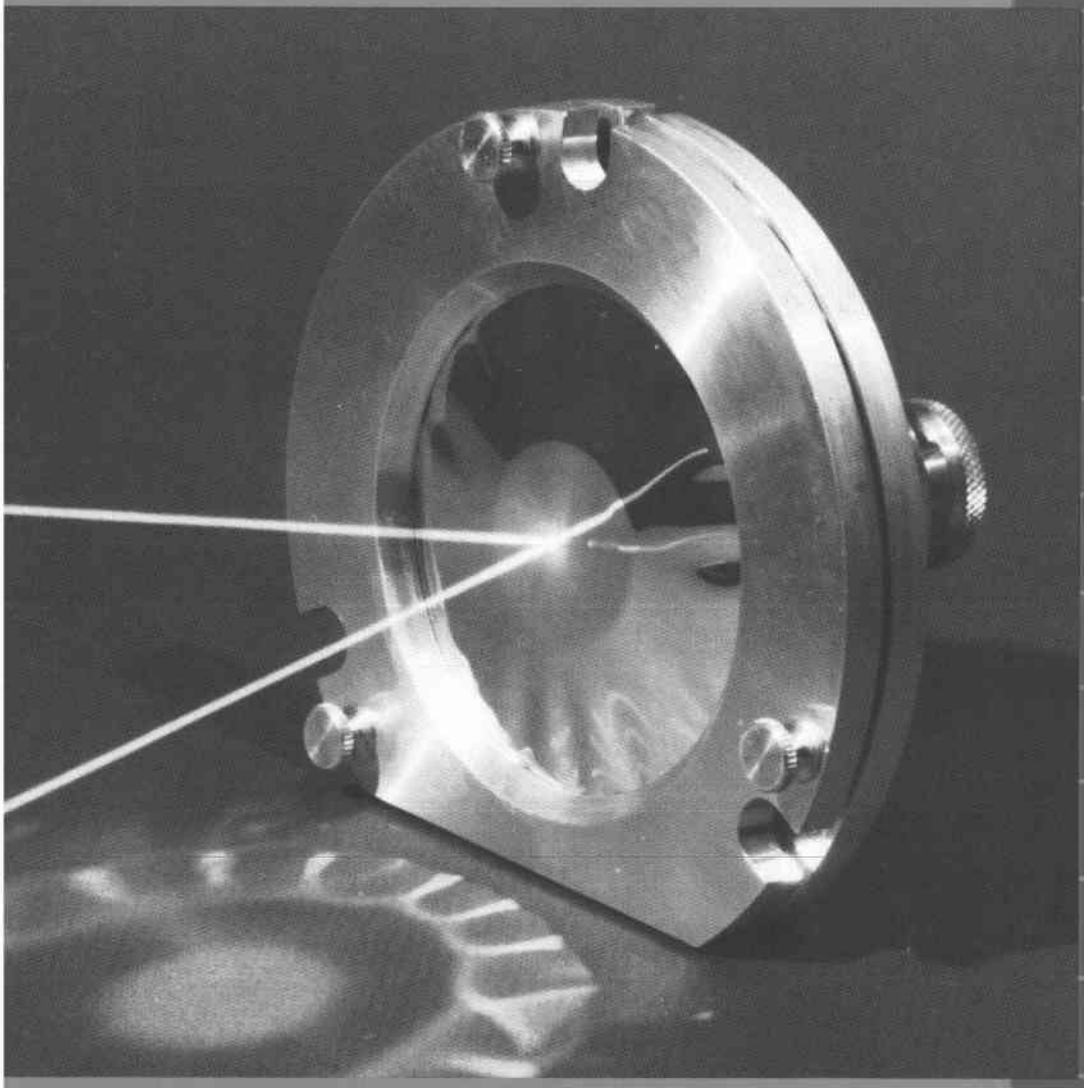
DOE/CH 10093-46



U.S. Department of Energy

Programs in Renewable Energy

Solar Thermal Program Summary

Volume II: Research Summaries

Fiscal Year 1988

On the cover: ECP 300 film under evaluation for its specular reflectance.

The *Solar Thermal Program Summary for Fiscal Year 1988* is a two-volume reference set describing the technological advances and future research and development (R&D) direction of the Solar Thermal Technology Program.

Volume I contains capsule descriptions of the various activities undertaken in the year, a brief history of the program, and the significant accomplishments realized. It also describes the management framework for the program and sets forth the FY 1988 budget. Volume II consists mainly of a compilation of detailed descriptions of the various R&D activities performed by the national laboratories and their subcontractors from industry, academia, and nonprofit research institutions. It also contains a bibliography of the various publications produced under the program in recent years.

This publication is one of a series of documents on the renewable energy program sponsored by the U.S. Department of Energy. Companion overview and research summaries include the following:

FY 1988 Program Summaries:

Energy Storage and Distribution
Solar Buildings
Biofuels
Geothermal Energy
Photovoltaic Energy
Wind Energy
Ocean Energy

Copies of these documents may be obtained by writing:

Solar Energy Research Institute
Technical Inquiry Service
1617 Cole Boulevard
Golden, Colorado 80401-3393

DOE/CH10093-46
UC Category: 234
DE89000861

Solar Thermal Program Summary

Volume II: Research Summaries Fiscal Year 1988

U.S. Department of Energy

Programs in Renewable Energy

May 1989

Contents

Introduction

The Federal Government has conducted the national Solar Thermal Technology Program since 1975. Its purpose is to provide focus, direction, and funding for the development of solar thermal technology as an energy option for the United States.

More than a decade of research and development has brought solar thermal systems to a point where they have proven useful for generating electricity and process heat. Improvements to these during the 1980s led to reductions in capital and energy costs of 80%. Parabolic trough systems are now considered technically mature and are being used in the world's largest solar electric systems, generating electricity for as low as 12¢/kWh. Central receiver and dish technologies have also been demonstrated in several plants throughout the world. The cost of concentrators, the largest cost component of solar thermal systems, has dropped from \$900–\$1300/m^2 in 1978 to \$100–\$160/m^2 today, while performance has improved significantly. Solar thermal technology has also shown strong potential for advanced applications, such as destroying hazardous wastes and processing materials and chemicals.

This annual summary provides an overview of the government-funded activities within the national Solar Thermal Technology Program. Tasks conducted in house by the participating national laboratories or under contract to industry and academic and other research institutions are highlighted. This document covers those activities initiated, renewed, or completed during FY 1988 (October 1, 1987, through September 30, 1988).

The summary is divided into two major sections. The first section includes the individual project descriptions for each activity grouped by directing organization. The second section provides a list of publications also grouped by directing organization. This list contains more complete bibliographic information than the individual contract descriptions.

For additional information on the national Solar Thermal Technology Program, refer to the *Solar Thermal Program Summary, Fiscal Year 1988, Volume I: Overview; The National Solar Thermal Technology Program Five-Year Research and Development Plan, 1986–1990; and Bringing Solar Thermal Technology to the Marketplace: A Report to the U.S. Congress.*

The first document summarizes this publication and provides further information on selected achievements during the past fiscal year as well as a breakdown of FY 1988 funding. The second document gives an overview of the program's history, framework, technical management plans, and goals. The last of these documents describes the significant progress already made in bringing solar thermal energy systems to the marketplace and the prospects for continued market development in the private sector. All three documents are available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Va. 22161.

Organizational Relationships

The federal Solar Thermal Technology Program is conducted by the U.S. Department of Energy and is organizationally assigned to the assistant secretary for conservation and renewable energy. Day-to-day research activities are managed by the Solar Energy Research Institute in Golden, Colo., and Sandia National Laboratories in Albuquerque, N.M.

FY 1988 Contract Descriptions

Solar Energy Research Institute

Optical Materials

Project/Area/Task:
Collection Technology

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: D.M. Blake

Telephone: (303) 231-1202

Contractor:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Principal Investigator: D.M. Blake

Telephone: (303) 231-1202

Contract Number: DE-ACO2-83CH10093

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$1,240,000	DOE
FY 1987	$1,247,000	DOE
FY 1988	$1,075,000	DOE

Objective:

To obtain silver/polymer reflecting surfaces for the silver ultralight polymer reflector (SUPR) films that meet long-term durability goals (while maintaining high-specularity performance requirements) and that operate satisfactorily in the solar environment.

Approach/Background:

Identify the causes of corrosion of the silver layer and take steps to prevent the corrosion, minimize the accumulation of soil on the surface of the reflective film, and improve the cleanability and resistance to abrasion for the film surface in normal use. Evaluate films made at SERI and the 3M Company in an outdoor environment and at SERI.

Status/FY 1988 Accomplishments:

Identified ultraviolet radiation and temperature as important factors in the corrosion of the silver. Identified sulfur-containing antioxidants added to the ECP-300 film during processing as possible contributors to the corrosion process. Conducted accelerated weathering tests at SERI that showed an improved lifetime of the silvered, sulfur-free film.

Tested cleaning methods at an outdoor site and in an accelerated laboratory procedure. Treated samples of SUPR with a hard coating and an outer layer of a fluorosilane, which showed improved soil resistance and cleanability when compared with untreated material. Langmuir-Blodgett films with fluorinated end groups applied to the SUPR film showed very good performance.

Major Project Reports:

- Gomez, P.M., and H.H. Neidlinger, 1987, "Incorporation of Ultraviolet Stabilizers into Acrylics Prepared by Group Transfer Polymerization," *Abstracts of Papers: 193rd ACS National Meeting; American Chemical Society*, Denver, Colo., April 5-10, 1987, Washington, DC: American Chemical Society, POLY 128.
- Neidlinger, H., and P. Schissel, Sept. 1987, "Polymers in Solar Technologies," *Adhesives, Sealants, and Coatings for Space and Harsh Environments*, New York: Plenum Press; also SERI/TP-255-3205, Golden, CO: Solar Energy Research Institute, 18 pp. Available NTIS: Order No. DE88001102.
- Schissel, P.O., and H.H. Neidlinger, Sept. 1987, *Polymer Reflectors Research During FY 1986*, SERI/PR-255-3057, Golden, CO: Solar Energy Research Institute, 133 pp. Available NTIS: Order No. DE88001101.

Summary Date: October 1988

Concentrators

Project/Area/Task:
Collection Technology

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: A. Lewandowski

Telephone: (303) 231-1972

Contractor:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Principal Investigator: A. Lewandowski

Telephone: (303) 231-1972

Contract Number: DE-ACO2-83CH10093

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$500,000	DOE
FY 1987	$611,000	DOE
FY 1988	$850,000	DOE

Objective:

To establish the technical feasibility and cost potential of the membrane dish concentrator concept compared with current concepts for glass and metal dishes.

Approach/Background:

Optical Analysis. Analyze the optical response of various stretched membrane dish configurations, evaluate the optical performance of a prototype dish, and provide technical support to the ongoing development of the membrane dish program.

Structural Analysis. Analyze the coupled optical/structural response of stretched membrane dish concentrators, build small prototypes to test materials and fabrication options, and provide technical support to the ongoing development in the membrane dish program.

Status/FY 1988 Accomplishments:

Developed the Scanning Hartmann Optical Testor (SHOT), which uses a laser beam to scan various points on the subject dish while researchers view and track the position of the return beam on a target using the spot-tracking system. SHOT has significant advantages over existing methods in terms of accuracy, dish size, f/D capabilities, and portability. Tested composite membrane dishes. Completed analytical tools to predict the response of nonaxisymmetric membrane dishes and developed the tools into useful computer codes. Developed a methodology for using the analysis of membranes interactively with linear, personal-computer-based finite-element codes. Developed an integrated computer code for nonaxisymmetric membrane analysis and optical-thermal performance of the resulting membrane shape.

Conducted structural analysis of the central-post, cable-supported membrane dishes. Evaluated membrane material samples using the large-aperture, near-specular imaging reflectometer. Completed an analysis of thermal expansion and contraction effects on membrane dish performance for several different membrane materials with a carbon steel ring. Completed an analysis of the potential for stabilization pressure adjustments to compensate for creep in membrane materials. Used structural and optical models to assess the effects of stabilization pressure, changes in wind pressure, and thermal expansion on membrane dish performance.

Major Project Reports:

- Lewandowski, A.A., and J.J. O'Gallagher, 1988, "Performance Sensitivities for Point-Focus Dish Systems with Secondary Concentrators," prepared for the Annual Meeting of ASES, 20-14 June 1988, Cambridge, Mass.; also SERI/TP-253-3324, Golden, CO: Solar Energy Research Institute, 6 pp. Available NTIS: Order No. DE88001152.

- Peterka, J., A. Tan, B. Bienkiewicz, and J. Cermak, Sept. 1987, *Mean and Peak Wind Load Reduction on Heliostats*, SERI/STR-253-3212, Golden, CO: Solar Energy Research Institute. Available NTIS: Order No. DE87012281.
- Wendelin, T.J., and A. Lewandowski, 1988, "A Performance Comparison of Multi-Facet and Single-Facet Dishes," *Solar Engineering—1988: Proceedings of the Tenth Annual ASME Solar Energy Conference*, Denver, Colo., April 10-14, 1988, L.M. Murphy and T.R. Mancini, eds., New York: The American Society of Mechanical Engineers, pp. 271-279.

Summary Date: October 1988

Concentrators

Project/Area/Task:
Collection Technology

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: M. Carasso

Telephone: (303) 231-1353

Contractor:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Principal Investigator: M. Carasso

Telephone: (303) 231-1353

Contract Number: DE-AC02-83CH10093

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$960,000	DOE
FY 1987	$1,010,000	DOE
FY 1988	$1,125,000	DOE

Objective:

To advance the state of theoretical and experimental knowledge of the phenomena involved to where the information necessary for designing a direct absorption receiver (DAR), including specifying feasible configurations, working fluids, and operating modes, is sufficient for an experienced designer to define a prototype development receiver.

Approach/Background:

Investigate, experimentally and analytically, many of the remaining issues of heat transfer and fluid dynamics involved in understanding the phenomena of direct absorption of concentrated solar flux in nitrate salt. Conduct experiments to identify a highly effective, chemically inert nonsettling blackener as a dopant with a broad liquid-operating temperature range for high-temperature molten nitrate salt to enhance absorption in the salt.

Status/FY 1988 Accomplishments:

Completed salt flow experiments on a 5-m panel tilted at 15 deg from vertical. Researchers obtained consistent data on salt droplet ejection; their data quantified the magnitude of droplet ejection. As a result, the research pointed out some promising methods for reducing the growth of waves and droplet ejection. Completed a sequence of tests on falling-film breakdown that determined how susceptible a molten salt film may be to high flux in a commercial DAR.

Developed a process for suspending metal oxide particles in the proposed DAR working fluid (molten draw salt) to enhance its solar absorption. The process involved using a dispersant and a wetting agent.

Conducted experiments with doped and undoped salt with a short panel and simulated high flux conditions on the salt film. These experiments provided data on three significant issues: the possibility of film dryout, the heat-transfer coefficient between the salt and the back plate, and efficiency of flux absorption in the doped salt.

Major Project Reports:

- Anderson, J.V., and N.L. Weaver, 1988, *High-Temperature Solar Central Receivers for Electricity Production*, SERI/TR-253-3196, Golden, CO: Solar Energy Research Institute, 82 pp. Available NTIS: Order No. DE88001171.
- Anderson, J.V., W.D. Short, T.J. Wendelin, and N.L. Weaver, 1987, *Direct Absorption Receiver (DAR) Systems Assessment*, SERI/TR-253-3162, Golden, CO: Solar Energy Research Institute, 50 pp. Available NTIS: Order No. DE87012277.

• Bohn, M.S., and K.Y. Wang, 1988, "Experiments and Analysis on the Molten Salt Direct Absorption Receiver Concept," *Journal of Solar Energy Engineering*, Vol. 110, February, pp. 45-51.

Summary Date: October 1988

Heat Engines

Project/Area/Task:
Conversion Technology

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: M. Carasso

Telephone: (303) 231-1353

Contractor:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Principal Investigator: M. Carasso

Telephone: (303) 231-1353

Contract Number: DE-AC02-83CH10093

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$100,000	DOE
FY 1987	$414,000	DOE
FY 1988	$195,000	DOE

Objectives:

To define a regenerative thermoelectrochemical conversion (RTEC) concept, to demonstrate its technical feasibility, and to assess its cost and economic potential for dishes and small central receiver systems.

Approach/Background:

Identify materials of construction for the regenerator in the RTEC system and determine the relevant thermochemical properties of the working fluid used in the system. With this information, select construction materials for the prototype receiver/regenerator and related equipment.

Status/FY 1988 Accomplishments:

Under a two-year cost-shared SERI/Hughes research project, completed a two-year master schedule with emphasis at Hughes on membrane research and emphasis at SERI on high-temperature materials containment and regenerator. Conducted a system study on an RTEC convertor mounted at the focal point of a dish concentrator to assess the overall concept. Experimental results of the regeneration process under thermochemical equilibrium conditions provided essential data on the behavior of the working fluid. Performed corrosion tests on a wide variety of materials and determined physical properties of the regenerator feed liquid for specific temperature ranges. Identified materials to be used to fabricate valve parts, erosion-resistant orifices, and valve seats for the laboratory test system. Began fabricating the regeneration flow experiment for RTEC at SERI. With the results of corrosion studies and other property requirements, identified graphite as the most likely material candidate for the high-temperature portion of the regenerator. Began fabricating the heater section of the regenerator using silicone-carbide-coated graphite at SERI.

Major Project Reports: None

Summary Date: October 1988

Direct Conversion

Project/Area/Task:
Conversion Technology

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: R.G. Nix

Telephone: (303) 231-1757

Contractor:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Principal Investigator: R.G. Nix

Telephone: (303) 231-1757

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$425,000	DOE
FY 1987	$225,000	DOE
FY 1988	$725,000	DOE

Objectives:

To define and validate the feasibility of using direct concentrated sunlight (500+ suns) efficiently to convert hazardous wastes such as chlorinated hydrocarbons to environmentally acceptable materials; to initiate and sustain endothermic chemical reactions with emphasis on reactions to produce transportable fuels and industrially important chemicals; and to understand beneficial transformations on material surfaces induced by highly concentrated solar radiation.

Approach/Background:

Conduct laboratory experiments to understand how the concentrated sunlight beneficially changes the chemistry, and conduct solar tests to validate the concepts.

Status/FY 1988 Accomplishments:

Performed solar tests that resulted in 99.9998% destruction of a dioxin. Performed these tests with the University of Dayton using the White Sands solar furnace. University of Dayton researchers completed the laboratory experiments to measure the destruction profiles to 99.9999% in a very controlled fashion under oxidative and pyrolytic conditions. The laboratory runs, coupled with the White Sands field tests, provided a good basis for understanding the chemistry at high-destruction levels.

Conducted an assessment to identify the best market for high-temperature, high-flux solar detoxification. Analyzed potential markets for the solar destruction of toxic wastes, concentrating on organic sludges and solid wastes and the use of rotary kilns for their destruction. Worked on modeling the radiative transfer in a detoxification reactor to enhance the capability of modeling the radiative transfer, gas dynamics, and reaction kinetics of various detoxification receiver/reactors.

Tested cladding materials bound to tool steel and conducted additional experiments in phase transformation hardening. Performed microhardness testing on two additional samples of a Ni-Cr hardfacing alloy that had been melted and bound onto an A2 steel substrate in a solar furnace. Conducted experiments on phase-transformation hardening at the solar furnace. These experiments included exposing 0.5-in.-thick steel plates, which were translated under the beam at various speeds under various conditions of flux.

Major Project Reports:

- Graham, J.L., and B. Dellinger, 1987, "Solar Thermal/Photolytic Destruction of Hazardous Organic Wastes," *Energy International Journal*, Vol. 12 (3/4), March/April.
- Dellinger, B., and J. Graham, 1988, *Solar Incinerability of Hazardous Waste*, SERI Subcontract XX-6-06082-1, in press.

Summary Date: October 1988

Optical Quality of Polymer Films for Protecting Silver Mirrors

Project/Area/Task:
Collection Technology/Optical Materials Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: P. Schissel

Telephone: (303) 231-1226

Contractor:
University of Akron
302 E. Buchtel Ave.
Akron, Ohio 44325

Principal Investigator: M. Cakmak/
J.L. White

Telephone: (216) 375-6928

Contract Number: XK-6-05059-01

Current Contract Period:
From: 02/86 **To:** 01/88

Contract Funding:		Source:
FY 1986	$65,675	DOE
FY 1987	-0-	—
FY 1988	$61,000	DOE

Objective:

To acquire research and development assistance to assess the factors that limit polymer-silver mirror specularity and durability.

Approach/Background:

Prepare films or sheets for optical and surface evaluation, placing particular emphasis on improving optical qualities to meet requirements of specularity (2 mrad) for mirrors. The films will be of two categories: highly transparent films to serve as protective covers for the silver mirror and films for mounting behind the silver-transparent polymer structure to serve as mechanical support for the membrane mirror configuration.

Status/FY 1988 Accomplishments:

Measured and documented the optical and structural properties of certain polymer films.

Major Project Reports:

- Cakmak, M., 1988, *Optical Quality of Polymer Films for Protecting Silver Mirrors*, final report, Golden, CO: Solar Energy Research Institute.
- Cakmak, M., 1988, *Optical Quality of Polymer Films for Protecting Silver Mirrors*, supplement to final report, Golden, CO: Solar Energy Research Institute.

Summary Date: October 1988

Composite Materials for Heliostats

Project/Area/Task:
Systems and Applications

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: L.M. Murphy

Telephone: (303) 231-1050

Contractor:
University of California at Berkeley
c/o Sponsored Projects Office
University of California
Berkeley, CA 94720

Principal Investigator: H. Dharan

Telephone: (415) 642-4933

Contract Number: XX-6-06019-01

Current Contract Period:
From: 09/86 **To:** 08/89

Contract Funding:		Source:
FY 1986	$97,715	DOE
FY 1987	$98,644	DOE
FY 1988	$103,641	DOE

Objectives:

To define the feasibility of composite materials for heliostat and solar concentrator applications and to contribute to present understanding of the response of complex laminates to long-term creep and thermal cycling.

Approach/Background:

Analyze the state of the art in heliostat design (materials, processes, and structural technology) to identify the important issues for improving performance and reducing cost. Study the application of composite materials to stretched-membrane heliostat design and identify areas where weight and cost savings have high potential. Construct a finite-element model of the stretched-membrane heliostat (structure and membrane) using a nonlinear finite-element analysis program such as ANSYS. Develop processes for manufacturing samples of composite substrate membranes and analyze ring structural elements that meet the requirements by model. Construct 1-m-diameter prototypes of composite stretched-membrane heliostat designs and subject them to structural and accelerated life testing.

Status/FY 1988 Accomplishments:

Created analytical models and obtained initial data on performance of composite structures. Began fabricating 1-m-diameter prototypes of better candidate materials.

Major Project Reports:

- Kiang, H-J., 1988, "Analysis of Composite Material Application to Heliostat Design," masters thesis, Berkeley, CA: University of California.
- Dharan, H., 1988, *Composite Materials for Heliostats*, progress report, Berkeley, CA: University of California.

Summary Date: October 1988

Methods for Achieving Extremely High Solar Flux Concentrations

Project/Area/Task:
Exploratory Research/Innovative Optics

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: B. Gupta

Telephone: (303) 231-1760

Contractor:
University of Chicago
Office of Research Administration
970 E. 58th Street
Chicago, IL 60637

Principal Investigator: R. Winston/
J. O'Gallagher

Telephone: (312) 962-7756/7757

Contract Number: XX-6-06019-02

Current Contract Period:
From: 08/86 **To:** 08/89

Contract Funding:		Source:
FY 1986	$63,902	DOE
FY 1987	$75,705	DOE
FY 1988	$75,393	DOE

Objectives:

To construct a prototype scale model of an optical system for achieving very high flux in a refractive medium with highest practical index of refraction not larger than 1.5. To develop sensors and techniques for measuring very high solar flux in the range 20,000-50,000 suns and beyond. To test and evaluate the scale prototypes and the sensors in the laboratory and a solar test facility (as decided during the first year) for proper design and integration with the facility. To investigate sunlight-to-laser-light conversion by designing and building a laser cavity compatible with solar end-pumping that will demonstrate high conversion efficiency.

Approach/Background:

Investigate conversion of sunlight to laser light by using a secondary concentrator and excitation of crystals with the highly concentrated solar flux.

Status/FY 1988 Accomplishments:

Verified over 60,000 suns concentration; the theoretical estimate for concentration using such a technique is over 100,000 suns. The key to this concentration is using a secondary concentrator with an index of refraction greater than that of air. Used an oil-filled cavity in these experiments with an index of approximately 1.5.

Major Project Report:

- Winston, R., 1988, "Achievement of Ultrahigh Solar Concentration with Potential for Efficient Laser Pumping," *Applied Optics*, Vol. 27 (21), pp. 4385-4391, Optical Society of America.

Summary Date: October 1988

Wind Load Reduction Research

Project/Area/Task:
Collection Technology/Concentrator Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: A. Lewandowski

Telephone: (303) 231-1972

Contractor:
Colorado State University
Department of Civil Engineering
Fort Collins, CO 80523

Principal Investigator: J. Peterka

Telephone: (303) 491-8344

Contract Number: XX-6-06034-1

Current Contract Period:
From: 02/86 **To:** 05/89

Contract Funding:		Source:
FY 1986	$46,000	DOE
FY 1987	$48,700	DOE
FY 1988	$45,000	DOE

Objectives:

To identify, evaluate, and demonstrate the technical feasibility of innovative concepts for avoiding or reducing the wind loads on concentrating collectors.

Approach/Background:

Study the moment loads on parabolic dishes in field environments to find methods to reduce load magnitudes and measure local pressure distributions on parabolic dish collectors for single-unit and in-field units to determine the extent of nonuniformity of wind loading.

Status/FY 1988 Accomplishments:

Obtained data with wind tunnel testing for both heliostats and dishes as isolated units and in a field. Examined similarities and differences on drag and lift loads of wind coming from different directions.

Major Project Reports:

- Peterka, J.A., N. Hosova, B. Bienkiewicz, and J.E. Cermak, 1986, *Wind Load Reduction for Heliostats: A Subcontract Report*, SERI/STR-253-2859, Golden, CO: Solar Energy Research Institute.
- Peterka, J.A., Z. Tan, B. Bienkiewicz, and J. Cermak, 1987, *Mean and Peak Wind Load Reduction on Heliostats*, SERI/STR-253-3212, Golden, CO: Solar Energy Research Institute.
- Peterka, J.A., Z. Tan, B. Bienkiewicz, and J.E. Cermak, 1989, *Wind Loads on Heliostats and Parabolic Dish Collectors*, SERI/STR-253-3431, Golden, CO: Solar Energy Research Institute.

Summary Date: October 1988

Solar Incineration of Hazardous Wastes

Project/Area/Task:
Energy Conversion Technology/Direct Conversion Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: R. Nix

Telephone: (303) 231-1757

Contractor:
University of Dayton
Research Institute
300 College Park
Dayton, OH 45469

Principal Investigator: B. Dellinger

Telephone: (513) 229-2846

Contract Number: XX-6-06082-01

Current Contract Period:
From: 09/84 **To:** 02/89

Contract Funding:		Source:
FY 1984	$105,000	DOE
FY 1985	-0-	—
FY 1986	$100,000	DOE
FY 1987	-0-	—
FY 1988	$123,000	DOE

Objectives:

To perform a chemical kinetic investigation of the thermal decomposition process, i.e., the destruction rate as a function of time, temperature, and intensity of solar flux. To determine the performance merits of pyrolysis relative to oxidation and to understand the role and extent of formation of products of incomplete combustion in solar detoxification of hazardous waste. To achieve a field confirmation of the observed laboratory phenomena with the confirmation in the actual solar environment.

Approach/Background:

Investigate the excited state thermal/photolytic process, study mechanistically the PIC formation under oxidative and pyrolytic conditions, and conduct solar detoxification tests.

Status/FY 1988 Accomplishments:

Performed solar tests of the detoxification of a dioxin using the White Sands Solar Furnace. Attempted to attain the 99.9999% destruction with a cleaner chemistry and to show definitely the difference between the thermal and the photo/thermal performance. Exceeded 99.9998% destruction with one sample, with most samples showing some contamination of dioxin. Tests continuing into early FY 1989 resulted in >99.9999% destruction of a dioxin.

Major Project Report:

- Graham, J.L., and B. Dellinger, 1987, "Solar Thermal Photolytic Destruction of Hazardous Organic Wastes," *Energy*, Vol. 12 (3/4): pp. 303.

Summary Date: October 1988

Carbon Fiber Research

Project/Area/Task:
Energy Conversion Technology/
Photo-Thermochemical Conversion
Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: D. Blake

Telephone: (303) 231-1202

Contractor:
Georgia Tech Research Institute
Administration Building
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: G. Freeman

Telephone: (404) 894-3650

Contract Number: XX-7-07029-1

Current Contract Period:
From: 03/87 **To:** 02/89

Contract Funding:		Source:
FY 1987	$144,873	DOE
FY 1988	$251,163	DOE

Objectives:

To prepare carbon fibers with improved or unique properties unobtainable by conventional processes using a high flux solar thermal process and to develop a semicontinuous process for carrying out the procedure.

Approach/Background:

Study the effect of process variables to identify those that produce beneficial effects. Expose carbon fibers to solar flux in a solar furnace capable of operating up to 9000 suns.

Status/FY 1988 Accomplishments:

Designed apparatus and procedure for sample preparation and began methods development for measuring interlaminar shear strength using a microdebonding method and single-fiber pullout. Completed a study on a moderate-temperature isothermal thermogravimetric analysis oxidation rate on fibers for over 100 hours and paralleled earlier accelerated-temperature results and the superior oxidation resistance of solar-treated fibers. Completed fiber surface morphology studies and demonstrated greater surface roughness of solar-exposed fibers using a scanning electron microscope.

Major Project Reports: Quarterly reports

Summary Date: October 1988

Solar-Enhanced Chemical Reactions

Project/Area/Task:
Direct Conversion/Photoenhanced Chemical Reactions

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: R.G. Nix

Telephone: (303) 231-1757

Contractor:
University of Houston
Sponsored Program
4800 Calhoun Road
Houston, TX 77004

Principal Investigator: L. Vant-Hull

Telephone: (713) 749-1154

Contract Number: XX-7-07028-01

Current Contract Period:
From: 03/87 **To:** 03/89

Contract Funding:		Source:
FY 1988	$260,000	DOE

Objectives:

To experimentally investigate the solar enhancement of chemical reactions to identify those most amenable to solar enhancement and to assess the technical and economic feasibility of an industrially valuable chemical reaction system.

Approach/Background:

Break chemical bonds using high flux solar radiation, analyze solar catalytic reactions, and research photoenhanced catalytic reactions.

Status/FY 1988 Accomplishments:

Investigated the use of direct-concentrated radiation to enhance catalytic chemical reactions. Established that a significant solar photoenhancement exists for the decomposition of 2-Propanol over a titanium dioxide or a vanadium pentoxide catalyst on a silica support. Reactions with potential commercial value are the reforming of straight chain paraffin compounds, such as normal hexane, to aromatics, such as benzene, or the cracking to olefins such as ethylene.

Major Project Reports:

- Hamada, M., 1988, "Photo-Assisted Reforming and Cracking Reactions Using High-Flux Solar Simulated Radiation," Ph.D. Thesis, Houston, TX: University of Houston.

- Wentworth, W., C.F. Batten, and M. Hamada, 1988, "Photo-Assisted Reforming and Cracking Reactions Using High-Flux Solar Simulated Radiation," *Journal of Solar Energy*, in press.

- Vant-Hull, L.L., and C.L. Pitman, 1988, "Central Receiver System Optimization under an Allowable Flux Constraint," *Proceedings, Fourth International Symposium on Research Development and Applications of Solar Thermal Technology*, Santa Fe, NM, June 13-17.

- Wentworth, W., C.F. Batten, and M. Hamada, 1988, "Photo-Assisted Hydrocarbon Reforming and Cracking Reactions," *Proceedings, Fourth International Symposium on Research Development and Applications of Solar Thermal Technology*, Santa Fe, NM, June 13-17.

- Ignatier, A., "A Combined High-Pressure Photocatalytic Reactor-Ultrahigh Vacuum System and Sample Transfer Device," *Review of Scientific Instruments.*

- Pringle, H.W., and M. Saghafy, 1988, "Production of Chemicals Using Photo-Thermal Solar Energy," *Proceedings, AIChE National Meeting*, August.

• Moshfegh, A.Z., and A. Ignatier, 1988, "Photo-Enhanced Catalytic Decomposition of Isopropanol on Vanadium Pentoxide," *Proceedings, AIChE National Meeting*, August.

Summary Date: October 1988

Antisoiling Solar Reflector Research

Project/Area/Task:
Energy Conversion Technology/Optical Materials Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: D. Blake

Telephone: (303) 231-1202

Contractor:
Georgia Tech Research Institute
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: L. Speaker

Telephone: (404) 894-3650

Contract Number: XX-7-07029-01

Current Contract Period:
From: 03/87 **To:** 02/89

Contract Funding:		Source:
FY 1987	$80,195	DOE
FY 1988	$40,405	DOE

Major Project Reports: Quarterly reports

Summary Date: October 1988

Objective:

To demonstrate that the Langmuir-Blodgett (L-B) monolayers can provide soil-resistant properties on the surface of polymeric reflector materials.

Approach/Background:

Establish conditions for applying L-B layers to the surface of 3M ECP-300 reflective film. Develop a test method for measuring the effectiveness of the treatments. Screen compounds to be used as precursors for the L-B layers.

Status/FY 1988 Accomplishments:

Produced and tested samples of ECP-300 attached to glass slides and L-B-layered with the compound L-10089 or polymerized 7F-10H itaconate.

Compound Optical Systems with Maximal Concentration for Solar Thermal Conversion

Project/Area/Task:
Collection Technology/Concentrator Research/Innovative Concepts

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: A. Lewandowski

Telephone: (303) 231-1972

Contractor:
University of Chicago
Research Administration
970 E. 58th Street
Chicago, IL 60637

Principal Investigator: J. O'Gallagher

Telephone: (312) 702-7757

Contract Number: XK-4-04070-03

Current Contract Period:
From: 01/85 **To:** 12/88

Contract Funding:		Source:
FY 1984	$77,127	DOE
FY 1985	-0-	—
FY 1986	$67,500	DOE
FY 1987	$50,000	DOE
FY 1988	$32,000	DOE

Objectives:

To analyze the general optical performance features of primary concentrators that are not axisymmetric, to develop a computer-based simulation model for characterizing their performance, and to explore the optical design and performance impacts of using nonimaging secondary concentrators with such configurations.

Approach/Background:

Determine specific code requirements (with SERI), develop and test a computer code for implementing the model, apply the model to evaluate (with SERI) selected candidate configuration designs, prepare a written description of the model and documentation of the computer code, deliver the computer code to SERI, and provide consultation and support to SERI users.

Status/FY 1988 Accomplishments:

Provided SERI with a computer model that is now being used with the optical analysis codes for membrane concentrators.

Major Project Report:

- O'Gallagher, J.J., and R. Winston, 1987, *Performance and Cost Benefits Associated with Non-Imaging Secondary Concentrators Used in Point-Focus Solar Thermal Applications*, SERI/STR-253-3113, Golden, CO: Solar Energy Research Institute.

Summary Date: October 1988

Regenerative Thermoelectrochemical Converter (RTEC) Power Module

Project/Area/Task:
Heat Engines/Heat Engine Technology

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: M. Carasso

Telephone: (303) 231-1353

Contractor:
Hughes Aircraft Company
Electro Optical Data Systems Group
2000 East El Segundo Blvd.
El Segundo, CA 90245

Principal Investigator: J. McHerdy

Telephone: (213) 616-8674

Contract Number: ZX-8-07057-1

Current Contract Period:
From: 12/87 **To:** 01/90

Contract Funding:		Source:
FY 1988	$473,600*	DOE
FY 1988	$118,400*	Hughes

Objectives:

To perform sufficient experimental research on each component to define a basic system configuration, to understand its performance, and to enable a reasonable estimate of its eventual cost and ultimate performance. To validate the system concept through operating a laboratory closed-loop system. To establish a technology base that will support the eventual engineering development of RTEC. To provide a basis for determining the extent to which RTEC may contribute toward achieving the Solar Thermal Technology Program goals. To achieve a minimum efficiency of 30% at a minimum current density of 50 mA/cm^2 with a definition of how to improve the system to later accomplish 40% efficiency at a current density of 200 mA/cm^2.

Approach/Background:

Provide research on electrochemical cell components, stripper components, condenser components, integrated systems, and materials and develop an engineering assessment and technology data base.

Status/FY 1988 Accomplishments:

Placed a cost-shared subcontract with the Hughes Aircraft Company to research the converter in a RTEC system. Hughes' portion emphasizes the electrochemistry, the cell definition, and the system electrolyte management. SERI's in-house research emphasizes the solar portions of the RTEC cycle. The joint effort defined system components and built and tested a 10-watt, proof-of-concept experimental model. Research at Hughes focused on experiments designed to identify high-performance RTEC cell electrode/membrane combinations. Studied hydrogen-bypass and hydrogen-through membranes. Received higher than expected results on experiments with a hydrogen-bypass electrode/membrane. Constructed a bipolar cell and characterized the condenser performance.

Major Project Reports: Quarterly reports

Summary Date: October 1988

*Costs are shared; DOE share includes funds from FY 1986 and FY 1987.

International Energy Agency (IEA) Support

Project/Area/Task:
Planning and Assessment

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: R. Hewett

Telephone: (303) 231-7063

Contractor:
Polydyne, Inc.
900 South Norfolk Street
Suite 209
San Mateo, CA 94403

Telephone: (415) 570-7797

Principal Investigator: P. Bos

Contract Number: HX-7-07200-01

Current Contract Period:
From: 10/87 **To:** 12/87

Contract Funding:		Source:
FY 1988	$47,000	DOE

Major Project Reports: None

Summary Date: October 1988

Objective:

To represent the DOE Solar Thermal Technology Program at the IEA workshop on the economics of renewable energy at Montreal, Canada, October 1987.

Approach/Background:

Provide the following: proposed utility financial analysis methodologies; detailed description of economic methodology; detailed methodology development; computer program development; data base generation; technical reviews; October workshop participation; workshop follow-up efforts.

Status/FY 1988 Accomplishments:

Developed a methodology, presented it at the workshop, and prepared a final review.

Instabilities in Molten-Salt Film

Project/Area/Task:
Direct Conversion/Solar Unique Beneficial Phenomenon

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: M. Bohn

Telephone: (303) 231-1755

Contractor:
SHD Associates
2735 Simpson
Evanston, IL 60201

Principal Investigator: S.H. Davis

Telephone: (312) 475-8026

Contract Number: HX-7-07131-1

Current Contract Period:
From: 04/88 **To:** 09/88

Contract Funding:		Source:
FY 1987	$19,150	DOE
FY 1988	$22,500	DOE

Objectives:

To provide technical support to SERI by developing models of liquid film dryout applicable to the direct absorption receiver (DAR) concept.

Approach/Background:

Develop equations that describe the evolution of liquid film dryout driven by surface-tension gradients. Start with quiescent liquid films subjected to flux gradients typical of a DAR; predict the likelihood of film dryout.

Modify the equations to account for mean, gravity-driven flow. Help SERI interpret experimental data.

Status/FY 1988 Accomplishments:

Developed a scaling law for the breakdown process that allows researchers for the first time to predict the effect of the properties of the liquid film on the breakdown. Once validated, the model can be used to predict the behavior of a salt film based on water film data. Previous data taken at SERI with water and a water/glycerol mixture were cast in the form specified by the scaling law. The resulting plot shows that water and the water/glycerol mixture follow the same correlation line.

Correlated breakdown flux for liquids with significantly different properties, which means that the breakdown behavior of molten salt films may be predicted.

Major Project Report: Technical letter report

Summary Date: October 1988

Industrial Support on Silver/Polymer R&D

Project/Area/Task:
Materials/Silver-Polymer Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: P. Schissel

Telephone: (303) 231-1226

Contractor:
3M Company
3M Center Building, 207-1W
St. Paul, MN 55144

Principal Investigator: B. Benson

Telephone: (612) 733-1031

Contract Number: ZX-8-07233-1

Current Contract Period:
From: 01/87 **To:** 10/88

Contract Funding:		Source:
FY 1988	$40,000	DOE
FY 1988	$40,000	3M

Major Project Reports: Quarterly reports

Summary Date: October 1988

Objective:

To develop a weatherable silver solar reflecting film having a reflectance of 95%.

Approach/Background:

Building on previous results, develop the silver solar reflecting film to a reflectance of 95%, which includes preparing and testing a substantial number of product constructions.

Status/FY 1988 Accomplishments:

Investigated methods for higher ultraviolet (UV) resistance in the film. Tested samples prepared from different materials and with different UV absorbers. Achieved good UV resistance through this research.

Protective Treatments for Membrane Heliostat Mirrors

Project/Area/Task:
Materials/Silver-Polymer Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: P. Schissel

Telephone: (303) 231-1226

Contractor:
Springborn Materials Science, Inc.
10 Springborn Center
Enfield, CT 06082-4899

Principal Investigator: B. Baum

Telephone: (203) 749-8371

Contract Number: XX-8-07247-01

Current Contract Period:
From: 10/87 **To:** 08/88

Contract Funding:		Source:
FY 1988	$24,949	DOE

Major Project Reports: Quarterly reports

Summary Date: October 1988

Objectives:

To evaluate and recommend a coating for soil-resistance on mirrors.

Approach/Background:

Apply commercial coatings on polymer and glass mirrors and examine their soil resistant properties.

Status/FY 1988 Accomplishments:

Completed work on applying soil-resistant coatings on glass and acrylic surfaces. Coated acrylic and glass surfaces with Owens Illinois Glass Coat 651 hard coating and overcoated with Petrarch T2494 fluorosilane, which improved the soil resistance over either the untreated acrylic or the untreated glass. Found five formulations to be optically clear, have good adhesion, and offer better resistance to soiling than untreated glass.

Solar Thermal Water Reclamation

Project/Area/Task:
Planning and Assessment

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: J. Thornton

Telephone: (303) 231-1269

Contractor:
Arizona Board of Regents
University of Arizona
College of Engineering and Mines
Harvil Building, Box 76
Tucson, AZ 85721

Principal Investigator: D. Osborne

Telephone: (602) 621-7496

Contract Number: XX-8-17199-01

Current Contract Period:
From: 08/87 **To:** 02/89

Contract Funding:		**Source:**
FY 1988	$108,543	DOE

Objectives:

To assess the technical and economic potential of using current solar thermal technologies and those expected to be available in the near-term to resolve specific ground and surface water reclamation problems in Arizona, New Mexico, Texas, Oklahoma, and Southern California. To assess the potential of solar thermal technologies expected to be available in the 2000-2010 timeframe. To create a systematic data base cataloging specific water reclamation problems having the potential to be resolved by treatment systems involving solar thermal technologies. To formulate recommendations regarding future research and development required to make the solar thermal technologies viable alternatives for cleaning up contaminated water resources.

Approach/Background:

Identify specific water treatment/reclamation problems potentially treatable by solar thermal technologies, formulate selection criteria to identify 5-10 water problems, select water treatment problems for solar thermal systems assessments, and identify water contamination problems treatable by advanced solar thermal technologies and solar-enhanced photodecomposition of contaminants in water.

Status/FY 1988 Accomplishments:

Tabulated water problems based on available data, and examined current levels of contaminants and techniques now used.

Major Project Report:

- Osborne, D., R. Slerka, M. Karpiscak, P. Huddy, G. France, D. Rivard, J. DeCook, S. Scanlon, C. MacLeod, M. Latif, and A. Cherri, 1988, "Solar Thermal Water Reclamation and Toxic Waste Destruction in the Southwest," *Proceedings, SOLAR 88*, American Solar Energy Society, June.

Summary Date: October 1988

Nonsymmetric Asymptotic Solutions

Project/Area/Task:
Concentrators/Alternate Optical Concepts Evaluation

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: L. Murphy

Telephone: (303) 231-1050

Contractor:
Shelltech Associates
Engineering Analysis Consultants
809 Tolman Drive
Stanford, CA 94305

Principal Investigators: C. Balch/
C.R. Steele

Telephone: (415) 723-2844

Contract Number: HX-8-18012-1

Current Contract Period:
From: 06/87 **To:** 04/29/88

Contract Funding:		Source:
FY 1988	$10,000	DOE

Objectives:

To consider nonsymmetric effects at the boundary as well as nonsymmetric loading in the analyses of the structural/optical response of stretched-membrane parabolic dishes.

Approach/Background:

Develop a harmonic asymptotic membrane solution for pressure-loaded membranes. Develop an asymptotic solution methodology to determine the membrane structural load deformation response of a membrane concentrator having a nominally parabolic shape subject to either uniform or asymmetric pressure loading as well as to prescribed harmonic displacements at the supports.

Status/FY 1988 Accomplishments:

Completed analytical descriptions, including shape, loading, material properties, and boundary conditions for deformations and slope of a membrane. Integrated this analytical model for the membrane with finite element models for the support structure and optical characterization models to determine overall structural/optical response characteristics. Provided a diskette using the Fortran computer language for evaluations with letter reports.

Major Project Reports: None

Summary Date: October 1988

Development of Capabilities to Conduct Analytical Studies of Volumetric Receiver and Receiver/Reactor Concepts

Project/Area/Task:
Volumetric Receiver and Receiver-Reactor Research

Directing Organization:
Solar Energy Research Institute
1617 Cole Boulevard
Golden, CO 80401

Project Manager: M. Carasso

Telephone: (303) 231-1353

Contractor:
Thermal Research, Inc.
1451 Olympus Avenue
Berkeley, CA 94708

Principal Investigator: C.L. Tien

Telephone: (714) 856-6296

Contract Number: IM-8-18077-01

Current Contract Period:
From: 04/88 **To:** 07/88

Contract Funding:		Source:
FY 1988	$14,850	DOE

Objective:

To help SERI develop the ability to conduct analytical studies of volumetric receiver and receiver/reactor concepts.

Approach/Background:

Solve the direct absorption receiver (DAR) radiative transfer problem parametrically for different salt film thicknesses and alternative dopant characteristics, and adapt the method for solving the more general radiative transfer problem in absorbing, scattering, and emitting media as encountered in volumetric receivers when chemical reactions, either photochemical or thermochemical, are present.

Status/FY 1988 Accomplishments:

Developed an analytical method for solving the radiative transfer equations, successfully applied the method to the DAR radiative transfer, and obtained temperature profiles in the salt film. Also applied the method to a volumetric receiver/reactor and provided an initial understanding of the governing radiative transfer parameters involved.

Major Project Reports: None

Summary Date: October 1988

Sandia National Laboratories

3-MW_t Molten Salt Test Loop for the Direct Absorption Receiver (DAR) Experiment

Project/Area/Task:
Central Receiver Technology/Balance of Plant

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: W.A. Couch

Telephone: (505) 844-6770

Contractor:
Advanced Thermal Systems
7600 E. Arapahoe Road
Suite 215
Englewood, CO 80112

Principal Investigator: D. Gorman

Telephone: (303) 721-8411

Contract Number: SNLA 06-3352

Current Contract Period:
From: 06/87 **To:** 12/87

Contract Funding:		Source:
FY 1987	$95,000	DOE
FY 1988	-0-	—

Objective:

To design a 3-MW_t test loop to be used to evaluate the performance of DAR experiments and other receivers in the future.

Approach/Background:

Design a 3-MW_t molten salt test system to allow flow testing with molten nitrate salt and provide a test bed for DAR testing with actual solar heating. The system will be capable of operating at flow conditions typical of a commercial-sized DAR with a heat rejection capacity of 3 MW_t. Design the apparatus to facilitate easy replacement of DAR panels and manifolds and to allow timely testing of different receiver configurations. In the future, use the apparatus as a test bed for other receiver designs needing a 3-MW_t molten salt flow loop.

Status/FY 1988 Accomplishments:

Completed the design of the flow loop apparatus in 1988; began constructing the experiment.

Major Project Reports: None

Summary Date: October 1988

Annual Energy Improvement Study

Project/Area/Task:
Central Receiver Technology/Systems Analysis

Directing Organization:
Sandia National Laboratories
P. O. Box 5800
Albuquerque, NM 87185

Project Managers: G.J. Kolb/D.J. Alpert

Telephone: (505) 846-1976

Contractor:
Sandia National Laboratories
P. O. Box 5800
Albuquerque, NM 87185

Principal Investigators: G.J. Kolb/
D.J. Alpert

Telephone: (505) 846-1976

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: 10/01/86 **To:** 09/30/88

Contract Funding:		Source:
FY 1986	-0-	—
FY 1987	$50,000	DOE
FY 1988	$30,000	DOE

Objective:

To identify the design and operation improvements necessary to achieve the annual plant efficiency goal for central receiver power plants established by DOE.

Approach/Background:

Review results from Sandia studies, which indicate that significant improvements in central receiver technology must be made to achieve the annual efficiency goal established by DOE. The Annual Energy Improvement Study will help bridge the gap between current technology (15%) and the goal (22%). Simulate the annual performance of the Solar One plant with the SOLERGY computer code to lend credence to annual energy predictions produced by SOLERGY and to gain a detailed understanding of the inefficiencies associated with the design and operation of Solar One. Based on insights gained from this task, recommend design improvements to achieve the efficiency goal.

Status/FY 1988 Accomplishments:

Finished validating the SOLERGY computer code with performance data collected at Solar One. Concluded that the SOLERGY code produces a good estimate of annual energy production at Solar One by only 10%. Further analysis indicated that the annual efficiency goal can be very nearly achieved if the following improvements are made:

- Replace the water-steam receiver with a direct absorption receiver using molten salt
- Improve the reflectivity of the heliostat by switching from glass to stretched membranes and clean the reflective surface more frequently than was done at Solar One
- Improve plant availability
- Reduce parasitic power consumption.

Major Project Report:

- Alpert, D.J., and G. J. Kolb, 1988, *Performance of the Solar One Power Plant as Simulated by the SOLERGY Computer Code*, SAND88-0321, Albuquerque, NM: Sandia National Laboratories.

Summary Date: October 1988

Direct Absorption Receivers (DAR) Panel Research Experiment Absorber Panel Module Design

Project/Area/Task:
Central Receiver Technology/Receivers

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.M. Chavez

Telephone: (505) 844-4485

Contractor:
Babcock & Wilcox
20 S. Van Buren Ave.
Barberton, OH 44203

Principal Investigator: J.P. Reed

Contract Number: SNLA 63-3991

Current Contract Period:
From: 09/87 **To:** 09/89

Contract Funding:		Source:
FY 1987	-0-	—
FY 1988	$60,608	DOE

Objective:

To design a DAR absorber panel for use on the DAR panel research experiment (PRE) being conducted at Sandia. The contractor provides fabrication drawings and participates in the test data analysis of the panel design.

Approach/Background:

Design and construct a 3-MW_t solar PRE to allow flow testing with molten nitrate salt and to provide a test bed for DAR testing. Use the previously designed thermal analysis for evaluating the DAR absorber panel requirements to design an absorber surface to meet the PRE test objectives. After the testing has begun, participate in the testing to evaluate the absorber panel performance.

Status/FY 1988 Accomplishments:

Sent drawings and computer-assisted design files of the originally agreed to absorber panel design. A final report is in progress.

Major Project Report:

Final design report to be issued February 1989

Summary Report: October 1988

Molten Salt Subsystem/Component Test Experiment

Project/Area/Task:
Central Receiver Technology/Receivers

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.M. Chavez

Telephone: (505) 844-4485

Contractor:
Babcock & Wilcox
P. O. Box 835
Alliance, OH 44601

Principal Investigator: B.D. Young

Telephone: (216) 860-6270

Contract Number: SNLA 91-4687

Current Contract Period:
From: 03/84 **To:** 10/89

Contract Funding:		Source:
FY 1984	$ 704,922	DOE
FY 1985	$1,845,078	Participants
FY 1986	$2,202,658	DOE
FY 1986	$ 329,948	Participants
FY 1987	$2,438,332	DOE
FY 1987	$ 353,118	Participants
FY 1988	$ 200,000	DOE
FY 1989	$ 300,000	DOE

Objectives:

To resolve the present technical uncertainties of solar central receiver molten salt subsystems and components; to provide a sound technological base for developing a molten-salt industry; and to support the design and construction plans for advanced commercial central receiver plants.

Approach/Background:

Conduct the molten salt subsystem/component test experiment, a hardware development and test program, at the Central Receiver Test Facility (CRTF). The project, managed by Sandia National Laboratories with Babcock & Wilcox as the prime contractor, is cost-shared by DOE and six contractors.

Build an advanced design of a 5-MW_t cavity receiver and test it at the CRTF. In addition, assemble full-sized (for use in a 30-MW_e central receiver plant) hot and cold molten-salt pumps and valves into test loops to simulate commercial plant operations.

Status/FY 1988 Accomplishments:

Completed the first phase of receiver characterization testing in FY 1987. The testing confirmed the receiver design. Found the receiver efficiency to be on the order of 90%, with the receiver tested at a nominal power of 4.5 MW_t. Completed a second phase of receiver testing in early FY 1988, and provided additional data and confirmed the results of the first phase of testing. Removed the receiver from the top of the CRTF tower once testing was completed.

Assembled the hot and cold pump and valve loops and tested them to some extent. However, only attained a limited test because of pump problems (manufacturer design problem) on the cold loop and valve problems (also manufacturer fabrication flaws) on the hot loop. Are currently testing the hot loop, which has approximately 400 hours of testing. Have only tested the cold loop for less than 2 hours and are awaiting a new pump.

Major Project Reports:

- Smith, D.C., and J.M. Chavez, 1989, *A Final Report on the Phase I Testing of a Molten-Salt Cavity Receiver—Volume I: A Summary Report*, SAND87-2290, Albuquerque, NM: Sandia National Laboratories.
- Smith, D.C., and J.M. Chavez, 1989, *A Final Report on the Phase I Testing of a Molten-Salt Cavity Receiver—Volume II: The Main Report*, SAND87-2290, Albuquerque, NM: Sandia National Laboratories, in press.

Summary Date: October 1988

Contract Engineering Design Services

Project/Area/Task:
Central Receiver Technology/
Central Receiver Test Facility and
Distributed Receiver Test Facility

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.V. Otts

Telephone: (505) 844-2280

Contractor:
Black & Veatch
P.O. Box 8405
Kansas City, MO 64114

Principal Investigator: B. Blesser

Telephone: (913) 339-2000

Contract Number: SNLA 33-1900

Current Contract Period:
From: 02/87 **To:** 12/89

Contract Funding:		Source:
FY 1987	$500,000	DOE
FY 1988	-0-	—

Objective:

To provide engineering design services for the National Solar Thermal Test Facility modifications and upgrades to satisfy central and distributed receiver test programs.

Approach/Background:

Provide the following services: mechanical engineering, electrical engineering, civil engineering, and design drafting services on an as-needed basis to satisfy testing programs.

Status/FY 1988 Accomplishments:

Provided design support for the Engine Test Facility, Distributed Receiver Test Facility, Central Receiver Test Facility, and direct absorption receiver.

Major Project Reports: None

Summary Date: October 1988

Receiver Thermal Testing

Project/Area/Task:
Distributed Receiver Technology/
Receivers/Receiver Analysis

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: A.A. Heckes

Telephone: (505) 844-3918

Contractor:
California State Polytechnic University
Kellog Unit Foundation
3801 W. Temple Avenue
Pomona, CA 91768

Principal Investigator: W.B. Stine

Telephone: (714) 869-2575

Contract Number: SNLA 02-5759

Current Contract Period:
From: 09/87 **To:** 09/89

Contract Funding:		Source:
FY 1987	$55,000	DOE
FY 1988	$20,000	DOE

Objectives:

To quantify the various heat loss mechanisms of a typical solar receiver, including heat conduction through the walls, convection from the aperture, and radiation from the aperture and walls. Also to quantify the losses versus the temperature of the heat-transfer fluid and versus the inclined angle of the receiver.

Approach/Background:

Measure temperature changes, plus heat and radiant energy fluxes, on a typical Shenandoah-type receiver. Also, measure variations in heat losses versus wind speed and direction for several receiver orientations.

Status/FY 1988 Accomplishments:

Extended contract from 12/31/87 to 09/30/88. Completed gathering all data and analyzing heat losses in still air. Wrote a technical society paper and are preparing another.

Major Project Reports:

- Stine, W.B., and C.G. McDonald, 1988, "Cavity Receiver Heat Loss Measurements," *Proceedings, 1988 ASME Solar Energy Engineering Conference*, Denver, CO, March.

- Stine, W.B., and C.G. McDonald, 1989, "Investigation of Aperture Size Effects on Cavity Receiver Heat Loss," *Proceedings, 1989 ASME Solar Energy Engineering Conference*, San Diego, CA, in press.

Summary Date: October 1988

Direct Absorption Receiver (DAR) Research and Development

Project/Area/Task:
Central Receiver Technology/
Receivers

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.M. Chavez

Telephone: (505) 844-4485

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigator: J.M. Chavez

Telephone: (505) 844-4485

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: 05/86 **To:** 05/90

Contract Funding:		Source:
FY 1986	$300,000	DOE
FY 1987	$1,250,000	DOE
FY 1988	$1,600,000	DOE

Objectives:

To perform research and development necessary to complete a concept evaluation of the DAR and conduct a system test of the DAR. In a DAR, the heat absorbing fluid (a blackened molten nitrate salt) flows in a thin film down a flat, near-vertical panel (rather than through tubes) and absorbs the concentrated solar flux directly. Potential advantages of the DAR include a significantly simplified design, improved thermal performance, increased reliability and operating life, and reduced capital and operating costs. The DAR has the potential to meet the long-term DOE cost goals.

Approach/Background:

Define a research and development program with SERI to determine the feasibility of the DAR concept. Several technological uncertainties affecting DAR feasibility require resolution before the concept can be considered a commercial alternative. Conduct system studies, materials research, small-scale panel tests with water and molten salt, and large-scale tests with water and salt. Design and construct a 3-MW_t salt flow loop to allow flow testing with molten nitrate salt and provide a test bed for DAR testing in an actual solar environment. This culminating test is called the panel research experiment (PRE). Demonstrate and evaluate the performance of the DAR by conducting a 3-MW_t solar test of the DAR at the Central Receiver Test Facility (CRTF) at Sandia.

Contract out three areas of the DAR design and development. An external DAR design study was conducted by Foster Wheeler Solar Development Corporation to evaluate on a systems level the feasibility and costs of an external commercial DAR. Advanced Thermal Systems performed the design and layout of the PRE structure and piping and is consulting on the fabrication of the PRE. Finally, Babcock & Wilcox Corporation has completed a preliminary design of the DAR absorber panel for the PRE.

Status/FY 1988 Accomplishments:

Completed systems studies of the DAR that show that the DAR has the potential to reduce the levelized energy cost by 26% over salt-in-tube receivers in the long term. Conducted water flow tests, small scale (1 m wide × 4 m long panel) and large scale (2 m diameter × 10 m long cylinder), to evaluate fluid flow performance in DAR-like conditions. Conducted tests with water to successfully design and test the inlet distribution and collection manifolds. Furthermore, conducted tests with water to observe and evaluate the wave phenomena that develops in falling liquid films. Although the wave phenomena are a concern at 4-5 m down the DAR panel because of

the potential to lose fluid, using an intermediate manifold prevents fluid loss by collecting the fluid before the waves become too large and redistributing the fluid down the panel.

Designed the PRE to be a stand-alone system that will fit on the CRTF module. Fabricated and installed the support structure for the PRE. Received all of the major components, i.e., pump, tanks, valves, heat rejection system, instrumentation, which are being installed. Doing the final design of the solar specific components of the PRE, i.e., the absorbing panel and the manifolds.

Have not resolved all the technical uncertainties of the DAR concept with the water flow testing and small-scale salt testing conducted so far. However, based on this testing, the DAR concept appears to be feasible and promising. The PRE test will demonstrate the feasibility and performance of the DAR.

Major Project Reports:

- Wu, S.F., and T.V. Narayana, 1989, *Commercial Direct Absorption Receiver Design Studies—Final Report*, SAND88-7038, Albuquerque, NM: Sandia National Laboratories. Work performed by Foster Wheeler Solar Development Corporation.

- Tyner, C.E., 1988, *Status of the DAR Panel Research Experiment; Salt Flow and Solar Test Requirements and Plans*, SAND88-2455, Albuquerque, NM: Sandia National Laboratories, in press.

- Chavez, J.M., D.K. Johnson, C.E. Tyner, and W.A. Couch, 1989, *Water Flow Testing of the Direct Absorption Receiver Concept*, SAND88-3390, Albuquerque, NM: Sandia National Laboratories, in press.

Summary Date: October 1988

Development of a Control System for a Direct Absorption Central Receiver

Project/Area/Task:
Central Receiver/Balance of Plant

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: G.J. Kolb

Telephone: (505) 846-1976

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigator: G.J. Kolb

Telephone: (505) 846-1976

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: 10/01/86 **To:** 09/30/88

Contract Funding:		Source:
FY 1986	-0-	—
FY 1987	$10,000	DOE
FY 1988	$30,000	DOE

Objective:

To develop control algorithms for experimental-scale and commercial-scale direct absorption receivers (DARs).

Approach/Background:

DARs have the potential for several design advantages over salt-in-tube receivers. One such advantage, and the focus of this investigation, is ease of receiver control. To demonstrate this advantage, develop control algorithms for the DAR to be tested during the upcoming panel research experiment (PRE) and a hypothetical commercial-scale receiver. The algorithms were developed with the aid of computer models that simulate the dynamics of the receiver. Compare the complexity of the control algorithms with that required by salt-in-tube receivers.

Status/FY 1988 Accomplishments:

Developed the control algorithms for the DARs and tested them with the simulation model. Simulation results indicate that a DAR panel can be successfully controlled with a simple PID control algorithm. The algorithm uses the salt outlet temperature as its sole input. The complex salt-in-tube receiver control strategy that uses flux sensors, back tube required for a DAR. The simplified design is a very desirable feature and enhances system reliability and performance. This algorithm will be implemented within the control system design of the upcoming PRE and tested further.

Major Project Report:

A report will be written after conclusion of the PRE.

Summary Date: October 1988

Manufacture Valves for the Direct Absorption Receiver (DAR) Experiment 3-MW_t Flow Loop

Project/Area/Task:
Central Receiver Technology/Balance of Plant

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: W.A. Couch

Telephone: (505) 844-6770

Contractor:
EG&G Sealol Eagle
P.O. Box 2158
Providence, RI 02905

Principal Investigator: E. Tremble

Telephone: (401) 781-4700

Contract Number: SNLA 63-4424

Current Contract Period:
From: 05/04/88 **To:** 11/30/88

Contract Funding:		Source:
FY 1988	$42,656	DOE

Objective:

To manufacture special stainless steel valves designed for molten nitrate salt service.

Approach/Background:

Construct a 3-MW_t solar panel research experiment (PRE) to allow flow testing with molten nitrate salt and to provide a test bed for DAR testing with actual solar heating. The system will be capable of operating at flow conditions typical of a commercialized DAR. Design the PRE for easy replacement of panels and manifolds to allow testing of different configurations in a timely manner. To this end, special valving is required to control the flow of molten nitrate salt in the PRE flow loop. The valving was chosen based upon critical evaluation of many types of valves and actual history of valves used in molten nitrate salt service at SNLA and SERI.

Status/FY 1988 Accomplishments:

Designed and manufactured the valves, which are scheduled to be delivered early in 1989.

Major Project Reports: None

Summary Date: October 1988

Test Support Personnel

Project/Area/Task:
Distributed Receiver Technology/
Distributed Receiver Systems/
Distributed Receiver Test Facility (DRTF)

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: C.P. Cameron

Telephone: (505) 844-0363

Contractor:
EG&G Washington Analytic
2450 Alamo Avenue, SE
Albuquerque, NM 87106

Principal Investigator: V. Dudley

Telephone: (505) 846-5483

Contract Number: SNLA 52-5653

Current Contract Period:
From: 08/83 **To:** 10/88

Contract Funding:		Source:
FY 1983	$150,000	DOE
FY 1984	-0-	—
FY 1985	$100,000	DOE
FY 1986	$200,000	DOE
FY 1987	$200,000	DOE
FY 1988	$40,000	DOE

Objective:

To provide engineering and technical support to the test activities at the DRTF.

Approach/Background:

Assign one test engineer and one technician, each with several years of experience in the solar thermal program, to support test activities under the direction of Sandia staff members on-site at the DRTF.

Status/FY 1988 Accomplishments:

Had the test engineer perform software development, data analysis, and testing for the Small Community Solar Experiments, Stirling heat engine, and sodium heat-pipe receiver projects.

Had the technician perform mechanical and electrical fabrication and operation in support of the same projects.

Major Project Report:

- Cameron, C.P., et al., 1987, *Modular Industrial Solar Retrofit Qualification Test Results*, (5 reports) SAND85-2316--2320, Albuquerque, NM: Sandia National Laboratories.

Summary Date: October 1988

Dynamic Simulation of Salt-in-Tube Central Receivers

Project/Area/Task:
Central Receiver/Balance of Plant

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: G.J. Kolb

Telephone: (505) 846-1976

Contractors:
Sandia National Laboratories

ESSCOR Corporation
512 Via de la Valle, Suite 311
Solana Beach, CA 92075

Principal Investigator: G.J. Kolb

Telephone: (505) 846-1976

Contract Number: 53-4209 (ESSCOR)

Current Contract Period:
From: 05/01/86 **To:** 03/31/88

Contract Funding:		Source:
FY 1986	$91,000	DOE
FY 1987	$84,500	DOE
FY 1988	$30,000	DOE

Objective:

To develop a PC-based simulation model of a salt-in-tube solar central receiver plant to support the development of a commercial-scale system.

Approach/Background:

Develop a commercial-scale central receiver system using molten salt as the working fluid. The U.S. utility industry participated in the development of a experimental-scale receiver tested at the Central Receiver Test Facility in 1987 and recently completed a study to define the next generation central receiver plant. Dynamic simulation models can be used to improve the design and operation of these plants. In particular, they can be used to optimize control algorithms, define margins of safety by studying the system response to equipment failures, and optimize energy production.

Developed a simulation model that mimicked the experimental-scale receiver just mentioned. The model is user-friendly and runs on an IBM personal computer. This promotes technology transfer between Sandia and the utility industry.

Status/FY 1988 Accomplishments:

Completed the simulation model and validated it with experimental data. The model accurately predicted the actual receiver performance during various transient conditions and can now be used to perform the design improvement studies listed previously. Disseminated copies of the user's manual, computer software, and project technical report to several utility companies and architect engineering firms interested in central receiver technology.

Major Project Reports:

- Neary, D.T., and M.R. Ringham, *A Dynamic Simulator/Analyzer for the Central Receiver Test Facility—User's Manual*, Solana Beach, CA: ESSCOR Corporation.
- Kolb, G.J., et al., *Dynamic Simulation of a Molten-Salt Solar Receiver*, SAND88-2895, Albuquerque, NM: Sandia National Laboratories.

Summary Date: October 1988

Contract Technicians

Project/Area/Task:
Central Receiver Technology/Central Receiver Test Facility

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: K.R. Boldt

Telephone: (505) 846-8109

Contractor:
Ewing Technical Design, Inc.
630 Haines, NW
Albuquerque, NM 87102

Principal Investigator: M. Watson

Telephone: (505) 243-6776

Contract Number: SNLA 48-0942

Current Contract Period:
From: 02/87 **To:** 12/88

Contract Funding:		Source:
FY 1987	$320,000	DOE
FY 1988	$380,000	DOE
FY 1989	$387,000	DOE

Objective:

To assist in the assembly, operation, and maintenance of facilities and experiments at the National Solar Thermal Test Facility (NSTTF).

Approach/Background:

Provide a maximum of 12 technicians on an as-needed basis to NSTTF. NSTTF includes five major facilities for performing solar thermal experiments: the Central Receiver Test Facility (CRTF), Distributed Receiver Test Facility, Solar Furnace, Line Fogs Facility, and Engine Test Facility. Assembly, operation, and maintenance of NSTTF facilities and experiments is performed by Sandia personnel with assistance of contract technicians. During FY 1988, the average labor level on this contract was five mechanical, three electronics, and one computer technician.

Status/FY 1988 Accomplishments:

Satisfying the basic objective, the technicians operated and maintained the NSTTF facilities during FY 1988. In addition, the technicians assisted in assembling, checking out, and testing several experiments performed at the facility, including the molten-salt direct absorption receiver, molten-salt pumps and valves, prototype heliostats, organic-Rankine engines, and the new CRTF field control and data acquisition systems.

Major Project Reports: None

Summary Date: October 1988

Contract Electrician

Project/Area/Task:
Solar Thermal Test Facility

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.M. Stomp

Telephone: (505) 844-1579

Contractor:
J&S Electric Co., Inc.
501 Eubank, SE, Suite 201
Albuquerque, NM 87123

Principal Investigator: J. Salas

Telephone: (505) 293-0160

Contract Number: SNLA 23-2639

Current Contract Period:
From: 06/88 **To:** 11/88

Contract Funding:		**Source:**
FY 1988	$70,000	DOE
FY 1989	$25,000	DOE

Objective:

To provide a journeyman electrician with high-voltage and low-voltage controls experience to assist with installing, starting up, modifying, and maintaining all electrical subsystems at the Solar Thermal Test Facility site.

Approach/Background:

Provide one journeyman electrician to meet objective.

Status/FY 1988 Accomplishments:

Provided a journeyman electrician to aid in installing the direct absorption receiver (DAR) H_2O test loop; to design the layout for DAR salt receiver panel structure and heat dump; to design the layout and installation of the Engine Test Facility test cell services; to modify, repair, and maintain the pump-and-valve loop tests; modify and maintain the Small Community Test Site.

Major Project Reports: None

Summary Date: October 1988

Direct Absorption Receivers (DAR) Design Studies

Project/Area/Task:
Central Receiver Technology/
Receivers

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.M. Chavez

Telephone: (505) 844-4485

Contractor:
Foster Wheeler Solar Development
Corporation
12 Peach Tree Hill Road
Livingston, NJ 07039

Principal Investigator: S.F. Wu

Telephone: (201) 535-2327

Contract Number: SNLA 06-0312

Current Contract Period:
From: 09/87 **To:** 09/89

Contract Funding:		Source:
FY 1987	$121,000	DOE
FY 1988	$15,884	DOE

Objective:

To investigate potential external DAR commercial designs, including panel and support system design, distribution and collection manifold design and thermal/hydraulic performance, blackener performance and costs, instrumentation and control requirements, and costs relative to salt-in-tube receivers.

Approach/Background:

In a DAR, the heat absorbing fluid (a blackened molten nitrate salt) flows in a thin film down a flat, near-vertical panel (rather than through tubes) and absorbs the concentrated solar flux directly. Potential advantages of the DAR include a significantly simplified design, improved thermal performance, increased reliability and operating life, and reduced capital and operating costs. To investigate the potential advantages of the DAR requires the following tasks: evaluate effects of receiver geometries and materials on thermal stress and panel deformation, assess response and hydraulic performance of manifold and piping, develop a receiver conceptual design, and estimate costs relative to salt-in-tube receivers developed for the Central Receiver Utility Studies.

Status/FY 1988 Accomplishments:

Completed the thermal stress analyses of the primary panel alternatives in 1987. Completed the conceptual design and cost estimates in 1988. Completed the final report, which is currently being reviewed for publication.

Major Project Report:

- Wu, S.F., and T.V. Narayana, 1989, *Commercial Direct Absorption Receiver Design Studies—Final Report*, SAND88-7038, Albuquerque, NM: Sandia National Laboratories. Work performed by Foster Wheeler Solar Development Corporation.

Summary Date: October 1988

Heat Engines

Project/Area/Task:
Distributed Receiver

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Division 6227
Albuquerque, NM 87185

Project Manager: K.L. Linker

Telephone: (505) 846-7817

Contractor:
Sandia National Laboratories
P.O. Box 5800
Division 6227
Albuquerque, NM 87185

Principal Investigator: P.C. Klimas

Telephone: (505) 844-8159

Contract Number: DE-AC04-760DP00789

Current Contract Period:
From: 01/86 **To:** 01/90

Contract Funding:		Source:
FY 1986	$1,100,000	DOE
FY 1987	$1,200,000	DOE
FY 1988	$1,200,000	DOE

Objectives:

To evaluate and develop heat engine technologies applicable to solar thermal electric technologies. Developing small, low-cost, efficient, long-life heat engines are of the utmost importance to the dish-electric concept. The *Solar Thermal Five-Year Plan* cites the need for engine performance and cost in the long term to be 41% annual efficiency and $300/kW$_e$ to support the system-level goal of $0.05/kWh$_e$.

Approach/Background:

Continue the research and development activities that have involved the dish-electric concept in which a heat engine and generator are located at the focus of a parabolic dish concentrator for heat-to-electric energy conversion. Study new concepts, design systems, develop hardware, and test the concepts.

Status/FY 1988 Accomplishments:

Stirling Thermal Motors (STM) demonstrated the engine at their facility and produced 23 kW of shaft power at a conversion efficiency of 40%. This measured power and efficiency agreed with the computer modeling predictions for this engine. After operating approximately 50 hours, STM delivered the engine to Sandia in September 1988 for further testing.

STM delivered to Sandia the four gas-fired heat pipes. Sandia is currently tuning the gas combustion system that will be connected to these units. STM did considerable design analysis for a heat pipe reflux receiver.

Purchased and fabricated some hardware to prove the technology. In addition, held a detailed design review of the reflux receiver at STM with Sandia attending. Sandia approved the design, and STM is continuing with procurement and fabrication.

Modified the DOE/National Aeronautics and Space Administration (NASA) Interagency Agreement in May 1988, extending the agreement through mid-1989. Released a request for proposal for the preliminary design of a 25-kW$_e$ free-piston Stirling engine, based upon the Phase I conceptual designs. Received proposals from the following contractor teams:

Cummins Engine Company (CEC) of Columbus, IN.

Mechanical Technology, Inc., of Latham, NY.

Stirling Technology Company (STC) of Richland, WA.

Completed the technical review with NASA Lewis Research Center of the proposals in August 1988 and made a recommendation to

the Lewis source selection official. Selected CEC and STC during the first quarter of FY 1989.

Major Project Reports:

- Mechanical Technology, Inc., 1988, *Conceptual Design of and Advanced Stirling Conversion System for Terrestrial Power Generation,* NASA CR-180890, Cleveland, OH: NASA Lewis Research Center.

- Stirling Technology Company, 1988, *25-kW$_e$ Solar Thermal Stirling Hydraulic Engine System, Final Conceptual Design Report,* NASA CR-180889, Cleveland, OH: NASA Lewis Research Center.

Summary Date: October 1988

Technician Support

Project/Area/Task:
Distributed Receiver Technology/
Receivers/Receiver Development

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: R.B. Diver

Telephone: (505) 846-0215

Contractor:
Kirk Mayer, Inc.
114 Washington, S.E.
Albuquerque, NM 87105

Principal Investigator: W.C. Ginn

Telephone: (505) 844-7473

Contract Number: SNLA 01-9646

Current Contract Period:
From: 12/86 **To:** 12/88

Contract Funding:		Source:
FY 1986	-0-	—
FY 1987	$60,000	DOE
FY 1988	$25,000	Sandia IR&D
FY 1989	$25,000	DOE

Major Project Reports: None

Summary Date: October 1988

Objective:

To provide technician support to assist in the development of distributed receiver technology and hardware.

Approach/Background:

Design and fabricate reflux heat-pipe solar receivers.

Status/FY 1988 Accomplishments:

Fabricated and shipped to Israel the Sandia-Israel reflux heat-pipe receiver/ reactor. Completed the design of the Sandia 75-kW reflux heat-pipe receiver.

Stretched-Membrane Dish Development Project, Phase I

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Dishes

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: T.R. Mancini

Telephone: (505) 844-8643

Contractor:
The LaJet Energy Company
P.O. Box 3599
Abilene, TX 79604

Principal Investigator: M.A. McGlaun

Telephone: (915) 698-8800

Contract Number: SNLA 53-9663B

Current Contract Period:
From: 11/86 **To:** 01/88

Contract Funding:		Source:
FY 1986	$496,000	DOE
FY 1987	-0-	—
FY 1988	-0-	—

Objective:

To develop a large diameter, stretched-membrane dish optical element, which includes developing fabrication techniques, designing the rim, and analyzing and evaluating the optical element.

Approach/Background:

The initial approach was to free-form yield a laminated polyester film to produce the large diameter membrane. Research at 3M, subcontracted by LaJet, showed that creep in the polymer film and the adhesive layers precluded the making of repeatable, stable stretched-membrane concentrators using this approach. A change in direction led to fabricating a concentrator from a composite made of fiberglass cloth and vinylester resin laminated to ECP-95 polyester film. The optical element was laid up on a tool plaster mandrel. LaJet fabricated two 1.8-m diameter membranes and one 4.6-m prototype. No measurements of the accuracy of the plaster mandrel were made. The poor optical quality of the concentrator elements made the evaluation impossible.

Status/FY 1988 Accomplishments:

Discontinued project; conducted a final project review January 1988.

Major Project Reports: None

Summary Date: October 1988

Feasibility Study for the Direct Catalytic Absorption Receivers (DCAR)

Project/Area/Task:
Distributed Receiver Technology/
Receivers/Receiver Development

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: R.B. Diver

Telephone: (505) 846-0215

Contractor:
Lawrence Berkeley Laboratory
Applied Science Division
Berkeley, CA 94720

Principal Investigator: A. Hunt

Telephone: (415) 486-5370

Contract Number: SNLA 02-7450

Current Contract Period:
From: 03/87 **To:** Complete

Contract Funding:		Source:
FY 1987	$80,000	DOE
FY 1988	-0-	—

Objective:

To assess the feasibility of DCARs for CO_2 reforming of methane.

Approach/Background:

Carry out an analytical program to analyze the performance of candidate DCAR designs.

Status/FY 1988 Accomplishments:

Established technical feasibility of DCAR.

Major Project Report:

Final report on the feasibility of DCARs for CO_2 reforming of methane will be published upon completion of project.

Summary Date: October 1988

Monitor Operation of the Solar One Power Plant

Project/Area/Task:
Central Receiver/System Experiments

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: G.J. Kolb

Telephone: (505) 846-1976

Contractor:
McDonnell Douglas Corporation
5301 Bolsa Avenue
Huntington Beach, CA 92647

Principal Investigator: R. Gervais

Telephone: (714) 896-3311

Contract Number: SNLA 98-2999

Current Contract Period:
From: 06/01/86 **To:** 12/31/88

Contract Funding:		**Source:**
FY 1988	$50,000	DOE

Contractor:
Marwest Engineering Services, Inc.5653
Stoneridge Drive, Suite 108
Pleasanton, CA 94566

Principal Investigator: A. Snedeker

Telephone: (415) 463-1780

Contract Number: SNLA 91-6374

Current Contract Period:
From: 01/01/84 **To:** 09/30/88

Contract Funding:		**Source:**
FY 1988	$25,000	DOE

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigator: G.J. Kolb

Telephone: (505) 846-1976

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: 10/01/87 **To:** 12/31/88

Contract Funding:		**Source:**
FY 1988	$40,000	DOE

Objectives:

To gather cost and performance data regarding the operation of the Solar One Pilot Plant during the semicommercial phase and to write a report describing the reliability of the plant during the power production phase.

Approach/Background:

Solar One was the world's largest central receiver power plant. Rated at 10 MW_e, the plant delivered 38,405 MWh (net) to the grid of the Southern California Edison Company during the three-year power production phase (August 1984--July 1987) and 14-month semicommercial phase (August 1987--September 1988). The goal of these phases was to deliver as much power as possible to the utility grid. The performance of the plant steadily improved during the more than 4 years of power operation.

During its final year, the plant achieved an availability of 96% and was only 10% below the long-term annual energy goal set for the plant. The very successful project concluded at the end of FY 1988, and the plant became inactive.

Status/FY 1988 Accomplishments:

Collected engineering data regarding the performance and operating costs of the plant during its final year of operation. The reasons behind the final stellar operating year will be documented in a report after these data are reviewed. In addition, a report was written that describes the frequencies and causes for plant outages during the power production phase. In addition to failure statistics, many qualitative

insights regarding the mitigation of component failures at future central receiver plants are also presented.

Major Project Reports:

- Kolb, G.J., and C.W. Lopez, 1988, *Reliability of the Solar One Plant During the Power Production Phase*, SAND88-2664, Albuquerque, NM: Sandia National Laboratories.

- Radosevich, L.G., 1987, *Final Report on the Power Production Phase of the 10-MW$_e$ Solar Thermal Central Receiver Pilot Plant*, SAND87-8022, Livermore, CA: Sandia National Laboratories.

Summary Date: October 1988

Free-Piston Stirling Engine (FPSE) Technology

Project/Area/Task:
Distributed Receiver

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Division 6227
Albuquerque, NM 87185

Project Manager: K.L. Linker

Telephone: (505) 846-7817

Contractor:
NASA Lewis Research Center
21000 Brookpark Rd
Cleveland, OH 44135

Principal Investigator: R.K. Shaltens

Telephone: (216) 433-6138

Contract Number: DE-AM04-80AL13137

Current Contract Period:
From: 10/85 **To:** 06/89

Contract Funding:		Source:
FY 1985	-0-	—
FY 1986	$475,000	DOE
FY 1987	$300,000	DOE
FY 1988	$300,000	DOE

Objectives:

To develop an FPSE for dish electric systems that can meet DOE's long-term performance and cost goals.

Approach/Background:

Under a DOE/ALO interagency agreement, the National Aeronautics and Space Administration (NASA) Lewis Research Center is providing technical management to develop an FPSE that has the potential for low maintenance and long life (over 60,000 hours). In the first phase, two industrial contractors, Mechanical Technology, Inc., (MTI) and Stirling Technology Company (STC) developed conceptual designs. The MTI design uses a system of gas springs to provide a coupling of the displacer and power pistons to drive a linear alternator. The design also calls for a wicked sodium heat pipe reflux boiler. The STC design features a potassium pool boiler receiver. In Phase II, a preliminary design will be developed based on the designs in Phase I.

Status/FY 1988 Accomplishments:

Modified the DOE/NASA Interagency Agreement in May 1988, extending the agreement through mid-1989. Released a request for proposal for the follow-on effort when the extension was approved. Phase II consists of a preliminary design of a 25-kW_e FPSE, based upon the Phase I conceptual designs. Received proposals from the following contractor teams:

Cummins Engine Company (CEC) of Columbus, IN

MTI of Latham, NY

STC of Richland, WA

NASA Lewis Research Center and Sandia completed the technical review of the proposals in August 1988 and made recommendations to the Lewis source selection official. Selected CEC and STC during the first quarter of FY 1989.

Major Project Reports:

- Mechanical Technology, Inc., 1988, *Conceptual Design of and Advanced Stirling Conversion System for Terrestrial Power Generation,* NASA CR-180890, Cleveland, OH: NASA Lewis Research Center.
- Stirling Technology Company, 1988, *25-kW_e Solar Thermal Stirling Hydraulic Engine System, Final Conceptual Design Report,* NASA CR-180889, Cleveland, OH: NASA Lewis Research Center.

Summary Date: October 1988

New Master Control System for Central Receiver Test Facility (CRTF)

Project/Area/Task:
Central Receiver Technology/Central Receiver Test Facility

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: K.R. Boldt

Telephone: (505) 846-8109

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigator: K.R. Boldt

Telephone: (505) 846-8109

Contract Number: DE-FC04-85AL30171

Current Contract Period:
From: 09/86 **To:** 08/88

Contract Funding:		Source:
FY 1986	-0-	—
FY 1987	$20,000	DOE
FY 1988	$30,000	DOE
FY 1989	$50,000	DOE

Objective:

Upgrade the CRTF control and data acquisition systems to support future operations.

Approach/Background:

The CRTF heliostat field control and data acquisition systems were originally installed with the facility in 1976. Due to age, the systems became increasingly unreliable and expensive to maintain. In FY 1986, new hardware was purchased to replace both of these systems. During the last two years, the new control and data acquisition software was developed as time permitted from other higher priority tasks. After the advanced molten-salt receiver test was completed early in FY 1988, both new systems were put into service and an initial checkout performed.

Status/FY 1988 Accomplishments:

In FY 1988, the new master control system and data acquisition systems for the CRTF were brought to a fully operational status. Both of the systems have satisfied their basic objectives and have had 100% availability for supporting experiments at the CRTF. The new master control system for the heliostat field has been extremely useful because it includes many advanced features that were previously not available. Both systems were used on a number of reimbursable experiments performed during the year.

The reduced physical size of the new systems has allowed relocation of all CRTF control functions to the windowed control tower at the site.

Major Project Reports: None

Summary Date: October 1988

Optical Materials Development

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Dishes

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: T.R. Mancini

Telephone: (505) 844-8643

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigator: T.R. Mancini

Telephone: (505) 844-8643

Contract Number: DE-AC04-76-DP00789

Current Contract Period::
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$100,000	DOE
FY 1987	$159,000	DOE
FY 1988	$208,000	DOE

Objective:

To develop an optical surface directly on a thin, metal substrate.

Approach/Background:

Develop optical materials in areas where Sandia has a unique expertise and a well-defined component application of which one is metal mirrors. Silvered, thin metals can be used for sheet metal collectors and for stretched-membrane solar collectors. They result in highly efficient structures because the optical surface becomes a load bearing part of the structure. If the structure is more efficient, it will also be more cost-effective.

Status/FY 1988 Accomplishments:

Mirrors produced to date use sol-gels as the planarizing-dielectric layer over the metal surface. Sol-gel glasses are produced using metal alkoxides as the glass precursors. In catalyzed alcoholic solutions, the metal alkoxides partially hydrolize to form glass-like polymer networks. Mirrors produced have demonstrated excellent specularity of 0.94 within a 15-mrad cone angle and having one standard deviation of about 1 mrad, which is comparable to good glass mirrors. Current emphasis is being placed on defining a suitable protective overcoat for the silver surface.

Major Project Reports: None

Summary Date: October 1988

Central Receiver Solar Thermal Study

Project/Area/Task:
Central Receiver Technology/System Studies/Conceptual Design

Directing Organization:
Albuquerque Operations Office
U.S. Department of Energy
P.O. Box 5400
Albuquerque, NM 87115

Project Manager: N.D. Lackey

Telephone: (505) 846-3220

Contractor:
Pacific Gas and Electric Company
3400 Crow Canyon Road
San Ramon, CA 94583

Principal Investigator: G.W. Braun

Telephone: (415) 866-5559

Contract Number: DE-FC04-86AL38740

Current Contract Period:
From: 06/86 **To:** 09/89

Contract Funding:		Source:
FY 1986	$1,000,000	DOE
FY 1987	$370,260	DOE
FY 1988	$200,000	DOE

Objective:

To study the appropriate path to eventual commercialization of solar central receiver technology. These utility studies have the users of the solar central receiver systems evaluate the state-of-the-art technology, select subsystem and integrated system design, provide a conceptual design, and define an experimental program to verify the adequacy of the designs.

Approach/Background:

Completed the Phase I conceptual design study in FY 1987. Define in Phase II the path to commercialize central receiver technology, including defining research and development needs to reduce the technical and financial risks.

Status/FY 1988 Accomplishments:

Combined the two utility teams into a single team. Completed Phase II studies; recommendations will be presented early in the first quarter of FY 1989.

Major Project Report:

- Delaquil, P., III, B.D. Kelly, and J.C. Egan, 1988, *Solar Central Receiver Technology Advancement for Electric Utility Applications: Phase I; Topical Report*, Vols. I and II, Report No. 007.2-88.2, San Francisco, CA: Bechtel.

Summary Date: October 1988

Low-Cost Drive Mechanism for Heliostats

Project/Area/Task:
Concentrator Development/Test, Evaluation, and Measurement

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.W. Grossman

Telephone: (505) 846-5482

Contractor:
Peerless-Winsmith, Inc.
172 Eaton St.
Springville, NY 14141

Principal Investigator: W.H. Heller

Telephone: (716) 592-9311

Contract Number: SNLA 90-5753

Current Contract Period:
From: 06/86 **To:** 11/88

Contract Funding:		Source:
FY 1986	-0-	--
FY 1987	$347,036	DOE
FY 1988	$140,304	DOE

Objective:

To develop a drive mechanism for heliostats that can be produced in quantities of 50,000/yr at a cost between $11 and $14/m^2 of heliostat area. In 1986, cost estimates for heliostat drives were approximately $32/m^2 of heliostat area.

Approach/Background:

Design an innovative approach using an open ball screw for the elevation drive and an orbiting-plate gear for the azimuth drive. The drive mechanism was sized to support a 150-m^2 heliostat. Build three prototypes for testing at the Solar Thermal Test Facility (STTF).

Status/FY 1988 Accomplishments:

Fabricated the prototypes and delivered them to the STTF. Tested the first unit to destruction under static load conditions. Returned it to the factory for evaluation; it was subsequently loaned to Alpha Solarco who will refurbish and evaluate it as a drive for a photovoltaic array.

Mounted the second unit on the Advanced Thermal Systems, Inc., large area heliostat where it is undergoing life-cycle testing. Do environmental tests on the third unit in FY 1989.

Major Project Report:

- Heller, W., and J. Peters, 1989, *Development of a Low-Cost Solar Heliostat Drive Mechanism*, Springville, NY: Peerless-Winsmith, Inc., in press.

Summary Date: October 1988

Photovoltaic-Central-Receiver (PVCR) Power Plant Study

Project/Area/Task:
Central Receiver/Systems Analysis

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Managers: D.F. Menicucci/
G.J. Kolb

Telephone: (505) 846-3068

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigators: D.F. Menicucci/
G.J. Kolb

Telephone: (505) 846-3068

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: 03/01/88 **To:** 06/30/88

Contract Funding:		**Source**
FY 1988	$30,000	DOE

Objective:

To assess the economic potential of a PVCR power plant.

Approach/Background:

For nearly a decade, various organizations and individuals from both the solar thermal and PV communities have expressed interest in pursuing a PVCR power plant. Such a plant is created by replacing the tubed receiver and steam cycle found in a conventional central receiver with a PV array and inverter. The concept of a PVCR system was not seriously considered in the past because of the high cost and marginal quality of concentrating-type PV cells. Recent breakthroughs in PV cell efficiency and quality coupled with the design of low-cost heliostats justified reconsidering the concept.

Status/FY 1988 Accomplishments:

Performed a systems analysis to better understand the potential economic benefits of a PVCR plant. The results suggest that a PVCR plant may be able to produce electricity more cost-effectively than a Fresnel lens photovoltaic concentrator or a molten-salt central receiver plant with a rating of less than 50 MW_e. Presented these results to several companies who are developing solar technology. Collectively, developed a project plan to address various approaches. It was decided that the first reflective system should put the PV receiver at the focal point of a dish rather than on a central receiver tower, even though the economics of a large system may favor the tower approach. Several companies have submitted cost-shared proposals to Sandia to continue development of the PV-dish concept.

Major Project Reports: None

Summary Date: October 1988

Small Community Solar Experiment #2 (SCSE#2) Support

Project/Area/Task:
Distributed Receiver Technology/
Distributed Receiver Systems/
Small Community Solar Experiment #2/
Qualification Testing

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: A.A. Heckes

Telephone: (505) 844-3918

Contractor:
Power Kinetics, Inc.
415 River St.
Troy, NY 12180-2822

Principal Investigator: W.E. Rogers

Telephone: (518) 271-7743

Contract Number: SNLA 05-7743

Current Contract Period:
From: 06/86 **To:** 08/88

Contract Funding:		Source:
FY 1988	$55,816	DOE

Objectives:

To provide technical support for the operation and testing of the SCSE#2. This work was performed in the conduction of Sandia's Qualification Testing Program after the SCSE#2 was installed at the Distributed Receiver Test Facility and operations were under Sandia control.

Approach/Background:

Furnish technical contractor personnel to perform Sandia Qualification Testing Program per a schedule directed by the Sandia delegated representative.

Status/FY 1988 Accomplishments:

Conducted qualification testing of the SCSE#2 project at Sandia's Distributed Receiver Test Facility from June through August 1988. Fully qualified the SCSE#2 project and concluded testing in August 1988.

Major Project Report:

- Cameron, C.P., 1986, *Small Community Solar Experiment #2 Module Test Results*, SAND86-2802, Albuquerque, NM: Sandia National Laboratories.

Summary Date: October 1988

Shenandoah Fiber Optic Link

Project/Area/Task:
Distributed Receiver Technology/
Distributed Receiver Systems/Shenandoah
Solar Total Energy Project/Data Evaluation

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: A.A. Heckes

Telephone: (505) 844-3918

Contractor:
Prime Manufacturing
765 E. Glen Avenue
Auburn, AL 36830

Principal Investigator: T. Hicks

Telephone: (205) 821-6334

Contract Number: SNLA 05-6490

Current Contract Period:
From: 06/88 **To:** 08/88

Contract Funding:		Source
FY 1988	$39,000	DOE

Objectives:

To improve the reliability of communication between individual collectors in the Shenandoah Solar Total Energy Project (STEP) solar collector field and between the collector field and the command center through fiber optics by eliminating spurious electrical signals and reducing the extent of damage caused by lightning strikes.

Approach/Background:

Design a low-cost fiber optic communication link and install it using plastic optic cabling and simple optical-to-electrical interfaces to interconnect individual solar collectors and to connect the solar field to a central controller.

Status/FY 1988 Accomplishments:

Began operation of fiber optic link at the STEP site during August 1988; current performance is excellent. Conduct future testing through continued solar field use.

Major Project Reports: None

Summary Date: October 1988

Reflux Heat-Pipe Solar Receivers

Project/Area/Task:
Distributed Receiver/Receivers

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: R.B. Diver

Telephone: (505) 846-0215

Contractor:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Principal Investigator: R.B. Diver

Telephone: (505) 846-0215

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source
FY 1987	$300,000	DOE
FY 1988	$600,000	DOE

Objective:

To develop the reflux heat-pipe solar receiver for dish-electric stirling systems through analytical design and experimental activities.

Approach/Background:

Stirling dish-electric systems were identified as being able to meet DOE's long-term energy cost goals. Dish-electric systems based on Stirling engine technology were successfully demonstrated by Advanco Corp. and McDonnell Douglas Corp. and showed the potential for high efficiency. To reach the ultimate potential for dish-electric systems requires a high-efficiency, low-maintenance, and low-cost receiver. The current development thrust is to improve the longevity and reduce the operations and maintenance costs of these systems, as well as to improve performance and raise operating temperatures.

The reflux heat-pipe receiver is the next step in evaluating Stirling receiver technology and has the potential to address all of the shortcomings of the Advanco and McDonnell Douglas designs.

In the reflux heat-pipe solar receiver, a liquid metal, such as sodium or potassium, is used as an intermediate heat-transfer fluid between a solar receiver/absorber and the heater tubes of a Stirling engine. The liquid metal is evaporated from the backside of the solar absorber and flows to the Stirling engine's heater tubes where it condenses. The liquid metal is then passively returned to the evaporator by gravity, capillary forces in a wick, or by a combination of the two effects.

Status/FY 1988 Accomplishments:

Completed the first on-sun test of a reflux heat-pipe solar receiver in Israel. In this test, solar energy was used to drive an endothermic chemical reaction.

Also developed experimental and analytical tools to evaluate reflux receiver design options. Completed a facility for bench-testing small-scale proof-of-concept hardware. Developed designs, test plans, and safe operating procedures for full-scale on-sun testing. Expanded computer programs to design and analyze reflux heat-pipe receivers and used them in the designs.

Major Project Reports:

- Andraka, C.E., R.B. Diver, 1988, "Reflux Heat-Pipe Solar Receivers for Dish-Electric Systems," SAND87-2976C, *Proceedings, 23rd IECEC.*
- Diver, R.B., J.D. Fish, R. Levitan, M. Levy, H. Rusin, and J.T. Richardson, 1988, "Solar Test of an Integrated Sodium Reflux Heat-Pipe Receiver/Reactor for Thermochemical Energy Transport," SAND88-1255C, *Proceedings, 4th International Symposium on Research: Development and Applications of Solar Thermal Technology.*

- Adkins, D.R., 1988, *Analysis of Heat Pipe Receivers for Point-Focus Solar Concentrators*, SAND88-0093, Albuquerque, NM: Sandia National Laboratories.

Summary Date: October 1988

Stretched-Membrane Heliostat Development

Project/Area/Task:
Central Receiver Technology/
Concentrators

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: D.J. Alpert

Telephone: (505) 844-6982

Contractor:
Science Applications International
Corporation
10401 Roselle St.
San Diego, CA 92121

Principal Investigator: B. Butler

Telephone: (619) 458-3844

Contract Number: SNLA 33-1226

Current Contract Period:
From: 04/87 **To:** 12/88

Contract Funding:		Source:
1987	$423,463	DOE
1988	$74,437	DOE

Objective:

To develop an improved design for a stretched-membrane heliostat for use in solar central receiver electric power or process heat applications.

Approach/Background:

The design and fabrication of the first prototype mirror module identified a number of areas where design improvements or additional cost savings might be possible. Based on previous work, develop an improved commercial-scale heliostat design. In addition, design and build a 50-m^2 prototype stretched-membrane mirror module that is as representative as possible of the commercial design. The prototype mirror module will be installed at the Central Receiver Test Facility for testing by Sandia.

Status/FY 1988 Accomplishments:

Completed the design of an improved commercial-scale heliostat. Built and installed a prototype mirror module at the Solar Thermal Test Facility.

Major Project Reports: None

Summary Date: October 1988

Stretched-Membrane Heliostat Development

Project/Area/Task:
Central Receiver Technology/
Concentrators

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: D.J. Alpert

Telephone: (505) 846-1976

Contractor:
Solar Kinetics, Inc.
10635 King William Dr.
Dallas, TX 75220

Principal Investigator: J.A. Hutchison

Telephone: (214) 556-2376

Contract Number: SNLA 33-1227

Current Contract Period:
From: 03/87 **To:** 06/89

Contract Funding:		Source:
FY 1987	$449,800	DOE
FY 1988	$112,200	DOE

Objective:

To develop an improved design for a stretched-membrane heliostat for use in solar central receiver electric power or process heat applications.

Approach/Background:

The design and fabrication of the first prototype mirror module identified a number of areas where design improvements or additional cost savings might be possible. Based on the previous work, develop an improved commercial-scale heliostat design. In addition, design and build a 50-m^2 prototype stretched-membrane mirror module that is as representative as possible of the commercial design. The prototype mirror module will be installed at the Central Receiver Test Facility for testing by Sandia.

Status/FY 1988 Accomplishments:

Completed the design of an improved commercial-scale heliostat. Began fabricating the prototype mirror module.

Major Project Reports: None

Summary Date: October 1988

Stretched-Membrane Dish Development Project, Phase I

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Dishes

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: T.R. Mancini

Telephone: (505) 844-8643

Contractor:
Solar Kinetics, Inc.
P.O. Box 540636
Dallas, TX 75354-0636

Principal Investigators: J.A. Hutchison/
D.L. White

Telephone:: (214) 556-2376

Contract Number: SNLA 53-9663A

Current Contract Period:
From: 11/86 **To:** 01/88

Contract Funding:		Source:
FY 1986	$551,000	DOE
FY 1987	-0-	—
FY 1988	-0-	—

Objective:

To develop a large-diameter stretched-membrane dish optical element that includes developing fabrication techniques, designing the rim, and analyzing and evaluating the optical element.

Approach/Background:

The Solar Kinetics, Inc., (SKI) stretched-membrane dish design makes use of a free-form yielded metal membrane with an overlaying, unattached, yielded polymer optical membrane. By applying a non-uniform load to the metal membrane during the forming process, SKI is able to control the shape and slope error of the final optical element. Under this contract, 35 metal membranes of 1.8 m-diameter and two 3.7-m-diameter membranes were fabricated. The best of these demonstrated slope errors of approximately 3.5 mrad.

Status/FY 1988 Accomplishments:

The Phase I results were very encouraging, and a second contract was placed with SKI to continue this work. Conducted a final design review in January 1988.

Major Project Reports:

- Solar Kinetics, Inc., 1989, *Development of a Stretched Membrane Dish—Phase I*, SAND88-7035, Albuquerque, NM: Sandia National Laboratories.

Summary Date: October 1988

Stretched-Membrane Dish Development Project, Phase II

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Dishes

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: T.R. Mancini

Telephone: (505) 844-8643

Contractor:
Solar Kinetics, Inc.
P.O. Box 540636
Dallas, TX 75354-0636

Principal Investigators: J.A. Hutchison/
D.L. White

Telephone: (214) 556-2376

Contract Number: SNLA 55-2495

Current Contract Period:
From: 04/88 **To:** 08/90

Contract Funding:		Source:
FY 1988	$900,000	DOE

Objective:

To develop an 11-m-diameter, stretched-membrane dish collector.

Approach/Background:

The Solar Kinetics, Inc., (SKI) stretched-membrane dish design makes use of a free-form yielded metal membrane with an optical membrane of CP 300 silvered film over the top. In Phase I of the project, SKI demonstrated the fabrication technique. Under this contract, SKI resolves issues associated with the membrane materials, fabrication techniques, and the optical effect of the seams. Once the membrane fabrication issues are resolved, SKI will build a 7-m-diameter optical element to be installed on an existing pedestal.

Following the successful demonstration of the 7-m optical element, they will design and build a stretched-membrane solar collector about 11 m in diameter that is compatible with a 25-kW Stirling engine.

Status/FY 1988 Accomplishments:

The contractor is currently evaluating the membrane fabrication issues.

Major Project Reports: None

Summary Date: October 1988

Kinematic Stirling Engine Technology

Project/Area/Task:
Distributed Receiver

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Division 6227
Albuquerque, NM 87185

Project Manager: K.L. Linker

Telephone: (505) 846-7817

Contractor:
Stirling Thermal Motors, Inc.
2841 Boardwalk
Ann Arbor, MI 48104

Principal Investigator: T. Godett

Telephone: (313) 995-1755

Contract Number: SNLA 53-8452

Current Contract Period:
From: 07/86 **To:** 12/86

Contract Funding:		Source:
FY 1986	$299,950	DOE
FY 1987	-0-	—
FY 1988	$5,000	DOE

Objective:

To demonstrate the Stirling Thermal Motors, Inc., (STM) kinematic Stirling engine for a dish-electric system that has near-term commercialization potential and meets DOE's performance and cost goals.

Approach/Background:

The kinematic Stirling cycle engine is considered a near-term heat engine for the solar thermal electric technology dish-electric applications. To advance the Stirling technology toward longer life and commercialization, Sandia recently acquired an STM 25-kW kinematic Stirling engine, STM4-120, for evaluation. This engine was designed from the outset to be a long-life and commercial product engine.

Status/FY 1988 Accomplishments:

In FY 1988, STM demonstrated the engine at their facility and produced 23 kW of shaft power at a conversion efficiency of 40%. This measured power and efficiency agreed with the computer modeling predictions for this engine. After operating approximately 50 hours, STM delivered the engine to Sandia in September 1988 for further testing.

Major Project Reports: None

Summary Date: October 1988

Kinematic Stirling Engine Technology

Project/Area/Task:
Distributed Receiver

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Division 6227
Albuquerque, NM 87185

Project Manager: K.L. Linker

Telephone: (505) 846-7817

Contractor:
Stirling Thermal Motors, Inc.
2841 Boardwalk
Ann Arbor, MI 48104

Principal Investigator: T. Godett

Telephone: (313) 995-1755

Contract Number: SNLA 33-3036

Current Contract Period:
From: 04/87 **To:** 09/88

Contract Funding:		Source:
FY 1987	$124,000	DOE
FY 1988	$31,000	DOE

Objective:

To design and fabricate four gas-fired heat pipes to operate with the Stirling Thermal Motors, Inc., (STM) STM4-120 kinematic Stirling engine delivered to Sandia. To develop and fabricate two solar flux receivers based on heat pipe technology.

Approach/Background:

To test the STM4-120 kinematic Stirling engine "on-sun" requires a solar reflux heat-pipe receiver. The solar receiver efficiently absorbs the sun's concentrated energy and transports the heat to the engine via heat pipes. STM has considerable experience in the field of heat-pipe technology and is familiar with the interface requirements of the STM4-120 engine. To test the STM4-120 delivered to Sandia requires four gas-fired heat pipes. These heat pipes allow the STM4-120 to be demonstrated in a test cell without solar energy. This is possible because the Stirling cycle engine is an external combustion engine.

Status/FY 1988 Accomplishments:

Delivered the four gas-fired heat pipes to Sandia. Sandia is currently tuning the gas combustion system that will be connected to these units. STM did considerable design analysis for a reflux heat-pipe receiver. Some hardware was purchased and fabricated to prove the technology. In addition, a detailed design review of the reflux receiver was held at STM with Sandia attending. Sandia approved the design, and STM is continuing with procurement and fabrication.

Major Project Reports: None

Summary Date: October 1988

Technical Support Services

Project/Area/Task:
Distributed Receiver Technology/
Receivers/Receiver Development

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: R.B. Diver

Telephone: (505) 846-0215

Contractor:
Tech Reps, Inc.
5000 Marble Ave., N.E.
Albuquerque, NM 87114

Principal Investigator: W. Jones

Telephone: (505) 262-2077

Contract Number: SNLA 01-2370

Current Contract Period:
From: 12/86 **To:** 12/88

Contract Funding:		Source:
FY 1986	-0-	—
FY 1987	$50,000	DOE
FY 1988	$50,000	DOE

Objective:

To provide technical support services to assist Sandia in the reporting and transfer of distributed receiver technology.

Approach/Background:

Provide support services for technical illustrations and preparation of technical and quarterly reports.

Status/FY 1988 Accomplishments:

Provided continuing technical support.

Major Project Reports: None

Summary Date: October 1988

Technical Computer Programming Support

Project/Area/Task:
Distributed Receiver Technology/Heat Engines/Stirling Engine Development

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: M.E. Fewell

Telephone: (505) 844-7120

Contractor:
Technadyne Engineering Consultants, Inc.
300 Virginia Ave., N.E.
Albuquerque, NM 87108

Principal Investigator: J. Collins

Telephone: (505) 266-3084

Contract Number: SNLA 06-5409

Current Contract Period:
From: 12/87 **To:** 12/88

Contract Funding:		Source:
FY 1987	$70,000	DOE
FY 1988	$81,000	DOE

Objective:

To provide technical computer programming support for Sandia engineers performing systems engineering and analysis.

Approach/Background:

Provide programming support for field system analysis, parametric studies, and input/output processing based on data input from Sandia technical staff.

Status/FY 1988 Accomplishments:

Supported central engine study, CIRCE analysis of SCAD concentrator, and input/output processing SOLTOX.

Major Project Reports: None

Summary Date: October 1988

Solar Collector Pedestal Fabrication, Assembly, and Installation

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Dishes

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: T.R. Mancini

Telephone: (505) 844-8643

Contractor:
TIW Fabrication and Machining, Inc.
1255 Coors Road, S.W.
P.O. Box 12156
Albuquerque, NM 87195

Principal Investigator: T. McLellan

Telephone: (505) 242-5251

Contract Number: SNLA 57-4436

Current Contract Period:
From: 09/87 **To:** 12/89

Contract Funding:		Source:
FY 1987	$57,140	DOE

Objectives:

To fabricate a solar collector pedestal per drawings provided by Sandia and assemble the drive and install it at Sandia's Solar Thermal Test Facility.

Approach/Background:

Build the redesigned Acurex innovative concentrator pedestal to accommodate the 7-m stretched-membrane optical element to be fabricated by Solar Kinetics, Inc., during Phase II of their contract. This all-purpose pedestal will serve as a test bed for solar concentrator optical elements and eliminate the need to build a new pedestal for each design.

Status/FY 1988 Accomplishments:

Completed the fabrication of the pedestal in FY 1988.

Major Project Reports: None

Summary Date: October 1988

Carbon Dopants for the Direct Absorption Receiver (DAR)

Project/Area/Task:
Central Receiver Technology/Receivers

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: J.T. Holmes

Telephone: (505) 844-6871

Contractor:
University of California
Lawrence Berkeley Laboratories
Berkeley, CA 94720

Principal Investigator: A. Hunt

Telephone: FTS 451-5370

Contract Number: SNLA 23-3357

Current Contract Period:
From: 05/87 **To:** 08/88

Contract Funding:		Source:
FY 1987	$35,000	DOE
FY 1988	$35,000	DOE

Objective:

To evaluate the potential use of carbon particles to make molten nitrate salts efficiently absorb concentrated sunlight for use in the falling-film DAR.

Approach/Background:

Molten nitrate salts do not efficiently absorb sunlight without the addition of blackeners. Nonreactive metal oxide particles can be used but must be recycled and may cause serious erosion effects when pumped through the piping systems. Carbon particles can provide the required absorptivity enhancement and will not recirculate because they react with the salt, forming carbon dioxide gas. Carbon is also a low-cost material compared to metal oxides. The feasibility of using carbon for blackening molten nitrate salts requires experimental and theoretical studies.

Status/FY 1988 Accomplishments:

Completed the work in FY 1988. Results showed that good absorptivities could be achieved with carbon particles generated from the pyrolysis of methane. The carbon reacts slowly enough in the salt to maintain its enhanced absorptivity while it is in the solar beam for falling-film direct absorption receiving applications.

Major Project Reports: None

Summary Date: October 1988

Technology Transfer from the University of Houston

Project/Area/Task:
Central Receiver/Systems Analysis

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: G.J. Kolb

Telephone: (505) 846-1976

Contractor:
University of Houston
Office of Research Administration
4800 Calhoun Street
Houston, TX 77004

Principal Investigator: L. Vant-Hull

Telephone: (713) 749-1154

Contract Number: 04-5741

Current Contract Period:
From: 03/07/86 **To:** 01/31/89

Contract Funding:		Source:
FY 1986	$25,000	DOE
FY 1987	$30,000	DOE
FY 1988	$25,000	DOE

Objective:

To transfer central receiver technology developed at the university over the last 10 years to Sandia and to industry.

Approach/Background:

The university has developed several computer codes over the last 10 years that can be used to optimize the optical design of a central receiver power plant. These codes were used to establish the optical design at the Solar One Pilot Plant and are used in several U.S. utility studies of central receiver plants. Sandia and the utility industry acquired these computer codes because they have some capabilities that the Sandia and industry codes currently do not possess. Technology transfer among the organizations was facilitated by improving the user-friendliness of the code-input modules, writing a user's manual, and holding several workshops on the theory and operation of the codes.

Status/FY 1988 Accomplishments:

Held a workshop regarding the operation of its central receiver code system. Sandia used the codes during the year to explore options for expanding the Central Receiver Test Facility heliostat field.

Major Project Report:

- Pitman, C.L., and L.L. Vant-Hull, 1989, *The University of Houston Central Receiver Code System: Updates and Start-up Kits*, Albuquerque, NM: Sandia National Laboratories, in press.

Summary Date: October 1988

Documentation Project Editor

Project/Area/Task:
Distributed Receiver Technology/Project Management Solar Thermal Energy Conversion Technology Status and Assessment

Directing Organization:
Sandia National Laboratories
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Project Manager: J.V. Otts

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Contractor:
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Solar Energy Laboratory
Houston, TX 77004

Principal Investigator: L. Vant-Hull

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Contract Number: SNLA 06-8076

Current Contract Period:
From: 09/87 **To:** 12/89

Contract Funding:		Source:
FY 1987	$144,321	DOE
FY 1988	-0-	—

Objectives:

To plan, organize, write portions of, and edit portions of the *Solar Heat Technologies: Fundamentals and Applications* documentation project.

Approach/Background:

Produce two volumes of the 12-volume documentation series. Direct the efforts of all individual authors, arrange for peer reviews, and coordinate the technical production and publishing agencies. These volumes will include research on central and distributed receiver technologies.

Status/FY 1988 Accomplishments:

Submitted a first draft outline (with recommended authors) to Sandia. The final outline is under negotiation. Determined the funding procedures for authors, thus clearing the way for negotiations with authors.

Major Project Reports:

Volumes 11 and 12 of *Solar Heat Technologies: Fundamentals and Applications* documentation series to be published.

Summary Date: October 1988

Volumetric Receivers Design and Testing

Project/Area/Task:
Central Receiver Technology/Receivers

Directing Organization:
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Project Manager: J.M. Chavez

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Contractor:
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Principal Investigator: J.M. Chavez

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Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: 05/87 **To:** 10/89

Contract Funding:		Source:
FY 1987	$20,000	DOE
FY 1988	$50,000	DOE
FY 1989	$75,000	DOE

Objective:

To participate in testing and keep up to date on the development of the volumetric receiver. In a volumetric receiver, air is drawn through a porous absorber (heat exchanger) on which the solar energy is concentrated and absorbed. The volumetric air receiver concept was proposed as an advanced receiver that would allow the use of higher fluid temperatures to improve efficiency in the process or cycle or to use in initiating particular chemical reactions. The European community is very interested in the concept of the volumetric receiver for producing high-temperature (>550°C) air.

Approach/Background:

Developed and tested a metal wire mesh volumetric receiver during FY 1987 under the International Energy Agency/Small Solar Power Systems Task VII. Sandia participated in the testing, which was conducted in Almeria, Spain, at the Plataforma de Solar Laboratory beginning in August 1987. Sandia prepared a computer model of the volumetric receiver for predicting and evaluating results. Sandia recently designed and fabricated a new volumetric receiver absorber to be tested at the Plataforma using a porous ceramic material.

Status/FY 1988 Accomplishments:

Tested volumetric receivers, which, thus far, demonstrate the feasibility of the concept for use in central receiver systems. Sent the porous ceramic absorber, designed and fabricated by Sandia, to the Plataforma in Spain for testing. The European PHOEBUS consortium is very interested in volumetric receivers for use in their proposed 30-MW_e central receiver power plant. Bechtel National has also performed a systems analysis and conceptual design of a volumetric receiver as their contribution to the PHOEBUS consortium.

Major Project Report:

- Skocypec R.D., et al., 1988, "Heat Transfer Modeling of the IEA/SSPS Volumetric Receiver," *Proceedings, AIChE/ANS 25th National Heat Transfer Conference*, Houston, TX, July 24-27, page 146-153.

Summary Date: October 1988

Dish Concentrator Development

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Dishes

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Project Manager: T.R. Mancini

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Contractor:
Sandia National Laboratories
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Albuquerque, NM 87185

Principal Investigator: T.R. Mancini

Telephone: (505) 844-8643

Contract Number: DE-AC04-76-DP00789

Current Contract Period:
Ongoing multiyear research

Contract Funding:		Source:
FY 1986	$500,000	DOE
FY 1987	$450,000	DOE
FY 1988	$457,000	DOE

Major Project Reports: None

Summary Date: October 1988

Objective:

To provide contract monitoring and technical support for dish collector development projects.

Approach/Background:

Provide technical and fiscal contract monitoring and technical support for Sandia contracts.

Status/FY 1988 Accomplishments:

Provided technical support for analyzing and redesigning the LaJet Innovative Concentrator and for the Solar Kinetics, Inc., Stretched-Membrane Dish Development Project.

Distributed Receiver Systems

Project/Area/Task:
Systems Engineering and Analysis

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Contractor:
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Principal Investigators: J.M. Diggs/
H.E. Reilly

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Contract Number: DE-AC04-76-DP00789

Current Contract Period:
From: FY 1987 **To:** FY 1989

Contract Funding:		Source:
FY 1987	$200,000	DOE
FY 1988	$152,000	DOE

Objective:

To develop the tools and expertise necessary to provide guidance from the system level about performance and cost trade-offs and to provide the means to investigate component interaction that can aid in directing component development. Toward that end, the capability for both parametric analysis and detailed analysis of dish electric systems was worked on. Systems analysis in support of internal research and development work on the solar destruction of hazardous waste was also conducted, as was continued support of analysis of the existing Shenandoah project.

Approach/Background:

Study dish-electric systems with Stirling engines, considering both kinematic and free-piston Stirling engine systems. The study consisted of model development, a preliminary feasibility study, conceptual designs, and detailed performance and economics.

Analyze systems in support of Sandia's internally funded work on solar destruction of hazardous wastes, which included system-level modeling of a solar-driven waste destruction process and evaluation of competing disposal technologies.

Status/FY 1988 Accomplishments:

A preliminary feasibility study showed that dish-Stirling systems had the potential to meet the DOE program long-term goals. The next more detailed study led to the development of a model for examining conceptual designs of systems with kinematic and free-piston Stirling engines and with gas hybrid capability. Annual performance of the various systems confirmed the potential for such dish-electric systems in the solar-only mode. Interest in hybridizing these systems with gas combustion comes from at least one potential application—that of peaking plants for utility companies.

Although the load demand from these plants coincides closely with the availability of sunshine, it is not identical. Thus, hybridization of the dish-electric system would appear beneficial. The study indicated that the increased flexibility and output from a gas-fired solar dish offers significant advantages and is economically feasible. The technical challenge of incorporating a gas combustor into a solar receiver will be addressed this coming year.

Two systems analysis activities supported Sandia's evaluation of the potential for using solar energy to destroy hazardous wastes. The first activity gathered data on the types and quantities of wastes produced and the types and costs of currently available disposal technologies. This information will be used to assess the viability of a solar waste destruction concept.

The second activity initiated a modeling effort to aid in designing a solar waste destruction process. This model will use process performance data, generated by a test program under (new structure) Mission 2, to size the solar equipment required to destroy a specified waste stream.

Thus, various tools for evaluating distributed receiver systems were developed. The first is used for parametric analysis to quickly assess system feasibility. A second was constructed to examine the annual performance and economics of dish-electric conceptual designs. Some additional work was completed to allow the portability of SOLTES (a large solar thermal design code) from a mainframe computer to personal computer with the goal of increased accessibility to industry.

And a fourth analytic tool was developed to aid in designing a solar waste destruction process.

Major Project Reports: None

Summary Date: October 1988

Point-Focus Concentrator Structural Analysis

Project/Area/Task:
Distributed Receiver Technology/
Concentrators/Point Focus

Directing Organization:
Sandia National Laboratories
P.O. Box 5800
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Contractor:
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6607 Stonebrook Circle
Dallas, TX 75420

Principal Investigator: V. Goldberg

Telephone: (214) 233-4729

Contract Number: SNLA 33-1510

Current Contract Period:
From: 01/87 **To:** 03/89

Contract Funding:		Source:
FY 1987	$99,000	DOE
FY 1988	$20,000	DOE

Objectives:

To assist Sandia in reviewing structural analysis of solar concentrators that are or will be constructed at Sandia's Distributed Receiver Test Facility and to support Sandia in conducting structural modifications or repairs to existing concentrators.

Approach/Background:

Review the adequacy of concentrator structural designs, emphasizing the possibility of structural failure and structural deflections that affect performance.

Status/FY 1988 Accomplishments:

Oversaw fabrication of, installation of, repairs of, and modifications to the Power Kinetics, Inc., concentrator for Small Community Solar Experiment #2. Analyzed bearing failure on the LaJet innovative concentrator and specified modifications. Reviewed designs for stretched-membrane concentrator program.

Major Project Reports: None

Summary Date: October 1988

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Murphy, L.M., and T.R. Mancini, eds., 1988, *Solar Engineering—1988: Proceedings of the Tenth Annual ASME Solar Energy Conference*, Denver, CO, April 10–14, New York: The American Society of Mechanical Engineers, 552 pp.

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Index of Current Contractors

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