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Solar Thermal Energy Systems

Program Summary Fiscal Year 1984

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Preface

The research and development (R&D) described in this document was conducted within the U.S. Department of Energy's (DOE) Solar Thermal Technology Program. The goal of the Solar Thermal Technology Program is to advance the engineering and scientific understanding of solar thermal technology and to establish the technology base from which private industry can develop solar thermal power production options for introduction into the competitive energy market.

In solar thermal technology, tracking mirrors or lenses concentrate sunlight onto a receiver. The heat absorbed by the receiver is converted into electricity or used as process heat. The two primary solar thermal technologies, central receivers and distributed receivers, use various point and line-focus optics to concentrate sunlight. Central receiver systems use fields of heliostats (two-axis tracking mirrors) to focus the sun's rays onto a single tower-mounted receiver. Parabolic dishes up to 17 meters in diameter track the sun in two axes and use mirrors or Fresnel lenses to focus radiant energy onto a receiver. Troughs and bowls are line-focus tracking reflectors that concentrate sunlight onto receiver tubes along their focal lines. Concentrating collector modules can be used alone or in a multi-module system. The concentrated radiant energy absorbed by the solar thermal receiver is transported to the conversion process by a circulating working fluid. Receiver temperatures range from 100°C in low-temperature troughs to over 1500°C in dish and central receiver systems.

The Solar Thermal Technology Program is directing efforts to advance and improve each system concept through research and development of solar thermal materials, components, and subsystems, and the testing and performance evaluation of subsystems and systems. Work is done under the technical direction of DOE and its network of national laboratories who work with universities and private industry. Together they are pursuing a comprehensive, goal-directed program to improve performance and provide technically proven options for eventual incorporation into the nation's energy supply.

To contribute to the national energy supply, solar thermal energy must eventually be economically competitive with other energy sources. Components and system-level performance targets have been developed as quantitative program goals. The performance targets are used in planning research and development activities, measuring progress, assessing alternative technology options, and optimizing components. These targets will be pursued vigorously to ensure a successful program.

This program summary highlights tasks conducted by the participating national laboratories under contract by industrial, academic, or other research institutions. This summary covers activities initiated, renewed, or completed during Fiscal Year 1984 (October 1, 1983 through September 30, 1984).

This document is divided into three sections. The first includes introductory information, a list of directing organizations, a list of acronyms and abbreviations, and an index of current contractors. The second section comprises individual activity summary sheets, grouped by directing organizations. The third section lists FY 1984 publications.

Table of Contents

	Page
Preface	iii
Introduction	v
Solar Thermal Technology Program	1
Background	1
Federal/Industrial Partnership	1
Organizational Relationships	3
Central Receiver (CR) Technology Research and Development	5
Distributed Receiver (DR) Technology Research and Development	7
Solar Thermal Research	11
Directing Organizations	17
Abbreviations and Acronyms	19
Contractor Index	21
FY 1984 Contract Descriptions	25
Sandia National Laboratories Livermore	27
Sandia National Laboratories Albuquerque	55
DOE San Francisco Operations Office	73
DOE Albuquerque Operations Office	89
Solar Energy Research Institute	99
FY 1984 Program Publications	139

Introduction

Solar Thermal Technology Program

Background

The goal of the Solar Thermal Technology Program is to advance the engineering and scientific understanding of solar thermal technology and to establish the technology base from which private industry can develop solar thermal power production options for introduction into the competitive energy market.

Through concentration and heat absorption, solar thermal energy can be converted into electricity or incorporated into products as process heat. Highly reflective surfaces or refractive lenses are arranged geometrically to focus on a receiver which converts the radiant energy into transportable heat (Figure 1). Solar thermal technologies can supply energy for applications over a broad range of sizes and temperatures. Solar thermal energy can also be stored, extending operation into non-daylight hours. Another highly reliable option is hybridization with a back-up fossil fuel combustor.

A five-year plan* outlines federal research and development activities that will be pursued to achieve the needed technology base from which industry may choose appropriate solar thermal systems options. This plan is the basis for all future solar thermal technology planning and reporting. It identifies eleven tasks in three major areas: (1) collection, (2) energy conversion, and (3) systems and applications. These tasks are designed to achieve needed technical improvements in numerous solar thermal system concepts currently under development.

Federal/Industrial Partnership

As a result of federal, university, and industrial efforts since 1975, the solar thermal energy industry has achieved technical advances that have significantly reduced the cost of solar thermal systems. Industry's involvement helps to expedite the solutions to the problems facing solar thermal technology and offers to the nation a more secure energy future. The partnership elements include

- Federally funded research and development into areas with significant long-term benefits.
- Cost sharing, where appropriate, between industrial teams and the federal government.
- Government-provided test facilities for component testing.
- Technology transfer activities.

Industry focuses mostly on the more developed technologies for commercial application, while the federal program concentrates on promising, but less-developed options. Long-term planning and broad strategy development are the responsibilities of the Solar Thermal Technology Division at DOE Headquarters. The long-term technical and cost targets, established in consultation with private industry during preparation of the five-year-plan, are shown in Table 1.

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*National Solar Thermal Technology Program, Five Year Research and Development Plan 1985-1989.

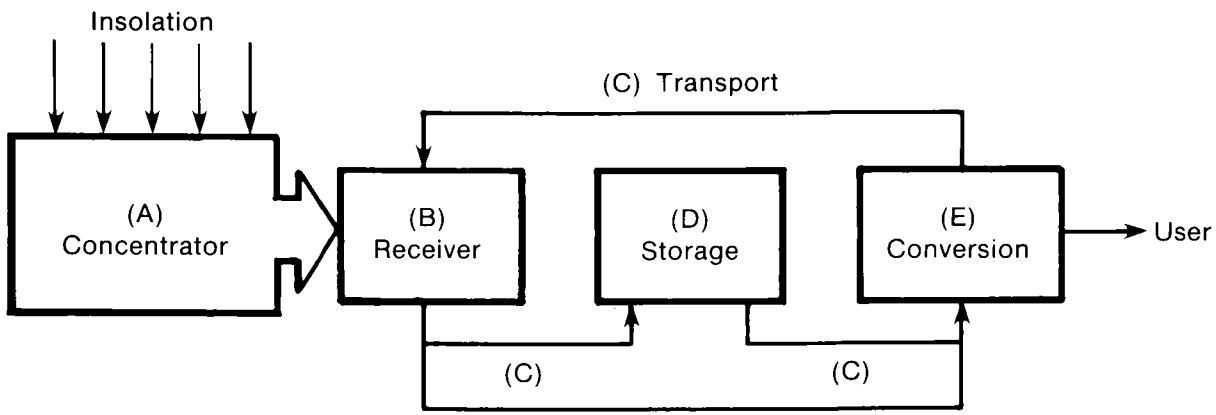

Figure 1. **Solar Thermal System.** Solar thermal systems convert the sun's radiation to useful products (such as electricity, fuels, or direct heat) by way of a thermal process. The basic elements of any solar thermal design are (A) the tracking optics used to concentrate the sun's energy, (B) the receiver which converts the photon energy to heat in a fluid, (C) transport piping to transfer the fluid to (D) storage for later use or directly to (E) the conversion device which consumes the solar heat and produces the user's product.

Table 1. Solar Thermal Long-Term Targets

	Electricity	Heat
System annual efficiency(%)	22-28	56-68
System capital cost (1984$)*	$1300-$1600/kWe	$390-$470/kWt
Capacity factor	0.25-0.50	0.25-0.30
System energy cost (1984$)**	5¢/kWhe	$9/MBtu

*Normalized to turbine or process capable of handling peak field thermal output; includes indirect costs.

**Energy costs levelized in real dollars; economic assumptions differ between electric and heat systems.

Organizational Relationships

The federal Solar Thermal Technology (STT) Program is conducted by the U.S. Department of Energy (DOE) under the Assistant Secretary for Conservation and Renewable Energy. Research and development is conducted on an in-house or contract basis by three national laboratories. The institutional relationships are shown in Figure 2.

Planning and Assessment. Planning and assessment for the Solar Thermal Technology program is conducted under the direction of the Technology Program Integrator (TPI) located at Sandia National Laboratories Livermore (SNLL). As an unbiased source of technical and economic analysis, the TPI recommends research priorities and future directions of the Solar Thermal Technology program.

Short and long-term planning, analysis, and assessment of technical and economic issues are conducted to ensure a properly balanced program. Special studies are conducted by the TPI on the economic competitiveness of solar thermal systems, understanding of market impact, industrial involvement, and the relative merits of competing technologies for particular applications. During FY84, the TPI conducted the following activities: (1) Five-Year Research and Development Plan, (2) Renewable Energy Development Technology Strategy, (3) Concentrator Research and Development Assessment, (4) Federal Revenue Effects from Solar Thermal Tax Incentives, and (5) Solar Thermal International Market Assessment.

Status Summary. The Solar Thermal Technology Program is organized into three major areas: (1) Central Receiver, (2) Distributed Receiver, and (3) Research. The following is a summary of progress attained in each of these areas in fiscal year 1984 (FY84).

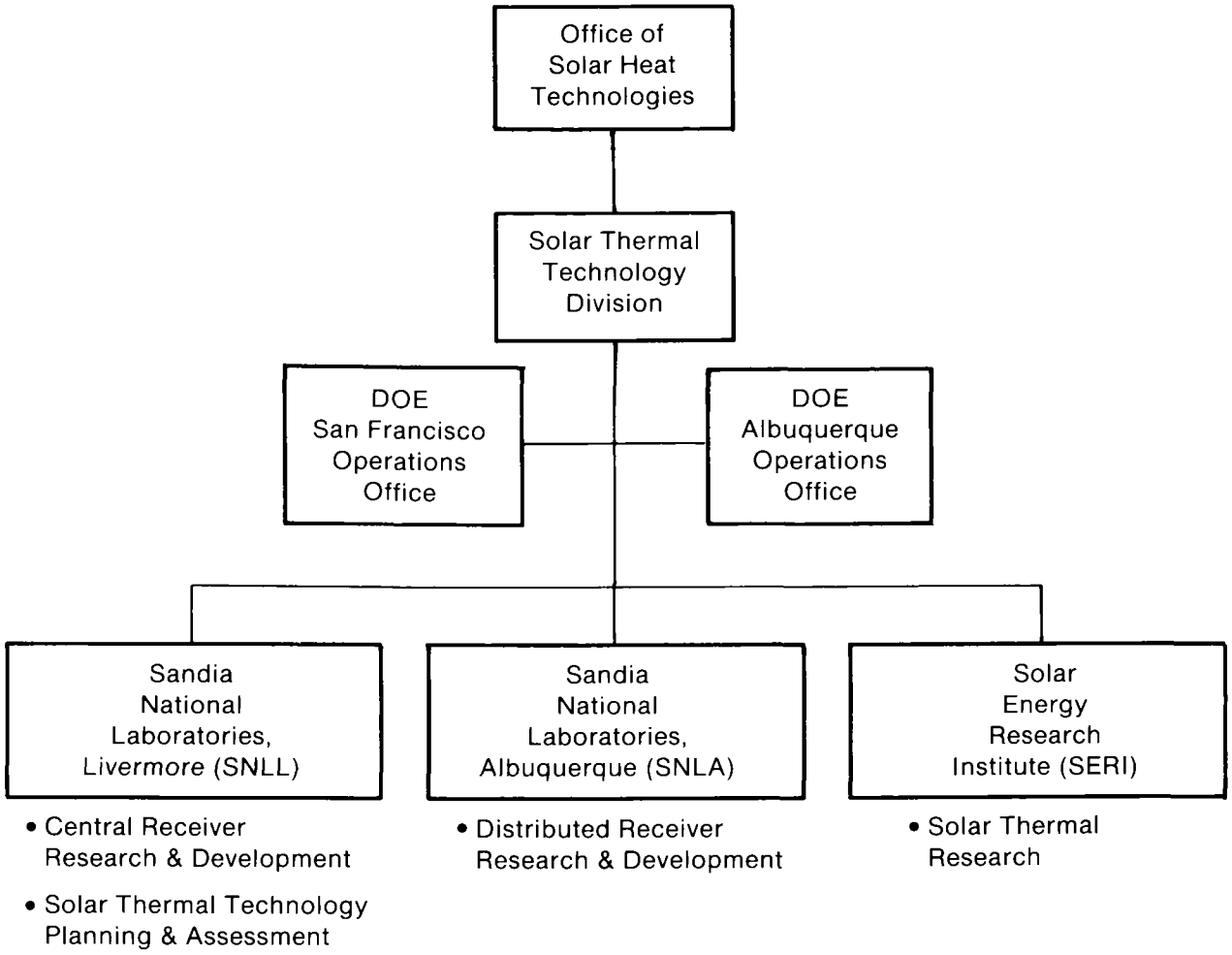

Figure 2. Solar Thermal Technology Organizational Structure and Responsibilities

Central Receiver (CR) Technology Research and Development

In a solar central receiver system, large sun-tracking mirrors (heliostats) concentrate solar energy by redirecting it to a tower-mounted receiver. In the receiver, the solar energy is captured as high-temperature thermal energy. This thermal energy can be used to drive a chemical reaction or to heat a transport fluid. The thermal energy from this fluid can be converted immediately to electric power or stored for use as required. Storage capability, if incorporated, allows plant operation to continue beyond daylight hours.

10 MWe Solar Central Receiver Pilot Plant. The plant, near Barstow, California is designed to produce at least 10 MWe net of power to the Southern California Edison utility grid for eight hours on the most favorable day (summer solstice) and four hours on the least favorable day (winter solstice). The two-year test and evaluation phase of Solar One was successfully completed on July 31, 1984, and the power production phase was started. Automation of the plant was completed on schedule. In the first two months of the pilot plant power production phase, over 1000 MW-hr were produced each month. Solar One integrates several major systems, including the collector, receiver, thermal storage, and control systems. The collector system consists of 1818 heliostats, a heliostat control system, and a heliostat beam characterization system.

Mirror corrosion has been a continuing concern and during FY84 a corrosion survey found that the total corroded area had increased by a factor of two over the previous year—an increase that was significantly less than the FY83 prediction factors of 5 to 10. Although mirror corrosion at this year's growth rate will not have a significant impact on plant performance for several years, vents are being added to dispel trapped moisture that causes corrosion. Receiver system activities have focused on gathering experimental data, investigating the cause of and correcting hardware problems, and evaluating receiver performance. Panel surface absorptivities decreased from 0.92 in 1982 to 0.88 in 1984. This reduced the actual absorbed power level about 77% compared to the design prediction of about 81%. Receiver problems include tube leaks and panel warpage. The tube leaks appear on the superheated portion of the receiver boiler panels outside the zone heated by the solar flux. Successful efforts to eliminate these leaks included changes to mitigate abrupt temperature changes and modification of the panel rollers and supports. Also during FY84, control stability, mode transition, and steady-state operation testing was completed for the thermal storage system.

Molten Salt Electric Experiment. The Molten Salt Electric Experiment (MSEE) is fully operational at the Central Receiver Test Facility (CRTF) in Albuquerque, New Mexico. For the first time in the United States, molten nitrate salt is being used as the heat transport fluid and thermal storage medium in an integrated central receiver system. The MSEE uses previously tested molten salt hardware. The 5 MWt receiver and 6.5 MWt-hr thermal and storage unit had been individually operated at the CRTF as subsystem research experiments. These systems were integrated with a new salt-to-steam heat exchanger specifically designed and built for the MSEE. Electricity is produced by a Navy-surplus 750-kW turbine generator. Some steady-state performance testing was completed in FY84, and the remainder will be done in FY85. Maximum power output to the grid has been 750 kW.

Molten Salt Receiver/Components. A development and test program was started in FY84 for full-size molten salt pumps, valves, and a 5-MW thermal receiver. Molten salt receiver/component experiments will be performed to minimize the major technical risks in a large molten salt solar plant. Work will focus on salt valves, salt pumps, and the

receiver. Through these experiments researchers hope to resolve the present major technical uncertainties relating to plant receiver/components, provide a sound technological base for development of the molten salt solar industry, and support the design and construction plans for the solar repowering of the Arizona Public Service Saguaro plant and the Southern California Edison Solar 100 plant.

Stretched Membrane Heliostat. Sandia National Laboratories Livermore (SNLL) and the Solar Energy Research Institute (SERI) have established the basic feasibility of stretched membrane heliostats and have identified design approaches. Computer codes have been developed for the complex calculations of predicting the mirror shape under wind and gravity loading. Preliminary investigations at SNLL and SERI indicate that substantial savings in material cost compared to cost of current heliostat designs (perhaps a 70% reduction for that portion above the drive unit) should be possible without a significant reduction in performance. SNLL released a Request for Quotation for developing a stretched membrane heliostat during FY84. Responses were received and negotiations were conducted for two contracts to develop full-size mirror modules. Development emphasizes design, fabrication, and cost of the membrane mirror assembly.

Solid Particle Receiver. Using solid particles as the working fluid and storage medium in solar central receivers is one approach to delivering solar energy at temperatures above the nominal 550°C peak of current water-steam and molten salt central receiver technologies. The technical feasibility of the solid particle concept is the subject of an ongoing examination at SNLL. In FY84, work continued in three principal areas: (1) completion of a proof-of-concept experiment at the Radiant Heat Facility, (2) characterization of candidate particle material properties, and (3) analysis of the thermal and aerodynamic performance of a receiver.

Volumetric Receiver. The volumetric receiver concept initially showed promise of high efficiency and low weight and size. In a volumetric receiver, air is heated to high temperatures at atmospheric pressure. The air is drawn into the receiver past an array of wedge-shaped fin surfaces and down the receiver tower piping. These fin surfaces intercept the incoming concentrated solar flux in what appears to be a volume, hence the name volumetric receiver. This receiver was envisioned to significantly reduce convective and reradiative losses because the highest temperatures are not on the receiver surface. Battelle Pacific Northwest Laboratory (PNL) evaluated the feasibility of this concept during 1984. Analysis and thermal modeling indicated that the original concept was not feasible. Necessary design changes would have eliminated the advantages of small size and simplicity. Work was terminated on the volumetric receiver concept.

Fuels and Chemicals System Design. SNLL issued a Request for Quotation in FY84 for solar fuels and chemicals conceptual system design studies. Contractors have been selected to do the system design studies. Negotiations are under way to complete the terms, conditions, and costs of each contract that will accomplish process optimization, facility design, identification of technological uncertainties, and facility and product cost estimates.

Hydrogen Production. Of all the fuels and chemicals, one of the most versatile is hydrogen. It is both a high energy fuel and a basic feedstock to the chemical industry. A process being studied uses energy from a solar central receiver to obtain hydrogen from the thermal splitting of water. Decomposition of vaporous sulfuric acid is an important step in the sulfuric acid/iodine thermochemical cycle that produces hydrogen by water splitting. GA Technologies is building and testing a solar catalytic reactor to decompose

vaporous sulfuric acid. The test reactor will accommodate a solar flux up to 100 suns, and operate at a temperature of 870°C (1600°F) and pressures between 5 and 10 atmospheres. A similar reactor was previously tested at the Advanced Components Test Facility (ACTF) but at a lower flux level and pressure. The hardware for the latest test was designed and fabricated in FY84. Test rig assembly was in progress at the end of the year, and testing and data evaluation are expected to extend into mid-FY85.

Garrett AiResearch is designing and fabricating a solar ceramic heat exchanger capable of vaporizing concentrated sulfuric acid in a solar flux of 300 suns. The experiment, sized at 10 kW, uses a single tube of silicon carbide radiated by electric heating rods. The test apparatus was assembled in FY84, and testing is scheduled for the first quarter of FY85.

A conceptual design of the sulfuric acid/iodine thermochemical process was performed in FY84 by Foster Wheeler Solar Development Corporation. The design uses solar energy as a primary external heat source. As part of the design, the receiver, balance of plant, and control strategy designs were developed, along with requirements for all major process vessels, heat exchangers, and pumps. In FY84, the design was completed with considerable attention given to a new receiver/reactor design.

Distributed Receiver (DR) Technology Research and Development

A solar thermal distributed receiver system consists of one or more line-focus or point-focus collectors, each of which uses a concentrator to focus the sun's energy and a receiver to absorb the energy and convert it to heat. The heat may be converted to electricity by an engine/alternator directly coupled to the receiver or may be moved by a thermal transport system to a central location for conversion to electricity, used for process heat, or for both (cogeneration). Increasing the number of modules within each system increases the capacity. The modules within each system are identical and hence favor mass production methods. Most of the work in the distributed receiver technology development during FY84 was directed toward developing of concentrating distributed solar collectors, optical materials, and heat engines.

Optical Materials. Research and development of optical materials for distributed receiver technology at Sandia Albuquerque during FY84 was directed toward the application of a sol-gel protective coating over a reflective film of silver that has been deposited directly on a sheet metal substrate such as stainless steel. The advantage of this type of reflective material over silvered glass, which is currently widely used as a reflective material for solar thermal collectors, is that the sheet metal substrate is stronger while also being more flexible and lighter. A number of samples of this new reflective material were prepared and tested. Significant accomplishments include specular reflectivities of 93% for samples before the application of protective sol-gel coatings, and specular reflectivities of about 90% after the application of sol-gel coatings. Further development is needed to achieve higher reflectivities comparable to the approximately 95% that can be realized with silvered glass.

Concentrators. Sandia Albuquerque began to develop more efficient point-focus concentrators for distributed solar thermal technology in FY84. To identify appropriate promising designs for concentrators and the best qualified industrial R&D teams for their development, an Innovative Concentrator Program Opportunity Notice (PON) was prepared and issued. Three proposals were selected for funding and contract negotiations were started at the close of FY84:

- o Acurex Solar Corporation was selected to develop a parabolic dish concentrator using stamped or stretched-formed sheet metal facets with sagged glass reflectors.
- o LaJet Corporation was selected to develop a substantially larger version of their faceted point-focus concentrator which uses a space frame structure and vacuum-formed, stretched-film reflectors.
- o ENTECH Corporation was selected to develop a 14-m diameter, domed point-focus Fresnel lens concentrator.

In addition, a contract will be placed with Solar Kinetics, Inc. for the most interesting aspects of their first phase proposal received under the Innovative Concentrator PON. This work will include research on the formation of facet substrates for point-focus parabolic dishes. The design analysis, completed in FY84, included trade-offs on such overall dish electric design parameters as concentration ratios, receiver temperature, engine type, concentrator efficiency, and overall system efficiency.

Other work was done in FY84 in the area of point-focus concentrator development. Two analytical studies of a Cassegrainian type concentrator by BDM Corporation, and one with the University of Chicago on terminal concentrators for point-focus solar thermal technology were conducted. The BDM Corporation completed the mirror systems and material/fabrication costs analysis during FY84. The results of the study indicated that the Cassegrainian reflector would not perform as well as the single reflecting parabolic dish. Also, some thermal problems would have to be resolved. However, for thermal applications, the Cassegrainian system cost could be lower than those of the conventional dish because of elimination of up-and-down piping and reduced receiver support structure.

The development of line-focus solar thermal concentrators was also continued in FY84. Several contracts were placed and completed for small but important retrofits of components on the various MISR systems at Sandia Albuquerque. These contracts included replacement of control units, retrofitting of glass/steel reflector laminants with sagged glass reflectors on part of the Acurex system, and replacement of flex hoses with rotary fluid joints. Also, the decision was made in FY84 to issue a Request for Proposals (RFP) for the continued development of line-focus solar thermal collectors.

Receivers. Sandia Albuquerque conducted research and development for distributed receiver technology in FY84. To establish a comprehensive and versatile point-focus receiver design capability, research began on development of a concentrator and receiver model. An SO_3 receiver/reactor engineering design study was begun at New Mexico State University (NMSU). The study is in parallel with scale-up of closed-loop thermochemical transport experiments of NMSU and will result in a design for a receiver/reactor suitable for future prototype experiments.

The evacuated annulus receiver development effort for line-focus collectors was conducted during FY84. Sandia Albuquerque conducted a study to develop a concept based on graded glass seals from Pyrex through an intermediate grade of glass to a "matched" (matched coefficient of expansion) seal from glass to Kovar.

Acurex discovered a less expensive and simplified direct Pyrex-to-Inconel "housekeeper" type of seal which is much less expensive and has, so far, demonstrated good integrity. Also, Acurex decided to eliminate disconnectable couplings in favor of field welding to connect receiver modules. This approach resulted in significantly reduced cost and simplified factory assembly.

Heat Engines. The objective of this activity is the evaluation and development of heat engine technology to distributed receiver systems. Future goals for engine performance and cost in the long-term are 41% annual efficiency and $300/kW in order to support the system-level objective $0.05/kWhe. Heat engine evaluations include Rankine, Stirling, and Brayton cycles. The first-generation Barber-Nichols (B-N) Organic Rankine Cycle (ORC) engine development effort for dish electric systems was completed in FY84. This system uses superheated toluene which is then expanded through a turbine of the turbine-alternator-pump (TAP) system to generate electricity. After a series of successful testing of the Power Conversion Assembly (PCA), B-N assembled and programmed a commercial control system with which ORC can be operated at the Distributed Receiver Test Facility (DRTF).

Advanco Corporation began full-power acceptance testing of a Stirling/dish module in FY84. They achieved record electrical power output of 25.2 kWe with direct normal insolation of 940 W/m^2. This output corresponded to a gross solar-to-electric conversion efficiency of 31.6% (29% net). In addition, Advanco Corporation conducted an endurance test of the Vanguard module, which involved complete automatic operation from sunrise to sunset. The gross electrical energy produced was 258 kWh compared with a net energy production of 238 kWh. This was a net all-day conversion efficiency of 25.2%.

Sanders Associates, using current technology, completed a Brayton-cycle parabolic dish module in FY84. This module used a 7-kWe subatmospheric Brayton-cycle (SABC) engine and an industry-developed small concentrator. In support of this effort, a small test facility was constructed near Sanders' offices in Nashua, New Hampshire. Sanders purchased and completed testing of a LaJet Model 460 stretched membrane concentrator and modified it for integration with SABC. Characterization was continued on the Development Test Module (DTM) until a steady-state solar-only operation of the SABC and 2kWe output was achieved. Based on a critical design review and analysis of the DTM test results, Sanders, Sandia Albuquerque, JPL, and DOE concluded that the SABC was not appropriate for dish-electric systems. Sanders then terminated work on the SABC and cancelled plans to fabricate the parabolic dish module.

Alternate Conversion Technologies. An investigation was conducted into the possibility of using alternative thermal energy conversion technologies for providing the thermal-to-electric conversion of energy collected by distributed solar thermal concentrators. This investigation led to the conclusion that the distributed solar thermal technology program should begin the development of a conversion technology similar to the sodium heat engine converter which has been under development at a low level of effort at Ford Motor Company for several years. Sandia is investigating the feasibility of using either an alkali metal such as sodium used in Ford's effort, or a liquid metal such as mercury in a converter that is principally the same as Ford's sodium heat engine. Work in this area will begin in earnest in FY 1985.

Thermal Energy Transport. In FY 1984 a reasonably aggressive effort was aimed at developing a thermochemical energy transport system as a cost-effective way of transporting thermal energy from point-focus solar thermal collectors in a distributed field to an end-use point at the edge of the field. Activities in FY 1984 included an assimilation and analysis of all of the earlier work in thermochemical transport reported in the literature, a workshop to discuss the status and most appropriate future directions for work in this energy transport area, initiation of two laboratory-scale experimental

projects which assess the feasibility of closed loop thremochemical energy transport, and a materials development program for this energy transport technology. The laboratory-scale experimental work consists of design, fabrication, and operation of a 500-W closed-loop experiment at New Mexico State University's Physical Science Laboratory on the thermochemical transport chemical system based on the dissociation of SO_3 in an endothermic reactor, and a second thermochemical transport laboratory experiment at Sandia Laboratories based on the use of carbon dioxide to reform methane in an endothermic reactor.

Distributed Receiver Test Facility. A Distributed Receiver Test Facility (DRTF) has been constructed adjacent to the Central Receiver Test Facility (CRTF) at Sandia. The DRTF encompasses areas with point- and line-focus test activities, such as the MISR test facility constructed previously. DRTF construction completed to date includes sites for several point-focus concentrators, instrumentation and power cable wireways, a circulating water system, an equipment shelter, and construction of a control room within the existing CRTF office building. This facility replaces the Jet Propulsion Laboratory's Parabolic Dish Test Site at Edwards Air Force Base which was dismantled during FY84.

System Experiments—Shenandoah Solar Total Energy Project. The objective of this project is to evaluate a solar total energy system that provides electric power, process steam, and air-conditioning in a realistic industrial setting. The Solar Total Energy Project (STEP) at Shenandoah, Georgia is a cooperative effort between DOE and the Georgia Power Company. The complete system became operational in April 1984 with the integration of all major components. The system was first prepared for evaluation testing in the total energy (cogeneration) mode in May 1984. Eighteen tests were performed by the end of FY84. All of the testing involving hybrid operation was completed. Three of the all-solar tests completed involved stand-alone start-up.

System Experiments—Industrial Process Heat (IPH). Five IPH experiments (out of 17 initiated in previous years) were operational under DOE funding during FY84. Of the five, three were routinely providing performance, operation and maintenance data, and two were undergoing system upgrades. Seven of the remaining 12 projects are being operated by their respective plant owners and five have been discontinued. An additional project funded under the JPL dish program has been added to the IPH program and is being operated by the site owner. Members of the DOE team (SNLA, SERI, and ETEC) provided technical support to these projects and analyzed and reported performance, operation, and maintenance data from all operating projects.

System Experiments—Modular Industrial Solar Retrofit (MISR). MISR is a distributed receiver project for evaluation of line-focus technology for IPH applications up to 210°C. In previous fiscal years, concepts were developed and five qualification test modules were installed; four at Sandia Albuquerque and one at SERI. Each modular qualification test system (QTS) consists of a T-loop of trough collectors, a steam generator, and a mechanical equipment/control system skid. Qualification testing of the systems has been completed.

Performance tests are being carried out to generate an experimental data base which may be used, along with Typical Meteorological Year (TMY) data, in annual performance predictions for various locations. Parameters being evaluated include module efficiency at ambient temperature and at various operating temperatures, incident angle modifier, thermal loss, heat capacity, equipment skid heat capacity, skid operating thermal loss, and parasitic power requirements. Measured optical efficiency of the collectors in MISR

systems varies from 69% for aluminized reflective surfaces (FEK-244) and untreated receiver glazings to 82% for collectors with silvered reflective surfaces (glass or ECP-300X) and anti-reflective glazing (prepared by the Corning etch or sol-gel processes).

System Experiments—Fixed Mirror Distributed Focus (FMDF) Solar Energy Development Project. The purpose of the FMDF project at Texas Tech University is to conduct research and report results pertaining to technical, economic, and environmental problems of FMDF technology. The project consists of three phases: Phase I General Studies and Analysis, Phase II Specific Application Studies and Analysis, and Phase III Equipment Acquisition and Experimental Testing. Phase I, which consisted of ten research tasks, was completed in May 1984.

System Experiments—Dish Electric Field Experiment Support. Small community solar experiment projects (SCSE's) are planned to evaluate solar electric 100-kWe plants. DOE has selected Osage City, Kansas, and Molokai Island, Hawaii as the sites for these experiments. Each SCSE will use point-focus concentrators and heat engines. New component development for these experiments is not envisioned as a part of these projects. A competitive solicitation for proposals, a Program Opportunity Notice (PON), was issued by DOE in FY84 and technical and cost evaluations of the proposals were completed. Barber-Nichols Engineering has been selected by DOE/Albuquerque as the prime contractor for the SCSE at Osage City, Kansas. Power Kinetics, Inc. is a subcontractor to Barber-Nichols and will provide the concentrators for the electric generating modules. The first of these modules is to be tested at the Distributed Receiver Test Facility at Sandia.

Solar Thermal Research

The objective of the Solar Thermal Research Program is to establish the feasibility of new concepts that will make solar thermal technologies more cost-competitive in the energy market. New applications and novel concepts result from the research activities in order to eventually improve market penetration, thus maximizing the potential for future use of solar thermal energy.

Silver/Polymer Reflector Research. The objective of this research project is to develop silvered polymer reflectors showing long-life potential. A long-term performance target of greater than 92% reflectance with specularity of 2 mrad has been established. During FY84 the chemical and physical phenomena causing the degradation of silvered polymethylmethacrylate (PMMA) were identified and approaches to increase durability were developed. During FY84 SERI completed an accelerated and real-time environmental exposure testing of promising polymer/silver/backing/adhesive/substrate reflector assemblies. The testing results led to determining the principal causes of degradation in silver/polymer mirror assemblies. The principal causes of degradation were identified as chlorine, UV radiation, elevated temperature, water vapor, and impurities in the silver/polymer interface. Commercial films from 3M, called ECP 300, were evaluated and improved in a collaborative effort with industry. This effort resulted in a film with good durability maintaining greater than 90% reflectance over 1-year outdoor tests. Research was also conducted to develop chemically bound stabilizers, anti-oxidants, and quenchers of excitation energy to improve the durability of polymer laminates used in fabricating silver/polymer reflectors. Emphasis in this activity was on polymethylmethacrylate (PMMA).

Concentrators Research. Emphasis in this activity during FY84 was on stretched membrane heliostats. Stretched membrane concepts under research and analysis during

the past three years showed the most promise for significant cost reduction of heliostats down to $\$50/m^2$ or less. Objectives were to (1) study stretched membrane lamination processes and fabricate a 2-m diameter variable focus stretched membrane module to evaluate the chosen design concept, and (2) establish membrane/frame coupling theory and fabricate at least one 3-m diameter stretched membrane module to evaluate performance experimentally.

A comparative analysis of the stretched membrane concept with a second-generation glass/metal heliostat was conducted. Results verified that the low cost potential could be realized with the same performance characteristics as the second-generation heliostats.

Dan-Ka Products was awarded a SERI subcontract to design and fabricate several 3-m diameter experimental stretched membrane modules. These modules were designed with different tensioning approaches to evaluate their performance characteristics as well as to evaluate the membrane frame interaction in a laboratory test setup.

High-Temperature Window Materials. The objective of the FY84 activity was to develop and test coatings to inhibit receiver window devitrification and design and test mosaic window structures to allow assembly of large windows for commercial-size solar reactors. At high operating temperatures, windows at the entrance apertures of cavity receivers may reduce thermal losses in spite of the transmission loss penalty. Georgia Institute of Technology (GIT), under subcontract to SERI, performed all of the FY84 research. In this year GIT completed a test program at the Advanced Components Test Facility (ACTF) to gain experience with transparent windows and to define the conditions where devitrification occurs. Only slight devitrification was observed in the testing of fused quartz and Vycor at a temperature up to 1000°C. Development, test, and evaluation of silica-based coatings to inhibit devitrification demonstrated that boron-silicon oxide polymer coatings inhibit devitrification. In addition, GIT completed thermal modeling of mosaic window structures that use fluid-cooled metal window sashes. Designs were formulated for welded fused quartz window assemblies.

Receivers Research. The goal of this research is to explore the feasibility of the high-temperature direct absorption receiver concept using molten carbonate salt. In particular, researchers are seeking to understand the heat and mass transfer phenomena and the associated material properties. The FY84 objectives were to (1) design a 900°C molten salt test loop to be used in ground and tower tests at the Advanced Component Test Facility, and (2) design and validate a direct absorption process computer model.

During FY84 the design was completed of the test loop (to be fabricated in FY85) which will provide essential experimental heat-transfer and fluid dynamics data regarding the direct absorption receiver concept. In addition, experimental studies were completed of the direct absorption process using experiments with water films. The experiments showed that dry spots can form on the absorber that could cause damage in the receiver in high flux operations. Dry spots can be avoided using roughened surfaces or screens.

High-Temperature Thermal Fluids/Containment. The emphasis was on thermal fluids and containment materials to be used in conjunction with the direct absorption molten salt/central receiver concept. The FY84 objectives were to study the oxidation and corrosion rates of carbonate salts containing chromophores (i.e., blackened) and to identify at least one stable thermal fluid/containment materials pair capable of sustained operation at 900°C.

A molten eutectic sodium-potassium-lithium carbonate salt was identified as a promising working fluid for the direct absorption receiver concept. Laboratory experiments were conducted exposing various alloys to molten eutectic salts at temperatures up to 900°C to identify a containment material for the direct absorption receiver concept. As a result of these experiments, Inconel 600 was identified as a high-temperature containment material that is compatible with the molten eutectic carbonate heat-transfer fluid.

Corrosion tests and mechanical property measurements were completed on single crystal sapphire, Coors AD998, and Monofrax M ceramic coupons exposed to molten eutectic lithium-sodium-potassium carbonate salt at 900°C. The tests results demonstrated that the three materials are compatible with the high-temperature molten salt and are promising containment materials for the direct absorption receiver. Also, researchers at the University of Denver identified one of the major phases in the passivating layers that forms when a molten carbonate salt reacts with sapphire and Coors AD998 aluminum.

Ceramics Research. The objectives of the FY84 ceramics research were to identify mechanisms responsible for the degradation of ceramic material exposed to concentrated solar flux and identify modifications to such materials to improve their performance in the solar thermal environment. During FY84 the Georgia Institute of Technology completed exposure testing and evaluation of 14 candidate ceramic materials at the ACTF and also by microstructure and x-ray analysis. After the initial tests, the researchers concluded that there appeared to be a clear correlation between material purity and mechanical performance in the solar flux. Higher purity refractory materials were less likely to fail at temperatures lower than their rated operating levels.

Complementing the tests at GIT, research at the University of Houston had the objective to conduct photo-corrosion studies of high-temperature/high-flux absorber coatings and to develop and characterize high-temperature/high-flux coatings for ceramics to inhibit photodegradation. Tests led to the observation that the ceramic material's surface degradation often depends not only on temperature but also on the incident solar flux. Determinations of the degradation mechanisms will make it possible to prevent the degradation or to develop new materials that are not adversely affected by high flux solar radiation, a unique characteristic of the solar application.

Exploratory Heat and Mass Transfer Research. Chemical heat pipes offer an efficient, low thermal loss means for transporting energy from solar receivers. The objective of the FY84 research activity was to assess the technical feasibility of receiver/reactors that use heat pipe technology for energy transport by constructing, operating, and evaluating a sub-pilot scale system for methane reforming. During FY84 the University of Houston completed testing of the system isothermally and used it to calibrate the mathematical model of the system developed in FY83. The University of Houston scientists also determined the catalytic rate equation for the system using the bench kinetic unit.

Direct Flux Solar Reactors. The FY84 objectives of the GIT research effort were to test and evaluate the entrained-flow solar reactor at the ACTF and to study the absorption phenomenon supported by better computer models for predicting heat transport and convective losses in such reactors. The GIT entrained-flow solar reactor was fabricated in FY83. During FY84 GIT completed 38.7 hours of solar testing of the entrainment reactor at the ACTF. In these tests, GIT studied two entrainment reactions: (1) carbon-carbon dioxide, and (2) sawdust-steam. Conversion efficiencies up to 15% were achieved in these initial tests. GIT completed an entrained-flow reactor computer

model. This activity centered around use of the Martin Marietta Interactive Thermal Analysis System (MITAS-II) computer code to model the entrained-flow reactor using a heat-transfer finite differences approach. Further work on reactor design was discontinued and future research will emphasize understanding of heat transfer between particles and gas stream.

Quantum/Thermal Hybrid Systems. The research activity in FY84 was to complete a thermodynamic analysis of thermally coupled and de-coupled quantum/thermal hybrid systems and use the analysis to identify the concept with the greatest potential. To determine the technical and economic feasibility of a hybrid/quantum solar energy conversion system, SERI completed (1) formulation of combined quantum/thermal system configurations for producing hydrogen via water splitting, (2) identification of holographic films as a promising means for solar beam splitting, and (3) thermodynamic analysis of a combined quantum/thermal system. A comparative cost assessment of a de-coupled quantum/thermal system and a chemically assisted thermal system for producing hydrogen showed no clear advantage of the quantum/thermal systems over a conventional system.

During FY84 SERI researchers developed methods for producing semiconductor photocatalysts and completed a study of producing hydrogen by splitting H_2S at high light intensity using a CdS/catalyst system. The water-splitting experiments showed that hydrogen sulfide was easily split, but with low efficiency. Conventional oxidation splitting technology is more attractive. Water splitting proved to be more difficult than was indicated in the literature. Water was not split successfully using various photoelectrochemical catalysts. This work was terminated since no obvious advantage was identified by using concentrated solar energy.

Instrumentation and Measurement. During FY84 researchers identified the STT program I&M needs through a survey and workshop. The five needs that were identified as having the highest overall priority were (1) improvement of the solar radiation network and resources data base, (2) flux measurements/instrumentation, including a primary standard, (3) temperature measurements/instrumentation in a high flux environment, (4) optical property measurements/instrumentation at high temperatures, and (5) ultraviolet spectral measurement/instrumentation for solar and artificial sources.

Atmospheric attenuation and spectral absorptivity, and reflectivity and emissivity of the receiver surface were identified as high priority near-term needs for the Solar One System I&M. In this year SERI researchers completed solar radiation measurements at Solar One.

In an attempt to develop a temperature-measuring device in a high flux environment, GIT was to design, fabricate, test, and evaluate a multispectral solar blind pyrometer to characterize optical properties of materials. During FY 1984 GIT researchers assembled the system and made multicolor pyrometer measurements of the emittances and temperatures of four sample materials. Four-color pyrometer data were collected over a broader temperature range than previously collected. This was made possible by new calibrated attenuators. The last set of data was collected for the temperature range of 975°C-1000°C. A temperature measurement accuracy of 2% to 4% was demonstrated for a limited number of materials and solar flux conditions.

Innovative Concepts and Applications. Several new concepts for application were studied under exploratory research contracts by industry and university research organizations. After the first phase, two ideas were selected for continued research into

the second phase. Hughes Aircraft Company's and Acurex Solar Corporation's concepts were chosen for continued research to explore their long-term potential. Hughes regenerative thermoelectrochemical system converts concentrated solar energy to electricity at high conversion efficiency. Because the conversion system may have few or no moving parts, initial and life-cycle cost advantages are readily apparent.

Acurex is investigating the feasibility of using a holographic optical element for solar concentrator applications. This new concept, based on defractive optics, has the potential to achieve solar concentrations of up to 100 suns and to allow the concentrator to focus its energy on the receiver without mechanically tracking the sun. During the first phase, an optical efficiency at a single wavelength of about 90% was achieved in small size holograms. Current reflective line-focus systems show about 85 percent optical efficiency over the solar spectrum.

A concept using concentrated solar flux to detoxify hazardous wastes was studied by Babcock and Wilcox. This new application attempts to use (1) the UV portion of the solar spectrum to break certain chemical bonds in the waste products, and (2) the remaining portion of the spectrum to produce the heat needed to complete the reaction.

SERI solicited more new ideas in FY84 and received several proposals. At the end of FY84, selection of the proposals was in progress for awards and exploratory first-phase research in early 1984.

Direct Flux Solids Decomposition. This research investigates the absorption of concentrated sunlight by solids, with emphasis on endothermic reactions. The goal is to understand physical, chemical, and thermodynamic processes through analytical and experimental research. A technology base is being established to enable an assessment of direct flux gas-solid reactions for beneficial solar thermal conversion.

Research is being performed at Lawrence Berkeley Laboratory (LBL) and at the University of Hawaii. The approach has two elements: (1) emphasize optical, heat transfer and thermodynamics (LBL), and (2) emphasize chemical kinetics (U. of Hawaii). LBL initiated an analytical and experimental investigation of the optical, thermal, and chemical aspects of the direct radiant heating of particle suspensions to produce useful fuels and chemicals. The University of Hawaii initiated experimental research to characterize the chemical kinetics of solids decomposition. The major incentive is that the high heat rates available may substantially reduce the temperature of decomposition reactions by controlling the decomposition reaction pathway.

Directing Organizations

Department of Energy
Solar Thermal Technology Division
Washington, DC 20585

DOE Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87115

DOE San Francisco Operations Office
1333 Broadway
Oakland, CA 94612

Sandia National Laboratories Albuquerque (SNLA)
P.O. Box 5800
Albuquerque, NM 87185

Sandia National Laboratories Livermore (SNLL)
P.O. Box 969
Livermore, CA 94550

Solar Energy Research Institute (SERI)
1617 Cole Boulevard
Golden, CO 80401

Abbreviations and Acronyms

A&E	Architects and Engineers
ACTF	Advanced Components Test Facility
BPNL	Battelle Pacific Northwest Laboratory
Btu	British thermal unit
CRTF	Central Receiver Test Facility
CdS	cadmium sulfide
DAR	direct absorption receiver
DOE	Department of Energy
DOE/AL	Department of Energy, Albuquerque Operations Office
DOE/SAN	Department of Energy, San Francisco Operations Office
DRTF	Distributed Receiver Test Facility
DTM	design test module
EAFB	Edwards Air Force Base
EPGS	electric power generator subsystem
EPRI	Electric Power Research Institute
FMDF	fixed mirror distributed focus
ft	foot
FY	fiscal year
GE	General Electric
GIT	Georgia Institute of Technology
I&M	instrumentation and measurement
IPH	industrial process heat
JPL	Jet Propulsion Laboratory
kW	kilowatt
kWe	kilowatt electric
kWh	kilowatt hour
kWhe	kilowatt hour electric
LMMH	liquid metal magnetohydrodynamic
m	meter
M	million
MISR	modular industrial solar retrofit
MRL	Missouri Research Laboratory
MSEE	Molten Salt Electric Experiment

MW	megawatt
MWe	megawatt electric
MWt	megawatt thermal
O&M	operation and maintenance
ORC	organic Rankine cycle
PAN	polyacrylonitrile
PCB	poly-chlorinated biphenyls
PMMA	polymethylmethacrylate
PNL	Pacific Northwest Laboratory
R&D	Research and Development
RFQ	request for quotation
s	second
SABC	subatmospheric Brayton cycle
SEIA	Solar Energy Industries Association
SERI	Solar Energy Research Institute
SNLL	Sandia National Laboratories Livermore
SP	scientific paper
STT	Solar Thermal Technology
TECH	thermoelectrochemical
TPI	Technical Program Integrator
TR	technical report
UV	ultraviolet
W	watt

Contractor Index

Page

Acurex Solar Corporation 62,116

Advanco Corporation 90

All American Enterprises 46

B&D Electronics 47

BDM Corporation 60,63

Babcock and Wilcox 54,83

Barber - Nichols Engineering 71

Battelle Pacific Northwest Laboratory 32,41,42,43,44

Black & Veatch 50,67,107

Colorado State University 114

Columbia Gas Systems 95

Custom Engineering, Inc. 64

Dan-Ka Products, Inc. 113

E.G.&G Washington Analytic 70

ETEC, Rockwell International 56

Energetics Corporation 97

Entech, Inc. 69

Foster Wheeler Solar Development Corporation 65,86,96

GA Technologies 88

Gardner Zimke Company 68

Garrett AiResearch 79

Georgia Institute of Technology 118,124,125,126,127,134,135

Georgia Power Company 92

HMJ Associates 76

Contractor Index (continued)

Page

Hughes Aircraft Company 81

Institute of Gas Technology 80

J. B. Henderson Construction 48

Jet Propulsion Laboratory 40,111,119

Jones Plumbing and Heating 45

Kellog Unit Foundation, Inc. 57

Martin Marietta Aerospace Corporation 35,36,84

Mathematical Sciences 87

McDonnell Douglas Astronautics Corporation 37,38

Missouri Research Laboratory 52

Nieken Engineering and Research 85

Public Service Company of New Mexico 49

Radiation Research Associates 123

Research Engineering Associates 78

Science Applications, Inc. 105

Sanders Associates, Inc. 61

Solar Energy Research Institute 39,59,100,103,104,106,108,110,112,117,120,121, 122,133,136,137

Solar Kinetics, Inc. 31,66

Southern California Edison Company 75

Southwest Research Institute 93,94

Stearns Roger Manufacturing 53

Tech Reps., Inc. 58

Technodyne Engineering 51

Terra Tek, Inc. 101

Contractor Index (concluded)

Page

Texas Technical University 91

University of Arizona 115

University of Dayton Research Institute 74

University of Denver 102,109

University of Hawaii 77

University of Houston 128,129,130,131,132

University of Minnesota 82

FY 1984

Contract Descriptions

Sandia National Laboratories Livermore

SNLL

Title: Stretched Membrane Heliostat

Contractor: TBD

Directing Organization: SNLL

Principal Investigator: TBD
Telephone:

Project Engineer: C.L. Mavis
Telephone: (415) 422-3031

Contract Number: SNLL 91-8808

Contract Funding		**Source**
FY84	$TBD	DOE

Current Contract Period **From:** TBD
To: TBD

Project/Area/Task: Advanced Heliostats/Central Receiver/Stressed Membrane Heliostat Mirror Module

---

Objectives: To determine the feasibility and potential cost-effectiveness of the stretched membrane heliostat for use in solar central receiver systems for electrical power or process heat applications.

Approach/Present Tasks: Phase I will consist primarily of design, fabrication, and cost investigation for a commercially mass-produced membrane heliostat. A prototype membrane mirror assembly will be designed, and bench testing of components and fabrication techniques will be performed to resolve design uncertainties. Phase II will consist of prototype mirror assembly, fabrication, installation, and testing at Sandia Livermore.

Status/FY 1984 Accomplishments: Quotations were received and evaluated from two companies. Fact finding meetings were held and technical evaluations were completed for both contractors. Sandia Purchasing is in the process of writing and placing the two contracts.

FY 1985 Milestones: Start contract November 1984

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Solar System Design Utilizing Solid Particles

Directing Organization: SNLL

Contractor: TBD

Project Engineer: J.M. Hruby
Telephone: (415) 422-2596

Principal Investigator: TBD
Telephone:

Contract Funding: **Source**

Contract Number: SNLL 90-1534

FY84 **$**TBD SNLL

Current Contract Period **From:** TBD
To: TBD

Project/Area/Task: Solid Particle Receiver/Central Receiver/Plant Conceptual Design

---

Objectives: To establish solar plant conceptual designs for specific applications which use a solid particle central receiver as a major source of heat.

Approach/Present Tasks: To establish the high-temperature system conceptual designs and applications utilizing a solid particle receiver to provide technical and economic information to guide future research and development efforts. The funding will be utilized by contractors with access to results of in-house investigations.

Status/FY 1984 Accomplishments: CBD advertisement appeared September 5, 1984. Request for Quotation (RFQ) prepared.

FY 1985 MILESTONES Issuing of RFQ and awarding of contracts.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Automatic Controls for the Molten Salt Electric Experiment

Directing Organization: SNLL

Contractor: TBD

Project Engineer: C.L. Mavis
Telephone: (415) 422-3031

Principal Investigator: TBD
Telephone:

Contract Funding:		**Source**
FY84	**$**TBD	DOE

Contract Number: SNLL 91-8843

Current Contract Period **From:** TBD
To: TBD

Project/Area/Task: Controls Development/Central Receiver/Unattended Operation of Molten Salt Electric Experiment

---

Objectives: Define the limits imposed by current solar technology on an unattended solar central receiver plant. Provide guidelines for the instrumentation, computer hardware and software, and operational constraints required to achieve unattended operation of a solar central receiver plant. Provide information to the solar central receiver industry to estimate the cost tradeoff of manpower versus unattended controls for future plants.

Approach/Present Tasks: The Molten Salt Electric Experiment will be automated for unattended operation to (1) verify design methods and hardware and software performance by field measurements, (2) determine to what extent automation can improve system and subsystem efficiencies and the impact on equipment failures and component lifetimes, (3) determine the impact of plant automation on system availability, (4) obtain operation and maintenance cost data, (5) obtain operating experience and develop one possible set of automation requirements and specifications.

Status/FY 1984 Accomplishments: A Request For Quotation (RFQ) with a statement of work has been prepared and approved. Release of the RFQ is awaiting action by Sandia Purchasing.

FY 1985 Milestones: Start contract August 1985.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Laminated Glass Mirror Modules

Contractor:
Solar Kinetics, Inc.
3300 Century Circle
Irving, TX 75060

Principal Investigator: G. Hutchinson
Telephone: (214) 556-2376

Contract Number: SNLL 81-7494

Current Contract Period **From:** 12/83
To: 10/84

Directing Organization: SNLL

Project Engineer: C.L. Mavis
Telephone: (415) 422-3031

Contract Funding:		**Source**
FY84	$92,400	DOE

Project/Area/Task: Heliostats/Central Receiver/Long-life Mirror Modules Systems

---

Objectives: To obtain long-life, high-performance mirrors that would be a direct replacement for the 10 MWe Central Receiver Pilot Plant mirrors and to demonstrate that such mirrors could be bought on a fixed price basis.

Approach/Present Tasks: Laminated glass mirror modules were to be designed and 150 fabricated to meet the requirements for performance and life-time and to be direct replacements for the existing mirror modules. The modules will be installed on pilot plant heliostats and monitored for degradation for several years.

Status/FY 1984 Accomplishments: Three initial production mirror modules were measured at Sandia Livermore to verify the mirror focal length and focal length change versus temperature. Subsequently, 48 modules were delivered to the pilot plant. Another 98 modules will be delivered to the pilot plant in October 1984. Four more will be tested at Sandia Livermore.

FY 1985 Milestones: Begin mounting mirror modules on heliostats by November 1984.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Solar Thermal Planning and Analysis Technical Support

Directing Organization: SNLL

Contractor:
Battelle PNL
P.O. Box 999
Richland, WA 99352

Project Engineer: J. Iannucci
Telephone: (415) 422-2140

Principal Investigator: T.A. Williams
Telephone: (509) 376-4743

Contract Funding:		**Source**
FY84	$53,111	DOE

Contract Number: SNLL 92-0435

Current Contract Period **From:** 4/84
To: 1/85

Project/Area/Task: Systems Analysis/Solar Thermal/Five-Year Plan Technical Support

---

Objectives: Support TPI systems analysis efforts.

Approach/Present Tasks: Provide technical support to the development of a solar thermal Five-Year Research Plan including economic analysis, development of technology targets, and documentation of this work. Provide technical support for the completion of analysis of fuels and chemicals applications begun during PNL on-site participation in the solar thermal planing and assessment project.

Status/FY 1984 Accomplishments: Prepared economic analysis and established technology targets for incorporation into the Five-Year Research Plan.

FY 1985 Milestones:
Documentation of fuels and chemicals studies.
Draft appendix for Five-Year Research Plan.
Solar thermal cost goals developed.
Documentation of cost goals.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Fuels and Chemicals System Designs

Contractor: TBD

Directing Organization: SNLL

Principal Investigator: TBD
Telephone:

Project Engineer: E. Carrell
L. Radosevich
Telephone: (415) 422-3344
(415) 422-2648

Contract Number: SNLL 91-4648

Current Contract Period **From:** TBD
To: TBD

Contract Funding: **Source**

FY84 **$**TBD DOE

Project/Area/Task: Advanced Systems for Thermochemical Applications/Central Receiver/Conceptual Design of Fuels and Chemicals Plant

---

Objectives: To (1) establish conceptual designs for the production of fuels and chemicals using a solar central receiver as a major source of heat, (2) stimulate broader industry participation in the development of a solar fuels and chemicals technology, and (3) develop a data base of process descriptions, design data, operating strategies and economic predictions to guide future research and development.

Approach/Present Tasks: Multiple contract awards are planned. Each contract will provide for (1) process optimization, (2) facility design, (3) identification of technological uncertainties, and (4) facility and product cost estimates.

Status/FY 1984 Accomplishments: Proposal evaluation is complete and contract negotiations are under way.

FY 1985 Milestones: Awarding of contracts

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Integrated Market, Cost, and Financial Analysis for Solar Central Receiver Projects

Contractor: TBD

Principal Investigator: TBD
Telephone:

Contract Number: SNLL 90-1557

Current Contract Period **From:** TBD
To: TBD

Directing Organization: SNLL

Project Engineer: L. Radosevich
Telephone: (415) 422-2648

Contract Funding:	**Source**	
FY84	**$**TBD	DOE

Project/Area/Task: Market Assessment/Central Receiver/Assessment of Past and Planned Central Receiver Projects

---

Objectives: To assess the capability of solar central receiver technology to enter the near-term energy markets.

Approach/Present Tasks: The study will (1) compile technical and economic data from past and planned central receiver projects, (2) develop a set of criteria which have a high probability of affecting the success or failure of solar central receiver ventures, (3) evaluate the projects based on these criteria, and (4) identify potential government and industry actions and roles that will facilitate the viability of various near-term solar thermal commercial projects.

Status/FY 1984 Accomplishments: Contract negotiations are under way.

FY 1985 Milestones: Awarding of contract.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Molten Salt Electric Experiment System Design and Integration

Contractor:
Martin Marietta Aerospace
P.O. Box 179
Denver, CO 80201

Principal Investigator: T. Tracey
Telephone: (303) 977-8701

Contract Number: SNLL 81-7469

Current Contract Period **From:** 1/83
To: 12/84

Directing Organization: SNLL

Project Engineer: W. Delameter
Telephone: (415) 422-2037

Contract Funding:		**Source**
FY83	$506,944	DOE
84	566,225	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/System Development and Testing

---

Objectives: To construct and test a full-system demonstration project which uses molten nitrate salt as a primary heat-transfer fluid and a thermal storage medium. Full-power conversion from solar energy to electricity on the grid has been accomplished.

Approach/Present Tasks: Martin Marietta coordinated the efforts of other MSEE participants in the design and construction of the project. They also had responsibility of control system design and system checkout test planning and implementation.

Status/FY 1984 Accomplishments:
Construction completed September 1983.
Receiver operational October 1983.
Steam generator operational and turbine roll December 1983.
Synchronization to grid April 1984.
Checkout testing complete July 1984.
Phase I Final Report submitted September 1984.

FY 1985 Milestones: Publish Final Report: May 1985

Major Project Reports: None.

Summary Date
October 1984

SNLL

Title: 10 MWe Solar Central Receiver Pilot Plant, Collector System Technical Support

Contractor:
Martin Marietta Aerospace
P.O. Box 179
Denver, ,CO 89210

Principal Investigator: R. Koenig
Telephone: (303) 977-6014

Contract Number: SNLL 84-8640A

Directing Organization: SNLL

Project Engineer: D. Tanner
Telephone: (422) 422-2314

Contract Funding:		Source
FY82	$ 79,873	DOE
83	196,106	DOE
84	183,979	DOE

Current Contract Period From: 4/82
To: 01/85

Project/Area/Task: 10 MWe Solar Central Receiver Pilot Plant/Central Receiver/ Collector System

---

Objectives: Correct the construction deficiencies in collector system software and hardware at Solar One.

Approach/Present Tasks: Software engineers at Solar One to complete software modifications and documentation.

Status/FY 1984 Accomplishments: Improvement was made in the problem of failure of the prime heliostat array controller to the backup. Changes were made in system initialization to reduce the possibility of error.

FY 1985 Milestones: Complete beam characterization system part of the HAC software, correct other operational deficiencies, complete documentation.

Major Project Reports: None.

Summary Date
October 1984

SNLL

Title: 10 MWe Pilot Plant Support

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

Principal Investigator: R.L. Gervais
Telephone: (714) 896-3239

Contract Number: SNLL 84-4690

Directing Organization: SNLL

Project Engineer: J. Bartel
Telephone: (415) 422-2952

Contract Funding:		**Source**
FY84	$147,839	DOE

Current Contract Period **From:** 3/84
To: Present

Project/Area/Task: 10 MWe Solar Central Receiver Pilot Plant/Central Receiver/Test Procedures

---

Objectives: 10 MWe Solar Central Receiver Data Evaluation and Analysis

Approach/Present Tasks: Prepare test procedures and provide test program support for the pilot plant test and evaluation phase.

Status/FY 1984 Accomplishments: Work is complete except for external distribution of the test procedures which is underway.

FY 1985 Milestones: Close out contract.

Major Project Reports: McDonnell Douglas Astronautics Co. "10 MWe Solar Thermal Central Receiver Pilot Plant Mode I (Test 1110) Test Report." Contractor Report. SAND 84-8181, October 1984.

Summary Date
October 1984

SNLL

Title: 10 MWe Solar Central Receiver Pilot Plant, System and Test Technical Support

Contractor:
McDonnell Douglas
5301 Bolsa Avenue
Huntington Beach CA 92647

Principal Investigator: R. Gervais
Telephone: (714) 896-3239

Contract Number: SNLL 84-8173

Current Contract Period **From:** 6/82
To: 9/85

Directing Organization: SNLL

Project Engineer: D. Tanner
Telephone: (415) 422-2314

Contract Funding:		**Source**
FY82	$ 727,575	DOE
83	5,888,425	DOE
84	4,468,759	DOE

Project/Area/Task: 10 MWe Solar Central Receiver Pilot Plant/Central Receiver/System and Test Technical Support

---

Objectives: Correct the construction deficiencies in the plant systems software and hardware at Solalr One. Conduct the test program for Sandia.

Approach/Present Tasks: Remaining effort is as-built documentation and test reports.

Status/FY 1984 Accomplishments: The test program was completed July 1984. Remaining tasks are to complete documentation of the plant and publish the test reports.

FY 1985 Milestones: The as-built documentation and test reports will be completed.

Major Project Reports: McDonnell Douglas Astronautics Co. "Solar One Solar Thermal Central Receiver Pilot Plant: 1983 Meteorological Data Report." Contractor Report. SAND84-8180, June 1984.

McDonnell Douglas Astronautics Co. "10 MWe Solar Thermal Central Receiver Pilot Plant Mode I (Test 1110) Test Report." Contractor Report. SAND84-8181, October 1984.

Summary Date
October 1984

SNLL

Title: On-Site Technical Staff Support

Contractor:
SERI
1617 Cole Blvd.
Golden, CO 80401

Principal Investigator: B. Gupta
Telephone: (303) 231-1760

Contract Number: SNLL 92-0054

Current Contract Period **From:** 4/83
To: 9/84

Directing Organization: SNLL

Project Engineer: J. Swearengen
Telephone: (415) 422-3022

Contract Funding:		**Source**
FY83	$170,000	DOE
84	100,000	DOE

Project/Area/Task: Central Receiver Technology/Central Receiver/Technical Staff

---

Objectives: Perform engineering analysis, conceptual design tradeoffs, and comparative evaluations of alternative options for solar central receiver technology. The specific areas to be investigated are (1) high-temperature receivers, (2) advanced enclosed heliostats, and (3) solar fuels and chemicals system studies.

Approach/Present Tasks: Participate as integral member of Sandia technical teams responsible for the definition and implementation of projects leading to feasibility demonstration and economic comparisons.

Status/FY 1984 Accomplishments: Completed on-site technical support for ongoing SNLL projects. Prepared inputs to joint report (below).

FY 1985 Milestones: None

Major Project Reports: Delaquil III, P. and J. V. Anderson. "The Performance of High-Temperature Central Receiver Systems." SAND84-8233, July 1984.

Summary Date
October 1984

SNLL

Title: Technology Transfer Support

Contractor:
Jet Propulsion Laboratory
4800 Oak Grove Dr.
Pasadena, CA 91109

Principal Investigator: P. Panda
Telephone: (213) 916-9319

Contract Number: SNLL 92-9458

Current Contract Period **From:** 4/82
To: 4/84

Directing Organization: SNLL

Project Engineer: J. Iannucci
Telephone: (415) 422-2140

Contract Funding:		**Source**
FY82/83	$100,000	DOE
84	25,000	DOE

Project/Area/Task: Technology Transfer/Solar Thermal/Briefing Book

---

Objectives: Update and publish management briefing book.

Approach/Present Tasks: Research, prepare, and reproduce updated management briefing books.

Status/FY 1984 Accomplishments: Updated and distributed management briefing book, "Solar Thermal Technology: State-of-the-Art."

FY 1985 Milestones: None

Major Project Reports: Management briefing book "Solar Thermal Technology: State-of-the-Art."

Summary Date
October 1984

SNLL

Title: TPI Staff Support

Contractor:
Battelle PNL
PO Box 999
Richland, WA 99352

Principal Investigator: T. Williams
Telephone: (509) 376-4743

Contract Number: SNLL 92-0030

Current Contract Period **From:** 3/83
To: 3/84

Directing Organization: SNLL

Project Engineer: J. Iannucci
Telephone: (415) 422-2140

Contract Funding:		**Source**
FY83	$57,851	DOE
84	55,149	DOE

Project/Area/Task: Planning and Analysis/Solar Thermal/Assessment Studies

---

Objectives: Provide staff services to the solar thermal program Technology Program Integrator Office.

Approach/Present Tasks: Provide technical and economics analyses on-site as a participant in the STT/TPI planning and assessment activities.

Status/FY 1984 Accomplishments: Participated in solar thermal technology planning and assessment activities through March 1984.

FY 1985 Milestones: None

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Solar Thermal Planning and Analysis Technical Support

Contractor:
Battelle PNL
P.O. Box 999
Richland, WA 99352

Principal Investigator: T.A. Williams
Telephone: (509) 376-4743

Contract Number: SNLL 92-0435

Current Contract Period **From:** 4/84
To: 1/85

Directing Organization: SNLL

Project Engineer: J. Iannucci
Telephone: (415) 422-2140

Contract Funding:		**Source**
FY84	$53,111	DOE

Project/Area/Task: Planning and Analysis/Solar Thermal/Technical Support

---

Objectives: Provide technical support to the development of the Solar Thermal Five-Year Research Plan and provide technical support to the fuels and chemicals applications analysis.

Approach/Present Tasks: Perform economic analyses and develop technology targets.

Status/FY 1984 Accomplishments: Prepared economic analyses and established technology targets for incorporation into Five-Year Research Plan.

FY 1985 Milestones: Continue TPI technical support activities.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Alternate Volumeric Receiver Conceptual Designs

Directing Organization: SNLL

Contractor:
Battelle PNL
P.O. Box 999
Richland, WA 99352

Project Engineer: J. Swearengen
Telephone: (415) 422-3022

Contract Funding: **Source**

FY84 $102,484 DOE

Principal Investigator: B. Johnson
Telephone: (509) 375-2006

Contract Number: SNLL 92-0504

Current Contract Period **From:** 5/84
To: 12/84

Project/Area/Task: High-Temperature Receivers/Central Receiver/Conceptual Design

---

Objectives: Complete preconceptual definition of alternate volumetric receiver designs. Document volumetric receiver conceptual design activities.

Approach/Present Tasks: Alternative volumetric receiver design approaches uncovered during original conceptual design activity will be investigated further. A final report will be prepared.

Status/FY 1984 Accomplishments: Preconceptual design activities completed and documentation started.

FY 1985 Milestones: Provide final report of Volumetric Receiver Conceptual Design Activities.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: High-Temperature Receiver Development

Contractor:
Battelle PNL
P.O. Box 999
Richland, WA 99352

Principal Investigator: B. Johnson
Telephone: (509) 375-2006

Contract Number: SNLL 92-0011

Current Contract Period **From:** 3/83
To: 9/84

Directing Organization: SNLL

Project Engineer: J. Swearengen
Telephone: (415) 422-3022

Contract Funding:		**Source**
FY83	$520,003	DOE
84	304,997	DOE

Project/Area/Task: High-Temperature Receivers/Central Receiver/Volumetric Receiver Conceptual Design

---

Objectives: Develop conceptual design of volumetric receiver. Provide technical support for repowering preliminary and final design activities.

Approach/Present Tasks: Perform engineering studies of critical parameters, such as heat transfer in low velocity air steam, coupling of radiation, reflection and absorption over volume of receiver, and specularity of reflectors over time.

Status/FY 1984 Accomplishments: Engineering analysis and experiments established that this volumetric concept for a high-temperature air receiver was not practical. Several alternate concepts were identified and explored. Earthquake structural standards for central receiver systems were proposed.

FY 1985 Milestones None

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: MSEE Construction

Contractor:
Jones Plumbing & Heating
1495 Bosque Farms Blvd.
Bosque Farms, NM 87068

Principal Investigator: J. Jones
Telephone: (505) 844-6871

Contract Number: SNLA 52-5836

Current Contract Period **From:** 4/83
To: 4/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY83	$325,000	DOE
84	35,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/Construction

---

Objectives: Install the electric power generator for the Molten Salt Electric Experiment

Approach/Present Tasks: Provide up to four mechanical personnel during installation.

Status/FY 1984 Accomplishments: Installed EPGS at CRTF.
Completed initial hookup and checkup.

FY 1985 Milestones: None

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: MSEE Construction/Maintenance

Contractor:
All American Enterprises
301 Eubank Blvd., SE
Albuquerque, NM 87123

Principal Investigator: J. Greigo
Telephone: (505) 844-6871

Contract Number: SNLA 52-5729

Current Contract Period **From:** 4/83
To: 4/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY83	**$** 20,000	DOE
84	143,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/Construction and Maintenance

---

Objectives: Provide on-site mechanical insulation support during construction and operation of Molten Salt Electric Experiment.

Approach/Present Tasks: Supply up to four insulators on an "as needed" basis.

Status/FY 1984 Accomplishments: Completed and maintained all insulation on the Molten Salt Electric Experiment.

FY 1985 Milestones None

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: MSEE Electric Construction

Contractor:
B & D Electronics
700 Rankin Road, SE
Albuquerque, NM 87107

Principal Investigator: J. Dawson
Telephone: (505) 844-2280

Contract Number: SNLA 52-5663

Current Contract Period **From:** 4/83
To: 12/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY83	$ 99,000	DOE
84	387,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/Construction

---

Objectives: Provide on-site services related to construction, checkout, and operation of Molten Salt Electric Experiment

Approach/Present Tasks: Supply up to three electronic technicians on an "as needed" basis for Molten Salt Electric Experiment support.

Status/FY 1984 Accomplishments: Completed Molten Salt Electric Experiment construction wiring.

FY 1985 Milestones: Support MSEE electrical O&M activities.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: MSEE Construction

Contractor:
J.B. Henderson Construction
329 Florida, SE
Albuquerque, NM 87108

Principal Investigator: J. Henderson
Telephone: (505) 844-2280

Contract Number: SNLA 52-5795-09

Current Contract Period **From:** 4/83
To: 10/84

Directing Organization: SNLA

Project Engineer: J. Holmes
Telephone: (505) 844-6871

Contract Funding:		**Source**
FY83	$127,000	DOE
84	97,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/Construction

---

Objectives: Provide on-site services related to electrical/mechanical construction activities for the Molten Salt Electric Experiment.

Approach/Present Tasks: Supply up to four electronic fabricators and technicians on an "as needed" basis during construction, modification, and testing of MSEE.

Status/FY 1984 Accomplishments: Henderson Construction provided services as required by the Molten Salt Electric Experiment activities.

FY 1985 Milestones: Continue MSEE support on an "as needed" basis.

Major Projects Reports: None

Summary Date
October 1984

Title: MSEE Engineering/Technician Support

Contractor:
PSC of New Mexico
414 Silver, SW
Albuquerque, NM 87102

Principal Investigator: A. Akhil
Telephone: (505) 844-2280

Contract Number: SNLA 52-5512

Current Contract Period **From:** 3/83
To: 6/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:	**Source**	
FY83	$25,000	DOE
84	76,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/Test Support

---

Objectives: Provide engineering and technician support related to design, setup, and operation of the Electric Power Generator Subsystem used on the Molten Salt Electric Experiment.

Approach/Present Tasks: Supply an engineer and up to three technicians as consultants during the Molten Salt Electric Experiment.

Status/FY 1984 Accomplishments: The EPGS subsystem was installed for operation. The EPGS demonstrated its rated output of 750 kW. The power was fed into the utility grid.

FY 1985 Milestones: None

Major Project Reports: None

Summary Date
October 1984

Title: A and E Services

Contractor:
Black & Veatch
1500 Meadow Lake Parkway
Kansas City, MO 64114

Principal Investigator: H. Lavarentz
Telephone: (913) 967-2000

Contract Number: SNLA 37-8752

Current Contract Period **From:** 12/82
To: 12/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY83	$ 69,000	DOE
84	291,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/A & E

Objectives: Provide A & E services during design, construction, operation, and modification phases of the Molten Sale Electric Experiment.

Approach/Present Tasks: Support program on an "as needed" basis through home office and on-site engineering and design personnel.

Status/FY 1984 Accomplishments: Completed Molten Salt Electric Experiment design.
Assisted in overseeing MSEE construction.
Supplied engineering and design assistance during modification and repair activities.

FY 1985 Milestones: Complete Molten Salt Electric Experiment involvement with a final report and full set of prints.

Major Project Reports: Operating and maintenance procedures.

Summary Date
October 1984

SNLL

Title: CRTF Engineering Support

Contractor:
Technadyne Engineering
300 Virginia Street, SE
Albuquerque, NM 87123

Principal Investigator: C. Maxwell
Telephone: (505) 844-7225

Contract Number:
SNLA 31-8564A-01
SNLA 48-0944-02

Current Contract Period **From:** 4/83
To: 4/85

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY83	$156,000	DOE
84	53,000	DOE

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

---

Objectives: Provide engineering support to the experiments conducted at the CRTF

Approach/Present Tasks: Technadyne Engineering Consultants supplies two engineers to the CRTF. One engineer's time is devoted 100% to the Molten Salt Electric Experiment. The other engineer supports all small-scale tests and some facility design.

Status/FY 1984 Accomplishments:
MSEE operation and maintenance.
HELIOS computer code upgrade.
General data analysis software upgrade.

FY 1985 Milestones:
MSEE support through phase III.
Category B setup and test support.
Solar furnace operation in support of solar thermal programs.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: CRTF Technician Support

Contractor:
Missouri Research Lab
620 Haines, SW
Albuquerque, NM 87102

Principal Investigator Vidal Morgas
Telephone: (505) 243-6772

Contract Number: SNLA 26-3925
SNLA 48-0942

Current Contract Period **From:** 6/82
To: 2/86

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY82/83	$225,000	DOE
84	190,000	DOE

Project/Area/Task: Central Receiver Test Facility/Central Receiver/O & M Support

---

Objectives: Provide technician support to the Central Receiver Test Faciltiy in the areas of operation, maintenance, and testing.

Approach/Present Tasks: Missouri Research Laboratory supplies up to a maximum of ten technicians with a background in mechanical, electrical, or computer technology.

Status/FY 1984 Accomplishments: CRTR O & M support during FY84.
Molten Salt Electric Experiment support during FY84.

FY 1985 Milestones: O & M Support.
MSEE support.
Category B setup and test support.

Major Project Reports: None

Summary Date
October 1984

SNLL

Title: MSEE Support Engineer

Contractor:
Stearns Roger Mfg.
P.O. Box 5888
Denver, CO 80217

Principal Investigator: Larry Nelson
Telephone: (505) 844-2280

Contract Number: SNLA 31-8465B

Current Contract Period **From:** 4/83
To: 4/85

Directing Organization: SNLA

Project Engineer: J. Holmes
Telephone: (505) 844-6871

Contract Funding:		**Source**
FY83	$100,000	DOE
84	37,000	DOE

Project/Area/Task: Molten Salt Electric Experiment/Central Receiver/Support Engineer

---

Objectives: Provide engineering support to the Molten Salt Electric Experiment; specifically, support of the power generation phase of the experiment.

Approach/Present Tasks: Stearns Roger supplies one engineer to the CRTF involved in operation of the Molten Salt Electric Experiment, specifically the power generation system.

Status/FY 1984 Accomplishments: Assisted in design, installation, and checkout of the power generation system. Successfully integrated the power generation equipment into the Molten Salt Electric Experiment.

FY 1985 Milestones: Continue to operate the power-generator system during experiments and continue engineering support of the MSEE to completion.
Major Project Reports: None

Summary Date
October 1984

SNLL

Title: Molten Salt Subsystem/Component Test Experiment

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

Principal Investigator: P.R. Elsbree
Telephone: (216) 860-1968

Directing Organization: SNLL

Project Engineer: W. Delameter
Telephone: (415) 422-2037

Contract Funding:		**Source**
FY84	**$**704,922	DOE

Contract Number: SNLL 91-4687

Current Contract Period **From:** 3/84
To: 4/86

Project/Area/Task: Repowering Category B/Central Receiver Systems Test and Evaluation

---

Objectives: To resolve the present technical uncertainties relating to the solar central receiver plant subsystems and components, provide a sound technological base for development of the molten salt solar industry, and support the design and construction plans for the Saguaro and Solar 100 plants.

Approach/Present Tasks: Full-size hot- and cold-molten salt pumps and representative valves, and a 5-MW receiver are being designed and purchased or fabricated for testing at the Central Receiver Test Facility. A test plan is being developed and testing will be completed as part of this effort.

Status/FY 1984 Accomplishments: Fabrication has started on a test bed for valve stem seal testing. Test loops for the hot and cold pump-and-valve testing has been designed and hardware procurement is in progress. The receiver design is under way; size and shape is complete; and solax flux onto the panels has been calculated and is being refined while detail design is under way. The contract effort is approximately two months behind schedule due to subcontract negotiation problems. A two-month contract extension is anticipated.

FY 1985 Milestones Complete bench test program by April 1985.
Start pump-and-valve testing by August 1985.

Major Project Reports: None

Summary Date
October 1984

Sandia National Laboratories Albuquerque

SNLA

Title: IPH Projects

Contractor:
ETEC, Rockwell Intl
P.O. Box 1449
Canoga Park, CA 91304

Principal Investigator: W.L. Bigelow
Telephone: (818) 700-5527

Contract Number: SNLA 47-1385

Directing Organization: SNLA

Project Engineer: E.L. Harley
Telephone: (505) 844-3574

Contract Funding:		**Source**
FY83	**$**200,000	DOE
84	---	---

Current Contract Period **From:** 10/83
To: 9/84

Project/Area/Task: Distributed Receiver/System Experiments/IPH

Objectives: Monitor Cycle 1 and Cycle 2 IPH Projects

Approach/Present Tasks: Provide technical support for active Cycle 1 and Cycle 2 IPH projects

Status/FY 1984 Accomplishments: Provided technical support and prepared monthly reports for following projects:

1. Campbell Soup; Sacramento, CA
2. Johnson & Johnson; Sherman, TX
3. Riegel Tetiles; La France, SC
4. York Building Products; Middletown, PA
5. Lamanuzi & Pantalleo; Fresno, CA
6. Bunge Corp. (Goldkist0: Decatur, AL
7. J.A. LaCour Kiln Services; Canton, MS
8. Georgia Power Office Bldg; Atlanta, GA

FY 1985 Milestones: Will continue to monitor projects listed and to prepare monthly reports.

Major Project Reports: None.

Summary Date
December 1984

SNLA

Title: Analysis of IPH Project Performance

Contractor:
Kellog Unit Foundation, Inc
California State Polytechnic University
3801 W. Temple Ave.
Pamona, CA 91768

Principal Investigator: W.B. Stine
Telephone: (818) 799-4717

Contract Number: SNLA 47-7666

Current Contract Period **From:** 9/83
To: 6/85

Directing Organization: SNLA

Project Engineer: E.L. Harley
Telephone: (503) 844-3574

Contract Funding:		**Source**
FY83	**$**50,100	DOE
84	$40,000	DOE

Project/Area/Task: Distributed Receiver/Systems Experiments/IPH and Shenandoah

---

Objectives: Analyze data from IPH and Shenandoah experiments and prepare technical reports.

Approach/Present Tasks Analyze data from IPH and Shenandoah experiments and prepare technical reports.

Status/FY 1984 Accomplishments: Co-authored annual IPH technical reports

FY 1985 Milestones: Develop capability to analyze Shenandoah Test Data Dec. 1984.
Complete evaluation of Shenandoah test data June 1985.

Major Project Reports: IPH Project Technical Report-FY1983; November 1984

Summary Date
December 1984

SNLA

Title: Technical Support of IPH Projects

Contractor:
Tech Reps., Inc.
5000 Marble Ave. NE
Suite 222
Albuquerque, NM 87110

Principal Investigator: W. Grant
Telephone: (505) 266-5678

Contract Number: SNLA 50-2567

Current Contract Period **From:** 4/82
To: 9/85

Directing Organization: SNLA

Project Engineer: E.L. Harley
Telephone: (505) 844-3574

Contract Funding:		**Source**
FY83	$150,000	DOE
84	$200,000	DOE

Project/Area/Task: Distributed Receiver/Systems Experiments/IPH

Objectives: Provide administrative and technical services for reporting data from the IPH projects

Approach/Present Tasks: Prepare bi-monthly reports of IPH projects and provide compositing, editing, and technical art for annual IPH report.

Status/FY 1984 Accomplishments: Prepared bi-monthly reports and supported preparation of FY1983 and FY1984 annual IPH reports.

FY 1985 Milestones IPH Project bi-monthly reports

Major Project Reports None

Summary Date
December 1984

SNLA

Title: Analysis of Shenandoah Test Results

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

Principal Investigator: M. Connolly
Telephone: (FTS) 327-1485

Contract Number: SNLA 59-5022

Current Contract Period **From:** 6/84
To: 3/85

Directing Organization: SNLA

Project Engineer: A. A. Heckes
Telephone: (505) 844-3918

Contract Funding:		**Source**
FY84	**$98,000**	DOE

Project/Area/Task: Distributed Receiver/System Engineering/Shenandoah

---

Objectives: Develop computer models and predict performance of Shenandoah Solar Total Energy System.

Approach/Present Tasks: Develop computer models and compare predictions with data from Shenandoah tests.

Status/FY 1984 Accomplishments: Began development of computer models and adapted SOLIPH code to total energy application.

FY 1985 Milestones: Complete SOLIPH analysis January 1985.
Complete final SERI report March 1985

Major Project Reports: Final report: comparison of test data with model predictions; March 1985.

Summary Date
December 1984

SNLA

Title: Innovative Solar Thermal Dish Technology Development

Contractor:
The BDM Corporation
1801 Randolph Road, SE
Albuquerque, NM 87106

Principal Investigator: W.E. Schwinkendorf
Telephone: (505) 848-5313

Contract Number: SNLA 52-3671

Current Contract Period **From:** 6/83
To: 6/84

Project/Area/Task: Concentrators

Directing Organization: SNLA

Project Engineer: R.W. Hunke
Telephone: (505) 846-7819

Contract Funding:		**Source**
FY84	$122,000	DOE

Objectives: To devise and explore new approaches to low-cost, high-efficiency thermal dish collectors of the parabolic Richey-Chretien/Cassegrainian reflector approach.

Approach/Present Tasks: Complete

Status/FY 1984 Accomplishments: Optical analysis code operational on Vax computer. Mirror system analysis complete; material/fabrication cost analysis completed. The results of the study indicated that the Cassegrainian reflector would not perform as well as the single reflecting parabolic dish. Also some thermal problems would have to be resolved. However, for thermal applications, the Cassegrainian system cost could be lower than those of the conventional dish because of elimination of up-and-down piping and reduced receiver support structure.

FY 1985 Milestones: None

Major Project Reports: SAND84-7011. "Innovative Solar Thermal Dish Technology Development." The BDM Corporation, September 1984.

Summary Date
November 1984

SNLA

Title: Brayton Dish-Electric System

Contractor:
Sanders Associates, Inc.
94 Canal Street
Nashua, NH 03080

Principal Investigator: S. Bear Davis
Telephone: (603) 885-3212

Contract Number: SNLA 58-1001

Current Contract Period **From:** 1/84
To: 7/85

Directing Organization: SNLA

Project Engineer: K.L. Linker
Telephone: (505) 846-7817

Contract Funding:		**Source**
FY84	$1,130,000	DOE

Project/Area/Task: Distributed Receiver Dish-Electric

Objectives: Develop the subatmospheric Brayton engine for distributed receiver dish-electric applications.

Approach/Present Tasks: Provide technical management and the design, fabrication, test and evaluation of the subatmospheric Brayton-cycle for dish-electric applications.

Status/FY 1984 Accomplishments: Completed characterization of subatmospheric Brayton-cycle (SABC), LaJet stretched membrane parabolic dish, and subsystem components. In addition, critical design and post-critical design reviews were completed in June 1984 and August 1984, respectively.

FY 1985 Milestones: Complete final report.

Major Project Reports: Final Report of Develoment
Test Module (DTM), April 1985

Summary Date
October 1984

SNLA

Title: Modular Industrial Solar Retrofit

Contractor:
Acurex Solar Corporation
485 Clyde Ave.
Mountain View, CA 94042

Principal Investigator: T. Muller
Telephone: (415) 964-3200

Contract Number: 61-3399

Current Contract Period **From:** 9/81
To: 12/84

Directing Organization: SNLA

Project Engineer: C.P. Cameron
Telephone: (505) 844-0363

Contract Funding:		**Source**
FY81	$999,000	DOE
82	---	---
83	63,000	DOE
84	---	---

Project/Area/Task: Modular Industrial Solar Retrofit

Objectives: Design a Modular Industrial Solar Retrofit industrial processs steam system and fabricate and install a qualification test system.

Approach/Present Tasks: Conduct design studies, design system, and construct qualification test system at MISR test facility.

Status/FY 1984 Accomplishments: System costing is essentially complete, including function and safety test, unattended operations test, collector performance characterization, system thermal loss and parasitic energy usage measurements. The equivalent of 16 years of operation have been completed in life-cycle testing. The following system modifications or improvements are also under test: three-top-lite flex glass mirrors, sagged glass mirrors, improved collector bearings, anti-reflective glazing, and rotary joints.

FY 1985 Milestones: None

Major Project Reports: "Proceedings of the Distributed Solar Collector Summary Conference--Technology and Applications." SAND83-0137C, March 1983.

"MISR Project Final Report." SAND85-0755, May 1985.

Summary Date
October 1984

SNLA

Title: Modular Industrial Solar Retrofit

Contractor:
BDM Corporation
1801 Randolph Road, SE
Albuquerque, NM 87106

Principal Investigator: T.J. Reynolds
Telephone: (505) 848-5000

Directing Organization: SNLA

Project Engineer: C.P. Cameron
Telephone: (505) 844-0363

Contract Number: 61-3397

Current Contract Period **From:** 9/81
To: 12/84

Contract Funding:		**Source**
FY81	$1,000,000	DOE
82	---	---
83	59,000	DOE
84	---	---

Project/Area/Task: Modular Industrial Solar Retrofit

Objectives: Design a Modular Industrial Solar Retrofit industrial process steam system and fabricate and install a qualification test system.

Approach/Present Tasks: Conduct design studies, design system, and construct qualification test system at MISR test facility.

Status/FY 1984 Accomplishments: System testing is essentially complete, including function and safety test, unattended operations test, collector performance characterization, system thermal loss and parasitic energy usuage measurements. Life-cycle testing was suspended in FY83 due to flexible hose failures. The following system modifications or improvements are also under test: flex glass reflective surfaces, silver film reflective surfaces, improved drive motors and controllers and trackers and controllers, a Winemith drive, center of gravity mounting, and 4-in. flexible hoses.

FY 1985 Milestones: None

Major Project Reports: "Proceedings of the Distributed Solar Collector Summary Conference-Technology and Applications." SAND83-0137C, March 1983.

Summary Date
October 1984

SNLA

Title: Modular Industrial Solar Retrofit

Contractor:
Custom Engineering, Inc.
2805 S. Tejon St.
Englewood, CO 80110

Principal Investigator: C. Castle
Telephone: (303) 761-7585

Contract Number: 61-3398

Current Contract Period **From:** 9/81
To: 3/83

Directing Organization: SNLA

Project Engineer: C.P. Cameron
Telephone: (505) 844-0363

Contract Funding:		**Source**
FY82	$1,110,000	DOE
83	50,000	DOE
84	---	

Project/Area/Task: Modular Industrial Solar Retrofit

Objectives: Design a Modular Industrial Solar Retrofit industrial process steam system and fabricate and install a qualification test system.

Approach/Present Tasks: Conduct design studies, design system, and construct qualification test system at MISR test facility.

Status/FY 1984 Accomplishments: System testing is essentially complete, including function and safety test, unattended operations test, collector performance characterization, system thermal loss and parasitic energy usage measurements. The equivalent of nine years of operation have been completed in life-cycle testing. The following system modifications or improvements are also under test; rotary joints, master and local control system modifications, and sol-gel treated receiver glazings.

FY 1985 Milestones: None

Major Project Reports: "Proceedings of the Distributed Solar Collector Summary Conference--Technology and Applications." SAND83-0137C, March 1983.

Summary Date
October 1984

SNLA

Title: Modular Industrial Solar Retrofit

Contractor:
Foster Wheeler
12 Peachtree Hill Road
Livingston, NJ 07039

Principal Investigator: D.J. Allen
Telephone: (201) 533-2966

Contract Number: 61-3400

Current Contract Period **From:** 9/81
To: 12/84

Directing Organization: SNLA

Project Engineer: C.P. Cameron
Telephone: (505) 844-0363

Contract Funding:		**Source**
FY81	$1,000,000	DOE
82	---	---
83	31,000	DOE
84	---	---

Project/Area/Task: Modular Industrial Solar Retrofit

Objectives: Design a Modular Industrial Solar Retrofit industrial process steam system and fabricate and install a qualification test system.

Approach/Present Tasks: Conduct design studies, design system, and construct qualification test system at MISR test facility.

Status/FY 1984 Accomplishments: System testing is essentially complete, including function and safety test, unattended operations test, collector performance characterization, system thermal loss and parasitic energy usage measurements. The equivalent of five years of operation has been completed in life-cycle testing. Flexible hoses were installed in place of the original Swagelok rotary joints due to leakage. Aeroquip rotary joints have been installed as well.

FY 1985 Milestones: None

Major Project Reports: "Proceedings of the Distributed Solar Collector Summary Conference-Technology and Aplications." SAND83-0137C, March 1983.

Summary Date
October 1984

SNLA

Title: Modular Industrial Solar Retrofit

Contractor:
Solar Kinetics, Inc.
P.O. Box 47045
Dallas, TX 75247

Principal Investigator: J.A. Hutchison
Telephone: (214) 556-2376

Contract Number: 61-3401

Current Contract Period **From:** 9/81
To: 12/84

Directing Organization: SNLA

Project Engineer: C.P. Cameron
Telephone: (505) 844-9363

Contract Funding:		Source
FY81	$870,000	DOE
82	---	---
83	---	---
84	51,000	---

Project/Area/Task: Modular Industrial Solar Retrofit

Objectives: Design a Modular Industrial Solar Retrofit industrial process steam system and fabricate and install a qualification test system.

Approach/Present Tasks: Conduct design studies, design system, and construct qualification test system at MISR test facility.

Status/FY 1984 Accomplishments: System installed and under test. System testing is essentially complete, including function and safety test, unattended operations test, collector performance characterization, system thermal loss and parasitic energy usage measurements. The following system modifications or improvements are also under test: improved drive motors and controllers, tracker controllers, a rotating light switch, and a 160-ft long drive group.

FY 1985 Milestones: None

Major Project Reports: "Proceedings of the Distributed Solar Collector Summary Conference--Technology and Applications." SAND83-0137C, March 1983.

Summary Date
October 1984

SNLA

Title: A & E Services

Contractor:
Black and Veatch
1500 Meadow Lake Parkway
Kansas City, MO 64114

Principal Investigator: H. Laverentz
Telephone: (913) 967-7132

Contract Number: SNLA 58-3544

Current Contract Period **From:** 2/84
To: 12/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY84	$170,000	DOE

Project/Area/Task: Distributed Receiver Test Facility/Construction

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Objectives: Provide A & E Services leading to construction of the Distributed Receiver Test Facility.

Approach/Present Tasks: Supply appropriate personnel both at home office and on-site during design and construction of Distributed Receiver Test Facility.

Status/FY 1984 Accomplishments: Completed phases A and B of DRTF designs, including designs for site preparation, foundations for TBC-1, LaJet and GE concentrators, a new control room, the circulating water system, standby power system, and electrical and instrumentation trays and trenches.

FY 1985 Milestones: Completed design of Distributed Receiver Test Facility

Major Project Reports: Complete set of construction drawings for DRTF

Summary Date
October 1984

SNLA

Title: DRTF Construction

Contractor:
Gardner Zimke Co.
4600 Lincoln Road, NE
Albuquerque, NM 87106

Principal Investigator: Gardner
Telephone: (505) 846-0781

Contract Number: SNLA 58-8316

Current Contract Period **From:** 3/84
To: 8/84

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY84	$282,000	DOE

Project/Area/Task: Distributed Receiver Test Facility/Site

Objectives: Construct the Distributed Receiver Test Facility as designed and specified.

Approach/Present Tasks: Supply personnel and equipment required to complete construction.

Status/FY 1984 Accomplishments: Constructed phase B of the DRTF including foundations for the LaJet and GE collectors, a new control room, the circulating water system, standby power system, and electrical and instrumentation trays and trenches.

FY 1985 Milestones: Completed construction of the DRTF.

Major Project Reports: None

Summary Date
October 1984

SNLA

Title: Engineering Support

Contractor:
Entech Incorporated
P.O. Box 261246
DFW Airport, TX 75261

Principal Investigator: Jack Wilkinson
Telephone: (214) 456-0900

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		Source
FY84	$137,000	DOE

Contract Number: SNLA 58-0206A,B, 59-7965

Current Contract Period **From:** 10/83
To: 11/84

Project/Area/Task: Distributed Receiver Test Facility/Site

Objectives: Provide engineering support during disassembly, movement and reassembly of the Jet Propulsion Laboratory Test Bed Concentrator No. 1, and No. 2.

Approach/Present Tasks: Supply two engineers during the operations at JPL Edwards Air Force Base and SNLA Distributed Receiver Test Facility.

Status/FY 1984 Accomplishments: Directed move of TBC-1, 2 and installation of TBC-1.

FY 1985 Milestones: Direct installation of TBC-2.

Major Project Reports: Procedure documents

Summary Date
October 1984

SNLA

Title: Test Support Personnel

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

Principal Investigator: V. Dudley
Telephone: (505) 844-6061

Contract Number: SNLA 52-5653

Current Contract Period **From:** 1/82
To: 1/87

Directing Organization: SNLA

Project Engineer: J.V. Otts
Telephone: (505) 844-2280

Contract Funding:		**Source**
FY81	$100,000	DOE
82	100,000	
83	100,000	
84	100,000	

Project/Area/Task: Distributed Receiver Test Facility

Objectives: Provide engineering and technical support to the test activities at the Distributed Receiver Test Facility.

Approach/Present Tasks: Supply one engineer and one technician on-site at the Distributed Receiver Test Facility.

Status/FY 1984 Accomplishments: Supported all distributed receiver test facility test activities during FY84.

FY 1985 Milestones: None

Major Project Reports: None

Summary Date
October 1984

SNLA

Title: Organic Rankine Cycle (ORC) Heat Engine

Contractor:
Barber-Nichols Engineering
6325 West 55 Avenue
Arvada, CO 80002

Principal Investigator: Bill Batton
Telephone: (303) 421-8111

Contract Number: SNLA 58-1797

Current Contract Period **From:** 1/84
To: 3/85

Directing Organization: SNLA

Project Engineer: K.L. Linker
Telephone: (505) 846-7817

Contract Funding:		**Source**
FY84	$86,000	DOE

Project/Area/Task: Heat Engines

Objectives: To test the power conversion assembly for an additional 200 hours of hot bench testing. Also, design, procure, fabricate, and install an automatic control system.

Approach/Present Tasks: Provide technical management and support for development of heat engines for dish-electric applications.

Status/FY 1984 Accomplishments: Completed 200-hour hot bench test. Began development of an automatic control system for the Organic Rankine Cycle (ORC) engine.

FY 1985 Milestones: Complete automatic control development and bench test with ORC. Transfer ORC to the DRTF for life and performance testing.

Major Project Reports: "TURBO-Alternator Package 200-Hour Test Report." April 23, 1984.

Summary Date
October 1984.

Department of Energy
San Francisco Operations Office

DOE/SAN

Title: Solar Incinerability of Hazardous Organic Wastes

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

Principal Investigator: B. Dellinger
Telephone: (513) 229-2919

Contract Number: DE-AC03-84SF15354

Current Contract Period **From:** 9/84
To: 12/85

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY84	**$105,000**	DOE

Project/Area/Task: Solar Unique Phenomena Program

Objectives: To determine the efficiency with which representative hazardous wastes can be destroyed by solar radiation and to distinguish purely thermal or photolytic effects from combined synergistic phenomena.

Approach/Present Tasks: Literature review, choice of compounds to be tested, reactor design and fabrication, data acquisition.

Status/FY 1984 Accomplishments: New award

FY 1985 Milestones: Development of a data base to facilitate the design of a solar hazardous waste incinerator.
Reactor design and fabrication.
Decomposition experiments.

Major Project Reports: None

Summary Date
October 1984

Title: Solar Ten Megawatt Pilot Plan

Contractor:
Southern California Edison (SCE)
Gen. Office 1, Room 497C
Rosemead, CA 91770

Principal Investigator: C. Lopez
Telephone: (619) 254-3124

Directing Organization: DOE/SAN

Project Engineer: Mike Lopez
Telephone: (415) 273-4264

Contract Number: DE-AC03-79SF10501

Current Contract Period **From:** 8/79
To: 7/87

Contract Funding:		Source
Prior Years	$141,000,000	DOE
FY84	$ 2,960,000	DOE

Project/Area/Task: Barstow 10-MWe Central Receiver Pilot Plant

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Objectives: To establish the technical feasibility of a central receiver solar thermal power plant. To obtain development, construction, operating, and maintance cost data to support private sector decisions to invest in solar central receiver energy systems.

Approach/Present Tasks: Operation and maintenance of the Solar 10-MWe Pilot Plant.

Status/FY 1984 Accomplishments: During the year all of the operating modes performed under manual control. Mode 3 (Storage Boosted) was released for SCE use on 2/21/84, and Mode 7 (Dual Flow) was released on 3/1. In addition, SCE submitted on March 6, for DOE and Sandia review, updated operating instructions for Mode 8 (Inactive/Warm Standby) which have reduced parasitic losses and extended daily operating hours well beyond design-phase expectations. Final plant improvement activities (warehouse HVAC, Oil and Chemical Storage Buildings) were completed on SCE capital funding. Current operating strategies greatly reduced problems with receiver boiler/superheater tubing. No new interstice cracks were found during a scheduled survey using dye-penetrant examination. One additional, non-leaking edge-tube crack was found by ultrasonic inspection. A survey of the heliostat field showed a much reduced rate of increase in corrosion (2.0-2.5X per annum, vs. the 5-10X seen previously) as a result of enhanced venting and revised storage strategies. Total field area corroded is now approximately 0.04%. The two-year test and evaluation phase was successfully completed 7/31/84. On August 1 the three-year power production phase was initiated.

FY 1985 Milestones: None

Major Project Reports:

"Wildlife Interactions at Solar One: Final Report." Southern California Edison. 1/84, DOE/SF/10501-306.

"Solar One Meterology, CY83 Annual Report." Sandia National Laboratory, Livermore (SNLL). SAND84-8180, 1984.

"Solar One Steady State Performance, Mode 1 Test Report." SNLL. SAND84-8181, 1984.

"Mirror Module Corrosion." SNLL. SAND84-8214, 1984.

"Thermal Storage Performance 1020/1040 Test Report." SNLL. SAND84-8186, 1984.

"Solar One Plant Operations, CY82." SNLL. SAND83-8027, 1983.

"Heliostat Beam Safety, Receiver Brightness." SNLL. SAND83-835, 1983.

Summary Date
October 1984

DOE/SAN

Title: Study of Solar Thermal Conversion Using Liquid Metal MHD Systems

Contractor:
HMJ Associates
11508 Regnid Dr.
Silver Spring, MD 20902

Principal Investigator: W. Jackson
Telephone:

Contract Number: DE-AC03-83SF11943

Current Contract Period **From:** 8/83
To: 5/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	$48,541	DOE

Project/Area/Task: Innovative Research Program

Objectives: Analyze feasibility of liquid metal MHD as an alternate to conventional power generation conversion.

Approach/Present Tasks: Perform parametric analyses, sensitivity studies, and system conceptual design to calculate liquid metal MHD.

Status/FY 1984 Accomplishments: It was found that liquid metal magnetohydrodynamic conversion (LMMHD) is compatible with concentrating solar receivers using liquid metal as the heat-transfer fluid. LMMHD offers significant increases in the system thermal efficiency over the 33% considered attainable with conventional turbomachinery. With sodium as the heat-transfer fluid, the efficiency is 39.5% at 1150°F. With lithium as the heat-transfer fluid, the efficiency is 46.5% at 1400°F. Although these efficiencies are high, follow-on research was not initiated at this time primarily because of the large non-solar related resources necessary to develop LMMHD technology.

FY 1985 Milestones: None

Major Project Reports: HMJ Corporation. "Performance of Solar Thermal Systems with Liquid Metal MHD Conversion." DOE/SF/11943-1, June 1984.

Summary Date
October 1984

DOE/SAN

Title: Use of Concentrated Sunlight to Enhance the Selectivity of Hydrocarbon Cracking

Contractor:
University of Hawaii at Monoa
Hawaii Natural Energy Institute
Directing Organization
2540 Dole St.
Honolulu, HI 96822

Principal Investigator: M. Antal
Telephone: (808) 948-8890

Contract Number: DE-AC03-84SF12221

Current Contract Period **From:** 9/84
To: 12/85

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone:

Contract Funding:		**Source**
FY84	$125,000	DOE

Project/Area/Task: Solar Unique Phenomena Program

Objectives: To explore the use of high-temperature photolytic reactions engendered by concentrated solar energy to influence the rates and selectivity of free radical cracking reactions used in the hydrocarbon processing industry.

Approach/Present Tasks: A vapor phase reactor will be designed and fabricated from fused silica. Selected initiators and chain carriers will be passed through the reactor. The active species will be mixed with a hydrocarbon and their influence, the cracking chemistry, will be studied as a function of reaction conditions.

Status/FY 1984 Accomplishments: New award

FY 1985 Milestones: Develop an apparatus capable of rapidly weighing materials exposed to concentrated radiant energy and measuring product yields.

Major Project Reports: None

Summary Date
October 1984

DOE/SAN

Title: Direct In-Situ Generation of Steam in a Line-Focus Collector

Contractor:
Research Engineering Associates
299 California Ave. No. 303
Palo Alto, CA 94306

Principal Investigator: Michael Kast
Telephone: (415) 322-9488

Contract Number: DE-AC03-83SF11946

Current Contract Period **From:** 6/83
To: 5/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	**$**49,290	DOE

Project/Area/Task: Innovative Research Program

Objectives: Define feasibility of producing in-situ steam in a line-focus solar collector.

Approach/Present Tasks: Literature search, experimental design, construct steam generator loop, experiment, and collect data.

Status/FY 1984 Accomplishments: The experimental results showed stable operation of the line-focus system during in-situ steam generation over a wide range of conditions. The simplicity of the control logic, small-pump horsepower requirement, and apparent hydraulic stability that combines with high thermal performance suggest possible commercial applications. The contract was completed.

FY 1985 Milestones: None

Major Project Reports: Research Engineering Associates. "Experimental Study of Direct In-Situ Generation of Steam in a Line Focus Solar Collector." DOE/SF/11964-1, September 1984.

Summary Date
October 1984

DOE/SAN

Title: Ceramic Heat Exchange/Acid Vaporizer

Contractor:
Garrett AiResearch
Manufacturing
2525 West 190th St
Torrance, CA 90509

Principal Investigator: M. Coombs
Telephone: (213) 512-1811

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		Source
FY83	$291,128	DOE

Contract Number: DE-AC03-83SF11717

Current Contract Period **From:** 9/83
To: 9/84

Project/Area/Task: Fuels and Chemicals/Research and Development

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Objectives: Study feasibility of ceramic heat exchangers to vaporize concentrated sulfuric acid in solar reactors.

Approach/Present Tasks: Ceramic heat exchanger design, fabricate single-tube test rig, test, data analysis.

Status/FY 1984 Accomplishments: Completion of test rig assembly. Results of compatibility testing have shown that the three samples of silicon carbide from different suppliers are equally suitable for the application. Bench testing of glass-to-metal seals for the high-temperature outlet of the tube resulted in selection of an industrial-grade gold seal over copper or platinum.

FY 1985 Milestones: Testing of ceramic heat exchanger.

Major Project Reports: None

Summary Date
October 1984

DOE/SAN

Title: Direct Flux Solar Reactors

Contractor:
Institute of Gas Technology
3424 South State St.
Chicago, IL 60616

Principal Investigator: Bernard D. Yudow
Telephone: (312) 567-3698

Contract Number: DE-AC03-82SF11662

Current Contract Period **From:** 9/82
To: 1/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4262

Contract Funding:		**Source**
FY82	$308,087	DOE

Project/Area/Task: Fuels and Chemicals/Research and Development

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Objectives: Determine technical feasibility of using direct flux solar reactors to operate thermochemical processes.

Approach/Present Tasks: Review previous reactor concepts, select reactants, select receiver design, evaluate reactor concepts, develop research plans.

Status/FY 1984 Accomplishments: The major finding was that the conveyor kiln is a technically feasible concept for a direct flux reactor for limestone calcination. The transparent, direct flux steam reformer is not technically feasible because of significant uncertainties in material performance, size availability of transparent tubes, and transparent material durability. Existing materials are too costly to compete against a solar steam reformer design based on use of metallic. The contract was completed.

FY 1985 Milestones: None

Major Project Reports: Institute of Gas Technology. 'Direct Flux Solar Chemical Reactors." DOE/SF/11662-1, September 1984.

Summary Date
October 1984

DOE/SAN

Title: Thermal Electrochemical Engine for Solar Application

Contractor:
Hughes Aircraft Company
P.O. Box 902
El Segundo, CA 90245

Principal Investigator: Frank Ludwig
Telephone: (213) 616-1375

Contract Number: DE-AC03-83SF11942

Current Contract Period **From:** 7/83
To: 7/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	$47,354	DOE

Project/Area/Task: Innovative Research Program

Objectives: Identify material requirements, optical operating conditions, and performance of a novel electrochemical cell.

Approach/Present Tasks: Prototype cell, test cell, perform theoretical analyses, and identify appropriate complex ion-forming material.

Status/FY 1984 Accomplishments: The ThermoElectroChemical converter (TECH) shows potential to out-perform state-of-the-art small and large-scale solar thermal-to-electric converters such as steam Rankine or air Brayton recuperators in cost, conversion efficiency, reliability, and simplicity. TECH operates at 40% efficiency and is a simple mechanical device. It possesses a high-power density device that is also modular.

FY 1985 Milestones: Bench test of a small-sacle system to determine energy balances that will enable a more accurate assessment of system performance to be made.

Major Project Reports: Hughes Aircraft Company. "Thermal Electrochemical Engine for Solar Application." DOE/SF/11942-1, September 1984.

Summary Date
October 1984

DOE/SAN

Title: Design of Collector with Liquid Medium

Contractor:
University of Minnesota
Dept of Mechanical Engrng
111 Church Street, SE
Minneapolis, MN 55455

Principal Investigator: Thomam Keuhn
Telephone: (612) 373-2785

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	$49,771	DOE

Contract Number: De-AC03-83SF11937

Current Contract Period **From:** 8/83
To: 8/84

Project/Area/Task: Innovative Research Program

Objectives: Design and analysis of a fluid-based parabolic concentrator with low re-radiation losses.

Approach/Present Tasks: Detailed thermodynamic modeling, literature research, definition of thermal optical & mechanical properties of concentrator.

Status/FY 1984 Accomplishments: Develop a model to simulate steady-state fluid flow and transient temperature conditions of a cylindrical porous absorber receiver. A receiver design has been finalized that represents a potential improvement over conventional line-focus receiver designs. The use of a porous absorber receiver in a point-focus receiver show great promise for high-pressure liquid heating or vapor generation. The contract was completed.

FY 1985 Milestones: None

Major Project Reports: University of Minnesota. "Innovative Receiver Design for Parabolic Trough and Paraboloidal Dish Solar Concentrator." DOE/SF/11662-1, September 1984.

Summary Date
October 1984

DOE/SAN

Title: Destruction of Hazardous Wastes Using Solar Energy

Contractor:
Babcock and Wilcox
1562 Beeson St.
Alliance, OH 44601

Principal Investigator: William Clancey
Telephone: (216) 753-4511

Contract Number: DE-Ac03-83SF11945

Current Contract Period **From:** 9/83
To: 9/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	**$**50,000	DOE

Project/Area/Task: Innovative Research Program

Objectives: Design an experimental receiver to test the destruction of hazardous wastes in concentrated solar flux.

Approach/Present Tasks: Select candidate PCB material, define optical requirements, material identified, and design test incinerator.

Status/FY 1984 Accomplishments: Feasibility of the concept verified through literature search on photochemical effects. The use of both the photoreduction energy and thermal aspects of solar energy to destroy toxic hazardous wastes. The test program extablished poly-chlorinated biphenyls (PCBs) as the candidate material for the detoxification process since its chlorine-carbon bonds are susceptible to photolytic reduction from intense solar flux in the UV range. The contract was completed.

FY 1985 Milestones: None

Major Project Reports: Babcock and Wilcox. "An Experimental Process for Destruction of Hazardous Wastes Using Solar Energy." DOE/SF/11945-1, December 1984.

Summary Date
October 1984

DOE/SAN

Title: Prototype Design of an Advanced Ceramic Receiver

Contractor:
Martin Marietta Corporation
P.O. Box 179
Denver, CO 80201

Principal Investigator: Bob McMordie
Telephone:

Contract Number: DE-AC03-83SF11938

Current Contract Period **From:** 8/83
To: 4/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	$44,080	DOE

Project/Area/Task: Innovative Research Program

Objectives: Test translucent ceramic tubes under simulated solar conditions for use in a Brayton-cycle receiver. Complete preliminary design of the receiver.

Approach/Present Tasks: Design receiver, analyze critical parameters of design, test materials, analyze results.

Status/FY 1984 Accomplishments: The baseline size of the commercial receiver selected was 50 MW_t. The parametric analysis performed yielded a receiver tube design of 10.2 cm (outside diameter), an inlet velocity of 30.5 m/s, and an average incident flux of 86.8 W/cm^2. The design utilizes alpha-alumina tubes. The contract was completed.

FY 1985 Milestones: None

Major Project Reports: Martin Marietta. "Prototype Design of an Advanced Ceramic Reactor." DOE/SF/11938-1, April 1984.

Summary Date
October 1984

DOE/SAN

Title: Swirling Air Curtain for Central Receivers

Contractor:
Nieken Engineering & Research
510 Clyde Avenue
Mountain View, CA 94043

Principal Investigator: O.J. McMilliam
Telephone: (415) 968-9457

Contract Number: DE-AC03-83SF11940

Current Contract Period **From:** 8/83
To: 8/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	$49,602	DOE

Project/Area/Task: Innovative Research Program

Objectives: Design and test chamber to simulate swirling air curtain for a central receiver.

Approach/Present Tasks: Design, construct, instrument, perform tests, and analyze data.

Status/FY 1984 Accomplishments: Demonstrated that air curtain can be used to reduce convective heat loss from a model solar central receiver cavity. Convective heat loss was reduced by 35%, though no attempt was made to optimize the convective heat loss reduction.

FY 1985 Milestones: Complete construction, testing, and analysis data.

Major Project Reports: Nielsen Engineering. "An Investigation into the Feasibility of an Air Curtain for a Solar Central Receiver." DOE/SF/11940-1, June 1984.

Summary Date
October 1984

DOE/SAN

Title: Thermochemical Process Design

Contractor:
Foster Wheeler
Solar Development Corp.
12 Peachtree Hill Road
Livingston NJ 07039

Principal Investigator: David J. Allen
Telephone: (201) 533-2958

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:	**Source**
FY83	$136,738

Contract Number: DE-AC03-83SF11974

Current Contract Period **From:** 9/83
To: 9/84

Project/Area/Task: Fuels and Chemicals Research Program

Objectives: Perform a preliminary design of a water-splitting process propelled by solar energy and based on the sulfuric acid/iodine thermochemical cycle.

Approach/Present Tasks: Thermochemical hydrogen process design, transient behavior control, evaluate solar heat source.

Status/FY 1984 Accomplishments: An existing 34 MWt, low-flux receiver configuration with superheater plus reheater was selected for the receiver system. An adiabatic sulfuric acid decomposition reactor design was selected because the initial reactor design lacked scale-up capability. HIGEE was selected as the intermediate storage medium. The receiver was a dual-cavity design.
FY 1985 Milestones: Publication of economic assessment.

Major Project Reports: Foster Wheeler Solar Development Corporation. "Thermochemical Process Design." DOE/SF/11974-1, March 1985.

Summary Date
October 1984

DOE/SAN

Title: An Investigation of Aerowindows for Solar Receiver

Contractor:
Mathematical Sciences
Northwest, Inc.
2755 Northup Way
Bellevue, WA 980004

Principal Investigator: R. Taussig
Telephone: (202) 827-0460

Contract Number: DE-AC03-83SF11693

Current Contract Period **From:** 9/83
To: 9/84

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:	**Source**
FY83	$46,129

Project/Area/Task: Innovative Research Program

Objectives: Perform theoretical analyses to define potential convective heat loss reduction using air jet window for solar central receivers.

Approach/Present Tasks: Perform concept design analyses, performance analyses, select aerowindow concept for development and testing.

Status/FY 1984 Accomplishments: For receiver cavity wall temperatures in the range of 1000°K to 1600°K, there is a large positive energy benefit to using the aerowindow. Effective use of the aerowindow probably will require the use of recirculated gases from the cavity to reduce mixing and heat transfer at the cavity gas/aerowindow interface. The contract was completed.

FY 1985 Milestones: None

Major Project Reports: Mathematical Sciences Northwest, Inc. "An Investigation of Aerowindows for Solar Receivers." DOE/SF/11693-1, May 1984.

Summary Date
October 1984

DOE/SAN

Title: Solar Hydrogen Project

Contractor:
GA Technologies
P.O. Box 81608
San Diego, CA 92138

Principal Investigator: G. Besenbruch
Telephone: (619) 455-3000

Contract Number: DE-AT03-83SF11929

Current Contract Period **From:** 6/83
To: 2/85

Directing Organization: DOE/SAN

Project Engineer: Michael Lopez
Telephone: (415) 273-4264

Contract Funding:		**Source**
FY83	$325,775	DOE

Project/Area/Task: Fuels and Chemicals/Research and Development

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Objectives: Design, construct, and test concept to produce hydrogen from concentrated sulfuric acid with solar energy.

Approach/Present Tasks: Catalytic reactor design and analysis, construct and operate a catalytic reactor, thermochemical cycle engineering.

Status/FY 1984 Accomplishments: Bench testing of glass-to-metal seals for the high-temperature outlet of the tube resulted in selection of industrial-grade gold. Tested three samples of silicon carbide from various suppliers.

FY 1985 Milestones: Compatibility testing of three ceramics with both liquid and vaporous sulfuric acid. Testing of the reactor. Publication of final report.

Major Project Reports: None

Summary Date
October 1984

Department of Energy
Albuquerque Operations Office

DOE/AL

Title: Solar Parabolic Dish Stirling Module

Contractor:
Advanco Corporation
Suite 314
999 No. Sepulveda Blvd.
ElSegundo, CA 90245

Principal Investigator: Byron Washom
Telephone: (213) 640-2429

Contract Number: DE-FC04-82AL16333

Current Contract Period **From:** 5/82
To: 9/85

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger
Telephone: (505) 846-5207

Contract Funding:		**Source**
FY82	$2,823,695	DOE
83	---	---
84	805,546	DOE

Project/Area/Task: Prototype design, construction and test of a solar thermal parabolic dish stirling engine module

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Objectives: To develop and demonstrate a low-cost, long-life solar thermal electric module utilizing a Stirling engine mounted at the focal point of a parabolic dish concentrator.

Approach/Present Tasks: The design of the Solar Parabolic Stirling Module incorporates a United Stirling 4-95 Solar II engine, and 11-m faceted concentrator and an exocentric gimbal mechanism.

Status/FY 1984 Accomplishments: During FY 1984 the design and construction of the module was completed and the performance characterized. The net peak efficiency in converting solar radiation to electricity was 29.4% with a net daily average of 25.2%. The typical gross output power at 1000 W/m^2 was 25.6 kWe.

FY 1985 Milestones: Reliability and life-testing of the Solar Parabolic Dish Module to be completed September 30, 1985.

Major Project Reports: "Vanguard I Solar Parabolic Dish Module." DOE-AL-16333-2(84-ADV-5). September 30, 1984. This report contains design and performance data of the module.

Summary Date
December 1984

DOE/AL

Title: Crosbyton Solar Power Project

Contractor:
Texas Tech University
Crosbyton Solar Power Project
P.O. Box 4709
Lubbock, TX 79409

Principal Investigator: Edgar O'Hair
Telephone: (806) 742-3441

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger
Telephone: (505) 846-5207

Contract Funding:		Source
FY84	$3,871,091	DOE

Contract Number: DE-AC04-83AL21557

Current Contract Period **From:** 6/83
To: 2/86

Project/Area/Task: Technical, economic and environmental research on fixed-mirror distributed receiver solar systems

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Objectives: To conduct technical, economic, and environmental research related to fixed-mirror distributed focus systems concept, with emphasis on industrial and agricultural applications.

Approach/Present Tasks: The major areas of research are alternate FMDF uses, aerodynamic loading, working fluid control, mirror panel design, receiver design, weather impact, and Analog Design Verification System operation.

Status/FY 1984 Accomplishments: Phase I, General Studies and Analysis, was completed May 1984. Phase II, Specific Application Studies, was half completed by the end of the fiscal year.

FY 1985 Milestones: Complete Phase II by February 1985.

Major Project Reports: None

Summary Date
December 1984

DOE/AL

Title: Shenandoah Solar Total Energy Project

Contractor:
Georgia Power Company
333 Piedmont
Atlanta, GA 30308

Principal Investigator: E.J. Ney
Telephone: (404) 253-0218

Contract Number: DE-FC04-77ET20216

Current Contract Period **From:** 6/77
To: 6/87

Directing Organization: DOE/AL

Project Engineer: D.C. Graves

Telephone: (505) 846-5202

Contract Funding:		**Source**
FY77	$345,073	DOE
78	140,000	DOE
79	275,000	DOE
80	30,000	DOE
81	180,000	DOE
82	726,000	DOE
83	---	---
84	250,174	DOE

Project/Area/Task: Provide solar-derived electricity, process steam and absorption air-conditioning to a knit-wear factory.

Objectives: To provide solar-derived electricity, process steam, and absorption air-conditioning to a knit-wear factory and perform 29 tests in solar, fossil, and cogeneration modes.

Approach/Present Tasks: To operate system and perform required tests.

Status/FY 1984 Accomplishments: System was operated and 19 out of 29 tests were completed.

FY 1985 Milestones: Complete test operation phase.

Major Project Reports: None

Summary Date
December 1984

DOE/AL

Title: IPH-Caterpillar Tractor

Contractor:
Southwest Research
Institute
6220 Culebra Road
San Antonio, TX 78284

Principal Investigator: D.M. Deffenbaugh
Telephone: (512) 684-5111

Contract Number: DE-FC04-79CS30309

Current Contract Period **From:** 9/79
To: 3/85

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger

Telephone: (505) 846-5207

Contract Funding:		**Source**
FY79-80	$2,199,445	DOE
81	431,318	DOE
82	---	---
83	---	---
84	---	---

Project/Area/Task: Distributed Receiver/Industrial Process Heat/Caterpillar Tractor Company

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Objectives: Design, fabricate, test, and evaluate an application of solar energy for generating and supplying intermediate pressure heat at the Caterpillar Tractor Co., San Leandro, California.

Approach/Present Tasks: Completing Phase III, the test and evaluation portion of the Solar IPH experiment at Caterpillar Tractor Co.

Status/FY 1984 Accomplishments: Operated solar IPH system at Caterpillar Tractor Company throughout the year. Operated at reduced capacity since output of IPH system exceeded plant load.

FY 1985 Milestones:

Complete system experiment and discontinue operation (plant closed) by December 1984.
Publish final report by March 1985.

Major Project Reports: None

Summary Date
December 1984

DOE/AL

Title: IPH Project - Lone Star Brewery

Contractor:
Southwest Research
Institute
6220 Culebra Road
San Antonio, Tx 78284

Principal Investigator: D.M. Deffenbaugh
Telephone: (512) 684-5111 Ext. 2384

Contract Number: DE-AC04-78CS32198

Current Contract Period **From:** 9/78
To: /85

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger

Telephone: (505) 846-5207

Contract Funding:		**Source**
FY79-80	$1,096,793	DOE
81	---	DOE
82	---	DOE
83	161,000	DOE

Project/Area/Task: Distributed Receiver/Industrial Process Heat/Lone Star Brewery

---

Objectives: Design, fabricate, test, and evaluate an application of solar energy for the generation of industrial process steam ranging in temperature from 300°F to 550°F.

Approach/Present Tasks: Modify IPH system at Lone Star Brewery from steam to hot water and upgrade system.

Status/FY 1984 Accomplishments: Solar IPH system at Lone Star Brewery, San Antonio, Texas was converted from a system that used an organic heat-transfer fluid to one that uses water. The system now produces hot water at 230°F instead of steam.

FY 1985 Milestones:
Complete conversion to hot water by October 1984.
Resume operation of system by November 1984.
Complete installation of Winsmith drives by January 1985.
Complete final report by August 1985.

Major Project Reports: None

Summary Date
December 1984

Title: IPH Project - USS Chemicals Co.

Contractor:
Columbia Gas System
Service Corp.
1600 Dublin Rd.
Columbus, OH 43215

Principal Investigator: J.P. Dechow
Telephone: (614) 418-1494

Contract Number: DE-FC03-79CS30310

Current Contract Period **From:** 9/79
To: 9/84

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger

Telephone: (505) 846-5207

Contract Funding:		**Source**
FY79-80	$2,340,516	DOE
81	399,047	DOE
82	---	---
83	---	---
84	89,017	DOE

Project/Area/Task: Distributed Receiver/Industrial Process Heat/USS Chemicals Co.

Objectives: Design, fabricate, test, and evaluate an application of solar energy to supply industrial process intermediate pressure heat at the United States Steel Chemicals plant in Haverhill, Ohio.

Approach/Present Tasks: Completed Phase III, the test and evaluation portion of the solar IPH experiment at USS Chemicals Co.

Status/FY 1984 Accomplishments: The solar IPH system at USS Chemicals Co. was upgraded by retrofitting the flexhoses in the collector field. Operation under DOE funding was completed in June 1984 after which the system was operated and continues to be operated by USS Chemicals Co.

FY 1985 Milestones: Final report by November 1984

Major Project Reports: "Haverhill - A Large Scale Solar Energy System for the USS Chemicals - Haverhill Plant." Final Report. P. Dechow, November 1984.

Summary Date
December 1984

DOE/AL

Title: IPH Project - DOW Chemical Co.

Contractor:
Foster Wheeler
Development Corp.
12 Peachtree Hill Rd.
Livingston, NJ 07039

Principal Investigator: M.D. Garber
Telephone: (201) 533-2958

Contract Number: DE-AC04-78CS32199

Current Contract Period **From:** 9/78
To: 1/85

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger

Telephone: (505) 846-5207

Contract Funding:

		Source
FY79-80	$1,089,817	DOE
81	297,614	DOE
82	---	---
83	63,786	DOE
84	---	---

Project/Area/Task: Distributed Receiver/Industrial Process Heat/Dow Chemical Co.

Objectives: Design, fabricate, test, and evaluate an application of solar energy for the generation of industrial process steam ranging in temperature from 300°F to 550°F.

Approach/Present Tasks: Complete Phase III, the test and evaluation portion of the solar IPH experiment at Dow Chemical Co.

Status/FY 1984 Accomplishments: Solar IPH system at Dow Chemical Co., Dalton, Georgia was upgraded by modifying pipe supports and re-insulating field piping. Operation under DOE funding was completed in March 1984, after which the system was operated by DOW because energy produced by the system was not economically justified.

FY 1985 Milestones: Complete final report by November 1984.

Major Project Reports: FWC/FWDC/tr-84-30. Final Report. "Solar Production of Industrial Process Steam for the Dow Chemical Co." M.D. Garber; D.J. Allen. November 1984. Foster Wheeler Development Corporation.

Summary Date
December 1984

DOE/AL

Title: IPH Project - Southern Union Co.

Contractor:
Energetics Corporation
1201 Richardson Drive
Richardson, TX 75080

Principal Investigator: Lee Wilson
Telephone: (214) 783-4731

Contract Number: DE-AC04-78CS32223

Current Contract Period **From:** 9/78
To: 6/84

Directing Organization: DOE/AL

Project Engineer: Joseph Weisiger

Telephone: (505) 846-5207

Contract Funding:		**Source**
FY79-80	$865,241	DOE
81	619,874	DOE
82	---	---
83	212,673	DOE
84	---	---

Project/Area/Task: Distributed Receiver/Industrial Process Heat/Southern Union Refining Co.

Objectives: Design, fabricate, test, and evaluate an application of solar energy for the generation of industrial process steam ranging in temperature from 300°F to 550°F.

Approach/Present Tasks: Completed Phase III, the test and evaluation portion of the solar IPH experiment at Southern Union Refining Co.

Status/FY 1984 Accomplishments: The solar IPH system at Southern Union Refining Co., Lovington, New Mexico was upgraded by modifying the piping and valving, installing an improved tracking system, and overhauling the collector drive mechanisms. The operation under DOE funding was completed in March 1984, after which the system was operated by Southern Union until September 1984 when the Southern Union plant closed.

FY 1985 Milestones: None

Major Project Reports: "A High-Temperature Process-Steam Application at the Southern Union Refining Company, Hobbs, New Mexico." Final Report. Phase III - Operation, Maintenance and Performance. L.E. Wilson and P.R. McGuire. May 1984.

Summary Date
December 1984

Solar Energy Research Institute

Title: Ceramics

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

Principal Investigator: R. T. Coyle
Telephone: (303) 231-1202

Directing Organization:
Solar Energy Research Institute,
Golden, CO 80401

Project Engineer: G. Gross
Telephone: (303) 231-1228

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Contract Funding:		**Source**
FY 1982	$120,000	DOE
83	300,000	DOE
84	192,000	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Materials/ Ceramics

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Objectives: To determine the radiative properties and corrosion behavior of ceramics at temperatures above 800°C in high radiant fluxes, in varying temperatures, and in aggressive chemical environments.

Approach Present Tasks: Measurement of the chemical stability of ceramics in molten salts. Measurement of the mechanical properties (fracture modulus, etc.) of ceramics at temperatures above 800°C. Measurement of the optical properties of high temperature ceramics.

Status/FY 1984 Accomplishments: Completion of corrosion tests and mechanical property measurements on single crystal sapphire, Coors AD998 and Monofrax M ceramic coupons exposed to a molten eutectic lithium-sodium-potassium carbonate salt at 900°C demonstrated that the three materials are compatible with the high temperature molten salt and are promising containment materials for the direct absorption receiver. Completion of studies on passivating layers that form when a molten carbonate salt reacts with sapphire and Coors AD998 aluminum.

FY 1984 Milestones: Complete preparation and check-out of procedures for measuring the chemical stability and corrosiveness of thermal fluids at temperatures up to 900°C (31 March 1984). Materials data package on materials to be tested in the molten salt test loop - (31 March 1984).

Major Project Reports: Coyle, R.T. et al. "The Corrosion of Materials in Molten Alkali Carbonate Salt at 900°C." (Letter Report). Solar Energy Research Institute, Golden CO., September 1984.

Summary Date
October 1984

Title:
Investigation of Improved Properties in Densified Ceramics Using Novel Powder Synthesis and Milling Techniques

Contractor:
Terra Tek, Inc.,
University Research Park
Salt Lake City, UT 84108

Principal Investigator: R. A. Cutler
Telephone: (801) 584-2442

Directing Organization:
Solar Energy Research Institute,
Golden, CO 80401

Project Engineer: R. T. Coyle
Telephone: (303)231-1202

Contract Funding:

		Source
FY 1983	$68,991	DOE

Contract Number: XP-3-03060

Current Contract Period **From:** 04/01/84
To: 02/29/84

Project/Area/Task: Solar Thermal Research Program/High Temperature Materials/ Ceramics

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Objectives: To investigate two approaches for improving the strength and reliability of ceramic components for high temperature solar thermal systems.

Approach Present Tasks: Synthesization of a mixture of ceramics by an exothermic reaction to make fine-grained ceramics. Ultrasonically aided ball milling to produce less-contaminated ceramics.

Status/FY 1984 Accomplishments: Preparation of SiC and SiC/Al2O3 ceramic powders by thermite reactions and analysis and testing of the powders. Preparation of SiC and Al2O3 powders by ultrasonic milling. Testing and characterization of the ceramic powders by chemical analysis and electron microscopy. (It was demonstrated that submicron silicon carbide powders can be fabricated by exothermic reactions — suggesting that further development could lead to sinterable silicon carbide powders.) Evaluation of the silicon carbide/aluminum oxide composite materials showed that they had good fracture toughness, good solar absorptance and good corrosion resistance when in contact with molten salts at high temperatures.

FY 1984 Milestones: None

Major Project Reports: Cutler, R.A. et al. "Investigation of Improved Properties in Densified Ceramics for High Temperature Solar Applications." Terra Tek, Inc., Salt Lake City, UT, June 1984.

Summary Date
October 1984

Title:
X-Ray Diffraction Analysis to Identify and Characterize Passivating Layers on Ceramics Exposed to Molten Salts

Contractor: University of Denver (Colorado Seminary) Denver, CO 80210

Principal Investigator: D. Chandra
Telephone: (303) 753-2141

Contract Number: XX-4-04047-1

Current Contract Period **From:** 04/01/84
To: 10/01/84

Directing Organization:
Solar Energy Research Institute, Golden, CO 80401

Project Engineer: R. T. Coyle
Telephone: (303) 231-1202

Contract Funding:		**Source**
FY 1983	$25,051	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Materials/ High Temperature Thermal Fluids

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Objectives: To provide exploratory x-ray diffraction analysis support to SERI to identify the passivating layers that may form at the interface between a molten eutectic carbonate salt and the containment system.

Approach Present Tasks: Performance of x-ray diffraction studies on alumina, sapphire, and Cabot-214 exposed to molten carbonate salts at 900°C. Analysis and interpellation of the x-ray diffraction data.

Status/FY 1984 Accomplishments: Completion of development of a methodology to be utilized to identify and analyze passivation layers. Identification of -LiAlO2 as one of the major phases in the passivating layer that forms when a molten eutectic lithium-sodium-potassium carbonate reacts with sapphire or Coors AD998 alumina.

FY 1984 Milestones: None

Major Project Reports: Chandra, D. and Coyle, R.T. "Characterization of Passivating Corrosion Layers Formed on Ceramic Materials by Reaction with Molten Carbonate Salt at High Temperature." Solar Energy Research Institute, Golden, CO. August 1984.

Summary Date
October 1984

Title: High Temperature Thermal Fluids/ Containment

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

Principal Investigator: R. T. Coyle
Telephone: (303) 231-1202

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: G. Gross
Telephone: (303) 231-1228

Contract Funding:		**Source:**
FY 1983	$150,000	DOE
84	$192,000	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Materials/ High Temperature Thermal Fluids

---

Objectives: To complete studies regarding the oxidation and corrosion rates of carbonate salts containing chromophores (i.e., blackeners) and to identify at least one stable thermal /fluid/containment materials pair capable of sustained operation at 900°C.

Approach Present Tasks: Optical property measurements and corrosion rate studies on candidate high-temperature thermal fluids. Identification of a compatible high-temperature containment system material.

Status/FY 1984 Accomplishments: Conducted laboratory experiments using various thermal fluids at temperatures up to 900°C and for periods in excess of 60 days to identify a stable thermal fluid/containment material combination capable of sustained operation in the solar thermal environment at temperatures up to 900°C. As a result of these experiments, a molten eutectic sodium-potassium-lithium carbonate salt was identified as a promising working fluid for the direct absorption receiver concept. Conducted laboratory experiments exposing various alloys to molten eutectic salts at temperatures up to 900°C to identify a containment material for the SERI direct absorption receiver concept. As a result of these experiments, Inconel 600 was identified as a high-temperature containment material that is compatible with the molten eutectic carbonate salt thermal fluid. Completion of corrosion rate studies and optical property measurements of the eutectic salt.

FY 1984 Milestones: None

Major Project Reports: Coyle, R.T. et al. "The Corrosion of Materials in Molten Alkali Carbonate Salt at 900°C." (Letter Report). Solar Energy Research Institute, Golden, CO. September 1984.

Summary Date
October 1984

SERI

Title: High Temperature Concept Analysis

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

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: L.M. Murphy
Telephone: (303) 231-1050

Project Engineer: J. Thornton
Telephone: (303) 231-1269

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Contract Funding:		**Source:**
FY 1984	$420,000	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Materials/ High Temperature Thermal Fluids

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Objectives: To conduct a comparative analysis of the stretched membrane and second generation glass/metal heliostat concepts and to evaluate a baseline direct absorption high temperature receiver system.

Approach Present Tasks: Comparative analysis of the stretched membrane and second generation glass/metal heliostats using computer models. Identification of and assessing a baseline high temperature direct absorption receiver system.

Status/FY 1984 Accomplishments: Completion of the stretched membrane and second generation glass/metal heliostat comparisons. The assessment showed that the stretched membrane heliostat is capable of a structural performance and an optical performance accuracy that equals or exceeds those of a second generation glass/metal heliostat. Formulation of a baseline high temperature direct absorption central receiver system for producing electricity. Assessment of the technical and economic performances of a baseline direct absorption receiver system. The assessment showed that the direct absorption receiver was potentially more cost effective than metal or ceramic tube receivers.

FY 1984 Milestones: Complete a preliminary technical performance and economic assessment of a baseline direct absorption receiver (DAR) system - August 31, 1984.

Major Project Reports: Murphy, L.M. et al. "Direct Absorption Receiver (DAR) System Study." (SERI/SP-253-2438), Solar Energy Research Institute, Golden, CO, August, 1984.

Summary Date
October 1984

Title: Evaluation of Discontinuous Silicon Carbide Reinforced Aluminum for Solar Thermal Technology Applications

Contractor:
Science Applications, Inc.
1200 Prospect Street
La Jolla, CA 92038

Principal Investigator: David Schuster
Telephone: (619) 456-6838

Contract Number: RX-4-04012-1

Current Contract Period **From:** 10/15/83
To: 06/15/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: L. M. Murphy
Telephone: (303) 231-1050

Contract Funding:		**Source:**
FY 1983	$12,000	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Materials/ High Temperature Concept Analysis

---

Objectives: To fabricate billets of silicon carbide reinforced aluminum using a proprietary process developed by Science Applications, Inc. and to test and evaluate the specimens regarding their mechanical and thermal properties—particularly in the solar thermal environment.

Approach Present Tasks: Fabrication, pressing and machining of six silicon carbide reinforced aluminum bars. Measurement of the elastic modules, tensile yield and strength of each tensile bar. Measurement of the fracture toughness and fatigue of each compact tension sample.

Status/FY 1984 Accomplishments: Fabrication of the silicon carbide reinforced aluminum sample bars completed. Elastic modulus, tensile yield and strength mechanical tests completed. Fracture toughness and fatigue tests and measurements completed. Demonstrated that silicon carbide reinforced aluminum was a promising structural material for solar thermal applications.

FY 1984 Milestones: None

Major Project Reports: Skibo, M.D. and Schuster, D.M. "Evaluation of Discontinuous Silicon Carbide Reinforced Aluminum (SiC-Al): Final Report." Science Applications, Inc., La Jolla, CA, June 15, 1984.

Summary Date
October 1984

SERI

Title: Program Management Support

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

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: B. P. Gupta
Telephone: (303) 231-1760

Project Engineer: B. P. Gupta
Telephone: (303) 231-1760

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Contract Funding:		**Source:**
FY 1982	$225,000	DOE
83	400,000	DOE
84	540,000	DOE

Project/Area/Task: Solar Thermal Research Program/Program Management Support

---

Objectives: Effective decentralized management of those portions of the DOE Solar Thermal Technology (STT) Program assigned to SERI.

Approach Present Tasks: Planning, coordination, evaluating and reporting on the activities of the DOE STT Program assigned to SERI. Timely transfer of technical information and data from the Solar Thermal Research Program to the appropriate audiences.

Status/FY 1984 Accomplishments: Provision of technological, programmatic and analysis support to DOE/HQ. Formulation of a multi-year research program plan for the STT Program in conjunction with DOE/HQ. Liaison with and technology transfer involving industry and universities. Conducting program progress reviews for various audiences.

FY 1984 Milestones: None

Major Project Reports: FY 1984 Solar Thermal Annual Operating Plan, Solar Energy Research Institute, Golden, CO, January 1984. Quarterly review briefing packages.

Summary Date
October 1984

Title: Solar Thermal Research Program Planning Support to SERI and Generation of Input for a Multi-Year Research Program Plan

Contractor:
Black & Veatch
1500 Meadow Lake Parkway
Kansas City, MO 64114

Principal Investigator: C. Grosskreutz
Telephone: (913) 967-2000

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: L. Shannon
Telephone: (303) 231-7676

Contract Funding:		Source:
FY 1984	$68,433	DOE

Contract Number: XK-4-04123-1

Current Contract Period **From:** 07/16/84
To: 02/15/85

Project/Area/Task: Solar Thermal Research Program/Program Management Support

---

Objectives: To prepare input for a SERI Solar Thermal Research Plan (from the perspective of the solar thermal industry) that clearly states the overall goals, the role and scope of SERI responsibilities, and the general tasks to be undertaken by SERI in solar thermal research.

Approach present Tasks: Survey and review of current solar thermal research programs. Establishment of a framework (ground rules). Compilation of research needs falling within SERI's scope of responsibilities.

Status/FY 1984 Accomplishments: Completion of a survey of solar thermal research activities at SERI, University of Houston, Georgia Institute of Technology and other laboratories. Establishment of ground rules to guide the planning efforts. Completion of a 2.5-day structured workshop to solicit ideas and inputs from various organizations (e.g. SEIA, EPRI, etc).

FY 1984 Milestones: None

Major Project Reports: (Report to be generated during FY1985)

Summary Date
October 1984

SERI

Title: Silver/Polymer Research

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

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: P. Schissel
Telephone: (303) 231-1226

Project Engineer: G. Gross
Telephone: (303) 231-1228

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Contract Funding:		**Source:**
FY 1982	$150,000	DOE
83	150,000	DOE
84	360,000	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials Silver Polymer Research

---

Objectives: To identify sputtered silvered polymers showing long life potential and to complete the identification of the chemical and physical phenomena causing the degradation of silvered polymethylmethocrylate (PMMA)

Approach present Tasks: Accelerated and real-time environmental exposure testing of polymer/silver/backing/adhesive/substrate reflector assemblies. Identification of degradation phenomena, determination of their causes and development of treatments.

Status/FY 1984 Accomplishments: Completion of accelerated and real-time environmental exposure testing of promising polymer/silver/backing/adhesive/substrate reflector assemblies. Determination of the principal causes of degradation in silver/polymer mirror assemblies (chlorine, UV radiation, elevated temperature, water vapor and impurities in the silver/polymer interface). Identification of Inconel as a backing material for silver/polymer reflectors to solve the blistering problem and to reduce UV effects on the mirror assembly. Identification of silvered PMMA, silvered PAN, and ECP 300X as silvered polymers having the potential to meet the technical performance requirements.

FY 1984 Milestones: Identify sputtered silvered polymers showing long life potential - June 30, 1984. Identification of chemical and physical phenomena causing the degradation of silvered PMMA - August 31, 1984.

Major Project Reports: Schissel, P. "Identification of Chemical and Physical Phenomena Causing the Degradation of Silvered PMMA." (SERI/TR-255-2493), Solar Energy Research Institute, Golden, CO, September, 1984. Webb, J. "Photodegradation of Transparent Polymers Measured In Situ Using FTIR - RA Spectroscopy: Volumes I and II." (SERI/TR255-2177), Solar Energy Research Institute, Golden, CO, 1984.

Summary Date
October 1984

Title: Polymer - Protected Silver Mirrors

Contractor:
University of Denver
Sponsored Agreement Services
Denver, CO 80201

Principal Investigator: D. Smith
Telephone: (303) 753-2966

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: P. Schissel
Telephone: (303) 231-1226

Contract Number: XK-04-04064-1

Current Contract Period **From:** 04/16/84
To: 04/30/85

Contract Funding:		**Source:**
FY 1983	$55,000	DOE
84	40,219	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Silver/Polymer Research

---

Objectives: To assess and characterize degradation processes in silver/polymer mirrors (to be utilized in fabricating solar concentrators) and develop methods for retarding the degradation.

Approach Present Tasks: Identification and evaluation of stabilizers for retarding degradation in polyacrylonitrile (PAN) films. Study of the enhanced adhesion phenomena induced by controlled UV radiation exposure.

Status/FY 1984 Accomplishments: Generation of a report documenting the results of FY 1983 research on photodegradation processes in PAN. Completion of studies on stabilizers for PAN films on silver and identified Tinuvin P as a promising multi-functional stabilizer. Completion of studies of the influences of surface contaminants on the photodegradation of PAN films.

FY 1984 Milestones: None

Major Project Reports: Smith, D. et al. "Photodegradation of Polyacrylonitrile (PAN): Final Report." University of Denver, Denver, CO, February 1984.

Summary Date
October 1984

SERI

Title: Polymer Synthesis, Characterization and Durability Research

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

Principal Investigator: P. Schissel
Telephone: (303) 231-1226

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: G. Gross
Telephone: (303) 231-1228

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Contract Funding:		**Source:**
FY 1982	$120,000	DOE
83	150,000	DOE
84	240,000	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Polymer Synthesis, Characterization and Durability Research

---

Objectives: To develop chemically bound stabilizers, antioxidants, and excitation energy quenches for transmitting and structural polymer materials for solar thermal applications.

Approach Present Tasks: Testing, characterization and evaluation of low-cost polymer materials. Development, testing and evaluation of stabilizers (UV-absorbers, antioxidants, etc.) to improve the durability of polymers for STT applications.

Status/FY 1984 Accomplishments: Identification, test and evaluation of several promising multi-functional stabilizers to improve the durability of polymers for STT Program applications. Identification of Tinuvin P as the leading stabilizer for protecting PMMA/silver mirrors from UV degradation and oxidation.

FY 1984 Milestones: None

Major Project Reports: Schissel, P. "Identification of Chemical and Physical Phenomena Causing the Degradation of Silvered PMMA." (SERI/TR-255-2493). Solar Energy Research Institute, Golden, CO, September 1984.

Webb, J. "Photodegradation of Transparent Polymers Measured In Situ Using FTIR-RA Spectroscopy: Volumes I and II." (SERI/TR-255-2177), Solar Energy Research Institute, Golden, CO 1984.

Summary Date
October 1984

Title: Development of Ultraviolet (UV) Stabilizers for Polymers

Contractor:
Jet Propulsion Laboratory
4800 Aok Grove Drive
Pasadena, CA 91109

Principal Investigator: R. H. Liang
Telephone: (818) 354-4321

Contract Number: XP-3-03036-01

Current Contract Period **From:** 05/01/84
To: 01/30/85

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: P. Schissel
Telephone: (303) 231-1226

Contract Funding:		**Source:**
FY 1983	$150,000	DOE
84	60,000	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Polymer Synthesis and Characterization

---

Objectives: To develop an understanding of the mechanisms whereby ultraviolet radiation degrades polymers used in reflectors/concentrators for solar thermal applications.

Approach Present Tasks: Studies of electronic energy dissipation and quenching processes in polymers. Preparation, test and evaluation of UV-stabilized polymer materials.

Status/FY 1984 Accomplishments: Completion of studies of electronic energy dissipation and quenching processes in glassy polymers. Preparation of monomers 2H5V and 2H5P for polymerizations conducted at SERI and JPL. Preparation and characterization of several copolymers regarding degradation mechanisms.

FY 1984 Milestones: None

Major Project Reports: Liang, R.H., "Status Report to the Solar Energy Research Institute: Polymers for Enclosed Heliostats." Jet Propulsion Laboratory, Pasadena, CA, October 1984.

Summary Date
October 1984

SERI

Title: Innovative Concentrator Analysis and Research

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

Principal Investigator: L. M. Murphy
Telephone: (303) 231-1050

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: J. Thornton
Telephone: (303) 231-1269

Contract Funding:		**Source:**
FY 1982	$675,000	DOE
83	790,000	DOE
84	420,000	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Innovative Concentrator Analysis and Research

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Objectives: To identify, test and demonstrate the technical feasibility of innovative, low-cost, durable solar concentrators for STT Program applications and to identify and study the important structural response and design issues associated with the stretched membrane heliostat.

Approach Present Tasks: Analytical modeling of stretched membrane heliostat modules. Fabrication, test and evaluation of stretched membrane modules. Identification and evaluation of other concentrator concepts.

Status/FY 1984 Accomplishments: Fabrication, testing and evaluation of a two-meter diameter reflector module with focusing capability that uses for a base a stainless steel/Lexan/stainless steel laminate. The peak center deflection was measured to be 12.7 mm.
Development of a non-linear computer model for predicting the technical performance of a laminated stretched membrane module. The model was used to screen different laminate designs and to determine their focussing capability. Construction and evaluation of two scale-model stretched membrane modules using polymer membranes. The modules held up well. Splitting and delamination, which appeared after the first few days in the structural polymer, did not progress further.
Fabrication and evaluation of a conical reflector module.
FY 1984 Milestones: Complete fabrication of a two-meter diameter variable focus stretched membrane module - February 28, 1984.
Major Project Reports: Murphy, L.M. and Sallis, D. "Analytical Modeling and Structural Response of a Stretched Membrane Reflective Module." (SERI/TR-253-2101), Solar Energy Research Institute, Golden, CO 1984.
Wood, R. and Murphy, L.M. "Assessment of Tensional Membrane Technology for Solar Concentrators." (SERI/SP-253-2437), Solar Energy Research Institute, Golden, CO 1984.

Summary Date
October 1984

Title: Design and Fabrication of Scale Model Stretched Membrane Heliostat Reflector Modules

Contractor:
Dan-Ka Products, Inc.
790 Umatilla, Unit 217
Denver, CO 80204

Principal Investigator: San Sallis
Telephone: (303) 825-1063

Contract Number: HK-4-04055-1

Current Contract Period **From:** 08/01/84
To: 05/17/85

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R. Woods
Telephone: (303) 231-7344

Contract Funding:		Source:
FY 1984	$99,790	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/ Innovative Concentrator Analysis and Research

---

Objectives: To design and fabricate several three-meter diameter stretched membrane heliostat reflector modules to study experimentally the structural response and design optimization issues.

Approach Present Tasks: Preparation of detailed engineering designs for five scale-model stretched membrane heliostat concepts.
Fabrication and calibration of four mirror modules.

Status/FY 1984 Accomplishments: Completion of ring frame design drawings.
Completion of preliminary design drawings for five stretched membrane concepts - (a) single membrane pneumatic tensioned mirror module (b) single membrane focusing laminate mirror module (c) double membrane mirror module (d) single membrane rigidly attached module, and (e) SERI testing hardware designs.

FY 1984 Milestones: None

Major Project Reports: Sallis, Dan. "Preliminary Designs for Three-Meter Diameter Stretched Membrane Structural Test Modules." Dan-Ka Products, Inc., Denver, CO, October 1984.

Summary Date
October 1984

Title: Technical Feasibility of Innovative Concepts for Avoiding or Reducing the Wind Load on Concentrating Collectors

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

Principal Investigator: J. E. Cermak
Telephone: (303) 491-6696

Contract Number: XX-4-04029-1

Current Contract Period **From:** 02/15/84
To: 04/15/85

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: L. M. Murphy
Telephone: (303) 231-1050

Contract Funding:		**Source:**
FY 1983	$70,000	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Innovative Concentrator Analysis and Research

---

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

Approach Present Tasks: Identification and preliminary analysis and evaluation of innovative wind avoidance/reduction concepts.
Detailed engineering analysis and scale model fabrication of promising concepts.

Status/FY 1984 Accomplishments: Identification of several innovative wind avoidance/reduction schemes and concepts. These included spoilers for individual heliostats and berms for fields of heliostats, etc.
Initiated a preliminary analysis and evaluation of the various concepts.

FY 1984 Milestones: None

Major Project Reports: (Final report to be generated in FY1985)

Summary Date
October 1984

Title: Fabrication and Evaluation of Graphite Fiber Composite Solar Concentrators

Contractor:
University of Arizona
Engineering Experiment Station
Tucson, AZ 85721

Principal Investigator: K. Ramohalli
Telephone: (602) 621-2235

Contract Number: XK-4-04063-1

Current Contract Period **From:** 04/16/84
To: 10/12/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: L. Murphy
Telephone: (303) 231-1050

Contract Funding:		**Source:**
FY 1984	$29,894	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Innovative Concentrator Analysis and Research

---

Objectives: To conduct research to determine the feasibility of low-cost, lightweight, high strength/high stiffness weather stable graphite composite materials for use in fabricating solar concentrators and structural supports.

Approach Present Tasks: Development of concentrator and structural support designs that utilize graphite composite materials.
Fabrication and testing of graphite composite mirror panels.

Status/FY 1984 Accomplishments: Completion of preliminary engineering designs for a scale-model parabolic concentrator and for a heliostat structural support subsystem--designs that utilize graphite composite materials.
Fabrication and laboratory testing of two sample graphite composite mirror panels (using aluminum as the reflective surface)
Award of a subcontract to General Veneer for the fabrication of two representative reflective panels to be subjected to optical testing at the University of Arizona.

FY 1984 Milestones: None

Major Project Reports: Ramohalli, K. "Graphite Composite Materials for Solar Applications." (Draft Report), University of Arizona, Tucson, AZ, August 1984.

Summary Date
October 1984

Title: Low-Cost Lightweight Silver-Coated Front Surface Metal Reflector

Contractor:
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Principal Investigator: J. Hull
Telephone: (415) 964-3200

Contract Number: XK-4-04062-1

Current Contract Period **From:** 04/16/84
To: 11/30/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: P. Schissel
Telephone: (303) 231-1226

Contract Funding:		**Source:**
FY 1984	$10,916	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Innovative Concentrator Analysis and Research

---

Objectives: To asses the technical feasibility of a concept for a durable, low-cost, lightweight silver-coated front surface solar reflector (silicon nitride is utilized to protect the silver from outdoor environmental exposure conditions).

Approach Present Tasks: Fabrication of eight sample reflector panels.
Specular reflectance measurements and preliminary environmental testing.

Status/FY 1984 Accomplishments: Fabrication of eight silver-coated front surface metal reflector panels—each 3 inches by 3 inches in surface area.
Environmental exposure testing of 4 of the panels for six weeks (testing in UV radiation, 130°F temperature and 90% relative humidity) and measurement of the effects of the exposure on reflectance.

FY 1984 Milestones: None

Major Project Reports: (Final report to be generated in FY1985)

Summary Date
October 1984

Title: Thermal Research and High Temperature Receivers

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

Principal Investigator: R. Copeland
Telephone: (303) 231-1012

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/84
To: 09/30/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: D. H. Johnson
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1983	$175,000	DOE
84	465,000	DOE

Project/Area/Task: Solar Thermal Research Program/Thermal Science Research Thermal Research and High Temperature Receivers

---

Objectives: To design a molten salt test loop for use with a high temperature molten salt to study the feasibility of direct absorption central receivers and to develop a mathematical model of the direct absorption receiver process.

Approach Present Tasks: Design of a 900°C molten salt test loop to be used in ground and tower tests at the Advanced Components Test Facility.
Design and validation of a direct absorption process computer model.

Status/FY1984 Accomplishments: Design of the 900°C molten salt test loop (to be fabricated in FY1985).Completion of experimental studies of the direct absorption process using experiments with water films. (The experiments showed that dry spots can form on the absorber that could cause damage in the receiver. Dry spots can be avoided using roughened surfaces or screens).
Development of the direct absorption process computer model (to be validated by experiments utilizing the molten salt test loop).

FY1984 Milestones: Complete a preliminary analysis of receiver film temperature profiles - December 31, 1983.
Complete design review of the molten salt test loop - June 30, 1984.
Complete check-out of the mathematical model of the direct absorption process - June 30, 1984.

Major Project Reports: Copeland, R.J. "Direct Absorption Receivers." (SERI/TP-252-2334). Solar Energy Research Institute, Golden, CO, April 1984.
Lazaridis, A.; Copeland, R.J.; and Althoff, J. "Temperature Distribution in a Solar Irradiated Liquid Layer Flowing Over a Wall of an Optical Cavity." (SERI/TR-252-2221), Solar Energy Research Institute, Golden, CO, 1984.

Summary Date
October 1984

Title: Design of a Molten Salt Test Apparatus

Contractor:
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: T. Brown
Telephone: (404) 894-3500

Contract Number: XX-4-04042-1

Current Contract Period **From:** 03/05/84
To: 10/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.J. Copeland
Telephone: (303) 231-1012

Contract Funding:		**Source:**
FY 1984	$12,635	DOE

Project/Area/Task: Solar Thermal Research Program/Thermal Science Research/High Temperature Receivers

---

Objectives: To design and generate cost estimates for a molten salt test apparatus to be used in experiments to assess the technical feasibility of high temperature, molten salt direct absorption central receivers.

Approach Present Tasks: Definition of fluid flow system.
Generation of detailed engineering designs.
Generation of construction cost estimates.

Status/FY1984 Accomplishments: Completion of the detailed engineering design for a 900°C molten salt test loop.
Generation of estimates of the cost of constructing the loop.

FY1984 Milestones: Design review at SERI - May 14, 15, 1984

Major Project Reports: "Design of a Molten Salt Test Apparatus: Final Report." Georgia Institute of Technology, Atlanta, GA, 1984.

Summary Date
October 1984

SERI

Title: Preliminary Engineering Designs for a Small High Temperature/High Flux Solar Thermal Experiment

Contractor:
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Principal Investigator: John Lucas
Telephone: (FTS) 961-9368

Contract Number: DX-4-04129-1

Current Contract Period **From:** 07/26/84
To: 02/28/85

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: John Thronton
Telephone: (303) 231-1269

Contract Funding:		**Source:**
FY 1983	$48,000	DOE

Project/Area/Task: Thermal Science Research/High Temperature/High Flux/Solar Thermal Experiment

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Objectives: To generate the preliminary engineering designs for a small high temperature/high flux solar thermal experiment to be installed at SERI.

Approach Present Tasks: Determination of high temperature/high flux experiment requirements.
Experiment preliminary design.
Liaison with an architectural and engineering (A&E) organization

Status/FY1984 Accomplishments: Determination of the SERI high temperature/high flux experiment requirements. (SERI requires an experiment that provides a vertical, attenuated solar beam with a target area located near ground level).
Completion of review of existing solar furnace technology applicable to the future research experiments.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated in FY1985)

Summary Date
October 1984

SERI

Title: Quantum/Thermal Hybrid Systems

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

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: D. H. Johnson
Telephone: (303) 231-1757

Project Engineer: D. H. Johnson
Telephone: (303) 231-1757

Contract Number: DE-AC02-83CH10093

Contract Funding:		**Source:**
FY 1984	$132,000	DOE

Current Contract Period **From:** 10/01/83
To: 09/30/84

Project/Area/Task: Solar Thermal Research Program/Thermal Science Research/ Quantum/Thermal Hybrid Systems

---

Objectives: To complete a thermodynamic analysis of thermally coupled and decoupled quantum/thermal hybrid systems and use of the analysis to identify the concept with the greatest potential.

Approach Present Tasks: Formulation of specific quantum/thermal hybrid system configurations.
Thermodynamic analysis of the system configurations.

Status/FY1984 Accomplishments: Formulation of combined quantum/thermal system configurations for producing hydrogen via water splitting.
Identification of holographic films as a promising means for solar beam splitting.
Completion of a thermodynamic analysis of combined quantum/thermal systems.
Completion of a comparative cost assessment of a decoupled quantum/thermal system and a conventional system for producing hydrogen (the quantum/thermal system showed no clear advantage over the conventional system).

FY1984 Milestones: Publish proceedings of 1983 conference - December 31, 1983
Complete a thermodynamic assessment of coupled and decoupled systems - June 30, 1984
Complete technical and economic assessment of one promising hybrid system - September 30, 1984

Major Project Reports: Johnson, D.H. and Karpuk, M. "Proceedings of the Solar Thermal/Photochemical Conversion Workshop." (SERI/CP-252-2026). Solar Energy Research Institute, Golden, CO, December 1983.

Summary Date
October 1984

SERI

Title: Photoconversion Processes Research

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

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: A. Nozik
Telephone: (303) 231-1953

Project Engineer: D. H. Johnson
Telephone: (303) 231-1752

Contract Number: DE-AC02-83CH10093

Contract Funding:		**Source:**
FY 1984	$132,000	DOE

Current Contract Period **From:** 10/01/83
To: 09/30/84

Project/Area/Task: Solar Thermal Research Program/Thermal Science Research/ Photoconversion Processes

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Objectives: To assess the technical feasibility of operating photoelectrochemical reactions at temperatures up to 100°C and solar concentrations up to 50 suns.

Approach Present Tasks: Experimentation with selected photoelectrochemical systems to demonstrate the efficiency gains possible using increased solar concentrations and higher operating temperatures.

Status/FY1984 Accomplishments: Development of methods for producing semiconductor photocatalysts. Completion of a study of producing hydrogen by splitting H_2S at high light intensity using a CdS/catalyst system.
Completion of water splitting experiments at varying light intensities and using a CdS/catalyst system. The experiment showed that hydrogen sulfide was easily split, but with low efficiency. Conventinal oxidation splitting technology is much more attractive. Water splitting proved to be much more difficult than was indicated in the literature. Water was not split successfully using various photoelectrochemical catalysts.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated in FY1985)

Summary Date
October 1984

SERI

Title: Instrumentation and Measurement

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

Principal Investigator: E.L. Maxwell
Telephone: (303) 231-7088

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R. Hulstrom
Telephone: (303) 231-1220

Contract Funding:		**Source:**
FY 1984	$191,456	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Measure/ Instrumentation

---

Objective: To identify near-, mid- and long-term instrumentation and measurement (I&M) needs in the STT Program and to meet one I&M need relating to the Solar One System at Barstow, CA.

Approach Present Tasks: Assessment and ranking of STT Program I&M needs.
Identification of one I&M need relating to the Solar One System and taking the measurements.

Status/FY1984 Accomplishments: Completion of an assessment of near-, mid-, and long-term STT Program I&M needs by means of a survey and a workshop.
Identification of atmospheric attenuation and spectral absorptivity, reflectivity and emissivity of the receiver surface as important Solar One System I&M needs.
Completion of solar radiation measurements at the Solar One site.

FY1984 Milestones: Complete preliminary assessment of instrumentation and measurement (I&M) needs in the STT Program - February 29, 1984.
Complete initial measurements of one high priority I&M need at Solar One - September 30, 1984

Major Project Reports: Maxwell, E.L. and Hulstrom, R. "Preliminary Assessment of Instrumentation and Measurement Needs of the Solar Thermal Technology Program." (SERI/TR-215-2314), Solar Energy Research Institute, Golden, CO, March 1984

Summary Date
October 1984

Title: Effects of Multiple Scattering and Visibility on Central Receiver Performance

Contractor:
Radiation Research Associates
3550 Hulen Street
Fort Worth, TX 76107

Principal Investigator: N.M. Schaeffer
Telephone: (817) 731-2711

Contract Number: B-4-17842-1

Current Contract Period **From:** 08/17/84
To: 12/17/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: E.L. Maxwell
Telephone: (303) 231-7088

Contract Funding:		**Source:**
FY 1984	$24,544	DOE

Project/Area/Task: Solar Thermal Research Program/High Temperature Measurement/Instrumentation

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Objectives: To perform calculations to determine the spectral irradiance incident on the central receiver (of the Solar One System) for four receiver-to-heliostat distances and for specified solar zenith angles.

Approach Present Task: Calculation of the direct normal and scattered radiation incident on the heliostat using the BRITE radiative transfer code.
Determination of the direct and scattered radiation reflected onto the receiver.

Status/FY1984 Accomplishments: Calculation of the amount of direct and scattered radiation intercepted by the heliostat at 5-7 wavelengths each hour between sunrise and noon for each wavelength.
Determination of the amount of direct and scattered radiation reflected from the heliostat onto the receiver.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated in FY1985)

Summary Date
October 1984

Title: High Temperature Window Materials

Contractor:
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: S.H. Bomar
Telephone: (404) 894-3650

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R. G. Nix
Telephone: (303) 231-1757

Contract Number: XX-4-04007-01

Current Contract Period **From:** 01/01/84
To: 12/31/84

Contract Funding:		**Source:**
FY 1983	$150,000	DOE
84	150,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/Georgia Institute of Technology

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Objectives: To develop and test coatings to inhibit receiver window devitrification and to design and test mosaic window structures to allow assembly of large windows for commercial-size solar receiver/reactors.

Approach Present Task: Development, test and evaluation of devitrification coatings. Thermal modeling of welded fused quartz mosaic window assemblies.

Status/FY1984 Accomplishments: Completion of a test program at the Advanced Components Test Facility (ACTF) to gain experience with transparent windows and to define the conditions where devitrification occurs. (Only slight devitrification was observed in the testing of fused quartz and Vycor at temperatures up to 1000°C).
Development, test and evaluation of silica-based coatings to inhibit devitrification. (Demonstrated that boron-silicon oxide polymer coatings inhibit devitrification).
Completion of the thermal modeling of mosaic window structures that utilize fluid-cooled metal window sashes.

FY1984 Milestones: Boron/silicon compounds for inhibiting window devitrification - August 31, 1984

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

SERI

Title: Surface Temperature Diagnostics

Contractor:
Georgia Institute of Technology
Atlanta, GA 30332

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: F.E. Mackie
Telephone: (404) 894-3324

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Number: XX-4-04007-1

Current Contract Period **From:** 01/01/83
To: 12/31/84

Contract Funding:		**Source:**
FY 1983	$130,000	DOE
84	130,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/Georgia Institute of Technology

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Objectives: To design, fabricate, test and evaluate a multi-spectral solar blind pyrometer (the pyrometer is to be used in the STT Program to characterize the optical properties of materials).

Approach Present Tasks: Fabrication of the system.
Determination of the measurement accuracy of the system by taking measurements on various materials.

Status/FY1984 Accomplishments: Completion of assembly of the system.
Completion of multi-color pyrometer measurements of the emittances and temperatures of four sample materials.
Demonstration of a temperature measurement accuracy of 2-4% for a limited number of materials and flux conditions.

FY1984 Milestones: Verify the temperature measurement accuracy of the multispectral (4 wavelength) solar blind pyrometer - September 30, 1984.

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

SERI

Title: Direct Flux Solar Reactors

Contractor:
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: D.H. Neale
Telephone: (404) 894-3329

Contract Number: XX-4-04007-1

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1983	$200,000	DOE
84	105,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/Georgia Institute of Technology Research

---

Objectives: To test and evaluate the GIT entrained-flow solar reactor (the system was fabricated in FY1983) at the Advanced Components Test Facility (ACTF) and to develop better computer models for predicting heat transport and convective losses in such reactors.

Approach Present Tasks: Test and evaluation of the entrainment reactor at the ACTF. Development of heat transport/convective loss computer models.

Status/FY1984 Accomplishments: Completion of 38.7 hours of solar testing of the entrainment reactor at the ACTF.
Completion of modification of the reactor to obtain improved entrainment and increased residence time in the direct flux zone—thereby improving efficiency.
Completion of an entrained flow reactor computer model.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Ceramic Structural Materials

Contractor:
Georgia Institute of Technology
Atlanta, GA 30332

Principal Investigator: S.H. Bomar
Telephone: (404) 894-3650

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Number: XX-4-04007-1

Current Contract Period **From:** 01/01/84
To: 12/31/84

Contract Funding:		**Source:**
FY 1983	$150,000	DOE
84	150,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/Georgia Institute of Technology Research

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Objectives: To identify mechanisms responsible for the degradation of ceramic materials exposed to concentrated solar flux and identify modifications to such materials to improve their performance in the solar thermal environment.

Approach Present Tasks: Exposure of ceramic materials to concentrated solar fluxes at the ACTF.
Identification of degradation mechanisms in the exposed samples by microstructure and X-ray analysis.

Status/FY1984 Accomplishments: Completion of exposure testing of 14 candidate ceramic materials at the ACTF and analysis and evaluation of the exposed materials at the ACTF and by microstructure and X-ray analysis.
Acquisition of analytical data to improve the fundamental understanding of damage processes in ceramic materials exposed to concentrated solar radiation.

FY1984 Milestones: Definition of service limits for silica-based structural materials (slip-cast, aggregate-cast castables)- November 30, 1984.

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Materials Degradation at High Solar Fluxes

Contractor:
University of Houston
Energy Laboratory
Houston, TX 77004

Principal Investigator: A. Ignatiev
Telephone: (813) 749-3889

Contract Number: XX-4-04006-01

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1984	$65,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/University of Houston Research

---

Objectives: To conduct photocorrosion studies of high temperature/high flux absorber coatings produced by ion bombardment and to develop and characterize high temperature/high flux coatings for ceramics to inhibit photodegradation.

Approach Present Tasks: Development and testing of advanced absorber coatings by ion bombardment.
Development and testing of aluminum oxide coatings for ceramics.

Status/FY1984 Accomplishments: Development of a series of advanced absorber coatings by ion bombardment of zirconium and testing of the coatings.
Development of two types of absorber coatings by nitrogen bombardment.
Development of aluminum oxide coatings for ceramics and completion of simulated solar radiant exposure studies of the coatings.

FY1984 Milestones: Complete photocorrosion studies of aluminum oxide coatings for ceramics - March 31, 1984

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Liquid Jet-Cooled/High Heat Flux Solar Receiver Research

Contractor:
University of Houston
Energy Laboratory
Houston, TX 77004

Principal Investigator: J. Lienhard
Telephone: (713) 749-2453

Contract Number: XX-4-04006-01

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1984	$45,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/University of Houston Research

---

Objectives: To demonstrate the technical feasibility of the liquid jet-cooled/high heat flux solar receiver concept as a means for increasing the heat removal rate from solar receivers.

Approach Present Tasks: Developing an understanding of the basic convective boiling mechanisms in the jet-cooled configuration.
Fabrication and operation of a 100 kW electrically heated experimental unit.

Status/FY1984 Accomplishments: Development of a dimensionless equation of the heat transfer processes in the system concept and verification of the equation using Japanese data.
Completion of construction of the 100 kW experimental unit.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Chemical Heat Pipe Receiver/Reactor Research

Contractor:
University of Houston
Energy Laboratory
Houston, TX 77004

Principal Investigator: J. Richardson
Telephone: (713) 749-2419

Contract Number: XX-4-04006-01

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1983	$110,000	DOE
84	60,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/University of Houston Research

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Objectives: To assess the technical feasibility of receiver/reactors that utilize heat pipe technology for energy transport by constructing, operating and evaluating a sub-pilot scale system for methane reforming.

Approach Present Task: Determination of the catalytic rate equation for the sub-pilot scale system constructed in FY1983.
Operation, test and evaluation of the sub-pilot scale system using simulated solar radiation.

Status/FY1984 Accomplishments: Completion of testing of the system isothermally.
Operation of the system for three weeks in a steady state mode (the operation was successful).
Determination of the catalytic rate equation for the system.
Operation of the system under daily, cyclic operating conditions using simulated solar radiation to generate data for use in validating and improving the computer model.

FY1984 Milestones: Operation of the solar chemical heat pipe under cyclic conditions to provide data to validate and improve the mathematical model - August 31, 1984

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Thermochemical Cycles for Energy Storage

Contractor:
University of Houston
Energy Laboratory
Houston, TX 77004

Principal Investigator: W. Wentworth
Telephone: (713) 749-2627

Contract Number: XX-4-04006-1

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R. G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1983	$75,000	DOE
84	15,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/University of Houston Research

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Objectives: To investigate the technical feasibility of a thermochemical energy storage system that involves the decomposition of ammonium hydrogen sulfate and the decomposition of zinc sulfate in the presence of a molten eutectic salt.

Approach Present Tasks: Formulation of the conceptual design for the system.
Determination of the kinetics and gaseous product distribution resulting from the cycle.

Status/FY1984 Accomplishments: Formulation of the conceptual design for the system.
Development of a catalyst (V_2O_5 supported on porous aluminum silicate) to facilitate decomposition of the zinc sulfate/lithium sulfate eutectic salt.
Development of a technique to separate the reaction product zinc oxide from the catalyst support structure.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Analytical Models Development

Contractor:
University of Houston
Energy Laboratory
Houston, TX 77004

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: W. R. Prengle
Telephone: (713) 749-2146

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Number: XX-4-04006-1

Current Contract Period **From:** 01/01/84
To: 12/31/84

Contract Funding:		**Source:**
FY 1984	$10,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research/University of Houston Research

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Objectives: To develop a computer model that simulates the recovery of energy stored in a latent heat storage system and to maintain and document various central receiver design and optimization computer models previously developed by the University of Houston.

Approach Present Tasks: Development and validation of a latent heat recovery computer model.
Generation of users' guides for previously-developed computer models.

Status/FY1984 Accomplishments: Development of a latent heat storage and recovery model.
Validation of the latent heat storage and recovery model by comparing model results to results obtained using a finite differences solution approach.
Completion of upgrading and documenting several previously-developed models.

FY1984 Milestones: None

Major Project Reports: None

Summary Date
October 1984

Title: Systems Analysis Support

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

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Principal Investigator: L.M. Murphy
Telephone: (303) 231-1050

Project Engineer: John Thornton
Telephone: (303) 231-1269

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 01/01/83
To: 09/30/84

Contract Funding:		**Source:**
FY 1982	$300,000	DOE
83	175,000	DOE
84	180,000	DOE

Project/Area/Task: Solar Thermal Research Program/Planning and Assessment/ Systems Analysis Support

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Objectives: To provide planning and systems analysis support to DOE/HQ and the Technical Program Integrator (TPI) for the Solar Thermal Technology (STT) Program.

Approach Present Tasks: Assessment of high temperature materials technology.
Performance, in conjunction with Sandia/Livermore, of a parametric study of the thermal performances of high temperature solar thermal systems.

Status/FY1984 Accomplishments: Identification and costing of 24 promising metals and ceramic materials for high temperature solar thermal applications.
Completion of a systems analysis study of the performance of high temperature central receiver systems (with cavity receivers) as functions of heliostat field layout, heliostat field size, cavity receiver configuration and system operating temperature.
Completion of an assessment of enclosed thermal dishes which showed that the concept was feasible, but that there were numerous technical barriers to overcome (e.g., beam walk-off, etc.)

FY1984 Milestones: Complete an assessment of the technical and economic feasibility of enclosed thermal dishes - December 31, 1983.
Complete a preliminary assessment of previous Sandia/Livermore and other high temperature thermal system studies - May 31, 1984.

Major Project Reports: DeLaquil, P., and Anderson, J.V. "The Performance of High Temperature Central Receiver Systems." (SAND84-8233) (Joint SERI and Sandia/Livermore Project), Sandia National Laboratories, Livermore, CA, 1984.

Summary Date
October 1984

Title: Spiral Concentrating Collector Research

Contractor:
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, GA 30332

Principal Investigator: R. Cassanova
Telephone: (404) 894-3589

Contract Number: XX-4-04007-01

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R.G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1984	$10,000	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Innovative Concentrator Analysis and Research

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Objectives: To assess the technical feasibility of low-cost, lightweight spiral concentrators having a concentration ratio in the range 500-1000.

Approach Present Task: Selection of reflective material systems.
Fabrication, testing and evaluation of a scale-model spiral concentrator.

Status/FY1984 Accomplishments: Survey of reflective materials, reflective material composites and thin laminated glass which might be applicable for use in spiral solar concentrators.
Completion of fabrication of the reflector assembly.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated by January 31, 1985)

Summary Date
October 1984

Title: Operation and Maintenance of the Advanced Components Test Facility (ACTF)

Contractor:
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, GA 30332

Principal Investigator: R. Cassanova
Telephone: (404) 894-3589

Contract Number: XX-4-04007-01

Current Contract Period **From:** 01/01/84
To: 12/31/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: R. G. Nix
Telephone: (303) 231-1757

Contract Funding:		**Source:**
FY 1984	$250,000	DOE

Project/Area/Task: Solar Thermal Research Program/University Research

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Objectives: To operate and maintain the Advanced Components Test Facility (ACTF) as the primary Solar Thermal Research Program facility for testing and evaluation of components, scale models, subsystems, and materials under actual solar conditions.

Approach Present Tasks: Testing and evaluation of materials, components, systems and subsystems at various solar flux levels.

Status/FY1984 Accomplishments: As a Solar Thermal Research Program resource, among the FY1984 activities in which the ACTF was utilized were the following:

- o Testing and evaluation of transparent windows for receivers/reactors.
- o Testing and evaluation of ceramic materials for STT Program applications.
- o Testing and evaluation of an entrained particle receiver/reactor.

FY1984 Milestones: None

Major Project Reports: None

Summary Date
October 1984

Title: Modular Industrial Retrofit System (MISR) Test Support

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

Principal Investigator: A. Lewandowski
Telephone: (303) 231-1972

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: J. Thornton
Telephone: (303) 231-1269

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Contract Funding:		**Source:**
FY 1982	$520,000	DOE
83	60,000	DOE
84	45,470	DOE

Project/Area/Task: Solar Thermal Research Program/Support to the DOe Systems Evaluation Research/MISR Test Support

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Objectives: To complete an additional program of life cycle testing of the refurbished SERI MISR system.

Approach Present Task: Refurbishment of the SERI MISR system by Foster-Wheeler under subcontract to Sandia/Albuquerque.
Life-cycle testing of the refurbished MISR system.

Status/FY1984 Accomplishments: Completion of refurbishment of the SERI MISR system by Foster-Wheeler (fabrication and installation of a new rotary joint).
Replacement of the pumps and heat exchangers in the system.
Initiation of the life cycle testing program.

FY1984 Milestones: None

Major Project Reports: (Final report to be generated in the first quarter of FY1985)

Summary Date
October 1984

SERI

Title: Stretched Membrane Concentrator Evaluation

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

Principal Investigator: L.M. Murphy
Telephone: (303) 231-1050

Contract Number: DE-AC02-83CH10093

Current Contract Period **From:** 10/01/83
To: 09/30/84

Directing Organization:
Solar Energy Research Institute
Golden, CO 80401

Project Engineer: J. Thornton
Telephone: (303) 231-1269

Contract Funding:		**Source:**
FY 1984	$61,858	DOE

Project/Area/Task: Solar Thermal Research Program/Reflector Materials/Innovative Concentrator Analysis and Research

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Objectives: To assess the cost and technical feasibility of utilizing stretched membrane technology for fabricating low-cost dish concentrating collectors.

Approach Present Tasks: Developing and evaluating low-cost dish concentrating collector concepts that utilize stretched membrane technology.
Estimating the capital costs of low-cost dish concentrators.

Status/FY1984 Accomplishments: Demonstrated that achieving an adequate dish depth is not trivial using a single membrane. The average material strain to achieve a typical 30o rim angle is close to or exceeds the yield strain for most candidate membrane materials. Consequently, dish shaped stretched membrane reflectors cannot be achieved simply by increasing the curvature inducing forces.
Demonstrated that membranes can be cast or plastically formed to achieve a deeper dish than if elastically formed.

FY1984 Milestones: None

Major Project Reports: Murphy, L.M. and Wood, R.L. "Assessment of the Tensioned Membrane Technology for Solar Concentrators." (SERI/SP-253-2437), Solar Energy Research Institute, Golden, CO, September 1984.

Summary Date
October 1984

FY 1984

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