Solar Total Energy (STE) to the residential sector.

Approach

a. Establish energy requirements within the residential sector.

b. Identify innovators and assess early market penetration of STE in residential sectors in the 1980's; project findings to the year 2020.

c. Produce/evaluate conceptual designs for STE systems in residential applications having minimum 50 kWe electric loads.

d. Develop criteria for selecting demonstration sites to promote early market penetration of STE systems in residential sectors.

Status

This project is complete except for publication of the final report. Principal conclusions resulting from this effort are:

a. That very limited market penetration will occur until after the year 2020.

b. That no lack of natural gas for the residential market will occur due to Government shifting of gas from other sectors to the residential areas.

c. That high-density low-rise apartment complexes look most promising due to the high cost of transporting thermal energy.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Institute of Gas Technology 3424 South State St. Chicago, Illinois 60616	Application Analysis of Solar Total Energy for the Residential Sector
	CONTRACT NO. EG—77-C-04-3707
PRINCIPAL INVESTIGATOR Name: T.P. Whaley	PERIOD OF PERFORMANCE April 1, 1977 to April 1, 1978
WORK LOCATION Chicago, Illinois	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $385,228

PROJECT SUMMARY (continued)

d. That roof-top mounting of collectors will be necessary due to the high value of residential land.

Future Effort

A final report should be available to the public through the National Technical Information Service by December 1978.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Total Energy Systems

CONTRACTOR/ADDRESS	TITLE
Rockwell International Energy Systems Group 8900 De Soto Avenue Canoga Park, California 91304	Commercial Applications of Solar Total Energy Systems
	CONTRACT NO. EY-76-C-03-1210
PRINCIPAL INVESTIGATOR Name: S.J. Nalbandian	PERIOD OF PERFORMANCE May 10, 1976 to May 31, 1978
WORK LOCATION Canoga Park, California	FISCAL YEAR 1978 FUNDING $12,087
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $247,341

PROJECT SUMMARY

Objective

To identify solar total energy systems applicable to various commercial building types based upon technical and economic feasibility of the systems and market potential of the building types.

Approach

Develop deterministic insolation model and other design methodologies to rank various of the more common commercial building types (e.g., office buildings, shopping centers) with respect to three total energy system concepts: solar "stand alone mode," thermal demand mode (i.e., electrical capacity sized to provide full thermal demand from waste heat), and solar insolation demand (i.e., system sized to utilize all available insolation).

Status

Shopping centers were found to be most promising of the commercial building types; however, insufficient land availability and thermal energy needs generally precluded significant solar contributions to overall building energy needs. As a result, thermal storage was found to be inadvisable. The most promising use of storage was battery storage, charged at off-peak utility hours, in conjunction with photovoltaic systems.

A final report is available to the public through the National Technical Information Service.

Future Effort

None.

Bibliography Reference Number: 7

SMALL THERMAL POWER APPLICATIONS
Small Community Systems
Project Summaries

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	Small Community System Applications Project
	CONTRACT NO. NAS7-100
PRINCIPAL INVESTIGATOR Name: V.C. Truscello/A.T. Marriott	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Pasadena, California	FISCAL YEAR 1978 FUNDING $1,023,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING

PROJECT SUMMARY

Objective

a. To provide technical management for Small Community Systems Application Program for DOE.

b. To define/develop near- and far-term markets for 1 to 10 MWe power plants.

c. To define/develop/install a series of engineering experiments to test feasibility in a user environment.

d. To develop strategies for accelerating commercialization, the required industrial infrastructure, and introduction into potential markets.

Approach

The project is structured to accomplish the four primary objectives with major participation from industry through contracts backed up by in-house analysis. Market areas offering a reasonable potential for small power systems will be identified and suitable technologies selected for implementation of engineering experiments designed to test the feasibility of approaches with regard to both the system and user. The experimental program is planned in three major stages: the first uses near-term technologies; the second, first generation technology from parallel DOE programs; and the third, fully developed technologies in the 1985 time period. Information on industrialization and commercialization of small power systems is being derived as a basis for decision making and recommendations to DOE regarding market penetration strategies.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	Small Community Systems Applications Project
	CONTRACT NO. NASA7-100
PRINCIPAL INVESTIGATOR Name: V.C. Truscello/A.T. Marriott	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Pasadena, California	FISCAL YEAR 1978 FUNDING $1,023,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING

PROJECT SUMMARY (continued)

Status

All major tasks are underway and total costs are within the scope of planned costs. Contracts for Phase I of the Engineering Experiment have been awarded. Negotiations have started with potential contractors for contracts on Effects of Ownership, Plant Impacts and Requirements, Effect of System Factors on Economics of Small Power Systems, and Industrialization and Mass Production. In-house supporting activities in all areas are well in progress.

Future Effort

The site for the first engineering experiment (EE #1) will be selected in FY 1979. Efforts will be accelerated to have a number of engineering experiments (small power systems) on line by 1983, all with significant industry participation in planning and production. Initial market penetration is to be achieved by the mid-1980's.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation P.O. Box 92957 Los Angeles, California 90009	Small Community Systems Applications Study
	CONTRACT NO. ET-89-C-03-2226
PRINCIPAL INVESTIGATOR Name: L.R. Sitacy	PERIOD OF PERFORMANCE July 15, 1978 to July 14, 1979
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $249,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $249,000

PROJECT SUMMARY

Objective

To determine conditions under which solar thermal power systems no larger than 10 MWe in generating capacity can provide cost-effective power for small communities and other applications, such as industrial power generation systems.

Approach

Electrical utilities and industrial power plants are being characterized on the basis of operating characteristics, fuel type, age, size, and location in order to permit parametric analyses to be performed. The purpose to lead to a determination of the potential market for small solar thermal electric power systems. Recommendations will be developed for incentives designed to accelerate the introduction of small solar thermal power plants into the utility and industrial power generating capability of the U.S.

Status

A characterization of utility systems, which was initiated under Contract No. EY-76-C-03-1101, is being completed and characterization of industrial power plants has been started.

Future Effort

An inventory of industrial power plants will be published early in 1979, comparable to the inventory of small utility-generating units published in 1978. Improved cost estimates will be developed for small solar thermal power systems and market penetration analyses will be carried out to determine the pattern for such penetration in both utility systems and industry. Based in part on the market penetration analysis, recommendations will be developed to accelerate the introduction of small solar thermal power systems into the U.S. power generation capability.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Energy Services Consulting 37 Shoal Drive Daly City, California 94014	Small Power Systems Application Workshop
	CONTRACT NO. JPL Subcontract No. 954832
PRINCIPAL INVESTIGATOR Name: Not applicable	PERIOD OF PERFORMANCE August 9, 1978 to December 30, 1977
WORK LOCATION Daly City, California/Pasadena, California/ Aspen, Colorado	FISCAL YEAR 1978 FUNDING $56,127
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $56,127

PROJECT SUMMARY

Objective

To develop, evaluate, and document Small Power Systems Applications.

Approach

a. Devise, plan, and conduct a Small Power Systems Workshop.

b. Publish workshop proceedings.

Status

Contract complete.

Future Effort

None.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Resource Planning Associates, Inc. 1901 "L" Street, N.W. Washington, D.C. 20036	Barriers and Incentives to the Innovation of Small Power Systems
	CONTRACT NO. JPL Subcontract No. 954986
PRINCIPAL INVESTIGATOR Name: J.W. Stafurik	PERIOD OF PERFORMANCE February 1978 to October 1978
WORK LOCATION Washington D.C.	FISCAL YEAR 1978 FUNDING $49,528
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $49,528

PROJECT SUMMARY

Objective

a. To identify and describe (1) the innovation process of new energy technologies and (2) the barriers and incentives to the development and commercialization of small power systems.

b. To recommend strategies to DOE program management for overcoming the barriers and accelerating the successful commercialization of small power systems.

Approach

Through a literature search and selected interviews, participants in the innovation of small power systems will be identified along with their needs and requirements for adopting new energy systems. Barriers to the adoption of small power systems will be identified. Incentives and program actions will be recommended to help ensure that participants requirements are met and potential barriers mitigated.

Status

The first interim report on the Federal and private innovation process was completed and Jet Propulsion Laboratory (JPL) comments were returned to Resource Planning Associates. The second interim report on barriers and incentives was due the end of August 1978. The final report providing the commercialization strategy recommendations will be completed during November 1978.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Resource Planning Associates, Inc. 1901 "L" Street, N.W. Washington, D.C. 20036	Barriers and Incentives to the Innovation of Small Power Systems
	CONTRACT NO. JPL Subcontract No. 954986
PRINCIPAL INVESTIGATOR Name: J.W. Stafurik	PERIOD OF PERFORMANCE February 1978 to October 1978
WORK LOCATION Washington D.C.	FISCAL YEAR 1978 FUNDING $49,528
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $49,528

PROJECT SUMMARY (continued)

Future Effort

None.

Bibliography Reference Number: 32

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Burns and McDonnell 4600 E. 63rd Street Kansas City, Missouri 64141	Potential for Small Power System in Small Utilities
	CONTRACT NO. JPL Subcontract No. 954971
PRINCIPAL INVESTIGATOR Name: C.K. Martin	PERIOD OF PERFORMANCE February 1, 1978 to September 30, 1978
WORK LOCATION Kansas City, Missouri	FISCAL YEAR 1978 FUNDING $55,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $55,000

PROJECT SUMMARY

Objective

To determine the application of solar thermal small power systems to small utilities in the U.S. in the years 1985 to 2000.

Approach

a. Modify the Burns and McDonnell power supply program to introduce the small utility power system with a 0.5-2.0 MWe peak-load capacity.

b. Compare conventional and small utility power system expansion plans.

c. Perform sensitivity analysis of the above small power system applications.

Status

All aspects of this project have been completed.

Future Effort

None.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Western Minnesota Municipal Power Agency 106 E. Holmes Street Detroit Lakes, Minnesota 56501	Detroit Lakes Energy Systems Study (Phase I)
	CONTRACT NO. ET-78-G-02-4709
PRINCIPAL INVESTIGATOR Name: Kenneth DeVillers	PERIOD OF PERFORMANCE February 1, 1978 to July 31, 1978
WORK LOCATION Detroit Lakes, Minnesota	FISCAL YEAR 1978 FUNDING $198,800
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $196,314

PROJECT SUMMARY

Objective

To assemble sufficient information from which to recommend specific classes of alternative energy systems for prototype fabrication.

Approach

a. Assess renewable resources in the Detroit Lakes region.

b. Evaluate various alternative energy sources.

c. Compare and evaluate various classes of solar thermal, solar photovoltaic, wind and biomass conversion systems for Detroit Lakes and the northern latitudes.

Status

A quarterly report dated May 8, 1978 and a final report and supporting documents dated July 31, 1978 were submitted to DOE.

Future Effort

Proposals for an extension of Phase I funding have been submitted. An extension of funding would allow preliminary design work to be completed so operating prototypes could be constructed and tested in Phase II.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
ESC Energy Corporation 37 Shoal Drive Daly City, California 94014	The Effects of Ownership on Life-cycle Costs
	CONTRACT NO. JPL Subcontract No. 955085
PRINCIPAL INVESTIGATOR Name: Richard Davis	PERIOD OF PERFORMANCE May 23, 1978 to November 1, 1979
WORK LOCATION Daly City, California	FISCAL YEAR 1978 FUNDING $25,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $25,000

PROJECT SUMMARY

Objective

To develop a small power systems financial analysis computer program whose purpose is to compare the financial implications of constructing and operating alternative small power systems from the viewpoint of various ownership options.

Approach

The computer program will be interactive and will have the flexibility to evaluate a wide range of alternative power systems and of ownership options. The output of the program will be a variety of capital investment analyses: annual cash flows, internal rate of return, payback period, etc. Sensitivity analyses will also be possible. Prior to computer coding, a number of sample or base cases will be developed and "hand-cranked", and then internally reviewed. These base cases subsequently will be used to test and validate the computer coding.

Status

The required inputs to the program have been identified and the input format agreed upon. The first base case for analysis is now being developed, with a target completion date of September 15, 1978.

Future Effort

Three more base cases will be completed by November 30, 1978. At this point, computer program coding, validation, and transfer to Jet Propulsion Laboratory computer facilities will commence. The development of a users manual will also be initiated at this time.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Corporation 5301 Bolsa Avenue Huntington Beach, California 92647	Small Community Engineering Experiment #1
	CONTRACT NO. JPL Contract No. 955117
PRINCIPAL INVESTIGATOR Name: R.J. Holl	PERIOD OF PERFORMANCE July 5, 1978 to May 5, 1979
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING $400,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY

Objective

To perform system analyses of solar thermal electric power plants for a specific category in the 1 MWe size range and to generate preferred system concepts for development, fabrication, and installation as initial experimental plants in the early 1980's. Categories to be studied under this contract include, but are not limited to, central receivers and linear-focusing systems.

Approach

Systematically study the available subsystem options; synthesize concepts from the preferred subsystems; and evaluate the cost, performance, risks, and reliability projections against suitable criteria to be supplied by the Jet Propulsion Laboratory (JPL).

Status

A study contract was initiated in July 1978. The contractor work plans have been updated recently and the initial progress review meeting has been conducted for JPL management.

Future Effort

Perform system analyses; synthesize and evaluate system concepts; select preferred system concepts; and prepare technical, management, and cost proposals for Phase II and Phase III efforts.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Ford Aerospace and Communications Corp. Aeroneutronics Division Newport Beach, California 92663	Small Community Engineering Experiment #1
	CONTRACT NO. JPL Subcontract No. 955115
PRINCIPAL INVESTIGATOR Name: R.L. Pons	PERIOD OF PERFORMANCE July 5, 1978 to May 5, 1979
WORK LOCATION Newport Beach, California	FISCAL YEAR 1978 FUNDING $400,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY

Objective

To perform system analyses of solar thermal electric power plants for a specific category in the 1 MWe size range and to generate preferred system concepts for development, fabrication, and installation as initial experimental plants in the early 1980's. Categories to be studied under this contract include point focusing, distributed collector, and energy conversion at the collector.

Approach

Systematically study the available subsystem options; synthesize concepts from the preferred subsystems; and evaluate the cost, performance, risks, and reliability projections against suitable criteria to be supplied by Jet Propulsion Laboratory (JPL).

Status

A study contract was initiated in July 1978. The contractor work plans have been updated recently and the initial progress review meeting has been conducted for JPL management.

Future Effort

Perform system analyses; synthesize and evaluate system concepts; select preferred system concepts; and prepare technical, management, and cost proposals for Phase II and Phase III efforts.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
General Electric Co. Energy Systems Program Dept. One River Road Schenectady, New York 12345	Small Community Engineering Experiment #1
	CONTRACT NO. JPL Subcontract No. 955116
PRINCIPAL INVESTIGATOR Name: H.E. Jones	PERIOD OF PERFORMANCE July 5, 1978 to May 5, 1979
WORK LOCATION Schenectady, New York	FISCAL YEAR 1978 FUNDING $400,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY

Objective

To perform system analyses of solar thermal electric power plants for a specific category in the 1 MWe size range and to generate preferred system concepts for development, fabrication, and installation as initial experimental plants in the early 1980's. Category to be studied under this contract include point focusing, distributed collector, and central steam conversion.

Approach

Systematically study the available subsystem options; synthesize concepts from the preferred subsystems; and evaluate the cost, performance, risks, and reliability projections against suitable criteria to be supplied by Jet Propulsion Laboratory (JPL).

Status

Study contract was initiated in July 1978. The contractor work plans have been updated recently and the initial progress review meeting has been conducted for JPL management.

Future Effort

Perform system analyses; synthesize and evaluate system concepts; select preferred system concepts; and prepare technical, management, and cost proposals for Phase II and Phase III efforts.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Texas Tech University P.O. Box 4709 Lubbock, Texas 79409	Crosbyton Solar Power Project
	CONTRACT NO. EY-76-C-04-3737
PRINCIPAL INVESTIGATOR Name: John D. Reichert, Herb J. Carper	PERIOD OF PERFORMANCE September 1, 1976 to January 31, 1980
WORK LOCATION Lubbock, Texas (Prime Contractor: Texas Tech)	FISCAL YEAR 1978 FUNDING $1,637,227
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $3,862,971

PROJECT SUMMARY

Objective

To develop Fixed Mirror, Distributed Focus (FMDF) concept for the production of electricity utilizing the electrical demand from the City of Crosbyton, Texas.

Approach

The work of the project has been staged to allow careful evaluation and assessment of the concept merits at various times as the program progresses. The work of Segment I of Phase I involved a research and development effort which resulted in a conceptual design of a full-scale Recommended Power System (RPS) for Crosbyton. Segment I also produced a conceptual design of an Analog Design Verification System (ADVS). Segment II of Phase I involves a continuation of the research and development program, including the construction and operation of the ADVS for the purpose of obtaining data to be used for refining performance predictions and economic analysis of the RPS. Phase II involves the construction of the RPS.

Status

Segment I has been completed, and the conceptual designs of the RPS and ADVS were presented at a DOE review held at Texas Tech University in February 1978. The work of Segment II was authorized and is presently in the initial stages of accomplishment.

Future Effort

The ADVS final design is to be completed during the first quarter of FY 1979. Construction and testing is scheduled for completion during the second quarter of FY 1980.

Bibliography Reference Number: 8

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
University of Oklahoma Center for Economic and Management Research 307 West Brooks Street, Room 4 Norman, Oklahoma 73091	Develop and Analyze Costs and Implications of Integrating a Solar Energy System with an Existing Conventional Electric Utility System
	CONTRACT NO. E(40-1)-5231
PRINCIPAL INVESTIGATOR Name: Don Murry	PERIOD OF PERFORMANCE November 1, 1977 to June 30, 1978
WORK LOCATION Norman, Oklahoma	FISCAL YEAR 1978 FUNDING $33,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $194,000

PROJECT SUMMARY

Objective

To determine how the output of a solar energy system could be best integrated with a large existing electric utility and determine the economic impact of such an integration.

Approach

Perform system analysis and analyze operation and maintenance problems and costs. The impact of costs and revenues combined as modified by an estimated regulatory assessment will be used to determine the optimum integration cost benefits.

Status

The contract has been completed and a final report has been prepared.

Future Effort

To be determined.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	Point Focusing Distributed Receiver (PFDR) Technology
	CONTRACT NO. NAS7-100
PRINCIPAL INVESTIGATOR Name: V.C. Truscell/J.W. Lucas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Pasadena, California	FISCAL YEAR 1978 FUNDING $2,970,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING

PROJECT SUMMARY

Objective

a. To provide technical management for the Point Focusing Distributed Receiver Technology Project for DOE.

b. To develop/mature point-focusing distributed receiver subsystems.

c. To demonstrate performance potential of point-focusing distributed receiver systems through module testing.

d. To mature manufacturing process to enable low-cost mass production of key point focusing distributed receiver subsystems.

Approach

Subsystem interfaces will be established and the functional and design requirements for each subsystem defined. Integration for the various subsystems will be performed, and the trade-offs necessary for system optimization will be determined. Performance and cost targets will be determined and allocations made for each major subsystem. Designing for low operating and maintenance costs will be an implicit part of the design process.

Status

All major tasks are on schedule and total costs are within the scope of planned costs. Concentrator development is proceeding in the areas of both a Test Bed Concentrator for subsystem tests at the Solar Thermal Test Site and the Low-Cost Concentrator. Contracts were awarded for both steam and gas receiver development. A new effort in manufacturing development was initiated and an accelerated effort to secure off-the-shelf hardware for testing was begun.

ELEMENT: Small Power System Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	Point Focusing Distributed Receiver (PFDR) Technology
	CONTRACT NO. NAS7-100
PRINCIPAL INVESTIGATOR Name: V.C. Truscello/J.W. Lucas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Pasadena, California	FISCAL YEAR 1978 FUNDING $2,970,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING

PROJECT SUMMARY (continued)

Future Effort

Testing for design verification of the subsystems at the component and module level will be accomplished at the Jet Propulsion Laboratory (JPL) Solar Thermal Test Site. Design verification will include obtaining data on operating and maintenance costs; these data will be input to the continuing subsystem design process. The subsystems have been scheduled for progressive testing, adding systems sequentially. The transfer of first generation PFDR Technology to industry could be by the early 1980's.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Blvd. Golden, Colorado 80401	Small Power Systems Study
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: C.J. Bishop/J.P. Thornton	PERIOD OF PERFORMANCE April 1978 to April 1979
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $212,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $212,000

PROJECT SUMMARY

Objective

To rank the various solar thermal technologies regarding their applicability to power systems in the 1-10 MWe size range.

Approach

Generic systems representing the various solar technologies are being selected and systems analyses to predict system performance and economic behavior are being performed. The generic systems under study will then be ranked according to criteria established by potential users, i.e., small utilities. Ranking will be based on performance, cost, reliability, safety, and social issues.

Status

a. Seven generic systems have been selected for study.

b. Systems have been sized at a base line of 5 MWe with sensitivity studies slated for 1 and 10 MWe.

c. Performance and economic simulation codes have been obtained and made operational.

d. Ranking parameters have been identified.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Blvd. Golden, Colorado 80401	Small Power System Study
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: C.J. Bishop/J.P. Thornton	PERIOD OF PERFORMANCE April 1978 to April 1979
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $212,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $212,000

PROJECT SUMMARY (continued)

Future Effort

a. Detailed systems analyses will be performed on all systems.

b. Quantification of ranking parameters will be completed through interviews with potential decision makers/users.

c. Systems will be ranked.

Bibliography Reference Number: 9

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
E-Systems Energy Technology Center P.O. Box 6118 Dallas, Texas 75222	Test-Bed Concentrator
	CONTRACT NO. JPL Subcontract No. 955191
PRINCIPAL INVESTIGATOR Name: V. Goldberg	PERIOD OF PERFORMANCE September 1, 1978 to October 1, 1979
WORK LOCATION Dallas, Texas and Hobbs, New Mexico	FISCAL YEAR 1978 FUNDING $40,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $40,000

PROJECT SUMMARY

Objective

To procure a test-bed concentrator to be used for point focus concentrator development and testing at the subsystem and module level.

Approach

Modify an existing antenna design to satisfy Jet Propulsion Laboratory (JPL) requirements for a test bed concentrator. The reflector surface will be made up of JPL-supplied mirror facets with Foamglas™ substrates. The contractor will do the required design modifications, fabrication, installation, and checkout.

Status

This project is in the early development stages.

Future Effort

No effort past the delivery of the test-bed concentrator is planned.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Sanders Associates, Inc. Defensive Systems Division 95 Canal Street Nashua, New Hampshire 03060	Gas (Brayton) Receiver Concepts
	CONTRACT NO. JPL Subcontract No. 955120
PRINCIPAL INVESTIGATOR Name: Mr. Varouj Nersesian	PERIOD OF PERFORMANCE July 6, 1978 to January 6, 1979
WORK LOCATION Nashua, New Hampshire	FISCAL YEAR 1978 FUNDING $75,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $75,000

PROJECT SUMMARY

Objective

To develop the preliminary design of a receiver compatible with an open-cycle air Brayton system. This receiver is to be representative of industry's best current state-of-the-art practice for low-cost design and fabrication.

Approach

An initial two months' parametric analysis is being performed to determine basic receiver design characteristics over a limited range of size and performance requirements. From this study and other concentrator and power conversion unit data, a preferred nearer optimum system design concept will be selected for final conceptual design.

Status

A parametric design was presented in September 1978. A final conceptual design is due January 6, 1979.

Future Effort

This contract is one of four parallel conceptual design efforts. Early in 1979, one of the four will be selected for final design and the production of a prototype receiver.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3707 Seattle, Washington 98124	Gas (Brayton) Receiver Concepts
	CONTRACT NO. JPL Subcontract No. 955119
PRINCIPAL INVESTIGATOR Name: Mr. John B. Schroeder	PERIOD OF PERFORMANCE July 6, 1978 to January 6, 1979
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $75,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $75,000

PROJECT SUMMARY

Objective

To develop the preliminary design of a receiver compatible with an open-cycle air Brayton system. This receiver is to be representative of industry's best current state-of-the-art practice for low-cost design and fabrication.

Approach

An initial two months' parametric analysis is being performed to determine basic receiver design characteristics over a limited range of size and performance requirements. From this study and other concentrator and power conversion unit data, a preferred nearer optimum system design concept will be selected for final conceptual design.

Status

A parametric design was presented in September 1978. A final conceptual design is due January 6, 1979.

Future Effort

This contract is one of four parallel conceptual design efforts. Early in 1979, one of the four will be selected for final design and the production of a prototype receiver.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
The Garrett Corporation AiResearch Manufacturing 2525 West 190th Street Torrance, California 90509	Gas (Brayton) Receiver Concepts
	CONTRACT NO. JPL Subcontract No. 955136
PRINCIPAL INVESTIGATOR Name: Mr. Max V. Greeven	PERIOD OF PERFORMANCE July 6, 1978 to January 6, 1979
WORK LOCATION Torrance, California	FISCAL YEAR 1978 FUNDING $75,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $75,000

PROJECT SUMMARY

Objective

To develop the preliminary design of a receiver compatible with an open-cycle air Brayton system. This receiver is to be representative of industry's best current state-of-the-art practice for low-cost design and fabrication.

Approach

An initial two months' parametric analysis is being performed to determine basic receiver design characteristics over a limited range of size and performance requirements. From this study and other concentrator and power conversion unit data, a preferred nearer optimum system design concept will be selected for final conceptual design.

Status

A parametric design was presented in September 1978. A final conceptual design is due January 6, 1979.

Future Effort

This contract is one of four parallel conceptual design efforts. Early in 1979, one of the four will be selected for final design and the production of a prototype receiver.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Dynatherm Corporation One Industry Lane Cockeysville, Maryland 21030	Gas (Brayton) Receiver Concepts
	CONTRACT NO. JPL Subcontract No. 955135
PRINCIPAL INVESTIGATOR Name: Dr. Walter B. Bienert	PERIOD OF PERFORMANCE July 6, 1978 to January 6, 1979
WORK LOCATION Cockeysville, Maryland	FISCAL YEAR 1978 FUNDING $50,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $50,000

PROJECT SUMMARY

Objective

To develop the preliminary design of a receiver compatible with an open-cycle air Brayton system. This receiver is to be representative of industry's best current state-of-the-art practice for low-cost design and fabrication.

Approach

An initial two months' parametric analysis is being performed to determine basic receiver design characteristics over a limited range of size and performance requirements. From this study and other concentrator and power conversion unit data, a preferred nearer optimum system design concept will be selected for final conceptual design.

Status

A parametric design was presented in September 1978. A final conceptual design is due January 6, 1979.

Future Effort

This contract is one of four parallel conceptual design efforts. Early in 1979, one of the four will be selected for final design and the production of a prototype receiver.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Garrett Corporation AiResearch Manufacturing 402 S. 36th Street P.O. Box 5217 Phoenix, Arizona 85010	Steam (Rankine) Receiver Concepts
	CONTRACT NO. JPL Subcontract No. 95-51-157
PRINCIPAL INVESTIGATOR Name: Max Greeven	PERIOD OF PERFORMANCE July 27, 1978 to December 27, 1978
WORK LOCATION Torrance, California	FISCAL YEAR 1978 FUNDING $83,500
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $83,500

PROJECT SUMMARY

Objective

To develop the preliminary design of a steam Rankine receiver which is representative of the current industrial state-of-the art in performance and low cost. The receiver design is constrained to fit a total point-focusing system (concentrator, receiver, and power conversion subsystems) which is being developed for DOE by JPL.

Approach

Perform a parametric analysis to determine receiver design characteristics over a limited range of thermal size and performance requirements. Results are being reviewed simultaneously with similar studies on power conversion and concentrator subsystems to select a near optimum total system design. The selected preliminary receiver design is then to be completed.

Status

Parametric studies are approximately 50 percent completed.

Future Effort

Phase II contracts will be issued to create a final design of the receiver, and to fabricate and test the receiver. The receiver will then be integrated into the total system feasibility test of the point-focusing steam system.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Fairchild Stratos 1800 Rosecrans Ave. Manhattan Beach, California 90266	Steam (Rankine) Receiver Concepts
	CONTRACT NO. JPL Subcontract No. 95-51-158
PRINCIPAL INVESTIGATOR Name: Richard Haglund	PERIOD OF PERFORMANCE July 27,1978 to December 27, 1978
WORK LOCATION Manhattan Beach, California	FISCAL YEAR 1978 FUNDING $83,500
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $83,500

PROJECT SUMMARY

Objective

To develop the preliminary design of a steam Rankine receiver which is representative of the current industrial state-of-the-art in performance and low cost. The receiver design is constrained to fit a total point-focusing system (concentrator, receiver, and power conversion subsystem) which is being developed for DOE by the Jet Propulsion Laboratory.

Approach

Perform a parametric analysis to determine receiver design characteristics over a limited range of thermal size and performance requirements. Results are being reviewed simultaneously with similar studies on power conversion and concentrator subsystems to select a near optimum total system design. The selected preliminary receiver design is then to be completed.

Status

Parametric studies are approximately 50 percent completed.

Future Effort

Phase II contracts will be issued to create a final design of the receiver, plus fabrication and test of the receiver. The receiver will then be integrated into the total system feasibility test of the point-focusing steam system.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Acurex Corporation Alternate Energy Division 485 Clyde Avenue Mountain View, California 94042	Low-Cost Concentrator
	CONTRACT NO. JPL Subcontract No. 955208
PRINCIPAL INVESTIGATOR Name: J. Vindum	PERIOD OF PERFORMANCE September 15, 1978 to February 16, 1979
WORK LOCATION Mountain View, California	FISCAL YEAR 1978 FUNDING $56,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, Claifornia	CUMULATIVE FUNDING $56,000

PROJECT SUMMARY

Objective

To select, study, optimize, and perform preliminary design of a point-focusing concentrator which has the potential, when mass produced, of attaining a cost/performance ratio of 0.004 to 0.012 kWt/$. The primary objective is to select an optimum set of design parameters to maximize kWt/$, perform preliminary design based on selected parameters, establish preliminary interfaces with the rest of the system, and assess how to implement mass production of the selected design.

Approach

Acurex Corporation is one of three contractors selected to perform a parameter optimization of its proposed concept to maximize the performance/cost ratio. The basic fixed-price contract covers the optimization study. A fixed-price option, funded in FY 1979, can be exercised to perform a preliminary design based upon the design parameters selected.

Status

Initial work on this project has begun.

Future Effort

Acurex, Boeing, and General Electric will submit proposals, following the completion of the described phase, for the design, fabrication, installation, and acceptance testing of up to six concentrators at the Solar Thermal Test Site, Edwards, California. One contractor will be selected to develop its concept into hardware.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3703 Seattle, Washington 98124	Low-Cost Concentrator
	CONTRACT NO. JPL Subcontract No. 955209
PRINCIPAL INVESTIGATOR Name: D.K. Zimmerman	PERIOD OF PERFORMANCE September 15, 1978 to February 16, 1979.
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $56,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $56,000

PROJECT SUMMARY

Objective

To select, study, optimize, and perform preliminary design of a point-focusing concentrator which has the potential, when mass produced, of attaining a cost performance ratio of 0.004 to 0.012 kWt/$. The primary objective is to select an optimum set of design parameters to maximize kWt/$, perform preliminary design based on selected parameters, establish preliminary interfaces with the rest of the system, and assess how to implement mass production of the selected design.

Approach

Boeing is one of three contractors selected to perform a parameter optimization of its proposed concept to maximize the performance/cost ratio. The basic fixed price contract covers the optimization study. A fixed price option, funded in FY 1979, can be exercised to perform a preliminary design based upon the design parameters selected.

Status

Initial work on this project has begun.

Future Effort

Acurex, Boeing, and General Electric will submit proposals, following the completion of the described phase, for the design, fabrication, installation, and acceptance testing of up to six concentrators at the Solar Thermal Test Site, Edwards, California. One contractor will be selected to develop its concept into hardware.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Small Community Systems

CONTRACTOR/ADDRESS	TITLE
General Electric Company Space Division King of Prussia Park, P.O. Box 8661 Philadelphia, Pennsylvania 19101	Low-Cost Concentrator
	CONTRACT NO. JPL Subcontract No. 955210
PRINCIPAL INVESTIGATOR Name: J. Zimmerman	PERIOD OF PERFORMANCE September 15, 1978 to February 16, 1979
WORK LOCATION Philadelphia, Pennsylvania	FISCAL YEAR 1978 FUNDING $56,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $56,000

PROJECT SUMMARY

Objective

To select, study, optimize, and perform preliminary design of a point-focusing concentrator which has the potential, when mass produced, of attaining a cost/performance ratio of 0.004 to 0.012 kWt/$. The primary objective is to select an optimum set of design parameters to maximize kWt/$, perform a preliminary design based no selected parameters, establish preliminary interfaces with the rest of the system, and assess how to implement mass production of the selected design.

Approach

General Electric is one of three contractors selected to perform a parameter optimization of its proposed concept to maximize the performance/cost ratio. The basic fixed-price contract covers the optimization study. A fixed price option, funded in FY 1979, can be exercised to perform a preliminary design based upon the design parameters selected.

Status

Initial work on this project has begun.

Future Effort

Acurex, Boeing, and General Electric will submit proposals, following the completion of the described phase, for the design, fabrication, installation, and acceptance testing of up to six concentrators at the Solar Thermal Test Site, Edwards, California. One contractor will be selected to develop its concept into hardware.

SMALL THERMAL POWER APPLICATIONS
Remote (Irrigation) Systems
Project Summaries

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Solar Irrigation Project
	CONTRACT NO. AT(29-1)-789
PRINCIPAL INVESTIGATOR Name: J.F. Banas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $1,508,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $3,540,000

PROJECT SUMMARY

Objective

To analytically develop techniques and methods for assessing solar-powered irrigation feasibility on both a regional and a national basis and to design, fabricate, and field demonstrate solar-powered irrigation systems on working farms.

Approach

a. Design, construct, and operate a shallow well solar irrigation project in New Mexico, and obtain performance data on its operation.

b. Assist DOE in preparing a Solar Irrigation Program.

c. Provide technical management for the solar irrigation experiment in Arizona.

d. Conduct system analyses (on both local and regional bases) on the feasibility of solar-powered irrigation.

e. Upgrade the New Mexico experiment to power a center pivot irrigation system and to study and conduct experiments on off-season solar energy usage.

Status

a. The collector field and storage subsystems for the New Mexico Irrigation Experiment have been upgraded and placed into operation.

b. An electrical generator has been installed in the New Mexico Irrigation Experiment to permit the system to be used for power generation during the non-irrigation season.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories P.O. Box 5800 Albuquerque, New Mexico 87185	Solar Irrigation Project
	CONTRACT NO. AT(29-1)-789
PRINCIPAL INVESTIGATOR Name: J.F. Banas	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $1,508,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $3,540,000

PROJECT SUMMARY (continued)

c. A study of solar-powered irrigation feasibility has been completed.

d. Detailed design of the Arizona Irrigation Experiment has been completed by Acurex and construction has been initiated.

Future Efforts

During FY 1979, it is expected that (1) the New Mexico Irrigation Experiment will be operated to compile an operations and maintenance (O&M) data base, (2) the Arizona Irrigation Experiment will be placed into operation, (3) an on-site solar power plant will be designed, and (4) design studies for a heat engine will be procured.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Acurex Corporation 485 Clyde Avenue Mountain View, California 94042	150 kWe Solar-Powered Deep-Well Irrigation Facility
	CONTRACT NO. EG-77-C-04-4159
PRINCIPAL INVESTIGATOR Name: J. Vindum	PERIOD OF PERFORMANCE September 30, 1977 to September 29, 1979
WORK LOCATION Mountain View, California/ Collidge, Arizona	FISCAL YEAR 1978 FUNDING $2,800,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $3,907,000

PROJECT SUMMARY

Objective

To design, construct, and operate for checkout and data-gathering a solar-powered experimental facility to provide 150 kWe of electric power for the operation of deep-well irrigation pumps.

Approach

Acurex, which was awarded this contract upon completion of a competitive preliminary design study phase conducted in FY 1977, will work cooperatively with DOE and the State of Arizona on this project. Arizona is providing the facility site, located on a farm in Arizona, and will conduct agricultural experimentations.

The following tasks are required to achieve the objective:

a. Perform a detailed design.

b. Construct the solar system.

c. Perform initial checkout and operation.

Status

a. Detailed design was completed in June 1978.

b. Construction was begun in August 1978.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Acurex Corporation 485 Clyde Avenue Mountain View, California 94042	150 kWe Solar-Powered Deep-Well Irrigation Facility
	CONTRACT NO. EG-77-C-04-4159
PRINCIPAL INVESTIGATOR Name: J. Vindum	PERIOD OF PERFORMANCE September 30, 1977 to September 29, 1979
WORK LOCATION Mountain View, California/ Coolidge, Arizona	FISCAL YEAR 1978 FUNDING $2,800,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $3,907,000

PROJECT SUMMARY (continued)

c. Completion of construction and installation is scheduled for the spring of 1979.

d. Initial operation and data-gathering is scheduled for the summer of 1979.

Future Effort

Upon completion of check-out by Acurex Corporation, the facility will be operated by the University of Arizona under contract to DOE for the purpose of measuring performance and operations and maintenance (O&M) data.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Bechtel Corporation 50 Beale Street P.P. Box 3695 San Francisco, California 94119	Technical and Economic Assessment of Solar Water Pumping for Remote Areas
	CONTRACT NO. P.O. 87-9813
PRINCIPAL INVESTIGATOR Name: E.Y. Lam	PERIOD OF PERFORMANCE July 20, 1977 to July 19, 1978
WORK LOCATION San Francisco, California	FISCAL YEAR 1978 FUNDING $14,967
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $14,967

PROJECT SUMMARY

Objective

To identify the currently available solar energy technology and hardware that could be utilized to pump water in remote areas.

Approach

a. Review the literature and contact suppliers or potential suppliers of solar water pumps and solar heat engines adaptable for water pumping to provide a technical and economic overview of the state-of-the-art of the technology.

b. Collect design, operational, maintenance, cost, and fuel-use data on a typical conventional water pump that is currently marketed and enjoying an extensive market for remote areas in the U.S.

c. Select a candidate solar water pumping concept which has the potential for cost-effective implementation in the near future; use the information obtained in the course of performing the two preceding tasks as a basis for selection. Modify the selected concept as necessary to permit comparison of performance with the conventional system examined. Take into consideration features that are essential for remote area application, such as low maintenance. Specify off-the-shelf components as much as possible in order to establish technical feasibility in the short-term and to aid in economic comparability.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Bechtel Corporation 50 Beale Street P.O. Box 3695 San Francisco, California 94119	Technical and Economic Assessment of Solar Water Pumping for Remote Areas
	CONTRACT NO. P.O. 87-9813
PRINCIPAL INVESTIGATOR Name: E.Y. Lam	PERIOD OF PERFORMANCE July 20, 1977 to July 19, 1978
WORK LOCATION San Francisco, California	FISCAL YEAR 1978 FUNDING $14,967
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $14,967

PROJECT SUMMARY (continued)

d. Develop estimates of capital and operating costs for the proposed solar water pumping system (these estimates assume large-scale production of the system). Compare the costs estimated to those of the previously selected typical conventional water pump. (This comparison provides a preliminary evaluation of the economic feasibility of the solar approach. The comparison of operating costs is also expressed as a function of energy cost for the conventional system. This allows a projection of the economic competitiveness of the solar system in the near future.

e. Prepare a report of study results, providing a general assessment of solar water pumping technology and identification of areas for future conceptual evolution and technological improvements. Include bibliography in the report.

Status

All of the tasks have been completed.

Future Effort

None anticipated.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Bechtel Corporation 50 Beale Street P.O. Box 3965 San Francisco, California 94119	Technical and Economic Assessment of the Feasibility of Solar Distillation for Large-Scale Production of Fresh Water
	CONTRACT NO. P.O. 87-9814
PRINCIPAL INVESTIGATOR Name: E.Y. Lam	PERIOD OF PERFORMANCE August 1, 1977 to March 31, 1978
WORK LOCATION San Francisco, California	FISCAL YEAR 1978 FUNDING $11,717
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $11,717

PROJECT SUMMARY

Objective

To produce an assessment of the technical and economic feasibility of solar distillation for the large-scale production of fresh water.

Approach

a. Review the literature and present a technical and economic overview of the state-of-the-art of large-scale solar distillation, and describe the more prominent concepts that have been proposed.

b. Select from the literature a candidate solar distillation concept which has the potential for short-term cost-effective implementation. (This concept has formed the baseline for a preliminary assessment of the solar distillation potential in general.)

c. Identify potential technical and application constraints and modify the baseline concept to improve its performance or lower its cost. (These modifications have been derived from the literature or have been originated by Bechtel.)

d. Review installation and operating costs data in the literature for the baseline concept and assess cost validity based on available Bechtel cost information. Similarly identify and estimate cost differences that may be expected as a result of implementing the identified modifications to the baseline concept.

e. Compare the lowest anticipated installation and operating costs of the foregoing improved solar distillation plant scheme with a typical conventional non-solar desalinization plant of the same installed capacity operating under similar site conditions. (This comparison has been expressed as a function of full cost for the conventional plant to allow a projection of the economic competitiveness of the solar plant in the future).

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Bechtel Corporation 50 Beale Street P.O. Box 3965 San Francisco, California 94119	Technical and Economic Assessment of the Feasibility of Solar Distillation for Large-Scale Production of Fresh Water
	CONTRACT NO. P.O. 87-9814
PRINCIPAL INVESTIGATOR Name: E.Y. Lam	PERIOD OF PERFORMANCE August 1, 1977 to March 31, 1978
WORK LOCATION San Francisco, California	FISCAL YEAR 1978 FUNDING $11,717
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $11,717

PROJECT SUMMARY (continued)

f. Prepare a report of study results providing a general assessment of the solar distillation technology and identification of areas for future conceptual evolution and technological improvements. In addition, comment on the potential of the candidate concepts not selected for this study. Include bibliography in the report.

Status

All of the tasks have been completed. The final report may be obtained through the National Technical Information Service.

Future Effort

No continuation is anticipated. The assessment will provide a data base establishing the need and potential for a new research and development program.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Payne, Inc. 1933 Lincoln Drive Annapolis, Maryland 21401	Investigation of Pulsejet Pump for Irrigation Systems
	CONTRACT NO. EG-77-C-01-4121
PRINCIPAL INVESTIGATOR Name: Peter R. Payne	PERIOD OF PERFORMANCE August 30, 1977 to April 30, 1979
WORK LOCATION Annapolis, Maryland	FISCAL YEAR 1978 FUNDING $104,671
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $207,868

PROJECT SUMMARY

Objective

In its simplest embodiment, the water pulsejet is a metal tube, closed at one end. When the closed end is heated, water in the tube oscillates to do work with a theoretical (no loss) cycle efficiency of 40 percent. The objective of the present program is to understand and characterize the engine and to develop an irrigation pump version of the engine which can be powered by flat plate or semi-concentrating solar collectors. Since the pump is self-starting, it is hoped that the attractiveness of an "install and forget" irrigation pump will lead to its early adoption.

Approach

At the beginning of the program, it was decided to place a major emphasis on work leading to a better understanding of the cycle, so that the full potential of the cycle could be assessed and pumps could be designed for optimum performance. This objective was partially achieved. It is now thought to be possible to build engines having an order of magnitude improvement in efficiency (10 percent cycle efficiency instead of 1 percent), even though the various secondary loss mechanisms (e.g., steam condensation on cold walls) are not yet adequately quantified.

Status

New, improved "boiler" designs are now being evaluated experimentally, and this work will continue until the end of December 1978. Then a "pre-production" pump design will be initiated, utilizing the best of the boiler technology.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Payne, Inc. 1933 Lincoln Drive Annapolis, Maryland 21401	Investigation of Pulsejet Pump for Irrigation Systems
	CONTRACT NO. EG-77-C-01-4121
PRINCIPAL INVESTIGATOR Name: Peter R. Payne	PERIOD OF PERFORMANCE August 30, 1977 to April 30, 1979
WORK LOCATION Annapolis, Maryland	FISCAL YEAR 1978 FUNDING $104,671
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $207,868

PROJECT SUMMARY (continued)

Future Effort

Any future effort will be based on the results of the current work.

Bibliography Reference No.: 33

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Thermo Electron Corporation 101 First Avenue Waltham, Massachusetts 02154	Directly Coupled Solar Thermal Water Pumping Concepts for Agriculture
	CONTRACT NO. ET-78-C-03-1571
PRINCIPAL INVESTIGATOR Dr. Walter J. Bornhorst	PERIOD OF PERFORMANCE August 14, 1978 to April 30, 1979
WORK LOCATION Waltham, Massachusetts	FISCAL YEAR 1978 FUNDING $98,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $98,000

PROJECT SUMMARY

Objective

To conduct analysis and preliminary design of directly coupled solar thermal water pumping concepts.

Approach

Preliminary and detailed analyses and designs will be performed. Components will be fabricated, tested, and evaluated. Configuration designs will be reviewed to enhance reliability, operating lifetimes, and maintenance. Fabrication studies will be performed.

Status

The project has only recently started.

Future Effort

Future efforts are dependent on the results of this contract.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
University of New Mexico Center for Environmental Research and Development 2414 Central, S.E. Albuquerque, New Mexico 87131	Solar Powered Liquid Piston Stirling-Cycle Irrigation Pump
	CONTRACT NO. ET-78-G-03-1894
PRINCIPAL INVESTIGATOR Richard S. Passamaneck	PERIOD OF PERFORMANCE May 1, 1978 to December 31, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $16,528
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $16,528

PROJECT SUMMARY

Objective

To conduct preliminary testing and analysis of a solar powered liquid piston Stirling-cycle irrigation pump.

Approach

A laboratory scale model of liquid piston Stirling-cycle pump is being constructed. Computer modeling and simulation for pump operation for use in scale up is being performed. Preliminary testing of a solar collector, storage, and energy transfer system is being performed.

Status

No results are available at this time.

Future Effort

Future efforts are dependent on the results of this grant.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Barber-Nichols Engineering Company 6325 W. 55th Avenue Arvada, Colorado 80002	10-25 hp Solar Powered Rankine-Cycle Irrigation Pump
	CONTRACT NO. ET-78-C-03-1891
PRINCIPAL INVESTIGATOR Name: Robert E. Barber	PERIOD OF PERFORMANCE May 1, 1978 to April 30, 1979
WORK LOCATION Arvada, Colorado	FISCAL YEAR 1978 FUNDING $105,369
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $105,369

PROJECT SUMMARY

Objective

To design, build, and test a system incorporating a unique approach to solar powered irrigation pumping.

Approach

A passive control approach is being used to simplify the basic Rankine-cycle engine by allowing the power cycle fluid to boil in the collector. A market study will be performed, including engine/pump matching and a detailed equipment and installation cost analysis for both prototype and production quantity units.

Status

No results are available at this time.

Future Effort

Future efforts are dependent on the results of this contract.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Transtech Corp. 3661 Mt. Diablo Blvd. Suite 10 Lafayette, California 94549	Welge Solar Powered Well Pump Engine
	CONTRACT NO. ET-78-C-03-1892
PRINCIPAL INVESTIGATOR Leslie A. Welge	PERIOD OF PERFORMANCE April 15, 1978 to August 15, 1978
WORK LOCATION Lafayette, California	FISCAL YEAR 1978 FUNDING $20,443
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $20,443

PROJECT SUMMARY

Objective

To conduct a system analysis, a refrigerant study, and a preliminary design of a Welge Solar Powered Well Pump Engine.

Approach

a. Perform a system analysis on a solar powered heat engine for application in a shallow well.

b. Study and choose refrigerants for various pumping depths.

c. Complete a preliminary system design and determine the technical, economic, and cost effectiveness.

Status

The contract final report is being prepared.

Future Effort

Future efforts are dependent on the results of this contract.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Systems Exploration, Inc. 3687 Voltaire Street San Diego, California 92106	Thermally Driven Water Pumping Concepts for Solar System Applications in Agriculture
	CONTRACT NO. ET-78-C-03-1890
PRINCIPAL INVESTIGATOR Dr. Dale E. Calkins	PERIOD OF PERFORMANCE May 1, 1978 to October 31, 1978
WORK LOCATION San Diego, California	FISCAL YEAR 1978 FUNDING $17,144
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $17,144

PROJECT SUMMARY

Objective

To prepare a preliminary design and a computer algorithm to analyze and evaluate a thermally driven water pump for agriculture application.

Approach

a. Develop a baseline conceptual design of the pump in addition to a computer algorithm of the system.

b. Perform a sensitivity study using the computer model to evaluate the system performance and economics.

Status

A contract final report is being prepared.

Future Effort

Future efforts are dependent on the results of this contract.

ELEMENT: Small Thermal Power Applications

SUB-ELEMENT: Remote Systems

CONTRACTOR/ADDRESS	TITLE
Foster Miller Associates, Inc. 135 Second Avenue Waltham, Massachusetts	Development of a Thermally Driven Direct Action Organic Rankine Pump
	CONTRACT NO. ET-78-C-03-1893
PRINCIPAL INVESTIGATOR John Dieckman	PERIOD OF PERFORMANCE June 1, 1978 to May 31, 1979
WORK LOCATION Waltham, Massachusetts	FISCAL YEAR 1978 FUNDING $88,858
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $88,858

PROJECT SUMMARY

Objective

To design, test, and analyze a thermally driven direct action organic Rankine pump.

Approach

Design specifications have been established for the proposed pump concept. Prepare a preliminary design of the direct action pump and perform laboratory testing. Prepare a design package for a prototype version.

Status

Design specifications have been completed. No test results are available at this time.

Future Effort

Future efforts are dependent on the results of this contract.

LARGE THERMAL POWER APPLICATIONS

LARGE THERMAL POWER APPLICATIONS

INTRODUCTION

The large thermal power application program element focuses upon large thermal plants ranging from 10 MWe to 300 MWe. These large plants are perceived as forming an integral part of existing electric utility networks. They can be either large (50-300 MWe), new power plants or retrofit systems for repowering small (10-100 MWe), older power plants now fueled with natural gas or oil. It is anticipated that these new and retrofit plants eventually could comprise 10 to 50 percent of the generating capacity of an individual utility. They could account for a comparable share of the utility's requirements for primary energy. In this application, the operation of solar plants would directly and specifically reduce the national consumption of premium fuels such as oil and natural gas.

Two important areas within the large thermal power application program element are:

- Large-scale systems for electric power generation and for high-temperature process heat.
- Subsystem and component development in support of these systems.

LARGE THERMAL POWER APPLICATIONS PROGRAM ACTIVITIES

Status

Systems and Applications. The 3-year research and development effort involving the preliminary design of a 10 MWe solar electric central receiver and the selection of a pilot plant site near Barstow, California marks a major milestone toward the objective of establishing an economic generation resource for electric utility application by the mid-1980's. The major contractors for the final design and construction of the pilot plant were selected in 1978 and the final design phase was initiated.

Studies of large-scale solar thermal concepts were initiated in 1975. They provided the basis for a 2-year preliminary design and component development program which consisted of three contractor teams investigating the complete system and one contractor investigating only a novel heliostat concept. The principal solar-related components developed by the contractors were fabricated and tested. An evaluation of the systems design and component performance data led to selection of one concept for the follow-on effort for the Barstow unit.

A consortium headed by the Southern California Edison Company was competitively selected during 1977 to join with DOE in the implementation of this pilot plant effort. The plant will adapt a high-temperature solar heat collection subsystem to supply steam to a turbine plant supplied by the utility partners.

Studies during 1978 have continued to add to the understanding of promising alternative large-scale system concepts for utility applications. These alternatives include (1) solar-fossil hybrids, both new and retrofitted, (2) other types of solar hybrids, (3) line focusing collector concepts and advanced systems using the Brayton cycle, and (4) Rankine cycle concepts involving a single phase receiver with liquid sodium or molten salt. Contracts to

investigate these alternative approaches were awarded during 1978. The results will provide options for a prototype utility power plant module experiment which could be a follow-on effort to the Barstow plant.

Subsystems and Components. The Phase-I conceptual designs for the advanced low-cost heliostat project were completed in 1978. This activity is oriented toward reducing the cost of solar power plant heliostats.

Considerable emphasis was directed toward advanced receiver concepts and storage subsystems also. The Phase-I studies of the advanced central receiver project were completed. The Phase-II contracts for preliminary system design and for the development and test of critical components and subsystems were awarded for this program and the designs were initiated.

The Central Receiver-Solar Thermal Test Facility was completed and placed in operation during 1978. This facility, located at Albuquerque, New Mexico, is designed to test a wide variety of receivers, heliostats, and storage systems. The receiver design selected for the 10 MWe pilot plant and the Electric Power Research Institute (EPRI)/Boeing receiver were the first components to be tested in the facility. It is also available for high-temperature research and development in this field. A voluntary Users Association is being supported in order to facilitate and widen research experiments with the facility. This organization has broadened its function to coordinate activities with other solar test facilities in the U.S. and abroad.

Future Effort

In the coming year, the repowering (retrofitting) of existing oil- and gas-fired power plants will be emphasized as the strategy for early implementation by utilities and early development of an industrial base. In addition, development of heliostat manufacturing technology and low-cost designs will continue to receive increasing attention. Studies and project management in support of the 10 MWe pilot plant at Barstow will continue. Completion of the Barstow plant is scheduled for 1981; operation will commence at the time with the objective of providing data and information needed to adapt water/steam central receiver technology to both repowering applications and the further development of systems that include thermal storage. Alternate concepts identified as having low-cost potential will be investigated in greater detail.

LARGE THERMAL POWER APPLICATIONS
Systems and Applications
Project Summaries

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories Livermore, California 94550	Solar Central Receiver Project Management
	CONTRACT NO. E(29-1)-0789
PRINCIPAL INVESTIGATOR Name: R.C. Wayne	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Livermore, California	FISCAL YEAR 1978 FUNDING $3,600,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING

PROJECT SUMMARY

Objective

To provide technical support for the DOE Solar Thermal Central Receiver Program which aims at demonstrating the technical and economic feasibility of the thermal conversion of solar energy into electricity by means of large central, utility-type, power plants.

Approach

a. Provide day-by-day technical management, coordination, systems analysis, and other services.

b. Select contractors for the Barstow Pilot Plant by the Solar Ten Megawatt Project Office (STMPO).

c. Develop conceptual designs for four advanced receiver systems.

d. Complete four prototype heliostat conceptual designs.

e. Select contractors for hybrid system conceptual design, advanced water/steam receiver design, and line focus system conceptual design.

f. Complete a repowering market survey and plant conceptual design.

g. Continue development of analytical methods and materials characterization for receivers, heliostats, and energy storage.

Status

All tasks have been completed.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories Livermore, California 94550	Solar Central Receiver Project Management
	CONTRACT NO. E(29-1)-0789
PRINCIPAL INVESTIGATOR Name: R.C. Wayne	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Livermore, California	FISCAL YEAR 1978 FUNDING $3,600,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING

PROJECT SUMMARY (continued)

Future Effort

This project will continue in FY 1979 with the following planned activities:

a. Support the detailed design of the Barstow Pilot Plant by STMPO contractors.

b. Create a detailed design and fabrication of experiments to verify the engineering feasibility of advanced central receiver systems.

c. Test two first-generation water/steam receivers at the Central Receiver-Solar Thermal Test Facility (CR-STTF).

d. Develop conceptual designs for hybrid solar/non-solar power plants.

e. Initiate a production heliostat program to design, build, and test prototypes of high volume designs.

g. Continue a program to develop analytical methods and characterize materials for receivers, heliostats, and energy storage.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation 2350 E. El Segundo Blvd. El Segundo, California 90245	Systems Engineering and Technical Management Support Advanced Central Power Project
	CONTRACT NO. EY-76-C-03-1101
PRINCIPAL INVESTIGATOR Name: E.L. Katz	PERIOD OF PERFORMANCE July 3, 1978 to July 2, 1979
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $120,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $120,000

PROJECT SUMMARY

Objective

a. To conduct system engineering studies to assess the technical and economic feasibility and risks for advanced central power concepts.

b. To provide the technical management of the Line Focus Receiver Phase I study contracts.

Approach

a. Define and evaluate repowering concepts, advanced heliostat designs, and advanced high-temperature receiver designs.

b. Combine solar and geothermal power sources.

c. In relation to the RFP, establish evaluation criteria, evaluate the proposals, and establish the DOE program plan.

Status

Accomplishments to date include:

a. Presentation of repowering briefing to DOE.

b. Participation in quarterly reviews of advanced receiver contracts.

c. Participation in quarterly reviews of advanced heliostat concepts.

d. Assistance preparing the Line Focus Project statement of work and evaluation criteria.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation 2350 E. El Segundo Blvd. El Segundo, California 90245	Systems Engineering and Technical Management Support Advanced Central Power Project
	CONTRACT NO. EY-76-C-03-1101
PRINCIPAL INVESTIGATOR Name: E.L. Katz	PERIOD OF PERFORMANCE July 3, 1978 to July 2, 1979
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $120,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $120,000

PROJECT SUMMARY (continued)

e. Establishment of the draft program plan for the Line Focus Project.

f. Participation in proposal evaluations.

Future Efforts

Analyses will continue on advanced concepts. In addition, after contractors for the Line Focus Project are chosen, meeting schedules will be established for kickoff and technical review meetings. Further computer simulations for the McDonnell Douglas receiver concept will be initiated to confirm test results from the Central Receiver-Solar Thermal Test Facility.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation P.O. Box 92957 Los Angeles, California 90009	Solar Thermal Power Technical and Management Support
	CONTRACT NO. ET-78-C-03-2225
PRINCIPAL INVESTIGATOR Name: L.R. Sitney	PERIOD OF PERFORMANCE July 15, 1978 to January 14, 1979
WORK LOCATION Washington, D.C./El Segundo, California	FISCAL YEAR 1978 FUNDING $65,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $65,000

PROJECT SUMMARY

Objective

To assist the Division of Central Solar Technology by providing support in the planning, preparation, review, and documentation of the Solar Thermal Power Systems Program.

Approach

In addition to special analyses and surveys carried out in response to DOE requests, a number of continuing support activities are planned which require a special technical expertise, solar thermal electric program experience, and/or a knowledge of major portions of the Solar Thermal Power Systems Program.

Status

Accomplishments during this period include coordination of technical analyses with program needs and objectives, collection and preparation of special technical program status reports, and planning for program review meetings and documentation.

Future Effort

A major activity for the remainder of the contract period will be collecting inputs, compiling, coordinating, and preparing the First Annual Solar Thermal Power Systems Technical Progress Report. Ongoing program support activities will continue. Additional technical material will be developed for inclusion in a multipurpose summary briefing describing the Solar Thermal Power Systems Program.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation P.O. Box 92957 Los Angeles, California 90009	Solar Thermal Power Systems Technical Support Services
	CONTRACT NO. EY-76-C-03-1101,PA 2
PRINCIPAL INVESTIGATOR Name: Dr. Mason Watson	PERIOD OF PERFORMANCE March 1, 1977 to October 15, 1978
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $2,900,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $3,348,000

PROJECT SUMMARY

Objectives

To aggregate several separate and independent analysis, engineering, planning, and technical support activities, including:

a. Mission/application analyses of solar thermal central power systems.

b. Systems engineering and project management support for the 10 MW Central Receiver Pilot Plant and Solar Thermal Test Facility.

c. Mission and market analyses of solar total energy systems.

d. Mission and market analyses of solar thermal irrigation systems.

e. Mission analysis of small solar power systems.

f. Solar Thermal Power Systems program support.

g. OTEC-1 and Ft. Hood projects technical support.

Approach

Perform independent technical analyses/evaluations within each task area; prepare and document independent technical surveys, assessments, program plans, RFP materials, and evaluations.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation P.O. Box 92957 Los Angeles, California 90009	Solar Thermal Power Systems Technical Support Services
	CONTRACT NO. EY-76-C-03-1101,PA 2
PRINCIPAL INVESTIGATOR Name: Dr. Mason Watson	PERIOD OF PERFORMANCE March 1, 1977 to October 15, 1978
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $2,900,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $3,348,000

PROJECT SUMMARY (continued)

Status

a. Technical and economic analyses were completed in support of the 10 MW Pilot Plant Project which contributed to the identification and definition of the preferred system concept.

b. Alternate and advanced central power analyses have been completed to guide and support the alternate central receiver, hybrid power systems, line focus central receiver, and repowering projects.

c. Solar total energy systems and solar irrigation system market analyses have been completed.

d. Solar industrial process heat and transportable fuels and chemicals applications, system concepts, and recommended programs have been prepared.

e. Central receiver effectiveness, insolation, storage interactions, and societal cost/benefit analyses have been completed for solar thermal central power plants.

Future Effort

Future efforts in each task area will be conducted separately.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Townsend and Bottum Incorporated 2245 South State Street P.O. Box 1368 Ann Arbor, Michigan 48106	Phase I Construction Management Services
	CONTRACT NO. EY-77-C-03-1454
PRINCIPAL INVESTIGATOR Name: Roger J. Schwing	PERIOD OF PERFORMANCE August 15, 1977 to October 31, 1978
WORK LOCATION El Monte, California	FISCAL YEAR 1978 FUNDING $592,320
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $592,320

PROJECT SUMMARY

Objective

To assist the Department of Energy by providing complete construction management services for the solar portion of the 10 MWe Pilot Plant and to provide an overview of the Turbine Generator Facility plans and specifications as they are developed by the Southern California Edison Company.

Approach

Assign key personnel experienced in value engineering, constructability studies, planning and scheduling, estimating, cost engineering, subcontracting, labor relations, and business management to assist the Department of Energy and other project participants in preparing for an orderly transition into the construction phase of the solar pilot plant project.

Status

Approximately 85 percent of the Phase I preconstruction tasks which have been assigned have been completed. Upon conclusion of negotiations between the Department of Energy and the project design contractors, and upon completion of the remaining preconstruction tasks, Townsend and Bottum is ready to proceed into the follow-on activities related to the construction phase of the project.

Future Effort

Continue to assist the DOE and other project participants by applying construction management and business management theory throughout detail design, construction, startup, and turnover of the pilot plant.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	Collector Subsystem for the Ten-Megawatt Pilot Plant
	CONTRACT NO. ET-78-C-03-2182
PRINCIPAL INVESTIGATOR Name: Paul Brown	PERIOD OF PERFORMANCE September 5, 1978 to September 28, 1979
WORK LOCATION Denver, Colorado	FISCAL YEAR 1978 FUNDING $485,024
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $485,024

PROJECT SUMMARY

Objective

To design and fabricate a collector subsystem for the 10 MWe Pilot Plant.

Approach

a. Complete the detailed design, beginning with selected conceptual features, and confirm its acceptability through preproduction unit fabrication and testing.

b. Minimize cost and schedule uncertainties and risks for the production phase.

Status

Advance Agreement with contract execution is scheduled for early FY 1979.

Future Effort

Martin Marietta will compete as a potential contractor for approximately 2,000 plant collectors.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Company 5301 Bolsa Avenue Huntington Beach, California 92647	Collector Subsystem for the Ten-Megawatt Pilot Plant
	CONTRACT NO. ET-78-C-03-1739
PRINCIPAL INVESTIGATOR Name: To be determined	PERIOD OF PERFORMANCE September 5, 1978 to September 28, 1979
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING To be determined
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING To be determined

PROJECT SUMMARY

Objective

To design and fabricate a collector subsystem for the 10 MWe Pilot Plant.

Approach

a. Complete the detailed design, beginning with selected conceptual features, and confirm its acceptability through preproduction unit fabrication and testing.

b. Minimize cost and schedule uncertainities and risks for the production phase.

Status

Advance Agreement with contract execution is scheduled for early FY 1979.

Future Effort

McDonnell Douglas will compete as a potential contractor for approximately 2,000 plant collectors.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation P.O. Box 92957 Los Angeles, California 90009	Systems Engineering Support to Solar Ten Megawatt Project Office
	CONTRACT NO. ET-78-C-03-2028
PRINCIPAL INVESTIGATOR Name: E.L. Katz	PERIOD OF PERFORMANCE May 15, 1978 to September 30, 1979
WORK LOCATION El Monte, California	FISCAL YEAR 1978 FUNDING $400,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY

Objective

To support the DOE Solar Ten-Megawatt Project Office (STMPO), i.e., to participate in the plant procurement activities, to provide on-site personnel at the STMPO for coordination of Aerospace efforts, to participate in the final system definition work, and to provide technical review and integration of the integrating contractor's design activities.

Approach

Initial activities include the development of plant requirements for DOE/industry implementation, the preparation of procurement materials, and the gathering and documentation of site-related design constraints. Chief products of the latter effort have been a detailed listing of the Barstow environmental conditions, and the development and initiation of experimental techniques to describe and quantify the occurrence and motion of clouds at that location.

Status

a. The statement of work for the plant integrating contractor position was completed and released. An integrating contractor has been selected.

b. The environmental appendix to the governing system specification has been released.

c. The design requirements of the plant's master control system have been published.

d. Equipment for the cloud-measurement work has been installed, and data are being obtained.

ELEMENT: Large Power System Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
The Aerospace Corporation P.O. Box 92957 Los Angeles, California 90009	Systems Engineering Support to Solar Ten Megawatt Project Office
	CONTRACT NO. ET-78-C-03-2028
PRINCIPAL INVESTIGATOR Name: E.L. Katz	PERIOD OF PERFORMANCE May 15, 1978 to September 30, 1979
WORK LOCATION El Monte, California	FISCAL YEAR 1978 FUNDING $400,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY (continued)

e. A large-scale computerized dynamic simulation of the plant subsystems has been developed.

Future Effort

With the involvement of DOE industry contractors, the support by Aerospace will shift to the disciplines of technical management for the next twelve months. Aerospace areas of responsibility in behalf of STMPO are system integration tasks and the master control subsystem task. A number of technical specialists will be made available for the effort.

Bibliography Reference Number: 10

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Public Service of New Mexico Albuquerque, New Mexico 87103	Technical and Economic Assessment of Solar Hybrid Repowering
	CONTRACT NO. EG(FY)C-03-1608
PRINCIPAL INVESTIGATOR Name: J.D. Maddox	PERIOD OF PERFORMANCE September 30, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $468,095
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $668,095

PROJECT SUMMARY

Objective

To assess the technical and economic viability of solar hybrid repowering as applied to the Southwest region and the Public Service of New Mexico System.

Approach

a. Conduct market survey and cost benefit analysis to determine the near-term market potential of repowering.

b. Select a candidate unit.

c. Prepare a conceptual design of the unit.

d. Assess the economics for the unit.

Status

The market survey and cost-benefit analyses are complete and a candidate unit has been selected. Conceptual design and economic assessments of the candidate unit are underway.

Future Effort

Results of this study will enable DOE to determine the desirability of constructing a demonstration plant to further assess the concept.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3703 Seattle, Washington 98124	10 MWe Central Receiver Solar Thermal Power System Phase I (Collector Subsystem Only)
	CONTRACT NO. EY-76-C-03-1111
PRINCIPAL INVESTIGATOR Name: J.B. Schroeder	PERIOD OF PERFORMANCE June 14, 1975 to December 31, 1978
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $1,425,316

PROJECT SUMMARY

Objective

To design and develop a collector subsystem which can be integrated with other subsystems to demonstrate the technical feasibility and potential economic feasibility of solar thermal water/steam central receiver type power plants.

Approach

The Boeing concept utilizes circular membrane reflectors, formed with aluminized polyester film, to direct sunlight to the central receiver. Transparent air-support plastic enclosures protect the lightweight reflectors from the environment. The reflectors are aimed with a two-axis gimbal and driven by digital controlled stepper motors under computer control.

Status

a. Three heliostats (1/4 scale) and a drive and control assembly have been fabricated and tested to provide design data and verification.

b. An evaluation program has been conducted on the key plastic materials used for the protective enclosure and reflector.

c. Performance and environmental exposure tests on large-scale heliostats have been conducted over a 25-month period at a Boeing desert test site in northeast Oregon to determine optical performance, demonstrate operation of the drive and control assembly in the various operational modes, and verify survivability of hardware in the environment.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3703 Seattle, Washington 98124	10 MWe Central Receiver Solar Thermal Power System Phase I (Collector Subsystem Only)
	CONTRACT NO. EY-76-C-03-1111
PRINCIPAL INVESTIGATOR Name: J.B. Schroeder	PERIOD OF PERFORMANCE June 14, 1975 to December 31, 1978
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $1,425,316

PROJECT SUMMARY (continued)

d. Plastic materials evaluation tests have included measurement of mechanical and optical properties, creep, chemical exposure, cleanability, accelerated simulated sunlight, and actual desert sunshine exposure tests.

e. A no-cost contract extension has been made for six months of additional desert exposure tests (28 months total exposure).

Future Effort

The three desert exposure heliostats may be retrofitted under a separate contract, with new protective enclosures. The new enclosures would be made of lower cost materials to obtain desert exposure data on quarter-scale hardware.

Bibliography Reference Number: 11

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3707 Seattle, Washington 98124	Advanced Central Receiver Concept Design
	CONTRACT NO. EG(FY)-C-03-1726
PRINCIPAL INVESTIGATOR Name: L.N. Tallerico	PERIOD OF PERFORMANCE September 30, 1977 to September 30, 1978
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $136,129
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $755,131

PROJECT SUMMARY

Objective

To establish the feasibility of developing a central receiver system that will significantly reduce the cost of electricity generated from solar central receivers.

Approach

The system incorporates an air/helium-cooled receiver, air/helium storage (sensible heat), and a Brayton-cycle turbine.

Status

a. The parametric studies are complete.

b. Boeing selected their conceptual design which includes two 75 MWe modules, plastic heliostats, a 360^0 field, a four-aperture cavity receiver, and sensible heat storage.

Future Effort

A DOE/Sandia review will be conducted to determine if certain Phase II activities should be initiated.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
General Electric Company Energy Systems Program Dept. 1 River Road Schenectady, New York 12345	Advanced Central Receiver Concept Design
	CONTRACT NO. EG(FY)-C-03-1725
PRINCIPAL INVESTIGATOR Name: L.N. Tallerico	PERIOD OF PERFORMANCE February 1, 1978 to February 1, 1979
WORK LOCATION Schenectady, New York 12345 Oakland, California	FISCAL YEAR 1978 FUNDING $674,767
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $674,767

PROJECT SUMMARY

Objective

To establish the feasibility of developing a central receiver system that will significantly reduce the cost of electricity generated from solar central receivers.

Approach

The system incorporates a sodium-cooled receiver, a sodium storage subsystem, and a Rankine-cycle turbine.

Status

a. The parametric studies are complete.

b. GE selected their conceptual design which includes a General Electric plastic heliostat, a 360° field, an external receiver, hot and cold storage vessels, and steam conditions: 2400 psi/1000°F/1000°F hard.

Future Effort

a. Phase I (Conceptual Design) is scheduled for completion by February 1, 1979.

b. A DOE/Sandia review will be conducted to determine if some Phase II activities should be initiated.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	Advanced Central Receiver Power System Project
	CONTRACT NO. EG-77-C-03-1724
PRINCIPAL INVESTIGATOR Name: Tom Tracey	PERIOD OF PERFORMANCE September 29, 1977 to September 29, 1978
WORK LOCATION Denver, Colorado	FISCAL YEAR 1978 FUNDING $86,985
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $635,906

PROJECT SUMMARY

Objective

To conduct systems analyses and develop conceptual designs for Advanced Central Receiver Power Systems.

Approach

The Martin Marietta Advanced Central Receiver concept uses a molten nitrate salt to transfer the energy from the receiver to the storage and steam generator components.

A nine-module, 300 MWe power plant has been selected as the baseline design. The design utilizes a surrounding field of heliostats working into a four-tank thermodine in which energy is stored as sensible heat in the molten salt. Pressure from the tower head is isolated from the storage system.

Status

Martin Marietta has selected the final baseline design and has completed the conceptual design phase of the contract. In addition, the follow-on research experiments for Phase II have been proposed as well as a preliminary development plan. A final report is being prepared. The remaining work will consist of continuing materials capability tests that were started earlier in the contract.

Future Effort

A DOE/Sandia review will be conducted to determine if Phase II activities should be initiated.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Systems and Applications

CONTRACTOR/ADDRESS	TITLE
Rockwell International Atomics International Division Canoga Park, California 91304	Advanced Central Receiver Concept Design
	CONTRACT NO. EG-77-C-03-1483
PRINCIPAL INVESTIGATOR Name: Thomas Springer	PERIOD OF PERFORMANCE September 30, 1977 to September 30, 1978
WORK LOCATION Canoga Park, California	FISCAL YEAR 1978 FUNDING $42,890
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $656,018

PROJECT SUMMARY

Objective

To provide and develop a conceptual design for an advanced central receiver power system that will significantly reduce the cost of electricity generated from solar central receivers.

Approach

The Phase I effort will provide:

a. Parametric analyses of subsystem alternatives.

b. Selection of an overall system configuration.

c. Conceptual design of a commercial-scale plant.

d. Assessment of the selected system.

e. Preparation of a development plan for the Advanced Central Receiver Power System.

Status

Atomics International (AI) has selected a design which utilizes liquid sodium at 1100°F as the heat transfer fluid between the receiver and the steam generators; these in turn supply the turbine generator. For thermal storage, AI will conduct system stuides on liquid sodium molten salt and hot air/rock.

Future Effort

A DOE/Sandia review will be conducted to determine if some Phase II activities should be initiated.

LARGE THERMAL POWER APPLICATIONS
Subsystems and Components
Project Summaries

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Sandia Laboratories Albuquerque, New Mexico 87115	Central Receiver-Solar Thermal Test Facility
	CONTRACT NO. E(29-1)0789
PRINCIPAL INVESTIGATOR Name: A. Narath/W. Marshall	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $2,385,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING

PROJECT SUMMARY

Objective

To provide design and planning support for construction of the Central Receiver-Solar Thermal Test Facility (CR-STTF) which is nearing completion, and to operate the facility in the testing of components.

Approach

The CR-STTF will be utilized to test: prototype receivers, other components, subsystems, and concepts related to solar energy as developed by industry, universities, and government agencies; heliostats and heliostat control concepts; and overall control concept requirements. In addition, the facility may be utilized for high-temperature research and testing of materials, prototype components, subsystems, and new components.

Status

The facility demonstrated at 1.8 MWt power capability in May 1977 and is scheduled for full power operation late in 1978. Installation of prototype receivers has started.

Future Effort

Receivers fabricated under other contracts will be tested upon completion of the facility.

ELEMENT: Large Thermal System Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	1 MWt Bench Model Solar Cavity Receiver Steam Generator: Build and Test
	CONTRACT NO. E(04-3)1068
PRINCIPAL INVESTIGATOR Name: Tom Heaton	PERIOD OF PERFORMANCE January 1, 1975 to January 1, 1978
WORK LOCATION Denver, Colorado	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $1,255,271

PROJECT SUMMARY

Objective

To fabricate and test a 1 MWt cavity receiver steam generator (suitable for the central receiver type of solar thermal conversion system to generate electricity). This receiver will be integrated with a circulation system, controls, mounting fixtures, closure mechanisms, and flux redirecting devices necessary to adapt it to solar test facilities. The system is designed to permit testing at the Radiant Heat Facility at Sandia Laboratories, in Albuquerque, New Mexico, the 1 MWt C.N.R.S. Solar Furnace at Odeillo, France, and the DOE Central Receiver-Solar Thermal Test Facility (CR-STTF) at Sandia-Laboratories in Albuquerque.

Approach

a. Provide validation of the north-facing cavity approach to the design of the CR-STTF.

b. Provide a basis for correlating radiant-heat simulator test results with those obtained with solar illumination.

c. Provide a steam generator suitable for use at the CR-STTF at the 1 MWt level.

d. Support the international exchange of solar data and technology.

Status

The cavity steam generator has been successfully operated under both radiant-heat simulation conditions at Sandia and concentrated solar illumination at Odeillo. Necessary modifications have been made to adapt the system to the CR-STTF for possible use at some future time. The system components have been shipped to Sandia.

ELEMENT: Large Thermal System Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	1 MWt Bench Model Solar Cavity Receiver Steam Generator: Build and Test
	CONTRACT NO. E(04-3)1068
PRINCIPAL INVESTIGATOR Name: Tom Heaton	PERIOD OF PERFORMANCE January 1, 1975 to January 1, 1978
WORK LOCATION Denver, Colorado	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $1,255,271

PROJECT SUMMARY (continued)

Future Effort

None.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3707 Seattle, Washington 98124	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. EG-77-C-03-1604
PRINCIPAL INVESTIGATOR Name: Roger B. Gillette	PERIOD OF PERFORMANCE October 1, 1977 to June 30, 1978
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $468,420

PROJECT SUMMARY

Objective

The 9-month initial phase of this two-phase effort has been created to:

a. Establish a heliostat design which, in quantity production, will yield significant reductions in capital and operating costs when compared with existing designs.

b. Stimulate broader industry participation in the DOE solar energy program.

c. Identify needs for near-term and future research and development of heliostats which would offer significant payoffs in the further reduction of the cost of electrical energy from solar central receiver power plants.

Approach

During Phase I, the following tasks have been undertaken:

a. Verification of the proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.

b. Preliminary design of a complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.

e. Conceptual design of processes and hardware for manufacture, assembly, installation, and maintenance of heliostats.

d. Estimation of heliostat life-cycle costs at various projected levels of production.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3707 Seattle, Washington 98124	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. EG-77-C-03-1604
PRINCIPAL INVESTIGATOR Name: Roger B. Gillette	PERIOD OF PERFORMANCE October 1, 1977 to June 30, 1978
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $468,420

PROJECT SUMMARY (continued)

e. Planning for Phase II activities. The proposed concept represents a further development of the approach pursued under Contract EY-76-C-03-1111, in which a stretched plastic film reflector is housed within a transparent, air-supported spherical plastic film enclosure. The present effort will involve exploration of increased performance and reduced cost resulting from increased reflector size, positive focusing, improved enclosure materials and fabrication, and other advances on the former design.

Status

All of the planned tasks for Phase I were completed by June 30, 1978. A final report has been published.

Future Effort

A contract was placed by Sandia on August 7, 1978 to develop a process for the thermoforming of a one-piece heliostat enclosure (dome) as part of the 2nd Generation Heliostat Development Program.

Bibliography Reference Number: 12

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Boeing Engineering and Construction Company P.O. Box 3707 Seattle, Washington 98124	2nd Generation Heliostat Development (Phase II Prototype Heliostat)
	CONTRACT NO. PO #18-7830 (Subcontract to AD-03-01-0520-A)
PRINCIPAL INVESTIGATOR Name: R.B. Gillette	PERIOD OF PERFORMANCE August 7, 1978 to August 7, 1979
WORK LOCATION Seattle, Washington	FISCAL YEAR 1978 FUNDING $360,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $360,000

PROJECT SUMMARY

Objective

To develop and demonstrate a process for thermoforming a one-piece protective enclosure (dome) for Boeing's heliostat. The heliostat was developed under Phase I of the DOE/SAN Prototype Heliostat Contract EG-77-C-03-1604.

Approach

Boeing's proprietary concepts will be utilized to attempt to achieve area stretch ratios approaching 50:1 so that 30-foot-diameter domes can be fabricated from commercially available materials. The necessary temperature and air-supply controls and degree of automation necessary to achieve successful and reproducible one-piece domes will be determined for small 3- to 5-foot-diameter domes. Candidate materials are oriented and non-oriented polyesters, cellulose acetate butryal, and polyvinylidene floride.

Status

The contract started August 7, 1978. A program initiation meeting was held on August 31, 1978.

Future Effort

If the 3- to 5-foot-diameter one-piece dome is feasible, and if the projected cost is low, then the design and fabrication of a 30-foot-diameter dome will be initiated.

Bibliography Reference Number: 12

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
General Electric Company Energy Systems Program Department One River Road Schenectady, New York 12345	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. EG(FY)-C-03-1468
PRINCIPAL INVESTIGATOR Name: Richard H. Horton	PERIOD OF PERFORMANCE September 30, 1977 to July 30, 1978
WORK LOCATION Schenectady, New York	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $996,574

PROJECT SUMMARY

Objective

The 9-month initial phase of this two-phase effort has been created to:

a. Establish a heliostat design, which, in quantity production, will yield significant reductions in capital and operating costs when compared with existing designs.

b. Stimulate broader industry participation in the DOE solar energy program.

c. Identify needs for near-term and future research and development in heliostats which would offer significant payloads in the further reduction of the cost of electrical energy from solar central receiver power plants.

Approach

During Phase I, the following tasks have been undertaken:

a. Verification of the proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.

b. Preliminary design of a complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.

c. Conceptual design of processes and hardware for manufacture, assembly, installation, and maintenance of heliostats.

d. Estimation of heliostat life-cycle costs at various projected levels of production.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
General Electric Company Energy Systems Program Department One River Road Schenectady, New York 12345	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. EG(FY)-C-03-1468
PRINCIPAL INVESTIGATOR Name: Richard H. Horton	PERIOD OF PERFORMANCE September 30, 1977 to July 30, 1978
WORK LOCATION Schenectady, New York	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $996,574

PROJECT SUMMARY (continued)

e. Planning for Phase II activities. This proposed concept involves a stretched plastic film reflector on a lightweight support structure protected by a framed plastic film enclosure with transparent panels for the passage of sunlight. The altitude/azimuth drive system will make use of direct-drive linear motors.

Status

The contract was awarded on September 30, 1977. Following initial project organization activities, contract activity on the 9-month Phase I effort started on November 1, 1977. All of the planned tasks were completed on July 28, 1978. The final report has been approved and published.

Future Effort

A materials development and testing contract will be placed by Sandia as part of the 2nd Generation Heliostat Development Program.

Bibliography Reference Number: 13

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
General Electric Company Energy Systems Programs Department 1 River Road Schenectady, New York 12345	2nd Generation Heliostat Development (Phase II Prototype Heliostat)
	CONTRACT NO. PO #83-0024 (Subcontract to AD-03-01-0520-A)
PRINCIPAL INVESTIGATOR Name: R.H. Horton	PERIOD OF PERFORMANCE October 1978 to October 1979
WORK LOCATION Schenectady, New York	FISCAL YEAR 1978 FUNDING $244,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $244,000

PROJECT SUMMARY

Objective

To produce, characterize, and test protective heliostat enclosure and plastic reflector materials. These materials will upgrade the performance of enclosed heliostat systems and increase their expected life cycle, leading to a lower cost/performance ratio.

Approach

Biaxially-oriented polyvinylidene floride will be produced. The effects of temperature and weathering rates will be investigated and mechanisms of degradation determined. Metalized plastic film reflectors will be tested to determine the effects of the metalizing process parameters and the effectiveness of protective overcoats.

Status

Work is scheduled to begin in October 1978.

Future Effort

Materials developed and tested under this program will be applicable to future heliostat development activities.

Bibliography Reference Number: 13

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Company 5301 Bolsa Avenue Huntington Beach, California 92647	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. EG-77-C-03-1605
PRINCIPAL INVESTIGATOR Name: Dr. C.R. Easton	PERIOD OF PERFORMANCE October 1, 1977 to June 30, 1978
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $501,000

PROJECT SUMMARY

Objective

The 9-month initial phase of this two-phase effort has been created to:

a. Establish a heliostat design, which, in quantity production, will yield significant reductions in capital and operating costs when compared with existing designs.

b. Stimulate broader industry participation in the DOE solar energy program.

c. Identify needs for near-term and future research and development in heliostats which would offer significant payoffs in the further reduction of the cost of electrical energy from solar central receiver power plants.

Approach

During Phase I, the following tasks have been undertaken:

a. Verification of a proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.

b. Preliminary design of a complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.

c. Conceptual design of processes and hardware for manufacture, assembly, installation, and maintenance of heliostats.

d. Estimation of heliostat life-cycle costs at various projected levels of production.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Company 5301 Bolsa Avenue Huntington Beach, California 92647	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. EG-77-C-03-1605
PRINCIPAL INVESTIGATOR Name: Dr. C.R. Easton	PERIOD OF PERFORMANCE October 1, 1977 to June 30, 1978
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING $0
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $501,000

PROJECT SUMMARY (continued)

e. Planning for Phase II activities. The proposed approach involves further exploration of the preliminary design developed under contract EY-76-C-03-1108. This will provide for improvement of performance and/or reduction in life-cycle cost. A baseline-perturbation approach will be utilized in which cost benefit of various departures from the existing baseline will be assessed.

Status

All of the Phase I tasks were completed on June 30, 1978. The final report has been approved and published.

Future Effort

A component fabrication and testing contract is planned by Sandia as part of the 2nd Generation Heliostat Development Program. A mirror module, drive mechanism, and pedestal development effort is anticipated.

Bibliography Reference Number: 14

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Company 5301 Bolsa Avenue Huntington Beach, California 92647	2nd Generation Heliostat Development (Phase II Prototype Heliostat)
	CONTRACT NO. PO #83-0024
PRINCIPAL INVESTIGATOR Name: D.A. Steinmeyer (714) 896-3080	PERIOD OF PERFORMANCE October 1978 to October 1979
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING $450,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $450,000

PROJECT SUMMARY

Objective

To develop the heliostat mirror modules, drive mechanism, and pedestal that was established by McDonnell Douglas in Phase I of DOE Contract ET-77-C-03-1605.

Approach

A detailed design will be developed for the McDonnell Douglas heliostat mirror module, drive mechanisms, and pedestal. Fabrication processes will be developed and prototype hardware will be fabricated and tested to demonstrate the processes and performance. The designs will be refined as indicated by test results.

Status

The contractor's quote is being reviewed and detailed cost breakdowns are being made in preparation for contract negotiations. The contract start date is October 1978.

Future Effort

The components developed under this program will be applicable to future heliostat development activities.

Bibliography Reference Number: 14

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Solaramics, Incorporated 1301 El Segundo Blvd. El Segundo, California 90245	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. ET(78)-C-03-1745
PRINCIPAL INVESTIGATOR Name: Harold E. Felix	PERIOD OF PERFORMANCE November 14, 1977 to September 15, 1978
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $438,639
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $438,639

PROJECT SUMMARY

Objective

The 9-month initial phase of this two-phase effort has been created to:

a. Establish a heliostat design, which, in quantity production, will yield significant reductions in capital and operating costs when compared with existing designs.

b. Stimulate broader industry participation in the DOE solar energy program.

c. Identify needs for near-term and future research and development in heliostats which would offer significant payoffs in the further reduction of the cost of electricity from solar central receiver power plants.

Approach

During Phase I, the following tasks have been undertaken:

a. Verification of a proposed heliostat concept against requirements for utilization of heliostats in a solar central receiver power plant.

b. Preliminary design of a complete heliostat system (including foundation, drives, and controls) with supporting bench model/component tests.

c. Conceptual design of processes and hardware for manufacture, assembly, installation, and maintenance of heliostats.

d. Estimation of heliostat life-cycle costs at various projected levels of production.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Solaramics, Incorporated 1301 El Segundo Blvd. El Segundo, California 90245	Solar Central Receiver Prototype Heliostat, Phase I
	CONTRACT NO. ET(78)-C-03-1745
PRINCIPAL INVESTIGATOR Name: Harold E. Felix	PERIOD OF PERFORMANCE November 14, 1977 to September 15, 1978
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $438,639
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $438,639

PROJECT SUMMARY (continued)

e. Planning for Phase II activities. The proposed approach involves application of glass-foam, ultra-thin glass, and glass/fly ash ceramic technology to the construction of heliostats of the configuration selected for the 10 MWe Solar Central Receiver Pilot Plant. State-of-the-art technology is also applied in the "adaptive control" concept for hybrid open-closed-loop heliostat tracking.

Status

All of the Phase I tasks have been completed.

Future Effort

A drive mechanism prototype fabrication and testing contract is planned by Sandia as part of the 2nd Generation Heliostat Development Program.

Bibliography Reference Number: 15

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Solaramics, Incorporated 1301 El Segundo Blvd. El Segundo, California 90245	2nd Generation Heliostat Development (Phase II Prototype Heliostat)
	CONTRACT NO. PO#83-0024
PRINCIPAL INVESTIGATOR Name: Harold E. Felix	PERIOD OF PERFORMANCE October 1978 to October 1979
WORK LOCATION El Segundo, California	FISCAL YEAR 1978 FUNDING $250,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $250,000

PROJECT SUMMARY

Objective

To develop the heliostat drive mechanism established by Solaramics in Phase I of DOE Contract ET-78-C-03-1745.

Approach

The conceptual design will be analyzed further and a detailed design developed. A prototype will be fabricated and tested to demonstrate the performance. The design will be refined as indicated by test results.

Status

The contractor's quote is being reviewed in preparation of contract negotiations. The contract start date is October 1978.

Future Effort

The drive mechanism developed under this program will be applicable to future heliostat development activities.

Bibliography Reference Number: 15

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
University of Illinois Dept. of Mechanical & Industrial Engineering Urbana, Illinois 61801	Experimental Study of Convective Losses from Solar Receivers
	CONTRACT NO. PO#87-9180 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: A.M. Clausing	PERIOD OF PERFORMANCE June 30, 1977 to August 31, 1979
WORK LOCATION Urbana, Illinois	FISCAL YEAR 1978 FUNDING $105,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $155,000

PROJECT SUMMARY

Objective

To support receiver design by establishing convective losses of both external and cavity receivers for various wind vectors.

Approach

To determine losses, three tasks are being carried out:

a. Establish techniques by which the combined influences of natural and forced convection on the convective heat loss can be modeled and experimentally studied.

b. Design and build a cryogenic facility for the experimental investigation.

c. Test models of solar receivers and obtain expressions which enable the prediction of the convective loss.

Status

An examination of the ratio of the characteristic velocity due to buoyant influences of the wind velocity has indicated that the effects of both natural forced convection have significant influences on the convective losses from solar receivers. A cryogenic wind tunnel has been constructed to enable the use of model tests with perfect modeling of both influences. Both room temperature and cryogenic temperature test runs are in progress. The objectives of these tests are to gain operational experience with the apparatus and to verify the performance characteristics of the tunnel. Several problems have been encountered and modifications are being effected. The data acquisition system has been assembled and tested. The computer program to process the recorded data also has been completed.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
University of Illinois Dept. of Mechanical & Industrial Engineering Urbana, Illinois 61801	Experimental Study of Convective Losses from Solar Receivers
	CONTRACT NO. PO#87-9180 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: A.M. Clausing	PERIOD OF PERFORMANCE June 30, 1977 to August 31, 1979
WORK LOCATION Urbana, Illinois	FISCAL YEAR 1978 FUNDING $105,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $155,000

PROJECT SUMMARY (continued)

Future Effort

The basic experimental study of the convective loss from solar receivers is to be conducted with the objectives of furthering the understanding of the mechanisms governing this loss and enabling its prediction. Although the emphasis of the investigation will naturally depend on future results, study in the following areas is planned:

a. A complete experimental study of cylindrical, external receivers, including the influence of (1) the relevant dimensionless groups, Re and Gr; (2) representative temperature distributions on the local heat transfer coefficients and, hence, on the total convective loss; (3) surface roughness; (4) free stream turbulance; and (5) the receiver aspect ratio.

b. The convective loss from idealized cavity receivers.

c. Model specific receiver concepts as specified by Sandia Laboratories.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Argonne National Laboratory 9700 S. Cass Avenue Argonne, Illinois 60439	Mechanical Testing in Support of Structural Design of Solar Energy Central Receiver Power Plant Components
	CONTRACT NO. ICO 92-7648 (Subcontract to E29-1-0789)
PRINCIPAL INVESTIGATOR Name: W. Shack/S. Majumdar	PERIOD OF PERFORMANCE July 6, 1977 to December 31, 1979
WORK LOCATION Argonne, Illinois	FISCAL YEAR 1978 FUNDING $245,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $288,000

PROJECT SUMMARY

Objective

To provide testing and data surveys of candidate materials for receivers and ancillary components utilized by water/steam-type receivers.

Approach

a. Conduct elevated-temperature biaxial cyclic loading plus compressive-holdtime tests on Type 316H stainless steel and Incoloy 800 tubing specimens to verify the adequacy of failure criteria currently being used in the design of solar receivers.

b. Survey available information on sodium effects on candidate materials for advanced solar thermal generators and superheaters. The survey will include information on mechanical properties, sodium compatibility, mass transfer effects, and recommendations for future testing.

c. Consult with Sandia Laboratories and Foster-Wheeler to identify materials and test conditions for mechanical properties testing in support of the American Society of Mechanical Engineers (ASME) code development for solar receivers.

Status

Materials testing is in progress and a sodium effects survey has been completed.

Future Effort

Materials testing will continue into FY 1979.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Foster Wheeler Development Corporation 12 Peach Tree Hill Road Livingston, New Jersey 07039	An Interim Structural Design Standard for Solar Energy Applications
	CONTRACT NO. PO#87-9151 (Subcontract to E29-10789)
PRINCIPAL INVESTIGATOR Name: A.C. Gangadharan	PERIOD OF PERFORMANCE May 20, 1977 to December 31, 1978
WORK LOCATION Livingston, New Jersey	FISCAL YEAR 1978 FUNDING $47,500
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $95,000

PROJECT SUMMARY

Objective

To develop structural design standards for solar central receivers and components.

Approach

a. Study the range of loads, environment, and possible failure modes that fall under the scope of the American Society of Mechanical Engineers (ASME) Boilers and Pressure Vessel Code, and identify the available rules and criteria dealing with failure modes.

b. Survey the available literature on the failure rates of components designed under various sections of the ASME code; categorize these failure rates and make a comparative evaluation of the reliability achieved by use of the code; and define the level of reliability, availability, and safety desired in central receiver solar thermal power system components.

c. Select existing code rules that ensure the desired levels of reliability, etc; modify the rules that are inconsistent with those levels; and determine the acceptable design limits and rules for solar design.

d. Identify the development and test program that is required to generate the design limit data for conditions (1) not covered in present codes and standards and (2) unique to the central receiver solar program. Data concerning properties of materials are to be provided under a parallel Sandia subcontract (Number 92-7648) with the Argonne National Laboratory.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Foster Wheeler Development Corporation 12 Peach Tree Hill Road Livingston, New Jersey 07039	An Interim Structural Design Standard for Solar Energy Applications
	CONTRACT NO. PO#87-9151 (Subcontract to E29-107989)
PRINCIPAL INVESTIGATOR Name: A.C. Gangadharan	PERIOD OF PERFORMANCE May 20, 1977 to December 31, 1978
WORK LOCATION Livingston, New Jersey	FISCAL YEAR 1978 FUNDING $47,500
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $95,000

PROJECT SUMMARY (continued)

Status

Items "a" and "b" have been completed. About 40 percent of items "c" and "d" has been completed.

Future Effort

A structural design standard will be proposed and supporting test and development programs will be identified. Additional tasks are being proposed to carry this work into advanced systems now under construction.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Stearns-Roger Engineering Company P.O. Box 5888 Denver, Colorado 80217	Receiver Tower Cost Study
	CONTRACT NO. PO#18-8446 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: W. Lang	PERIOD OF PERFORMANCE August, 1978 to February 1979
WORK LOCATION Denver, Colorado	FISCAL YEAR 1978 FUNDING $90,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $90,000

PROJECT SUMMARY

Objective

To obtain tower cost data for use in current and future solar central receiver studies.

Approach

Forty separate cases will be evaluated, each with its own set of tower variables and environmental variables. The effect of each variable on tower cost will be determined. Some of the variables to be examined are tower type (concrete or steel), tower height, receiver weight, ground acceleration, and wind velocity.

Status

The contract was signed in August 1978. Work started shortly thereafter.

Future Effort

The report will be made available to the large power systems community.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Company 5301 Bolsa Avenue Huntington Beach, California 92647	Extended Testing Storage Fluids and Flow Loop Experiment
	CONTRACT NO. EG-77-C-03-1108
PRINCIPAL INVESTIGATOR Name: R.W. Hallet	PERIOD OF PERFORMANCE July 6, 1977 to July 6, 1978
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING $173,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $173,000

PROJECT SUMMARY

Objective

To provide data on fluid stability, compatibility, and surface fouling to permit fluid selection for thermal storage applications.

Approach

Long-term stability and compatibility tests are to be performed on a variety of hydrocarbon heat transfer fluids at temperatures up to 600°F. Fouling tests are to be conducted to temperatures of 650°F. A laboratory flow loop is to be run to simulate important heat exchange, fluid flow, and materials compatibility features for the Barstow pilot plant.

Status

Several thousand hours of test data have been obtained on fluid weight, loss, and viscosity change for storage fluid candidates.

Future Effort

Additional test data will be obtained and standard tests for fluid monitoring will be developed.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	Modification and Test of SRE Receiver at CR-STTF - Phase II
	CONTRACT NO. EY-76-C-03-1110
PRINCIPAL INVESTIGATOR Name: Tom Heaton	PERIOD OF PERFORMANCE August 1977 to June 1978
WORK LOCATION Denver, Colorado Albuquerque, New Mexico	FISCAL YEAR 1978 FUNDING $933,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $933,000

PROJECT SUMMARY

Objective

To gather performance data on the 5 MWt cavity receiver in the solar environment at the Central Receiver-Solar Thermal Test Facility (CR-STTF).

Approach

Before testing can begin, a number of changes must be made to the existing receiver. To accomplish the objective, the following tasks are being undertaken:

a. Design of modifications, including a water-cooled shield around the cavity aperture, thermal insulation, motorized cavity door, additional attemperator, and structural modifications for receiver transport.

b. Fabrication of parts and completion of modifications.

c. Movement of receiver to CR-STTF and test planning.

d. Solar testing and data analysis.

Status

The design of modifications to the 5 MWt receiver has been completed and long lead procurement items are received or on order. Start of actual modifications is awaiting availability of funds.

Future Effort

Modifications and testing will be completed.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	Heliostat Wind Tunnel Test
	CONTRACT NO. EG(FY)C-03-1110
PRINCIPAL INVESTIGATOR Name: J.E. Cermack	PERIOD OF PERFORMANCE July 1, 1978 to October 30, 1978
WORK LOCATION Fort Collins, Colorado	FISCAL YEAR 1978 FUNDING $65,223
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $65,223

PROJECT SUMMARY

Objective

a. To determine the mean wind velocity and relative drag loads within and over a 1/60 scale heliostat field.

b. To evaluate the effect of the wind-induced loads on the heliostats to establish requirements consistent with these effects.

Approach

A meteorological wind tunnel will be used to determine the effect of free stream velocity, wind direction, heliostat azimuth and elevation angles, packing density and man-made barriers by means of flow visualization, hot-wire anemometer probes, and strain gages.

Status

Scale models have been built. Testing began in early September 1978.

Future Effort

No activity is planned upon completion of the stated task.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystem and Components

CONTRACTOR/ADDRESS	TITLE
Martin Marietta Corporation Aerospace/Denver Division P.O. Box 179 Denver, Colorado 80201	Storage Fluid Evaluation
	CONTRACT NO. EY-76-C-03-1110
PRINCIPAL INVESTIGATOR Name: T.R. Heaton	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Denver, Colorado	FISCAL YEAR 1978 FUNDING $158,928
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $250,522

PROJECT SUMMARY

Objective

To provide engineering and chemical data regarding the changes in hydrocarbon oil with exposure to high temperature. The data is to be used to define treatment of the fluid to extend its life in a thermal storage application.

Approach

A side stream vacuum distillation unit is to be built and tested to evaluate the effect of removal of the high and low boiling components on the high temperature stability of the fluid.

Status

Testing of the vacuum distillation unit is underway.

Future Effort

Test data will be analyzed and the design requirements for a side stream processor will be established.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Beckman Instruments, Inc. Advanced Technology Operations 1630 South State College Boulevard Anaheim, California 92816	Portable Absolute Reflectometer
	CONTRACT NO. P.O.#83-0385 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: Bob Weagant	PERIOD OF PERFORMANCE March 1978 to September 1978
WORK LOCATION Anaheim, California	FISCAL YEAR 1978 FUNDING $115,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $115,000

PROJECT SUMMARY

Objective

Beckman Instruments, Inc. will develop the instrument to measure heliostat mirror reflectivity, dust buildup, and the transmittance of plastic heliostat enclosures.

A hand-held instrument utilizing a geometry change as its principle of measurement will provide data on an absolute basis. A mirror area of one square foot will be covered by each measurement. A simulated solar spectrum, as well as limited bandwidths, can be used for measurements.

Status

A quotation was received in August 1978, the proposal has been reviewed and a contract is anticipated by October 1978.

Future Effort

The instrument will be applicable for heliostat dust buildup, mirror, and degradation measurements in solar central receiver power plants and for field measurements in glass and plastic weatherability studies.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Battelle Pacific Northwest Laboratories Battelle Boulevard Richland, Washington 99352	Heliostat Glass and Foam Specification
	CONTRACT NO. P.O.#92-7854 (Subcontract to EY-76-C-06-1830)
PRINCIPAL INVESTIGATOR Name: M.A. Lind	PERIOD OF PERFORMANCE January 1978 to September 1978
WORK LOCATION Richland, Washington	FISCAL YEAR 1978 FUNDING $130,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $130,000

PROJECT SUMMARY

Objective

To provide background information on the availability, quality, and cost of low-iron float and fusion glass for heliostats.

Approach

Heliostat mirror substrates will be evaluated and characterized such that procurement specifications can be written and any additional development effort will be identified.

Pilot plant glass procurement specifications will be developed and coordinated with glass manufacturers. The glass specification will be written based on heliostat requirements and the ability of the glass industry to produce the required glass at reasonable costs. Laboratory and field testing will be used to characterize critical characteristics of glass and mirror substrate materials.

Status

A preliminary glass specification was delivered in July 1978. The styrofoam used for glass support has been analyzed and creep tests have been performed. A final report was delivered and further efforts were recommended in September 1978.

Future Effort

Testing and evaluation of different glasses and mirror support substrates will continue.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Battelle Pacific Northwest Laboratories Battelle Boulevard Richland, Washington 99352	Heliostat Manufacturing Study
	CONTRACT NO. P.O.#92-7926 (Subcontract to EY-76-C-06-1830)
PRINCIPAL INVESTIGATOR Name: Kirk Drumheller	PERIOD OF PERFORMANCE June 1978 to September 30, 1978
WORK LOCATION Richland, Washington	FISCAL YEAR 1978 FUNDING $62,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $62,000

PROJECT SUMMARY

Objective

To obtain an independent assessment of proposed heliostat manufacturing plans, heliostat cost estimates, heliostat factory costs, and a study of the options for developing a national heliostat manufacturing base.

Approach

The heliostat designs currently under development will be analyzed for costs, how they might be best produced, and what a heliostat factory might cost. The estimating methodology will be formalized, documented, and made available for future cost estimates and planning.

Status

Initial cost estimates for first generation heliostats has been completed and a draft report has been written. The final report will be published in October 1978.

Future Effort

Second generation heliostats will be studied in FY 1979.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
Honeywell, Inc. Energy Resources Center 2600 Ridgeway Parkway Minneapolis, Minnesota 55413	Honeywell Latent Heat Thermal Storage Subsystem Research Experiment
	CONTRACT NO. PR#18-8426
PRINCIPAL INVESTIGATOR Name: R. LeFrois	PERIOD OF PERFORMANCE August 7, 1978 to August 7, 1979
WORK LOCATION Minneapolis, Minnesota	FISCAL YEAR 1978 FUNDING $430,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $430,000

PROJECT SUMMARY

Objective

To collect a quantitative set of experimental data to evaluate a particular design concept for storage of thermal energy vs. heat of fusion in salts. Potential applications include (1) storage of excess thermal energy during off-peak hours of electric utility plants for the purpose of providing energy to meet later peak requirements and (2) storing thermal energy at solar thermal power stations.

Approach

Honeywell and its contractor, Northern States Power, will provide labor, materials, and facilities to design, construct, test, and evaluate a 1.3 MWt/h molten salt thermal storage subsystem research experiment. In order to provide good heat transfer during the energy retrieval step, the Honeywell concept utilizes rotary tube scrappers for removing frozen salt from heat exchange surfaces.

Status

Work under the present contract has recently begun. Project staffing is nearly complete and "long lead time" hardware items have been ordered. Much of the experimental hardware is available from previous DOE contract activities.

Future Effort

An experimental control console will be designed and assembled. Installation of experimental apparatus and data acquisition will take place at the Northern States Power Riverside Facility, Minneapolis, Minnesota.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
McDonnell Douglas Corporation 5301 Bolsa Avenue Huntington Beach, California 92647	Non-Inverting Heliostat Study
	CONTRACT NO. PO#18-7872 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: J.J. Dietrich	PERIOD OF PERFORMANCE August 25, 1978 to March 30, 1979
WORK LOCATION Huntington Beach, California	FISCAL YEAR 1978 FUNDING $50,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $50,000

PROJECT SUMMARY

Objective

To investigate the implications of employing a non-inverting heliostat design where vertical stow is normally used and mirror-up stow is used to survive extreme winds. The effects of lack of capability to invert will be investigated in two principal areas: (1) washing effects and frequency due to possible added dust buildup and (2) increased heliostat damage probabilities due to hail effects. Identification of (1) any additional safety issues affecting the ability to meet beam safety criteria for a non-inverting design and (2) life-cycle cost impacts of heliostat damage due to wind or hail as a function of glass thickness will also take place.

Approach

Data from the current dust buildup program will be analyzed and evaluated for dust buildup rates as a function of stowage position. Previous hail test results will be reviewed in conjunction with historical weather data to predict heliostat field losses. Results of the Sandia Safety Study (GLINT) will be used to examine the probability of beam cross-over and to identify any additional safety criteria.

Status

Work on this contract began in August 1978.

Future Effort

None.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
University of Minnesota Dept. of Chemical Engineering and Materials Science 151 Chemical Engineering Bldg. 421 Washington Avenue, S.E. Minneapolis, Minnesota 55455	Hydraulic Stability of Solar Boilers
	CONTRACT NO. PO#87-9150 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: H.S. Isbin	PERIOD OF PERFORMANCE August 15, 1977 to June 30, 1979
WORK LOCATION Minneapolis, Minnesota	FISCAL YEAR 1978 FUNDING $20,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $47,000

PROJECT SUMMARY

Objective

To evaluate solar receivers relative to two-phase hydraulic stability.

Approach

Four tasks are being carried out in connection with this project:

a. A numerical calculation technique for analyzing the two-phase (water-steam) flow in parallel channels is being developed. The calculational technique will be based on the drift flux model of Patankar-Spalding. The numerical model of the flow will predict the critical heat fluxes and susceptibility of the parallel channel flows to thermal-hydraulic instabilities. The model will be suitable for analyzing the transient conditions that will exist in the solar boiler.

b. Geometrics are being investigated, including those typical of solar boilers with nonuniform heat-flux distributions.

c. Analytical studies are being merged with experiments conducted by the DOE central receiver system contractors.

d. The accuracy of the model predictions are being verified by comparison with experimental results. A systematic sensitivity study of the significant modeling parameters, including geometrical variations, is being performed. Appropriate analytical techniques and tools for future work are being provided.

ELEMENT: Large Thermal Power Applications

SUB-ELEMENT: Subsystems and Components

CONTRACTOR/ADDRESS	TITLE
University of Minnesota Dept. of Chemical Engineering and Materials Science 151 Chemical Engineering Bldg. 421 Washington Avenue, S.E. Minneapolis, Minnesota 55455	Hydraulic Stability of Solar Boilers
	CONTRACT NO. PO#87-9150 (Subcontract to AD-03-01-0520A)
PRINCIPAL INVESTIGATOR Name: H.S. Isbin	PERIOD OF PERFORMANCE August 15, 1977 to June 30, 1979
WORK LOCATION Minneapolis, Minnesota	FISCAL YEAR 1978 FUNDING $20,000
CONTRACTING OFFICE Sandia Laboratories Livermore, California	CUMULATIVE FUNDING $47,000

PROJECT SUMMARY (continued)

Status

The numerical model has been formulated. First efforts to correlate experimental test data to the code have shown good results. Task "a" has been initiated.

Future Effort

The model will be applied to the external receiver configuration selected for the 10 MWe Pilot Plant at Barstow, California.

ADVANCED THERMAL TECHNOLOGY

ADVANCED THERMAL TECHNOLOGY

INTRODUCTION

The Advanced Thermal Technology program element emphasizes the development of advanced materials, subsystems, components, and testing in support of the overall solar thermal program.

Advanced Thermal Technology includes the definition of needs for likely future applications, identification of cost-effective candidate systems, and the development of key advanced subsystems. In addition, this segment of the program assesses the current state-of-the-art of solar thermal technology, as well as developing trends.

These functions are performed by the development or characterization of:

- Support technology.
- New concept demonstrations.
- Advanced systems.
- Technology assessment.

ADVANCED THERMAL TECHNOLOGY PROGRAM ACTIVITIES

Status

Projects initiated during FY 1978 emphasized advanced component concepts and designs in support of both large and small solar thermal power systems. A high-temperature, 2000^{0}F advanced ceramic heat receiver for application to gas turbine systems was developed and tested. Studies and development were conducted for liquid metal and molten salt heat receivers for large and small systems applications. Lower cost and advanced collectors have received much attention, with the testing of a prototype line focus collector receiving major emphasis during FY 1978. Extensive work was performed in supporting areas such as improved absorber coatings and reflective surfaces. Planning of programs for these areas was completed.

During FY 1978, the 400 kWt Advanced Components Test Facility (ACTF) at the Georgia Institute of Technology was used to test the 2000^{0}F ceramic heat receiver as the first major component tested in this facility.

Future Effort

The Advanced Thermal Technology effort will continue to support the long-term goals of the large and small power program elements. It will be aimed at developing improved coatings, reflective surfaces, and materials of construction and containment. The technical feasibility of new and advanced component and process concepts/designs will be experimentally demonstrated, especially for advanced heat receivers.

A dish-Stirling engine distributed collector system has been tentatively identified for development. Engine studies, initiated in FY 1978, will be completed and will provide inputs to a decision by DOE to proceed to development of this system.

The ACTF will be used to test advanced solar thermal components and subsystems in the coming years. Through the utilization of DOE's Division of Energy Storage Systems, a draft thermal storage development plan will be completed and public comment will be sought.

ADVANCED THERMAL TECHNOLOGY
Supporting Technology
Project Summaries

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute (SERI) 1536 Cole Blvd. Golden, Colorado 80401	Materials Research and Development
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: Barry L. Butler	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $700,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $700,000

PROJECT SUMMARY

Objective

a. To provide solar system designers with advanced materials which have lower life-cycle costs.

b. To provide long-range solar materials research and development (R&D) planning, coordination of solar materials R&D efforts, and basic materials research.

Approach

National materials program plans have been formulated with the aid of the Jet Propulsion Laboratory, the Sandia Livermore and Sandia Albuquerque Laboratories, the Battelle Pacific Northwest Laboratories, and the National Bureau of Standards. Portions of these plans have been presented at polymer, absorber and reflector materials workshops, and represent generally agreed upon national solar material research and process development needs. Based on these planning activities, SERI has undertaken research in areas which were important but were not being pursued. SERI's research projects include silvered polymer mirrors, black cobalt and black chrome selective absorbers, rapid corrosion monitoring methods, thermoelectrics, polymer degradation, reliability, and standards.

Status

The first SERI Materials Branch Semiannual Progress Report has been published and describes in detail both the national materials program planning activities, and progress and scope of the SERI material research programs. Several research contracts were placed to support the SERI research activities. A materials limitations study has also been used to rank materials research activities.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute (SERI) 1536 Cole Blvd. Golden, Colorado 80401	Materials Research and Development
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: Barry L. Butler	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $700,000
CONTRACTING OFFICE DOE Headquarters, Washington, D.C.	CUMULATIVE FUNDING $700,000

PROJECT SUMMARY (continued)

Future Effort

The FY 1978 research activities will continue and glass development and high temperature materials research projects will be started. The materials planning activities should result in DOE national materials research program plans in FY 1979.

Bibliography Reference Number: 16 and 17

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute (SERI) 1536 Cole Boulevard Golden, Colorado 80401	Thermal Power Systems Workshop on Selective Absorber Coatings
	CONTRACT NO. (Prime) EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: P. Call	PERIOD OF PERFORMANCE October 1, 1977 to December 31, 1977
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $25,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $25,000

PROJECT SUMMARY

Objective

a. To review progress of ongoing and recently completed research and development within the Advanced Solar Thermal Technology Branch.

b. To discuss critical problems concerning absorber surfaces development and applications.

c. To determine goals for a comprehensive Absorber Surfaces Program.

Approach

The workshop consisted of four sessions with invited papers and structured discussion:

a. Users Forum.

b. Optical Properties Measurements and Low to Medium Temperature Coatings.

c. Semiconductor/Metal Systems.

d. Advanced/High Temperature Coatings and Systems Analysis.

Status

a. The workshop was held at SERI on December 6-8, 1977 and was attended by fifty absorber surfaces developers and users.

b. Twenty-one invited papers were presented.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute (SERI) 1536 Cole Boulevard Golden, Colorado 80401	Thermal Power Systems Workshop on Selective Absorber Coatings
	CONTRACT NO. (Prime) EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: P. Call	PERIOD OF PERFORMANCE October 1, 1977 to December 31, 1977
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $25,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $25,000

PROJECT SUMMARY (continued)

c. Major programmatic recommendations were:

(1) The program funding level is appropriate and should not be reduced.

(2) Absorber surfaces are most important for low to intermediate concentrating systems.

(3) Benefit analysis should be refined and extended.

(4) Optical measurements should be standardized.

(5) Consistent environmental stressing is needed.

Future Effort

An annual Absorber Surfaces Conference will be held to provide a forum for new developments, to improve communications between absorber surface developers and users, and to aid in program review. The next workshop will be held in January 1979.

Bibliography Reference Number: 17

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Exxon Research and Engineering Company Government Research Laboratories Linden, New Jersey 07036	Optimization of Exxon's High Temperature Coating for Solar Applications
	CONTRACT NO. EG-77-C-02-4270
PRINCIPAL INVESTIGATOR Name: A.H. Muenker	PERIOD OF PERFORMANCE June 1, 1977 to March 31, 1978
WORK LOCATION Linden, New Jersey	FISCAL YEAR 1978 FUNDING $77,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $77,000

PROJECT SUMMARY

Objective

To develop a low-cost solar receiver coating that can be applied using conventional paint spraying techniques, that has a high solar absorptance-(α_S>0.95), and that has optical and mechanical stability to 700°C.

Approach

Extend previous Exxon research under U.S. Air Force contracts and explore selected spinel-metal oxide black pigments in silicone and organo-polysilicate binders.

Status

Seven inorganic pigments have been identified which yield a solar absorptance between 0.95 to 0.98 when formulated in silicate and silicone matrices: CoO, CoO-Co_2O_3, FeMn-CuO_x, Co-Cuo and three mixed oxides of Cu-CrO_x. These coatings show no evidence of degradation after a 24-hour treatment in air at 700°C.

Future Effort

a. The thermal stability, thermal-cycling resistance, and photothermal degradation mechanisms will be investigated.

b. The best candidate(s) coatings for commercial applications will be chosen.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Engelhard Minerals and Chemical Corporation Engelhard Industries Division Menlo Park Edison, New Jersey 08817	Improved Absorber Coatings for Thermal Utilization of Solar Energy
	CONTRACT NO. AER-75-17470 (National Science Foundation Contract)
PRINCIPAL INVESTIGATOR Name: R. Farrauto	PERIOD OF PERFORMANCE July 1, 1976 to June 30, 1978
WORK LOCATION Edison, New Jersey	FISCAL YEAR 1978 FUNDING $127,000
CONTRACTING OFFICE National Science Foundation Washington, D.C.	CUMULATIVE FUNDING $254,000

PROJECT SUMMARY

Objective

To develop selectively absorbing films prepared by the thermal decomposition of metallo-organic solutions for solar receivers at 300-700°C.

Approach

Prepare matrix films based on earlier work by Engelhard Industries for space applications by applying metallo-organic solutions to glass, quartz, or metallic substrates and air firing at 500-800°C.

Status

a. α_s has been increased from 0.5 to 0.8 with $\varepsilon_t(300^\circ C) = 0.06$ and $\varepsilon_t(540^\circ C)$ of 0.06 for gold matrix films by compositional and preparatory modifications.

b. A silver matrix, copper oxide film doped with rhodium oxide has been developed. A α_s of 0.91 has been achieved and the absorptance can be stabilized at 500°C by increasing the percentage of CuO. However, the hemispherical emittance increases with increasing CuO.

c. The agglomeration of Ag has been identified as a high-temperature degradation mechanism.

Future Effort

a. Develop a metallo-organic system with $\alpha_s > 0.9$, $\varepsilon_t(500^\circ C) < 0.1$ and long-term stability in air and vacuum at 500°C.

b. Vary the film composition to stabilize Ag agglomeration.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Arizona Optical Sciences Center Tucson, Arizona	Chemical Vapor Deposition of Spectrally Selective Absorbers
	CONTRACT NO. E(29-2)-3709
PRINCIPAL INVESTIGATOR Name: B.O. Seraphin	PERIOD OF PERFORMANCE May 1, 1976 to April 30, 1977
WORK LOCATION Tucson, Arizona	FISCAL YEAR 1978 FUNDING $100,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $276,000

PROJECT SUMMARY

Objective

To develop chemical vapor deposition techniques and produce optical multilayer stacks which are spectrally selective, are stable at temperatures greater than 500°C, and are economically attractive for large-scale manufacture.

Approach

Create a multilayer stack which is comprised of a diffusion barrier at the substrate surface, followed by a metal reflector layer, a diffusion barrier, a semiconductor absorber layer, and an anti-reflection surface coating.

Status

a. Stainless steel/oxide/Ag/Cr_2O_3/Si/Si_3N_4 multilayer stacks have been produced and cycled several thousand times to 500°C in roughing pump vacuum without optical radiation. α_s lies in the range 0.7 to 0.85 and ϵ_t at approximately 0.6 to 0.12.

b. Stacks that can be fabricated entirely by CVD have been produced with Mo in place of Ag. An Al_2O_3/Si_3N_4 bilayer replaces the Cr_2O_3 diffusion barrier layer. This film has similar optical properties to the Ag/Si multilayer and has been stressed for 1000 hours at 550°C in air with localized (and explainable) degradation.

Future Effort

a. Demonstrate that absorptance can be increased to 0.90 using amorphous semiconductors as absorbers.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Arizona Optical Sciences Center Tucson, Arizona	Chemical Vapor Deposition of Spectrally Selective Absorbers
	CONTRACT NO. E(29-2)-3709
PRINCIPAL INVESTIGATOR Name: B.O. Seraphin	PERIOD OF PERFORMANCE May 1, 1976 to April 30, 1977
WORK LOCATION Tucson, Arizona	FISCAL YEAR 1978 FUNDING $100,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $276,000

PROJECT SUMMARY (continued)

b. Improve process control for consistent high IR reflectance from Mo.

c. Continue to investigate the stability of Mo as the IR reflecting metal layer in multilayer stacks.

Bibliography Reference Number: 18

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Houston Physics Department Houston, Texas 77004	Surface Morphologies of Efficient Solar Energy Absorbing Materials
	CONTRACT NO. EG-770-C-04-3974
PRINCIPAL INVESTIGATOR Name: A. Ignatiev	PERIOD OF PERFORMANCE May 1, 1978 to April 30, 1979
WORK LOCATION Houston, Texas	FISCAL YEAR 1978 FUNDING $73,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $153,000

PROJECT SUMMARY

Objective

a. To determine the role of surface morphology and microstructure in defining the optical absorption and emission of absorber coatings.

b. To compare the optical properties of laboratory and commercial gold, chrome, and nickel blacks.

Approach

Produce and corroborate a theory that relates the microstructure and optical properties of a black metal film and investigate the implications of this theory in producing improved absorber coatings.

Status

a. A mean field continuum model was developed based on previous work on gold black that showed the applicability of this theory in describing the optical properties of dispersed metallic particles in dielectric media.

b. Scanning Electron Microscope/Electron Spectroscopy for Chemical Analysis (SEM/ESCA) studies suggest that the microstructure for electroplated black chrome is:

   (1) A 200-300 Å surface layer of loosely packed Cr_2O_3 particles covering.

   (2) Several layers of loosely packed 1000-2000 Å diameter chromium particles, each coated with a thin oxide layer.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Houston Physics Department Houston, Texas 77004	Surface Morphologies of Efficient Solar Energy Absorbing Materials
	CONTRACT NO. EG-770-C-04-3974
PRINCIPAL INVESTIGATOR Name: A. Ignatiev	PERIOD OF PERFORMANCE May 1, 1978 to April 30, 1979
WORK LOCATION Houston, Texas	FISCAL YEAR 1978 FUNDING $73,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $153,000

PROJECT SUMMARY (continued)

c. Theoretical calculations indicate that a film with $\alpha_s = 0.92$ and $\varepsilon_t(120^0C) = 0.036$ can be achieved with a black gold 0.8 μm thick comprised of a mixture of spheres and ellipsoids.

Future Effort

Develop detailed model of the thermal degradation of black chrome.

Bibliography Reference Number: 19

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Minnesota Minneapolis, Minnesota 55455	Composition Profiling of Solar Coating and Materials with AES and ESCA
	CONTRACT NO. EY-76-S02-2953
PRINCIPAL INVESTIGATOR Name: G.K. Wehner	PERIOD OF PERFORMANCE April 16, 1977 to April 15, 1979
WORK LOCATION Minneapolis, Minnesota	FISCAL YEAR 1978 FUNDING $55,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $167,277

PROJECT SUMMARY

Objective

To use the facilities and in-house expertise of the University of Minnesota to provide "cost-free" Auger Electron Spectrosocpy (AES) and Electron Spectroscopy for Chemical Analysis (ESCA) profile analyses of sample films submitted by DOE contractors engaged in coating research and development for Solar Thermal Power programs.

Approach

DOE contractors have been encouraged to submit coating samples for profile composition analysis using both AES and ESCA.

Status

Analyses have been performed for numerous DOE contractors; a first year report on this program has been published. Among samples received for analysis in the past year have been about 20 samples of boron-doped amorphous silicon for Auger analysis (in support of the amorphous silicon selective absorber program at Argonne National Laboratory), about 17 samples of CVD-deposited Mo on glass for Auger analysis (in support of the CVD silicon-metal selective absorper program at the University of Arizona), about 20 samples of black nickel and black chromium coating for ESCA analysis from Honeywell, 1 sample of Inconel attacked by high-temperature molten salts for Auger analysis (in support of the Honeywell Central Receiver Phase I Support), and several samples of caron on crystalline silicon films from Honeywell (in support of the DOE photovoltaic effort in solar electric).

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Minnesota Minneapolis, Minnesota 55455	Composition Profiling of Solar Coating and Materials with AES and ESCA
	CONTRACT NO. EY-76-S02-2953
PRINCIPAL INVESTIGATOR Name: G.K. Wehner	PERIOD OF PERFORMANCE April 16, 1977 to April 15, 1979
WORK LOCATION Minneapolis, Minnesota	FISCAL YEAR 1978 FUNDING $55,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $167,277

PROJECT SUMMARY (continued)

Future Efforts

The University of Minnesota will be supported in this service function by DOE as part of the national program plan in absorber coatings research and development.

Bibliography Reference Number: 20

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Cornell University Laboratory of Atomic and Solid State Physics Ithaca, New York 14853	Optical Properties of Metallic Surfaces, Small Particles, and Composite Coatings
	CONTRACT NO. EG-77-S-03-1456
PRINCIPAL INVESTIGATOR Name: A.J. Sievers	PERIOD OF PERFORMANCE May 1, 1977 to March 31, 1979
WORK LOCATION Ithaca, New York	FISCAL YEAR 1978 FUNDING $168,794
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $328,794

PROJECT SUMMARY

Objective

To investigate the optical and physical properties of metals, alloys, and composite coatings.

Approach

Develop a theoretical model explaining the interactions of metal particles with light and experimentally investigate metal smokes and metal dispersions in insulators as selective solar absorbers.

Status

a. An advanced multiple scattering theory of metal particle-light interactions has been developed. The theory includes the nonuniform distribution of particle shapes and sizes in composite coatings.

b. Dispersions of Ni, V, Fe, and Pt in Al_2O_3, SiO_2, and MgO have been produced by dual beam evaporation. The Ni/Al_2O_3 cermet with $\alpha_s = 0.94$, $\varepsilon_t(100^0C) = 0.16$ and $\varepsilon_t(500^0C) = 0.35$ appears to be stable at 500^0C. Pt/Al_2O_3 shows $\varepsilon_t(500^0C) \leq 0.1$.

Future Effort

a. Investigate the temperature limits of physical stability including adhesion, oxidation, and agglomeration.

b. Investigate problems of solar photon-assisted diffusion and photochemistry.

c. Investigate techniques to limit atomic metal dispersion in cermets.

Bibliography Reference Number: 21

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
RCA Laboratories David Sarnoff Research Center Princeton, New Jersey 08540	Development of Granular Semiconductors as Selective Absorbers
	CONTRACT NO. EG-77-C-04-4557
PRINCIPAL INVESTIGATOR Name: J.I. Gittleman	PERIOD OF PERFORMANCE September 1, 1977 to August 31, 1978
WORK LOCATION Princeton, New Jersey	FISCAL YEAR 1978 FUNDING $100,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $100,000

PROJECT SUMMARY

Objective

To study and develop selective absorbers comprised of dispersions of Si and Ge in a transparent matrix.

Approach

Co-sputter Si (or Ge) and a low index of refraction, transparent insulator such as CaF_2 to produce dispersed semiconductor grains. The intention is to decrease the index of refraction mismatch at the absorber surface by grading the composition from an insulator-rich surface layer to a higher concentration of semiconductor absorber in the bulk.

Status

High absorptance for wavelengths up to 1.5 μm has been demonstrated with rapid transition to low IR emittance at longer wavelengths for films of Ge-CaF_2 on Al substrates having an $\alpha_s = 0.81$ and ε_t of .05 at room temperature.

Future Effort

a. Investigate temperature dependence of the emissivity of Ge/CaF_2 system.

b. Produce Ge/Si alloys dispersed in CaF_2 for improved optical performance.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Arizona Optical Sciences Center Tucson, Arizona 85721	High Temperature Optical Properties of Alloys for Central Receiver Solar Power Systems
	CONTRACT NO. E(29-2)-3673
PRINCIPAL INVESTIGATOR Name: Keith Masterson	PERIOD OF PERFORMANCE January 1, 1976 to April 30, 1978
WORK LOCATION Tucson, Arizona	FISCAL YEAR 1978 FUNDING $15,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $87,000

PROJECT SUMMARY

Objective

To measure the absorption/emission characteristics of uncoated boiler tube steels at 500°C. The steels selected for study are those specified for the three 10 MWe receiver designs.

Approach

The program was divided into four phases: (1) selection of suitable alloys, (2) preparation of the alloy surface, (3) determination of total hemispherical emittance and spectral reflectance, and (4) testing the optical properties' durability. Up to 10 alloys were selected based on their suitability for central-receiver boiler tube applications (based on oxidation resistance, creep and stress rupture strength, fabricability, commercial availability in tubular form, and use by the 10 MWe contractors). The surfaces were prepared in a two-stage treatment to remove scale and to control oxidation. Optical measurements were performed both before and after temperature cycling to simulate the "steady-state" use conditions expected in the three receivers. The total hemispherical emittance at elevated temperatures up to 600°C and the spectral reflectance were measured. The stability of the optical properties of the surfaces was tested for various surface treatments. This was done at accelerated oxidation rates.

Status

Some provisional conclusions reached in this program were:

a. Pyromark-coated steels performed better than oxidized steels as receiver surfaces; typical α was ~ 0.95 with $\varepsilon \gtrsim 0.9$. In addition, pyromark-coated samples showed good stabilty to high temperature cycling.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Arizona Optical Sciences Center Tucson, Arizona 85721	High Temperature Optical Properties of Alloys for Central Receiver Solar Power Systems
	CONTRACT NO. E(29-2)-3673
PRINCIPAL INVESTIGATOR Name: Keith Masterson	PERIOD OF PERFORMANCE January 1, 1976 to April 30, 1978
WORK LOCATION Tucson, Arizona	FISCAL YEAR 1978 FUNDING $15,000
CONTRACTING OFFICE Albuquerque Operations Office Albuquerque, New Mexico	CUMULATIVE FUNDING $87,000

PROJECT SUMMARY (continued)

b. Typical performance of oxidized steels as receiver surfaces were $a \simeq 0.85$ to 0.9; $\varepsilon \simeq 0.5$. No significant difference was observed in the room-temperatures α vs. high-temperatures of oxidized steels after several thermal cycles had occurred up to $\sim 700^{0}$C.

c. A recommended choice for an exposed receiver for the 10 MW plant would be pyromark of Inconel steel.

Future Effort

None.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
National Bureau of Standards Thermal Processes Division Washington, D.C. 20234	Thermal Radiation Property Measurements
	CONTRACT NO. EA77-A-01-6010 Task Order A097ST
PRINCIPAL INVESTIGATOR Name: Joseph C. Richmond	PERIOD OF PERFORMANCE August 1, 1978 to July 30, 1979
WORK LOCATION Gaithersburg, Maryland	FISCAL YEAR 1978 FUNDING $30,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $30,000

PROJECT SUMMARY

Objective

To procure and calibrate standards of absorptance, reflectance, and emittance which will be available for sale to the solar community.

Approach

One hundred samples each of high-specular reflectance, high-diffuse reflectance, and low-diffuse reflectance will be prepared and certified. The high-specular reflectance standards will be second-surface aluminum in quartz. The high-diffuse reflectance will be ca. 90 percent reflecting white porcelain enamel, and the low-diffuse reflectance will be ca. 7 percent reflecting black porcelain enamel. Appropriate instrumentation to measure the optical performance of the standards will be rehabilitated by the National Bureau of Standards from older instrumentation inhouse. Initial efforts will be directed to room-temperature measurements; later efforts are to be extended to high-temperature measurements for the diffuse standards.

Status

Instrumentation is being designed for the calibration of room-temperature standards.

Future Effort

None.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
National Bureau of Standards Thermal Processes Division Washington, D.C. 20234	Review of Reflectance, Absorptance, and Emittance Measurement Techniques in Use by the Solar Community
	CONTRACT NO. EA77-A-01-6010
PRINCIPAL INVESTIGATOR Name: Joseph C. Richmond	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Gaithersburg, Maryland	FISCAL YEAR 1978 FUNDING $80,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $80,000

PROJECT SUMMARY

Objective

To reconcile disparate measurements by the various laboratories presently studying emittance and solar absorptance of absorbers and solar reflectance of collectors.

Approach

a. Visit laboratories of DOE contractors making such measurements and review their measurement techniques.

b. Attend meetings called by DOE at which contractors report on their projects.

c. Organize and conduct meetings on measurements of solar energy materials.

d. Prepare and present papers on related subjects.

Status

Visits to approximately 30 laboratories have been undertaken. Two meetings have been organized and conducted: (1) the National Meeting of the Institute of Environmental Sciences of Solar Energy held in Houston, Texas, and (2) Testing Solar Energy Materials and Systems held at the National Bureau of Standards (NBS) and sponsored by the Institute of Environmental Sciences, NBS, and DOE. Meetings attended include: (1) several meetings of DOE contractors in Golden, Colorado, (2) a meeting of the American Society of Testing Materials (ASTM) Committee E-21 in San Diego, (3) a meeting in Philadelphia at which ASTM Committee E-44 on Solar Energy was formed, and (4) the Sixth European Conference on Thermophysic Properties, in Dubrovnik, Yugoslavia. Four papers have been prepared and presented, as indicated in the bibliography.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
National Bureau of Standards Thermal Processes Division Washington, D.C. 20234	Review of Reflectance, Absorptance, and Emittance Measurement Techniques in Use by the Solar Community
	CONTRACT NO. EA77-A-01-6010
PRINCIPAL INVESTIGATOR Name: Joseph C. Richmond	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Gaithersburg, Maryland	FISCAL YEAR 1978 FUNDING $80,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $80,000

PROJECT SUMMARY (continued)

Future Effort

Standardized optical test procedures and measurement parameters will be developed with industrial participation, and consensus will be officially disseminated to the solar comunity. Cooperation with ASTM or similar organizations will be encouraged.

Bibliography Reference Number: 22

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Battelle-Pacific Northwest Laboratories Richland, Washington 99352	Research and Development in Solar Mirror and Quality Assurance Performance
	CONTRACT NO. EY-76-C-06-1830
PRINCIPAL INVESTIGATOR Name: M.A. Lind	PERIOD OF PERFORMANCE April 1977 to April 1979
WORK LOCATION Richland, Washington	FISCAL YEAR 1978 FUNDING $300,000
CONTRACTING OFFICE Richland Operations Office Richland, Washington	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY

Objective

To create a materials-oriented program aimed at establishing quality assurance standards and developing measurement techniques for use throughout the entire solar industry. (This program will provide a technical overview for the solar reflector technology, a development of reflector standards and testing procedures, and long-term component applications data to support all solar energy projects involving reflectors.)

Approach

The program contains three primary tasks:

a. Solar Mirror Materials Evaluation consisting of (1) degradation mechanisms, (2) correlation of natural vs. accelerated aging, (3) evaluation of surface measurement techniques, and (4) surface contamination and dust accumulation.

b. Information Dissemination and Standards Development consisting of (1) industry interaction, (2) publication in journals, and (3) American Society of Testing Materials (ASTM) interaction.

c. Instrumentation Development consisting of (1) specularity measurement, (2) transmittance/reflectance measurement, and (3) mirror figure measurement.

Status

a. Solar Mirror Materials Evaluation: Environmental degradation and studies have focused on teflon and glass. Studies are nearly complete on non-contact cleaning agents for mirror surfaces.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Battelle-Pacific Northwest Laboratories Richland, Washington 99352	Research and Development in Solar Mirror and Quality Assurance Performance
	CONTRACT NO. EY-76-C-06-1830
PRINCIPAL INVESTIGATOR Name: M.A. Lind	PERIOD OF PERFORMANCE April 1977 to April 1979
WORK LOCATION Richland, Washington	FISCAL YEAR 1978 FUNDING $300,000
CONTRACTING OFFICE Richland Operations Office Richland, Washington	CUMULATIVE FUNDING $400,000

PROJECT SUMMARY (continued)

b. Information Dissemination and Standards Development: A Solar Reflective Materials Workshop was conducted in cooperation with SERI and DOE Headquarters. The workshop resulted in the formulation of a national reflective materials program plan set up at SERI to direct and coordinate materials research in mirror materials. Interaction is underway with the ASTM to develop industry-acceptable standards for mirror performance.

c. Instrumentation Development: Instrumentation to measure specularity, transmittance and reflector absorptance, laboratory and field use is about 75 percent completed.

Future Efforts

Support of materials data base through industrial interaction, standards activities, and planning activities in support of SERI will continue. New instrumentation and techniques to characterize mirror performance will continue with emphasis to be placed on specularity and optical figures.

Bibliography Reference Number: 23

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Boulevard Golden, Colorado 80401	Reflector Materials Workshop
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: P. Call and M. Lind (Battelle PNL)	PERIOD OF PERFORMANCE February 1, 1978 to April 30, 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $13,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $13,000

PROJECT SUMMARY

Objective

a. To identify current state-of-the-art of solar reflector technology with regards to material properties, material availability, reflector surface conditions, user experience, and characteristic technologies.

b. To define mirror design requirements for specularity, reflectivity, fabrication and construction, maintenance, life expectancy, and economics.

c. To develop recommendations for DOE program goals and areas of future research and development support.

Approach

a. Hold workshop with invited and contributed papers covering: (1) intrinsic properties of mirror materials and structures, (2) exposure test results and environmental effects on reflector properties, (3) measurement and testing methodologies, and (4) innovative materials and structures.

b. Hold discussions of above listed topics in small working groups.

c. Present summary of working group discussions by session chairmen.

d. Prepare a formal report consisting of an executive summary to be completed by end of FY 1978.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Boulevard Golden, Colorado 80401	Reflector Materials Workshop
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: P. Call and M. Lind (Battelle PNL)	PERIOD OF PERFORMANCE February 1, 1978 to April 30, 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $13,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $13,000

PROJECT SUMMARY (continued)

Status

a. The workshop was held March 28-30, 1978, in Denver, Colorado. Ninety-five individuals representing 60 different organizations were in attendance.

b. A rough draft of the executive summary has been compiled and is undergoing revisions.

Future Effort

It is recommended that in the future several of the specific areas identified during this workshop be readdressed in topical workshops having fewer attendees.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technlogy

CONTRACTOR/ADDRESS	TITLE
University of California Lawrence Berkeley Laboratory Berkeley, California 94720	Measurement of Circumsolar Radiation
	CONTRACT NO. W-7405-eng-48
PRINCIPAL INVESTIGATOR Name: Donald Grether	PERIOD OF PERFORMANCE October 1, 1975 to September 30, 1978
WORK LOCATION Berkeley, California	FISCAL YEAR 1978 FUNDING $184,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $1,023,000

PROJECT SUMMARY

Objective

To provide solar radiation measurements necessary for accurate prediction of the performance of solar energy conversion systems employing concentrating collectors, i.e., to obtain accurate measurements of the true "direct" solar flux from the sun's disc and also the detailed radiation from the circumsolar region between the edge of the sun's disc and the 6 field of view of a pyrheliometer.

Approach

The measurements have been made by scanning telescopes that determine the flux of energy from the sun and the circumsolar region (the small-angle region around the sun) as a function of angle, wavelength, and atmospheric conditions. The circumsolar radiation arises from forward scattering of sunlight from aerosols, ice crystals, or water droplets in thin clouds. This dependence on meteorological variables leads to large regional and seasonal variations. The angular and wavelenth measurements provided by the project allow detailed considerations of the actual performance of the concentrating system. The data can be used as input to optimization of receiver sizes, characterization of a site or region, and comparisons between competing designs at a given location.

Status

The major accomplishments of the project include:

a. The design, construction, and deployment of four complete circumsolar telescopy systems.

b. The operation, maintenance, and data collection from these four instruments at a total of nine sites for the past two years.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technlogy

CONTRACTOR/ADDRESS	TITLE
University of California Lawrence Berkeley Laboratory Berkeley, California 94720	Measurement of Circumsolar Radiation
	CONTRACT NO. W-7405-eng-48
PRINCIPAL INVESTIGATOR Name: Donald Grether	PERIOD OF PERFORMANCE October 1, 1975 to September 30, 1978
WORK LOCATION Berkeley, California	FISCAL YEAR 1978 FUNDING $184,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $1,023,000

PROJECT SUMMARY (continued)

c. The compilation, validation, analysis, and dissemination of these data to DOE and other users.

d. Collaboration with other national laboratories to quantify the impact of circumsolar radiation on specific solar collector designs (including the 10 MWe pilot plant and the 5 MW test facility).

Future Effort

Continued data collection is planned to characterize circumsolar effects for other climate types of interest for solar energy collection. Analysis of the data will be expanded to determine the impact of circumsolar radiation on (1) the design and siting of large scale solar thermal power plants, (2) the performance of concentrating photovoltaic collectors, and (3) the relative efficiencies of imaging and non-imaging solar collectors.

Bibliography Reference Number: 24

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Boulevard Golden, Colorado 80401	Effects of Circumsolar Radiation on Collector Performance
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: Ari Rabl and Keith Masterson	PERIOD OF PERFORMANCE October 1, 1977 to August 1, 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $20,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $20,000

PROJECT SUMMARY

Objective

To obtain quantitative information on the effect of circumsolar radiation on the thermal efficiency of various generic types of concentrators. To develop procedures for sizing receivers to optimize their performance for various amounts of circumsolar radiation.

Approach

Performance for various circumsolar profiles has been compared in order to determine its effects on energy collection. The angular response characteristics of concentrator collectors has been determined from analytical and ray-trace techniques. Taken together with the size of the solar disk and statistical expressions for concentrator imperfections and circumsolar profiles, energy collection as a function of receiver size, i.e., concentration ratio, has been determined and compared to the receiver's thermal losses in order to optimize performance.

Status

a. Ray trace and analytical calculations have been performed for a line focus collector and used to optimize concentration ratios for five circumsolar profiles. A concentration ratio exists which optimizes performance for all but the most severe cases of circumsolar radiation. An informal report has been drafted on the work.

b. The study of point focus concentrators has been initiated.

Future Effort

a. Ray trace and analytical techniques to determine collector response will be refined to include point focus devices.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute 1536 Cole Boulevard Golden, Colorado 80401	Effects of Circumsolar Radiation on Collector Performance
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: Ari Rabl and Keith Masterson	PERIOD OF PERFORMANCE October 1, 1977 to August 1, 1978
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $20,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $20,000

PROJECT SUMMARY (continued)

b. Line focus collectors will also be reviewed using refined techniques.

c. Using the collector performance model developed, the early energy collection will be calculated using circumsolar data base generated by Lawrence Berkeley Laboratories.

d. The results will be summarized in a final report.

Bibliography Reference Number: 25

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
University of Texas at Dallas P.O. Box 688 Richardson, Texas 75080	Studies of Solar Intensities in the United States
	CONTRACT NO. JPL 955216
PRINCIPAL INVESTIGATOR Name: Donald Rapp	PERIOD OF PERFORMANCE September 1, 1978 August 31, 1979
WORK LOCATION Richardson, Texas	FISCAL YEAR 1978 FUNDING $45,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $45,000

PROJECT SUMMARY

Objective

a. To evaluate procedures for accumulating historical measurements of global insolation.

b. To determine methods for handling errors made in accumulating past measurements.

c. To develop a procedure for establishing model years to be used in computer simulation solar energy systems design.

Approach

Critically review the data taken by NOAA from 1950 to 1977 and devise a procedure for rehabilitating data on global insolation. Develop theoretical models for accurately estimating global solar intensities.

Status

Work under this contract began in September 1978.

Future Effort

None.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Dow Corning Corporation Midland, Michigan 48640	Reflective Surface Protective Coatings
	CONTRACT NO. ET-78-C-02-4614
PRINCIPAL INVESTIGATOR Name: Dr. William E. Dennis	PERIOD OF PERFORMANCE January 2, 1978 to January 1, 1980
WORK LOCATION Midland, Michigan	FISCAL YEAR 1978 FUNDING $71,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $71,000

PROJECT SUMMARY

Objective

To perform research and development of protective resins suitable for heliostats.

Approach

Identify or develop resins for the protection of heliostats. The resins will not appreciably degrade the performance of the heliostat, will maintain stability for 20 years, and will clean easily. Protection of front-surfaced mirrors will receive primary emphasis with some activity going to protect second-surface mirror applications.

Status

Identification of resins and coating of initial samples and spectral testing is underway.

Future Effort

Continue to identify/develop heliostat protective coatings.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
The Mitre Corporation Metrek Division 1820 Dolley Madison Boulevard McLean, Virginia 22101	Atmospheric Considerations for a Central Receiver Power Plant
	CONTRACT NO. ET-77-C-01-2896
PRINCIPAL INVESTIGATOR Name: Ali H. Ghovanlou	PERIOD OF PERFORMANCE April 10, 1978 to April 10, 1979
WORK LOCATION McLean, Virginia	FISCAL YEAR 1978 FUNDING $99,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $99,000

PROJECT SUMMARY

Objective

To determine the energy loss from the heliostat field to the central receiver due to scattering and absorption in the intervening atmosphere.

Approach

Calculate the scattering and absorption of direct and reflected solar radiation in the near-Earth atmosphere by use of an existing simplified transfer model or an existing Monte Carlo computer simulation model. Apply results to the transfer of solar radiation from a heliostat field to receivers for three representative sites.

Status

Optical environment of selected sites (Barstow, Phoenix, El Paso, and Houston) and the U.S. Southwest has been defined and a computer program has been adapted for handling scattering elements. The Monte Carlo method has been selected for performing radiation transfer calculations.

Future Effort

No further effort is contemplated beyond the completion of this contract's described tasks.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Energy Foundation of Texas 4800 Calhoun Street Houston, Texas 77004	Solar Energy System Simulation and Analysis
	CONTRACT NO. EG-77-C-04-3974
PRINCIPAL INVESTIGATOR Name: Lorin L. Vant-Hall	PERIOD OF PERFORMANCE May 1977 to April 1979
WORK LOCATION Houston, Texas	FISCAL YEAR 1978 FUNDING $86,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $176,000

PROJECT SUMMARY

Objective

a. To develop, improve, and document mathematical simulations of various system components for a central receiver power plant.

b. Establish a code center for central receiver-related codes.

Approach

Subprograms on (1) the simulation of distribution and redistribution of radiation for cavity receivers, (2) the effects of blocking and shading for domed heliostats, and (3) small central receiver performance for low, intermediate, and high-temperature applications will be developed. Improvements to existing optimization simulations will be carried out. The code center will process and transmit codes from code developers to interested users.

Status

The development of the subprograms is underway. Documentation guidelines for submittal forms for the code center are being prepared.

Future Effort

As the subprograms are developed, they will be debugged and verified by comparison with prior evaluations; the models will then be used as improved production codes. For the code center, known codes will be solicited and processed. A listing of codes with their anticipated availability from the code center will be distributed.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Supporting Technology

CONTRACTOR/ADDRESS	TITLE
Energy Foundation of Texas 4800 Calhoun Boulevard Houston, Texas 77004	Analysis of Extreme Winds on Solar Tower Generators
	CONTRACT NO. EG-77-C-04-3974
PRINCIPAL INVESTIGATOR Name: James R. McDonald	PERIOD OF PERFORMANCE May 1977 to April 1979
WORK LOCATION Texas Technology University Lubbock, Texas	FISCAL YEAR 1978 FUNDING $50,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $84,000

PROJECT SUMMARY

Objective

a. To support the 10 MWe Pilot Plant by analyzing and predicting the effects of extreme winds on the tower and on the heliostat field.

b. To advise and assist in methods of designing components that will be wind resistant.

Approach

Wind data for the site will be evaluated to determine the probability of wind vectors.

Status

A one-year report has been issued.

Future Effort

A subtask concerning "Heliostat Vortex Shedding Frequencies" will continue.

Bibliography Reference Number: 26

ADVANCED THERMAL TECHNOLOGY
New Concept Demonstrations
Project Summaries

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Sanders Associates, Inc. 95 Canal Street Nashua, New Hampshire 03069	One-Quarter Megawatt (Thermal) Solar Brayton Receiver Design, Construction and Testing
	CONTRACT NO. EG-77-C-03-1555
PRINCIPAL INVESTIGATOR Name: Armand Poirier	PERIOD OF PERFORMANCE July 25, 1977 to October 30, 1978
WORK LOCATION Nashua, New Hampshire and Georgia Institute of Technology (Testing)	FISCAL YEAR 1978 FUNDING $276,106
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $1,232,106

PROJECT SUMMARY

Objective

To fabricate and test a 250 kWt silicon carbide honeycomb receiver at atmospheric pressure and 2000°F. (This work extends the previous effort, conducted under contract E(11-1)-2823, that resulted in the test of a 1700°F heat receiver of 10 kWt capacity. Successful testing of the 250 kWt receiver will verify the potential of this technology for application to large-scale solar power generation using open-cycle Brayton systems.)

Approach

a. Design a 250 kWt air-cooled receiver, operating at atmospheric pressure and having a thermal efficiency of 84 percent at 2000°F.

b. Conduct experiments and analyses to evaluate the potential loss of heat by convection from the receiver.

c. Conduct analysis to verify that the receiver design and performance will be capable of further scaling to commercial power generation levels.

d. Fabricate the 250 kW receiver, together with fixtures and accessories required for testing at the DOE/Georgia Institute of Technology (GIT) 400 kWt Test Facility.

e. Conduct laboratory testing of the completed receiver for at least 10 cycles to temperatures in excess of 1000°F, using heated air.

f. Prepare a test plan for the receiver in concentrated sunlight at the GIT facility.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Sanders Associates, Inc. 95 Canal Street Nashua, New Hampshire 03069	One-Quarter Megawatt (Thermal) Solar Brayton Receiver Design, Construction and Testing
	CONTRACT NO. EG-77-C-03-1555
PRINCIPAL INVESTIGATOR Name: Armand Poirier	PERIOD OF PERFORMANCE July 25, 1977 to October 30, 1978
WORK LOCATION Nashua, New Hampshire and Georgia Institute of Technology (Testing)	FISCAL YEAR 1978 FUNDING $276,106
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $1,232,106

PROJECT SUMMARY (continued)

g. Ship the receiver to the GIT facility.

h. Test receiver at GIT.

i. Reduce data and produce final report.

Status

All of the above tasks have been completed except items "h" and "i."

Future Effort

Complete the receiver testing at GIT, reduce the data, and issue the final report.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Massachusetts Institute of Technology Lincoln Laboratories P.O. Box 73 Lexington, Massachusetts 02173	Solar Heated-Air Cavity Receiver Development
	CONTRACT NO. EY-78-5-02-4878
PRINCIPAL INVESTIGATOR Name: Philip Jarvinen	PERIOD OF PERFORMANCE May 1978 to May 1979
WORK LOCATION Lexington, Massachusetts	FISCAL YEAR 1978 FUNDING $249,680
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $249,680

PROJECT SUMMARY

Objective

To develop a novel approach for a solar heated-air cavity receiver.

Approach

a. Conduct studies to establish the technical and economical performance of such a receiver.

b. Develop, evaluate, and test dome sealing designs.

c. Perform tests to determine leakage at various temperature and pressure conditions.

Status

Design and structural analysis has been completed. A ceramic dome/seal test fixture has been built.

Future Effort

Ceramic domes will be tested under pressure and temperature conditions to determine leakage.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Rockwell International Energy Systems Group 8900 DeSoto Avenue Canoga Park, California 91304	Characterization of Sodium Oxide Aerosols Released in a Natural Environment from a Heat Receiver
	CONTRACT NO. EY-76-C-03-0701
PRINCIPAL INVESTIGATOR Name: H.A. Morewitz, T.H. Springer	PERIOD OF PERFORMANCE February 1978 to September 30, 1978
WORK LOCATION Canoga Park, California	FISCAL YEAR 1978 FUNDING $150,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $150,000

PROJECT SUMMARY

Objective

Characterize the physical properties (concentration, size distribution, fallout, and chemical make up, if possible) of the aerosols formed by the exposure of hot liquid sodium in jet and pool form from a heat receiver to air in a natural environment and validate chemical and depletion models in the COMRADEX Code.

Approach

a. Conduct a series of laboratory tests in order to determine the adequacy of aerosol sample collectors.

b. Select appropriate sampling techniques.

c. Perform tests of the technique.

d. Conduct a series of actual tasks at the Idaho National Engineering Laboratory (INEL) site.

Status

a. Sample collector systems, devices, and techniques were surveyed, developed where necessary, fabricated or procured, and successfully tested on a laboratory scale.

b. A series of five release tests for spray, jet, and pool configurations was accomplished at INEL at various elevations up to 30 meters and under various atmospheric stability conditions.

c. Calculations of the expected results were carried out using existing computer models.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Rockwell International Energy Systems Group 8900 DeSoto Avenue Canoga Park, California 91304	Characterization of Sodium Oxide Aerosols Released in a Natural Environment from a Heat Receiver
	CONTRACT NO. EY-76-C-03-0701
PRINCIPAL INVESTIGATOR Name: H.A. Morewitz, T.H. Springer	PERIOD OF PERFORMANCE February 1978 to September 30, 1978
WORK LOCATION Canoga Park, California	FISCAL YEAR 1978 FUNDING $150,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $150,000

PROJECT SUMMARY (continued)

d. Analysis of the experimental data is underway.

e. Analysis of the INEL field tests is being completed.

f. The adequacy of the computer model for calculating the aerosol characteristics is being ascertained on the basis of the experimental results.

Future Effort

None is anticipated upon completion of the project.

Bibliography Reference Number: 27

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
University of Chicago The Enrico Fermi Institute 5630 Ellis Avenue Chicago, Illinois 60637	Non-Imaging Concentrators for Wide-Angle Collection of Solar Energy
	CONTRACT NO. E(11-1)-2446
PRINCIPAL INVESTIGATOR Name: R. Winston, J.O. Gallagher	PERIOD OF PERFORMANCE July 1, 1977 to September 30, 1978
WORK LOCATION Chicago, Illinois	FISCAL YEAR 1978 FUNDING $300,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $800,000

PROJECT SUMMARY

Objective

To develop non-imaging concentrators for wide-angle collection using advanced concepts, perform basic collector research, and collect compound parabolic concentrator (CPC) performance data at a New Mexico Indian School.

Approach

The prototype development entials constructing approximately 15 square feet of CPC's, conducting optical and thermal tests, and publishing results. The potential for this nontracking system is 600°F (315°C) at an efficiency of 42 percent. The roof-top test station is to be expanded to include a high-temperature test loop, solar/weather station, and data acquisition system.

Advanced concepts for lens/mirror combinations using Fresnel lenses are to be studied. An approximate 10-square-foot lens-mirror module is to be constructed, tests are to be conducted (700°F potential and 40 percent efficiency), and results are to be published.

Status

High temperature tests have been run on 5.25X evacuated receiver CPC's and 6X non-evaluated receivers. A Fresnel lens/mirror system has been constructed.

The 3X CPC heating system for a New Mexico Indian School with Bureau of Indian Affairs support is in operation and data are being gathered.

Future Effort

None.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
University of Arizona Optical Science Center Tucson, Arizona 85271	Study of a Small Fixed-Mirror Distributed-Focus Concentrator
	CONTRACT NO. JPL 955162
PRINCIPAL INVESTIGATOR Name: Aden P. Meinel	PERIOD OF PERFORMANCE July 28, 1978 to April 30, 1979
WORK LOCATION Tucson, Arizona	FISCAL YEAR 1978 FUNDING $45,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $45,000

PROJECT SUMMARY

Objective

To study small module fixed spherical mirror distributed-focus concentrators.

Approach

a. Perform a comparative study of existing fixed-mirror distributed-focus (FMDF) designs.

b. Optimize the size using numerous engineering techniques.

c. Perform an engineering analysis of optimized size to confirm design.

Status

Visits were made to other FMDF sites and initial data is being gathered.

Future Effort

None.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Sun Power Corporation 3 High Point Road Westport, Connecticut 06880	Paravac Solar Collector
	CONTRACT NO. EG-77-C-01-4031
PRINCIPAL INVESTIGATOR Name: Carl Whiteford	PERIOD OF PERFORMANCE September 15, 1978 to January 1, 1979
WORK LOCATION Westport, Connecticut	FISCAL YEAR 1978 FUNDING $11,450
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $102,650

PROJECT SUMMARY

Objective

To demonstrate the feasibility of constructing a parabolic trough concentrator employing Fresnel reflectors on a vacuum-formed cylinder. The funding for this project was provided by DOE's Division of Solar Technology. The goal of the project was to provide a basis for 600°F fluid collection at approximately $6.00 per square foot.

Approach

A thin polycarbonate sheet is extrusion-formed with a pattern of approximately 0.130 wide Fresnel reflector elements running the length of the sheet. Each 0.130 wide surface is sloped at an angle calculated to reflect the solar insolation onto a receiver tube when the polycarbonate sheet is formed into a partial cylindrical surface. The cylindrical surface is formed by pulling a slight vacuum on the under side of the sheet which is stretched into a mounting form with edges clamped and sealed.

Status

a. Design of the sheet-holding trough is completed.

b. Optical design of the Fresnel surface is completed.

c. Under the FY 1978 contract amendment, the designs of a supporting structure for the trough and tracking and drive components are completed.

d. The polycarbonate sheet extrusion roller has been subcontracted for completion.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Sun Power Corporation 3 High Point Road Westport, Connecticut 06880	Paravac Solar Collector
	CONTRACT NO. EG-77-C-01-4031
PRINCIPAL INVESTIGATOR Name: Carl Whiteford	PERIOD OF PERFORMANCE September 15, 1978 to January 1, 1979
WORK LOCATION Westport, Connecticut	FISCAL YEAR 1978 FUNDING $11,450
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $102,650

PROJECT SUMMARY (continued)

e. The first prototype sheet-holding trough has been fabricated for use in optical testing.

f. Tracking and drive components have been procured for use in a prototype collector.

Future Effort

a. Extrusion-formed sheets will be made, mirrored, and trimmed to size.

b. The mirror Fresnel extrusion will be mounted, clamped, and sealed to a test frame. Optical test of reflecting accuracy will be done.

c. A complete test collector with support structure, tracking, and drive will be shipped to Sandia Laboratories in Albuquerque for testing in the oil loop.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstration

CONTRACTOR/ADDRESS	TITLE
Mechanical Technology, Inc. 968 Albany-Shaker Road Latham, New York 12110	Concept Definition of Solar and Stirling Engine for Advanced Dispersed Electric Power Systems
	CONTRACT NO. DEN 3-56
PRINCIPAL INVESTIGATOR Name: George Dochat	PERIOD OF PERFORMANCE September 1, 1978 to March 1, 1979
WORK LOCATION Latham, New York	FISCAL YEAR 1978 FUNDING $245,000
CONTRACTING OFFICE NASA Lewis Research Center	CUMULATIVE FUNDING $245,000

PROJECT SUMMARY

Objective

To design a high-efficiency 15 kWe free-piston Stirling engine/alternator and a kinematic Stirling engine/alternator. One of the two will be selected to operate in conjunction with a paraboloidal dish concentrating solar collector electrical generating plant.

Approach

Configuration definition studies will be performed to identify the most attractive configurations for an advanced 15 kWe Stirling engine with an electrical alternator. Technology which can reasonably be expected in 1985 may be incorporated in the design concepts. From the foregoing task, the most attractive configuration for development to a production engine status and eventual widespread implementation will be assessed for development effort required, producibility, durability, and growth potential. In order to make a test bed engine for the 1980 time period, the most attractive configuration will be designed with modification to avoid technology risks.

Status

Contract to be issued shortly.

Future Effort

Detail design and fabricate a 15 kWe test bed engine with free-piston or kinematic features.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Garrett Corporation AiResearch Manufacturing 402 South 36th Street Phoenix, Arizona 85034	Concept Definition Study of Small Brayton Engine for Solar Electric Power Systems
	CONTRACT NO. DEN-3-69
PRINCIPAL INVESTIGATOR Name: Mr. Lyle Six	PERIOD OF PERFORMANCE September 1978 to March 1979
WORK LOCATION Phoenix, Arizona	FISCAL YEAR 1978 FUNDING $160,000
CONTRACTING OFFICE NASA-Lewis Research Center Cleveland, Ohio	CUMULATIVE FUNDING $160,000

PROJECT SUMMARY

Objective

To establish economically viable Brayton engines (10-20 kWe) for use with point focus distributed receiver Solar Thermal Power Systems.

Approach

Parametrically investigate performance and estimate costs of candidate Brayton power conversion units, including electrical generator and recuperator.

Status

Contract effort was initiated on September 15, 1978.

Future Effort

Select the best engine/generator set through competitive procurement and fabricate test units for system performance evaluation at NASA Edwards Air Force Base Solar Test Facility.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
BiPhase Engines, Inc. 2907 Ocean Park Boulevard Santa Monica, California 90406	Evaluation of a Two-Phase Turbine System for Solar Electric Power Generation
	CONTRACT NO. E(04-3)-1255
PRINCIPAL INVESTIGATOR Name: William Amend	PERIOD OF PERFORMANCE June 1976 to December 1978
WORK LOCATION Santa Monica, California	FISCAL YEAR 1978 FUNDING $241,000
CONTRACTING OFFICE NASA/Lewis Research Center Cleveland, Ohio	CUMULATIVE FUNDING $334,903

PROJECT SUMMARY

Objective

To analyze, design, fabricate, test, and evaluate a two-phase turbine for operation at 660^0 F.

Approach

Deliver a trailer-mounted engine to a DOE selected site; provide cost and performance estimates for low (660^{0}F), medium (1000^{0}F), and high (1600^{0}F) temperature versions. The specific design chosen was based on the operating conditions and parameters of the Total Energy Test Facility at the Sandia Laboratories, Albuquerque, New Mexico.

Status

Biphase Engines, Inc., has designed the turbine and has fabricated all parts. The turbine was assembled and tested. The first series of tests were conducted at 400^{0}F with partial success. Separation of thermal and water was not complete. Biphase has indicated they will study other fluids using their own funds because contracted dollars and time have been expended.

Future Effort

Continued development of the two-phase turbine will depend on results of tests of the turbine at conditions approximating the Total Energy Test Facility.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
General Atomic Company P.O. Box 81608 San Diego, California 92138	Solar Heat Transfer Test Loop
	CONTRACT NO. FY-76-C-03-0167
PRINCIPAL INVESTIGATOR Name: John L. Russell	PERIOD OF PERFORMANCE March 1978 to March 1979
WORK LOCATION San Diego, California	FISCAL YEAR 1978 FUNDING $200,000
CONTRACTING OFFICE San Francisco Operations Office Oakland, California	CUMULATIVE FUNDING $200,000

PROJECT SUMMARY

Objective

To design and construct a high-temperature liquid heat transfer test loop using a high-temperature eutectic salt and to demonstrate its operation for use in solar thermal power plants.

Approach

A company-provided molten salt reservoir and four spare fixed-mirror solar concentrator (FMSC) modules from Sandia will be used as a basis for the design and construction of a high-temperature eutectic salt as the heat transfer medium. A heat receiver cooled by the molten salt will be designed, built, and incorporated into the loop.

Status

The test site has been prepared and FMSC modules have been installed. The heat transfer loop design is essentially complete and hardware and receiver components are on order.

Future Effort

Construction and check out of molten salt loop should be completed by the end of December 1978. Test operation and system evaluation is expected during the first quarter of calendar year 1979.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Dynatech R/D Company 99 Erie Street Cambridge, Massachusetts 02139	Combined Dry Cooling Tower and Thermal Storage Pond Waste Heat Rejection System for Solar Thermal Electric Power Stations
	CONTRACT NO. ET-78-C-02-4680
PRINCIPAL INVESTIGATOR Name: Eric Guyer	PERIOD OF PERFORMANCE March 1, 1978 to February 28, 1979
WORK LOCATION Cambridge, Massachusetts	FISCAL YEAR 1978 FUNDING $57,270
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $57,270

PROJECT SUMMARY

Objective

To conduct a preliminary evaluation of a dry cooling tower/thermal storage pond concept for integration with a solar thermal steam-electric plant.

Approach

a. Define heat rejection requirements for a solar thermal plant; evaluate system design and operation options.

b. Investigate engineering problems of system design and implementation.

c. Provide a preliminary evaluation of system economics.

Status

Computer programs have been written for the heat rejection requirements and the system operations options.

Future Effort

Complete computer simulation capabilities and apply input data from two locations.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Naval Research Laboratory Washington, D.C. 20375	Development of Converter/Heat Receiver for Solar Thermo-chemical Energy Collection
	CONTRACT NO. Eg-77-A-29-1105
PRINCIPAL INVESTIGATOR Name: Talbot Chubb	PERIOD OF PERFORMANCE September 1977 to September 1978
WORK LOCATION Washington, D.C.	FISCAL YEAR 1978 FUNDING $120,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $120,000

PROJECT SUMMARY

Objective

To evaluate a converter/heat receiver design based on ceramic honeycomb extrusion technology. This technology may be used for conversion of solar energy to thermo-chemical energy for transport, storage, and conversion to electricity. The energy transport and storage system to be SO_3 gas input, $SO_2 + O_2$ output at three atmospheres.

Approach

Procure ceramic extrusions from industry to test and checkout chemical reaction of SO_3 gas and resulting constituents.

Status

Ceramic samples are being procured and evaluated for bench model testing. A small test facility has been designed to evaluate chemical reactions and design concepts.

Future Effort

A test facility will be built and a ceramic model of a converter/heat receiver will be procured for bench model testing.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
General Electric Company Space Division, Adv. Energy Programs P.O. Box 15132 Cincinnati, Ohio 45215	Conceptual Design Study on the Application of Liquid Metal Heat Transfer Technology to Solar Thermal Power
	CONTRACT NO. JPL Subcontract No. 955018
PRINCIPAL INVESTIGATOR Name: W. Zimmerman	PERIOD OF PERFORMANCE April 1978 to April 1979
WORK LOCATION Evandale, Ohio	FISCAL YEAR 1978 FUNDING $209,000
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $209,000

PROJECT SUMMARY

Objective

Liquid metals applications to dispersed solar power systems are to be investigated. Emphasis of the study is to be placed on the Stirling engine for power conversion, high-temperature operation (1100^{o}-1200^{o}K) and for short-term thermal storage provision.

Approach

Liquid metal transport and storage is being studied for three possible systems: the point focus system, the Cassegrainian system, and the power station system. Emphasis will be placed on a wickless, configuration-pumped heat pipe concept for a point focus system that has the solar receiver and power conversion unit at the focus of a paraboloidal concentrator. The power station system will transport the input of several solar collectors to a centrally located power conversion unit.

Status

Heat losses expected with the three possible systems have been evaluated. It appears that the power station system would not be feasible. The contracted effort is about 20 percent complete as of August 1, 1978.

Future Effort

Advanced technology effort in liquid metal buffer storage is expected in follow-on efforts.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Dynatherm Corporation One Industry Lane Cockeysville, Maryland 21030	Heat Pipe for Central Solar Receiver
	CONTRACT NO. E(11-1)-2839
PRINCIPAL INVESTIGATOR Name: Walter B. Bienert	PERIOD OF PERFORMANCE February 1, 1976 September 30, 1978
WORK LOCATION Cockeysville, Maryland	FISCAL YEAR 1978 FUNDING $29,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $352,000

PROJECT SUMMARY

Objective

To investigate heat pipes as extended surfaces for a gas (Brayton Cycle) heat exchanger for application to a central solar receiver.

Approach

a. Evaluate various heat exchanger concepts with respect to performance in conjunction with a typical generation cycle.

b. Extend the existing heat pipe technology to meet the requirements of a solar-to-gas heat exchanger.

c. Select a reference design heat exchanger and generate sufficient design detail to enable costing the unit.

d. Lay out, analyze, and cost a solar-gas system and compare its energy cost with those of the reference central receiver plants.

Status

Testing of prototype heat pipes has been conducted and the conceptual design of a receiver with definition of flux intensities has been completed. An economic analysis, a development plan, and a definition of heat pipe manufacturing techniques are being completed.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: New Concept Demonstrations

CONTRACTOR/ADDRESS	TITLE
Dynatherm Corporation One Industry Lane Cockeysville, Maryland 21030	Heat Pipe for Central Solar Receiver
	CONTRACT NO. E(11-1)-2839
PRINCIPAL INVESTIGATOR Name: Walter B. Bienert	PERIOD OF PERFORMANCE February 1, 1976 September 30, 1978
WORK LOCATION Cockeysville, Maryland	FISCAL YEAR 1978 FUNDING $29,000
CONTRACTING OFFICE Chicago Operations Office Argonne, Illinois	CUMULATIVE FUNDING $352,000

PROJECT SUMMARY (continued)

Future Effort

A follow-on program has been proposed: to design, fabricate, and test a 250 kWt receiver and perform life tests of liquid metal heat pipes.

Bibliography Reference Number: 28

ADVANCED THERMAL TECHNOLOGY
Advanced Systems
Project Summaries

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Advanced Systems

CONTRACTOR/ADDRESS	TITLE
Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	Advanced Solar Thermal Technology
	CONTRACT NO. NAS7-100
PRINCIPAL INVESTIGATOR Name: V.C. Truscello/J.C. Becker	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Pasadena, California	FISCAL YEAR 1978 FUNDING $3,286,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $4,452,000

PROJECT SUMMARY

Objective

a. To perform technology assessment and planning.

b. To manage component development and feasibility experiments.

c. To define advanced dispersed power system configurations.

d. To develop components and subsystems for advanced dispersed power systems.

Approach

a. Prepare project development and operating plans.

b. Establish a project organization.

c. Implement certain near-term tasks.

d. Conceptualize a dispersed, paraboloidal dish-Stirling power system.

e. Issue RFP's to industry to develop concentrators, receivers, and engines for this system.

f. Develop economic, programmatic, and other special studies and plans in support of the DOE Advanced Technology Branch of Solar Thermal Power Systems.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Advanced Systems

CONTRACTOR/ADDRESS	TITLE
Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103	Advanced Solar Thermal Technology
	CONTRACT NO. NAS7-100
PRINCIPAL INVESTIGATOR Name: V.C. Truscello/J.C. Becker	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Pasadena, California	FISCAL YEAR 1978 FUNDING $3,286,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $4,452,000

PROJECT SUMMARY (continued)

Status

All major tasks are on schedule and total costs are within the scope of planned costs. The Advanced Dispersed Power Systems Study is progressing and the Semiannual Technical Report was published. Advanced technology development in the areas of receivers, transport, engines, and concentrators is continuing. Jet Propulsion Laboratory is contributing to the development of a DOE Fuels and Chemicals Program and has also provided DOE with a recommended Advanced Thermal Technology Program Plan.

Future Effort

The development of advanced solar thermal technologies is to be accelerated. A dish-Stirling subsystem demonstration is to be completed by mid-1982 and the technology then transferred to industry.

Bibliography Reference Number: 29

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Advanced Systems

CONTRACTOR/ADDRESS	TITLE
Industrial Research Institute Research Corporation 7800 Bonhomme Avenue St. Louis, Missouri 63105	Survey of Industrial Input to R&D Planning for Use of High-Temperature Solar Energy in Chemicals and Fuels Processing
	CONTRACT NO. JPL Subcontract No. 955186
PRINCIPAL INVESTIGATOR Name: Howard K. Nason	PERIOD OF PERFORMANCE August 1978 to May 1979
WORK LOCATION St. Louis, Missouri	FISCAL YEAR 1978 FUNDING $24,371
CONTRACTING OFFICE Jet Propulsion Laboratory Pasadena, California	CUMULATIVE FUNDING $24,371

PROJECT SUMMARY

Objective

To establish the potential for a research and development program which will enable the formation of collaborative and communicative ties between DOE and industrial organizations.

Approach

Collect, assess, and interpret the facts and opinions obtained through a survey of chemical and fuel industry leaders. This survey will address energy costs, the adaptability of various processes to alternate energy, and possibilities for industry participation.

Status

Contract entered into on August 10, 1978.

Future Effort

Future efforts are undetermined at present.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Advanced Systems

CONTRACTOR/ADDRESS	TITLE
Oak Ridge National Laboratory (ORNL) P.O. Box X Oak Ridge, Tennessee 37830	High-Temperature Solar Heat for Fuels and Chemicals
	CONTRACT NO. W7405-eng-26
PRINCIPAL INVESTIGATOR Name: S.E. Beall, Jr., C.E. Bamberger	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Oak Ridge, Tennessee	FISCAL YEAR 1978 FUNDING $124,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $150,000

PROJECT SUMMARY

Objective

To outline a suggested solar high-temperature fuels and chemicals program with a breakdown of tasks, milestones, and budgets for the 1979-1984 period.

Approach

Determine which high-temperature processes appear most suitable for conversion to solar energy by:

a. Establishing criteria (temperature above 200^0 C, energy consumption above 10^{12} Btu per year, mostly thermal energy, no significant development for commercial operation).

b. Identifying processes which meet the criteria.

c. Analyzing the processes based on solar costs, competing energy costs, retrofit costs, etc.

d. Selecting a few processes which appear most attractive.

e. Identifying institutional problems.

f. Arranging for a technology transfer so that industry will be involved in decision making, as well as in jointly implementing the program.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Advanced Systems

CONTRACTOR/ADDRESS	TITLE
Oak Ridge National Laboratory (ORNL) P.O. Box X Oak Ridge, Tennessee 37830	High-Temperature Solar Heat for Fuels and Chemicals
	CONTRACT NO. W7405-eng-26
PRINCIPAL INVESTIGATOR Name: S.E. Beall, Jr., C.E. Bamberger	PERIOD OF PERFORMANCE October 1, 1977 to September 30, 1978
WORK LOCATION Oak Ridge, Tennessee	FISCAL YEAR 1978 FUNDING $124,000
CONTRACTING OFFICE Oak Ridge Operations Office Oak Ridge, Tennessee	CUMULATIVE FUNDING $150,000

PROJECT SUMMARY (continued)

Status

The results of process selection studies are presently being prepared for publication by ORNL and a subcontractor, the Institute of Gas Technology (IGT). ORNL's effort has identified bulk chemicals which might be suitable for solar heating, and the IGT has identified petro-chemical and feedstock chemical processes which appear attractive.

ORNL has also identified several future processes, including creating hydrogen from water splitting, carbon monoxide from CO_2 dissociation, and nitrogen oxide from nitrogen fixation; all these processes are based on the use of high-temperature solar energy.

Suggestions for a five-year program plan have been completed.

Future Effort

The study and analysis of possible future processes will continue into FY 1980.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Advanced Systems

CONTRACTOR/ADDRESS	TITLE
Lawrence Livermore Laboratory P.O. Box 808 Livermore, California 94550	Solar Coal Gasification
	CONTRACT NO. W-7405-eng-48
PRINCIPAL INVESTIGATOR Name: David W. Gregg	PERIOD OF PERFORMANCE August 1, 1978 to September 30, 1978
WORK LOCATION Livermore, California	FISCAL YEAR 1978 FUNDING $35,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $35,000

PROJECT SUMMARY

Objective

To evaluate the technical and economical feasibility of utilizing solar energy to gasify coal, i.e., to "scope" the feasibility of a solar coal gasification plant and identify critical parameters.

Approach

Explore the feasibility of utilizing a solar central receiver plant for gasifying coal with the intention of (1) merging as much as possible the solar central receiver plant technology, being developed by DOE/Division of Central Solar Technology, with the coal gasification technology, being developed by DOE/Division of Fossil Energy, and (2) identifying where new technology will be needed.

Status

It has been determined that:

a. The estimated cost range of product gas from a solar Coal Gasification Plant brackets the estimated gas costs for alternate surface coal gasification plants being developed by DOE. Thus, solar coal gasification is potentially an economical process.

b. A solar coal gasification plant will produce 20 percent to 40 percent more gas per ton of coal than alternate coal gasification plant designs.

Work has been initiated to identify basic plant design concepts and thus establish what existing and what new technology will be needed.

Future Effort

None.

ADVANCED THERMAL TECHNOLOGY
Technology Assessment
Project Summaries

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Technology Assessment

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute (SERI) 1536 Cole Boulevard Golden, Colorado 80401	Solar Thermal Test Facilities Users Association
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: C.J. Bishop	PERIOD OF PERFORMANCE June 27, 1977 to April 30, 1979
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $79,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $267,600

PROJECT SUMMARY

Objective

a. To provide liaison (1) among experimenters, solar thermal test facility operators, and DOE and (2) in facilitating the use of the Government-owned facilities by outside experimenters.

b. To act as the point of contact for users of solar thermal test facilities (STTF's) and as a primary access link between users and operators of STTF's.

c. To solicit and review proposals for experiments to be performed on the STTF's, and make recommendations regarding utilization of STTF's.

d. To provide funding for STTF users, subject to DOE program approval and funding availability.

e. To disseminate STTF and experiment information on a regular basis.

Approach

The Solar Thermal Test Facilities Users Association (STTFUA), funded and managed by SERI, sponsors workshops and conferences, makes presentations at various professional societies regarding the STTFUA and test facilities, solicits and reviews proposals for experiments to perform on the facilities, and funds (directly or through SERI) selected experiments.

Status

In FY 1978 the STTFUA accomplished the following:

a. Established an office in Albuquerque, New Mexico.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Technology Assessment

CONTRACTOR/ADDRESS	TITLE
Solar Energy Research Institute (SERI) 1536 Cole Boulevard Golden, Colorado 80401	Solar Thermal Test Facilities Users Association
	CONTRACT NO. EG-77-C-01-4042
PRINCIPAL INVESTIGATOR Name: C.J. Bishop	PERIOD OF PERFORMANCE June 27, 1977 to April 30, 1979
WORK LOCATION Golden, Colorado	FISCAL YEAR 1978 FUNDING $79,000
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $267,600

PROJECT SUMMARY (continued)

b. Held two workshops on the subject of high-temperature chemistry and high-temperature processing.

c. Held the First Annual Association meeting which addressed facility status and proposed experiments.

d. Issued five subcontracts for experiments related to STTF utilization.

Future Effort

Dissemination of STTFUA and test facility information will continue and additional (10-20) subcontracts for experiments will be issued.

Bibliography Reference Number: 30

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Technology Assessment

CONTRACTOR/ADDRESS	TITLE
Georgia Institute of Technology Engineering Experiment Station Atlanta, Georgia 30332	DOE-Advanced Components Test Facility
	CONTRACT NO. EY-76-C-05-5018
PRINCIPAL INVESTIGATOR Name: Nick Poulos	PERIOD OF PERFORMANCE January 1976 to September 1978
WORK LOCATION Atlanta, Georgia	FISCAL YEAR 1978 FUNDING $812,000
CONTRACTING OFFICE Oak Ridge National Laboratory Oak Ridge, Tennessee	CUMULATIVE FUNDING $1,340,000

PROJECT SUMMARY

Objective

The initial objective of this contract was to transfer solar thermal/steam technology to the U.S. by building a 400 kWt Francia-type plant. Presently, the objective is to support the DOE Solar Thermal Advanced Components Test Facility (ACTF) research and development effort.

Approach

Convert the present one-of-a-kind solar steam plant to a general purpose, flexible facility through the upgrading and extension of the facility capabilities to enable testing of a variety of advanced components.

Status

The initial conversion of the facility into the ACTF is complete. Integration for the first "outside" test article, Sanders Receiver, is underway.

Future Effort

The enhancement of the facility capabilities in such areas as data retrieval and reduction and in minor field tracking modifications is to continue.

Bibliography Reference Number: 31

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Technology Assessment

CONTRACTOR/ADDRESS	TITLE
New England Center for Continuing Education Durham, New Hampshire 03824 and The AETA Corporation 117 Silver Street Dover, New Hampshire 03820	International Market Potential for Small Solar Thermal Systems
	CONTRACT NO. ET78X01-4307
PRINCIPAL INVESTIGATOR Name: Fred K. Manasse	PERIOD OF PERFORMANCE May 22, 1978 to August 10, 1978
WORK LOCATION Dover, New Hampshire	FISCAL YEAR 1978 FUNDING $9,990
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $9,990

PROJECT SUMMARY

Objective

a. To develop a preliminary analysis of the international market potential for small solar thermal electric generators.

b. To identify the existence and nature of such markets and to recommend suitable approaches for U.S. manufacturers to reach them.

c. To evaluate techniques and product types suitable for deployment to the less developed country market.

Approach

a. Conduct preliminary but extensive literature search and discussions with AETA consultants.

b. Attend U.S.-based solar conferences and workshops involving extensive international participation, such as those organized by the Solar Thermal Test Facility Users Association, Solar Energy Research Institute (SERI), International Solar Energy Society, DOE, and most specifically those at the University of New Hampshire New England Center for Continuing Education.

c. Assess European sales efforts in Asian, African, and Latin American countries to identify thrusts and to learn from their experience.

d. Make a comparison with competing conventional technologies, such as photovoltaics.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Technology Assessment

CONTRACTOR/ADDRESS	TITLE
New England Center for Continuing Education Durham, New Hampshire 03824 and The AETA Corporation 117 Silver Street Dover, New Hampshire 03820	International Market Potential for Small Solar Thermal Systems
	CONTRACT NO. ET78X01-4307
PRINCIPAL INVESTIGATOR Name: Fred K. Manasse	PERIOD OF PERFORMANCE May 22, 1978 to August 10, 1978
WORK LOCATION Dover, New Hampshire	FISCAL YEAR 1978 FUNDING $9,990
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $9,990

PROJECT SUMMARY (continued)

Status

a. The literature search and summary evaluation have been completed.

b. Attendance at four meetings and discussions with consultants have taken place.

c. Telephone contacts with several foreign manufacturers have been initiated.

d. Visits to the Jet Propulsion Laboratory, SERI, Agency for International Development, and two U.S. companies currently involved in solar thermal electric product development have been made.

e. Diesel and photovoltaic generation costs have been compared using a net present value accounting approach to equivalent sizes for potentially available solar thermal generators (for two representative manufacturers).

f. A final report is in preparation.

Future Effort

None.

ELEMENT: Advanced Thermal Technology

SUB-ELEMENT: Technology Assessment

CONTRACTOR/ADDRESS	TITLE
OAO Corporation 50/50 Powder Mill Road Beltsville, Maryland 20705	Review and Analysis of Solar Thermal Component and Subsystems Technology
	CONTRACT NO. ET-78-C-01-2889
PRINCIPAL INVESTIGATOR Name: Stanley W. Hodges	PERIOD OF PERFORMANCE March 6, 1978 to September 30, 1978
WORK LOCATION Washington, D.C.	FISCAL YEAR 1978 FUNDING $47,827
CONTRACTING OFFICE DOE Headquarters Washington, D.C.	CUMULATIVE FUNDING $47,827

PROJECT SUMMARY

Objective

To perform review and analysis of solar thermal component and subsystem technology with the goals of establishing the state-of-the-art, defining areas requiring new or additional research and development (R&D), providing overviews of current R&D activities and enhancing technical communication throughout the solar thermal power (STP) community.

Approach

a. Identify a full set of required data elements.

b. Develop optimum format for reporters and users of data.

c. Test the reporting and use of the technology monitoring system.

d. Implement system. (Objectives will be satisfied from data base obviating visits to sites of development work.)

Status

a. Data elements have been identified and format has been adopted.

b. Testing of the initial technology monitoring system has been initiated.

Future Effort

The technology monitoring system will be modified as applicable following testing; these modifications will be implemented throughout the STP community. As the system develops, topical reports will be prepared as directed by the DOE Headquarters Program Manager.

Bibliography

This bibliography lists reports and papers which have resulted from or are related to research projects described in this Program Summary.

Most of the technical journals/publications containing listed papers can be obtained through technical libraries. Unless otherwise specified, most of the reports can be obtained from:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, Virginia 22161
(703) 557-4650

The NTIS is required by its enabling legislation to recover the costs incurred for printing and distributing copies of reports to the public. To comply with this legislation, NTIS imposes a cost for each service provided.

The following methods of payment may be used:

- Enclose a personal check or money order with the written request.
- Charge the order to an American Express Card by calling the above phone number or writing to NTIS at the above address, providing the American Express Card number, the cardholder's name, and the expiration data.
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National Technical Information Service
425 13th Street, N.W., Room 620
Washington, D.C. 20230

The materials will be ready for pick-up approximately two weeks after the order was placed and must be paid for either by check, money order, or American Express Card. One day pick-up rush service can be obtained for an extra cost of $6.00 per volume or book.

- Establish an NTIS deposit account. Information can be obtained directly from NTIS at the Springfield, Virginia address.

For further information contact:

DOE's Solar Thermal Power Systems Branch
Division of Central Solar Technology
600 E. Street, N.W.
Washington, D.C. 20545
(202) 376-9134

1. The project related to these publications is described on pages 49-50.

"Evaluation of Portable Optical Property Measurement Equipment for Solar Selective Services"
Author: R.B. Pettit
ASME Publication No.: 77-WA/SOL-1
Date: August 1977

"Solar Energy Research at Sandia Laboratories and Its Effects on Health and Safety"
Author: L.L. Young
Report No.: SAND 77-1412
Date: October 1977

"FY 78 Annual Operating/Management Plan--Solar Total Energy Test Facility Project"
Report No.: SAND 78-0128
Date: January 1978

"Heliostat Dust Buildup and Cleaning Studies"
Author: R.S. Berg
Report No.: SAND 78-0510
Date: March 1978

"Performance Testing of the General Atomic Fixed Mirror Solar Concentrator"
Authors: V.E. Dudley and R.M. Workhaven
Report No.: SAND 78-0624
Date: April 1978

"Solar Total Energy Test Facility Project Test Summary Report: Rankine Cycle Energy Conversion Subsystem"
Author: J.P. Abbin
Report No.: SAND 78-0396
Date: April 1978

"Performance Testing of the Hexcel Parabolic Trough Solar Collector"
Authors: V.E. Dudley and R.M. Workhaven
Report No.: SAND 78-0381
Date: March 1978

"Solar Total Energy Test Facility Project Test Results: High Temperature Thermocline Storage Subsystem"
Authors: T.D. Harrison, C.E. Hickox, A. Ortega, and K. Wally
Report No.: SAND 77-1528
Date: April 1978

"Solar Total Energy Project Semiannual Report"
Authors: H.J. Gerwin and G. Kinoshita
Report No.: SAND 78-0109
Date: April 1978

"Thermal Aging of Electrodeposited Black Chrome"
Authors: R.R. Sowell and R.B. Pettit
Report No.: SAND 78-0554
Date: April 1978

"Sensitivity of Slope Measurement on Parabolic Solar Mirrors to Positioning and Alignment of the Laser Scanner"
Author: L. Orear
Report No.: SAND 78-0700
Date: May 1978

"Summary Report: Concentrating Solar Collector Test Results--Collector Module Test Facility"
Authors: V.E. Dudley and R.M. Workhaven
Report No.: SAND 78-0815
Date: May 1978

"Linear Concentrating Solar Collectors--Current Technology and Applications"
Author: J.A. Leonard
Report No.: SAND 78-0949c
Date: June 14-15, 1978

"Operating Experience at the DOE/Sandia Mid-temperature Solar Systems Test Facility"
Author: J.A. Leonard
Report No.: SAND 78-0820c
Date: August 20-24, 1978

"Sandia Solar Total Energy Test Facility Project, Final Report, Suntec 260 Square Meter SLATS Subsystem"
Author: S.N. Zender
Report No.: SER 1022-60
Date: December 1977

2. The project related to these publications is described on pages 59-60.

"Preliminary Modeling and Collector Sizing Analysis" (12 pages)
Author: R.J. Waldron, Jr.
Report No.: ATR-78 (7733)-1
Date: April 5, 1978

"An Assessment of the Accuracy of Energy Load Measurements at Fort Hood--Draft Topical Report" (7 pages)
Author: D.H. Ross
Report No.: ATR-78 (7743)-1
Date: July 1978

3. The project related to these publications is described on pages 63-64.

"Solar Total Energy--Large Scale Experiment--Shenandoah, Georgia Site, Annual Report" (277 pages)
Author: E.J. Ney
Reoprt No.: ALO/3394-77/3
Date: June 1978

"A Case Study of Shenandoah Energy Conservation Features in Connection with Solar Total Energy--Large Scale Experiment" (27 pages)
Author: R. Bruce Hammock
Report No.: ALO/3994-78/1
Date: March 1978

4. The project related to these publications is described on pages 67-68.

"Model for Comparing Cost of Flat-Array and Concentrator Photovoltiac Solar-Cell Systems"
Author: A.S. Roy
Publication: Conference Record of 13th IEEE Photovoltaic Specialists Conference
Date: June 5-8, 1978
Available from: Institute of Electrical and Electronic Engineers 345 E. 47th St., New York, N.Y. 10017

"Analysis of Performance Capabilities of Redox Flow Storage Batteries"
Authors: A.S. Roy and S.I. Kaplan
Publication: Proceedings of the 1978 Annual Meeting, American Section of the International Solar Energy Society
Date: August 28-31, 1978
Available from: American Section of ISES, Inc., PO Box 1416, Killeen, TX 76541

5. The project related to this publication is described on pages 69-70.

"Total Energy Solar Photovoltaic Conversion System for Mississippi County Community College--Technical Progress Report" (63 pages)
Author: H.V. Smith
Date: March 31, 1978
Available from: Solar Thermal Power Systems Branch, DOE

6. The project related to these publications is described on pages 71-72.

"Final Report on Phase II Conceptual Design of Solar Total Energy--Large Scale Experiment (622 pages)
Author: General Electric Space Division
SD Document No.: 78SDS4200
Date: January 12, 1978

"Preliminary Design of the Solar Total Energy--Large Scale Experiment at Shenandoah, Georgia"
Author: A.J. Poche, R.W. Hunke, and S.A. Haas
Publication: Proceedings of the 1978 Intersociety Energy Conversion Engineering Conference
Paper No.: 789183
Date: August 20-25, 1978
Available from: Society of Automotive Engineers

"Final Report on Phase III Preliminary Design of the Solar Total Energy--Large Scale Experiment"
Author: General Electric Space Division
Date: October 1978

7. The project related to these publications is described on page 75.

"Commercial Applications of Solar Total Energy Systems--Final Report" (Volumes I-IV, 598 pages)
Authors: M.G. Boobar, B.L. McFarland, S.J. Nalbandian, W.W. Wilcox, E.P. French, and K.E. Smith
Date: September 1978

"Manual for the Solar Total Energy System Evaluation Program" (174 pages)
Author: B.L. McFarland
Date: September 1978

"Deterministic Insolation Model--Program Description and User's Guide (53 pages)

Author: E.P. French
Date: September 1978

"Commercial Applications of Solar Total Energy Systems"
Authors: M.G. Boobar, B.L. McFarland, S.J. Nalbandian, and K.E. Smith
Publication: Proceedings of the 12th Intersociety Energy Conference, pages 1693-99
Date: August 28 to september 2, 1977

"Deterministic Insolation Estimates of Solar Total Energy Systems"
Author: E.P. French
Publication: Proceedings of the 12th Intersociety Energy Conference, pages 1231-37
Date: August 28 to September 2, 1977

8. The project related to these publications is described on page 91.

"Crosbyton Solar Power Project Phase I--Interim Technical Report" (Vol. 1-3, 934 pages)
Authors: J.D. Reichert, J.D. Liberty, et al.
Report No.: CSP-TR-1
Date: February 1977

"Crosbyton Solar Power Project Phase I--Interim Technical Report" (Vol. 4-5, 615 pages)
Authors: J.D. Reichert, H.J. Carper, et al.
Report No.: CSP-TR-2
Date: February 1978

"A Strategy for Calculation of Optical Concentration Distributions for Fixed Mirror Systems"
Author: J.D. Reichert
Publication: Proceedings of the ERDA Solar Workshops on Methods for Optical Analysis of Central Receiver Systems, pages 155-174
Date: August 10-11, 1977

"The Crosbyton Solar Power Project: Fixed Spherical Mirror/Tracking Receiver"
Author: J.D. Reichert
Publication: Proceedings of the ERDA Conference on Concentrating Solar Collectors, pages 3/61-3/70
Date: September 26-28, 1977

"Demand Modeling for Municipally Owned Utilities"
Authors: M.L. Smith, S.R. Liberty, and G. Moe
Presented at: The Operations Research Society of America-Annual Meeting
Date: November 1977

"Design Considerations for the Energy Receiver in a Fixed Mirror Distributed Focus Solar Energy System"
Author: L.D. Clements
Presented at: The International Symposium on Alternate Energy Sources
Date: December 5-7, 1977

"Field Evaluation of Solar Mirror Survivability"
Author: R.M. Bethea
Presented at: The SERI Solar Reflector Materials Technology Workshop
Date: March 1978

"Hail Testing of Solar Reflector Panels"
Presented at: The SERI Solar Reflector Materials Technology Workshop
Date: March 1978

"Non-adaptive Optics for Solar Thermal Electric Power"
Author: J.D. Reichert
Presented at: The IEEE Region Five Annual Conference
Date: April 16-18, 1978

9. The project related to this publication is described on pages 95-96.

"Small Power Systems Study, Quarterly Report No. 1" (47 pages)
Authors: J.P. Thornton, C.J. Bishop, K.C. Brown, and A.L. Edgecomb
Report No.: SERI-36
Available from: Solar Energy Research Institute

10. The project related to these publications is described on pages 141-142.

"Pilot Plant Environmental Conditions"
Report No.: ATR-78 (7695-05)-5
Date: May 9, 1978

"Requirements Study for the 10 MW ... Master Control Subsystem"
Report No.: ATR-78 (7695-05)-4
Date: June 1, 1978

"10 MW Solar Thermal Pilot Plant Dynamic Simulation"
Report No.: ATR-78 (7747)-1
Date: August 1, 1978

11. The project related to these publications is described on pages 144-145.

"Central Receiver Solar Thermal Power System, Collector Subsystem, Final Report"
Author: Boeing Engineering and Construction Co.
Report No.: SAN 1111-76-7
Date: August 15, 1977

"Central Receiver Solar Thermal Power System, Collector Subsystem, Pilot Plant Preliminary Design Report" (Vol. 1 and 3)
Author: Boeing Engineering and Construction Co.
Report No.: SAN-1111-8/1 (Vol. 1); SAN-1111-8/2 (Vol. 3)
Date: April 29, 1977

12. The projects related to these publications are described on pages 156-157.

"Solar Central Receiver, Prototype Heliostat, Volume 1, Final Technical Report" (203 pages)
Author: Boeing Engineering and Construction Co.
Report No.: SAN/1604-1
Date: June 30, 1978

"Solar Central Receiver Prototype Heliostat, Volume II, Phase II Program Plan" (30 pages)
Author: Boeing Engineering and Construction Co.
Report No.: SAN/1604-2
Date: June 30, 1978

13. The projects related to this publication are described on pages 159-161.

"Solar Central Receiver Prototype Heliostat, Phase I, Final Technical Report" (425 pages); Appendixes (100 pages)
Author: General Electric, Energy Systems Programs
Report No.: SAN-1468-77-2
Date: September 1978

14. The projects related to these publications are described on pages 162-164.

"Solar Central Receiver Prototype Heliostat CDRL Item B.d, Final Technical Report" Vol. 1 (318 pages); Vol. 2 (260 pages)
Author: McDonnell Douglas Astronautics Co.
Report No.: MDC G 7399
Date: September 1978

"Solar Receiver Prototype Heliostat Task 5, Phase II Plans and Schedules" (approximately 55 pages)
Author: McDonnell Douglas Astronautics Co.
Reoprt No.: MDC G 7399
Date: September 1978

15. The project related to this publication is described on pages 165-167.

"Solar Central Receiver Prototype Heliostat, Phase I, Technical Progress Final Report" (approximately 250 pages)
Author: SOLARAMICS
Date: November 1978

16. The project related to this publication is described on pages 191-192

"SERI Materials Branch Semiannual Report, Janaury 1, 1978 - June 30, 1978" (38 pages)
Author: Solar Energy Research Institute
Report No.: SERI/TR-31-042
Date: August 1978

17. The projects related to this publication are described on pages 191-194.

"Proceedings, DOE/DST Thermal Power Systems Workshop on Selective Absorber Coatings" (477 pages)
Editor: Patrick J. Call
Report No.: SERI/TP-31-061
Date: December 1977

18. The project related to these publications is described on pages 197-198.

"Chemical Vapor Deposition of Refractory Metal Reflectors for Spectrally Selective Solar Absorbers" (41 pages)
Authors: D.D. Allred and B.O. Seraphin
Date: July 1978
Available from: Optical Sciences Center, University of Arizona

"Spectrally Selective Surfaces and Their Impact on Photothermal Solar Energy Conversion" (98 pages)
Author: B.O. Seraphin
Date: July 1978
Available from: Optical Sciences Center, University of Arizona

"Passivating CVD Molybdenum Films Against Infrared Reflection Losses Caused by Oxidation"
Authors: G.E. Carver, H.S. Gurev, and B.O. Seraphin
Publication: Solid-State Science and Technology J. of the Electrochem. Soc., Vol. 125, No. 7, pp. 1138-1141
Date: July 1978

"Optical Performance of Absorber-Reflector Combinations for Photothermal Solar Energy Conversion"
Authors: A. Donnadieu and B.O. Seraphin
Publication: Journal of the Optical Society of America, Vol. 68, No. 3, pages 292-297
Date: March 1978

"Chemical Vapor Deposition of Refractory Metal Reflectors for Spectrally Selective Solar Absorbers" (31 pages)
Authors: H.S. Gurev and B.O. Seraphin
Date: June 1977
Available from: Optical Sciences Center, University of Arizona

"Thin Film Reflectors of Improved Thermal Stability"
Authors: H.S. Gurev and B.O. Seraphin
Publication: Proceedings, High Power Laser Optical Components and Component Materials Meeting, pages 1-15
Date: October 1977

"High Temperature Spectrally Selective Coatings Fabricated by Chemical Vapor Deposition"
Author: B.O. Seraphin
Publication: Proceedings of the 23rd National SAMPE Symposium, pages 1-2
Date: May 1978

19. The project related to this publication is described on pages 199-200.

"Structural Composition and Optical Properties of Solar Blacks: Gold Black"
Authors: P. O'Neill, C. Doland, and A. Ignatieo
Publication: Applied Optics (Optical Society of America), Vol. 16, No. 11, pages 2822-2826
Date: November 1977

20. The project related to these publications is described on pages 201-202.

"Composition Variations as a Function of Ejection Angle in Sputtering of Alloys"
Authors: R.R. Olson and G.K. Wehner
Publication: Journal of Vacuum Science Technology (American Vacuum Society), Vol. 14, No. 1, Pages 319-321
Date: January/February 1977

"Composition-vs-Depth Profiles Obtained with Auger Electron Spectroscopy of Air-Oxidized Stainless-Steel Surfaces"
Authors: G. Betz, G.K. Wehner, L. Toth and A. Joshi
Publication: Journal of Applied Physics (American Institute of Physics), Vol. 45, No. 12, pages 5312-5316
Date: December 1974.

"Isotope Enrichment in Sputter Deposits"
Author: G.K. Wehner
Publication: Applied Physics Letters (American Institute of Physics), Vol. 30, No. 4, pages 185-187
Date: February 1977

"Composition Profiling of Solar Coating Materials" (35 pages)
Author: G.K. Wehner
Report No.: COO-2953-2
Date: October 1977

21. The project related to these publications is described on page 203.

"Optical Properties of Small Particle Composition: Theories and Applications" (20 pages)
Authors: W. Lamb, D.M. Wood, and N.W. Ashcroft
Report No.: MSC 2895
Date: September 1977

Available from: Materials Science Center, Cornell University

"Effective Medium Theory of Optical Properties of Small Particle Composites"
Authors: D.M. Wood and N.W. Ashcroft
Publications: Philosophical Magazine, Vol. 35, No. 2, pages 269-280
Date: 1977

"Far-Infrared Absorption in Ultrafine Al Particles"
Authors: C.G. Granquist, R.A. Buhrman, J. Wyns, and A.J. Sievers
Publication: Physical Review Letters, Vol. 27, No. 10, pages 625-629.

22. The project related to these publications is described on pages 208-209.

"Solar Spectral Irradiance at Ground Level"
Authors: A.T. Mecherkinnel and J.C. Richmond
Publication: Proceedings of the I.E.S. Solar Seminar on Testing Solar Energy Materials and Systems
Date: May 23-25, 1978

"Measurment of Thermal Radiation Properties of Materials"
Author: J.C. Richmond
Presented at: The 6th European Conference on Thermophysical Properties, Dubrovnik, Yugoslavia, June 29, 1978.
Publication: NBS Technical Note
Available from: National Bureau of Standards, Gaithersburg, MD

"Optical Measurements of Selective Solar Absorber Coatings"
Author: J.C. Richmond
Publication: Proceedings of DOE/DST Thermal Power Systems Workshop on Selective Absorber Coatings
Date: December 6-8, 1977

"Evaluation of Solar Absorptance"
Publication: Proceedings of DOE/DST Thermal Power Systems Workshop on Selective Absorber Coatings
Date: December 6-8, 1977

23. The project related to these publications is described on pages 210-211.

"Specularity Measurement by Fourier Transform Examination"
Authors: H.L. Hampton, J.S. Hartman, and M.A. Lind
Publication: Proceedings of the I.E.S. Solar Seminar on Testing Solar Energy Materials and Systems
Date: May 23-25, 2978

"Specularity Measurements for Solar Materials"
Authors: M.S. Lind, J.S. Hartman, and H.L. Hampton
Publication: Proceedings of the Society of Photo-Optical Engineers, Optics Applied to Solar Energy, IV, Vol. 161
Date: August 28-31, 1978

24. The project related to these publications is described on pages 214-215.

"Circumsolar Radiation Data for Central Receiver Simulation"
Publication: Proceedings of the ERDA Solar Workshop on Methods for Optical Analysis of Central Receiver Systems
Date: August 1977

"Measurement of Circumsolar Radiation" (Energy and Environment Division Annual Report, 1977, Lawrence Berkeley Laboratory)
Authors: D.F. Grether, A.J. Hunt, and M. Wahlig
Report No.: LBL-6877

"The Circumsolar Measurement Program: Assessment of the Effects of Atmospheric Scattering on Solar Energy Conversion"
Authors: A.J. Hunt, D.F. Grether, and M. Wahlig
Presented at: The 4th Joint conference on Sensing of Environmental Pollutants
Date: November 1977

"Circumsolar Radiation: Monthly Summaries of the Effect on Focusing Solar Energy Collection Systems"
"Circumsolar Radiation: Sensitivity Analysis for Central Receiver Designs"
"Circumsolar Radiation: Correlations with Solar Radiation"
Authors: D.F. Grether, A.J. Hunt, and M. Wahlig
Date: October 1977

25. The project related to this publication is described on pages 216-217.

"The Effects of Circumsolar Radiation on the Linear Receivers: Preliminary Analysis" (Draft, 25 pages)
Author: Thermal Conversion Branch, Solar Energy Research Institute
Date: June 15, 1978

26. The project related to this publication is described on page 222.

"Wind Effects on Solar Tower Generators, Subtask A: Assessment of Tornado and Straight Wind Risks at Daggett, California" (40 pages)
Author: J.R. McDonald
Date: February 1978
Available from: Institute for Disaster Research, Texas Technical University

27. The project related to these publications is described on pages 228-229. Limited copies of the listed reports are available at no cost from: Energy Systems Group, Rockwell International, 8900 DeSoto Ave., Canoga Park, CA 91304.

"Safety Analysis Report for Characterization of Released Airborne Particles" (31 pages)
Authors: R. Dickson, R.P. Johnson, and C.J. Nelson
Date: April 13, 1978

"Test Plan for Subtask M Characterization of Released Sodium Oxide Aerosols" (30 pages)
Authors: R.P. Johnson and C.J. Nelson
Report No.: N707TP130021
Date: July 13, 1977

"Test Procedure for the Characterization of Released Airborne Particles" (24 pages)
Authors: R.P. Johnson and C.J. Nelson
Report No.: N707DTP130010
Date: April 21, 1978

"Characterization of Sodium Oxide Aerosols Released in a Natural Environment" (Quarterly Progress Report for Period April-June 1978)

"Summary of Characterization of Released Airborne Particle Tests Conducted at INEL" (19 pages)
Author: R.P. Johnson
Report No.: N707TI130053
Date: August 10, 1978

28. The project related to these publications is described on pages 241-242. Both reports are available from the Dynatherm Corporation.

"Semi-annual Progress Report for Heat Pipe Central Solar Receiver" (112 pages)
Authors: W.B. Bienert and D.A. Wolf
Report No.: DTM-76-7
Date: November 1976

"Semi-annual Progress Report for Heat Pipe Central Solar Receiver" (48 pages)
Authors: W.B. Bienert and D.A. Wolf
Report No.: DTM-77-5
Date: September 1977

29. The project related to these publications is described on pages 245-246. These reports are available from the Jet Propulsion Laboratory.

"Siting Issues for Solar Thermal Power Plants with Small Community Applications"
Authors: H.J. Holbeck and S.J. Ireland
Report No.: 78-75
Date: July 20, 1978

Projection of Distributed-Collector Solar-Thermal Electric Power Plant Economics to Years 1990-2000"
Authors: T. Fujita, N. El Gabalawi, G. Herrera, and R.H. Turner
Report No.: 77-79
Date: December 1977

"Thermal Power Systems Research and Development Project, Advanced Technology Development" (Semi-annual Progress Report)
Report No.: 5102-67
Date: June 1978

30. The project related to this publication is described on pages 253-254.

"Proceedings of the Facility Operators/High Temperature Sciences Workshop" (125 pages)
Date: November 28-30, 1977

31. The project related to this publication is described on page 255.

"User's Manual Management Plan for U.S. DOE Advanced Component Test Facility"
Date: April 1978

32. The project related to this publication is described on pages 83-84.

"First Interim Report: Private and Federal Innovation, Working Papers"
Author: Resource Planning Associates
Date: June 12, 1978

33. The project related to these publications is described on pages 117-118.

"Engine with No Moving Parts"
Publication: Chemtech
Date: January 1975

"A New Steam Engine Cycle"
Publication: Proceedings of the 9th Intersociety Energy Conversion Engineering Conference (IECEC)
Date: August 1974

"A Progress Report on the Water Pulsejet"
Publication: Proceedings of the 10th Intersociety Energy Conversion Engineering Conference (IECEC)
Date: August 1975

"Intermittent Propulsors - An Overview"
Publication: Proceedings of the Winter Meeting of the ASME
Date: December 1976

"Recent Developments with the Water Pulsejet"
Publication: Proceedings of the 13th Intersociety Energy Conversion Engineering Conference (IECEC)
Date: August 1978

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*U.S. GOVERNMENT PRINTING OFFICE : 1979 O-287-366/6033