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SAND92-2742 • UC-900

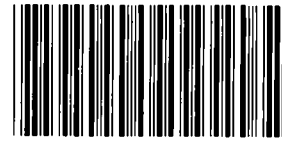
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Printed January 1993

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The Solar Thermal Design Assistance Center Report of Its Activities and Accomplishments in Fiscal Year 1992

David Menicucci



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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

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NTIS price codes
Printed copy: A03
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SAND92-2742
Unlimited Release
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Distribution
Category UC-900

THE SOLAR THERMAL DESIGN ASSISTANCE CENTER

Report of Its Activities and Accomplishments in Fiscal Year 1992

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Abstract

This report contains an outline of the Solar Thermal Design Assistance Center's (STDAC) major activities and accomplishments in Fiscal Year 1992 (FY92). The report describes the resources allocated to fund STDAC and the personnel needed to carry out STDAC activities and accomplishments. It also contains a comprehensive list of persons that called STDAC for consultation in FY92.

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THE SOLAR THERMAL DESIGN ASSISTANCE CENTER

Report of Its Activities and Accomplishments in Fiscal Year 1992

1. INTRODUCTION

The Solar Thermal Design Assistance Center (STDAC) at Sandia National Laboratories (SNL) is a resource provided by the Department of Energy's (DOE) Solar Thermal Program. Its major objectives are to accelerate the use of solar thermal systems through direct technical assistance to users, cooperative test, evaluation and development efforts with private industry, and educational outreach activities.

The major activities and accomplishments in Fiscal Year 1992 (FY92) are outlined in this report. Section 2, STDAC Resources and Personnel, outlines the resources that are allocated and describes the personnel involved. Some of the most significant STDAC accomplishments are described in Section 3, Summary of STDAC Accomplishments in FY92. The List of STDAC Contacts, Section 4, contains a comprehensive list of persons that contacted the STDAC by telephone for technical consulting.

2. STDAC RESOURCES AND PERSONNEL

A majority of the STDAC activities reported here are supported by (1) the Solar Thermal Electric Program, (2) the Solar Thermal Industrial Program, or (3) both programs. They are reported together for completeness and in recognition that boundaries are often not distinct within each activity. Additional resources are provided through the DOE Office of Technology and Financial Assistance (OTFA) and SNL's Technology Transfer and Educational Outreach Programs.

The total funding for STDAC operations in FY92 totalled about \$1.2 million, which was provided in the following approximate proportions: 54% from the DOE Solar Thermal Electric Program; 39% from the Solar Process Heat Program; and 7% from other sources including OTFA, and internal SNL programs.

STDAC personnel include two full-time equivalent (FTE) engineers and several part-time engineers and technicians for a total of four FTEs. Approximately 40% of the STDAC funds are expended on direct charges, with the majority of these expenditures for contracts such as specialty studies and solar system monitoring support from universities, technology development activities with the solar industry, and reports concerning existing solar thermal systems. Other direct expenditures include travel, test and evaluation materials, and other miscellaneous items.

3. SUMMARY OF STDAC ACCOMPLISHMENTS IN FY92

The STDAC accomplishes its objectives by pursuing activities in three major areas:

- **Direct Technical Assistance to the Industry and End Users.** A vital element of this activity is to inform users how they can apply solar thermal technology by providing information on technology status, application screening, component and system performance predictions, and design and installation guidance. To do this, the STDAC incorporates the experience base of solar energy personnel and facilities at SNL, and the broad base of human and physical resources located within other parts of the laboratory. This capability is provided upon request and enhances the US solar industry's ability to bring improved systems to the marketplace with a higher probability of success. Moreover, by collaborating with other similar activities at SNL, such as the Photovoltaic Design Assistance Center, other laboratories, and the National Renewable Energy Lab (NREL), the STDAC can provide each customer with complete service regarding the application of solar energy.

The STDAC provides direct technical assistance to four principal groups: industry, state and local governments, military organizations, and private end users.

- **Cooperative Test, Evaluation, and Development Efforts with Private Industry.** The STDAC helps industry develop technology by providing testing and evaluation of new and innovative solar thermal technology at the National Solar Thermal Test Facility. The evaluations are conducted in close cooperation with the manufacturer and the results are used to improve the product and/or to more fully understand and document its performance characteristics. These projects help manufacturers improve the design, performance, operation, and economic performance of new solar thermal technology.

In addition to the testing activities, the STDAC co-funded projects to develop advanced technology, such as more cost-effective trough receivers and a technique to produce low-cost mirror replacements for solar electric generating systems (SEGS) troughs.

- **Educational Outreach.** The principal purpose of this activity is to promote an accurate understanding about the economic potential and operation of solar thermal technology. This task is accomplished through a coordinated educational effort to public and private professionals, administrators, business executives, and decision makers. Additionally, instructional materials are prepared for use in educational institutions ranging from elementary through high schools and universities.

Some of the most significant accomplishments in FY92 in each of the three major areas are described below:

DIRECT TECHNICAL ASSISTANCE

The STDAC provides a variety of technical services to industry, government agencies, and end users, including the installation of new solar fields and the refurbishment of existing fields. Also, the STDAC consults with governments on ways to reduce energy use and has recently provided recommendations to the State of New Mexico Energy Conservation and Renewable Task Force. These and other services are described in detail in this section.

Assistance to SEGS. In September 1992, the STDAC agreed to assist the Daggett Leasing Corporation (DLC) and the Kramer Junction Company (KJC) in the following ways:

- Currently, SNL and DLC engineers are working together to evaluate the various engineering applications for using the SOLAR 1 storage tank at SEGS 2 and to assess the cost effectiveness of each option. Work on this project is expected to continue through FY93.
- Presently, SNL is performing a finite element analysis of the significant damage to the SEGS facility during the recent earthquake and will help determine corrective measures. Most of the damage involved loss of reflective surface. Because the original equipment manufacturer will not provide replacements, SEGS is looking for help from domestic sources. Industrial Solar Technology (IST) was contacted to help construct aluminum plates laminated with reflective film. SNL agreed to help IST develop the replacement mirrors. This project will continue through FY93.

- SNL has agreed to analyze existing solar radiation data to explain the apparent reduction in insolation because of the volcanic eruption. The SEGS owners have requested some explanations about the problem, since it has reduced their revenue by about 20%. This effort will continue in FY93.

Assistance to IST to Prevent Wind Damage to Solar Field at Tehachapi.

Since early Calendar Year 1992 (CY92), the STDAC has been assisting IST regarding the performance of the solar trough hot water system in Tehachapi, CA. In late 1991, high winds began to damage some of the collectors. A major problem was that some of the rods connecting adjacent collectors were breaking; also, the trough edges were bending along the leading edge. In response, SNL analyzed the wind-induced problems and recommended changes to the connecting rod design.

At IST's request, SNL engineers are currently helping develop both retrofit improvements for existing collectors and a set of design improvements for new trough collectors to make them more resistant to wind damage. This work involves using finite element analysis, and a finite element model is being developed for use in the analysis. IST will conduct some destructive static load tests on some existing modules to provide calibration data for the finite element model. Work on this project will continue into FY93.

Support of Gould's Effort to Upgrade its Solar Industrial Process Heat (IPH) System. For the last two years, the STDAC has provided Gould, Inc., with technical consulting regarding the refurbishment of its 60,000 square foot solar IPH system. This 10-year-old solar system had been experiencing serious operation and maintenance problems; in 1990, the problems had become so severe that the Gould management was considering its removal.

The STDAC agreed to help determine the value of upgrading the solar system. As a result, a field assessment was conducted and the conclusion was that new technology could be transferred to Gould to upgrade the system. This new technology, some of which was developed through the DOE Solar Program, included improved flex hoses, techniques to repair damaged reflective film, methods to optimize operation, and techniques to monitor the system's energy and economic performance.

In FY92, the new technology was tested in a small section of the Gould field. The tests demonstrated the value of applying the new technology and, as a result, Gould decided to fully upgrade the plant. The upgrade should be completed in mid FY93 and is expected to produce electricity savings of about \$120,000 per year. SNL has issued a contract to Gould to provide records of the economic and energy performance of the systems in FY92 and FY93. These records will be assembled into a report detailing the performance of the Gould system.

This effort effectively applied government resources. In addition to transferring government technology to the private sector, the net energy savings resulting from the effort are worth about 20 times DOE's cost of providing the consulting and technology transfer.

Technical Consultation for the California Energy Commission (CEC). Currently, SNL engineers are involved in several CEC activities.

- The first involves the solar project at the prison in San Luis Obispo, CA. SNL engineers are working with BESICO regarding the instrumentation for monitoring the solar system that will be installed. Some of these activities include engineering analysis of the hot water load at the prison, assistance on modeling the solar system's performance, and consultation on design details.
- A second effort is to help CEC and California Department of Corrections officials develop Requests for Proposals for third-party financed solar systems in other prisons. Work on these RFPs began in September and is expected to continue through FY93.
- A third effort is to install, at the state's request, a solar hot water performance monitoring system at Galt, CA. This evacuated tube collector system was purchased by the State of California, and they are interested in having a neutral third-party measure its performance. The project will continue into FY93.

Refurbishment of a Solar System at a New Mexico College. The State of New Mexico Energy and Minerals Department has asked for SNL's assistance in refurbishing a solar system at the Northern New Mexico Community College. The solar system, which is currently not operating, was originally intended to heat water and space. At the end of FY92, negotiations were underway to develop a cost-shared project that

will include SNL, the State of New Mexico, and the New Mexico Solar Energy Industries Association. The STDAC will focus its assistance activities on training the involved parties in the techniques to reengineer and refurbish the system and to monitor its performance.

Technical Assistance to State of Arizona. SNL provided engineering consulting to the Arizona Department of Commerce concerning the refurbishment of an existing, nonoperational solar trough system at a school. The system, built in the early 1980s, was never used, but it is currently being considered for heating the building space and indoor pool. The proposed refurbishment would involve simplifying the system to heat water. In FY92, STDAC engineers, along with a local architect and engineering firm, examined the solar system and estimated that the conversion would cost about \$25,000. The State of Arizona has asked for additional study of the project before they proceed. They will seek funds to complete the study through a prefeasibility study contract that will be managed by NREL and funded through the Solar Industrial Program. SNL will continue to provide engineering consulting on the project through FY93.

Participation in State of New Mexico Energy Task Force. During the last half of FY92, a STDAC representative participated in a State of New Mexico Energy Conservation and Renewable Energy Task Force. The task force's purpose was to develop recommendations for implementing the State's Energy Policy. The STDAC was invited to participate in this activity, which involved only 18 persons from throughout the state. This effort will be completed in early FY93.

Technical Assistance to State of Arkansas. In mid FY92, State of Arkansas energy officials asked for STDAC assistance regarding the refurbishment of an inoperative 30,000-square-foot solar trough system at the Mississippi County Community College (MCCC) in Blythville, AR. The experimental system was built in the early 1980s and was shut down around 1985. Chris Benson of the Arkansas Energy Department contacted the solar thermal program to request technical advice about relocating the IPH system to a state prison. STDAC engineers inspected the system and concluded that it would require some major renovation to make it operational. Arkansas officials agreed to obtain some information about the current hot water loads at the prisons, the associated costs for producing the hot water, and the disposition of the prison officials concerning a solar addition to the facilities. SNL agreed to assess the costs to move and refurbish the MCCC system. After all information has been obtained, SNL will help the state estimate the potential cost effectiveness of relocating the solar system. This phase of the project is expected to be completed in mid FY93.

Assistance for State of Virginia to Install New Solar Hot Water Systems. As part of the engineering support to the NREL Solar Industrial Program, the STDAC is currently providing engineering consulting to the Virginia Department of Mines, Mineral, and Energy (VDMME) about procuring and monitoring various solar thermal water heating systems in state institutions. The State of Virginia is providing the majority of the funds to procure the systems; NREL is co-funding the effort; and VDMME is coordinating the solar program that involves several state agencies.

The engineering help involves site evaluations, recommendations include applicable solar thermal technology, preparation of RFP packages, technical consulting on proposal evaluations, and training on the techniques for monitoring and analyzing solar system performance. This effort will conclude in mid FY93.

Support to City of Albuquerque. In FY92, STDAC engineers consulted with City of Albuquerque officials in an effort to reduce the city's energy use through conservation and renewable technology. Presently, SNL representatives serve on an advisory committee that is forming recommendations to the city council. After the council acts, the committee will discuss how to implement the final decisions. This action is expected to continue in FY93.

Solar Thermal Technology Applied at Military Installations. Currently, SNL engineers are involved in several projects at military installations. These projects are expected to be completed in FY93 or early FY94.

- SNL engineers directed the evaluation of potential solar systems at March AFB, CA, and Kirtland AFB, NM. The proposed solar systems at these bases will be used for water heating and, possibly, absorption air conditioning.
- SNL helped the US Army assess the potential of solar energy systems at Dugway Proving Grounds, UT. A site survey was conducted this year, and it was determined that solar systems have widespread opportunities on this Army post. SNL may cost share some of these projects.
- SNL is also helping the Army Corps of Engineers reduce the costs of developing an issuing third-party finance contract. The Corps is responsible for all contracts on Army posts. However, they have limited experience in issuing these kinds of contracts for solar systems and, as a result, their costs are prohibitively high and some projects have been stymied. Hopefully, some of SNL's experience can be applied to reduce the costs and allow some third-party financed solar projects to proceed.

Technical Assistance to Luke AFB on a Solar Refurbishment. In July, STDAC engineers began working with officials of Luke AFB near Phoenix, AZ, to refurbish a 12,000-square-foot solar thermal trough system that was intended to heat water for three airman dormitories. This solar system has been shut down since early 1980 because of the drive mechanism.

After studying the system, STDAC engineers concluded that, based on refurbishment costs plus a two-year O&M and training contract, the energy cost savings would pay for the refurbishment costs in about three to four years. Luke officials authorized the project. SNL will contract to Luke AFB for a report on the refurbishment effort and the performance of the system for the first year of operation.

Refurbishment of Solar System at the Veteran's Administration (VA) Hospital. SNL completed a solar refurbishment effort at the VA Hospital in Albuquerque, NM. This system, installed in 1985, had been shut down since 1986 because it produced excessively hot water and caused pressure/temperature relief valves to open. In FY92, SNL began working with VA engineers to restart the system. One-half of the system is now operating under automatic control, but there is insufficient load for the other half of the system. As a result, half of the system will remain idle until new loads develop that warrant its operation. The solar system will save about \$6,000 per year in gas usage.

Support for SNL's Technology Transfer Programs. Throughout FY92, the STDAC consulted with SNL's Technology Transfer Program concerning the application of solar thermal technology. Engineering support consisted of advising various private organizations on the benefits of solar energy technology. Support for this effort is provided through SNL's Technology Transfer Programs and will continue through FY93.

Commercialization of Solar Thermal Technology of an SNL-Sponsored Project. In August, the STDAC initiated a new nine-month project to commercialize a single solar thermal technology. This three-phase project, funded through SNL's Technology Transfer Program, will begin by identifying minority-owned companies that have the capability to commercialize a small-scale solar thermal technology. After these companies have been identified, each will be asked to select a solar thermal technology to commercialize. Each company will then compete for involvement in a technology transfer activity designed to assist the company in developing a complete business plan to manufacture and market the solar product. The STDAC is providing the management and technical direction for the project. This effort will be completed around mid FY93.

Consultation to the Government of Mexico. SNL has worked with the Mexican Government on two projects in FY92.

- Throughout FY92, SNL's Photovoltaic Design Assistance Center was coordinating a technical consulting effort to help the Mexican Government apply renewable technologies in Mexico. As part of the effort, the STDAC provided consultation about solar thermal technologies. SNL assisted in the design of a walk-in, fish storage bin that will be cooled with several Energy Concepts ice maker. SNL is contracted with Energy Concepts Company to report on the installation and operation of other solar ice makers.
- Another effort involves the development of a 30-kW solar thermal electric project in Puerto Lobos. This project has been approved and funded by the Mexican government. A used organic Rankine cycle (ORC) engine coupled with IST troughs will be employed for this demonstration project. The Mexican government has recently released a plan for installing this system, which is currently being reviewed by SNL and DOE for areas in which the STDAC can provide technical assistance to ensure success.

COOPERATIVE TEST, EVALUATION, AND DEVELOPMENT EFFORTS

In FY92, STDAC worked on several research projects, including testing small-scale solar thermal products, monitoring existing solar thermal systems, and developing an advanced, low-cost trough collector system. These projects are described in this section.

Testing of Small-Scale Solar Thermal Products. SNL engineers worked with Energy Concepts Company to test the Mini- and Full-Isaac solar ice maker. The testing followed a plan that was developed jointly by DOE and Energy Concepts. The results of the tests are being used by Energy Concepts to improve the system design.

- In FY92, SNL tested a new model of a residential solar distiller developed by BSAR. This testing followed SNL tests of a previous version of the distiller that produced information to improve its design. Many of these suggestions have been incorporated into the new model. Tests of the new model are based on a plan that was developed jointly by DOE and BSAR.
- Late in FY92, SNL began testing a solar concentrating oven developed by Burns Milwaukee, Inc. The purpose of the tests was to quantify the oven's performance for use in the company's commercialization activities and to identify design/manufacturing deficiencies.

Monitoring of Fielded Solar Thermal Systems. In FY92, STDAC engineers were involved in several efforts to monitor and report on the performance of installed solar thermal systems. The most important of these is the solar concentrating system at Tehachapi, CA, that produces hot water for a nearby prison. System performance data are recorded hourly by a system that was installed by SNL engineers, and the results are used by California officials to assess the performance of the system. The data are also used by IST, the solar system developers, as a diagnostic aid. A summary of the system performance is published monthly and annually. Other systems being monitored include an evacuated tube solar water heating system and insolation monitoring stations.

The monitoring activities will expand in FY93 to include new systems in California and Mexico. The STDAC will focus much of its efforts in FY93 on training others about the techniques of solar system monitoring.

Developing an Advanced, Low-Cost Trough Collector System. Currently, SNL is cost sharing the development of an advanced trough collector with IST. The objective of this project is to reduce the cost of electrical energy and/or process heat produced by parabolic trough systems. The project aims to achieve this goal by developing and commercializing improved receivers. In FY92, there was significant progress on all three efforts. A description of each effort follows:

- (1) *Developing a commercialized process to apply an anti-reflective (AR) sol-gel based coating for receiver glass.*

In FY92, there was significant progress on all three efforts. The sol-gel coating was developed at SNL; however, the process to apply it has been labor intensive, resulting in an effort to simplify the process that has reduced costs. The effort in FY93 will center on developing some limited production runs of tubes using the new coating process.

- (2) *Developing a new lower cost and more environmentally benign absorptive coating for the receiver tube.*

Significant progress was made in developing a black-nickel process as an alternative to black chrome. In FY92, work produced samples of blackened metal that showed absorptance and emittance characteristics similar to black chrome. The effort in FY93 will be aimed at applying the process to full-scale receiver tubes.

(3) *Developing an evacuated receiver.*

The development of the evacuated receiver involved solving the problems of sealing glass to the metal bellows. Tests of the prototype evacuated tube seals have been positive. Efforts in FY93 will focus on developing full-scale prototype receiver tubes and applying the process in a production environment.

The rationale for the project is based on a recently completed study by Tom Williams of NREL. (The study will be published at the 1993 ASME Solar Energy Conference.) In this study, the above three items were identified as having a high potential for reducing the cost of producing heat from trough collectors.

EDUCATIONAL OUTREACH

In FY92, the STDAC used its educational outreach program to inform the public about solar energy use. SNL co-sponsored the SOLTECH 92 meeting in Albuquerque, NM, participated in various workshops and conferences, and developed solar educational modules for use in schools. These projects are detailed in this section.

Solar Message Presented to the Public. STDAC engineers presented various solar talks or participated in various civic activities. These are outlined below:

- *City of Albuquerque Energy Forum*

SNL engineers participated in a City of Albuquerque workshop entitled *Creating a Sustainable Energy Future*. The workshop was developed by six city departments, along with a city Energy Conservation Council, to prepare a plan to reduce the Albuquerque's conventional fuel use by 10% by 1995 using renewable technologies and conservation.

One of the STDAC engineers was an organizer and coordinator in the Energy Education breakout session, which developed a plan to educate energy users about alternatives and energy conservation. Another STDAC engineer participated in the Land Use breakout session, which addressed land use issues related to energy use and renewable energy production.

- *Solar Energy Talk for Albuquerque/Las Cruces, NM, Electricity Task Force.*

A solar energy technology talk was presented to the Albuquerque/Las Cruces, NM, SENSE task force. This task force is a coalition of city councilors from Albuquerque and Las Cruces. The purpose of the task force is to explore alternative energy sources that can be used by municipal utilities.

SNL was invited to this meeting to discuss the current state of solar technology and some issues relating to electricity generation. The presentation included an overview of all solar technologies and a discussion about the pros and cons of tax credits. Special emphasis was placed on the efforts in California and Nevada to incorporate long-term pollution costs in the estimates for new electric generating plants. With the addition of these environmental costs, solar plants like central receivers are among the most cost-effective generating systems.

- *Solar Energy Talk at the Annual New Mexico Science Teacher's Conference*

An invited address concerning solar energy technology was presented at the Annual Conference of the New Mexico Science Teacher's Association. Members of this association include most of the science teachers in New Mexico. This conference attracted about 100 attendees and one of its focuses was renewable energy.

SOLTECH 92 Meeting. SNL, co-sponsor for the SOLTECH 92 meeting held Feb. 17 - 20, 1992, in Albuquerque, NM, was responsible for organizing two solar thermal electric symposiums and for designing and constructing an exhibit on solar electric technology.

The solar thermal electric sessions focused on central and distributed generation, and a variety of speakers discussed the three major technologies, market factors and opportunities, and state and federal regulations pertaining to solar generated electricity.

The solar electric exhibit was the result of a collaboration with SNL's photovoltaic system research division. The exhibit featured small- and medium-sized photovoltaic systems, along with large-scale solar thermal electric systems. Many people attended the exhibit and thousands of SNL documents were distributed.

Solar Educational Modules Developed. In FY92, the STDAC, working in cooperation with SNL's educational outreach project, developed a set of classroom modules designed to educate students on the fundamentals of solar energy. Three modules are being prepared for various grade levels, including grades 4 through 5 and grades 7 through 9. Each module contains a video tape that explains solar energy collection fundamentals, an outline of classroom activities and experiments, and a description of how to build simple solar collector models. The grades 4 through 5 module was completed early in FY92 and was field tested during the 1991/92 school year in several schools nationwide. Results of the tests show that the packages are very applicable for classroom use. The grades 7 through 9 module was recently completed and will be ready for the 1992/93 school year. Copies of these educational modules are available through SNL's Teacher's Resource Center. The solar collector models associated with each module will be available for loan to teachers in Albuquerque.

4. LIST OF STDAC CONTACTS

Central Receiver

Jeff Antisdell	Nevada Energy Commission
Ray Bennett	Hogan Industries
Jim Bergnon	Bergnon Engineering
Bob Burns	Astronaut
Tom Coffey	University of Chicago
Russell Garnsworthy	CRA, LTD., Australia
Joel H. Goodman	Consultant
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Ken Hoogakker	Consultant
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John Johnson	Photon Energy
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Carlo LaPorta	UST
Frank Mancini	Arizona Energy Commission
Hank Price	LUZ Engineering Corp.
Robert J. Radway	Radway & Associates
John Reardon	University of New Mexico
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Dish/Engine

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Paul Mahole	STM
Jack Noble	Stirling Thermal Company
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Art Seki	Hawaiian Electric Co.
Bob Shaubach	Thermacore, Inc.
Mike Snyder	Sunstrandt Corp.
Mark Steele	Consultant
Jim Ulrich	Consultant
Ed Wagner	The Franklin Institute
Douglas A. Wilke	Architecture-Engineering Environmental Studies

Education

Randi Buck	University of New Mexico
John Erden	University of New Mexico
Lawrence Haywood	Arizona State University
Cliff Holt	University of New Mexico
Tom Lewis	Taylor Middle School
Dan Morley	Consultant
Soson Patro	University of San Diego
Vern Risser	Consultant
Barbara Rogers	Hawthorne Elementary
Pat Ryan	University of Oregon
Rachel Skolneck	Futures
Bob Wilden	University of New Mexico

General Information

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Yasushi Aoki	Nippon Steel USA, Inc.

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Don Barrlet	Plains Electric
Jeff Beamon	Idaho Power
Gary Beckwith	Real Goods
Mark Bel	Union Electronics
Lynn Benfield	Consultant
Kelly Beninga	SAIC
Jim Besho	Consultant
Jim Besquorn	Consultant
Walter Bienert	Dynatherm
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