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SOLAR HEATING AND COOLING

RESEARCH AND DEVELOPMENT PROJECT SUMMARIES

MASTER

U.S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR CONSERVATION
AND SOLAR APPLICATIONS
DIVISION OF SOLAR APPLICATIONS

MAY 1978

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June
1978

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TABLE OF CONTENTS

	PAGE
Foreword	v
I Introduction	I-1
R&D Program Objectives	I-1
Evolution of the R&D Program	I-1
The NSF/RANN Program (FY 1971-1975)	I-1
Directed R&D Program Plan	I-1
FY 1977 Projects	I-2
Program Status	I-3
Program Structure	I-3
Report Availability	I-4
II Solar Heating and Cooling Research and Development Projects Selected for Negotiation or Supported in FY 1977	
Collectors	II-1
Thermal Storage/Heat Exchangers	II-6
Heat Pumps	II-8
Cooling	II-9
Passive Systems	II-11
Advanced Systems Development	II-13
System Analysis	II-15
Controls	II-16
Support Projects	II-17
III Project Summary Sheets for R&D Projects	
✓ 1. Collectors	1-1
✓ 2. Thermal Storage/Heat Exchangers	2-1
all except 2 at entry ✓ 3. Heat Pumps	3-1
✓ 4. Cooling	4-1
✓ 5. Passive Systems	5-1
✓ 6. Advanced Systems Development	6-1
✓ 7. Systems Analysis	7-1
✓ 8. Controls	8-1
not entry 1 ✓ 9. Support Projects	9-1
or 2	

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FOREWORD

The National Program for Solar Heating and Cooling of Buildings, directed by the Department of Energy (DOE), responds to the Solar Heating and Cooling Demonstration Act of 1974 (P.L. 93-409), September 3, 1974). That Act calls for programs to develop, demonstrate, and promote the use of solar heating and cooling systems. The role of the Federal Government is to stimulate the use of solar heating and cooling equipment and to assist industry with the development of technology and the demonstration of systems.

The Federal program includes demonstrations of heating and/or combined heating and cooling systems for residential and commercial buildings. A comprehensive discussion of this program is contained in ERDA Report 76-6, dated November 1976. The report is being updated and will be redesignated DOE/CS-0007. Early solar system development relied heavily on the utilization of readily available, although not necessarily efficient, equipment with advances in technology being incorporated as they became available. The new technology being advanced by this program is directed at improving performance and reliability and reducing the cost of component and system procurement and operation. The schedule for this program follows the Congressional directive in P.L. 93-409: "(b) ...to provide for the demonstration within a three-year period of the practical use of solar heating technology and to provide for the development and demonstration within a five-year period of the practical use of combined heating and cooling technology."

This report is one of two volumes that contain summaries of projects that were funded by ERDA/DOE through FY 1977 and conducted under the National Pro-

gram for Solar Heating and Cooling of Buildings. The two volumes are as follows:

- Volume 1, DOE/CS-0009: Commercial and Residential Demonstrations. This report summarizes the design and operating characteristics of the demonstration solar heating and cooling systems. It also gives brief descriptions of the buildings where the systems are installed and includes pictures of the buildings and sketches of the systems.
- Volume II, DOE/CS-0010: Research and Development. This report describes the Conservation and Solar Applications Solar Heating and Cooling Research and Development Program. It summarizes the research and development projects presently supported for further development of collectors, thermal energy storage and heat exchangers, heat pumps, solar cooling, controls, and systems. The report has two parts, an introduction and a series of project descriptions. The introduction describes the evolution of the R&D program and outlines the present program. The second part of the report describes the R&D projects. It includes a list of R&D projects and summary information on all current R&D projects. While these are essentially projects supported during FY 1977, the projects resulting from the FY 1977 series of PRDA and RFP solicitations which were selected for support, but were not funded by the end of the fiscal year, are also included for completeness.

SECTION I

INTRODUCTION

INTRODUCTION

&D PROGRAM OBJECTIVES

The general objective of the Department of Energy (DOE) Solar Applications R&D program is to assist in creating a viable solar energy industry by improving the performance and reliability of solar energy components and systems, and by reducing their costs. Specific objectives are to identify potentially cost-effective systems for building, agricultural and industrial process heating and cooling applications, and to provide the emerging solar energy industry and other users with the materials, components, information, and methodology needed for designing, producing and installing these systems. The application of solar energy for heating and cooling involves, to a significant extent, components (such as heat pumps, air conditioning machines, and controls) which are used in conventional HVAC systems, and components being produced by the relatively new and rapidly developing solar energy industry. The DOE program builds on this technology and attempts to assist the solar energy industry in accelerating the development of cost-effective components and systems.

EVOLUTION OF THE R&D PROGRAM

Before 1971, no significant Federal support was provided for research and development for the terrestrial applications of solar energy. The National Science Foundation (NSF) began such support in 1971 through its Research Applied to National Needs (RANN) Program. The major steps in the subsequent development of the research and development program for solar heating and cooling are summarized in the following paragraphs.

THE NSF/RANN PROGRAM (FY 1971-1975)

In FY 1971, NSF provided more than \$1 million for solar energy R&D. Of this amount, \$540,000 was designated for R&D on the solar heating and cooling of buildings. From FY 1971 through FY 1973, the funding level for solar heating and cooling R&D remained essentially constant, with all awards being made in response to unsolicited proposals submitted to NSF. By September 1973, the solar heating and cooling R&D program consisted of eight projects, at a total funding level of \$1,200,000.

In a Fall 1973 program solicitation, NSF requested proposals for solar heating and cooling R&D in seven areas:

- Solar collectors.
- Thermal energy storage subsystems.
- Solar space cooling subsystems.
- Solar assisted heat pumps.
- Advanced solar collectors for heating and cooling systems.
- Alternative approaches to solar energy systems.
- Evaluation of buildings having solar energy systems.

DIRECTED R&D PROGRAM PLAN

A series of technology review meetings was called by the Los Alamos Scientific Laboratory during the winter of 1975-1976. The meetings were held to assess the state-of-the-art, identify impediments to improved performance and reduced costs, and recommend short- and long-term means (R&D tasks) for removing such impediments. Participants included representatives from industry, universities, and Government laboratories and agencies.

In these meetings and in other discussions, the status of the national solar heating and cooling effort was defined. The following points became clear:

- The major problem to be addressed is cost effectiveness.
- The state-of-the art varies greatly for different components and applications, solar cooling technology being generally less developed than that for solar heating.
- Because the applications and climatic zones are quite varied, careful analysis is required to determine the most cost-effective approaches.
- Cost-effective retrofit systems do not exist, nor are techniques available for optimizing retrofit design.

The meetings and discussions also uncovered many other problems that must be solved before the technology can be significantly advanced.

As a result of these meetings, it was decided that ERDA's components-oriented R&D program, which has contributed significantly to the present state of technology, should be strengthened by the initiation of an ERDA-directed, applications-oriented R&D program. This program is fully described in ERDA 76-144, the *National Program Plan for Research and Development in Solar Heating and Cooling*.*

The specific objective of the directed R&D program is to provide the solar energy industry and other users with the materials, components, and information needed for cost-effective solar heating and cooling systems. The directed R&D plan defines promising approaches, called paths, for achieving this objective and outlines a systematic program for providing materials, components, and systems designed to establish the cost effectiveness of each approach as rapidly as possible.

The directed R&D plan (ERDA 76-144) contains 10 paths, two for hot water and four each for space heating and cooling. Each path links a method of solar energy

*Copies of this document are available from the U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

collection or rejection with a specific application. The 10 paths are illustrated in Figures 1 through 3. In each figure, four items are identified:

- The energy source or sink.
- The method of energy collection or heat rejection.
- Energy conditioning (when required).
- The application.

Storage is assumed to be present for all paths.

In order to develop cost-effective technology for achieving the path applications, various tasks must be accomplished. Approximately 275 such tasks have been identified and placed in the following five categories: collectors, storage and heat exchangers, air conditioning and heat pumps, systems and controls, and non-engineering aspects.

The task descriptions in ERDA 76-144 are sufficiently detailed to indicate work that must be done but broad enough to give the program flexibility. Many of the tasks are common to several of the paths. In each path the tasks are arranged in sequence, so that the paths develop in a logical manner.

IN FY 1977, after the distribution of the Interim Report (ERDA 76-144), a series of 11 competitive solicitations were issued by ERDA's Division of Solar Energy. These solicitations called for proposals specifically related to one or more tasks in the directed R&D plan. The 135 resultant projects, and the projects previously initiated, are described in this report. The program development in support of demonstration programs being managed by the National Aeronautics and Space Administration's (NASA) Marshall Space Flight Center (MSFC) and previously reported in ERDA 76-128 have been integrated within the R&D program and are also being reported in this document. These projects are described in the appropriate program element. Many of the tasks are under study, either fully or in part. Other tasks will be initiated as indicated in the plan. The balanced involvement of industry, universities, small business, and Government organizations, which characterized the prior R&D program, is continued by the new awards. While the implementation of this directed R&D program will continue to be primarily based on solicitations (RFP's and PRDA's), the support of fundamental and innovative research related to longer-term objectives will continue to be based on unsolicited proposals.

Since the R&D program is a part of DOE's total energy program, it has many points of impact on other DOE programs and organizations and on other Federal agencies. Implementation of the R&D program is being coordinated with the appropriate groups, and special emphasis is being placed on integration with the residential and commercial demonstration programs.

The R&D Program Plan, ERDA 76-144, was circulated widely for review and comment. A revised plan, based on this review and additional studies, is scheduled to be released in March 1978 (DOE/CS-0008). This report will not only indicate the status of the R&D tasks, but will include an additional solar cooling path and a detailed description of 11 paths for agricultural and industrial process applications.

FY 1977 PROJECTS

In FY 1977, the R&D program expanded from 76 projects to 245. Most of these projects are directed at providing improved performance in components and systems, improved manufacturing techniques, and/or lower initial and maintenance costs. The projects in each of the program elements are categorized in the following paragraphs and described in Section III.

COLLECTORS - There are 84 collector projects. They emphasize the development of liquid and air-heating flat-plate collectors, evacuated tubular collectors, stationary non-imaging concentrators, tracking concentrators, selective coatings for absorber surfaces, fundamental heat transfer studies, and development of improved collector materials.

THERMAL STORAGE/HEAT EXCHANGERS
There are 27 projects addressing thermal energy storage and/or heat exchangers. The emphasis is on development of storage/heat exchanger components which provide optimum solar system performance and have the most promising near-term market potential. Appropriate design guidance and testing standards are being developed as well.

HEAT PUMPS - There are six projects addressing heat pumps. Emphasis is on the identification of optimum solar-assisted heat pump system configurations, and the design, manufacturing, and marketing of heat pumps to support these systems.

COOLING - There are 26 cooling projects currently being funded. Emphasis is on cost, performance, and reliability through the development of preengineered, integrated systems and product development. Concepts currently under development include low temperature Rankine engines, high temperature Rankine engines, absorption, desiccants, and photovoltaic/thermal heat pumps. These projects are supported with special studies addressing materials, heat exchanger designs, and component analysis.

PASSIVE SYSTEMS - There are 31 research and development projects of passive solar heating and cooling systems including computer modeling and development of design methods. Nineteen projects are concerned with the design, construction, and instrumentation of innovative passive hybrid systems. Two projects deal with energy flow control techniques for passive systems.

ADVANCED SYSTEMS DEVELOPMENT - There are 27 advanced system projects. The emphasis of these projects is on the analysis and assessment of thermal and economic performance of systems under controlled experimental testing. The systems are operated under various control strategies and climatic conditions to determine optimal life-cycle benefits.

SYSTEMS ANALYSIS - There are five systems analysis projects including the development of models, design methods, and computer programs to simulate and predict the performance of active solar energy systems. A variety of system models are being validated against performance data obtained from solar systems integrated into buildings.

CONTROLS - There are 15 control projects including the development of novel solar controllers, analysis of control strategies, and analysis of interface problems of components functioning in systems and their effect on system performance. Two projects emphasize the impact of solar heating and cooling systems on the reduction of electric utility peak loads.

PROGRAM SUPPORT - The R&D program includes 24 program support projects. These projects are concerned with the technical support work of the DOE laboratories, workshops, and other program management support activities.

PROGRAM STATUS

Some of the most significant recent accomplishments in the DOE solar heating and cooling R&D program are as follows:

- The Compound Parabolic Concentrator developed by Argonne National Laboratory received an IR-100 design award from Industrial Research Magazine, and is being developed by several companies.
- The collector and storage test standards drafted by NBS were modified and adopted by ASHRAE.
- An 8000-square-foot array of the integrated steel roof collector developed by the Los Alamos Scientific Laboratory was installed on the National Security and Resources Study Center at LASL.
- The jet impingement air heating collector developed by Honeywell was incorporated in a HUD cycle three demonstration project.
- Construction was completed and operation initiated on two annual hot water storage systems.

- An integrated 3-ton absorption system was developed and installed.
- A 3-ton Rankine engine was developed and tested.
- The detailed design of a series of 3, 10, 25, and 75-ton integrated Rankine engines was completed.
- A comprehensive and flexible passive computer simulation analysis model was completed and is in use.
- Fourteen passive test rooms and 10 passively heated buildings were instrumented to facilitate collection of data on a variety of concepts.
- The installation and collection of data on advanced cooling systems using evacuated tubular collectors were completed.
- Comparison of air and liquid heating systems at Colorado State University showed that both systems produced approximately the same amount of usable thermal energy on an annual basis.
- Simplified solar design procedures (FCHART, SOLCOST) were expanded for use in more cities and configurations.
- An updated version of an hour-by-hour analyses computer program (TRNSYS) was released.
- Studies on the use of adaptive controls resulted in savings of up to 20% over conventional solar controls.

PROGRAM STRUCTURE

Under the current management structure of the R&D Branch, each program manager is responsible for one or more of the major program elements and for the projects in these elements. Technical review and support are provided to each program element by a DOE laboratory. Figure 4 illustrates this relationship.

The responsibilities of the support laboratories are as follows:

- Technical review, critique, and project management in assigned program element.
- Coordinate peer-review panels for unsolicited proposals.
- Prepare work statements for solicitations.
- Participate in the evaluation of solicited proposals.
- Provide technical support to program managers.
- Periodic preparation and review of material for the R&D program plan.

REPORT AVAILABILITY

Most of the technical reports listed for the projects described in this book are available through the U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830. Persons wishing to receive reports should request them by the title of the report, name of contractor, and contract number. In the event that a particular report is not available through TIC, a limited number of reports may be available directly from the Principal Investigator of the project.

FIGURE 1
PATHS TO SOLAR HEATING OF SERVICE HOT WATER

FIGURE 2
PATHS TO SOLAR SPACE HEATING

FIGURE 3 PATHS TO SOLAR SPACE COOLING

THIS FIGURE SHOWS SUPPORT LABORATORIES FOR THE MAJOR PROGRAM ELEMENTS. THE ABBREVIATIONS ARE AS FOLLOWS:

- AIPH - AGRICULTURAL AND INDUSTRIAL PROCESS HEAT
- ANL - ARGONNE NATIONAL LABORATORY
- BNL - BROOKHAVEN NATIONAL LABORATORY
- LASL - LOS ALAMOS SCIENTIFIC LABORATORY
- LBL - LAWRENCE BERKELEY LABORATORY
- LLL - LAWRENCE LIVERMORE LABORATORY

FIGURE 4
MANAGEMENT STRUCTURE FOR THE
RESEARCH AND DEVELOPMENT BRANCH

SECTION II

**SOLAR HEATING AND COOLING
RESEARCH AND DEVELOPMENT PROJECTS
SELECTED FOR NEGOTIATION
OR SUPPORTED IN FY 1977**

**SOLAR HEATING AND COOLING RESEARCH
AND DEVELOPMENT PROJECTS SELECTED FOR
NEGOTIATION OR SUPPORTED IN FY 1977**

1. COLLECTORS

INSTITUTION	TITLE	PAGE
Acurex Corporation	Low-Cost Solar Panel Development Program	1-1
Alcoa Laboratories	Development of Solar Wall Assembly	1-2
*Altas Corporation	Development of Cost Effective Techniques and Concepts for the Protection of Glazing Against Breakage Caused by Hail, Vandals or Thermal Stresses	1-3
*American Science & Engineering	Development of a Second-Generation Concentrating Tracking Solar Collector	1-4
*Ametek, Inc. Power Systems Group	Empirical Study of Solar Collector Breathing	1-5
Argonne National Laboratory Chemical Engineering Division	Development and Demonstration of Compound Parabolic Concentrators for Solar Heating and Cooling Applications	1-6
Battelle Memorial Institute	Low Temperature Liquid Heater, 70°-120°F	1-7
Battelle-Pacific Northwest Laboratory	Development of Improved Cover Plates for Solar Collectors	1-8
*Berry Solar Products	Commercial Selective Surfaces Applicable to Copper, Aluminum, and Stainless Steel, Their Cost Effective Improvement and Evaluation of Potential Durability in Solar Absorbers	1-9
University of California School of Engineering and Applied Science	Transparent Glass Honeycomb Structures for Energy Loss Control	1-10
University of California School of Engineering and Applied Science	Transpired Solar Air Heater	1-11
**Calmac Manufacturing Corporation	Further Development of a Single Glaze Plastic Tube Liquid Flat Plate Collector	1-12
**Calmac Manufacturing Corporation	Further Development of a Single Glaze Plastic Tube Liquid Flat Plate Collector	1-13
Center for Environment and Man	Viscosity Stabilized Solar Ponds, Phase II, Segment 1	1-14

*PRDA - Selected in Fiscal Year 1977 but not negotiated

**NASA/MSFC Contract

COLLECTORS (Cont.)

INSTITUTION	TITLE	PAGE
*Chamberlain Manufacturing Corporation	Development of 3X Concentrating Solar Collector	1-15
Corning Glass Company	Research on Evacuated Tubular Solar Collectors Utilizing a Heat Pipe	1-16
*DeSoto, Inc.	Solar Selective Absorber Coatings by Electrodeposition of Paint	1-17
*Dow Corning Corporation	Development of Improved Insulation Materials	1-18
*Dow Corning Corporation	Development of Superior Liquid Coolants	1-19
Drexel University	Double-Exposure Collector System	1-20
*EIC Corporation	Corrosion Protection of Solar-Collector Heat Exchangers with Electrochemically Deposited Films	1-21
*University of Florida	Vegetable Oils: A Superior Liquid Coolant	1-22
Georgia Institute of Technology College of Engineering	Development of a Solar Heat Supply System with Fixed Mirror Concentrators	1-23
Giner Corporation	Aluminum Corrosion Studies for Solar Heat Collectors	1-24
*Honeywell, Inc. Systems & Research Center	Selective Paint and Black Chrome Coatings Development	1-25
*Honeywell, Inc. Systems & Research Center	Low-Cost Solar Anti-Reflection Coatings	1-26
*Honeywell, Inc. Systems & Research Center	Selective IR Reflective Coatings Development	1-27
Honeywell, Inc. Systems & Research Center	Low Cost Solar Air Heaters	1-28
Honeywell, Inc. Systems & Research Center	Optimization of Coating for Flat Plate Solar Collectors, Phase II	1-29
Honeywell, Inc. Energy Resources Center	Dual Curvature Acoustical Damped Concentrating Collector	1-30
**Houston Chemical Corporation	Testing of Aqueous Fluids for Use in Collectors of Solar Energy	1-31

*PRDA - Selected in Fiscal Year 1977 but not negotiated

**NASA/MSFC Contract

COLLECTORS (Cont.)

INSTITUTION	TITLE	PAGE
University of Houston Department of Mechanical Engineering	Analysis, Design, Fabrication and Testing of Moderately Concentrating Solar Energy Collectors, Phase II	1-32
*Hughes Aircraft Company Aerospace Group	Non-Glass Glazings and Surface Coatings	1-33
IIT Research Institute	Exposure Testing and Evaluation of Solar Collector Materials	1-34
Lawrence Livermore Laboratory	Inflated Cylindrical Concentrating Solar Collector	1-35
Lehigh University Department of Geological Sciences	Low Cost Solar Collector of Packed Bed Design	1-36
**Life Sciences	Further Development of an All Aluminum Double Glaze Air Collector	1-37
Lockheed Missiles & Space Company Palo Alto Laboratory	Optimization of Thin Film Transparent Plastic Honeycomb Covered Flat-Plate Solar Collector	1-38
Los Alamos Scientific Laboratory	Research on Integrated Solar Collector Roof Structures, Phase II	1-39
Los Alamos Scientific Laboratory	Solar Collector and Materials Research	1-40
Massachusetts Institute of Technology Department of Mechanical Engineering	Development and Evaluation of Thermic Diode Solar Panels for Building Heating and Cooling, Phase II	1-41
MEGA Engineering	Low-Cost High Temperature Cement-Bonded Collector	1-42
Mississippi State University	Addition of Solar Air Heaters to Pre- Engineered Metal Buildings	1-43
*Mithra Corporation	Optimized Concentrating/Passive Track- ing Solar Collector	1-44
Monsanto Research Corporation	Medium Temperature Air Heaters Based on Durable Transparent Films	1-45
*Monsanto Research Corporation	Low-Cost Mirror Concentrators Based on Double-Walled, Metallized, Tubular Films	1-46
National Aeronautics and Space Administration (Jet Propulsion Laboratory)	A Fixed Tilt Solar Collector Employing Reversible Vee-Trough Reflectors and Vacuum Tube Receivers	1-47

*PRDA - Selected in Fiscal Year 1977 but not negotiated

**NASA/MSFC Contract

COLLECTORS (Cont.)

INSTITUTION	TITLE	PAGE
**Northrup, Inc.	Further Development of a Concentrating Collector Using Fresnel Lens	1-50
Ohio State University Research Foundation	Salt Gradient Solar Pond Development	1-51
*Owen & Mayes Solar of Virginia	"Winston" Parabolic Compound Collector Development	1-52
Owens-Illinois, Inc.	Draining of the SUNPAK TM Evacuated Tube Collector	1-53
Owens-Illinois, Inc.	Evaluation of an All-Glass, Evacuated, Tubular, Non-Focusing, Non-Tracking, Air-Heating, Solar Collector Array	1-54
*Owens-Illinois, Inc.	Evaluation of SUNPAK TM Tube Vacuum Durability	1-55
*Owens-Illinois, Inc.	Improved Collector Efficiency Through the Use of Anti-Reflective Coatings	1-56
*Owens-Illinois, Inc.	Improvement of Solar Selective Coating Stability	1-57
**Owens-Illinois, Inc.	Further Development of an Air/Liquid Collector with Vacuum Insulation	1-58
Payne, Inc.	A Proposal to Develop Very Low Cost, Non-Concentrating Collectors	1-59
*Pennsylvania State University Materials Research Laboratory	Black Germanium Selective Absorber Surfaces	1-60
Polysat, Inc.	Development of a Freeze-Tolerant Solar Water Heater Using Cross-Linked Polyethylene	1-61
*Products Research & Chemical Corporation	Development of 400°F Resistant Sealants for Flat Plate Solar Collector Construction and Installation	1-62
*RCA Corporation	High Temperature Evacuated Tubular Collector	1-63
Rensselaer Polytechnical Institute	Development of a Focusing Solar Collector Energy Conversion	1-64
*Research Triangle Institute	Non-Glass Glazings	1-65
National Bureau of Standards	Development of Methods for Evaluation and Test Procedures for Solar Collectors and Thermal Storage Devices, Phase III	1-48
University of New Mexico Department of Physics & Astronomy	A Demonstration Salt Gradient Solar Pond	1-49

*PRDA - Selected in Fiscal Year 1977 but not negotiated

**NASA/MSFC Contract

COLLECTORS (Cont.)

INSTITUTION	TITLE	PAGE
*Solar (International Harvester Group)	Development of Polyimide Materials for Use in Solar Energy Systems	1-66
Solar Energy Technology, Inc.	Imaging Collapsing Concentrators	1-67
Solaron Corporation	Improvement of Solar Air Heaters	1-68
*Solaron Corporation	Development of a High Performance Air Collector Through Use of an Evac- uated Tube Cover System	1-69
Solation Products, Inc.	Research and Development on Non- Concentrating Collectors for Solar Heating and Cooling Applications	1-70
Sun Systems	Double Absorber Plate	1-71
*Swedlow, Inc.	Cast Acrylic - Fresnel Lens	1-72
*TELIC Corporation	Development of Selective Surfaces	1-73
Texas A&M University Texas Engineering Experiment Station	Structural Integrity of Solar Collectors	1-74
Thermacore, Inc.	Cost-Effective Solar Collectors Using Heat Pipes	1-75
Total Environmental Action, Inc.	Development of a Site Fabricated, Build- ing Integrated Air Collector	1-76
*Tufts University Department of Electrical Engineering	Studies for Predictably Modifying the Optical Constants of Doped Indium Oxide Films for Solar Energy Appli- cations	1-77
University of Virginia School of Engineering	Engineering Analysis and Testing of Water Trickle Solar Collector	1-78
University of Waterloo Department of Mechanical Engineering	Methods for Reducing Heat Losses from Flat-Plate Solar Collectors, Phase III	1-79
University of West Virginia	Grooved Foamglas Solar Air Heater	1-80
Westinghouse Electric	Develop and Test Evacuated Tube	1-81
O. G. Williams and R. L. Skaggs	Solar Parabolic Trough Forming	1-82
*University of Wisconsin at Madison	Polymer Surface Coatings for Down- conversion of UV Radiation and Inhibition	1-83
University of Wisconsin Solar Energy Laboratory	Interferometric Study of Natural Convection Characteristics of Flat- Plate and Vee-Corrugated Solar Collectors	1-84

*PRDA - Selected in Fiscal Year 1977 but not negotiated

2. THERMAL STORAGE/HEAT EXCHANGERS

INSTITUTION	TITLE	PAGE
University of Alabama in Huntsville School of Science and Engineering	Computer Modeling of Thermal Stratification in Water Tanks	2-1
*Altas Corporation	The Development of a Gas Backup Heating Water Tank Properly Integrated with Solar Heated Domestic Water Storage Tanks	2-2
Altas Corporation	Investigation of Methods to Transfer Heat from Solar Liquid-Heating Collectors to Heat Storage Tanks	2-3
Argonne National Laboratory	Develop and Apply Theoretical Model of Flow Stratification in Solar Systems	2-4
Argonne National Laboratory	A Handbook and Guide for Thermal Energy Storage Applications in Solar Heating and Cooling Systems	2-5
**Arttech Corporation	Development of a Thermal Energy Storage Using Phase Change Salts	2-6
Boeing Computer Services, Inc. Energy Technology Applications Division	Developing and Upgrading of Solar System Thermal Energy Storage Simulation Models	2-7
*California State University	Series-Parallel Solar Augmented Rock Bed Heat Pump	2-8
*Calmac Manufacturing Company	Salt Hydrate Thermal Energy Storage System for Space Heating and Air Conditioning	2-9
Colorado State University Solar Energy Applications Laboratory	Direct Contact Liquid-Liquid Heat Exchangers for Solar Heated and Cooled Buildings	2-10
*University of Delaware Department of Mechanical and Aerospace Engineering	Development of Intermediate Temperature Thermal Energy Storage Systems	2-11
Dynatech R/D Company	Rock Bed Storage for Cooling	2-12
EIC Corporation	Analysis of Advanced Thermal Energy Storage Subsystems for Solar Heating and Cooling	2-13
The Franklin Institute Research Laboratory	Evaluation of Self-Driven Heat Transport Schemes	2-14
*General Electric Company Corporate Research and Development	Prototype Design and Testing of the Rolling Cylinder Thermal Energy Storage System	2-15
General Electric Company Valley Forge Space Center	Two-Component Thermal Material Study	2-16
*Independent Living, Inc.	Development of an Improved Water Tank for Thermal Energy Storage	2-17
*PRDA - Selected in Fiscal Year 1977 but not negotiated		
**NASA/MSFC Contract		

THERMAL STORAGE/HEAT EXCHANGERS (Cont.)

INSTITUTION	TITLE	PAGE
*Martin Marietta Corporation	Solar Cooling Using Paired Ammoniated Salt Reactions	2-18
University of Nebraska Engineering Research Center	Membrane-Lined Foundation Systems for Liquid Thermal Energy Storage	2-19
North Carolina State University Department of Mechanical and Aerospace Engineering	Research on Solar Energy Storage Sub-systems Utilizing the Latent Heat of Phase Change of Certain Organic Materials, Phase II	2-20
Rockwell International	Hybrid Thermal Storage with Water	2-21
**Sigma Research, Inc.	Development of a Thermosyphon Heat Exchanger for Residential Solar Heating Systems	2-22
*Suntek Research Associates	Engineering Design for Thermocrete Central Storage Units for Low Temperature Solar Application	2-23
University of Toronto Mechanical Engineering	Solar Space Heating Systems Using Annual Heat Storage	2-24
University of Virginia Department of Mechanical Engineering	Annual Collection and Storage of Solar-Heated Water for Heating of Buildings	2-25
*Westinghouse Electric Advanced Energy Systems Division	Lightweight Concrete Materials and Structural Systems for Water Tanks for Thermal Energy Storage	2-26
*Zia Associates, Inc.	Rock Bed Storage with Heat Pump	2-27

*PRDA - Selected in Fiscal Year 1977 but not negotiated

**NASA/MSFC Contract

3. HEAT PUMPS

INSTITUTION	TITLE	PAGE
Battelle Columbus Laboratories	A Solar Powered Heat Pump Utilizing Pivoting-Tip Vane Rotating Equipment, Phase II	3-1
***General Electric Company Corporate Research and Development	Solar Assisted Heat Pump (SAHP) Develop- ment	3-2
***Lennox Industries, Inc.	Development of Marketable Solar Assisted Heat Pump	3-3
***Northrup, Inc.	Development of Solar Assisted Heat Pumps	3-4
The Singer Corporate Research and Development Laboratory	Analytic Selection of Marketable Systems	3-5
Syracuse University College of Engineering	Commercial Building Unitary Heat Pump System with Solar Heating, Phase II	3-6

***RFP - Selected in Fiscal Year 1977 but not negotiated

4. COOLING

INSTITUTION	TITLE	PAGE
AiResearch Manufacturing Company of California	Development of Solar Desiccant Air Conditioner	4-1
**AiResearch Manufacturing Company of California	Design and Development of a Single Family, Multi-Family, Light Commercial, and Commercial Size Solar Heating and Cooling Systems	4-2
ARKLA Industries, Inc.	Engineering Design, Construction and Testing of a Water Absorption Cooling Unit Optimized for Use with a Solar Collector Heat Source, Phase II	4-3
ARKLA Industries, Inc.	Unitary Solar Heating/Cooling System Package Development	4-4
Biphase Engines, Inc.	Two-Phase Turbine Engine for Solar Space Cooling	4-5
Carrier Corporation Energy Systems Division	Development of a High-Temperature Solar-Powered Water Chiller for Use in a Solar Heating and Cooling System, Phase I	4-6
Carrier Corporation Energy Systems Division	Development of a Single Family Absorption Chiller for Use in a Solar Heating and Cooling System	4-7
Center for the Environment and Man, Inc.	Studies of Silica Gel Absorption for the Dehumidification and Air Conditioning of Buildings with Solar Energy	4-8
EIC Corporation	Design, Construction and Testing of a Novel Solar Air Conditioner Using a Solid-Phase Absorbent	4-9
Energy Technology, Inc.	Demonstration of a Solar Steam Turbine Engine for Heating and Cooling	4-10
**General Electric Company	Design and Development of Single Family and Commercial Size Solar Heating, Cooling and Hot Water Systems	4-11
Hittman Associates, Inc.	Assessment of Solar Powered Cooling of Buildings	4-12
**Honeywell, Inc.	Design and Development of Single Family, Multi-Family, Light Commercial and Commercial Size Solar Heating, Cooling, and Hot Water Systems	4-13
Illinois Institute of Technology	Development of a Solar Desiccant Dehumidifier	4-14
Institute of Gas Technology	Testing of Solar-MEC Systems Installations	4-15
Institute of Gas Technology	Development of New Fluid for Solar-Absorption Cooling	4-16

COOLING (Cont.)

INSTITUTION	TITLE	PAGE
Lawrence Berkeley Laboratory	Development of Solar-Driven Absorption Air-Conditioners and Heat Pumps	4-17
Lawrence Berkeley Laboratory	Nitinol Engine Development	4-18
Los Alamos Scientific Laboratory	Evaluation of a Solar Rankine-Cycle Cooling Unit in the National Security and Resources Study Center at LASL	4-19
University of Maryland Mechanical Engineering Department	Solar Cooling Component Modeling and Optimization	4-20
University of Pennsylvania	Chiller Driven by a Solar Steam Powered Rankine Engine (SSPRE)	4-21
Scientific-Atlanta, Inc.	Development of a Solar Driven Free Piston Dual Loop Heat Pump	4-22
**Solaron Corporation	Development of an Integrated Single Family Size Solar Heating, Cooling, and Hot Water System Using Air Collectors and a Heat Pump for Heating and the Heat Pump with Off-Peak Storage for Cooling	4-23
Southern Research Institute	Analysis of Advanced Conceptual Designs for Single-Family-Sized Absorption Chillers	4-24
United Technologies Research Center	Solar Powered Turbocompressor (Rankine Cycle) Air Conditioning System	4-25
United Technologies Research Center	Design, Develop and Test a Multi-Family Residential Size Prototype Solar-Powered Turbocompressor Heat Pump System	4-26

**NASA/MSFC Contract

5. PASSIVE SYSTEMS

INSTITUTION	TITLE	PAGE
Ames Design Collaborative	Experimental and Theoretical Study of the Thermal Performance of a Hybrid Solar Residence for the Farm of Today and Tomorrow at Living History Farms, Urbandale, Iowa	5-1
Architectural Alliance, Inc.	Solar Energy Using a Hybrid Solar System	5-2
Ayres Associates	Rehabilitation and Testing of Skytherm Atascadero House	5-3
Banwell, White and Arnold, Inc.	White Mountain School Faculty Housing and Dormitory	5-4
Battelle Memorial Institute Columbus Laboratories	Evaluation of Heat Pipe Applications for Passive System	5-5
The Regents of the University of California	Impact of Controls on Back-up Energy Consumption in Passive Solar Heated and Cooled Residences	5-6
University of Delaware Institute of Energy Conversion	The Application of Phase Change Materials in Passive Solar Systems	5-7
Earth Integral of Living Systems	Suncatcher Monitoring Project	5-8
Eikonix Corporation	Passive Solar Collector/Connector Incorporating Energy Storage	5-9
Energy Engineering Group	Experimental Investigation of the Trombe Wall Passive Solar Energy System	5-10
Foster-Miller Associates	Development of a Passive Heating and Cooling System Using a Pumped Heat Pipe	5-11
General Electric Company Advanced Energy Programs, Space Division	Non-Concentrating Collectors for Medium Temperature Air Heaters	5-12
Harold R. Hay	Skytherm Design Study	5-13
Kalwell Corporation	Low Cost Modular Passive Solar Furnace System Development	5-14
Lawrence Berkeley Laboratory	Radiative and Passive Cooling	5-15
Living Systems	An Integrated Passive Heating and Cooling System	5-16
Londe-Parker-Michels, Inc.	Retrofit of an Existing Masonary Home for Solar Passive Space Heating: A Demonstration and an Experiment	5-17

PASSIVE SYSTEMS (Cont.)

INSTITUTION	TITLE	PAGE
Los Alamos Scientific Laboratory	Research on Passive Solar Heating of Buildings	5-18
Massachusetts Institute of Technology Department of Mechanical Engineering	Performance Characteristics of Thermic Diode Solar Panels	5-19
Massachusetts Institute of Technology Department of Architecture	Design Methodologies for Energy Conservation and Passive Heating of Buildings Utilizing Improved Building Components	5-20
Miami University Department of Architecture and Institute of Environmental Sciences	Analysis of Performance of Passive Solar Heated Patoka Nature Center	5-21
New Mexico State University	Performance Evaluation of a Passively Heated and Cooled House	5-22
Princeton Energy Group	Passive Water Wall and Focusing Roof Aperture Solar Heating Building Experiment	5-23
PRC Energy Analysis Company AIA Research Corporation	National Program Plan for Passive Heating and Cooling	5-24
Rensselaer Polytechnic Institute Center for Architectural Research	Evaluation of Energy Flow Control Techniques for Passive Heating and Cooling Systems	5-25
Norman B. Saunders	Evaluation of Costs and Performance of Four Solar Heating Building Experiments	5-26
Solar Room Company, Inc.	Performance Analysis of a Double Polyethylene Inflated Hybrid Solar Space Heating System	5-27
Trinity University	Regional Assessment of Cooling Rates Resulting from Convection, Nocturnal Radiation and Evaporation	5-28
Ueland & Junker	Solar Atrium: A Hybrid Solar Heating and Cooling System	5-29
Francis Wessling	Passive Retrofit Research of an Existing Dwelling	5-30
Ying Manufacturing Company	Passive Nocturnal Cooling Building Research	5-31

6. ADVANCED SYSTEMS DEVELOPMENT

INSTITUTION	TITLE	PAGE
Colorado State University Solar Energy Applications Laboratory	Evaluation of a Residential Solar Air Heating and Cooling System	6-1
Colorado State University Solar Energy Applications Laboratory	A Study of Cost Effective Ways for Improving the Fabrication and Installation of Solar Energy Heating and Cooling Systems for Residences	6-2
Colorado State University Solar Energy Applications Laboratory	Evaluation of Maintenance Cost and Mechanical Improvement of the Solar Equipment in Denver House	6-3
Colorado State University Solar Energy Applications Laboratory	Evaluation of the Corning and Philips High Performance Collectors in a Residential Solar Heating and Cooling System	6-4
Colorado State University Solar Energy Applications Laboratory	Residential Solar Heating and Cooling Using Evacuated Tube Solar Collector	6-5
**Colt, Inc.	Development of an Integrated Commercial or Single Family Size Solar Heating and Hot Water System Using Paraffinic Oil in the Solar Loop	6-6
**Contemporary Systems, Inc.	Development of an Integrated Single Family Solar Heating and Hot Water System Using Air Collectors Integral to Building Structures, Air Mover, Rock Storage, Air/Water, and Heat Exchanger	6-7
University of Delaware	Performance of Advanced Systems and Subsystems Experiments on University of Delaware Solar One	6-8
**Elcam, Inc.	Development of an Integrated Single Family Solar Hot Water "Flow Through" System Using Two Storage Tanks with a "Cascade" Control System and a Collector Dump Valve for Freeze Protection	6-9
**Fern Engineering, Inc.	Development of an Integrated Single Family Solar Heating and Hot Water System Using Air Collectors, Air/Water Heat Exchangers, Water Tank Storage, and Integral Air Handler.	6-10
General Electric Company	Exploration, Design Construction and Evaluation of Solar Energy Systems for the Heating and Cooling of Mobile Homes - Phases I and II	6-11
General Electric Company	Design and Fabrication of an Integral Low Cost High Performance Solar Heater	6-12
General Electric Company	Application Study of Solar Heating Systems Using a Solair Heater	6-13
General Electric Company	Solair Heater Test and Evaluation Program	6-14

**NASA/MSFC Contract

ADVANCED SYSTEMS DEVELOPMENT (CONT.)

INSTITUTION	TITLE	PAGE
George Washington University	Evaluation of Solar Heating and Cooling System Using a Trickle Collector and Combined Rockbed Storage	6-15
Gershon Meckler Assoc.	Parameter Grouping and Regionalizing to Simplify Solar Life Cycle Cost Models for Application to Solar Heating and Cooling of Buildings	6-16
Kaman Science Corporation	The Phoenix House, City of Colorado Springs Solar Assisted Heat Pumps	6-17
Lawrence Livermore Laboratory	Study of Industrial Process Steam Systems	6-18
Los Alamos Scientific Laboratory	Application of Solar Energy to Mobile/ Modular Home Heating	6-19
Los Alamos Scientific Laboratory	National Security and Resources Study Center Instrumentation	6-20
National Bureau of Standards	Water Heating Performance Data	6-21
University of Pennsylvania	Performance Analysis and Optimization of the University of Pennsylvania Retrofitted Solar Heated Philadelphia Row Home	6-22
Pennsylvania State University	Evaluation of the Solar Building, Albuquerque, NM	6-23
**Solar Engineering and Equipment Company	Development of an Integrated Single Family or Light Commercial Solar Assisted Heating System Using Air Collectors Made from Prefabricated Steel Building Materials	6-24
**Solar Engineering and Manufacturing Company	Development of an Integrated Single Family Solar Hot Water System Using One Storage Tank with a Variable Speed Pump Control in the Collector Fluid Loop	6-25
Wormser Scientific Corporation	Evaluation of Solar Energy Heating and Cooling System Employing Pyramidal Optics Solar Collection System	6-26
**Wormser Scientific Corporation	Development of an Integrated Multi-Family Solar Heating and Hot Water System Using Liquid Collectors with a Pyramidal Optics Concentrator (Roof Lite Glazing, Reflective Panels on Roof Structure and Copper Rollbond Absorbers at Focal Plane in Attic)	6-27
**NASA/MSFC Contract		

7. SYSTEMS ANALYSIS

INSTITUTION	TITLE	PAGE
Los Alamos Scientific Laboratory	Solar Energy System Optimization Study for the Los Alamos National Security and Resources Study Center	7-1
Martin Marietta Corporation	Solar Heating and Cooling Computer Analysis - A Simplified Sizing Design Method for Non-Engineers	7-2
Sandia Laboratories	System Studies for Heating and Cooling	7-3
Solar Environmental Engineering, Inc.	Model Validation Studies of Solar Systems	7-4
University of Wisconsin	Computer Modeling and Simulation of Solar Heating and Cooling Systems	7-5

8. CONTROLS

INSTITUTION	TITLE	PAGE
Colorado State University Solar Engineering Applications Laboratory	Optimal Temperature Control in a Solar House	8-1
Drexel University	Evaluation of the Performance of a Proportional Flow Control System in a Building	8-2
The Franklin Institute Research Laboratories	Novel Control Strategies for Solar Assisted Systems	8-3
Georgia Institute of Technology School of Electrical Engineering	Management of Electrical Backup Demand in Solar Heating and Cooling Applications	8-4
Honeywell, Inc. Energy Resources Center	Cost Effective Control Systems for Solar Heating and Cooling Applications	8-5
Honeywell, Inc. Energy Resources Center	Solar Energy Management System (SEMS) Controller Design and Development	8-6
Lawrence Berkeley Laboratory	Development of Electronic Controller and Evaluation of Control Algorithms for Solar Heating and Cooling Systems	8-7
Los Alamos Scientific Laboratory	Adaptive Control for Energy Conservation	8-8
Rho Sigma, Inc.	Assessment of Need for New Controllers	8-9
**Rho Sigma, Inc.	Development of a Programmable Microprocessor for Solar Heating and Cooling Systems	8-10
The Singer Research and Development Corporation	Two-Stage Approach to Effective Controllers via Adaptive Optimization	8-11
Solar Control Corporation	Development of a Novel Controller	8-12
**Solar Control Corporation	Development of Modular Electronic Controller for Solar Heating Systems	8-13
**Sunkeeper Control Corp.	Development of a Programmable Microprocessor/Hydronics Package for Solar Heating and Cooling Systems	8-14
Zia Associates	Assessment of Need for New Controllers	8-15
***NASA/MSFC Contract		

9. SUPPORT PROJECTS

INSTITUTION	TITLE	PAGE
Altas Corporation	Workshop on the Use of Solar Energy for Cooling Buildings	9-1
Argonne National Laboratory	Program Support for the Research and Development Branch - Thermal Energy Storage	9-2
ASHRAE	R&D Plan Review	9-3
Boston University	Conference on the Control of Solar Energy Systems for the Heating and Cooling of Buildings	9-4
Brookhaven National Laboratory	Program Support for the Research & Development Branch - Solar Heat Pumps & Cooling	9-5
University of Colorado Center for Management and Technical Programs	Workshop on the Use of Solar Energy for Cooling Buildings	9-6
University of Colorado	Solar Energy Training Seminars for Jamaica, W.I.	9-7
Energy Systems International	Retrofit Program Planning for Solar Heating and Cooling of Buildings	9-8
Florida Solar Energy Center	Solar Energy Flat Plate Collector Conferences/Exhibit/Workshop	9-9
Georgia Institute of Technology	Workshop on Concentrating Solar Collectors	9-10
Institute of Public Administration	Product Planning Analysis for Solar Heating and Cooling Branch	9-11
Lawrence Berkeley Laboratory	Program Support for the Research and Development Branch - Controls and Non-Engineering Aspects	9-12
Lawrence Livermore Laboratory	Program Support Agricultural/Industrial Systems	9-13
Los Alamos Scientific Laboratory	Assistance in Developing Solar Heating and Cooling R&D Plan	9-14
Los Alamos Scientific Laboratory	Program Support for the Research and Development Branch - Collectors	9-15
Los Alamos Scientific Laboratory	Workshop on Passive Solar Heating and Cooling of Buildings	9-16

SUPPORT PROJECTS (Cont.)

INSTITUTION	TITLE	PAGE
Los Alamos Scientific Laboratory	Program Support for the Research and Development Branch - Passive Systems	9-17
University of Maryland Department of Mechanical Engineering	Assist the NATO Committee on the Challenges of Modern Society (CCMS) Solar Heating and Cooling of Building Projects	9-18
National Bureau of Standards	Assist Division of Solar Energy in Planning for IEA Cooperative Projects	9-19
PRC Energy Analysis Company	Solar System Engineering and Management Support	9-20
Sandia Laboratories	Program Support for the Research and Development Branch - Systems	9-21
SERI	Solar Energy Research and Program Support	9-22
Systems Consultants, Inc.	Support of Solar Application of the Project Management System	9-23
University of Utah Department of Mechanical Engineering	Conference on Monitoring and Evaluation of Solar Heating and Cooling Systems	9-24

SECTION III

PROJECT SUMMARY SHEETS FOR R&D PROJECTS

1. COLLECTORS

PROJECT DESCRIPTION

The objective of this project is to develop a low-cost nonconcentrating solar collector fabricated from polymer and elastomer films by high-speed printing, laminating and extruding processes.

The Low-Cost Solar Panel concept will be further developed from its present preliminary design stage through detailed design, fabrication, testing and evaluation. A detailed design analysis and a three-stage materials and process development will be performed. In the first stage a number of materials and processes using hand fabricated subscale panels will be evaluated. In the second stage prototypes of half-scale panels will be produced. In the third-stage pilot production of full-scale panels will begin. Standard collector performance testing will be conducted concurrently with materials and process selection. The results of this testing will be combined with a detailed production cost analysis to establish the new life-cycle cost of the Low-Cost Solar Panels.

Acurex will also examine potential applications of this collector and system requirements specific to it. The final product of this development program will be a sample production run of the panel with full documentation of performance, longevity, application considerations and life-cycle costs. On the basis of a 10-year life-cycle cost analysis, it is estimated that this collector will deliver thermal energy at a new cost of about \$2.50/10⁶ Btu.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Low-Cost Solar Panel
Development Program

INSTITUTION:

Acurex Corporation
Aerotherm Division
485 Clyde Avenue
Mountain View, CA 94042

PRINCIPAL INVESTIGATOR:

Robert C. Mawhinney

CONTRACT NUMBER: EG-77-C-04-4121

STARTING DATE: 09/16/77

DURATION: 14 months

AMOUNT: \$138,032

PROJECT DESCRIPTION

The objective of this project is to develop a low temperature, nonconcentrating solar air heater which can be installed as an integral part of a structure. This heater is to be used in either an active or a passive system for comfort air heating. It will also provide low temperature assistance for heat pumps or hot water heating systems. The key criterion will be to develop a collector with an efficiency and cost that will ensure a payback period of less than 10 years.

The project consists of four main tasks:

- Task 1—SYSTEM MODELING: Parametric analysis of the thermal and structural requirements of the building and solar collector with the final configuration dictated by optimal cost effectiveness.
- Task 2—LABORATORY PROTOTYPE: Designing, fabricating, constructing, testing, evaluating and analyzing a small-scale system.
- Task 3—FULL-SCALE PROTOTYPE: Modifying the laboratory prototype design, fabricating, constructing, testing, evaluating and analyzing a full-scale system mock-up.
- Task 4—PROJECT WRAP-UP: Finalizing design details, compiling test data, analyzing cost and writing final report.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Solar Wall Assembly

INSTITUTION:

Alcoa Laboratories
Alcoa Center, PA 15069

PRINCIPAL INVESTIGATOR:

Joseph N. Garcia

CONTRACT NUMBER: EG -77-C-04-4132

STARTING DATE: 09/20/77

DURATION: 12 months

AMOUNT: \$135,890

PROJECT DESCRIPTION

The objective of this project is to develop protection devices and design concepts for the glazing of domestic flat-plate collectors. These devices involve the use of either special glass or plastic covers, or mesh screens mounted above the glazing. Both of these alternatives and their mounting structures will be studied and optimized. The objective will be to develop a reliable, long-lived protection device at the lowest possible total cost.

Incidence of hail will also be studied to determine the areas where protection is necessary. Tests will be performed to determine the damage threshold of different hail sizes. Ice masses will be used to simulate hail stones by impelling them at the speed they would attain in free fall. These tests will be needed for developing the hail protection devices and for determining the geographic distribution of hail which is serious enough to require protective devices.

This work is divided into three main tasks:

Task 1—Hail and vandal danger definition.

Task 2—Design and optimization.

Task 3—Testing.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Cost Effective Techniques and Concepts for the Protection of Glazing Against Breakage Caused by Hail, Vandals, or Thermal Stresses

INSTITUTION:

Altas Corporation
500 Chestnut Street
Santa Cruz, CA 95060

PRINCIPAL INVESTIGATOR:

Francis de Winter

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$60,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to develop a concentrating solar energy collector with emphasis on improving performance and reducing production costs. The collector is a second-generation system developed using the data and experience gained from the development of three previous solar collectors.

The project is concerned with the design, analysis and fabrication of this concentrating collector. Improved thermal performance is achieved by a combination of theoretical and experimental methods. Predictions and data analysis will be used to identify those characteristics which influence reliability and maintainability of the collector. Individual collector components and the collector system will be evaluated specifically to incorporate designs and fabrication techniques which yield low-cost units in production quantities.

The end result will be a concentrating solar collector system having improved performance. Data which define mass-production techniques, unit costs as a function of market parameters, factors which influence reliability and collector maintenance considerations will also be produced.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a Second-Generation
Concentrating Tracking Solar Collector

INSTITUTION:

American Science & Engineering
955 Massachusetts Avenue
Cambridge, MA 02139

PRINCIPAL INVESTIGATOR:

Roy Miller

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 18 months

AMOUNT: 284,000 (Requested)

PROJECT DESCRIPTION

The objective of this 18 month study is to determine empirically the breathing characteristics of solar collectors as a function of design characteristics.

The project will consist of two phases. Phase I will involve the exposure of several solar collectors, each using different breathing techniques, to various ambient conditions. Measurements of humidity, air flow rate, etc., will be made. Phase II will involve accelerated cycling of desiccant tubes. Measurements will be made to determine effectiveness, regenerative-ness, etc., for the purpose of better understanding desiccant design as applied to solar collectors. The overall goal is to be able to predict more accurately breathing characteristics and humidity levels in solar collectors using different breathing techniques. This knowledge will assist design engineers in breathing design and material selection to produce economically optimized solar collectors.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Empirical Study of Solar Collector Breathing

INSTITUTION:

Ametek, Inc.
Power Systems Group
One Spring Avenue
Hatfield, PA 19440

PRINCIPAL INVESTIGATOR:

Maurice Darwish

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 18 months

AMOUNT: \$69,000 (Requested)

PROJECT DESCRIPTION

The objective of this project is the development of an improved collector system for heating and cooling buildings. To reach this objective, the project is building from the basic existing technology and expanding those development areas that are appropriate for house heating and cooling.

The project is divided into four major portions that are strongly interrelated. They are as follows: 1) basic collector and system design studies specifically for heating and cooling applications, 2) collector testing, 3) engineering development of improved low-cost collectors suitable for use with advanced absorption cycle air-conditioning systems, and 4) fabrication development and procurement contracts.

The whole effort is designed to encourage rapid industrial development with subsequent commercialization at the earliest possible date.

IMPORTANT REPORTS OR PUBLICATIONS

- Allen, J., et al., "Development and Demonstration of Compound Parabolic Concentrators for Solar Thermal Power Generation and Heating and Cooling Applications," ANL-76-71, Progress Report for the Period July - December 1975.
- Colee, R., et al., "Performance and Testing of a Stationary Concentrating Collector," presented at the Concentrating Solar Collector Conference Exhibit/Workshop, Atlanta, Georgia, September 1977.
- General Electric Company, "Analysis of Design Changes Necessary to Adapt Receiver to Compound Parabolic Reflector - Final Report," ANL-K77-3805-1, September 13, 1977.
- Reed, K. A., "CPC Thermal Collector Test Plan," presented at the Concentrating Solar Collector Conference Exhibit/Workshop, Atlanta, Georgia, September 1977.
- Schertz, W. W., et al., "Status Report for Non-imaging Collectors (Compound Parabolic Concentrators)," ANL-SOL-77-01, Report for the Period July 1976 - January 1977.

PROJECT TITLE:

Development and Demonstration of
Compound Parabolic Concentrators
for Solar Heating and Cooling
Applications

INSTITUTION:

Argonne National Laboratory
Chemical Engineering Division
9700 South Cass Avenue
Argonne, IL 60439

PRINCIPAL INVESTIGATOR:

William Schertz

CONTRACT NUMBER: W-7409-ENG-38

STARTING DATE: 11/01/75

DURATION: Continuing

AMOUNT: \$250,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to develop a highly efficient, cost effective, and reliable low temperature, nonconcentrating, liquid-heating collector to be used as a thermal energy source for heat pumps or other low temperature applications. The system incorporates a "black-liquid" collector in which radiation is absorbed directly by the heat transfer medium. This type of collector has the potential of significantly lower costs than a conventional flat-plate collector, while offering comparable performance in the temperature range suitable for heat pump operation.

To initiate the project, the most promising liquids and transparent cover materials will be selected. A small test cell will be constructed to test the materials selected by the survey; the best one or two liquids and covers will be chosen for full-scale testing. An extensive system analysis (technical and economic) will be conducted for final optimization of a system design concept. One or more full-scale test models of the finalized design concepts will be built and extensively tested. Data from preliminary and full-scale testing will be used to validate the computer models. Performance data collected from all analyses and tests will be analyzed and presented in a final report.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Low Temperature Liquid Heater, 70°-120°F

INSTITUTION:

Battelle Memorial Institute
Columbus Laboratories
505 King Avenue
Columbus, OH 43215

PRINCIPAL INVESTIGATOR:

D. Karl Landstrom

CONTRACT NUMBER: EG-77-C-04-4097

STARTING DATE: 09/12/77

DURATION: 13 months

AMOUNT: \$122,622

PROJECT DESCRIPTION

One disadvantage of using thin sheets of reinforced plastics or plastics films as cover plate materials is their lack of structural rigidity, necessitating the need for some supporting structure. A small internal program at PNL was conducted to determine the feasibility of using commercial honeycomb as a structural support for plastics. These studies showed that honeycomb can provide structural support for thin plastics skins (film or RP sheet) including 4 mil PVF (Tedlar), thus making it possible to use plastics in large sheets. A preliminary analysis indicated that a plastic/honeycomb cover plate can be fabricated at lower cost than a double pane, 1/8 inch glass cover plate.

The properties of commercially available honeycomb will be evaluated to determine which materials and sizes will provide the necessary parameters for structural support for plastic skins. Adhesives and techniques will be developed for bonding plastic skins to honeycomb.

Studies will be performed to determine the effects of thermal and physical stresses on the bond between the honeycomb and the skins. The strength characteristics of the cover plate will also be evaluated. The effectiveness of reduced pressure within the cells to improve the thermal insulation of the cover plate will be determined.

Prototype cover plates will be fabricated and used in conjunction with commercially available flat plate solar collectors as a means of comparing the efficiency of the plastics/honeycomb cover plate with a double pane glass cover plate.

A study will be made to determine the economic incentives for using a honeycomb/plastics cover plate, procedures will be developed for commercial production of cover plates, and the technology will be transferred to industry.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of Improved Cover
Plates for Solar Collectors

INSTITUTION:

Battelle-Pacific Northwest
Laboratory
Battelle Blvd.
Richland, WA 99352

PRINCIPAL INVESTIGATOR:

T. D. Chikalla

CONTRACT NUMBER: EY-76-C-06-1830

STARTING DATE: 05/19/76

DURATION: 21 months

AMOUNT: \$62,500

PROJECT DESCRIPTION

The overall objective of this project is to investigate means of improving selective surfaces on copper, aluminum and stainless steel.

This investigation will: (1) evaluate the respective qualities of copper and stainless hydronic absorbers, black chrome selective surface plated by the best possible commercial methods, applicable and, (2) simultaneously evaluate aluminum in air heaters. Certain improvements in coating techniques and over coating procedures will be explored to improve the durability of black chrome on all three metals. Evaluation will include accelerated and long term corrosion and optical coating deterioration testing.

The study is divided as follows:

Phase I —Evaluation of Existing Coatings not Post-Treated.

Phase II —Investigation of Improvement Processes for Black Chrome.

Phase III—Testing of Developed Coatings.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Commercial Selective Surfaces Applicable to Copper Aluminum, and Stainless Steel, Their Cost Effective Improvement and Evaluation of Potential Durability in Solar Absorbers

INSTITUTION:

Berry Solar Products
P. O. Box 327
Edison, NJ 08817

PRINCIPAL INVESTIGATOR:

John L. Cotsworth

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$150,000 (Requested)

SELECTIVE SURFACE SOLAR ABSORBER
TEST STAND AND SURFACE EXPOSURE
TESTING.

PROJECT DESCRIPTION

The objective of this study is to continue the development of glass honeycombs for suppressing natural convection and radiation losses within flat plate solar collectors. The study consists of four main tasks:

Task 1—Studies of honeycomb arrays made up of corrugated and plain thin glass sheets, exploration of new fabrication methods, and computation and measurements of the array transmittance and emittance of collector prototypes utilizing such arrays.

Task 2—Further studies with honeycomb arrays of thin-walled glass cylinders, including prototype collector performance under hazy and cloudy conditions, testing of honeycombs with a transpired air-heating collector, effect of cell wall thickness on collector cost effectiveness, and effect of glass optical properties on honeycomb solar transmittance.

Task 3—Scaled-up collector experiments and studies of possible methods for large-scale manufacture of glass honeycombs, including measurement of outdoor performance of a 3 ft. by 6 ft. collector using the optimum honeycomb design, and consultation with the glass industry on feasible mass production methods.

Task 4—Design application studies, including the use of a liquid-heating honeycomb collector to run an absorption refrigeration cycle, and a honeycomb porous bed transpiration air collector for desiccant space cooling systems and agricultural process heat.

The end product of this study will be the determination of the cost effectiveness of the glass honeycomb, and a number of alternate design configurations and processes for mass production of honeycomb structures.

IMPORTANT REPORTS OR PUBLICATIONS

- "Transparent Glass Honeycomb Structures for Energy Loss Control," Final Report, Report NO: SAN/1084-75/1.
- "Natural Convection in Enclosed Spaces—A Review of Application to Solar Energy Collection."
- "Transparent Glass Honeycomb Structures and Energy Loss Control," Progress Report for the Period April 1976 - July 1977.

PROJECT TITLE:

Transparent Glass Honeycomb Structures for Energy Loss Control

INSTITUTION:

University of California
School of Engineering and
Applied Science
Los Angeles, CA 90024

PRINCIPAL INVESTIGATOR:

Harry Buchberg

CONTRACT NUMBER: EY-76-G-03-1084

STARTING DATE: 09/01/74

DURATION: 39 months

AMOUNT: \$139,900

PROJECT DESCRIPTION

The purpose of this project is to investigate two high performance transpired solar air heater concepts that have technical merit and potential for low cost mass production. These are a transpired honeycomb porous-bed solar absorber and a transpired vee-corrugated solar absorber.

The study has the following aims:

1. To establish and prove the technical merit of transpired porous-bed honeycomb configurations that have potential for low cost mass production.
2. To establish and prove the technical merit of transpired vee-corrugated configurations that have potential for low cost mass production.
3. To develop the necessary technical and economic data that will permit determination of the most meritorious transpired porous-bed honeycomb and transpired vee-corrugated configurations for various applications.
4. To conduct design tradeoff studies including cost optimization. (If during the course of these studies it is conclusively demonstrated that one or the other concept is superior for ultimate commercial use, study of the other is to be phased out and the total effort shifted to the development of the better concept.)
5. To validate the performance of a full-scale, single-module solar air heater representing the best concept of those studied.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Transpired Solar Air Heater

INSTITUTION:

University of California
School of Engineering and
Applied Science
Los Angeles, CA 90024

PRINCIPAL INVESTIGATOR:

Harry Buchberg

CONTRACT NUMBER: EG-77-G-04-4088

STARTING DATE: 09/30/77

DURATION: 24 months

AMOUNT: \$115,465

PROJECT DESCRIPTION

Calmac Manufacturing Corporation will develop, test and deliver a solar operated pump that uses a minimum of moving parts. The pump uses the energy of condensing steam for the suction stroke. It has low mechanical efficiency, but energy loss will heat collector fluid. Equipment performance will be monitored by Marshall Space Flight Center.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Further Development of a Single Glaze
Plastic Tube Liquid Flat Plate Collector

INSTITUTION:

Calmac Manufacturing Corporation
150 South Van Brunt Street
Englewood, NJ 07631

PRINCIPAL INVESTIGATOR:

John Armstrong

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32253

STARTING DATE: 10/15/76

DURATION: 15 months

AMOUNT: \$46,508

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Calmac Manufacturing Corporation will design, develop, test and deliver the "Sunmat" liquid flat-plate collector. This collector uses insulation as the collector structure, plastic heat collecting tubes, two copper headers on one end of the collector and variable length with a width of 4 ft. Marshall Space Flight Center will monitor equipment progress.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Further Development of a Single Glaze
Plastic Tube Liquid Flat Plate Collector

INSTITUTION:

Calmac Manufacturing Corporation
150 South Van Brunt Street
Englewood, NJ 07631

PRINCIPAL INVESTIGATOR:

John Armstrong

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32253

STARTING DATE: 10/15/76

DURATION: 15 months

AMOUNT: \$133,374

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to attempt to ascertain, by laboratory experiments, the probability of success of viscosity-stabilized solar ponds.

The project is divided into the following tasks:

Task 1—Continue to search, both theoretically and experimentally, for satisfactory thickening agents. Materials must provide high viscosity, have high optical clarity and show low degradation for long periods at temperatures up to 75°C.

Task 2—Heat likely viscous materials from the bottom in insulated containers of dimensions 20" deep x 8" diameter for long times. Observe for signs of convection or optical degradation.

Task 3—Expose a similar "minipond," with black absorber at the bottom, to artificial sunlight for long times. Measure induced temperature gradients and note any tendencies to convect or degrade. Measure and/or calculate thermal balance, i.e., "solar" input vs. heat losses.

Task 4—Irradiate with artificial sunlight a "pond" consisting of a 20" layer of viscous material with a 10" water layer containing a black absorber sheet below it. Observe temperature distributions and any effects caused by withdrawing heated water.

Task 5—From the results in Tasks 2, 3 and 4, project whether or not a viscosity-stabilized pond will work, and what its dimensions should be for year-long heating of a typical residence in Connecticut.

IMPORTANT REPORTS OR PUBLICATIONS

- "Viscosity Stabilized Solar Ponds: Phase I Summary Report."

PROJECT TITLE:

Viscosity Stabilized Solar Ponds,
Phase II, Segment 1

INSTITUTION:

Center for Environment and Man
275 Windsor Street
Hartford, CT 06120

PRINCIPAL INVESTIGATOR:

Lloyd H. Shaffer

CONTRACT NUMBER: EY-76-C-02-2980

STARTING DATE: 05/01/76

DURATION: 6 months

AMOUNT: \$82,466

PROJECT DESCRIPTION

The main objective of this project is to develop a 3X concentrating, high temperature, non-tracking solar energy collector. A truncated version of the Compound Parabolic Concentrator Reflector and the General Electric Evacuated Tubular Receiver will be combined into a mass producible collector design having broad heating and cooling applications.

This approach provides for collector performance prediction models and verified collector performance characteristics. This will be accomplished by assimilating previously generated data to: (1) select the optimum 3X collector design, (2) optimize reflector cost effectiveness, and (3) optimize the most cost effective heat extraction components. Empirical data will be generated from tests of approximately 300 ft² of collectors fabricated for the project.

The key criterion for the end product will be the minimization of the cost per Btu collected under specified conditions.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of 3X Concentrating
Solar Collector

INSTITUTION:

Chamberlain Manufacturing Corporation
P. O. Box 2545
East 4th and Ester Streets
Waterloo, Iowa 50705

PRINCIPAL INVESTIGATOR:

Robert W. Ballheim

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$339,000 (Requested)

PROJECT DESCRIPTION

The objective of this project is to conduct an integrated program of solar collector research and to develop a tubular thermal collector having significantly better performance characteristics and cost benefits than existing flat-plate collectors. The first phase of the project includes the designing, building, testing and costing of a tubular evacuated collector constructed from mass producible glass components.

The principal feature of the solar collector is a strong, clear glass tube incorporating an integral cusp reflector and vacuum encapsulating a tubular absorber in its focal area. Flow-through and heat-pipe tubular absorbers, vacuum insulation, selective absorber coatings and anti-reflecting films will be examined.

Success of Phase I will lead to a Phase II program which would incorporate a glass heat-pipe in the tubular collector and include an extensive economic analysis of solar heated and cooled climate control systems using advanced tubular collectors.

IMPORTANT REPORTS OR PUBLICATIONS

- "Evacuated Tubular Solar Collector Analysis," Technical Paper, ISES Meeting, UCLA, July 1975.

PROJECT TITLE:

Research on Evacuated Tubular
Solar Collectors Utilizing a
Heat Pipe

INSTITUTION:

Corning Glass Company
Lighting Products Division
Corning, NY 14830

PRINCIPAL INVESTIGATOR:

Ugur Ortabasi

CONTRACT NUMBER: EY-76-C-02-2608

STARTING DATE: 05/01/75

DURATION: 29 months

AMOUNT: \$743,668

CORNING GLASS COMPANY HEAT PIPE RECEIVER
COUPLED TO A CPC REFLECTOR MADE AT ANL.
PHOTO TAKEN DURING TEST AT ANL IN A
COOPERATIVE EXPERIMENT WITH CORNING.

PROJECT DESCRIPTION

This effort is directed at the development of solar selective absorber coatings through the electrodeposition of paints onto metal absorber panels. This process has the potential for depositing uniform coatings in the film thickness range desired for solar selective properties.

The work will (1) identify the black pigments which maximize the solar absorbency and minimize emission, (2) identify electrocoating polymers which have minimum emissivities, and (3) identify and optimize the formulating parameters and operating conditions for the commercial application of an electrocoated selective paint.

The final product is a selective paint with a minimum solar absorbency of 0.95 and a maximum emittance of 0.30. The project is divided into two phases. Phase I proposes to further show the "proof of concept" of this process by selecting polymer binders, pigments and formulating parameters to enhance solar selectivity. Phase II provides for polymer synthesis, scale up and commercial development of this process.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Selective Absorber Coatings by
Electrodeposition of Paint

INSTITUTION:

DeSoto, Inc.
1700 South Mt. Prospect Road
Des Plaines, IL 60018

PRINCIPAL INVESTIGATOR:

Richard E. Wolf

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$100,000 (Requested)

PROJECT DESCRIPTION

The purpose of this 1-year study is to develop a low density silicone elastomeric foam as principal insulation for flat-plate solar collectors and to determine its cost effectiveness compared with presently used insulations.

Cost effectiveness will be evaluated principally on the basis that this foam will be thermally stable over long periods at high temperatures. This would maintain high collector efficiency over long panel lifetimes.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Improved
Insulation Materials

INSTITUTION:

Dow Corning Corporation
Midland, MI 48640

PRINCIPAL INVESTIGATOR:

Sherwood Spells

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$144,000 (Requested)

PROJECT DESCRIPTION

Dow Corning proposes to determine the cost effectiveness of three silicone fluids as heat transfer liquids in solar collectors. Physical data will be obtained to show the performance of these fluids in actual collectors.

Cost effectiveness will be evaluated based on a variety of data including data of the fluid's performance in collectors as compared with currently used fluids. Simplification of collector systems by the elimination of devices and premium metals which protect against freezing, overheating and corrosion will be possible because these fluids are non-freezing, non-boiling and non-corrosive. These simplifications will contribute to cost effectiveness.

The studies will be divided as follows:

- Task 1—Physical data taking.
- Task 2—Toxicity testing.
- Task 3—Solar collector testing.
- Task 4—High temperature testing.
- Task 5—Flammability testing.
- Task 6—Development.
- Task 7—Analysis of data.
- Task 8—Cost effectiveness.
- Task 9—Reports.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Superior
Liquid Coolants

INSTITUTION:

Dow Corning Corporation
Midland, MI 48640

PRINCIPAL INVESTIGATOR:

James A. Marinik

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$178,000 (Requested)

PROJECT DESCRIPTION

A retrofit solar water-heating system is being installed in a three-story apartment building at Drexel University. The system employs two banks of conventional flat-plate collectors and two specially designed Double-Exposure Collectors (DEC's) in fixed-flat-mirror enclosures.

It is the purpose of this project to verify the calculated performance. In order to achieve this goal, the project is divided into the following three tasks:

- Task I—An on-site evaluation of the performance of the existing DEC's.
- Task II—Studies of alternative fixed-mirror and adjustable-mirror DEC design for both winter and year-round solar energy applications.
- Task III—A detailed DEC system design analysis.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Double-Exposure Collector System

INSTITUTION:

Drexel University
Physics & Atmospheric Science
Philadelphia, Pa. 19104

PRINCIPAL INVESTIGATOR:

D. C. Larson
C. W. Savery

CONTRACT NUMBER: EG-77-G-04-4089

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$50,436

PROJECT DESCRIPTION

The objectives of this project are to select electrochemically deposited polymeric coatings for solar-collector heat exchangers, to define conditions for their application, to test their effectiveness for inhibition of corrosion and to characterize them in terms of the other important properties which will determine their ultimate cost-effectiveness. Such properties include thermal stability, effect on heat transfer, abrasion resistance, expected life and ease of reconditioning.

A laboratory development and demonstration program will be performed. This program is projected to establish the feasibility for the electrochemically deposited polymer film corrosion protection of mild steel, Cu and Al. Further, it is anticipated that one type of film on one of these metals will be optimized with respect to method of deposition and physical properties. For this system, a 4000-hour demonstration will be made under appropriate conditions of thermal cycling.

The project is divided into the following tasks:

Task I—Selection of the most promising system(s).

Task II—Optimization of the most promising/cost-effective system.

Task III—Demonstration of the Most Promising/cost-effective system.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Corrosion Protection of Solar
Collector Heat Exchanger with
Electrochemically Deposited Films

INSTITUTION:

EIC Corporation
55 Chapel Street
Newton, MA 02158

PRINCIPAL INVESTIGATOR:

S. Barry Brummer

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 18 months

AMOUNT: \$206,000 (Requested)

PROJECT DESCRIPTION

The purpose of this project is to investigate the use of vegetable oils as liquid coolants. The thermophysical properties of several natural oils will be obtained in order to evaluate their use in high temperature solar applications. Cost and performance evaluation for the use of these oils will be established.

Five different phases will be considered:

Phase I—Organization.

Phase II—Acquisition of supplies and equipment.

Phase III—Experimentation and data development.

Phase IV—Analysis of raw data.

Phase V—Reports.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Vegetable Oils: A Superior
Liquid Coolant

INSTITUTION:

University of Florida
Gainesville, FL 32611

PRINCIPAL INVESTIGATOR:

Herbert A. Ingley

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

18 months

AMOUNT:

\$88,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project is a continuation of work supported by the National Science Foundation, grant GI-43936. Based on initial results, a 540 sq. ft. mirror was constructed with assistance from Scientific Atlanta, a subcontractor experienced in building large dish radar antennas. In both setups the energy receiver ("heat exchanger") is moved appropriately to keep it in the focal "line" of the fixed mirror strips. A tank filled with 4-inch-diameter rocks was constructed to provide heat storage at 500°F for 24-hour operation.

The project has four tasks:

- Task I—To try several designs of more efficient receptor/heat exchanger; to make a better and less expensive actuator to position the receptor in the focal "line" of the mirror; and to improve and reduce cost of the controls which position the receptor and operate valves to produce 500°F air on demand.
- Task II—To take data on the system operating in normal outdoor conditions for 1 year.
- Task III—To develop a computer model of the system which will allow its operation to be calculated under the climatic conditions prevailing in other parts of the country.
- Task IV—To develop a second generation design of the entire system that will have a low cost and a long lifetime reasonably free of maintenance costs.

IMPORTANT REPORTS OR PUBLICATIONS

- "Development of Solar Heat Supply System with Fixed Mirror Concentrators," Final Report, Report No: NSF/RANN/GI 439361 75-1.
- Williams, J. Richard, and Samuel F. Hutchins, "Experimental Solar Heat Supply System with Fixed Mirror Concentrators for the Heating and Cooling of Buildings," NSF Grant GI-43939, July 1, 1974 - June 30, 1975.

PROJECT TITLE:

Development of a Solar Heat Supply System with Fixed Mirror Concentrators

INSTITUTION:

Georgia Institute of Technology
College of Engineering
Atlanta, GA 30332

PRINCIPAL INVESTIGATOR:

J. Richard Williams

CONTRACT NUMBER: EY-76-S-05-4970

STARTING DATE: 07/01/75

DURATION: 24 months

AMOUNT: \$157,386

PROJECT DESCRIPTION

The objective of this proposed 2-year effort is to study the corrosion of aluminum and aluminum alloys in Solar Thermal Energy Collector system and to develop methods to control this corrosion.

In Phase I the corrosion of aluminum alloys in heat transfer fluids, including ethylene-glycol and pure water, will be investigated under conditions directly relevant to solar thermal energy collection systems. Phase II will develop methods to control the corrosion identified in Phase I.

The program is divided into the following tasks:

Phase I:

Task 1—Field study of STEC demonstration projects.

Task 2—Corrosion behavior of 1100 series aluminum in aqueous ethylene-glycol.

Task 3—Corrosion behavior of other alloy-coolant systems.

Task 4—Galvanic series for all alloys.

Phase II:

Task 1—Development and production of corrosion monitoring devices.

Task 2—Development of specific inhibiting agents.

Task 3—Development and production of complete corrosion protection system.

IMPORTANT REPORTS OR PUBLICATIONS

- "Study of Corrosion and its Control in Aluminum Solar Collectors," Progress Report for period September 1, 1976 - November 30, 1976.
- Progress Report for period June 1, 1976 - August 31, 1976.
- Progress Report for period December 1, 1976 - February 28, 1977, NTIS - C00/2934-2.

PROJECT TITLE:

Aluminum Corrosion Studies for
Solar Heat Collectors

INSTITUTION:

Giner Corporation
14 Spring Street
Waltham, MA 02154

PRINCIPAL INVESTIGATOR:

J. Giner

CONTRACT NUMBER: EY-76-C-02-2934

STARTING DATE: 06/01/76

DURATION: 24 months

AMOUNT: \$129,630

PROJECT DESCRIPTION

The purpose of this study is to improve the performance of solar selective black chrome and paint coatings. The solution chemistry of the entire black chrome process, including the nickel plating step, will be investigated and related to the coating performance parameters important to solar collector applications. This effort will concentrate on improving adhesion and abrasion resistance and developing techniques for large-scale applications. New pigments and binders will also be investigated in an effort to identify alternate materials. Techniques to apply both the black chrome and paint coatings to aluminum foil will be investigated as a means of achieving a widely available and easy to use solar selective surface. Testing procedures will be upgraded through long-term tests, coupled with a careful analysis of breakdown mechanisms.

The following tasks will be considered:

Task 1—Material and process study.

Task 2—Advanced coatings development.

Task 3—Characterization and analysis.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Selective Paint and Black
Chrome Coatings Development

INSTITUTION:

Honeywell, Inc.
Systems & Research Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

R. E. Peterson

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

18 months

AMOUNT:

\$228,000 (Requested)

PROJECT DESCRIPTION

The overall objective of this project is to develop large-scale production processes for low-cost organic and anti-reflection (AR) coating and etched AR coating on glass. The use of two etched AR glass covers may increase the total efficiency of a solar collector by 24 percent, while the cost increases approximately 4 percent, assuming the total collector cost is \$5.00/square foot.

The optical properties of the organic AR coating have been well developed. The program emphasis will be on the improvement of mechanical durability and the development of coating thickness control for large glass panes. The stability of coating solution will also be improved to meet the requirement of a continuous long-hour operation. The coating will finally be scaled-up to a sample size of 3 feet x 6 feet.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Low-Cost Solar Anti-Reflection
Coatings

INSTITUTION:

Honeywell, Inc.
Systems & Research Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

R. J. H. Lin

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$136,000 (Requested)

PROJECT DESCRIPTION

The objective of this 15-month study is to demonstrate the feasibility of coating large surface areas of plastic films with substances that have both high solar transmission and infrared reflectance. Processes such as glow discharge activation and glow discharge assisted vacuum evaporation are proposed as unique methods for demonstrating this.

Optimization of doping level and crystal structure would result in coatings with 85-90% solar transmittance and 90-95% IR reflectance. The development of anti-reflection (AR) coatings would increase the solar transmittance to 90-95%.

The project is divided into the following tasks:

Task 1—Evaluate substrate, reflective coating and AR coating materials and two coating deposition techniques.

Task 2—Optimize the best coating system and fabrication process as determined during Task 1.

Task 3—Scale-up feasibility demonstration by coating long strips of flexible plastic substrate material.

Task 4—Reports.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Selective IR Reflective Coatings
Development

INSTITUTION:

Honeywell, Inc.
Systems & Research Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

W.T. Boord

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 15 months

AMOUNT: \$150,000 (Requested)

PROJECT DESCRIPTION

The objective of this program was to design, fabricate, test and evaluate the jet impingement concept collector, and to increase the efficiency of the air heater over that of a "conventional" parallel-plate type, by increasing the absorber plate-to-air stream heat transfer coefficient. For comparison, a baseline parallel-plate collector was analyzed, fabricated and tested.

Values for the average jet heat transfer coefficient were predicted and used in computer simulation using a nodal network collector model to predict collector performance. The predicted Y-intercept efficiency improvement of the jet-plate collector over that of the baseline parallel-plate collector was approximately 10 percent for a one-cover design. If the existing selective absorber coating and etched cover glass technology of Honeywell is applied to the jet-plate collector, the predicted performance gain over the baseline parallel-plate collector is 19 percent at the intercept and 35 percent at a typical space heating operating point.

The collector mechanical design effort involved a study of less expensive ways for assembling and selecting materials. The final jet-plate collector design recommended was an aluminized steel sheet, painted with an acrylic paint, for the box material; a semi-rigid fiber glass for the insulation; a steel plate with a selective black chrome coating for the absorber; and a perforated steel plate for the jet-plate. Two sheets of 0.318 cm (0.125 inch) tempered, low iron glass are used for the glazings. Etching is recommended to improve the cover glass transmittance. Experimental test runs were conducted on four parallel-plate collector configurations and 15 jet-plate collector configurations. The test results indicate that the jet-impingement concept improved the Y-intercept efficiency by 13 percent over that of the baseline parallel-plate collector.

Cost performance analyses were performed with the aid of a computer simulation for a solar air collector space and domestic hot water heating system for a single-family residence.

IMPORTANT REPORTS OR PUBLICATIONS

- Rask, D.R., Mueller, L.J. and Pejsa, J.H., "Low-Cost Solar Air Heater," Honeywell Report C00-2929, August 22, 1977.

PROJECT TITLE:

Low Cost Solar Air Heater

INSTITUTION:

Honeywell, Inc.
Systems and Research Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

D.R. Rask

CONTRACT NUMBER: EY-76-C-02-2929

STARTING DATE: 06/29/76

DURATION: 12 months

AMOUNT: \$105,689

PROJECT DESCRIPTION

The overall objective of this study is to continue development of low-cost coatings to enhance the performance and cost-effectiveness of flat-plate solar collectors.

The initial study explored three main areas:

1. Selectively absorbing paints.
2. Selectively absorbing electrochemical coatings.
3. Anti-reflection coatings for glazing materials.

The present program will concentrate on improving the long-term stability and reproducibility of the most promising coatings identified in the initial study. A proposed continuation effort would investigate the feasibility of scaling the coating processes to large panels and high production volumes. An outdoor durability test program is also proposed.

IMPORTANT REPORTS OR PUBLICATIONS

- "Optical Coatings for Flat-Plate Solar Collectors," Final Report, Report No: C00/2625-75/1.
- "Collector Coatings for Solar Heating and Cooling Systems," Phase II, Progress Report, C00-2930-1, June 28 - December 31, 1976.
- Optimization of Coatings for Flat-Plate Solar Collectors," Phase II, Final Report, C00-2930-12, June 28, 1976 - June 27, 1977.

PROJECT TITLE:

Optimization of Coating for Flat-Plate
Solar Collectors, Phase II

INSTITUTION:

Honeywell, Inc.
Systems & Research Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

Henry Y.B. Mar

CONTRACT NUMBER: EY-76-C-02-2930

STARTING DATE: 16 months

DURATION: 06/28/76

AMOUNT: \$153,827

PROJECT DESCRIPTION

The purpose of this study is the configuration of a concentrator which uses an elastic film mounted under tension on a frame to form a near hyperbolic paraboloid surface. This surface is backed with urethane coated polystyrene foam separated from the film by a damping air-gap. The surface is capable of linear focusing, at a concentration ratio of 10x or greater, on a heat shielded tube-in-cavity receiver. A reflector/heat shield sub-assembly tracks the sun's apparent motion in one axis, pivoted about the heat transfer tube.

This project is divided into five main tasks:

Task 1—A research effort to identify the physical properties and behavior of reflecting film and techniques (processes) for mounting them under tension on frames. This task includes the physical specification of the collector components.

Task 2—Prepare engineering model drawings and specifications and a device test plan. Investigate field (array) issues such as piping, pumping, storage, power conversion and load matching. Included is wind tunnel testing of a small scale array of modules.

Task 3—Fabricate test engineering model.

Task 4—Use the results of the design and test tasks to investigate the economics of large scale production and application. Commercial marketing, distribution and service concepts shall be formulated. This effort shall also plan and cost a large scale system demonstration.

Task 5—Reporting task that includes a comprehensive oral design review.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Dual Curvature Acoustical Damped
Concentrating Collector

INSTITUTION:

Honeywell, Inc.
Energy Resources Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

B. Gupta

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

18 months

AMOUNT:

\$359,000 (Requested)

PROJECT DESCRIPTION

Houston Chemical Corporation will test material compatibility between aqueous base heat transport fluids (i.e. deionized water, hard water, propylene glycol etc.) and collector materials (i.e. copper, steel, aluminum).

Marshall Space Flight Center will monitor this project's progress.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Testing of Aqueous Fluids for Use in
Collectors of Solar Energy

INSTITUTION:

Houston Chemical Corporation
P. O. Box 4026
Corpus Christi, TX 77408

PRINCIPAL INVESTIGATOR:

John P. Wisnewski

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32255

STARTING DATE: 11/15/76

DURATION: 26 months

AMOUNT: \$212,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this 2-year study is to continue development of the V-Trough moderately concentrating solar collector, and to optimize its design for thermal performance and mass production manufacturability. The emphasis of the project will be divided between the two general areas of thermal performance improvement and manufacturing studies. Eight tasks are included as follows:

Task 1—Improve computer simulation for radiative performance of trapezoid reflecting grooves.

Task 2—Test and measure properties of reflective groove model.

Task 3—Computer simulation of entire collector performance to optimize the design.

Task 4—Design and fabricate several advanced collector prototypes.

Task 5—Upgrade collector test facility at University of Houston.

Task 6—Test advanced prototypes.

Task 7—Analyze and evaluate prototype performance.

Task 8—Report and disseminate information.

The expected end product of this study is a design for a cost-effective, mass-producible, moderately concentrating collector capable of driving an absorption or Rankine-cycle refrigeration machine at acceptable overall efficiency.

IMPORTANT REPORTS OR PUBLICATIONS

- "The Evaluation of Surface Geometry Modification to Improve the Performance of Solar Energy Collectors," Technical Report, Report NO: NSF/RANN/GI-41003/TR/7411.
- Mannan, K. D. and Bannerot, R. B., "Optimal Geometries for One and Two-Faceted Symmetric Side-Wall Booster Mirrors," Pg 207, Proceedings of 1977 Flat-Plate Collector Conference, Orlando, FL, February 28-March 2, 1977.
- Bannerot, R. B. and Howell, J. R., "The Effect on Non-Direct Insolation on the Radiative Performance of Trapezoidal Grooves Used as Solar Energy Collectors," Paper 52-5. Presented at the International Solar Energy Society International Congress and Exposition, Los Angeles, CA, July 28-August 1, 1975. To be published in Solar Energy.
- Bannerot, R. B. and Howell, J. R., "Predicted Daily and Yearly Average Radiative Performance of Optimal Trapezoidal Groove Solar Energy Collectors," "Proceedings of 'Sharing the Sun!' Conference," Winnipeg, Manitoba, August 15-20, 1976, pp. 111-125.

PROJECT TITLE:

Analysis, Design, Fabrication
and Testing of Moderately Con-
centrating Solar Energy Collectors,
Phase II

INSTITUTION:

University of Houston,
Dept. of Mechanical Engineering
3801 Cullen Boulevard
Houston, TX 77004

PRINCIPAL INVESTIGATOR:

John R. Howell
Richard B. Bannerot

CONTRACT NUMBER: EY-76-S-05-5100

STARTING DATE: 05/01/76

DURATION: 25 months

AMOUNT: \$94,532

PROJECT DESCRIPTION

The objective of this project is to develop a non-glass glazing material for solar collectors, which has optimum optical and physical properties, and is cost-effective. Modifications of a polycarbonate, the best plastic glazing material available, will be made by copolymerizing two diphenols into a polycarbonate that has a glass transition temperature high enough to be usable at 300°F. These copolymers will be evaluated for thermal, physical and optical properties before and after environmental exposure. Improvement of the transmission of solar energy through the plastic glazing material will be attempted by various surface etching procedures. Protection of the plastic glazing material against ultraviolet radiation will be accomplished by incorporating one of the ultraviolet absorbing benzotriazoles into the plastic prior to the molding process, rather than by coating it on the surface. The system will be evaluated and the cost-effectiveness of the project ascertained.

This project is divided into three different phases:

Phase I—Polymeric Glazing Materials.

Phase II—Surface Etching Process.

Phase III—UV Protection of Plastic Glazings.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Non-Glass Glazings and Surface Coatings

INSTITUTION:

Hughes Aircraft Company
Aerospace Group
Culver City, CA 90230

PRINCIPAL INVESTIGATOR:

N. Bilow

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$169,000 (Requested)

NON GLASS GLAZINGS FOR SOLAR COLLECTORS

HUGHES

- COPOLYMER SYNTHESSES
- COPOLYMER EVALUATION
 - FABRICABILITY
 - COMPRESSION MOLDING
 - INJECTION MOLDING
 - MECHANICAL PROPERTIES
 - TENSILE STRENGTH AND MODULUS
 - ELONGATION
 - WORK TO FAILURE
 - THERMAL PROPERTIES
 - GLASS TRANSITION TEMPERATURE
 - COEFFICIENT OF EXPANSION
 - HEAT DEFLECTION TEMPERATURE
 - ENVIRONMENTAL STABILITY
 - WEATHERING
 - TEMPERATURE HUMIDITY CYCLING
 - HEAT AGING
- SURFACE ETCHING STUDIES
- ETCHING SURFACE COATINGS
- UV PROTECTIVE ADDITIVES
 - BLENDING STUDIES
- OPTICAL PROPERTIES

1000Å ETCHED SURFACE WITH PORES < 200Å

UV STABILIZED HIGH T_g POLYCARBONATE COPOLYMER

FEB 78

PROJECT DESCRIPTION

This project is a continuation of EY-76-C-02-0578. The objective of the previous work was to establish comprehensive objective criteria for the testing and evaluating of materials under consideration for use in solar collectors. Properties of these materials were determined before and after testing.

The overall objective of the present project is to determine, by direct exposure to sunlight and ambient weather, those collector materials which are most satisfactory because they are solar and weather-resistant and hence can be expected to provide long, reliable collector life. To monitor material performance by means of appropriate optical and mechanical tests, to investigate accelerated testing with sunlight concentrated about eight times and to investigate material deterioration at temperatures above ambient are also objectives.

There are four principal tasks:

Task I—Continue to expose eighty-eight (88) samples to direct and concentrated sunlight, and perform optical and mechanical tests.

Task II—Obtain up to 50 new materials and test them as in Task I.

Task III—Test up to 20 of the most promising materials from Task I for up to a year at temperatures approaching collector stagnation temperatures.

Task IV—Study mechanisms of degradation for the development of weathering models and predictive techniques.

Task V—Report results.

IMPORTANT REPORTS OR PUBLICATIONS

- "Exposure Testing and Evaluation of Solar Utilization Materials," Semi-annual Report, Report No: IITRI C6342-1.

PROJECT TITLE:

Exposure Testing and Evaluation of
Solar Collector Materials

INSTITUTION:

IIT Research Institute
10 West 35th Street
Chicago, IL 60616

PRINCIPAL INVESTIGATOR:

J. Gilligan

CONTRACT NUMBER: EY-76-C-02-2672

STARTING DATE: 03/01/77

DURATION: 12 months

AMOUNT: \$295,000

PROJECT DESCRIPTION

The objective of this project is to design and develop an inflated cylindrical concentrator (ICC) collector which produces hot water or steam up to a temperature of 170°C. A major consideration of the work is to develop a low cost system.

Most industrial concerns require an after-tax rate of return of 10 percent or more on an investment in a solar process heat system. This is roughly equivalent to a payback period of 7 years and translates into an allowed solar system cost of about \$50 per square meter of collector area. It is believed that the ICC and its associated system components can be built for this cost.

This low cost is achievable by the use of inexpensive, weatherable plastics and by a design which does not require tracking the sun. The use of plastics, however, means replacing these components at regular intervals, but in an industrial environment, where there are operation and maintenance people available to perform this task, the life cycle costs can be kept low.

The inflated concentrating collector was conceived by Tabor in Israel around 1960. The basic idea is to form the reflector with a large, inflated, thin film plastic cylinder whose upper portion is clear and whose lower portion is aluminized thin film. The axis of the cylinder lies in a horizontal east-west direction, and the collector will be designed so it can be manually tilted in the north-south plane. A receiver tube with a selective surface will be placed in the focusing region to carry the fluid to be heated or boiled.

IMPORTANT REPORTS OR PUBLICATIONS

- Gerich, Jerry W., "An Inflated Cylindrical Concentrator for Producing Industrial Process Heat," Proceedings of the 1977 Concentrating Collector Workshop, Atlanta, GA, September 1977.

PROJECT TITLE:

Inflated Cylindrical Concentrating
Solar Collector

INSTITUTION:

Lawrence Livermore Laboratory
P.O. Box 808
Livermore, CA 94550

PRINCIPAL INVESTIGATOR:

William Dickinson

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 10/01/76

DURATION: 24 months

AMOUNT: \$80,000

PROJECT DESCRIPTION

The objective of this study is to investigate experimentally the use of naturally occurring black materials for solar collector absorbers. The primary candidates, coke and black volcanic scoria, offer the potential of lower absorber cost than conventional metallic materials.

The research will involve the construction and testing of several air and water heating collectors to determine thermal efficiency and pressure drop as a function of particle size.

The program is divided into the following tasks:

Task 1—Literature search.

Task 2—Design of a versatile air collector.

Task 3—Construction of an air collector.

Task 4—Instrumentation for testing.

Task 5—Testing.

Task 6—Determination of efficiency.

Task 7—Design of a versatile water collector to accommodate a packed-bed of coke or scoria.

Task 8—Construction, testing and evaluating of the water collector.

Task 9—Design of a practical collector.

IMPORTANT REPORTS OR PUBLICATIONS

- Final Report No. C00-2972-2.

PROJECT TITLE:

Low Cost Solar Collector of
Packed Bed Design

INSTITUTION:

Lehigh University
Department of Geological Sciences
Bethlehem, PA 18015

PRINCIPAL INVESTIGATOR:

Dale R. Simpson

CONTRACT NUMBER: EY-76-S-02-2972

STARTING DATE: 05/16/76

DURATION: 14 months

AMOUNT: \$34,180

PROJECT DESCRIPTION

Life Sciences will develop an air heating flat-plate collector that uses an aluminum frame and absorber plate, and double glazing. The absorber is coated with flat black paint. "Sunadex" glass is used as the inner glazing and "Tedlar" is used as the outer glazing.

Marshall Space Flight Center is monitoring equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Further Development of an All Aluminum
Double Glaze Air Collector

INSTITUTION:

Life Sciences
Route 1, Box 746
Morrison, CO 80465

PRINCIPAL INVESTIGATOR:

Robert Scarlata

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32261

STARTING DATE: 11/01/76

DURATION: 12 months

AMOUNT: \$144,954

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project is a continuation of Contract No. E-(04-3)-1081 which involved the development of transparent plastic honeycomb covered solar collectors.

The objectives of this project are to develop an optimized transparent plastic honeycomb covered solar collector with improved high temperature performance and stability, and further reduce collector costs through judicious selection of materials, cellular structure configurations and fabrication techniques. This work will include the development of high temperature plastic honeycomb systems and continued work to optimize the configuration of the low temperature, low-cost plastic honeycombs. The use of plastic cover materials over honeycomb collectors will be analytically and experimentally studied, and the feasibility of employing methods for protecting low-temperature plastic honeycombs from the high temperatures often encountered during static flow conditions will be determined. Trade-off studies will be performed to establish the optimum honeycomb collector design(s) in terms of materials, cellular configurations, manufacturing techniques and costs, resulting in the design of an inexpensive and reliable collector compatible with the installation and operational requirements of a building heating and cooling systems.

IMPORTANT REPORTS OR PUBLICATIONS

- "Development of Plastic Honeycomb Flat-Plate Solar Collectors," Final Report, Report NO: SAN/1081-76-1.
- "Optimization of Thin-Film Transparent Plastic Honeycomb-Covered Flat-Plate Solar Collectors", Final Report, October, 1977.

PROJECT TITLE:

Optimization of Thin Film Transparent
Plastic Honeycomb Covered Flat-Plate
Solar Collector

INSTITUTION:

Lockheed Missiles & Space Company
Palo Alto Laboratories
3251 Hanover Street
Palo Alto, CA 94303

PRINCIPAL INVESTIGATOR:

Matt McCargo

CONTRACT NUMBER: EY-76-C-03-1256

STARTING DATE: 05/24/76

DURATION: 20 months

AMOUNT: \$131,200

PROJECT DESCRIPTION

This development program was completed early in FY-77 with the installation of 400 high-performance, liquid-heating, structurally-integrated solar collectors as part of the roof of the new National Security and Resources Study Center at the Los Alamos Scientific Laboratory. The LASL collector, which originated with NSF Grant AER-7409003, saves costs compared to conventional designs by serving the dual role of energy absorber and weather-tight roof structure. The design that finally evolved after 3 years of development incorporates a high-efficient absorber plate fabricated from mild steel by a seam welding and pressure expansion process and electroplated with a selective coating ($\alpha = 0.94$, $\epsilon = .08$) of black chrome over nickel. The absorber is covered with a single pane of patterned, tempered glass, supported by a strong steel "C" beam frame, and back insulated with foamed-in-place polyurethane backed with a sheet-metal fire barrier.

The collector has undergone intensive performance, structural and durability testing. A 40-panel array has been in operation for 3 years and continues to provide information on corrosion, weatherability and long-term performance characteristics. In addition, the array has been used to perform experiments to determine the most effective means of controlling condensation, sealing glazing, tolerating stagnation conditions, connecting parallel and series collectors and installing assemblies.

A very detailed fabrication study was conducted to determine the cost of the collector and some of its possible variants as a function of production volume. Although the collector design has not yet been adopted by a manufacturer as a standard product, some of its features have been incorporated into production collectors, and the design has been specified for one of the commercial building demonstration projects.

IMPORTANT REPORTS OR PUBLICATIONS

- Balcomb, J.D., Hedstrom, J.C. and Moore, S.W., "Research on Integrated Solar Collectors Roof Structures, Progress Report for the Period April 1 to June 30, 1974," LA-5859-PR, Jan. 1975.
- Balcomb, J.D., Hedstrom, J.C., and Moore, S.W., "Progress Report - Research on Integrated Solar Collector Roof Structures for the Period July 1 to September 30, 1974, LA-5874-PR, Feb. 1975.
- Moore, S.W., Balcomb, J.D. and Hedstrom, J.C., "Design and Testing of a Structurally Integrated Steel Solar Collector Unit Based on Expanded Flat Metal Plates," LA-UR-74-1093, presented at the U.S. Section, ISES Meeting, Ft. Collins, CO, Aug. 19-23, 1974.

PROJECT TITLE:

Research on Integrated Solar Collector
Roof Structures, Phase II

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

J. Douglas Balcomb

CONTRACT NUMBER: W-7405-ENG-36,D496

STARTING DATE: 07/01/74

DURATION: 24 months

AMOUNT: \$225,000

PROJECT DESCRIPTION

LASL is conducting a continuing program of research into the design, development and application of solar collectors. Investigations include a broad range of studies of collector materials, fluids, engineering and design techniques, application systems analyses, concept evaluations and test methods and techniques. Most of the tasks undertaken in this program are tasks that are crucial to the completion of the paths of the Heating and Cooling R&D plan that are not covered by contractor projects. The program is intimately tied to LASL's role of technical support for the solar collector element of the R&D program and this association makes it possible to respond quickly with short-term research to meet the program's needs.

The current collector research experiments emphasize air-heating collector concepts and improvements, development of facilities and techniques for evaluation of high-temperature collectors, novel and low-cost concentrating collector concepts, the use of spectral and diffuse reflectors to enhance flat-plate collector performance, selective absorber coatings for glass and metal absorbers and the determination of physical properties of collector fluids and materials.

Theoretical studies include evaluation of novel advanced collector concepts, collector application system studies and studies of the sensitivity of collector performance and cost to variations in design and operating parameters. LASL also systematically collects information relative to the state of the art in collector development, research, applications and operating experience and establishes structured data bases to permit rapid and efficient retrieval and correlation of this information.

IMPORTANT REPORTS OR PUBLICATIONS

- Grimmer, D.P., and Moore, S.W., "Practical Aspects of Solar Heating: A Review of Materials Use in Solar Heating Applications," LA-UR-75-1752, presented to the Society for the Advanced of Materials and Process Engineering (SAMPE), Oct. 14-16, 1975.
- Grimmer, D.P., and Herr, K.C., "Solar Process Heat from Concentrating Flat-Plate Collectors," LA-UR-76-1492, presented at the International Solar Energy Society Meeting, Winnipeg, Canada, August, 1976.
- Moore, S. W., "Results Obtained from Black Chrome Production Run of Steel Collectors," LA-UR-76-2019, presented to the American Electroplaters' Society Coatings for Solar Collectors Conference, Nov. 9-10, 1976.

PROJECT TITLE:

Solar Collector and Materials Research

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

C. A. Bankston

CONTRACT NUMBER: W-7405-ENG-36, D496

STARTING DATE: 07/01/76

DURATION: Continuing

AMOUNT: \$300,000

PROJECT DESCRIPTION

An initial NSF-funded study established the feasibility of using thermic diode panels as passive solar collector and storage devices. The objective of this 1 year project is to advance thermic diode solar panels into a fully developed, marketable product.

The specific project objectives are: (1) to develop a diode panel which can be retrofitted onto existing structures; (2) to refine the existing economic analysis to include greater technical detail and market analysis; (3) to conduct manufacturing studies aimed at closing the gap between laboratory studies and actual manufacture and marketing; (4) the addition of glazing to the thermic panels; and (5) to install the panels on test structures.

The program is divided into the following tasks:

Task 1—Determine appropriate thermic logic for building heating and cooling.

Task 2—Build and test small-scale panel.

Task 3—Economic analysis including analytical model of panel.

Task 4—Glazing for the manufacturing prototypes.

Task 5—Full-scale prototype testing.

IMPORTANT REPORTS OR PUBLICATIONS

- Wayne, W., "Modeling, Parameter Optimization, and Economic Evaluation of Thermic Solar Panels," MIT Thesis, June 1972.
- "Thermic Controls to Regulate Solar Heat Flux into Buildings," Semi-Annual Progress Report No. NSF/RANN/SE/GI-43897/PR/75/2.
- "Thermosyphon Analysis of a Thermic Diode Solar Heating System."
- "Thermic Diode Solar Panels for Space Heating."

PROJECT TITLE:

Development and Evaluation of Thermic Diode Solar Panels for Building Heating and Cooling, Phase II

INSTITUTION:

Massachusetts Institute of Technology
Dept. of Mechanical Engineering
Cambridge, MA 02139

PRINCIPAL INVESTIGATOR:

B. Shawn Buckley

CONTRACT NUMBER: EY-76-S-02-2854

STARTING DATE: 11/01/75

DURATION: 23 months

AMOUNT: \$141,551

PROJECT DESCRIPTION

The objective of this project is to design and construct a low-cost, high-temperature, liquid heating flat-plate collector.

The collector design uses low cost materials bonded to copper circulating tubes by "high-service-temperature, low-outgassing, high-conductivity" adhesives. Many of these adhesives have been used previously for high temperature applications in heat exchangers and engines. Others have been developed for high vacuum aerospace applications.

The engineering research phase of this project will evaluate and thermally test a series of candidate adhesives. Galvanized sheet steel collector plates and copper tubes will be used to examine conductivity of bond joints and the structural integrity of joints under relative thermal expansion at temperatures ranging from -35°C to 300°C . Thermal-cycling will be used to evaluate fatigue of bond joints and the degradation of thermal conductivity at the bond joints. In addition to evaluating galvanized steel plates, aluminum/copper adhesive bonded joints will be examined as an alternative collector plate construction.

During the development and evaluation phase of the project, 128 square feet of flat plate collectors will be constructed; one insulated hot water storage tank of 300 gallon capacity will be used for systems thermal evaluation and installation cost evaluation.

Finally, a cost/performance study will be made to determine the potential cost savings realized by using conventional materials and adhesive bonded joints in flat-plate collectors.

The project is divided into five different tasks:

Task 1—Literature search.

Task 2—Test and evaluation of candidate "high-service-temperature, high-conductance, low-outgassing" adhesives.

Task 3—Thermal/structural design analysis of the proposed collector system.

Task 4—Fabricate a system of flat-plate liquid collectors using the most promising construction methods.

Task 5—Prepare typical design guidelines and cost performance studies to permit fabrication of low-cost collectors by plumbing and heating contractors.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Low-Cost High-Temperature
Cement-Bonded Collector

INSTITUTION:

MEGA Engineering
11499 Columbia Pike
Silver Spring, MD 20904

PRINCIPAL INVESTIGATOR:

R. E. Dame

CONTRACT NUMBER: EG-77-C-04-4122

STARTING DATE: 09/30/77

DURATION: 14 months

AMOUNT: \$97,562

PROJECT DESCRIPTION

Proposed is the modification to an existing pre-engineered metal building which presently has 480 sq. ft. of solar air heaters installed on the south wall. Material cost for this collector was $60¢/\text{ft}^2$. The 30 x 48 ft. building is currently being operated as a solar heated poultry house where ambient air is pulled into the collector, routed to the house or a rock storage bed, and is finally exhausted to ventilate the house. The ventilation, although wasteful from an energy standpoint, is required in all livestock shelters.

Modifications will be performed on the present collector system so that air from the heat structure can be returned to the collectors in a recirculation mode. The building will be available at no cost to the proposed research, with only minimal expenses associated with conversion from "once-through" heating to the recirculation mode.

Instrumentation requirements will be analyzed and necessary changes made in the existing data recording system. Data will be recorded on a continuous basis during the heating season 1977-78. Auxiliary heating requirements will be met by a central propane furnace. Propane consumption will be measured by monitoring the weight of propane consumed during a given test.

Tests will also be made to assess the importance of the rock storage system. Such a system could be added in a retrofit situation with minimal cost if no storage were included; the system performance will also be investigated as part of the work.

The final result of the proposed research will be the development and testing of a final design which can then be marketed on a cost competitive basis through the present dealers for the metal buildings.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Addition of Solar Air Heaters
to Pre-Engineered Metal Buildings

INSTITUTION:

Mississippi State University
Drawer ME
Mississippi State, MS 39762

PRINCIPAL INVESTIGATOR:

R. Forbes

CONTRACT NUMBER: EG-77-G-04-4086

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$31,585

PROJECT DESCRIPTION

The objective of this project is to complete development of an optimum reflective concentrating, passive tracking solar collector. The selected configuration shall be capable of year-round operation without requiring realignment, thus the maximum possible concentration ratio is necessarily closer to 2X than 3X. The manufacturing techniques developed will also be applicable to high concentration ratio devices, albeit such designs will require periodic realignment.

The proposed baseline configuration is based on a reflector system fabricated from a metalized plastic film/nonwoven fabric laminate which is vacuum formed to shape and then rigidized with a thin layer of high strength gypsum. The absorber system is composed of a set of low carbon steel conduits coated with spectrally selective iron oxide. Each conduit is concentrically mounted within a glass tube. A plastic glazing sheet protects the reflector surface and the absorbers from the environment. The entire assemblage is mounted in an insulated supporting structure.

A number of experimental units has been built and tested based on this concept. Several alternative fabrication methods have been explored, a few of which warrant further comparative evaluation.

This research will also explore the more promising manufacturing techniques, prepare a cost comparison, demonstrate the validity of the selected manufacturing techniques and build and test several prototype units which will demonstrate the success of the program.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available.

PROJECT TITLE:

Optimized Concentrating/Passive
Tracking Solar Collector

INSTITUTION:

Mithra Corporation
4227 Spence Street
Torrance, CA 90503

PRINCIPAL INVESTIGATOR:

Karl E. Sterne

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$99,000 (Requested)

PROJECT DESCRIPTION

The purpose of this project is to attain a low-cost, unitized modular design in which a fiber-reinforced PVC film glazing, a film absorber and the necessary control thermostats and electric fan air blowers are mounted on a strong 4 ft. by 8 ft. mounting base of painted outdoor-grade plywood. The optimum PVC film glazing and absorbing materials will be defined from the standpoint of strength, optical transmission, thermal performance, absorption and cost. Simultaneously, designs will be developed and methods will be investigated for producing the optimized film economically on a large scale. Then the optimized collector will be built and its performance evaluated. At the completion of the project one complete collector (30 sq. ft.) incorporating the best materials and design will be delivered to DOE with all design and performance data.

The program is divided into six tasks:

- Task 1—Optimize formulation for clear, outdoor stable polyvinyl chloride film.
- Task 2—Define type and spacing of fiber network reinforcement.
- Task 3—Define process for film manufacture capable of scale-up and economic, large-scale production
- Task 4—Design and build modular collector unit.
- Task 5—Determine collector performance and evaluate cost effectiveness.
- Task 6—Prepare final report and deliver demonstration modular unit.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Medium Temperature Air Heaters
Based on Durable Transparent Films

INSTITUTION:

Monsanto Research Corporation
P. O. Box 8, Station B
Dayton, OH 45407

PRINCIPAL INVESTIGATOR:

G. L. Ball III

CONTRACT NUMBER: EG-77-C-04-4147

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$106,657

PROJECT DESCRIPTION

The key to large-scale utilization of 3X mirror concentrators is the development of a design that is significantly lower in cost than state-of-the-art concentrators and can be economically mass-produced. Most current designs of 3X mirror concentrators, such as the reflecting compound parabolic concentrator, require expensive precision molds and processes whose costs compound as the size of the concentrator is increased.

The overall objective of this project is to design, build and test new, lower-cost 3X cylindrical mirror concentrators based on an air-inflatable tube with a metallized bottom half. This design requires no mold and takes advantage of the natural tendency of flexible film flat "tubes" to form cylinders when inflated by gas.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Low-Cost Mirror Concentrators Based on Double-Walled, Metallized, Tubular Films

INSTITUTION:

Monsanto Research Corporation
P. O. Box 8, Station B
Dayton, OH 45407

PRINCIPAL INVESTIGATOR:

G. L. Ball III

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

24 months

AMOUNT:

\$220,000 (Requested)

PROJECT DESCRIPTION

The objective of this project is to investigate and optimize the performance of the collector system, to yield a minimum cost (\$/MBtu) for the energy collected and to develop a design which will be reliable in performance and long-lived. The Jet Propulsion Laboratory has already begun initial analysis and design of such a collector with limited internal discretionary funds. The proposed effort will complete construction of the collector, perform a series of experiments, develop an analytical thermal model of collectors of this type and conduct optimization studies leading to a minimum cost (\$/MBtu) collector configuration. Finally, a prototype collector using the optimized configuration will be constructed.

IMPORTANT REPORTS OR PUBLICATIONS

- "Fixed Tilt Vee-Trough Collector Project," Quarterly Progress Report for the Period September - November 1976.
- "A Fixed Collector Employing Reversible Vee-Trough Concentrator and a Vacuum Tube Receiver for High Temperature Solar Energy Systems."
- "Fixed Flat Plate Collector with a Reversible Vee-Trough Concentrator."
- "A Vacuum Tube Vee-Trough Collector for Solar Heating and Air Conditioning Applications."
- "Experimental Evaluation of a Fixed Collector Employing Vee-Trough Concentrator and Vacuum Tube Receivers."

PROJECT TITLE:

A Fixed Tilt Solar Collector
Employing Reversible Vee-Trough
Reflectors and Vacuum Tube Receivers

INSTITUTION:

National Aeronautics and Space Administration
(Jet Propulsion Laboratory)
277/202
Pasadena, CA 91103

PRINCIPAL INVESTIGATOR:

M. Kudret Selcuk

CONTRACT NUMBER: EX-76-A-29-1024

STARTING DATE: 04/12/76

DURATION: 12 months

AMOUNT: \$130,000

PROJECT DESCRIPTION

The objectives of this project are to develop standard test methods for determining the thermal performance of solar collectors and thermal storage devices for space heating, cooling and hot water heating in buildings; and to verify experimentally the proposed test procedure utilizing test facilities at NBS and other test facilities.

The program is divided into the following task areas:

- Task 1—Review of methods of analysis for solar collectors and thermal storage devices.
- Task 2—Review of testing procedures for solar collectors and thermal storage devices.
- Task 3—Preparation of a preliminary test procedure for solar collectors and thermal storage devices.

IMPORTANT REPORTS OR PUBLICATIONS

- "Methods of Testing for Rating Solar Collectors Based on Thermal Performance," Report No. NBSIR 74-635.
- "Development of Proposed Standards for Testing Solar Collectors and Thermal Storage Devices," NBS TN-899.
- "Development of Test Procedures for Solar Collectors and Thermal Storage Devices"
- "Testing of Flat-Plate Air Heaters According to ASHRAE Standard 93-77."
- "Round Robin Testing Results," Mar '77, Flat-Plate Collector Conference, Orlando, FL.

PROJECT TITLE:

Development of Methods for Evaluation and Test Procedures for Solar Collectors and Thermal Storage Devices, Phase III

INSTITUTION:

National Bureau of Standards
Washington, D.C. 20234

PRINCIPAL INVESTIGATOR:

James Hill

CONTRACT NUMBER: E(49-26) 3800

STARTING DATE: 05/01/75

DURATION: Continuing

AMOUNT: \$444,300

PROJECT DESCRIPTION

The primary objectives of this project are to improve monitoring instrumentation, to automate the elimination of convection layers, to develop two-dimensional computer codes which will predict optimum operating conditions, to investigate the causes of instability and to extract heat quantitatively so as to define the usefulness of such a pond as a source of heat for buildings.

This project is divided into the following task areas:

- Task 1—Continued operation of the UNM pond, but with automation of data taking, detection of convection instabilities and the corrections of instabilities.
- Task 2—Theoretical studies using a computer program which includes all pond characteristics, heat input and losses. Experimental studies of instabilities, perturbation and salt concentration in the pond.
- Task 3—Quantitative heat extraction and the study of corrosion problems associated with hot brine solutions.
- Task 4—Environmental impact of incorporation of ponds into communities.
- Task 5—Economic assessment.

IMPORTANT REPORTS OR PUBLICATIONS

- Zangrando, F., "Performance of a Salt Gradient Stabilized Solar Pond," presented at the Solar Energy in the Southwest 1977 meeting, Dallas, Texas, August, 1977.
- Zangrando, F. and Bryant, M. C., "Solar Ponds for Residential Heating—Final Report," for State of New Mexico Energy Resources Board, Grant No. ERB-161, Technology Application Center, NASA, LSS-155/Suppl. 1, August, 1976.

PROJECT TITLE:

A Demonstration Salt Gradient Solar Pond

INSTITUTION:

University of New Mexico
Department of Physics & Astronomy
800 Yale Boulevard
Albuquerque, NM 87131

PRINCIPAL INVESTIGATOR:

H. Bryant

CONTRACT NUMBER: EG-77-S-04-3977

STARTING DATE: 04/01/77

DURATION: 12 months

AMOUNT: \$57,229

PROJECT DESCRIPTION

Northrup, Inc. will redesign, develop and deliver a concentrating collector with a Fresnel lens that is improved over the present successful design. The concentration ratio will be 12 to 1. Four absorbers will be on one mounting structure with improved tracking capability.

Marshall Space Flight Center will monitor the equipment's performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Further Development of a Concentrating Collector Using Fresnel Lens.

INSTITUTION:

Northrup, Inc.
302 Nichols Drive
Hutchins, TX 75141

PRINCIPAL INVESTIGATOR:

James Northrup

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32251

STARTING DATE: 10/01/76

DURATION: 19 months

AMOUNT: \$334,852

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this study is to develop improved pond design and operation procedures so as to make the solar pond a practical heat collection and storage device.

The emphasis of the project is on the following areas:

1. Further test of procedures for measurement and control of transparency.
2. Experimental, theoretical and numerical study of convection layer dynamics.
3. Calculation and accurate measurement of perimeter heat losses.
4. Continuing operation of the present Farm Science Review pond.
5. Construction of a new and deeper pond for research and all-winter heating.
6. Continuing collaboration with the Wooster solar pond program.
7. Collection of data from non-research ponds constructed elsewhere.
8. Improved public communication.

Research to date has demonstrated the stability of the salt-gradient zone and has provided adequate procedures for dealing with most aspects of solar pond design and operation. If solar ponds can be made to provide the calculated amount of winter heat, they will be the lowest cost solar heating system available. With existing construction technology, they could immediately be put to widespread use.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Salt Gradient Solar Pond Development

INSTITUTION:

Ohio State University Research
Foundation
Dept. of Physics, Ohio State Univ.
Columbus, OH 43210

PRINCIPAL INVESTIGATOR:

Carl E. Nielsen

CONTRACT NUMBER: EG-77-G-04-4155

STARTING DATE: 09/30/77

DURATION: 19 months

AMOUNT: \$184,945

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective is to accelerate bringing the "Winston" compound parabolic collector to the market. In order to make this a viable system, mass-production methods must be developed. Systems engineering will be performed so that the collector installs at the least possible cost. A complete thermal performance and maintenance evaluation of individual collector components and collector system and verification by testing will insure that it will perform at high efficiency in the temperature ranges of 200 to 450°F.

As part of the evaluation of collector system cost effectiveness, optimum sizing for the collector and the methods of mounting the collectors in different types of applications are investigated. Not only a collector module, but also the associated manifolding and support structure required for various applications will be developed.

The advantage of this collector system is the availability of high temperature with no moving parts; it collects both diffuse and direct radiation; has high performance on a year-round basis without seasonal adjustments; has high transmittance non-breakable cover; is cost-competitive with high quality flat plate collectors and priced below "high performance collectors" presently available. The Winston collector is suitable for space and domestic water heating, processing hot water, processing steam, absorption cooling, Rankine cycle cooling, desalinization, and solar electric production.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

"Winston" Parabolic Compound
Collector Development

INSTITUTION:

Owen & Mayes/Solar of Virginia
8503-A Timberlake Road
Lynchburg, VA 24502

PRINCIPAL INVESTIGATOR:

J. M. Owen

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

15 months

AMOUNT:

\$115,000 (Requested)

PROJECT DESCRIPTION

The objective of this project is to design a complete draining system to be used in conjunction with the SUNPAKTM evacuated tube collector. Benefits include avoiding significant heat losses during overnight periods, avoiding problems associated with collector boil-out during system failure, and avoiding system freeze-up in winter. Also, a fully drained collector provides safe access for maintenance at any time. The preferred approach to SUNPAKTM draining is by modifications to the collector or system, since this could be achieved with no major changes in manifolding, flow configuration, or other features of the present baseline design. An alternate approach would involve more major changes to the baseline design and flow configuration.

The work consists of four major tasks:

Task 1—Feasibility study.

Task 2—Proof of concept testing and configuration definition.

Task 3—Full scale testing.

Task 4—Documentation and reporting.

The program output will be precise drawings and recommendations for a configuration that allows complete draining, supported by relevant test data and analysis.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Draining of the SUNPAKTM
Evacuated Tube Collector

INSTITUTION:

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, OH 43666

PRINCIPAL INVESTIGATOR:

Y.K. Pei

CONTRACT NUMBER: EG-77-C-04-4150

STARTING DATE: 09/30/77

DURATION: 13 months

AMOUNT: \$150,000

PROJECT DESCRIPTION

The objective of this project is the evaluation of an advanced evacuated solar energy collector using air as the heat transfer fluid. The performance goal is an air exit temperature of 250°F at a collection efficiency of 40%. An advanced liquid-heating collector has been fabricated and is being marketed by Owens-Illinois. This collector demonstrates the feasibility of the evacuated, all-glass, tubular design.

This program will modify the successful design to utilize air as the collector fluid. The major program emphasis will be on the installation and testing of a multi-tubular collector array and the evaluation of its air flow characteristics in terms of flow distribution and pressure drop, and its thermal performance in comparison with the liquid collector design.

The program is divided into the following tasks:

- Task 1—Air system definition and test plan.
- Task 2—O-I liquid system installation and test.
- Task 3—Air collector system installation.
- Task 4—O-I hybrid system installation and test.
- Task 5—Air collector system test and evaluation.
- Task 6—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- "Evaluation of an All-Glass, Evacuated, Tubular, Non-Focusing, Non-Tracking Solar Collector Array," Task 1 Report, August 10, 1976.

PROJECT TITLE:

Evaluation of an All-Glass, Evacuated,
Tubular, Non-Focusing, Non-Tracking,
Air-Heating, Solar Collector Array

INSTITUTION:

Owens-Illinois, Inc.
Corporate Technology
P. O. Box 1035
Toledo, Ohio 43666

PRINCIPAL INVESTIGATOR:

Kenneth Moan

CONTRACT NUMBER: EY-76-C-02-2919

STARTING DATE: 07/01/76

DURATION: 11 months

AMOUNT: \$111,232

PROJECT DESCRIPTION

The purpose of this project is to investigate two of the mechanisms which may limit the life of the SUNPAKTM evacuated, tubular collector by degrading its vacuum. These are outgassing and helium permeation. The former will be investigated under accelerated life conditions so as to determine the time-dependent composition of the emitted gas. The results will be used to determine the feasibility of lowering the cost of the tube by eliminating vacuum bake-out prior to sealing.

The rate of helium permeation into the vacuum jacket will be measured at elevated temperatures. At the same time, the degradation of thermal performance of the vacuum jacket as a function of internal helium pressure will be measured. The results will make possible a prediction of tube life to the extent that it depends on vacuum integrity.

The project is divided into the following tasks:

- Task I—Outgassing rate and composition of emitted gas.
- Task II—Evaluation of elimination of bake-out.
- Task III—Rate of helium permeation into jacket under operating conditions.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Evaluation of SUNPAKTM Tube
Vacuum Durability

INSTITUTION:

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, Ohio 43666

PRINCIPAL INVESTIGATOR:

F. H. Brown

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$298,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

In an evacuated, all glass tubular collector, three surfaces can utilize an anti-reflective coating: two surfaces of the cover tube and the selective coating itself. The purpose of this project is to analyze the cost effectiveness of coatings for these surfaces, given that the greatest incremental benefit could be realized by coating the solar selective surface of the absorber tube.

First, anti-reflective coating materials for the solar selective surface will be evaluated; second, optimal application techniques will be assessed; and finally, prototype collectors will be prepared and evaluated for performance and stability.

The project is divided into the following tasks:

Task I—Materials study.

Task II—Materials compatibility.

Task III—Application techniques.

Task IV—Prototype samples.

Task V—Performance.

Task VI—Long-term stability.

Task VII—Analysis.

Task VIII—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Improved Collector Efficiency
Through the Use of Anti-Reflective
Coatings

INSTITUTION:

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, Ohio 43666

PRINCIPAL INVESTIGATOR:

L. Spanoudis

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 20 months

AMOUNT: \$189,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The purpose of this project is to examine the thermal degradation of thin film Al/black chrome degradation mechanisms both by analyses of the actual thin film coatings and by study of bulk reactions.

The thermophysical and thermochemical properties of glass will also be studied and their effect on coating degradation assessed. Experiments to evaluate selected methods for minimizing these effects are outlined.

An investigation into the possible use of barrier coatings is proposed with the intention of preventing reaction between coatings and glass resulting from diffusion.

The project plan includes the following major tasks:

- Task I—Literature search.
- Task II—Characterization.
- Task III—Parallel characterization.
- Task IV—Thermophysical, thermochemical properties of borosilicate glass.
- Task V—Protective undercoats.
- Task VI—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Improvement of Solar Selective
Coating Stability

INSTITUTION:

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, Ohio 43666

PRINCIPAL INVESTIGATOR:

L. Spanoudis

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

24 months

AMOUNT:

\$166,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Owens-Illinois will design, develop and deliver the SUNPAK™ collector. This air collector uses a vacuum as insulation in the tube array and a selective coating on the inner tube absorber. A working liquid collector design using the same configuration will be developed.

Marshall Space Flight Center is monitoring equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Further Development of an Air/Liquid
Collector With Vacuum Insulation

INSTITUTION:

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, OH 43666

PRINCIPAL INVESTIGATOR:

T. W. Brock

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32259

STARTING DATE: 11/01/76

DURATION: 19 months

AMOUNT: \$275,684

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project applies experience with trickle-type lightweight concrete water heaters to low temperature air heating collectors. This is accomplished by optimizing, designing and building three different types of low temperature integral wall air heaters all of which are "building blocks" intended to comprise part or all of a south-facing wall. Two of the intended configurations are "precision blocks," and are bonded together in the wall with epoxy resin—a technique which is already gaining favor with conventional concrete blocks. The third scheme uses conventional blocks and mortar, and may be retrofitted to an existing building. Fairly detailed mathematical models of collector performance will be devised and careful comparisons made between the predictions of these models and actual performance. The project also includes an analysis of thermal stress effects, and the structural load capabilities of the various designs.

This project is divided into the following tasks:

Task 1—Define optimum materials and establish thermal and structural characteristics.

Task 2—Analytical optimization.

Task 3—Design.

Task 4—Tool construction.

Task 5—Preliminary performance measurements.

Task 6—Field evaluation.

Task 7—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

A Proposal to Develop Very
Low Cost Non-Concentrating Collectors

INSTITUTION:

Payne, Inc.
1910 Forest Drive
Annapolis, MD 21401

PRINCIPAL INVESTIGATOR:

P. R. Payne

CONTRACT NUMBER: EG-77-G-04-4138

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$129,261

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Semiconductor films with an appropriate band gap (20.5 to 1.25 eV) have a high absorption coefficient in the solar spectrum region and high transmission in the IR thermal-emission region. Thus, they make nearly ideal selective surfaces. However, semiconductor films also have a high reflectance above their absorption edge which limits the total absorption. A coating which would retain the advantages of the semiconductor's selectivity and also reduce the reflectance from the present values of 30-50% to a level of less than 2% would be a significant advancement. A controlled-surface morphology Ge film as a selective absorber surface, or a substrate such as a selective absorber surface, or a substrate such as a central heat transfer pipe in a concentrating type collector can satisfy this requirement of low reflectance and also have the advantage of simplicity in design and manufacture.

The purpose of this research is to develop the basic and applied understanding of the preparation, characterization and properties of Black Germanium Films so as to determine, if feasible, the conditions necessary for large scale production of these films for use as optimized selective absorber surfaces in solar collector.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract — No report available

PROJECT TITLE:

Black Germanium Selective
Absorber Surfaces

INSTITUTION:

Pennsylvania State University
Materials Research Laboratory
University Park, PA 16802

PRINCIPAL INVESTIGATOR:

K. Vedam
R. F. Messier

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$67,000 (Requested)

PROJECT DESCRIPTION

The objective of the study is to examine the feasibility of using carbon black-impregnated cross-linked polyethylene (XLPE) as a material for solar collector absorbers. This material has the potential for low cost, long service life and ability to withstand repeated freezing of water within the absorber.

The initial phase of the study has five tasks:

Task 1—Extrusion of 2000 ft. of 5/16" OD tubing.

Task 2—Freeze-thaw testing of 10-ft. coils of tubing filled with water at pressure between 30 and 240 psi.

Task 3—Fabrication of a simple water heating collector out of coiled tubing.

Task 4—Collector performance and equilibrium testing at Los Alamos Scientific Lab.

Task 5—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- "The Development of a Freeze-Tolerant Solar Water Heater Using Crosslinked Polyethylene as a Material of Construction," Final Report for the period June 18, 1976 - October 1, 1977.

PROJECT TITLE:

Development of a Freeze-Tolerant
Solar Water Heater Using Cross-Linked
Polyethylene

INSTITUTION:

Polyset, Inc.
7 Summer Street
Manchester, MA 01944

PRINCIPAL INVESTIGATOR:

John M. Bradley

CONTRACT NUMBER: EY-76-C-02-2956

STARTING DATE: 05/01/76

DURATION: 17 months

AMOUNT: \$53,512

PROJECT DESCRIPTION

The objective of this project is to evaluate elevated temperature-resistant sealants based upon silicones, fluorocarbons, acrylic elastomers and ethylene propylene terpolymers. In addition, sealants prepared from polyethers, chlorinated polyethylene, chlorinated polyethers and polythioethers will be similarly evaluated. Candidates are to be modified to have maximum solids, heat and environmental resistance, and good adhesion retention.

Application properties similar to those found desirable in current manufacturing practice will be provided. In addition to standard laboratory testing, performance confirmation will be provided with small-scale units. It is anticipated that at least two high temperature sealants will be developed, probably differing in cost and high temperature range. Both sealants will have a solids content of at least 85% and "cure to handle" in 24 hours or less. Complete room temperature up (to 120°F) vulcanization in this period may not occur, but it will be adequate for storage and installation. Adhesion to glass, aluminum and galvanized iron will be provided.

The project is divided into the following tasks:

Task 1—Examination of current materials.

Task 2—Preparation and examination of new sealants.

Task 3—Effect of organic modifiers on performance.

Task 4—Effect of stabilizers and pigmentation on performance.

Task 5—Modifications for improved adhesion, including primers.

Task 6—Effect of formulation and manufacturing procedures on application.

Task 7—Confirmation of properties of final sealants.

Task 8—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Development of 400°F Resistant Sealants
for Flat Plate Solar Collector Construction and Installation

INSTITUTION:

Products Research & Chemical Corporation
2919 Empire Avenue
Burbank, CA 91505

PRINCIPAL INVESTIGATOR:

Lester Morris

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$71,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this twenty-four-month program is to conduct research leading to a more cost effective high-temperature evacuated collector. The strategy is to combine existing technology in the areas of amorphous silicon, glass fabrication and thermal design under the auspices of a single development team which will bring these technologies to bear on the problem of high temperature heat collection.

There are three areas of concentration: a) development of a low-cost, stable, semi-conductor, selective absorber which has potential for application as a photovoltaic converter, b) development of a non-circular envelope that can act as the substrate for a low-concentration (possible 3X) optical system, c) development of antireflection and infrared reflection films for the envelope.

The project is divided into the following tasks:

Task I—State-of-the-art assessment.

Task II—Mathematical modeling and performance prediction.

Task III—Selective absorber investigation.

Task IV—Optical coating investigation.

Task V—Collector geometry study.

Task VI—Prototype model fabrication and testing.

Task VII—Production and cost study.

Task VIII—Life and reliability assessment.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

High Temperature Evacuated Tubular Collector

INSTITUTION:

RCA Corporation
Front and Cooper Streets
Camden, NJ 08102

PRINCIPAL INVESTIGATOR:

M. Crouthamel

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

24 months

AMOUNT:

\$279,000 (Requested)

PROJECT DESCRIPTION

The purpose of this project is to develop a solar collector package consisting of a concentrating reflector, a cavity boiler receiver with fluxtrap and a programmable control system. This system is based on a previously tested collector design which emphasizes simplicity of construction and low cost. The design uses reflectors to focus on one area. Concentration ratios from 10 to several hundred are possible.

This project is divided into the following tasks:

Task I—Concentrator design.

Task II—Receiver design.

Task III—System integration and control.

Task IV—Weather data gathering and analysis.

Task V—Full term component testing.

Task VI—Evaluation and reporting.

The desired end product is an automated system which delivers 250°C steam at a 30 to 60 kilowatt rate within 1 minute of turning the system on.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Development of a Focusing Solar
Collector Energy Conversion

INSTITUTION:

Rensselaer Polytechnic Institute
School of Engineering
Troy, NY 12181

PRINCIPAL INVESTIGATOR:

A. A. Burr

CONTRACT NUMBER: EG-77-G-04-4161

STARTING DATE: 09/30/77

DURATION: 24 months

AMOUNT: \$222,035

PROJECT DESCRIPTION

The optical and thermal properties of plastic glazings are sensitive to prolonged exposure to solar ultraviolet radiation/weathering. It is the purpose of this project to evaluate several types of organosilicones as glazing materials. These are in the form of commercially available, reinforced and non-reinforced silicone elastomer membranes, optically clear silicone rubbers, reinforced silicone rubber sheets, and reinforced, low temperature curing, transparent potting compounds. The proposed organosilicones were chosen because of their superior weathering characteristics and commercial availability. The organosilicones that are found to be the best in the preliminary evaluation will be formed into glass fiber reinforced films, Teflon fiber reinforced films, and glass or Teflon net (fabric) supported films, and evaluated for absorption characteristics and weathering resistance. In a different approach an optically clear polydimethylsiloxane rubber film will be coated on both sides with a hard, abrasion-resistant polymonomethylsiloxane, thus forming a laminate structure. Finally, polyphenyl and polyphenylmethylsiloxane compositions will be cast into sheets and evaluated for glazing applications.

The program will be divided into the following tasks:

Task 1—Preliminary screening.

Task 2—Detailed evaluation, including economic analysis.

Task 3—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Non-Glass Glazings

INSTITUTION:

Research Triangle Institute

P. O. Box 12194

Research Triangle Park, NC 27709

PRINCIPAL INVESTIGATOR:

R. Liepins

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

24 months

AMOUNT:

\$161,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The major objective of this project is to optimize and characterize fire retardant, lightweight polyimide foams with improved insulation properties and a wide spectrum of rigidity and density for use in a variety of solar system components to be protected from solar heat.

A second objective is to provide the basis for cost effective, pilot plant scale processes for producing these foams. Improvement of foam properties will result from refinement of process parameters or from modification of the polymer structure.

The rigidity and density of these foams can be increased by thermal processes to yield rigid shapes for use as hardware to replace structural glass thermal insulation or plastic foams which burn or melt when impinged by high heat sources. Major considerations, in addition to fire behavior, will be minimum water absorption, durability, strength, thermal insulation, outgassing, low cost and ease of manufacturing.

In the final test, large prototype samples would be prepared and shipped to DOE for verification and application.

The program will be divided into the following tasks:

- Task I—Project planning.
- Task II—Flexible foams.
- Task III—Rigid foams.
- Task IV—Advanced testing.
- Task V—Prototype production.
- Task VI—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Development of Polyimide Materials
for use in Solar Energy Systems

INSTITUTION:

Solar (International Harvester Group)
2200 Pacific Highway
San Diego, CA 92138

PRINCIPAL INVESTIGATOR:

J. Gagliani

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$132,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project consists of analyzing, optimizing, constructing and testing improved non-tracking, cylindrical Fresnel lens concentrators. Two new concepts will be treated: (a) a two-point corrected, wide-angle lens technique which gives Fresnel lenses $\pm 23^\circ$ of acceptance angle coverage, (b) the live images thus produced are further concentrated using a kind of optical envelope to concentrate the focal field onto a small receiving rod.

Investigation will also include studies of selective surfaces for lens and mirrors and energy loss mechanisms. Performance will be compared with tracking Fresnel lens systems.

Working temperatures in the order of $200^\circ\text{--}300^\circ\text{F}$ are expected from Fresnel lenses with efficiencies of over 50% and a non-tracking system.

The program will be divided into the following tasks:

- Task 1—Fresnel lens design.
- Task 2—Design lens and subreflector system.
- Task 3—Construct concentrator (ICC).
- Task 4—Thermal efficiency and operating temperature testing.
- Task 5—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Imaging Collapsing Concentrators

INSTITUTION:

Solar Energy Technology, Inc.
Civil Terminal Building
L. G. Hanscom Field
Bedford, MA 01730

PRINCIPAL INVESTIGATOR:

C. J. Sletten

CONTRACT NUMBER: EG-77-G-04-4163

STARTING DATE: 09/30/77

DURATION: 7 months

AMOUNT: \$57,341

PROJECT DESCRIPTION

The objective of this study is to improve the thermal performance of solar air-heating collectors by increasing the forced-convection heat transfer between the air stream and absorber plate.

The program is divided into three tasks:

Task 1—Review of existing technical and patent literature.

Task 2—Construction and comparative performance testing of several full scale (2' x 10') collector modules of the most promising configurations. Manufacturing costs in various production volumes will be estimated.

Task 3—Construction and testing of a 108 square foot collector array of the most promising design from the standpoint of thermal performance and manufacturing cost. The array will be operated simultaneously with an equal area of standard design collectors over an entire heating season.

The results of the above tests, coupled with a vigorous cost analysis, should provide the basis for commercialization of the improved collector design.

IMPORTANT REPORTS OR PUBLICATIONS

- "Review of Technical Literature and Patents," Report No. 1, August 8, 1976.
- "Colo-Appel, B.E., Lof, G.O., and Shaw, L.E., "Flat Plate Air-Heater Improvements."

PROJECT TITLE:

Improvement of Solar Air Heaters

INSTITUTION:

Solaron Corporation
Suite 300, Galleria Tower
720 S. Colorado Boulevard
Denver, CO 80222

PRINCIPAL INVESTIGATOR:

Les Shaw

CONTRACT NUMBER: EY-76-C-04-3713

STARTING DATE: 05/01/76

DURATION: 19 months

AMOUNT: \$99,495

PROJECT DESCRIPTION

Present air collectors do not operate at acceptable efficiencies at high temperatures (170°F-230°F). The purpose of this study is to develop an improved design air heating solar collector suitable for this outlet temperature range operation. The design uses evacuated tubes, similar in dimension to fluorescent lamps, as a convection suppressing inner cover and either a selectively coated absorber or infrared mirrors on the lower half of the tubes to reduce radiative losses. This low heat loss cover system is then combined with an enhanced heat transfer system between the air and absorber, to form an exceptionally efficient collector.

This work consists of the following tasks:

- Task 1—Initial collector design and fabrication.
- Task 2—Initial collector testing.
- Task 3—Final collector design and fabrication.
- Task 4—Final collector tests.
- Task 5—Evaluation.
- Task 6—Reporting.

The potential cost effectiveness of this collector is due to the relatively low cost of evacuated tubes in these sizes.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Development of a High Performance
Air Collector Through Use of an
Evacuated Tube Cover System

INSTITUTION:

Solaron Corporation
Suite 300, Galleria Tower
720 S. Colorado Blvd.
Denver, CO 80222

PRINCIPAL INVESTIGATOR:

Rodney L. Oonk

CONTRACT NUMBER:

STARTING DATE:	Under negotiation
DURATION:	12 months
AMOUNT:	\$156,000 (Requested)

PROJECT DESCRIPTION

This work is a continuation of a development effort for the production of low-cost, lightweight flat-plate collectors.

Plans include the completion of the design and construction of a pre-prototype for testing at an accredited solar testing laboratory.

Any needed modifications will then be made and a lot of 20 final prototypes will be fabricated for statistical testing and on-site installation. Throughout the work frequent analyses will be made to assure that the collector is made available at contractor level for under \$5.00/sq. ft., based on 1977 materials cost.

The project is divided into nine tasks:

Task 1—Collector design—includes drawing production and prototype testing of components.

Task 2—Mechanical design—testing of mechanical design as to manufacturability at medium and high levels of production.

Task 3—Prototype parts tests—produce parts from drawings for prototype tests.

Task 4—Reflective surface tests—final decision as to reflective surface to be used in the panel.

Task 5—Fabrication of one unit and tests—fabrication and performance test sequence as specified in ASHRAE Standard 93-77.

Task 6—Multiple fabrication and tests—fabrication of 20 prototypes and testing of a sample collector.

Task 7—On site tests—further determine any installation or operating problems.

Task 8—Cost monitoring and evaluation.

Task 9—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Research and Development of
Non-Concentrating Collectors for
Solar Heating and Cooling Applications

INSTITUTION:

Solation Products, Inc.
385 Toll Gate Road
York, PA 17403

PRINCIPAL INVESTIGATOR:

R. S. Newton

CONTRACT NUMBER: EG-77-G-04-4137

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$98,899

PROJECT DESCRIPTION

This study consists of extensive thermal/mechanical testing of the "air heater" collector configuration to verify its thermal and pressure drop characteristics and additional engineering design to reduce costs and improve reliability.

The "air heater" collector design uses a combination of unique collector heat transfer design and mechanical configurations to connect adjacent collector panels so that many (up to 10) collector panels can be connected in series without excessive pressure drops (1 in. H_2O or less). This eliminates the need for external ducts for most systems and greatly reduces the installed cost of the collector array. Also, the collector heat transfer arrangement results in a higher thermal efficiency than for most air collector arrangements.

The project is divided into five tasks:

Task 1—Preliminary collector panel testing.

Task 2—Collector array test and evaluation-system installed.

Task 3—Evaluation of half black absorber.

Task 4—Value engineering.

Task 5—Reporting.

The result of this effort will be a highly engineered air collector capable of integration into low cost collector arrays without the need for expensive and thermally inefficient heater ducts. This will, in turn, greatly enhance the prospect for solar space heating in many applications.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Double Absorber Plate

INSTITUTION:

Sun Systems
170 Granite Avenue
Boston, MA 02124

PRINCIPAL INVESTIGATOR:

P. A. Hayes

CONTRACT NUMBER: EG-77-G-04-4148

STARTING DATE: 09/30/77

DURATION: 10 months

AMOUNT: \$73,010

PROJECT DESCRIPTION

This is a research and development project of a Fresnel lens concentrator for solar heating applications. The work is directed toward a 10X tracking lens concentrator but results will apply in the range of 3X to 50X.

Included are a comprehensive examination of parameters and their effect on lens performance as well as predicted performance results with two or more parameters varying. The theoretical effort will be substantiated by experimental measurements. A 10X lens will be designed and produced in conformance with the upgraded model. The conformance expectations of this lens design will be confirmed by tests.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Cast Acrylic - Fresnel Lens

INSTITUTION:

Swedlow Inc.
12122 Western Avenue
Garden Grove, CA 92642

PRINCIPAL INVESTIGATOR:

D. Holdridge

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$134,000 (Requested)

PROJECT DESCRIPTION

This is a four phase program to develop methods for producing low-cost selective absorber surfaces by DC reactive sputtering. Recent advances in sputtering technology, using magnetically confined plasmas, permit coatings to be deposited over large areas with significantly increased deposition rates.

This technology is already being used for various production applications. The proposed program extends its use to solar selective coatings. Two representative absorber coatings, with wide potential for application, will be selected for development as a vehicle for evaluating the sputtering technology. One phase will examine a sputter-deposited substitute for the graded oxide-metal coating (black chrome) that is formed by electroplating. The coatings will be deposited on aluminum foil for subsequent attachment to flat plate collectors. This phase will illustrate the graded-interface capabilities of sputtering. A second phase will illustrate the multilayer capabilities of sputtering by depositing an Al_2O_3 -Mo- Al_2O_3 coating that has been found to have excellent thermal stability and therefore is suitable for concentrating collectors. In two proof-of-concept phases, metal oxide coatings will be continuously deposited on aluminum foil, and hollow cathodes will be used to deposit Al_2O_3 -Mo- Al_2O_3 coatings over short tubular sections. All of the basic sputtering equipment required to pursue the program is presently available.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Selective Surfaces

INSTITUTION:

TELIC Corporation
1631 Colorado Avenue
Santa Monica, CA 90404

PRINCIPAL INVESTIGATOR:

J. A. Thornton

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION::

15 months

AMOUNT:

\$89,000 (Requested)

PROJECT DESCRIPTION

Seven site visits will be conducted to determine whether supporting and collector structures can be materially reduced with resultant cost savings. The visits will determine what collector systems are candidates.

The program is divided into the following tasks:

Task 1—On-site evaluations.

Task 2—Design information analysis.

Task 3—Suitability of codes, design load and criteria.

Task 4—Application of recent wind technology.

Task 5—Suitability of testing facilities.

Task 6—Reporting.

Task 7—Structural integrity.

IMPORTANT REPORTS OR PUBLICATIONS

- "Structural Integrity of Solar Collectors."

PROJECT TITLE:

Structural Integrity of Solar
Collectors

INSTITUTION:

Texas A&M University
Texas Engineering Experiment Station
FE Box H
College Station, TX 77843

PRINCIPAL INVESTIGATOR:

Howard Chevalier

CONTRACT NUMBER: EY-76-S-05-5130

STARTING DATE: 06/15/76

DURATION: 24 months

AMOUNT: \$48,014

PROJECT DESCRIPTION

The objective of this project is the development of heat pipes which satisfy the requirements of tubular solar collectors and are cost compatible with the market needs.

Previous research has included a search for candidate working fluids; the design and test of preliminary freeze-resistant water heat pipes; demonstration of water compatible steel heat pipes; investigation of materials, fabrication processes and closure methods for heat pipes and considerable thought on the means, technical problems and advantages associated with integrating heat pipes into tubular collectors. This project is the end product of that prior work. In critical areas, such as fluid selection, it is recognized that an ideal fluid will probably not be identified. Alternate, parallel paths are proposed to accommodate the shortcomings of less-than-ideal fluids such as water. This work represents a practical approach to product design, not an abstract investigation in materials research.

The project is divided into the following tasks:

- Task 1—Design requirements.
- Task 2—Component design.
- Task 3—System integration design review.
- Task 4—Fabrication and initial test.
- Task 5—Design verification.
- Task 6—Project management.

The end products of this work will be a proven volume-producible heat pipe and a report describing its development.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Cost-Effective Solar Collectors
Using Heat Pipes

INSTITUTION:

Thermacore, Inc.
P. O. Box 135
Leola, PA 17540

PRINCIPAL INVESTIGATOR:

G. Y. Eastman

CONTRACT NUMBER: EG-77-C-04-4099

STARTING DATE: 09/01/77

DURATION: 18 months

AMOUNT: \$219,088

PROJECT DESCRIPTION

This project is the optimization of the "base case air heater" with respect to performance, cost, durability, ease of fabrication and building integration.

The specific objectives of this work are:

1. Development of sufficient technical and economic data, drawings and other information to promote the application of the design, and provide for its evaluation.
2. Development of the air heater design so that it can be cost-effectively integrated into building structures in a majority of building situations with a minimum of construction quality problems.
3. Development of sufficient technical and economic data, drawings and other information to promote the application of the design, and provide for its evaluation.

The specific tasks are:

- Task 1—Assessment of site fabricated solar air heaters.
- Task 2—Assessment of material availability.
- Task 3—Sensitivity analysis of site fabricated solar air heater performance.
- Task 4—Design of air heater for cost effective integration into building structure including minimal sensitivity to poor quality installations.
- Task 5—Assessment of reliability and durability.
- Task 6—Design commitment.
- Task 7—Test program for performance and building integration.
- Task 8—Final design.
- Task 9—Regional economic and performance projections.
- Task 10—Production and dissemination of application and evaluation documents and required reports.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a Site Fabricated,
Building Integrated Air Collector

INSTITUTION:

Total Environmental Action, Inc.
Harrisville, NH 03450

PRINCIPAL INVESTIGATOR:

J. J. Coleman

CONTRACT NUMBER: EG-77-G-04-4123

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$92,076

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objectives of this research are to correlate the wavelength dependence (ca.300 nm-10 nm) of the optical constants of polycrystalline films of doped indium oxide (DIO) with structure, composition, and thermal history and to arrive at a useful model of the electromagnetic behavior of doped indium oxide so that one could predictably modify its optical constants and those of related metal oxides.

This study is expected to provide a better understanding of the relative contributions of interband and intraband transitions in DIO. It should provide information about the role of defects (especially oxygen vacancies and substitutional impurities) in regard to some of the optical frequency properties of DIO—particularly the near infrared optical mobility, the effective free carrier concentration, and the effective polarizability of the defect centers.

The work will be performed as follows:

- a) Measure the optical constants of films of doped indium oxide (DIO) as a function of structure, composition, and thermal history.
- b) Look for and attempt to measure an inhomogeneous profile for the optical constants in DIO.
- c) Attempt to devise one or more models that could be used to predictably modify the optical constants of DIO and/or related materials.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Studies for Predictably
Modifying the Optical Constants
of Doped Indium Oxide Films for
Solar Energy Applications

INSTITUTION:

Tufts University
Department of Electrical Engineering
Medford, MA 02155

PRINCIPAL INVESTIGATOR:

R. B. Goldner

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

18 months

AMOUNT:

\$67,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The "Solaris" water-trickle collector, developed by Dr. Harry E. Thomason, uses an inclined corrugated aluminum plate with a flat black coating. The plate is heated by solar radiation passing through a transparent glass cover. A manifold at the top of the plate distributes water to each corrugation. The water is heated by the plate as it flows down the corrugations to a trough at the bottom which directs the water to a single outlet. The rear of the plate is insulated with fiberglass.

Thermal performance characteristics of the "Solaris" water-trickle collector have been experimentally determined using the University of Virginia Solar Energy Research Facility. A theoretical model of the collector has also been used to determine the sensitivity of the collector's performance to such variables as ambient temperature, mass flow rate, insolation rate, wind and glazing cleanliness. It was found that ambient temperature and wind are the two major variables which influence collector performance.

Experimental measurements and the model were also used to demonstrate how design changes, such as glazing spacing, glazing material, double glazing and condensate suppression influence the performance of the water-trickle collector. Improved glazing materials and double glazing were the design changes found to significantly improve the collector's performance.

IMPORTANT REPORTS OR PUBLICATIONS

- "Engineering Analysis and Testing of Water Trickle Solar Collector." Progress Report, Report No. 1-ORO-4927-76-1.
- Beard, J. T., et al, "Analysis of Thermal Performance of 'Solaris' Water-Trickle Solar Collector," ASME Paper No. 76-WA/Sol-21.
- Beard, J. T., et al, "Thermal Performance of an Open Fluid-Film Solar Collector," Proceedings of the Flat-Plate Collector Conference, Orlando, Fla., February 1977.
- Beard, J. T., Iachetta, F. A., Lillpleht, L. U., Huckstep, F. L., and May, W. S. Jr., "Design and Operational Influences on the Thermal Performance of 'Solaris' Solar Collector," ASME Paper No. 77-WA/Sol-2.
- Huckstep, F. L., "Performance Parameters for Water-Trickle Solar Collector," master's thesis, University of Virginia, School of Engineering and Applied Science, Charlottesville, Virginia, May 1977.

PROJECT TITLE:

Engineering Analysis and Testing of
Water Trickle Solar Collector

INSTITUTION:

University of Virginia
School of Engineering
Charlottesville, VA 22901

PRINCIPAL INVESTIGATOR:

J. Taylor Beard

CONTRACT NUMBER: EY-76-S-05-4927

STARTING DATE: 06/01/75

DURATION: 24 months

AMOUNT: \$107,339

PROJECT DESCRIPTION

In the first and second phases of this project, methods of reducing heat losses from flat plate solar collectors were examined. The studies concentrated largely on the free convective heat transfer taking place in solar collectors of both honeycomb and non-honeycomb types. Topics examined included:

- a) Free convective heat transfer across inclined air layers constrained by honeycombs of cell shapes consisting of squares, hexagons and long rectangles;
- b) Free convective heat transfer across inclined air layers not constrained by a honeycomb, having both planar and v-corrugated boundaries.

Results from the honeycomb work are correlation equations which permit the design of a honeycomb to suppress free convection currents with reasonable accuracy. These equations were derived from measurements made on the University of Waterloo Natural Convection Apparatus. In this apparatus, the upper and lower bounding surfaces (or plates), corresponding to the glass cover and the absorber plate in the solar collector, are polished copper plates having low emissivity for thermal radiation.

In the third phase of the investigation, experiments will be carried out measuring conductive, radiant and free convective heat transfer across honeycombs for various combinations of plate (endwall) emissivity. Honeycombs to be tested will be mostly of plastic, of the type developed for solar collectors - for example the SOLAR-CORE mylar honeycomb developed by Hexcel Corporation. Aspect ratios from 2 to 10 will be investigated. Plate emissivities used will range from .06 to .92.

In conjunction with the experimental program will be an analytical program which will attempt to predict the radiant-conductive heat transfer across the honeycomb. Both analytical and numerical solutions to the problem will be undertaken, with the analytical treatments giving solutions for limiting cases for comparison.

IMPORTANT REPORTS OR PUBLICATIONS

- Cane, R.L.D., Hollands, K.G.T., Raithby, G.D., Unny, T.E., "Free Convection Heat Transfer Across Inclined Honeycomb Panels," Journal of Heat Transfer, 99, No. 1, Feb. 1977.

PROJECT TITLE:

Methods for Reducing Heat Losses
from Flat-Plate Solar Collectors,
Phase III

INSTITUTION:

University of Waterloo
Dept. of Mechanical Engineering
Waterloo, Ontario, Canada N2L 3G1

PRINCIPAL INVESTIGATOR:

K.G.T. Hollands

CONTRACT NUMBER: EY-76-C-02-2597

STARTING DATE: 02/01/76

DURATION: 12 months

AMOUNT: \$59,497

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

A cost effective medium temperature grooved foamglas solar air heater has recently been developed and tested. Air passes inside deep V grooves which are cut in a black slab of foamglas. The grooves act as effective radiation absorbers and a large hot heat transfer area relative to the smooth cold cover area. The foamglas also acts as an insulator and can be glued directly onto the shingles of an existing roof.

The purpose of this work is to investigate the air heater's thermal performance using different cover materials and the efficiency of a hybrid system where a series of air to water type heat exchangers are placed in the air return loop. Different cover materials and several heat exchangers in combination with the air type collector will be tested.

To determine the best construction technique different manifolding and cover sealing methods will be used. Some of the air heater configurations used are expected to cost less than \$1.00 per square foot.

The project is divided into the following task areas:

- Task 1—Collector design.
- Task 2—Construction of panels and instrumentation.
- Task 3—Collector and heat exchanger performance.
- Task 4—Data reduction.
- Task 5—Cost evaluation and performance comparison.
- Task 6—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Grooved Foamglas Solar Air Heater

INSTITUTION:

University of West Virginia
Morgantown, WV 26506

PRINCIPAL INVESTIGATOR:

J. L. Loth

CONTRACT NUMBER: EG-77-G-04-4087

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$106,578

PROJECT DESCRIPTION

This 12-month study will complete a design and manufacturing analysis of an evacuated tube solar collector module that is efficient and cost-effective. After the design has been optimized a description of the required production facilities, tooling and process specifications will be formulated. Costs for module manufacture will then be projected in sufficient detail to form, when coupled with an adequate market survey, the basis for a strategic funding decision.

Conservative estimates indicate a manufactured cost for the module of less than \$2.40 per square foot of active surface area. The cost of initial plant, tooling, and warehouse investment (excluding startup cost) is projected to be about \$2.1 million.

The project will be divided into nine tasks:

Task 1—Optimize absorber tube design.

Task 2—Determine resistance of tube to hailstone damage.

Task 3—Investigate coating for reducing outer envelope reflectance.

Task 4—Investigate vacuum deposition of selective coatings.

Task 5—Develop low-cost module isolation system.

Task 6—Design module pan and header.

Task 7—Specify production machines.

Task 8—Design production-line layout.

Task 9—Document study results.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Develop and Test Evacuated Tube

INSTITUTION:

Westinghouse Electric
1310 Beulah Road
Pittsburgh, Pa. 15235

PRINCIPAL INVESTIGATOR:

D. T. Beecher

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 month

AMOUNT:

\$311,000 (Requested)

PROJECT DESCRIPTION

The purpose of this project is to improve a forming fixture for the processing of aluminum parabolic shells for concentrators.

The project is divided into the following areas:

1. Forming Fixture:
 - a) Finalize forming fixture drawings.
 - b) Fabricate and assemble forming fixture.
 - c) Performance tests of forming fixture.
2. Concentrator Design:
 - a) Analysis of several small samples for time and aperture optimization.
 - b) Improvement of the working model receiver support design.
 - c) Continue preliminary work on the contour and dimensions of the full size trough shells.
3. Concentrator Fabrication and Test:
 - a) Fabrication of end receiver support from drawings. Concentrator shell material to be formed by a certified heat treatment oven.
 - b) Checking of line focus by use of a simulated receiver. Test for rigidity.
4. Evaluation and Reporting:
 - a) Performance evaluation of the concentrator based on quality of the tolerances obtained.
 - b) Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Parabolic Trough Forming

INSTITUTION:

O. G. Williams

R. L. Skaggs

3800 S. Decatur # 36

Las Vegas, Nevada 89103

PRINCIPAL INVESTIGATOR:

O. G. Williams

CONTRACT NUMBER: EG-77-G-04-4158

STARTING DATE: 09/30/77

DURATION: 6 months

AMOUNT: \$27,304

PROJECT DESCRIPTION

This project focuses on the development and optical evaluation of surface coatings on polymeric substrates which will downconvert the UV component of solar radiation into the visible region and will simultaneously inhibit photodegradation of the plastic glazings.

Coatings will be developed to adhere lanthanide trivalent ions on plastic substrates. They will then be tested, evaluated and compared to the optical and mechanical properties of coated systems. Solarization testing and development of an experimental methodology to assay the absolute and relative performance will also be performed. Cost-effectiveness analyses with the purpose of settling on optimum coating, coating method and substrate will follow. Finally, a scale-up of the coating operation to commercial scale will be investigated.

The project is divided into the following tasks:

Task 1—Coating design and testing.

Task 2—Solarization testing.

Task 3—Selection of optimum coating.

Task 4—Scale-up of coating method.

Task 5—Field testing.

Task 6—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract—No report available

PROJECT TITLE:

Polymer Surface Coatings for
Downconversion of UV Radiation
and Inhibition

INSTITUTION:

The University of Wisconsin at Madison
University Avenue
Madison, WI 53706

PRINCIPAL INVESTIGATOR:

W. M. Yen
H. Yu

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$303,000 (Requested)

PROJECT DESCRIPTION

The objective of this study is to obtain heat transfer relationships for natural convection between solar collector absorber plates and the collector transparent cover. The absorber plates are both flat and of the Vee-corrugated design, a shape particularly favorable for solar air heaters.

Mach-Zender interferometers and associated equipment are used to obtain accurate and detailed values of local and overall heat transfer parameters.

The program is divided into the following tasks:

Task 1-Experimental Investigation involves testing of flat plates; the design, construction and testing of Vee-groove geometries; and testing of a honeycomb geometry.

Task 2-Analytical Studies consists of solving the governing equations of energy and fluid motion using various finite difference techniques.

Task 3-Development of Correlations will provide heat transfer data in a generalized form, based on the results of Task 1 and 2.

Local and average heat transfer coefficients for natural convection between parallel plates have been experimentally studied using interferometric techniques. The experimental conditions were similar to those existing in flat-plate collectors. Correlations have been developed for the local and average heat transfer Nusselt numbers as functions of tilt angle and Grashof number. The results are useful in determining the top loss coefficient for flat plate collectors and, eventually, for finding means of minimizing these losses.

IMPORTANT REPORTS OR PUBLICATIONS

- "Natural Convection Characteristics of Flat Plate Collectors," Progress Report, April 1977.
- Randall, K. R., El-Wakil, M. M., and Mitchell, J. W., "Natural Convection Characteristics of Flat Plate Collectors," Proceeding of the 1977 Annual Meeting of the American Section of the International Solar Energy Society, Orlando Florida, June, 1977, Volume 1, Section 4.

PROJECT TITLE:

Interferometric Study of Natural
Convection Characteristics of Flat-
Plate and Vee-Corrugated Solar
Collectors

INSTITUTION:

University of Wisconsin
Solar Energy Laboratory
1500 Johnson Drive
Madison, WI 53706

PRINCIPAL INVESTIGATOR:

M. M. El-Wakil
John W. Mitchell

CONTRACT NUMBER: EY-76-S-02-2971

STARTING DATE: 06/01/76

DURATION: 23 months

AMOUNT: \$70,360

2. THERMAL STORAGE/HEAT EXCHANGERS

PROJECT DESCRIPTION

A quantitative analysis of the effects of various degrees of temperature stratification on the overall performance of solar energy systems will be conducted with the TRNSYS code to determine potential benefits and guidelines in developing more highly stratified tanks.

Existing one dimensional stratification codes will be evaluated and tested against available experimental data. An improved one dimensional code, which provides a more realistic and accurate modeling capability, but is still quick and economical to run, will be developed. This code is intended to provide a superior, but simple and inexpensive, water tank heat storage design tool for solar system designers using TRNSYS type programs. These improved codes will also be used in further studies of the optimum interaction of temperature stratified heat storage with the overall solar system performance.

A detailed experimental apparatus, incorporating full two-dimensional temperature measurements and capable of producing three-dimensional temperature profiles in an operating heat storage tank, with realistic inputs (weather data and solar insolation) and load outputs, will be constructed. This apparatus will be used to provide detailed, reliable and realistic data for the validation of the two and three dimensional, transient, hydrodynamic temperature stratification codes under development at Argonne National Laboratory.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Computer Modeling of Thermal
Stratification in Water Tanks

INSTITUTION:

University of Alabama in
Huntsville
School of Science and Engineering
P. O. Box 1247
Huntsville, AL 35807

PRINCIPAL INVESTIGATOR:

S. T. Wu

CONTRACT NUMBER: EG-77-S-02-4479

STARTING DATE: 09/29/77

DURATION: 12 months

AMOUNT: \$90,000

PROJECT DESCRIPTION

Current gas heaters for domestic hot water have several problems which make them unsuitable for use as a backup for solar heated DHW systems:

- a. Their central flue produces continuous standby losses of a large magnitude.
- b. A significant fraction of these standby losses must be made up with gas. The gas heater is too tall to mount on top of the solar tank, so as to have a thermosyphon replacement of standby losses from thermal storage. It is expensive to put in a second pumped loop to replace standby losses.
- c. An electronic pilot should be used.

In typical (non-solar backup service) conditions the efficiency of a normal gas DHW heater is about 50% (Consumer Reports, March 1976, pp. 165-169). In solar backup service it is likely to be much worse.

In this project Altas will develop a gas backup heater aimed at solving this difficulty. An electronic pilot will be used. The heater will be mounted on top of the solar tank, with conductive coupling on the down flow of heat, convective coupling on up flow. A one-way (gravity condensate return) heat pipe will be used to feed gas heating to the tank, with a probable firing efficiency of about 75-80%. Standby heat losses for a 10-15 gallon, 140°F (single family) backup heater for a full year can be kept at around 500,000 Btu. Virtually all of these losses will be supplied by solar, not gas.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

The Development of a Gas Backup Heating Water Tank Properly Integrated with Solar Heated Domestic Water Storage Tanks

INSTITUTION:

Altas Corporation
500 Chestnut Street
Santa Cruz, CA 95060

PRINCIPAL INVESTIGATOR:

Francis de Winter

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

24 months

AMOUNT:

\$197,000 (Requested)

PROJECT DESCRIPTION

This project is a comprehensive survey and analysis of the most cost-effective methods of transferring heat from the solar collector to a water storage system. Project emphasis is on those exchange systems which either minimize or eliminate the problems of freezing and corrosion. Initially, a data compilation on commercially available heat transfer fluids and heat exchangers was performed. The remainder of the project consists of detailed analyses and evaluation of specific heat exchange methods. These include: evaporating collector-condensing exchange, double loop exchange, liquid-liquid exchange, and traced (heat exchanger jacketed) tank systems. With the double loop and traced tank systems, computer modeling is to be used in operational simulation and design optimization.

IMPORTANT REPORTS OR PUBLICATIONS

- "Toxicological Evaluation of Liquids Proposed for Use in Direct Contact Liquid-Liquid Heat Exchangers for Solar Heated and Cooled Buildings."
- "A Direct Contact Liquid-Liquid Heat Exchanger for Solar Heated and Cooled Buildings."
- Annual Progress Report for Period February 1, 1976 - July 31, 1977, Report No. C00-2867-2.

PROJECT TITLE:

Investigation of Methods to Transfer
Heat from Solar Liquid-Heating
Collectors to Heat Storage Tanks

INSTITUTION:

Altas Corporation
500 Chestnut Street
Santa Cruz, CA 95060

PRINCIPAL INVESTIGATOR:

Francis de Winter

CONTRACT NUMBER: EY-76-C-03-1238

STARTING DATE: 03/15/76

DURATION: 20 months

AMOUNT: \$60,085

ERDA CONTRACT
EY-76-C-03-1238
ALTAS CORPORATION

PROJECT DESCRIPTION

This project will develop a three-dimensional (with 2-D option), transient, single fluid computer model, based on the COMMIX code, for modeling thermal stratification and hydrodynamic and heat flow in liquid heat storage tanks. This is a completely detailed hydrodynamic, iterative simulation code which makes no ad-hoc assumptions or approximations, and will include turbulence and buoyancy effects, tank wall thermal capacity and variable mesh. (Calculation regions may vary throughout tank for finer analysis in more active regions). It will be capable of modeling the effects of baffles, jetting, heat sources or sinks within the tank and wall effects.

The model will be validated and used to optimize heat storage and solar system designs and parameters including system optimization for stratification. Expansion to include modeling of two fluid and multifluid systems is contemplated for later periods.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Develop and Apply Theoretical
Model of Flow Stratification
in Solar Systems

INSTITUTION:

Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

PRINCIPAL INVESTIGATOR:

W. W. Schertz
W. T. Sha

CONTRACT NUMBER: W-7409-ENG-38
(ANL-189-49572)

STARTING DATE: 10/01/77

DURATION: 24 months

AMOUNT: \$70,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Not only has a tremendous variety of TES systems for solar heating and cooling applications been developed, but the state-of-the-art technology continues to change rapidly. In response to this situation, a set of handbooks containing descriptive and numerical information on the characteristics and application of TES technologies in solar heating and cooling of buildings will be prepared. TES systems for which data and information will be presented include state-of-the-art and advanced concepts utilizing water tank storage, rock bed storage, phase change storage, and hybrid-system storage. The handbooks will be designed to meet the needs of solar system designers, R&D groups and program planners. Revision and updating of the handbooks will follow on a continuous basis.

The initial handbook to be developed will be a "Design and Installation Manual" for state-of-the-art commercially available heat exchanger, water tank and rock bed subsystems. This handbook will be directed to the small residential or commercial builder and HVAC Contractor, as well as to the more sophisticated "do-it-yourselfers". This will be followed by a comprehensive review, engineering data summary and guidelines on more advanced systems still being developed. A design handbook on advanced concept thermal energy storage and heat exchange systems which are sufficiently developed for commercial utilization will also be produced.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

A Handbook and Guide for Thermal
Energy Storage Applications in
Solar Heating and Cooling Systems

INSTITUTION:

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

PRINCIPAL INVESTIGATOR:

W. W. Schertz
R. L. Cole

CONTRACT NUMBER: W-7409-ENG-38

STARTING DATE: 10/01/76

DURATION: 36 months

AMOUNT: \$136,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Artech Corporation will design, develop, assemble and deliver a thermal energy storage system using low temperature, phase change salt hydrates. This storage system will be used for both heating and cooling applications. The storage medium will be packaged in plastic trays which greatly reduces volume and weight per stored energy when compared to conventional rock or water storage. Marshall Space Flight Center will monitor equipment progress.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of a Thermal Energy Storage
Using Phase Change Salts

INSTITUTION:

Artech Corporation
2816 Fallfax Drive
Falls Church, VA 22042

PRINCIPAL INVESTIGATOR:

Fred Ordway

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32254

STARTING DATE: 10/01/76

DURATION: 16 months

AMOUNT: \$151,306

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The purpose of this study is to use a comprehensive approach to solar thermal energy storage (TES) system modeling. TES component models throughout the solar thermal energy community and elsewhere will be sought, acquired and evaluated. The best models will then be standardized as compatible system "library" modules. In order to concentrate maximum resources on model-oriented activities, including subsequent upgrading, validation and streamlining, the existing computer code, SIMWEST will be used as the linkage vehicle. SIMWEST performs automatic linkage, simulation and analysis of storage system model concepts. Solar TES subsystems automatically generated by SIMWEST from the updated TES component models will be exercised with field installation data for the validation. After adjusting component models as necessary to achieve acceptable correlation, streamlined models will be developed, validated and added to the SIMWEST model library. Appropriate reports and documentation will be developed and updated for the duration of the project. A major project deliverable is a complete, user-driven solar TES system modeling tool based on an existing highly-competent model generation and simulation technique developed specifically for energy storage modeling.

The project is divided into the following task areas:

- Task 1—Standardized and link models.
- Task 2—Upgrade models.
- Task 3—Validation of models.
- Task 4—Streamline models.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Developing and Upgrading of Solar
System Thermal Energy Storage
Simulation Models

INSTITUTION:

Boeing Computer Services, Inc.
Energy Technology Applications Division
P. O. Box 24346
Seattle, Washington 98124

PRINCIPAL INVESTIGATOR:

Richard T. Haelsig

CONTRACT NUMBER: EG-77-C-02-4482

STARTING DATE: 09/23/77

DURATION: 36 months

AMOUNT: \$479,000

PROJECT DESCRIPTION

Using computer modeling and simulation, the objective of this project is to define the performance advantages and disadvantages of the thermal storage/heat pump subsystem when used in the series-parallel configuration, and to develop the concept to the point where it can be considered for detailed design of actual installations.

To initiate the study, the project will develop new subroutines, compatible with the TRNSYS executive, to adequately model the rock bed and heat pump. Using this model, the performance of the rock bed/heat pump subsystem will then be mapped over the full range of anticipated operating conditions in order to determine the relationships between subsystem design parameters and system performance parameters. At this point, cost considerations will be introduced in the form of sensitivity analyses. These analyses will define the subsystem design parameters which have a significant effect on life cycle costs and will develop a set of practical subsystem design rules which would yield a cost-effective system. The final project task will entail the preparation of conceptual designs for the overall system, the determination of overall system performance for nominal and extreme conditions, and the estimation of initial and operating costs.

The project will culminate with a series of 1-year simulation runs for a single building and two locations.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Series-Parallel Solar Augmented
Rock Bed Heat Pump

INSTITUTION:

California State University
Fullerton, CA 92634

PRINCIPAL INVESTIGATOR:

Edward F. Sowell

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

9 months

AMOUNT:

\$95,000 (Requested)

PROJECT DESCRIPTION

The objectives of this project are the development and fabrication of three thermal energy storage subsystems, the measurement and testing of the performance characteristics of the subsystems and the preparation of documentation necessary to incorporate the subsystems into larger systems.

During the project's first stage, the three separate subsystems for space heating and coldside and hotside storage for air conditioning will be developed to meet three stated sets of specifications. These specifications will be tested and certified by an independent laboratory. Measurements will then be made of the subsystem's performance characteristics to provide documentation necessary to design, install and maintain the subsystem in larger systems.

In its second stage, the project will develop equipment and techniques necessary to fill on-site 45°, 115° and 240°F subsystems larger than those mentioned above with all three types of storage media. Different alternatives for on-site filling will be explored, and the most suitable techniques will be used. Necessary testing to verify the effectiveness of the equipment and techniques will be conducted.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Salt Hydrate Thermal Energy Storage
System for Space Heating and Air
Conditioning

INSTITUTION:

Calmac Manufacturing Corporation
150 South Van Brunt Street
Englewood, NJ 07631

PRINCIPAL INVESTIGATOR:

Calvin D. MacCracken

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$419,000 (Requested)

PROJECT DESCRIPTION

This research is designed to establish the technical feasibility and economic practicality of using direct contact liquid-liquid heat exchangers in solar heated and cooled buildings. First year research was directed toward finding several liquids with suitable properties and obtaining experimental heat transfer data for these liquids in an all glass pilot plant. In addition, a full-scale exchanger was designed, constructed and installed in a specially built mobile laboratory.

Second year research will perform a preliminary evaluation using a controlled heat source and a simulated load. Once the unit is modified as indicated by the preliminary data analysis, it will be connected to a solar house for full-scale testing. The experimental data will be analyzed, and the all-liquid heat exchange concept will be technically and economically evaluated.

IMPORTANT REPORTS OR PUBLICATIONS

- "Toxicological Evaluation of Liquids Proposed for Use in Direct Contact Liquid-Liquid Heat Exchangers for Solar Heated and Cooled Buildings."
- "A Direct Contact Liquid-Liquid Heat Exchanger for Solar Heated and Cooled Buildings."
- Annual Progress Report for Period February 1, 1976 - July 31, 1977. Report No. C00-2867-2.

PROJECT TITLE:

Direct Contact Liquid-Liquid Heat
Exchangers for Solar Heated and
Cooled Buildings

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Engineering Research Center
Ft. Collins, CO 80523

PRINCIPAL INVESTIGATOR:

John C. Ward

CONTRACT NUMBER: EY-76-S-02-2867

STARTING DATE: 02/01/76

DURATION: 28 months

AMOUNT: \$107,466

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to develop an optimized system providing thermal storage capability in the 90°C to 180°C range, suitable for solar-driven air conditioning.

The project will commence with the identification of suitable storage processes and materials and the selection of one combination for further project investigation. The selected heat transfer material will then be tested to determine its relevant properties and to verify its compatibility with the proposed containment material. Upon completion of the requisite system design studies, construction of a fully-instrumented model system will begin. Following completion of the model system, extensive testing in accordance with the NBS/ASHRAE thermal storage test standards will be conducted. The project will conclude with a final report of test performance and the results of the supporting design studies.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Intermediate
Temperature Thermal Energy Storage
Systems

INSTITUTION:

University of Delaware
Department of Mechanical and
Aerospace Engineering
Newark, DE 19711

PRINCIPAL INVESTIGATOR:

J. R. Moszynski

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 36 months

AMOUNT: \$309,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this study is to investigate and quantify, on a regional level, the costs and performance of rock beds chilled by night air or air from an evaporative cooler as an air conditioning system. This concept is particularly applicable to regions characterized by large diurnal temperature variation and low atmospheric humidity.

In the initial phase of the research project, an information base will be established through literature review, model formulation, meteorological and economic data assimilation, and rock thermal property evaluation. Upon this base, a detailed regional assessment of rock bed storage systems can be made.

During the second phase, a consistent and appropriate basis for comparing various night-effect system designs with each other and with conventional air-conditioning systems will be defined and utilized to evaluate various system options.

The final phase will be a detailed regional evaluation of rock-bed-storage cooling system concept applicability and economy. Characteristics to be considered include meteorology, energy costs and thermal properties of available rocks. A simulation model is to be developed and used for the economic study. This includes simulations of extended periods of time. The simulation model will be integrated with a system optimization procedure and will be generally applicable to a variety of residential and commercial buildings.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Rock Bed Storage for Cooling

INSTITUTION:

Dynatech R/D Company
99 Erie Street
Cambridge, MA 02139

PRINCIPAL INVESTIGATOR:

Eric C. Guyer

CONTRACT NUMBER: EG-77-C-02-4481

STARTING DATE: 09/25/77

DURATION: 12 months

AMOUNT: \$100,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This study is for simulating the performance characteristics of advanced thermal energy storage subsystems for solar heating and cooling. Four energy conditioning and storage subprograms will be constructed and later integrated into a single system program that will handle external variables such as solar input, environmental conditions and heating/cooling load.

This project will lead to two types of results: a set of programs capable of simulating the performance of a wide variety of thermal storage and conditioning units under realistic assumptions as to collector, heat exchanger, storage media and conditioning system performance, and a set of full-year simulation runs for thermal energy storage/conditioning subsystems that have been proposed in the literature.

This project is divided into the following tasks:

Task 1—Design and construction of overall system model.

Task 2—Construction of sensible, phase-change, and reversible chemical subsystem models (SPHW model).

Task 3—Electric heat pump energy conditioning with multiple storage possibilities (SAHP model).

Task 4—Absorption and Rankine cycle air conditioning with multiple heating options and storage possibilities (TACSH model).

Task 5—Construction of model for thermal storage in thermochemically driven heat pump (TDHP model).

Task 6—Preliminary testing.

Task 7—Simulation runs on published designs.

Task 8—Additional simulation runs on the most promising designs.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Analysis of Advanced Thermal Energy Storage Subsystems for Solar Heating and Cooling

INSTITUTION:

EIC Corporation
55 Chapel Street
Newton, MA 02158

PRINCIPAL INVESTIGATOR:

Peter O'D. Offenhartz

CONTRACT NUMBER: EG-77-C-02-4483

STARTING DATE: 09/01/77

DURATION: 12 months

AMOUNT: \$76,452

PROJECT DESCRIPTION

This project will evaluate self-controlling, self-pumping heat circulation schemes in solar energy systems. Schemes that will be studied, among others, are thermodynamic cycles that drive a circulation pump or blower, percolators, heat pipes, capillary pumping, osmotic pumping, and thermosyphoning.

A computerized literature search will be made for the documentation, schemes and physical principles of self-pumping methods. This will be augmented by personal contact with workers in the field. Criteria for judging the suitability of schemes will be developed, and all the potential schemes will be categorized and evaluated accordingly. The final report will summarize these findings and recommend selected schemes for development. Any new schemes suggested by the project staff will be included in a separate section of the report.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Evaluation of Self-Driven
Heat Transport Schemes

INSTITUTION:

The Franklin Institute Research Laboratory
20th & Race Streets
Philadelphia, PA 19103

PRINCIPAL INVESTIGATOR:

G. P. Wachtell

CONTRACT NUMBER: EG-77-C-02-4484

STARTING DATE: 08/01/77

DURATION: 12 months

AMOUNT: \$102,600

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to use state-of-the-art phase change materials (those with phase change temperatures below 195°F) combined with the rolling cylinder phase change process to develop an optimized system providing thermal energy storage capability for various space heating, hot water and/or air-conditioning cold side storage applications.

During the initial phases of the research the performance of a rolling cylinder phase change system will be tested, using rate calorimetry, with at least three known phase change materials. Another early project task will be the container material selection which will be guided by the corrosive properties of the candidate phase change materials. The preliminary work will conclude with the development of a mathematical model describing the thermal behavior of a rolling cylinder phase change heat storage subsystem.

Using the documented results of the initial selection and evaluation efforts, a prototype subsystem with a capacity of approximately 200,000 Btu will be designed and built. Additionally, a testing system designed to measure the performance of the prototype will be assembled. The prototype testing will be conducted in accordance with the requirements of the applicable NBS/ASHRAE standards.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Prototype Design and Testing of
the Rolling Cylinder Thermal Storage
System

INSTITUTION:

General Electric Company
Corporate Research & Development
Power Systems Laboratory
P. O. Box 8
Schenectady, NY 12301

PRINCIPAL INVESTIGATOR:

C. S. Herrick

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 30 months

AMOUNT: \$375,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to develop a packed bed of encapsulated paraffin spheres with a water transfer medium as a thermal energy storage material. During the initial year, a small laboratory scale sample of 500 to 1000 micron encapsulated pellets was cycled successfully for over 3000 cycles and a subscale experimental test assembly of a packed bed system of capsules was constructed for combined flow and thermal cycle testing. Successful results were achieved during constant temperature flow through the bed, but temperature cycling of the bed inlet temperature resulted in the clogging of the test assembly. A 13-week no-cost project extension will allow a systematic approach to resolving this problem so that full-scale testing can begin.

An initial investigative effort will be directed in areas which affect the ultimate concept. Next, several sequential sets of samples will be procured and subjected to three tests: microscopic examination, cycling tests, and packed bed tests. Finally, a review of possible container alterations and an economic analysis will be made.

IMPORTANT REPORTS OR PUBLICATIONS

- "Two Component Thermal Storage Material Study-Phase 2," Interim Progress Report, March 1976.

PROJECT TITLE:

Two Component Thermal Material
Study

INSTITUTION:

General Electric Company
Valley Forge Space Center
P. O. Box 8661
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

A. T. Tweedie
E. M. Mehalik

CONTRACT NUMBER: EY-76-C-02-2845

STARTING DATE: 02/23/76

DURATION: 12 months

AMOUNT: \$105,871

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project is a complete development effort, from preliminary design to mass production techniques, of a uniquely designed water storage tank fabricated from a fiberglass sandwich material.

The fiberglass material consists of a foam core sandwiched between a rigid fiberglass structural layer on the outside and a flexible moisture boundary layer on the inside. The inner layer is designed to prevent high-temperature moisture degradation of the fiberglass. One of the initial tasks, then, will be to evaluate and select, from a number of candidates, the most suitable coating for this boundary application.

Prototype tanks for use in project testing will be laid up by hand using well established manufacturing technology. For the long run, however, cost analyses shall be made to determine how other production manufacturing methods can lower unit costs.

The storage tank in its final form will be modular, lightweight, under 250 pounds, and have materials and characteristics adequate to provide a life expectancy of 30 years or longer.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of an Improved Water Tank
for Thermal Energy Storage

INSTITUTION:

Independent Living, Inc.
Suite 2200, Two Exchange Place
2300 Peachford Road
Atlanta, GA 30341

PRINCIPAL INVESTIGATOR:

W. T. Hudson
L. W. Rehfield

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$130,000 (Requested)

PROJECT DESCRIPTION

This project will design, construct and test a prototype, reversible, thermochemical storage system.

An initial feasibility study will assemble data on the fundamental processes involved, and demonstrate the viability of the thermal storage concept. Upon completion of this study, analysis and evaluation including computer modeling, will guide the selection of an appropriate subscale reactor bed design. Selection of appropriate construction materials will be guided by compatibility test, cost and ease of fabrication.

With the information gained from the subscale experiments, a prototype residential size storage system will be constructed. To determine the prototype operational and performance characteristics, tests will be conducted. The project will conclude with an evaluation of the test data and an economic analysis.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Cooling Using Paired
Ammoniated Salt Reactions

INSTITUTION:

Martin Marietta Corporation
Aerospace Division
P. O. Box 179
Denver, CO 80201

PRINCIPAL INVESTIGATOR:

F. A. Jaeger

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$304,000 (Requested)

PROJECT DESCRIPTION

The objective of this project is to investigate the cost-effectiveness, technical feasibility, versatility and performance advantages of membrane-lined storage tank concepts.

Membrane-lined storage projects will be surveyed, and alternative membrane materials and means for enclosure construction will be studied. A cost-effectiveness study will determine the most promising material/enclosure alternatives for three specified storage volumes.

In a second activity, alternative methods for heat transfer and exchange will be investigated and analyzed. The best methods of designs will be identified and detailed. Emphasis will be on concepts for incorporation of heat exchange features into a prefabricated membrane liner.

A third aspect of the project will evaluate various designs promoting temperature stratification. Cost models will be prepared and utilized for each design. Small-scale models of several promising designs, emphasizing fabrication and installation processes, will be constructed.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Membrane-Lined Foundation Systems
for Liquid Thermal Energy Storage

INSTITUTION:

University of Nebraska
Engineering Research Center
W181 Nebraska Hall
Lincoln, NB 68588

PRINCIPAL INVESTIGATOR:

R. C. Bourne

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

20 months

AMOUNT:

\$110,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The forerunner to this study was the development of a heat storage subsystem which utilized the latent heat of melting and solidification of organic waxes. The general objective of this program is to analytically model, design, develop and test larger prototype subsystems which utilize mixtures of paraffins the previous study showed to be effective and inexpensive.

The first stages of the program will concentrate upon the modelling and designing of three subsystem configurations. The later stages will concentrate upon construction, testing and cost analysis.

IMPORTANT REPORTS OR PUBLICATIONS

- Baily, J.A., Mulligan, J.C., Liao, C.K., Reddy, Mike, and Naik, N.L., "Research on Solar Energy Storage Subsystems Utilizing the Latent Heat of Phase Change of Certain Organic Materials."
- Bailey, J.A., Mulligan, J.C., "Research on Solar Energy Storage Subsystems Utilizing the Latent Heat of Phase Change of Certain Organic Materials for the Heating and Cooling of Buildings."
- "Research on Solar Energy Storage Subsystems Utilizing the Latent Heat of Phase Change of Paraffin Hydrocarbons for the Heating and Cooling of Buildings," Semi-Annual Report, Report No. NSF/RANN/GI 44381/75.
- "A Solar Energy Storage Subsystem Utilizing the Latent Heat of Fusion of Paraffin Hydrocarbons," Semi-Annual Report to ERDA, March, 1977.

PROJECT TITLE:

Research on Solar Energy Storage
Subsystems Utilizing the Latent
Heat of Phase Change of Certain
Organic Materials, Phase II

INSTITUTION:

North Carolina State University
Dept. of Mechanical and Aerospace
Engineering
Raleigh, NC 27607

PRINCIPAL INVESTIGATOR:

J.A. Bailey

CONTRACT NUMBER: EY-76-G-05-5101

STARTING DATE: 05/15/76

DURATION: 15 months

AMOUNT: \$94,408

PROJECT DESCRIPTION

This study is an effort to evaluate the potential benefits of, and to provide engineering and cost data for, the effective design of hybrid thermal storage systems.

The project will begin with a state-of-the-art survey. This survey will lead to the establishment of from four to six hybrid storage concept designs. Three existing hybrid storage installations will be visited, and operating test data will be requested. This data will be used along with studies of existing computer models in the development and checkout of a hybrid thermal storage subroutine to serve in project modeling. Based on the test data analysis and cost results, candidate hybrid system designs will then be selected. Finally, using stylized load demand profiles for each of three applications in six regional areas of the United States, the yearly performance characteristics of these concepts will be simulated using a complete system computer model such as TRNSYS in conjunction with the simpler hybrid thermal storage model.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Hybrid Thermal Storage with Water

INSTITUTION:

Rockwell International
Atoms International Division
8900 De Soto Avenue
Canoga Park, CA 91304

PRINCIPAL INVESTIGATOR:

T. L. Johnson

CONTRACT NUMBER: EG-77-C-02-4480

STARTING DATE: 09/29/77

DURATION: 12 months

AMOUNT: \$110,000

PROJECT DESCRIPTION

Sigma Research, Inc. will design, develop and deliver a thermosyphon heat exchanger for use with air heating collectors and water storage tanks. Sigma Research, Inc. plans to market this heat exchanger.

Marshall Space Flight Center will monitor equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of a Thermosyphon Heat Exchanger for Residential Solar Heating Systems

INSTITUTION:

Sigma Research, Inc.
2952 George Washington Way
Richland, WA 99352

PRINCIPAL INVESTIGATOR:

E. Dale Waters

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32260

STARTING DATE: 10/15/76

DURATION: 18 months

AMOUNT: \$91,831

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Under a previous ERDA contract (No. EY-76-C-05-5177) Suntek Research Associates developed a thermal storage system, trade named Thermocrete, consisting of phase-change materials injected in modular foamed cement storage elements coated with epoxy rubber. The purpose of this project is to develop detailed performance specifications, design criteria, and engineering blueprints for prototype central storage Thermocrete units for low temperature (7°C to 70°C - 45°F to 158°F) solar heating and cooling applications. Two small scale heat storage subsystems will be fabricated and tested as part of this design effort.

A computer program which models the behavior of Thermocrete has been developed at M.I.T. This program will be further developed and used to size components and simulate the performance of the designs developed under this project.

The overall objective of this project is not to produce a set of design drawings, but to design storage units which can be fabricated at a competitive cost using standard industrial manufacturing techniques. Therefore, each of the finalized designs will be subjected to thorough cost analysis to identify the cost of each component in the subsystem.

Project plans include phase-change thermal storage unit applications for solar space heating, domestic hot water, and cold side space cooling storage.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Engineering Design for Thermocrete
Central Storage Units for Low-
Temperature Solar Application

INSTITUTION:

Suntek Research Associates
500 Tamal Vista, #506
Corte Madera, CA 94925

PRINCIPAL INVESTIGATOR:

S. Wellesley Miller

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 12 months

AMOUNT: \$133,000 (Requested)

PROJECT DESCRIPTION

This project has been investigating solar heating systems utilizing annual storage of solar heated water and determining the relationship between the primary weather variables and the optimum system configuration.

During the first year of the project, emphasis was on the exploration of the thermal characteristics of large storage tanks. In its second year, the project will emphasize expansion of the first-year work.

The separate tank computer simulation model developed in the first year will be further developed to include soil layering and to examine square-cornered tanks. Comparison of model performance to real data will continue and be more meaningful as a full year's cycle of Provident House data becomes available.

Also, optimum configurations will be formulated through the use of an optimum search program, and a complete range of ETR and ETC values will be published. Finally, a noncomputer algorithm, allowing calculation of the optimum system, will be developed.

IMPORTANT REPORTS OR PUBLICATIONS

- Report COO-2939-1. Progress Report for Period July 1, 1976 to December 31, 1976.
- Report COO-2939-4. Progress Report for Period January 1, 1977 to June 30, 1977.
- "A Design Method for Heat Loss Calculation for In-Ground Heat Storage Tanks."
- "Optimization of an Annual Storage Solar Heating System over its Life Cycle."
- "Seasonal Heat Storage for Solar Space Heating Systems in Cold High Latitude Locations."
- "The Effects of Collector Tilt and Orientation on Solar Heating Performance."

PROJECT TITLE:

Solar Space Heating Systems
Using Annual Heat Storage

INSTITUTION:

University of Toronto
Mechanical Engineering
Toronto, Ontario
Canada M5S1A4

PRINCIPAL INVESTIGATOR:

F. C. Hooper

CONTRACT NUMBER: EY-76-C-02-2939

STARTING DATE: 07/01/76

DURATION: 24 months

AMOUNT: \$137,413

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The end product of this multi-year study will be to demonstrate the feasibility of using a covered pond for the annual collection and storage of solar heated water for the heating of buildings. During the first phase of the project, a prototype (27,500 gallon) collector-storage subsystem was designed and constructed. The second phase will be one of analytical modelling, further testing, and final reporting.

A computer/digital and an analog heat loss model for these large storage pools has been developed and will be validated against design and test data from operation of the prototype pool. In addition, an analysis of the thermal and structural performance for a full year's operation of the prototype will be prepared from the results of computer simulation and compared to actual operating performance of the prototype. Subsystem design considerations and recommendations for a full-scale annual storage pool will also be developed in the computer modeling phase.

IMPORTANT REPORTS OR PUBLICATIONS

- Report No. 2 - Annual Progress Report, May 1976 - July 1977.
- "Annual Collection and Storage of Solar Energy for the Heating of Buildings."
- "Evaluation of 'Solaris' Water-Trickle Solar Collector and Demonstration of Annual Cycle Collection and Storage of Solar Heated Water."
- "Energy Loss Analysis from Hot Water Storage Pool."
- "Heat Transfer Analysis of a System for Annual Collection and Storage of Solar Energy."
- "Annual Collection and Storage of Solar-Heated Water for the Heating of Buildings," Report No. 1 - Progress Report, May 1976 - November 1976.

PROJECT TITLE:

Annual Collection and Storage of
Solar-Heated Water for Heating of
Buildings

INSTITUTION:

University of Virginia
Dept. of Mechanical Engineering
Charlottesville, VA 22901

PRINCIPAL INVESTIGATOR:

J. T. Beard

CONTRACT NUMBER: EY-76-S-05-5136

STARTING DATE: 05/01/76

DURATION: 27 months

AMOUNT: \$87,485

PROJECT DESCRIPTION

This project will develop light-weight concrete insulating and structural elements as construction material for water tanks designed for thermal energy storage.

Initially, the project will produce analyses and test results on the selection of materials, processes and designs for modular (slab) units and sub-scale 500-gallon tanks. These subscale modular units and tanks will then be fabricated and tested. Using the results of these preliminary tests, a 2000 gallon prototype tank will be designed, constructed and tested. These latter tests will provide data for both structural and thermal performance analysis. An economic analysis and recommendations for optimization of the materials, designs and fabrication procedures will be provided, with an emphasis on retrofit applications.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Lightweight Concrete Materials
and Structural Systems for Water
Tanks for Thermal Energy Storage

INSTITUTION:

Westinghouse Electric Corporation
Advanced Energy Systems Division
Post Office Box 10864
Pittsburgh, PA 15236

PRINCIPAL INVESTIGATOR:

M. Gunasekaram

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

24 months

AMOUNT:

\$361,000 (Requested)

PROJECT DESCRIPTION

The primary objective of this project is to establish the technical feasibility, for most retrofit applications, of mating a heat pump to a rock bed storage unit for optimal performance at the lowest cost. This project consists of two general task areas, a feasibility study and a cost-effectiveness study.

The feasibility study will analyze the physical restraints involved in coupling a heat pump to a conventional rock-bed-storage-type air system with flat-plate collectors. In order to incorporate accurate pricing and performance data into the study only components currently available will be used. The main result of the feasibility study is to be a control strategy which will optimize the performance of a cost-effective heat pump/solar system.

The product of the cost-effectiveness study will be a method for sizing, locating and arranging the various system components resulting in an optimum, cost-effective performance. The emphasis of this study will be on lowest cost in the retrofit and new markets.

Provided that further investigative work is justified by these studies, optimum designs for new and retrofit applications including life-cycle costing and optimum operation strategies will be developed.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Rock Bed Storage with Heat Pump

INSTITUTION:

Zia Associates, Inc.
5590 Arapahoe Road
P. O. Box 1466
Boulder, CO 80306

PRINCIPAL INVESTIGATOR:

J. E. Anderson

CONTRACT NUMBER:

STARTING DATE:

Under negotiation

DURATION:

12 months

AMOUNT:

\$107,000 (Requested)

NO PHOTOGRAPH AVAILABLE

3. HEAT PUMPS

PROJECT DESCRIPTION

The objective of this project is to study the Pivoting Tip Vane Rotating Heat Pump when used as an expander/compressor with solar heat services for heating, cooling and generating electric power. Phase I of the project was directed toward the production of the requisite analyses and layout design for a prototype heat pump.

Phase II will focus on actual prototype evaluation. It will begin with the construction, testing and refinement of compressor and expander prototypes. After testing and evaluating the prototypes, preliminary development and marketing studies will be made. These studies will involve three areas: thermodynamics, materials and mechanics, and cost and market analysis. Finally, a prototype heat pump will be fabricated and an assessment of both its on-design and off-design performance will be made. Prototype testing will be conducted with procedures and facilities prepared specifically for the project.

IMPORTANT REPORTS OR PUBLICATIONS

- "A Solar-Powered Heat Pump Utilizing Pivoting Tip Rotating Equipment - Phase I," Summary Report, Report No. NSF/RANN/SE/C-876/FR/75/3.

PROJECT TITLE:

Did not find
A Solar Powered Heat Pump Utilizing
Pivoting-Tip Vane Rotating
Equipment, Phase II

INSTITUTION:

Battelle Columbus Laboratories
505 King Avenue
Columbus, OH 43201

PRINCIPAL INVESTIGATOR:

Robert D. Fischer

CONTRACT NUMBER: W-7405-ENG-92

STARTING DATE: 09/15/76

DURATION: 9 months

AMOUNT: \$64,000

PROJECT DESCRIPTION

The main objective of this project is to design, fabricate and test a prototype heat pump subsystem. The subsystem will be optimized to operate within the best SAHP system as determined by work on advanced heat pumps and SAHP systems, initial studies within this program and liaison with the contractor executing the SAHP 2 contract.

The project is divided into three phases:

Phase I—Conceptual Design: Explore the cost and performance of several SAHP systems configurations to determine the best candidates for heat pump subsystems as well as duty specifications. Once this is done, studies for marketing and commercialization will be conducted.

Phase II—Detailed Design and Performance: Provide for SAHP systems a detailed design of one or two cost-effective heat pumps.

Phase III—Fabrication and Testing: Conduct component tests, heat pump assembly and system tests.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Assisted Heat Pump (SAHP)
Development

INSTITUTION:

General Electric Company
Corporate Research and Development
P. O. Box 8
Schenectady, NY 12301

PRINCIPAL INVESTIGATOR:

H. Jaster

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$770,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to design, fabricate, test and analyze heat pumps used in the solar heating and cooling of residential, multi-family and commercial buildings.

Solar assisted heat pump systems will be developed emphasizing the following design goals:

1. Efficient part-load performance.
2. Maximum cost-effectiveness.
3. Wide market appeal.
4. Economic and energy efficiency.

This program will be divided into three phases:

Phase I—Conceptual Design and Commercialization and Marketing Plan.

Phase II—Detailed Design and Performance Prediction.

Phase III—Fabrication and Test.

The final report will summarize the technical accomplishments of the program and include a comprehensive commercialization and marketing plan of what is required for consumer acceptance of the solar assisted heat pump in each of the three major applications in the program.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Marketable Solar Assisted Heat Pumps

INSTITUTION:

Lennox Industries, Inc.
200 South 12th Avenue
Marshalltown, Iowa 50158

PRINCIPAL INVESTIGATOR:

T. L. Youngblood

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$1,100,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to develop a group of solar assisted heat pumps that will be commercially acceptable and offer significant opportunities for energy conservation and reduced operating costs.

The coefficients of performance of all solar heat pump systems evaluated will be determined in financial as well as thermal terms. These systems will incorporate the advantages of modulated capacity, a new low cost air source heat exchanger and control logic that optimizes the seasonal efficiency of proven compression machines. A commercialization and production plan will show how solar heat pumps will become viable within 5 years. The solar heat pumps will be tested in a comprehensive solar building load simulator and the problems of integrating the solar subsystem, the heat pump and the structure will be analyzed.

The project will consist of the following phases:

Phase I—Conceptual design, which includes preliminary analysis and a commercialization and marketing plan.

Phase II—Detailed design.

Phase III—Fabrication and testing.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Solar Assisted
Heat Pumps

INSTITUTION:

Northrup, Inc.
302 Nichols
Hutchins, TX 75141

PRINCIPAL INVESTIGATOR:

L. L. Northrup, Jr.

CONTRACT NUMBER:

STARTING DATE: Under negotiation

DURATION: 24 months

AMOUNT: \$1,072,000 (Requested)

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this three-phase project is to identify the solar assisted heat pump (SAHP) configurations with the most promising market potentials.

The first phase will identify SAHP systems whose components are currently available and have lower life cycle costs than other heating/cooling systems. The most viable SAHP configurations designed, installed and/or reported in literature will be identified. The selection of promising combinations of SAHP systems, climatic regions and building types will be made from a preliminary climate/load analysis. Performance characteristics of these promising configurations will be studied via computer simulations using an upgraded version of TRNSYS.

The second phase will identify design modifications that exist between them. Collector improvements, heat pump design, storage methods and the concept of SAHP system energy management strategies for better market potential will be addressed.

The third phase will select the best SAHP systems from those identified in Phase I, model them with the upgraded components studied in Phase II and analyze them in detail to understand their technical merits and drawbacks. A judiciously limited level of effort will be used to determine system cost.

The output of this work will be the selection and characterization of the best marketable SAHP systems and their performance.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Analytic Selection of Marketable Systems

INSTITUTION:

The Singer Corporate Research and
Development Laboratory
286 Eldridge Road
Fairfield, NJ 07006

PRINCIPAL INVESTIGATOR:

W. Kahan

CONTRACT NUMBER: EG-77-C-03-1467.

STARTING DATE: 09/30/77

DURATION: 25 months

AMOUNT: \$308,000

* VALVES A NORMALLY OPEN AND VALVES B NORMALLY CLOSED. THIS IS REVERSED WHEN THE TEMPERATURE AT THE LEFT IS HIGH ENOUGH TO BYPASS THE HEAT PUMP.

PROJECT DESCRIPTION

This program is a continuation of an effort to demonstrate the feasibility of using solar assistance in a closed-loop water source decentralized heat pump.

The feasibility of such an effort was determined through digital computer simulation. In this program improvements and refinements in the simulation will be made. These will include a detailed heat pump model for optimizing the heat pump solar component combination, a more realistic temperature control deadband and stratification of the storage tank. Simulation runs of an entire year will be made to determine the savings due to hot water production. Simulation runs of 2 and 3 consecutive cloudy or cloudless days will be made. Finally, a study of economic low temperature focusing collectors with heat pump systems will be made.

Developments expected to arise from the program include a high rise residential model, weather and insolation data for eight new geographical areas, a simulation model of the heat pump cycle and an evaluation of the parametric limits to its performance, experimental measurement support for previous heat pump modelling, and an investigation of possible system modifications.

The project will develop a computer model usable by architects and engineers and an accompanying literature and user's guide.

IMPORTANT REPORTS OR PUBLICATIONS

- “Commercial Building Unitary Heat Pump System with Solar Heating,” Final Report No. NSF/RANN/SE/GI-43894/FR/75/3.
- “Computer Model for a Solar-Assisted, Closed-Liquid-Loop Heat Pump System.”
- “Generalized Weather Functions for Computer Analysis of Solar-Assisted HVAC Systems.”
- “Commercial Building Unitary Heat Pump System with Solar Heating,” Progress Report, May 1, 1976 - May 1, 1977.
- “Solar Building Energy Use Analysis,” ISES Meeting, June 1977.
- “Efficient Use of Energy in a Solar Building,” October 24-28, 1977.
- “Thermal Simulation of a Building with Solar Assisted Closed Liquid Loop Unitary Heat Pumps.”

PROJECT TITLE:

Commercial Building Unitary Heat Pump System with Solar Heating, Phase II

INSTITUTION:

Syracuse University
College of Engineering
Syracuse, NY 13210

PRINCIPAL INVESTIGATOR:

Eugene E. Drucker

CONTRACT NUMBER: EY-76-S-02-2979

STARTING DATE: 05/01/76

DURATION: 18 months

AMOUNT: \$132,184

4. SOLAR COOLING

PROJECT DESCRIPTION

This air-conditioner features a desiccant type dehumidifier consisting of a rotary silica gel bed and regenerator. Through heat recovery the amount of solar thermal energy used for desorption (regeneration of the silica gel) is minimized. The dehumidifier can be used in series with a heat exchanger and evaporative cooler to form a solar powered air conditioner. In a hybrid system consisting of the dehumidifier in conjunction with a solar powered Rankine or absorption cooling system, the evaporator temperature can be increased, resulting in significantly better performance of the Rankine or absorption subsystem.

The project is divided into three phases:

Phase I—Conceptual Design - Preliminary design of the desiccant cooling subsystem and a complete solar system. The residential solar air conditioner will be evaluated for three representative geographic locations of the U.S. where its use would present an advantage over competitive concepts. Commercialization studies will be conducted to determine the economic viability of the system.

Phase II—Detailed Design - Detailed design of the desiccant cooling system stemming from subsystem/system design changes. The results of Phase II will be parts lists, drawings and specifications for the desiccant cooling subsystem and the complete system.

Phase III—Fabrication, Testing and Evaluation - Fabrication and test of the desiccant cooling subsystem. Following data evaluation a complete simulated solar-powered air conditioner will be assembled and tested (only the solar collector will be simulated). Data from these test programs will be used to upgrade the results of the commercialization and cost effectiveness investigations of the previous project phases.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of Solar Desiccant
Air Conditioner

INSTITUTION:

AiResearch Manufacturing Company
of California
2525 W. 190th Street
Torrance, CA 90509

PRINCIPAL INVESTIGATOR:

J. Rousseau

CONTRACT NUMBER: EG-77-C-03-1591

STARTING DATE: 09/30/77

DURATION: 36 months

AMOUNT: \$681,694

DEHUMIDIFIER CROSS SECTION

SYSTEM SCHEMATIC

PROJECT DESCRIPTION

AiResearch will design, develop and deliver four sizes of various solar heating and cooling systems for equipment monitoring by Marshall Space Flight Center (NASA).

These systems are:

1. Single family heating, cooling and hot water.
 - a. Single loop, solar assisted heat pump and domestic hot water.
 - b. Rankine driven turbo compressor heat pump and cooling tower.
 - c. Flat plate collectors and storage tanks.
 - d. 3-ton cooling capacity, 80,000 Btu/hr heating capacity.
 - e. Site locations - Novato, CA, Allaire State Park, NJ, Harrisonburg, VA, and Lawrenceburg, TN.
2. Light commercial heating, cooling and hot water.
 - a. Same system characteristics as 1.
 - b. 25-ton cooling capacity, 800,000 Btu/hr heating capacity.
 - c. Site locations - St. Louis, MO and Los Angeles, CA (General area).
3. Commercial heating, cooling and hot water.
 - a. Same system characteristics as 1 above.
 - b. 75-ton cooling capacity, 2,000,000 Btu/hr heating capacity.
 - c. Site locations - Clear Lake (Houston), TX and Las Vegas, NV.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available.

PROJECT TITLE:

Design and Development of Single Family, Multi-Family, Light Commercial, and Commercial Size Solar Heating and Cooling Systems

INSTITUTION:

AiResearch Manufacturing Company
of California
2525 West 190th Street
Torrance, CA 90509

PRINCIPAL INVESTIGATOR:

George McDonald

CONTRACT NUMBER: NASA/MSFC Contract:
NAS832091

STARTING DATE: 07/12/76

DURATION: 38 months

AMOUNT: \$4,800,000

ONE OF MULTIPLE SYSTEMS BEING INSTALLED. SEE TEXT FOR DESCRIPTION OF OTHER SYSTEMS.

PROJECT DESCRIPTION

The objective of this continuation effort is the development of a low-tonnage solar-fired air conditioner. The tasks will:

- (1) Continue development of the evaporatively cooled absorber/condenser.
- (2) Develop a high reliability small tonnage hermetic solution pump with external drive through magnetic coupling.
- (3) Field test three 3-ton chiller units during the summer of 1977 by supplying units as components of selected DOE sponsored systems.
- (4) After field test experience, refine 3-ton chiller design with a view to limited production by ARKLA for availability for private and Government demonstration activity during the summer of 1978.

IMPORTANT REPORTS OR PUBLICATIONS

- "Engineering, Design, Construction and Testing of a Salt Water Absorption Cooling Unit Optimized for Use with a Solar Collector Heat Source," Final Report, Report No. C00/4095-7612.

PROJECT TITLE:

Engineering, Design, Construction, and Testing of a Salt Water Absorption Cooling Unit Optimized for Use with a Solar Collector Heat Source, Phase II

INSTITUTION:

ARKLA Industries, Inc.
819 East Franklin Street
P. O. Box 534
Evansville, IN 47704

PRINCIPAL INVESTIGATOR:

Richard Merrick

CONTRACT NUMBER: EY-76-C-02-2859

STARTING DATE: 03/01/76

DURATION: 24 months

AMOUNT: \$244,720

PROJECT DESCRIPTION

This project closely parallels the ARKLA contract to manufacture 3- and 25-ton solar optimized LiBr/H₂O Chillers. This project will develop and integrate a 3-ton absorption chiller (LiBr/H₂O) into a unitary solar system package with chiller, controls, fan coil unit, auxiliary heat, storage, domestic hot water preheat pumps. This project will also develop application and installation software (i.e., sizing) and provide installation and operating manuals.

This project is divided into the following tasks:

Task 1—Development of a residential unitary system hardware package comprising an evaporatively cooled chiller, controls, auxiliary heat (gas or oil), heat storage and domestic water preheat pumps. This package will connect to collectors on the roof and a fan coil unit in the conditioned space and a conventional water heater.

The collectors will not be part of the package and can be of any manufacture meeting the specification of copper tubes, self draining and performance at least equal to double glazed selective surface flat plate designs. This could include evacuated tube and concentrating types.

The fan coil unit would be mated to the system package through special related design features favorable to part load operation.

Task 2—Development of the complementing application and installation software. Personnel involved shall participate in the system field testing, visit other installations, evaluate available sizing techniques and employ the supporting services of DOE recommended system analysts. The goal of this effort will be to approach the simplicity typical of current residential HVAC practice. This is only possible working with a unitary system hardware package.

Task 3—Identification of repetitively encountered commercial heating/cooling applications and development of reliable system designs with the ARKLA 25-ton WFB300 solar chiller as the core. System development activities will include visits to existing installations and laboratory testing of a chiller unitized with prescribed essential peripheral hydronic and control hardware. Sizing and solar dependency forecasting software will be developed with sub-contracted help from DOE-recommended system analysts.

PROJECT TITLE:

Unitary Solar Heating/Cooling
System Package Development

INSTITUTION:

ARKLA Industries, Inc.
819 E. Franklin Street
P. O. Box 534
Evansville, IN 47704

PRINCIPAL INVESTIGATOR:

Richard Merrick

CONTRACT NUMBER: EG-77-C-02-4593

STARTING DATE: 08/01/77

DURATION: 16 months

AMOUNT: \$887,488

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT DESCRIPTION

This study is the first phase of a program to demonstrate commercial application of solar space cooling using the Biphase engine to produce motive power at high efficiency and low capital costs. Selection of appropriate working fluids, performance analysis and a conceptual design are the principal tasks to be studied. In addition, an applications study will be undertaken to determine the commercialization potential of such a system.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Two-Phase Turbine Engine for
Solar Space Cooling

INSTITUTION:

Biphase Engines, Inc.
2907 Ocean Park Blvd.
Santa Monica, CA 90406

PRINCIPAL INVESTIGATOR:

Lance Hayes

CONTRACT NUMBER: EG-77-C-03-1542

STARTING DATE: 09/16/77

DURATION: 6 months

AMOUNT: \$60,018

PROJECT DESCRIPTION

This project will design, construct, test and commercialize an air cooled water chiller in the 15-25 ton size range for multi-family/commercial applications.

The design, shown in the sketch, utilizes a dual loop Rankine power cycle driving a Rankine vapor compression cycle. A high speed electric motor auxiliary energy source can share the load with the solar powered turbine under certain operating conditions. A single refrigerant condenser will be used. The prime mover will be a high speed turbine, directly driving a centrifugal compressor on the same shaft. The machine will be air cooled and will supply 45°F chilled water under outdoor conditions of 95°F (d.b.) and 75°F (w.b.). The solar heated liquid supply temperature will be between 220°F and 300°F.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a High-Temperature
Solar-Powered Water Chiller for
Use in a Solar Heating and Cooling
System, Phase I

INSTITUTION:

Carrier Corporation
Energy Systems Division
P. O. Box 1000
Syracuse, NY 13201

PRINCIPAL INVESTIGATOR:

R. A. English

CONTRACT NUMBER: EG-77-C-03-1590

STARTING DATE: 09/26/77

DURATION: 36 months

AMOUNT: \$1,308,509

PROJECT DESCRIPTION

This project will design, construct and operate a direct air cooled absorption machine in the 3 to 5 ton size. This machine will be capable of delivering 45°F water to a coil with an ambient 95°F (d.b.) and a fluid supply temperature no greater than 230°F. The thermal coefficient of performance is targeted for 0.65 to 0.70. The unit will be capable of delivering a high percentage of its rated capacity at ambient temperatures up to 110°F.

Carrier will evaluate various refrigerant-organic absorbent combinations to be used in the design of the absorption machine. Carrier will perform cycle analysis, design optimization, and will construct and test a prototype.

IMPORTANT REPORTS OR PUBLICATIONS

- Bierman, W. J., "Candidate Chemical Systems for Air Cooled Solar Powered, Absorption Air Conditioner Design Part 1 — Organic Absorbent Systems," January 1978.

PROJECT TITLE:

Development of a Single Family
Absorption Chiller for Use in
a Solar Heating and Cooling System

INSTITUTION:

Carrier Corporation
Energy Systems Division
P. O. Box 1000
Syracuse, NY 13201

PRINCIPAL INVESTIGATOR:

W. J. Bierman

CONTRACT NUMBER: EG-77-C-03-1587

STARTING DATE: 09/26/77

DURATION: 36 months

AMOUNT: \$834,954

PROJECT DESCRIPTION

The objective of this project is to design a realistic desiccant air-conditioning system for use with low temperature solar collectors. Phase I goal is the construction and test of a $\frac{1}{4}$ capacity unit in realistic configuration. Phase II will demonstrate the feasibility of a full size residential desiccant cooling system used with conventional flat plate collectors.

The program is divided into the following tasks:

Phase I

Task 1—Computer modeling.

Task 2—A/C system design outline.

Task 3— $\frac{1}{4}$ capacity bed design and test installation.

Task 4—Preliminary A/C design.

Phase II

Task 1—Full size A/C demonstration (2 ton).

Task 2—Dehumidifier demonstration.

Task 3—Research on system performance and cost.

IMPORTANT REPORTS OR PUBLICATIONS

- "Solar Powered Desiccant Air Conditioning System," Final Report, Report No. NSF/RANN/SE/GI 44062/FR/75/1.
- "Studies of Silica Gel Absorption for the Dehumidification and Air Conditioning of Buildings with Solar Energy," Monthly Progress Report for October 1976 - May 15, 1977.
15. 1977.

PROJECT TITLE:

Studies of Silica Gel Absorption for the Dehumidification and Air Conditioning of Buildings with Solar Energy

INSTITUTION:

Center for the Environment and Man, Inc.
275 Windsor Street
Hartford, CT 06120

PRINCIPAL INVESTIGATOR:

Peter Lunde

CONTRACT NUMBER: EG-77-C-02-4286

STARTING DATE: 10/01/76

DURATION: 11 months

AMOUNT: \$262,371

PROJECT DESCRIPTION

The objective of this project is to develop a novel solar air conditioning system. This system will be based on principles similar to those of the lithium bromide absorption air conditioner.

The project is a three-phase development program geared to demonstrate the feasibility of the solid-substrate absorption air conditioner. In the first phase, optimum salt substrates to be used as absorbents will be selected. The second phase will use thermodynamic and kinetic data as input for the cost analysis and for the selection of salt in construction of a prototype air conditioner. In the third phase, this unit will be tested for performance and, based on these tests, a plan for commercial production and marketing of the air conditioner will be drawn up.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Design, Construction and Testing of a Novel Solar Air Conditioner Using a Solid-Phase Absorbent

INSTITUTION:

EIC Corporation
55 Chapel Street
Newton, MA 02158

PRINCIPAL INVESTIGATOR:

Peter Offenhartz

CONTRACT NUMBER: EG-77-C-02-4537

STARTING DATE: 09/20/77

DURATION: 12 months

AMOUNT: \$159,561

PROJECT DESCRIPTION

The objective of this project is to develop and demonstrate a high efficiency solar energy conversion system for driving conventional freon air conditioners and heat pump systems with small, high performance solar collectors. System capacity on air conditioning mode will be approximately 20 tons.

This program is divided into the following tasks:

Task 1—Selection of prime mover fine point.

Task 2—Design of radial outflow turbine and refrigeration compressor.

Task 3—Modification of the present Steam Turbine Engine Test rig to simulate operation on the selected solar energy thermodynamic cycle.

Task 4—Fabrication and assembly of the turbine/compressor package.

Task 5—Testing and demonstration of the turbine/compressor package as integrated with the converted test rig.

The result will be a prime mover that is adaptable to various solar heating and cooling concepts which are economically viable.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Demonstration of a Solar Steam Turbine Engine for Heating and Cooling

INSTITUTION:

Energy Technology, Inc.
4914 East 154th Street
Cleveland, OH 44128

PRINCIPAL INVESTIGATOR:

Cecil Martin

CONTRACT NUMBER: EG-77-C-02-4543

STARTING DATE: 09/28/77

DURATION: 15 months

AMOUNT: \$279,552

PROJECT DESCRIPTION

General Electric Company will design, develop and deliver four sizes of various solar heating and cooling systems for equipment monitoring by Marshall Space Flight Center (NASA).

These systems are:

1. Single family heating and hot water.
 - a. Liquid vacuum tube collector with three separate system fluid loops.
 - b. "Energy Management Module" and control systems are prepackaged.
 - c. Site locations - Ft. Meade, MD and Normal, IL.
2. Commercial heating and hot water.
 - a. Liquid vacuum tube collector with four separate system fluid loops.
 - b. Site locations - Milwaukee, WI and Spokane, WA.
3. Single family heating, cooling and hot water.
 - a. Liquid high temperature vacuum tube collector with four fluid loops.
 - b. Cooling from a compressor driven by a Rankine expander electric motor.
 - c. 3-ton cooling capacity.
 - d. Air cooled condenser.
 - e. "Energy Management Module" and control systems are prepackaged.
 - f. Site locations - Philadelphia, PA and Dallas, TX.
4. Light commercial heating, cooling and hot water.
 - a. Same system characteristics as 3 above.
 - b. 10-ton cooling capacity.
 - c. Site locations - Muscle Shoals, AL and Philadelphia, PA.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Design and Development of Single Family and Commercial Size Solar Heating, Cooling and Hot Water Systems

INSTITUTION:

General Electric Company
King of Prussia Park
P.O. Box 8661
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

James C. Graf

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32092

STARTING DATE: 08/20/76

DURATION: 39 months

AMOUNT: \$6,700,000

ONE OF MULTIPLE SYSTEMS BEING INSTALLED. SEE TEXT FOR DESCRIPTION OF OTHER SYSTEMS.

PROJECT DESCRIPTION

The objective of this continuation project is to apply modeling procedures to a comparative review of the National Science Foundation and the Department of Energy supported research on new approaches to solar cooling of buildings. The model will be used for review and evaluation by Hittman Associates, Inc., of approximately 20 funded projects in the current research program. Types of approaches to be considered are: absorption machines, heat pump systems, advanced Rankine cycle machines, solid state engines, vuilleumier cycle machines, pivoting tip-vane rotating heat pump, silica gel absorption equipment and others which have been completed.

The following tasks have been completed:

Task 1—Assessment of solar powered Rankine cycle.

Task 2—Assessment of solar-assisted Rankine cycle.

Task 3—Analysis of reducing cooling loads by structural changes.

Task 4—Analysis of solar absorption cooling.

Task 5—Preparation of marketing segmentation analyses for the United States. These will be based on geographic variations in climate, projected availability and cost of non-solar energy resources and water, restrictive codes and other barriers, and residential and commercial construction growth rates.

Results will be used to conduct a penetration analysis for potential solar cooling technology options.

IMPORTANT REPORTS OR PUBLICATIONS

- "Assessment of Solar-Power Cooling of Buildings," 'Final Report, Report No. NSF/RANN75-012.

PROJECT TITLE:

Assessment of Solar Powered Cooling of Buildings

INSTITUTION:

Hittman Associates, Inc.
9190 Red Branch Road
Columbia, MD 21045

PRINCIPAL INVESTIGATOR:

Henry Curran

CONTRACT NUMBER: EY-76-C-02-2703

STARTING DATE: 06/01/75

DURATION: 33 months

AMOUNT: \$377,563

PROJECT DESCRIPTION

Honeywell, Inc. will design, develop and deliver four sizes of various solar heating and cooling systems for equipment monitoring by Marshall Space Flight Center (NASA), and for demonstration purposes.

These systems are:

1. Single family heatings and hot water.
 - a. Two fluid loop system with flat-plate collectors.
 - b. Water storage tank.
 - c. Site locations - New Castle, PA and Minneapolis, MN.
2. Single family heating, cooling and hot water.
 - a. Two fluid loop solar assisted Rankine engine powered AC and air heating fluid coils with additional fluid loop for hot water heating.
 - b. 3-ton cooling capacity.
 - c. Site locations - Sacramento, CA and Jacksonville, FL.
3. Multi-family heating, cooling and hot water.
 - a. One fluid loop solar assisted Rankine engine powered AC, air heating coils and additional fluid loop for hot water heating.
 - b. Cooling tower for Rankine powered AC.
 - c. 25-ton cooling capacity.
 - d. Site locations - Lawrence, KS and Washington, D.C.
4. Commercial heating, cooling and hot water.
 - a. Same system characteristics as 3 above.
 - b. 75-ton cooling capacity.
 - c. Site locations - Carrolton, TX and Chapel Hill, NC.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Design and Development of Single Family, Multi-Family, Light Commercial and Commercial Size Solar Heating, Cooling, and Hot Water Systems

INSTITUTION:

Honeywell, Inc.
2700 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

Glen Merrill

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32093

STARTING DATE: 07/09/76

DURATION: 39 months

AMOUNT: \$3,936,000

ONE OF MULTIPLE SYSTEMS BEING INSTALLED. SEE TEXT FOR DESCRIPTION OF OTHER SYSTEMS.

PROJECT DESCRIPTION

The objective of this project is to design, construct and test an entire solar energy cooling system using a desiccant dehumidifier cooling unit which provides economic advantages over solar cooling systems presently marketed.

The system consists of a cross-cooled dehumidifier constructed from paper-like sheets of silica gel of submicron particle size.

Phase I of the project includes:

- a) Literature search.
- b) Conceptual designs for analytical studies and tests for desiccant cooler and dehumidifier systems for a single family dwelling.
- c) Pilot production and testing of desiccant sheet.
- d) Study of temperature ranges of collectors required to refluorate the desiccant material. Determine the potential cost savings associated with using a small number of high temperature collectors as opposed to using a larger quantity of medium temperature collectors.
- e) Select several geographic areas and determine three which provide the best location for implementing a desiccant cooling system.
- f) Design two solar systems, one to be compatible with the desiccant cooling system and the other with the desiccant dehumidifier system.
- g) Predict the performance of both the desiccant dehumidifier and cooling subsystems over the range of load conditions of the three selected locations.
- h) Review potential environmental impact of the desiccant systems.
- i) Determine the maintenance requirements, expected life and the amount of skilled supervision necessary for the systems. Determine quality control required in manufacturing and estimate annual maintenance cost for a consumer.
- j) Determine which of the cooling systems offers greater economic advantage and compare with systems presently available.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a Solar Desiccant Dehumidifier

INSTITUTION:

Illinois Institute of Technology
3300 S. Federal Street
Chicago, IL 60616

PRINCIPAL INVESTIGATOR:

Zalman Lavan
Dimitri Gudispow

CONTRACT NUMBER: EG-77-C-03-1589

STARTING DATE: 09/30/77

DURATION: 36 months

AMOUNT: \$590,350

PROJECT DESCRIPTION

The overall objective of this project is to achieve and demonstrate improvements that will enhance the commercial marketability of the Solar-MEC System.

The study is divided into the following tasks:

Task 1—Obtain necessary data on the dynamic performance of the desiccant structure and use this information to improve IGT's mathematical design of the MEC process. Use the description to suggest design improvements for better seasonal energy efficiencies in the cooling mode.

Task 2—Continue to operate one of the demonstration prototype MEC units in IGT's laboratory to test the hardware application of the design improvements developed in Task 1, evaluate new desiccant wheel matrix materials developed, and obtain further information on MEC component durability.

IMPORTANT REPORTS OR PUBLICATIONS

- Staats, William R., Jaroslav, W., Wright, L.R., Kunc, V., and Banasak, H.A., "Field Testing of Solar - MECTM Systems," July, 1977.

PROJECT TITLE:

Testing of Solar-MEC Systems
Installations

INSTITUTION:

Institute of Gas Technology
3424 S. State Street
Chicago, IL 60616

PRINCIPAL INVESTIGATOR:

William Staats

CONTRACT NUMBER: EG-77-C-02-4495

STARTING DATE: 04/01/77

DURATION: 24 months

AMOUNT: \$539,480

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The first objective of this project is to select and screen candidate refrigerant-absorbent pairs. Selection will be based on literature and data obtained as part of this work. Pairs exhibiting endothermic heats of mixing will be further screened on the basis of a set of guidelines that determine whether an air absorption cooling unit, using these pairs, will be practical.

The second objective is to develop more detailed data on vapor pressures, heats of solution, corrosion and stability for the best three or four candidate systems. This will permit further evaluation of their potential for solar-absorption cooling.

The third objective is the evaluation of these systems using a computer model of absorption cooling to carry out cycle calculations and to put in practical cycle parameters such as heat-exchanger approach, solution pump efficiency, etc. Limited cycle optimization, as necessary and dictated by the specific system properties, will also be part of the evaluation.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of New Fluids for
Solar-Absorption Cooling

INSTITUTION:

Institute of Gas Technology
3424 S. State Street
Chicago, IL 60616

PRINCIPAL INVESTIGATOR:

Robert A. Macriss

CONTRACT NUMBER: EG-77-C-03-1439

STARTING DATE: 09/18/77

DURATION: 12 months

AMOUNT: \$96,513

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is the development of absorption air conditioners for solar cooling applications. The approaches being investigated are those that avoid the necessity for water cooling towers (and instead use air-cooled condensers and absorbers) and those leading to COP's (Coefficient of Performance) that increase as the input temperature increases. This is an experimental project, with the emphasis on designing, fabricating and testing ammonia/water absorption chillers in operating regimes that are particularly suited for solar energy applications, and for which no previous experimental data exist.

During FY 1977, testing of the first ammonia/water experimental chiller was completed and the results were published. The second prototype single-effect chiller (shown in the accompanying figure) has been designed and is being fabricated.

IMPORTANT REPORTS OR PUBLICATIONS

- Lawrence Berkeley Laboratory Reports: LBL-3293, LBL-5224, LBL-5911 and LBL-5982.

PROJECT TITLE:

Development of Solar-Driven Absorption
Air-Conditioners and Heat-Pumps

INSTITUTION:

Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

PRINCIPAL INVESTIGATOR:

Kim Dao

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 10/01/76

DURATION: 12 months

AMOUNT: \$130,000

PROJECT DESCRIPTION

The objective of this project is to determine the feasibility of applying the shape memory effect in certain intermetallic compounds (particularly "55-Nitinol") to the conversion of heat energy to mechanical work by means of solid-state heat engines. A primary milestone is the development of a prototype Nitinol engine on a scale suitable for powering a moderate-sized residential air conditioner with solar heated hot water. Research during the last funding period centered on the construction of a developmental engine concept (the Nitinol Cam-Track engine) which matches a novel mechanical cycle to the thermo-mechanical behavior of the Nitinol materials. Analytic and experimental work towards characterization of the thermodynamic cycle of Nitinol has been pursued.

IMPORTANT REPORTS OR PUBLICATIONS

- Banks, R., "Nitinol Heat Engines," from *Shape Memory Effects in Alloys*, J. Perkins, ed.; Plenum Publishing Corporation, 1976.
- Mohamed, H. A., Washburn, J., "Deformation Behavior and Shape Memory Effect of Near Equi-Atomic NiTi Alloy," *Journal of Materials Science* 12, 1977, 469-480.
- Banks, R., Wahlig, M. "Nitinol Engine Development," Lawrence Berkeley Laboratory, LBL-5293, 1976.

PROJECT TITLE:

Nitinol Engine Development

INSTITUTION:

Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

PRINCIPAL INVESTIGATOR:

Michael Wahlig

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 10/01/76

DURATION: 12 months

AMOUNT: \$170,000

PROJECT DESCRIPTION

The principal objectives of this work are to design, procure and test a 77-ton-rated solar-powered Rankine cycle/vapor compression cycle cooler. This unit has been installed in the National Security and Resources (NSR) Study Center at LASL. Its performance will be recorded and evaluated in a side-by-side comparison with a solar-powered lithium-bromide absorption chiller under various design and off-design conditions. The reliability and maintenance costs of both coolers will be compared. Engineering and economic performance data for solar air conditioning will be furnished to the construction industry to provide a firm basis for choice between the two cooling systems. An important auxiliary objective of this work is to confirm the economic feasibility of combined solar heating and cooling systems in a large building.

IMPORTANT REPORTS OR PUBLICATIONS

- "Design of a 77 Ton Solar Rankine Cycle Air Conditioning Unit for the National Security and Resources Study Center at Los Alamos, New Mexico," July 1975.
- "Design, Fabrication and Testing of a 77 Ton Solar Powered Water Chiller for the National Security and Resources Study Center at Los Alamos, New Mexico," Final Report, September 1977, Barner-Nichols Engineering.
- Bankston, C. A. and Neep, D. A., "Solar Energy Research at LASL," Progress Report Covering the Period July 1, 1976 - September 1977, LA-7115-PR.

PROJECT TITLE:

Evaluation of a Solar Rankine-Cycle
Cooling Unit in the National Security
and Resources Study Center at LASL

INSTITUTION:

Los Alamos Scientific Laboratory
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

C. A. Bankston
J. D. Balcomb
J. Headstrom

CONTRACT NUMBER: W-7405-ENG-36, D494

STARTING DATE: 01/04/75

DURATION: Continuing

AMOUNT: \$183,000

PROJECT DESCRIPTION

The specific objectives of this research are as follows:

1. Develop cooling subsystem model for inclusion in existing system programs, especially TRNSYS.
2. Validate cooling component models with manufacturers' data.
3. Develop one generalized and one simplified program for cooling component model performance.
4. Optimize studies of cooling systems under various control strategies for purposes of identifying optimal cooling systems.
5. Study parameters including a simplified economic model.
6. Design procedures for cooling systems similar to the FCHART approach for designing heating systems.
7. Make available for manufacturers and other users a checked out cooling subsystem simulation program.

This project is divided into the following tasks:

Task 1—Develop a generalized computer program for predicting component performance of LiBr/H₂O absorption cycle and Rankine/Vapor-Compression Cycle.

Task 2—Develop storage, transients and a very simplified economic model similar to that developed by the University of Wisconsin, and conduct optimization studies under various control strategies.

Task 3—Validate performance models.

IMPORTANT REPORTS OR PUBLICATIONS

- Allen, R.W., and Anand, D.K., "Parametric Study of a Dynamic Solar Powered Absorption Cycle." Proceedings, ISES, 1976, Winnipeg, Vol. 3, pp. 27-33.
- Anand, D.K., "Solar Air Conditioning System Performance Predictions Using Load, Storage and Stochastic Weather Models for Different Regions," Paper No. 1048 - ISES - ISEC '77 Proceedings, New Delhi, India, January 16-21, 1978.
- "Optimization Studies of Solar Absorption Air-Conditioning Systems," Interim Progress Report, Report No. NSF/RANN/SE/GI-39117/PR/74/15.
- "Optimization Studies of Solar Absorption Air-Conditioning Systems," Final Progress Report, Report No. NSF/RANN/SE/GI-39117/PR/76/2.

PROJECT TITLE:

Solar Cooling Component Modeling and Optimization

INSTITUTION:

University of Maryland
Mechanical Engineering Dept.
College Park, MD 20742

PRINCIPAL INVESTIGATOR:

R. W. Allen
D. K. Anand

CONTRACT NUMBER: EY-76-S-05-4976

STARTING DATE: 07/01/77

DURATION: 24 months

AMOUNT: \$50,000

PROJECT DESCRIPTION

The objective of this project is to design, fabricate, test and analyze a solar-powered heat engine/vapor compression (SSPRE/VC) chiller of 15-25 ton capacity that uses water as a working fluid. The chiller will be designed for efficient operation with solar-heated fluid supply temperatures of 220° to 300°F.

The project is divided into the following three phases:

Phase I—A literature search will be conducted. In three different climatic regions cooling loads will be determined for residential multi-family buildings. Conceptual designs will be developed for different SSPRE/VC chillers. A computer program will be developed to do the system performance analysis. Environmental effects will be determined. Manufacturing, installation, operation procedures and costs will be assessed. One of the designs will be selected for further development.

Phase II—Detailed design features of the water chiller will be studied. The SSPRE/VC chiller system components will be specified and a detailed design of the selected heat engine/vapor compression chiller will be made.

Phase III—The design unit will be fabricated, assembled, inspected and tested. Experiments will be performed on a simulated solar-powered A/C test bed. Prospective improvements in the design will be analyzed and the system economics will be reviewed and updated. Based on results obtained so far, recommendations will be made for system development and marketing.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Chiller Driven by a Solar Steam
Powered Rankine Engine (SSPRE)

INSTITUTION:

University of Pennsylvania
Philadelphia, PA 19104

PRINCIPAL INVESTIGATOR:

Hsuan Yeh
Noam Lior

CONTRACT NUMBER: EG-77-C-03-1588

STARTING DATE: 09/01/77

DURATION: 36 months

AMOUNT: \$677,937

LEGEND

1. SHAFT
2. CRANK
3. BEARING SURFACE
4. ROLLER
5. CYLINDER
6. ROLLER SEAL
7. MAIN ROLLER
8. CURTAIN VALVE
9. HINGE
10. PORT
11. STEAM PASSAGE
12. STEAM CUTOFF CURTAIN
13. EXHAUST PORT

PROJECT DESCRIPTION

The objective of this program is to develop a free piston expander-compressor device suited for Rankine cycle driven vapor compression in solar heating/cooling systems. The device uses heat sources with temperatures as low as 150°F without the need of auxiliary energy. This low temperature capability is achieved by maintaining low mechanical friction in the expansion-compression device. Unlike other devices, it also has the inherent capacity to accept varying temperature heat sources without throttling losses at any condition, thereby maintaining a high isentropic efficiency.

These capabilities allow the use of heat at the varying optimum temperatures of the solar collector-heat pump system or storage-heat pump system. During periods when low temperature solar heat is not available, auxiliary fossil fuel can be used as the energy source.

A 12-month analytical and experimental research and development program is proposed to design, construct and test a heat drive heat pump system using the previously discussed free-piston-expander-compressor (FPEC). The program will have three tasks: (1) analysis, (2) FPEC operation on air, (3) FPEC operation in a heat pump system.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a Solar Driven
Free Piston Dual Loop Heat Pump

INSTITUTION:

Scientific-Atlanta, Inc.
3845 Pleasantdale Road
Atlanta, GA 30340

PRINCIPAL INVESTIGATOR:

Sam V. Shelton

CONTRACT NUMBER: EG-77-C-02-4539

STARTING DATE: 09/01/77

DURATION: 12 months

AMOUNT: \$169,141

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Solaron will design and study three configurations of solar assisted heat pump systems and four configurations of solar assisted desiccant systems. The most optimum system will be selected and a single family residential heating, cooling and hot water system will be chosen for two sites. These two sites are Akron, OH and Arkansas. Air heating flat-plate collectors with rock storage will be used at both sites. Marshall Space Flight Center will monitor project progress.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Single Family Size Solar Heating, Cooling, and Hot Water System Using Air Collectors and a Heat Pump for Heating and the Heat Pump with Off-Peak Storage for Cooling

INSTITUTION:

Solaron Corporation
Suite 300, Galleria Tower
720 S. Colorado Blvd.
Denver, CO 80222

PRINCIPAL INVESTIGATOR:

L. E. Shaw

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32249

STARTING DATE: 11/01/77

DURATION: 30 months

AMOUNT: \$458,300

ONE OF MULTIPLE SYSTEMS BEING INSTALLED.

PROJECT DESCRIPTION

The objective of this project is to develop and analyze new refrigerant-absorbent pairs, new additives to presently used refrigerant-absorbent pairs, and modifications to the absorption cycle, which can potentially improve performance or reduce the cost of an absorption chiller in the size range of three tons. The chiller is to operate with heat supplied by solar-heated fluid at 160°F to 230°F.

To meet this objective, candidate refrigerant-absorbent pairs and additives which appear to offer the required characteristics will be selected. For the most promising pairs other properties needed for analyses of absorption cycles will be determined.

Conceptual designs of absorption cycles will be prepared and computer simulation models of these designs will be developed. The output items from the computer will include the initial cost of each absorption chiller, the annual cost to the consumer and the coefficient of performance.

The project is divided into nine tasks:

Task 1—Search for refrigerant absorbent pairs and additives.

Task 2—Acquisition of data.

Task 3—Conceptual designs.

Task 4—Computer models.

Task 5—Comparison of refrigerant-absorbent pairs and additives.

Task 6—Cycle modifications.

Task 7—Selection of more promising pairs and additives.

Task 8—Recommendations for further research.

Task 9—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Analysis of Advanced Conceptual
Designs for Single-Family-Sized
Absorption Chillers

INSTITUTION:

Southern Research Institute
2000 Ninth Ave., South
Birmingham, AL 35205

PRINCIPAL INVESTIGATOR:

Robert E. Lacey

CONTRACT NUMBER: EG-77-C-03-1586

STARTING DATE: 09/01/77

DURATION: 12 months

AMOUNT: \$114,472

PROJECT DESCRIPTION

This project is a continuation of the work supported by the National Science Foundation, grant number NSF-C903. The objectives of the continuation work include the following:

- 1) Additional characterization tests at water cooled and air cooled condenser temperature levels over a selected range of turbine inlet conditions to evaluate features of the system.
- 2) Modification of the turbine for high capacity operation at temperature levels below those achievable with present day absorption equipment.
- 3) Evaluation and further modification of the turbocompressor system to permit operation at turbine inlet temperatures consistent with medium concentration collectors and indicate performance potential.
- 4) Incorporation of automatic controls and other component simplifications to the system.

IMPORTANT REPORTS OR PUBLICATIONS

- "Feasibility Demonstration of Solar-Powered Turbo Compressor Air Conditioning and Heating System," Final Report, Report No.: C0054-C903/75/1.
- "Test and Evaluation of a Solar-Powered Turbo-compressor Rankine Cycle System for Building Air Conditioning."
- "Test and Evaluation of a Solar-Powered Turbo-compressor Air Conditioning and Heating System for Building Heating and Cooling," Final Report, UTRC Report No.: R77-952529-1.

PROJECT TITLE:

Solar Powered Turbocompressor (Rankine Cycle) Air Conditioning System

INSTITUTION:

United Technologies Research Center
400 Main Street
East Hartford, CT 06108

PRINCIPAL INVESTIGATOR:

Frank R. Biancardi

CONTRACT NUMBER: EG-76-C-02-2824

STARTING DATE: 12/15/75

DURATION: 13 months

AMOUNT: \$219,388

Turbocompressor A/C System

PROJECT DESCRIPTION

The objective of this project is to design, fabricate and test a prototype solar-powered turbocompressor heat pump system for multi-family residential applications. The system will define specifications for limited-production units to be used in the DOE Solar Heating and Cooling Demonstration Program. The prototype system will incorporate a new turbocompressor designed to operate at temperatures consistent with medium concentration collectors and will utilize heat exchanger and system design data developed by United Technologies under ERDA-sponsored programs.

The system will be configured to provide a nominal design cooling capacity of approximately 18 tons. In the air conditioning mode, the condenser is air-cooled, while in the heat pump mode, the source of low temperature heat is derived from solar energy.

The program will consist of the following five tasks:

Task 1—Analyses to finalize the prototype design characteristics and provide component specifications.

Task 2—Specification, procurement and checkout testing of two types of solar collectors, a storage tank and the system fan coil and furnace.

Task 3—Design, fabrication and assembly of the heat pump system components and integration with the solar/storage elements and auxiliaries.

Task 4—Test and performance evaluation of the integrated solar-powered heat pump system.

Task 5—Liaison between the Contractor's Research Center (UTRC) personnel and the Contractor's Hamilton Standard Division (HSD) manufacturing and production personnel to provide a design suitable for low production runs.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Design, Develop and Test a Multi-Family Residential Size Prototype Solar-Powered Turbocompressor Heat Pump System

INSTITUTION:

United Technologies Research Center
400 Main Street
East Hartford, CT 06108

PRINCIPAL INVESTIGATOR:

Frank R. Biancardi

CONTRACT NUMBER: EG-77-C-02-4510

STARTING DATE: 09/01/77

DURATION: 16 months

AMOUNT: \$1,068,433

System Configuration # 2 Water cooled condensers and external HX

5. PASSIVE SYSTEMS

PROJECT DESCRIPTION

This project will study the thermal performance of a solar-heated residence in order to develop a design formula that will incorporate passive concepts in optimal ways and provide a building design prototype.

The residence to be studied uses several passive solar energy concepts, including a solar pond. These concepts have been used in previous designs, but have never been combined to the degree they will be in this research. It is estimated that except for the electrical energy needed to operate fans and water pumps, this composite passive system will provide 100% of the heating needs for the house. During the cooling season, however, the house will operate only partially in the passive mode, using a heat exchange unit. The thermal performance of the building will be monitored by pyranometers and thermocouples.

Also, this project will develop a computer model of the passive solar house coincident with actual house construction. This new model, and the hybrid model's prediction accuracy will be perfected using the measurement data obtained from the solar house.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Experimental and Theoretical Study of the Thermal Performance of a Hybrid Solar Residence for the Farm of Today and Tomorrow at Living History Farms, Urbandale, Iowa

INSTITUTION:

Ames Design Collaborative
208 5th Street
Ames, Iowa 50010

PRINCIPAL INVESTIGATOR:

Ray D. Crites

CONTRACT NUMBER: EG-77-G-04-4136

STARTING DATE: 09/19/77

DURATION: 14 months

AMOUNT: \$54,500

PROJECT DESCRIPTION

The purpose of this project is to design and construct a single family residence that uses passively collected solar energy for a significant portion of its space heating requirements. The building will be in the Minneapolis metropolitan area, an area that has a high winter heating load, average to above average winter sunshine, and periods of relatively warm summer weather.

Upon completion of the residence a number of ways to store and control low temperature heat will be tested, and data will be collected.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Energy Using a Hybrid Solar System

INSTITUTION:

Architectural Alliance, Inc.
400 Clifton Avenue South
Minneapolis, MN 55403

PRINCIPAL INVESTIGATOR:

Peter Pfister
Charles Lindeberg

CONTRACT NUMBER: EG-77-G-04-4146

STARTING DATE: 09/30/77

DURATION: 27 months

AMOUNT: \$19,300

PROJECT DESCRIPTION

The purpose of this study is to reduce the thermal leakage, improve the control system and increase reliability of the system in the Skytherm Atascadero house. The design will include redesigning sliding insulating panels, using a new system of metal slide tracks and seals, reinsulating portions of the walls, changing the pitch of the metal roof, and creating a thermal break between the metal roof supporting the thermoponds and the roof of the attached carport. The redesigned plans have been submitted to several local contractors for construction bids. The assembly of the sliding panels and seals will be assigned to a fabricator in Los Angeles. The project originally included a construction and test phase. This portion has been terminated due to the excessive size of the only construction bid received.

IMPORTANT REPORTS OR PUBLICATIONS

- "Rehabilitation and Testing of the Skytherm Atascadero House," Final Report, ERDA Report No. ALO-E(29-2)-3756-1.

PROJECT TITLE:

Rehabilitation and Testing
of the Skytherm Atascadero House

INSTITUTION:

Ayres Associates
1180 So. Beverly Drive, Suite 600
Los Angeles, CA 90035

PRINCIPAL INVESTIGATOR:

J. Marx Ayres

CONTRACT NUMBER: EY-76-C-04-3756

STARTING DATE: 08/15/76

DURATION: 6 months

AMOUNT: \$62,420

PROJECT DESCRIPTION

The White Mountain School Faculty Housing and Dormitory Project is designed to use a solar assisted heating system to minimize fuel consumption and to provide an environment for teaching students the principles of solar energy and how to use it more effectively.

The following design conditions have been established:

1. The dormitory is sited against a 9-foot embankment which will take advantage of the thermal stability of the earth as well as provide a lower building profile against the north winds. The north facing foundation wall is designed to contain a 6-inch cavity between a 12-inch insulated exterior masonry wall and a 3½-inch interior stud wall.
2. The south facing elevation is a continuous solarium. Four-fifths of the solarium is an unheated intermediate zone between the living units and the outdoors.
3. The living units, like the food production area, have auxiliary heat and south orientation.
4. The Common Room on the lower level and the Resource Center on the upper level are designed to use solar heat from the solarium and the heat from a highly efficient Austrian "Kachelofen," or wood-burning stove.
5. The outer wings of the building use an active system, and the central section uses a passive/hybrid system. Mathematical models of both types of systems will be constructed and validated.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

White Mountain School Faculty
Housing and Dormitory

INSTITUTION:

Banwell, White and Arnold, Inc.
Two West Wheelock Street
Hanover, NH 03755

PRINCIPAL INVESTIGATOR:

C. Stuart White

CONTRACT NUMBER: EG-77-G-04-4139

STARTING DATE: 09/30/77

DURATION: 26 months

AMOUNT: \$67,716

PROJECT DESCRIPTION

This project will examine the potential of heat pipes for furthering the commercialization and use of passive solar energy heating and cooling systems. Several approaches for combining heat pipes and passive systems will be taken.

The program is divided into the following tasks:

Task 1—Identification of new concepts for passive systems incorporating heat pipes or heat pipe principles.

Task 2—Adaptation and use of available analytical tools.

Task 3—Systems analysis and evaluation of thermal performance.

Task 4—Cost effectiveness evaluation.

Task 5—Development and fabrication of prototype heat pipes and/or heat pipe techniques.

Task 6—Assessment of marketability.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Evaluation of Heat Pipe Applications
for Passive Systems

INSTITUTION:

Battelle Memorial Institute
Columbus Laboratories
505 King Avenue
Columbus, OH 43201

PRINCIPAL INVESTIGATOR:

John M. Corliss

CONTRACT NUMBER: EG-77-C-03-1601

STARTING DATE: 09/19/77

DURATION: 18 months

AMOUNT: \$199,366

PROJECT DESCRIPTION

The objective of this project is to evaluate the energy saving benefits and dollar costs of the various energy control techniques associated with passive solar heating and cooling systems. Manual and automatic controls will be examined. The term "control" is used here in the most general sense and includes such things as electronic devices, moveable insulation, and shadowing of parts of buildings.

The program is divided into the following tasks:

- Task 1—Review of passive heating and cooling techniques with emphasis on appropriate climate zones.
- Task 2—Heat-flow model development and control characterization.
- Task 3—Estimate of cost associated with each technology on per-unit-performance basis.
- Task 4—Control evaluation and approximate optimization.
- Task 5—Verification of approximate optimum using BLAST.
- Task 6—Ranking of control strategy performance at optimum.
- Task 7—Evaluation of continuous controls.
- Task 8—Identification of new research and development needs in controls for passive systems.
- Task 9—Approximate cost of optimally controlled passive systems.
- Task 10—Reporting.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Impact of Controls on Back-up Energy Consumption in Passive Solar Heated and Cooled Residences

INSTITUTION:

The Regents of the University of California
University of California at San Diego
La Jolla, CA 92093

PRINCIPAL INVESTIGATOR:

A.V. Sebald
J.R. Clinton

CONTRACTOR NUMBER: EG-77-G-04-1603

STARTING DATE: 09/19/77

DURATION: 12 months

AMOUNT: \$42,834

PROJECT DESCRIPTION

The objective of this project is to construct and test a modular thermal wall panel. This thermal panel will use a unique salt hydrate mixture with sodium sulfate decahydrate as an 89°F phase-change storage medium and a patented polyhedral insulation. Methods of incorporating phase-change materials with conventional building techniques and materials will also be studied. Simulation work previously performed on passive solar systems will be used.

A test panel will be constructed and installed in a specially prepared laboratory room. The performance of the panel and its transfer function will be determined using an A-B comparison test method. An analysis will be made to determine ways in which the performance can be optimized.

To achieve cost savings, the techniques of fabrication, construction materials and the methods of installation will be studied.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract No report available

PROJECT TITLE:

The Application of Phase Change
Materials in Passive Solar Systems

INSTITUTION:

University of Delaware
Institute of Energy Conversion
Newark, DE 19711

PRINCIPAL INVESTIGATOR:

Joseph Sliwkowski

CONTRACT NUMBER: EG-77-S-04-4085

STARTING DATE: 09/30/77

DURATION: 14 months

AMOUNT: \$59,130

PROJECT DESCRIPTION

This project will gather temperature, radiation, wind speed and energy-use data on a passive solar house. The house to be monitored has three passive components which have not been adequately studied. They are a "suncatcher," a breadbox hot water heater and vertical water-cylinders for thermal storage. In addition, measurements and analysis that trace heat flows inherent in the function of passive solar systems will be made. These heat flows include night-time cooling and ventilation, and slab and ground heat flux.

A year-long house-comfort monitoring program using an automated data acquisition system will be performed. Concurrently, energy and radiation experiments, infrared radiation tests and specific monitoring efforts will be conducted.

Following technical evaluation and reporting, the results will be published in scientific journals and reports. Technical articles for builders, architects and the public will be written. House tours and seminars will be held at the site to permit public viewing of the house design.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Suncatcher Monitoring Project

INSTITUTION:

Earth Integral of Living Systems
Route 1, Box 170
Winters, CA 95694

PRINCIPAL INVESTIGATOR:

Bruce T. Maeda

CONTRACT NUMBER: EG-77-C-04-4154

STARTING DATE: 09/30/77

DURATION: 15 months

AMOUNT: \$32,408

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this program is to gather experimental data on the mechanical and thermal performance of a passive, multi-functional solar collector/energy store. This system uses wax encapsulated in 50 to 100 Angstrom pores in a plastic sheet as an absorber and store of solar energy. The data will be used to produce a commercial solar energy collector that will heat air by natural convection.

The variables of the design which will be investigated are:

- The composition thickness, optical absorptivity and mass of the poroplastic/wax
- The mechanical design of the convector housing and the mechanical arrangement of the poroplastic/wax absorber.

This project will involve laboratory experiments using artificial illumination and experiments using four different full scale modules exposed to the sun.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Passive Solar Collector/Connector
Incorporating Energy Storage

INSTITUTION:

Eikonix Corporation
103 Terrace Hall Avenue
Burlington, MA 01803

PRINCIPAL INVESTIGATOR:

Charles R. Hauer

CONTRACT NUMBER: EG-77-C-04-4125

STARTING DATE: 09/12/77

DURATION: 12 months

AMOUNT: \$40,000

PROJECT DESCRIPTION

This experiment will determine the free convection flow patterns and heat transfer characteristics of the Trombe wall, a passive solar energy collection system.

A small one-room building with a Trombe wall system for its south wall will be constructed and instrumented. Measurements will be made of incident solar radiation, conventional wall temperatures, wall inlet/outlet air temperatures, temperature profiles in the air gap, outside ambient air temperature and flow rate in the air gap via velocity profile. The accumulated data will be analyzed to determine the operating characteristics of the wall, including both thermal and cost considerations, and the passive system's contribution to the building space heating load.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Experimental Investigation of the
Trombe Wall Passive Solar Energy System

INSTITUTION:

Energy Engineering Group
P. O. Box G
Idaho Springs, CO 80452

PRINCIPAL INVESTIGATOR:

Richard L. Casperson

CONTRACT NUMBER: EG-77-G-04-4145

STARTING DATE: 09/30/77

DURATION: 19 months

AMOUNT: \$39,170

PROJECT DESCRIPTION

The objective of this project is to develop a passive solar heating and cooling system that is long lived and reliable, and compatible with the residential retrofit market.

The system to be evaluated is based on heat pipe technology, but differs from the conventional heat pipe in that the condensate is pumped from the condensor to the evaporator by a small positive displacement pump. This hybrid system is designed to accommodate the requirements of a wide variety of heating/cooling applications.

The program will design, fabricate, install and test the concept.

The final report will include design and performance information on the demonstration installation, concept evaluations, and recommendations for future concept development.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a Passive Heating and Cooling System Using a Pumped Heat Pipe

INSTITUTION:

Foster-Miller Associates
135 Second Avenue
Waltham, MA 02154

PRINCIPAL INVESTIGATOR:

John Dieckman

CONTRACT NUMBER: EG-77-C-04-4098

STARTING DATE: 09/06/77

DURATION: 13 months

AMOUNT: \$46,350

PROJECT DESCRIPTION

The objective of this project is to develop a medium temperature, non-concentrating vacuum tube air collector. This project will result in a collector which has the simplicity of a flat-plate collector, the performance of a vacuum tube collector and an energy/cost ratio (Btu/\$) lower than any equivalent collector presently on the market.

An optimized air collector design will be manufactured and tested. One of these optimized modules will also be manufactured for verification testing at an independent laboratory.

The project is divided into the following tasks:

Task 1—Design optimization development.

Task 2—Fabrication.

Task 3—Design verification cost.

Task 4—Pre-production prototype design.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Non-Concentrating Collectors for
Medium Temperature Air Heaters

INSTITUTION:

General Electric Company
Advanced Energy Programs, Space Division
P. O. Box 8661
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

Alan S. Jacobsen

CONTRACT NUMBER: EG-77-C-04-4126

STARTING DATE: 09/30/77

DURATION: 15 months

AMOUNT: \$149,800

PROJECT DESCRIPTION

This project will study the use of thermoponds for passive heating and cooling.

In the first phase of the study, professionals will assess untested Skytherm roof designs and select two for ground-level accelerated testing. The design will then be installed on a full-scale house and tested.

In Phase Two, the information and design details from Phase One will be combined with what has already been learned about Skytherm and with FHA Minimum Building Standards. The result of this synthesis will be a design manual for low-cost Skytherm applications. Based on this manual, the selected and proved low-cost design will undergo further analysis.

Also separate structural analysis will be conducted, above-ceiling elements will be detailed and the working plans for the low-cost structures will be costed and thermally and structurally analyzed. A revised design manual will be distributed.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Skytherm Design Study

INSTITUTION:

Harold R. Hay
2425 Wilshire Boulevard
Los Angeles, CA 90057

PRINCIPAL INVESTIGATOR:

Harold R. Hay
Daniel A. Aiello

CONTRACT NUMBER: EG-77-G-04-4134

STARTING DATE: 09/19/77

DURATION: 12 months

AMOUNT: \$39,980

PROJECT DESCRIPTION

This project will assist in the development of a new type of modular "solar furnace" that can be built into, onto, or next to any building, to provide solar heat at a very low cost and minimize moving parts and auxiliary energy input.

The project will begin with preliminary heat transfer studies, initial design development and cost analysis. Working modules will be constructed with design refinements to cut construction costs and simplify the assembly sequence. The performance of the modules will be measured to obtain useable Btu output. Performance curves for Manchester, NH will be developed based on actual data and estimated performance for at least two different sites. The cost per Btu will be measured and analyzed versus the cost performance of other available devices. Finally, a set of Builder's Plans and a Kit for Do-It-Yourselfers will be developed along with a marketing plan to disseminate "solar furnaces" economically and rapidly in the market place.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Low Cost Modular Passive Solar
Furnace System Development

INSTITUTION:

Kalwall Corporation
1111 Candia Road
P. O. Box 237
Manchester, NH 03105

PRINCIPAL INVESTIGATOR:

Bruce M. Keller

CONTRACT NUMBER: EG-77-G-04-4092

STARTING DATE: 09/05/77

DURATION: 13 months

AMOUNT: \$73,156

PROJECT DESCRIPTION

The feasibility of using direct radiative cooling for removing substantial amounts of heat from buildings is being investigated. To evaluate the radiative cooling "resource" a computer program has been developed to model the infrared spectral emission characteristics of the atmosphere under a variety of weather conditions. A version of this program will be incorporated into a dynamic building loads program to enable simulation of radiative cooling systems of various designs in different climates. Evaporative and convective cooling mechanisms will be included in the simulation program. An experimental data gathering effort is being initiated in which four infrared spectrometers are to be installed at various locations about the country during the summer of 1978. The data received from these instruments, along with the results of the modeling effort, will be used to evaluate the feasibility of using direct radiative cooling, including the performance of selective radiators.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available.

PROJECT TITLE:

Radiative and Passive Cooling

INSTITUTION:

Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

PRINCIPAL INVESTIGATOR:

Marlo Martin

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 03/01/77

DURATION: Continuing

AMOUNT: \$85,000

Computed infrared emission of the atmosphere from four directions for a typical mid-latitude clear sky.

PROJECT DESCRIPTION

This study will design and construct inexpensive mass storage units, efficient solar collection systems, a cost-effective movable insulation system and a powerful night-sky cooling system with no moving parts. Computer algorithms will be developed to extend computer modeling capabilities for the prediction of passive system performance. A preliminary architectural design will be prepared for a rural community center, predicting the thermal performance, cost effectiveness and architectural simplicity of a passive heating and cooling system for a specific building.

The project is divided into the following tasks:

Task 1—Component research and development.

Task 2—Component integration.

Task 3—Evaluation of performance.

Task 4—Community center building design and architectural coordination.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

An Integrated Passive Heating and Cooling System

INSTITUTION:

Living Systems
Route 1, Box 170
Winters, CA 95694

PRINCIPAL INVESTIGATOR:

Jonathan Hammond

CONTRACT NUMBER: EG-77-G-04-4153

STARTING DATE: 09/30/77

DURATION: 15 months

AMOUNT: \$81,292

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This retrofit project will modify an existing dwelling in accordance with state-of-the-art passive solar design technology, gather data and derive design principles from data analysis and evaluation.

The solar heating system to be used is designed to provide 50% of the space heating requirements of a typical masonry walled St. Louis house.

The passive heating system will consist of:

1. Transforming 300 feet square of the south wall to a Trombe wall by means of exterior double glazing.
2. Mounting insulation outside of all remaining masonry walls (composite R 15) to provide thermal storage inside the building skin.
3. Using a blower and insulated ducting to distribute the heated air from the top of the two-story Trombe region to the rest of the house.
4. Installing storm sashes.
5. Providing air locks on house entrances.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Retrofit of an Existing Masonary
Home for Solar Passive Space
Heating: A Demonstration and
an Experiment

INSTITUTION:

Londe-Parker-Michels, Inc.
6096 Lemay Ferry Road
St. Louis, MO 63129

PRINCIPAL INVESTIGATOR:

Timothy I. Michels

CONTRACT NUMBER: EG-77-G-04-4127

STARTING DATE: 09/08/77

DURATION: 17 months

AMOUNT: \$15,339

PROJECT DESCRIPTION

The objectives of this research are to analyze the design of sun-tempered buildings on a quantitative basis, to verify this analysis against test units and occupied buildings and to publish this material in a form that can be used by the design professionals for constructing buildings.

This project is divided into the following tasks:

Task 1—Digital simulation analysis of designs in a variety of climates.

Task 2—Numerical parameter studies.

Task 3—Monitoring of existing passive solar buildings.

Task 4—Verification of simulation models.

Task 5—Construction of 14 passive heating test rooms.

Task 6—Performance of experiments in these rooms.

Task 7—Architectural study.

Task 8—Identification of best designs.

Task 9—Information dissemination.

IMPORTANT REPORTS OR PUBLICATIONS

- Balcomb, J. D., Hedstrom, J. C., and McFarland, R. D., "Simulation Analysis of Passive Solar Heated Buildings," *Solar Energy*, Vol. 19, pp 277-282, Pergamon Press, 1977.
- Balcomb, J. D., "Passive Solar Systems Development," Los Alamos Scientific Laboratory Report LA-UR-76-2135, presented to the New Mexico Solar Energy Association, September 1976.
- Balcomb, J. D., and Keller, M. (eds.), "Passive Solar Heating and Cooling Conference Proceedings," Los Alamos Scientific Laboratory Report LA-6637-C, compiled from the Passive Solar Heating and Cooling Conference and Workshop, May 18-19, 1976.
- Balcomb, J. D., and McFarland, R. D., "Simulation Analysis of Passive Solar Heated Buildings—The Influence of Climate and Geometry on Performance," Los Alamos Scientific Laboratory Report LA-UR-77-938, Proceedings of the 1977 ISES, American Section Annual Meeting, June 6-10, 1977, page 11-1.
- Balcomb, J. D., McFarland, R. D., and Moore, S. W., "Simulation Analysis of Passive Solar Heated Buildings—Comparison with Test Room Results," Los Alamos Scientific Laboratory Report LA-UR-77-939, Proceedings of the ISES, American Section Annual Meeting, June 6-10, 1977, page 11-5.
- Balcomb, J. D., Hedstrom, J. C., and McFarland, R. D., "Passive Solar Heating of Buildings," submitted to Workshop on Solar Energy Applications, Associated Universities, Inc., June 27-July 31, 1977, Los Alamos Scientific Laboratory Report LA-UR-77-1162.

PROJECT TITLE:

Research on Passive Solar Heating of Buildings

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663, MS 571
Los Alamos, New Mexico 87545

PRINCIPAL INVESTIGATOR:

J. D. Balcomb

CONTRACT NUMBER: W-7405-ENG-36

STARTING DATE: 10/01/77

DURATION: 12 months

AMOUNT: \$400,000

PROJECT DESCRIPTION

The purpose of this project is to determine the performance characteristics of thermic diode solar panels used for heating systems. Performance characteristics will be determined for climates in the continental United States. These results will then be compared with those obtained by the "FCHART" and the "load-collector ratio" methods.

Parameter variations will determine the optimum panel geometry for minimizing energy costs.

Experimental verification of thermic panel performance is also proposed. Although some experimental data on test panels exists, no verification has been attempted on "production prototype" panels. The verification process will insure that computer generalizations of panel performance are valid.

The work is divided into the following tasks:

Task 1—Computer simulation.

Task 2—Develop design procedure.

Task 3—Experimental verification.

Task 4—Documentation.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Performance Characteristics of
Thermic Diode Solar Panels

INSTITUTION:

Massachusetts Institute of Technology
Department of Mechanical Engineering
Cambridge, MA 02139

PRINCIPAL INVESTIGATOR:

Shawn Buckley

CONTRACT NUMBER: EG-77-S-02-4383

STARTING DATE: 07/01/77

DURATION: 12 months

AMOUNT: \$53,170

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to develop design methods for the use of three new building components. These components are a transparent insulation, heat storage masonry and a glare control device. A small scale proof-of-concept structure to verify the design methodology and component performance predictions will be built.

Research in alternative glazing and thermal storage systems will also be performed. Subjects for investigation include heat mirror alternatives to the transparent insulation and alternative packaging systems for heat of fusion materials that lend themselves to wall installations. Other experimental products will be evaluated.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Design Methodologies for Energy
Conservation and Passive Heating
of Buildings Utilizing Improved
Building Components

INSTITUTION:

Massachusetts Institute of Technology
Department of Architecture
Cambridge, MA 02139

PRINCIPAL INVESTIGATOR:

John Habraken
Timothy Johnson

CONTRACT NUMBER: EG-77-S-02-4513

STARTING DATE: 08/01/77

DURATION: 12 months

AMOUNT: \$73,100

PROJECT DESCRIPTION

The purpose of this project is to analyze the thermal performance of the passive solar heated Patoka Nature Center Building in Orange County, Indiana. The A-frame roof of this structure has an E-W ridge, S-slope glazing/beam wall and N-slope insulation/reflector.

The specific objectives are:

1. Determine the suitability of direct gain passive solar heating in climates such as that of southern Indiana,
2. Determine the overall effectiveness of this particular passive system in maintaining occupant thermal comfort as measured by: (a) ASHRAE recommended standards and (b) occupant perception of comfort,
3. Determine the specific effectiveness of the following unique features of this system:
 - a. N-sloped foil reflector roof,
 - b. S-sloped beam wall roof,
 - c. sand-filled wood-frame ceiling construction at bottom of A-frame, and
 - d. vertical water tubes and slab-on-grade as thermal storage masses,
4. Assess the public acceptance of the visual aesthetics, thermal comfort and visual comfort of the building,
5. Determine an estimate of the overall contribution of the passive solar heating to the thermal load of the building, and
6. Report and disseminate the knowledge gained from this project.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Analysis of Performance of Passive
Solar Heated Patoka Nature Center

INSTITUTION:

Miami University
Department of Architecture and
Institute of Environmental Sciences
Oxford, OH 45056

PRINCIPAL INVESTIGATOR:

F. Moore

CONTRACT NUMBER: EG-77-C-04-4090

STARTING DATE: 09/30/77

DURATION: 18 months

AMOUNT: \$10,000

PROJECT DESCRIPTION

This study will document the performance of a moderately priced Skytherm solar house in a severe cooling climate. With this information, the project will allow for side-by-side comparison of Skytherm's performance with an active solar system. Specific comparison areas include: cost, maintenance, reliability and resident response. Also, the enhanced heat transfer characteristics and thermal coupling between the roof pond and the ambient air and the interior space will be examined. A major objective of the project will be to make the study information available to contractors and interested persons through seminars and workshops.

The project will begin with the purchase and installation of Skytherm and instrumentation systems in a house constructed and designed with funding provided by the state government. The performance of the passive system will be monitored and documented in both the heating and cooling modes of operation. The final report will detail and evaluate the Skytherm house's cost, maintenance and performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Performance Evaluation of a
Passively Heated and Cooled House

INSTITUTION:

New Mexico State University
Las Cruces, New Mexico 88003

PRINCIPAL INVESTIGATOR:

T. R. Mancini

CONTRACT NUMBER: EY-76-S-04-4157

STARTING DATE: 09/01/75

DURATION: 15 months

AMOUNT: \$58,000

PROJECT DESCRIPTION

This project will design, construct, instrument and monitor a building experiment using a passive focusing roof aperture system operating with a passive water-wall with moveable insulation/reflectors.

Using computer simulation, a preliminary network model analysis of critical nodes for both focusing roof aperture and water-wall will be performed. Design parameter optimization will also be conducted.

When the building is completed, a modified version of an existing "Omnibus" instrumentation package will be installed to measure the critical variables identified during the computer modelling. Data will be collected and analyzed, and the combined system performance and cost will be evaluated.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Passive Water Wall and Focusing
Roof Aperture Solar Heating
Building Experiment

INSTITUTION:

Princeton Energy Group
245 Nassau Street
Princeton, NJ 08540

PRINCIPAL INVESTIGATOR:

Harrison Fraker, Jr.

CONTRACT NUMBER: EG-77-G-04-4149

STARTING DATE: 09/30/77

DURATION: 18 months

AMOUNT: \$43,009

PROJECT DESCRIPTION

The contractor will perform the following tasks:

- Task 1—A meeting was held involving various experts and Government agents to review the passive solar heating and cooling program of the Department of Energy, assess the state-of-the-art in passive systems, identify needed work and make recommendations on the future role of the Federal Government. (This meeting was held Oct. 31-Nov. 2, 1977, in Reston, Va.)
- Task 2—Draw on the results of the Reston meeting and a literature search conducted by AIA-PRC to assess the state-of-the-art of passive systems.
- Task 3—Prepare a preliminary and final draft of a National Program Plan for Passive Solar Systems that deals with both technology development and technology utilization issues.

IMPORTANT REPORTS OR PUBLICATIONS

- Summaries of conclusions of Reston meeting are available from PRC.

PROJECT TITLE:

National Program Plan for
Passive Solar Heating and Cooling

INSTITUTION:

PRC Energy Analysis Company
AIA-Research Corporation
7600 Old Springhouse Road
McLean, Va. 22101

PRINCIPAL INVESTIGATOR:

Wayne Place
Michael J. Holtz

CONTRACT NUMBER: EG-77-C-01-2522
Task 1208.001

STARTING DATE: 07/01/77

DURATION: 9 months

AMOUNT: \$60,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project will evaluate energy flow control techniques for different passive heating and cooling systems. These systems will include incidental heat traps, thermosyphoning walls and roofs, solar ponds and incidental wind traps. These passive systems incorporate energy flow controls which respond to air pressure differences, convection, conduction and radiation characteristics. Systems considered will be moveable insulation, thermal mass components, building orientation/configuration characteristics and storage devices.

Observations, documentation and analysis of energy flow controls will be made. The evaluation will include analysis of passive systems which are not yet built, but which are sufficiently documented to facilitate evaluation.

The goal is to evaluate how well energy flow control techniques transport energy, block and/or modulate the amount of energy flow from the standpoint of efficiency and cost effectiveness. The results of this proposal will allow adaptation of energy flow controls in other building projects by architects, engineers, builders and researchers.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Evaluation of Energy Flow
Control Techniques for Passive
Heating and Cooling Systems

INSTITUTION:

Rensselaer Polytechnic Institute
Center for Architectural Research
Troy, NY 12181

PRINCIPAL INVESTIGATOR:

W. N. Kroner
R. N. Smith

CONTRACT NUMBER: EG-77-G-04-1602

STARTING DATE: 09/15/77

DURATION: 12 months

AMOUNT: \$69,081

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to measure and document the performance and costs of four solar heated buildings and to disseminate the results. This will be done by installing instrumentation and data-logging devices in the subject buildings; assembling, analyzing, and evaluating the performance data; and publishing the results in quarterly reports with a recapitulation in the report for the last quarter of the project. Suitable procedures for conducting the research were established under ERDA project WA-75-4947.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Evaluation of Costs and Performance
of Four Solar Heating Building
Experiments

INSTITUTION:

Norman B. Saunders
Experimental Manor
15 Ellis Road, Sunshine Circle
West, MA 02193

PRINCIPAL INVESTIGATOR:

Norman B. Saunders, P.E.

CONTRACT NUMBER: EG-77-X-04-1078

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$9,999

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project will gauge and evaluate the performance and cost of three solar modules in comparison with a control module. Each module will have separate metering so that all energy other than solar entering each envelope will be accounted for. Elapsed time meters on all accessories and the back-up heaters will provide a basis for generating an integral energy distribution budget for each system. Although instrumentation will be used to verify temperatures, the prime data base for the experiment will be the electrical energy entering the envelope of each module. Heating degree day calculations will be performed on each module and justified against the electrical energy demand.

Each experimental module is a south wall greenhouse of approximately 56 feet square and an attached room, i.e., a thermal load.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Performance Analysis of a Double
Polyethylene Inflated Hybrid
Solar Space Heating System

INSTITUTION:

Solar Room Company Inc.
P. O. Box 1377
Taos, NM 87571

PRINCIPAL INVESTIGATOR:

Stephen R. Kenin

CONTRACT NUMBER: EG-77-G-04-4129

STARTING DATE: 09/30/77

DURATION: 12 months

AMOUNT: \$25,875

PROJECT DESCRIPTION

The objective of this project is to assess the regional potential for cooling by various combinations of convection, nocturnal radiation and evaporation. Climate regions will be defined based on environmental parameters critical in these passive cooling processes and residential cooling loads. Predicted passive cooling potential will be expressed in terms of regional charts of the average monthly cooling rates for various surface designs and for a narrow range of temperatures centered near the average wet bulb temperature. The most promising processes will be applied in a simulation for two reference residences in each region. These simulations will:

- (1) indicate actual average surface temperatures,
- (2) yield the fraction of cooling load supplied as function of cooling surface and storage volume, and
- (3) support an assessment of existing components and systems.

The program is divided into the following tasks:

Task 1—Literature search.

Task 2—Nocturnal radiation cooling investigation, with emphasis on cloud cover effects.

Task 3—Define critical environmental parameters.

Task 4—Define climate regions.

Task 5—Form environmental data base.

Task 6—Predict regional cooling rates.

Task 7—Predict regional cooling area requirements.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Regional Assessment of Cooling
Rates Resulting from Convection,
Nocturnal Radiation and Evaporation

INSTITUTION:

Trinity University
715 Stadium Drive
San Antonio, TX 78284

PRINCIPAL INVESTIGATOR:

E. E. Clark

CONTRACT NUMBER: EG-77-C-03-1600

STARTING DATE: 09/01/77

DURATION: 12 months

AMOUNT: \$89,353

PROJECT DESCRIPTION

This project will design, construct, instrument and monitor a hybrid solar building project using the "Solar Atrium" concept.

This solar system has a two-story atrium with operable internal insulated shutters for controlling heat loss and gain, passive heat storage in a small water pond and the atrium floor, and a fan to pump heated air from the top of the atrium to a rock bed in the basement.

The house will be instrumented and monitored for 1 year.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Atrium: A Hybrid Solar Heating and Cooling System

INSTITUTION:

Ueland & Junker
1616 Walnut Street, Suite 1500
Philadelphia, PA 19103

PRINCIPAL INVESTIGATOR:

Mark Ueland

CONTRACT NUMBER: EG-77-G-04-4135

STARTING DATE: 09/19/77

DURATION: 26 months

AMOUNT: \$38,938

PROJECT DESCRIPTION

The project encompasses both an experimental and analytical effort. The former will begin once construction of the test modules is accomplished; the latter will commence with a heat transfer analysis of the test modules for selection of module components.

A previously solved model of the distributed mass direct gain module will be used to design the system. Analytical models of the rock bed storage and the direct gain module will be designed, and a model of the perforated wall will be developed. The energy required to heat and cool the house without additional modules will be provided using a residential energy audit module known as Two-Zone. The basic heat transfer analysis will be accomplished within a month after the final design is defined. A second experiment will endeavor to ascertain the model system's latent heat load due to plant evapotranspiration.

Three solar greenhouse test modules and one thermal storage wall test module will be constructed across the south side of an existing residence. One of the solar greenhouse modules is a regular greenhouse space with no additional features. The second greenhouse incorporates a high density thermal storage wall built on the outside of the existing frame construction of the house. The third test module incorporates a fan-forced rock bed thermal storage system. The thermal storage wall room utilizes a perforated thermal storage wall to let some direct-gain light into the space. The space in each of these rooms is coupled to the house through a fan-forced vent system.

In addition to the above test rooms, a cold room has been constructed underground in front of the house. It utilizes a seasonal cold storage system driven by passive air distribution through a surrounding rock bed.

The project encompasses both experimental and analytical efforts. Experimental data taken will compare the operational performance of the different test rooms. The analytical effort will commence with heat transfer analysis of the test modules based on previously solved models of the distributed-mass, direct-gain characteristics of the system. Analytical effort will be extended in an endeavor to ascertain model systems and constants due to latent heat load associated with plant evapotranspiration.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Passive Retrofit Research of an
Existing Dwelling

INSTITUTION:

Francis Wessling
4107 Mackland Drive, NE
Albuquerque, NM 87110

PRINCIPAL INVESTIGATOR:

Francis Wessling

CONTRACT NUMBER: EG-77-G-04-4130

STARTING DATE: 09/07/77

DURATION: 12 months

AMOUNT: \$38,541

PROJECT DESCRIPTION

This project will test and analyze a passive cooling building module that uses a combined passive and hybrid nocturnal air-cooling system. This study will test and evaluate a small test module that simulates a portion of a building and also simulates its daily use. The contractors have calculated the performance for this and similar systems and found them to be advantageous. The system uses standard but somewhat modified building components and has potential cost advantages.

Module design, instrumentation design and debugging and construction will be done within the first 3 months of the project. Experimentation and data analysis will follow.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Passive Nocturnal Cooling
Building Research

INSTITUTION:

Ying Manufacturing Company
1957 West 144th Street
Gardenia, CA 90249

PRINCIPAL INVESTIGATOR:

Ying-Nien Yu

CONTRACT NUMBER: EG-77-C-04-4140

STARTING DATE: 09/30/77

DURATION: 15 months

AMOUNT: \$58,718

6. ADVANCED SYSTEMS DEVELOPMENT

PROJECT DESCRIPTION

CSU Solar House II has a solar air heating system which was donated to the University by the manufacturer. It was instrumented by a grant from the sheet metal industry and nocturnal cooling with pebble-bed heat exchange and solar water heating are provided.

The objectives of this project are the development, evaluation and improvement of economical solar air systems for space heating and water heating, and the development of economical methods for cooling by the use of solar air system components.

Evaluation of data obtained between February and May 1976 shows evidence that Solar House II can deliver significantly more heat (20 to 30% more) than the liquid flat plate system in Solar House I.

The design objective was to provide 75% of House II space and hot water demands; performance results of 73% were achieved in 1975-76 and 1976-77 heating seasons. A high percentage of data has been obtained during times when the system was in the operating mode.

Additional R&D effort is required to complete analysis of data for cooling, Summer 1977, obtain additional system data during the heating season 1977-78, verify TRNSYS for Solar House II, and improve nocturnal cooling strategy. Further comparisons of performance from Houses, I, II and III will be made.

IMPORTANT REPORTS OR PUBLICATIONS

- Karaki, S., Lof, G.O.G., and Smith, C.C., "Comparative Performance of Solar Heating with Air and Liquid Systems," August, 1976.
- Karaki, S., "Evaluation of a Residential Solar Air Heating System," Interim Progress Report, May 1977.
- Karaki, S., Duff, W.S., Lof, G.O.G., and Ward, D.S., "A Performance Comparison Between Air and Liquid Solar Residential Heating Systems," Proceedings - ISES 1977 Annual Meeting.

PROJECT TITLE:

Evaluation of a Residential Solar
Air Heating and Cooling System

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Fort Collins, CO 80523

PRINCIPAL INVESTIGATOR:

Susuma Karaki

CONTRACT NUMBER: EY-76-S-02-2868

STARTING DATE: 02/01/77

DURATION: 16 months

AMOUNT: \$78,277

LEGEND

EVC = EVAPORATIVE COOLER
AUX = AUXILIARY HEATER
HUM = HUMIDIFIER
B1, B2 = BLOWERS
P = RECIRCULATING PUMP
MD = MOTORIZED DAMPER
W/S = MANUAL WINTER/SUMMER DAMPER

PROJECT DESCRIPTION

This project will gather background information on the design, installation and cost of solar systems being built in the central Colorado region.

The program is divided into three phases:

Phase I—Literature search, discussions with builders and architects, and review of plans and specifications.

Phase II—Detailed study of several houses during solar system installation.

Phase III—Analysis of results on installation methods and costs and final report.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

A Study of Cost Effective Ways for Improving the Fabrication and Installation of Solar Energy Heating and Cooling Systems for Residences

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Ft. Collins, CO 80523

PRINCIPAL INVESTIGATOR:

S. B. Thayer

CONTRACT NUMBER: EG-77-S-02-4520

STARTING DATE: 06/01/77

DURATION: 12 months

AMOUNT: \$13,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This program is a continuation of NSF grant GI-43921. The effort concentrated on the repairs and modifications necessary to determine maintenance costs. Since there has been no maintenance on the solar heating system in the 18 years of its use, the Löff House offers a unique opportunity for ascertaining the extent of degradation in the performance of the solar collector, the storage system, and the efficiency as well as the costs necessary to bring the system back to the original or improve operating standards. After repairs and modifications were completed, the performance during the 1975-76 heating season was determined, utilizing instrumentation still available in the dwelling.

The program was divided into the following tasks:

Task 1—Repair existing system.

Task 2—Collect and test low reflectivity glass solar absorber plates before and after cleaning.

Task 3—Measure solar heat load and portion supplied by solar energy; analyze data.

Task 4—Measure hot water heat load and portion supplied by solar energy; analyze data.

Task 5—Remove instrumentation and restore areas affected.

Task 6—Report.

The performance comparison between December through April 1959-60, and 1974-75, showed a decline to about 73.3% of its original value (15-year period). This was mainly due to a gradual decline in solar collector efficiency.

The development of annual maintenance cost expressed as a percent of the original cost requires a good deal of judgement in arriving at a reasonable figure. It appears that this figure lies somewhere between 0.56 and 1.6% per year compared with a decline in performance of between 1.1 (unavoidable) and 1.8% per year.

IMPORTANT REPORTS OR PUBLICATIONS

- Ward, J.C., and Lof, G.O.G., "Long Term Performance of a Residential Solar Heating System," Solar Energy, Vol. 18, 1976.
- Ward, J.C., Lof, G.O.G., and Hadley, L.N., "Maintenance Costs of Solar Air Heating Systems," Final Report, April 1977.

PROJECT TITLE:

Evaluation of Maintenance Cost and Mechanical Improvement of the Solar Equipment in Denver House

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Fort Collins, CO 80523

PRINCIPAL INVESTIGATOR:

John C. Ward

CONTRACT NUMBER: EY-76-S-02-2830

STARTING DATE: 12/01/75

DURATION: 12 months

AMOUNT: \$51,960

PROJECT DESCRIPTION

Solar House I is a research facility for investigating solar heating, hot water heating and air conditioning systems. Its operational performance with liquid flat plate collectors has been obtained, and it is now being used to obtain performance comparison data on evacuated tubular collectors. Corning ETC's will be under test from December, 1976 until February, 1977, when an exchange of ETC's will be made with the Federal Republic of Germany to determine how an advanced-design collector works within an entire residential solar system. Both the Corning and Philips ETC's are and will be operated in conjunction with an advanced ARKLA lithium bromide water chiller designed specifically for use with solar energy systems.

Preliminary results from data evaluation indicate that the Corning ETC delivers about twice the energy of a comparably-sized flat plate collector for heating and about three times as much energy for cooling.

Further analysis and comparison on this R&D facility are continuing as performance data are collected on both the Corning and Philips Evacuated Tubular collectors.

IMPORTANT REPORTS OR PUBLICATIONS

- "Evaluation of the Corning and Philips Evacuated Tubular Collectors in a Residential Solar Heating and Cooling System," Final Report for the Period May 1, 1976 - December 1, 1976, March 1977.
- Duff, W.S., Löf, G.O.G., Winn, Lefler, J., and Meredith, D., "Evaluation of a Residential Solar Heating and Cooling System with High Performance Evacuated Tubular Collectors," Proceedings - ISES 1977 Annual Meeting.

PROJECT TITLE:

Evaluation of the Corning and Philips
High Performance Collectors in a
Residential Solar Heating and Cooling
System

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Fort Collins, CO 80523

PRINCIPAL INVESTIGATOR:

William S. Duff

CONTRACT NUMBER: EY-76-S-02-4012

STARTING DATE: 05/04/76

DURATION: 5 months

AMOUNT: \$93,138

PROJECT DESCRIPTION

This is a continuation of an ERDA R&D contract. Initial tests of the tubular collector show that for a given insolation it produces a higher temperature output fluid at a higher efficiency than a standard flat-plate glazed collector. The higher temperature has the potential of increasing efficiency in operating the absorption cooler.

The objective of this study is to test and evaluate the practicality of an integrated solar heating and cooling system in CSU House III and make performance comparisons with CSU Solar Houses I & II. The components of the system are:

- Owens Illinois Liquid Evacuated Glass Tube Collectors
- ARKLA Lithium Bromide Absorption Cooling Unit (3 Ton)
- Cold and Hot Storage
- Non-Pressurized Water Storage

The heating system performance for the month of March 1977 was as follows:

- Solar Collector Efficiency — 48.6%
- Solar System Efficiency — 41.1%
- Solar Fraction for the Month — 79.7%

The evacuated tubes turn on at an insolation level of $I=30$ to 50 Btu/hr/ft^2 as compared to flat plates which turn on at $I=100$. The CSU House III is fully instrumented.

IMPORTANT REPORTS OR PUBLICATIONS

- "Cooling Subsystem Design in CSU Solar House III."
- "Design Considerations for Residential Solar Heating and Cooling Systems Utilizing Evacuated Tube Solar Collectors."
- "Residential Solar Heating and Cooling Using an Evacuated Tube Solar Collector Annual Progress Report for 1 February 1976 - 31 March 1977 (April 1977)."
- Ward, D.S., and Ward, J.C., "Design Considerations for Residential Solar Heating and Cooling Systems Utilizing Evacuated Tubular Collectors," Proceedings ISES - 1977 Annual Meeting"

PROJECT TITLE:

Residential Solar Heating and
Cooling Using Evacuated Tube
Solar Collector

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Ft. Collins, CO 80523

PRINCIPAL INVESTIGATOR:

Dan S. Ward

CONTRACT NUMBER: EY-76-S-02-2858

STARTING DATE: 02/01/76

DURATION: 28 months

AMOUNT: \$219,055

PROJECT DESCRIPTION

Colt, Inc. will design, develop and deliver two identical commercial solar assisted heating systems for delivery to two sites. The heating systems employ flat-plate collectors made of aluminum roll-bond with non-selective coating and single glazing. Paraffin oil will be used as the collector fluid, and tanks with enclosed heat exchangers will be used for storage.

The two sites for installation are Yosemite, CA and Pueblo, CO. Marshall Space Flight Center will monitor equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Commercial or Single Family Size Solar Heating and Hot Water System Using Paraffinic Oil in the Solar Loop

INSTITUTION:

Colt, Inc.
71-590 San Jacinto Drive
Rancho Miroge, CA 92270

PRINCIPAL INVESTIGATOR:

B. D. Hunter

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-3-32242

STARTING DATE: 10/15/76

DURATION: 12 months

AMOUNT: \$313,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Comtemporary Systems, Inc., will design, develop and deliver two identical single family solar assisted heating and hot water systems to two sites. The heating and hot water systems use air heating flat-plate collectors, that are made from aluminum sheets and are double glazed. Rock storage and an air-to-water heat exchanger will be used.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Single Family Solar Heating and Hot Water System Using Air Collectors Integral to Building Structures, Air Mover, Rock Storage, Air/Water, and Heat Exchanger

INSTITUTION:

Comtemporary Systems, Inc.
68 Charlonne Street
Jeffrey, NH 03452

PRINCIPAL INVESTIGATOR:

John Christopher

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32243

STARTING DATE: 10/15/76

DURATION: 18 months

AMOUNT: \$67,500

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The project accomplishments are:

1. Development of the data acquisition system.
2. Establishment of the "threshold value" of solar collection for the Solar One system.
3. Evaluation of the performance of vertical vs. 45° collectors. Based on pyronometer readings, it was determined that vertically oriented collectors perform, in some cases, equal to or better than the 45° oriented collectors for winter heating.
4. Determination of Solar One's thermal inertia (half-life of 15 hours) and its passive contribution which was found to be significantly higher than previously thought. This raised the question as to what is the incremental cost/effectiveness of passive vs. active solar systems in the mid-Atlantic region.
5. Preparation of project report and mode recommendations for performance improvements in operating R&D systems at Solar One.

IMPORTANT REPORTS OR PUBLICATIONS

- "Data Acquisition on Solar One," Draft Final Report, U. of Delaware, June 30, 1977.

PROJECT TITLE:

Performance of Advanced Systems and Subsystems Experiments on University of Delaware Solar One

INSTITUTION:

University of Delaware
Newark, DE 19711

PRINCIPAL INVESTIGATOR:

Stuart Faunce

CONTRACT NUMBER: EY-76-S-02-2589

STARTING DATE: 05/01/75

DURATION: 28 months

AMOUNT: \$247,707

PROJECT DESCRIPTION

Elcam, Inc. will design, develop and deliver two identical single family solar assisted hot water systems to two sites. The hot water systems use flat-plate, liquid heating collectors with a non-selective coating and a single glazing. "Cascade" control system will be used.

The two sites for installation are Phoenix, AZ, and San Diego, CA. Marshall Space Flight Center will monitor equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Single Family Solar Hot Water "Flow Through" System Using Two Storage Tanks With a "Cascade" Control System and a Collector Dump Valve for Freeze Protection

INSTITUTION:

Elcam, Inc.
5330 Debbie Lane
Santa Barbara, CA 93111

PRINCIPAL INVESTIGATOR:

Terrence Honikman

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32245

STARTING DATE: 08/15/77

DURATION: 24 months

AMOUNT: \$74,300

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Fern Engineering, Inc., will develop, manufacture and deliver two single family solar assisted heating and hot water systems to two sites. The systems consist of air heating flat-plate collectors using a dual air path from the collector. The collector uses a textured copper foil absorber with a black chrome selective coating.

The site locations are Lansing, MI and Tunkhannok, PA. Marshall Space Flight Center will monitor equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Single Family Solar Heating and Hot Water System Using Air Collectors, Air/Water Heat Exchangers, Water Tank Storage, and Integral Air Handler

INSTITUTION:

Fern Engineering, Inc.
P. O. Box M
Bourne, MA 02532

PRINCIPAL INVESTIGATOR:

Robert Meyers

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32246

STARTING DATE: 10/15/76

DURATION: 18 months

AMOUNT: \$157,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project was to design and fabricate a solar system that could be easily retrofitted into a small residence or mobile home and supplement the conventional heating system.

Tests show that the system met its designed load. The mobile home has been displayed in Chicago, Louisville and Los Angeles. About 18,000 people visited the mobile home. The measured and simulated results were 15% during a 30-day test period.

IMPORTANT REPORTS OR PUBLICATIONS

- "Solar Heating and Cooling of Mobile Homes Test Results," Proceedings - ISES 77 Annual Meeting, Orlando 1977, pp. 13-11 to 13-15.

PROJECT TITLE:

Exploration, Design Construction and Evaluation of Solar Energy Systems for the Heating and Cooling of Mobile Homes - Phases I and II

INSTITUTION:

General Electric Company
Valley Forge Space Center
P. O. Box 8555
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

Alan S. Jacobsen

CONTRACT NUMBER: EY-76-C-02-2705 (Mod. 1)

STARTING DATE: 05/27/75

DURATION: 19 months

AMOUNT: \$154,186

PROJECT DESCRIPTION

The goal of this project was to develop a low cost self-contained solar air heating system suitable for retrofit application on small or mobile homes. The units developed under this R&D contract were designated Solairsource Furnaces. Throughout the design and subsequent fabrication of three experimental units, costs were kept to a minimum. The design decided upon utilized two groups of evacuated air collector tubes with a common center manifold, a variable size rock-bin storage compartment, and built-in circulation fans. This system was designed to be truck/forklift portable for placement on the ground near the house.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Design and Fabrication of an Integral Low Cost High Performance Solar Heater

INSTITUTION:

General Electric Company
Valley Forge Space Center
P.O. Box 8555
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

Alan S. Jacobsen

CONTRACT NUMBER: EY-76-C-02-2705
(MOD. 1)

STARTING DATE: 6/01/76

DURATION: 5 months

AMOUNT:

PROJECT DESCRIPTION

GE is developing a self contained solar air heating unit with evacuated air tubular collectors. The objective of this study is to evaluate the retrofit potential of the Solairsource Furnace. Configuration studies will be performed for Solairsource - heat pump, Solairsource - domestic hot water and other potential configurations. The following tasks will be performed for all potential configurations:

Task I—Evaluation of control procedures.

Task II—Performance estimates.

Task III—Cost comparison with other alternative designs.

Task IV—Evaluation of repackaging "off the shelf" equipment.

Preliminary reports are that the best solar hot water heating configuration for near term application of Solair units is one with a conventional air/water heat exchanger.

IMPORTANT REPORTS OR PUBLICATIONS

- General Electric Company, "Solair Heater Program, Solair Applications Study," Final Report, GE Document No. 77SDS4262, December 1977.

PROJECT TITLE:

Application Study of Solar Heating Systems
Using a Solair Heater

INSTITUTION:

General Electric Company
Valley Forge Space Center
P. O. Box 8555
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

Alan S. Jacobsen

CONTRACT NUMBER: EY-76-C-02-2705 (Mod. 2)

STARTING DATE: 10/01/76

DURATION: 6 months

AMOUNT: \$67,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Three Solair units, designed and fabricated under earlier ERDA R&D funding were subjected to tests at three locations. Unit No. 1 was tested at the GE facility in Valley Forge, where it provided heat for a mobile home and also served as a laboratory unit where improvements could be made. Unit No. 2 was located at South Dakota State University, Brookings, S.D., where it supplied heat to a small home. Unit No. 3 used an air-to-water heat exchanger at Arizona State University to meet the simulated hot water demands of a small residence.

As a result of these experiments, recommendations for design improvements have been made and will be incorporated on second generation Solair units. Testing will be continued on the units either at other locations or with different load applications.

IMPORTANT REPORTS OR PUBLICATIONS

- General Electric Company, "Solair Heater Test Program," Final Report, December 1977.

PROJECT TITLE:

Solair Heater Test and Evaluation Program

INSTITUTION:

General Electric Company
Valley Forge Space Center
P.O. Box 8555
Philadelphia, PA 19101

PRINCIPAL INVESTIGATOR:

Alan S. Jacobsen

CONTRACT NUMBER: EY-76-C-02-2075 (Mod. 3)

STARTING DATE: 12/30/76

DURATION: 6 months

AMOUNT: \$84,439

PROJECT DESCRIPTION

The overall objective of this project is to obtain test and economic data to assist in evaluating the thermal performance and cost effectiveness of the test system. Thermal data requirements and performance evaluation procedures are in conformance with NBSIR 76-1137, August 1976. Measurements include sufficient amounts of data to provide appropriate performance information according to the reporting format recommended by CCMS Solar Energy Pilot Study, August 1975.

The test system was a Solaris system patented by Dr. H. Thomason and consists of a trickle water collector and a combined water tank/rockbed storage.

Very little data were obtained during the 1976-77 heating season due to initial instrumentation start-up difficulties and subsequent instrumentation operating troubles. Data were evaluated during a relatively cold period of winter weather.

IMPORTANT REPORTS OR PUBLICATIONS

- "Performance Testing of a Residential Solar Climate Control System Using a Water Trickle Collector and a Water-Rockbed Thermal Storage—Draft Report, June 1977.

PROJECT TITLE:

Evaluation of Solar Heating and Cooling System Using a Trickle Collector and Combined Water Rockbed Storage

INSTITUTION:

George Washington University
Office of Sponsored Research
Washington, D.C. 20052

PRINCIPAL INVESTIGATOR:

Ali Kiper

CONTRACT NUMBER: EY-76-C-01-2284

STARTING DATE: 01/16/76

DURATION: 18 months

AMOUNT: \$194,903

PROJECT DESCRIPTION

There is a growing interest in the use of life cycle cost procedures as part of the technology assessment of viable solar systems for heating and cooling of buildings. Although the principle is to account for all the expected costs over the system's lifetime, the parameters or factors involved are quite complex.

Martin-Marietta of Denver developed a simplified design method for optimal sizing of solar heating and cooling systems by non-engineers wherein minimum cost will be the optimization criterion. Cost is defined as life cycle cost. This project calls for an immediate interaction with the Martin-Marietta project in order to explicitly define parameter groupings and regions during the development of the simplified sizing design method.

IMPORTANT REPORTS OR PUBLICATIONS

- Halldane, J., "Parameter Grouping and Regionalizing to Simplify Solar Life Cycle Cost Models for Application to SHAC of Buildings," NTIS TID-27681, Dec. 1976.

PROJECT TITLE:

Parameter Grouping and Regionalizing to Simplify Solar Life Cycle Cost Models for Application to Solar Heating and Cooling of Buildings.

INSTITUTION:

Gershon Meckler Assoc.
150 17th Street, N.W.
Washington, D.C. 20036

PRINCIPAL INVESTIGATOR:

John Halldane

CONTRACT NUMBER: EY-76-C-01-2410

STARTING DATE: 4/01/76

DURATION: 8 months

AMOUNT: \$27,250

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project was initiated in June of 1973 when the City of Colorado Springs disallowed new connections to its natural gas system. Several utility improvements were made, along with the construction of the Phoenix House Project (1974), where comparative tests on several types of solar heating systems using electrical power (or fossil fuel) as a backup were conducted. As a result, a preferred solar heating and cooling system has been developed. It is a solar assisted optimized (for Colorado Springs area) heat pump, utilizing a large year-round thermal energy storage system, along with liquid flat plate solar collectors.

DOE R&D is funding the effort to obtain data on the preferred system reliability and the completion of manufacturing designs for the necessary components. The Phoenix House is an energy conserving house and has several passive features.

IMPORTANT REPORTS OR PUBLICATIONS

- Jardine, D.M., "Phoenix House, City of Colorado Springs Solar Assisted Heat Pump Project" Technical Report dated October, 1977.

PROJECT TITLE:

The Phoenix House, City of Colorado Springs
Solar Assisted Heat Pumps

INSTITUTION:

Kaman Science Corporation
1500 Garden of the Gods Road
P. O. Box 7563
Colorado Springs, CO 80933

PRINCIPAL INVESTIGATOR:

Douglas M. Jardine

CONTRACT NUMBER: EG-77-C-02-4351

STARTING DATE: 09/09/77

DURATION: 12 months

AMOUNT: \$120,000

PROJECT DESCRIPTION

The objective of this project is to make a "micro"-study of particular industrial plants that use substantial amounts of low temperature process steam and are good candidates for solar systems. Working closely with two or three selected industrial plants, this study will examine the detailed requirements for each plant in terms of steam pressures, temperatures, flow rates, chemical purity and the tolerances on each of these. Maintenance requirements and problems relating to the specific plant's operation will be evaluated for their potential impact on a solar steam system. Seasonal characteristics of each plant operation will be evaluated.

The project will also examine the practicality of interfacing a solar steam system with an existing fuel system in terms of connecting with the existing piping and the availability of adequate space to locate the collectors.

Upon conclusion, the study will identify one or more specific plants that would be excellent candidates for conversion to solar steam and also identify general categories of plants where solar steam systems might prove feasible.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Study of Industrial Process
Steam Systems

INSTITUTION:

Lawrence Livermore Laboratory
P. O. Box 808
Livermore, CA 94550

PRINCIPAL INVESTIGATOR:

W. C. Dickinson

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 10/01/76

DURATION: 12 months

AMOUNT: \$80,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Two prototype solar-heated mobile/modular homes have been designed by the LASL solar energy group and are being tested and evaluated. The first (Mobile/Modular I) uses an active system and the second (Mobile/Modular II) uses a passive system. Both could have considerable impact on manufactured housing in the United States as the country's first air-type and passive-type solar energy systems designed for factory built housing.

Mobile/Modular I incorporates an active solar air-heating system into an attractive double-wide mobile/modular home of 1,056 square feet. Seventeen air-heating collector panels are located on the south side of the house at a 60° angle. An unusual thermal storage system was designed for this structure using 1,536 pint glass jars filled with water.

Mobile/Modular II uses a passive solar heating system in which the thermal energy flow to the room space is primarily by radiation. This home collects solar energy through four rows of double-glazed apertures which are arranged in a saw-toothed pattern on the roof with the glazing oriented at a 65° angle from the horizontal. Aluminum reflectors are used to increase the energy collected. One reflector is placed on the roof in front of the aperture and another is on the underside of a movable insulation panel which is pulled down on top of the thermal storage area at night to reduce heat loss. Water bags located in the area between the roof and the ceiling provide the thermal storage.

The first prototype, located at a LASL technical area site, has undergone testing for over a year. The second prototype, located next to the first, will begin testing in the winter of 1977. Both of the solar mobile/modular homes are available for public tours by appointment.

IMPORTANT REPORTS OR PUBLICATIONS

- Balcomb J. D. "Solar Energy Systems for Manufactured Housing," LA-UR-76-2094, presented at the Consumer Conference on Solar Energy Development, Albuquerque, NM, Oct. 2-5, 1976.
- Bankston, C.A., and Neeper, D.A., "Solar Energy Research at LASL - Progress Report Covering the Period July 1, 1976 - September, 1977," LA-7115-PR.

PROJECT TITLE:

Application of Solar Energy to
Mobile/Modular Home Heating

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

J. D. Balcomb
S. W. Moore

CONTRACT NUMBER: W-7405-ENG-36, D495

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$135,000

PROJECT DESCRIPTION

This project is part of an overall program to use a solar demonstration building at Los Alamos (The National Security and Resources Study Center) as an experimental building in which to conduct studies in solar computer codes and advanced control system studies. Each of these areas requires the installation of instrumentation into the facility in order to accomplish the field experiments.

The objective of this project is to install instrumentation in addition to that already planned to provide the opportunity to complete advanced control system studies, accomplish computer calculation field validations and provide a facility in which researchers can study many aspects of energy conservation in the future.

Sensor emplacement, field calibration and interface with the data acquisition system were accomplished in FY76A and 77.

IMPORTANT REPORTS OR PUBLICATIONS

- Murray, Hugh S., Trump, Michael A., and Hedstrom, James C., "Solar Heating and Cooling System Performance Experiments in the Los Alamos National Security and Resources Study Center," Proceedings of the 1977 Annual Meeting of the American Section of the International Solar Energy Society, Orlando, Florida, June, 1977, p. 9-1.

PROJECT TITLE:

National Security and Resources Study
Center Instrumentation

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

T. E. McDonald

CONTRACT NUMBER: W-7405-ENG-36, D503

STARTING DATE: 07/01/76

DURATION: 15 months

AMOUNT: \$88,000

PROJECT DESCRIPTION

The objective of this project is to test selected solar domestic hot water (DHW) systems under controlled laboratory and outdoor conditions at NBS. The data will be used for TRNSYS, FCHART, SOLCOST validation and system optimization. The project will contribute to preparation of validated solar DHW system design handbooks.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Water Heating Performance Data

INSTITUTION:

National Bureau of Standards
Washington, D. C. 20234

PRINCIPAL INVESTIGATOR:

Hunter Fanny

CONTRACT NUMBER: EA-77-A-01-6010

STARTING DATE: 08/01/77

DURATION: 16 months

AMOUNT: \$89,800

PROJECT DESCRIPTION

The objectives of this project are to monitor and analyze the performance of the Philadelphia row home which was retrofitted to solar heating by the University of Pennsylvania, and to examine its acceptance in the urban environment; to optimize the performance of the system relative to energy-efficiency and cost; and to provide hourly weather and insolation data for Philadelphia for a period of 2 years.

IMPORTANT REPORTS OR PUBLICATIONS

- N. Lior, et al. "Optimized Spacing Between Rows of Solar Collectors," Proceedings ISES 1977 Annual Meeting; June 1977 Orlando, FL; pp. 3-15 to 3-19.
- "Residential Solar Heating Retrofit in the Urban Environment (December 1976)"
- "Solar System Retrofit of Row Houses—A Proven Energy Conservation Method?"

PROJECT TITLE:

Performance Analysis and Optimization
of the University of Pennsylvania
Retrofitted Solar Heated Philadelphia
Row Home

INSTITUTION:

University of Pennsylvania
Office of Research Administration
Philadelphia, PA 19174

PRINCIPAL INVESTIGATOR:

Noam Lior

CONTRACT NUMBER: EG-77-S-02-4142

STARTING DATE: 10/15/76

DURATION: 12 months

AMOUNT: \$69,810

PROJECT DESCRIPTION

The objective of this project is to promote the use of solar energy assisted heat pump systems in commercial buildings by developing a design procedure for use by consulting engineers and other system designers and by checking the results of system simulations against field collected data. Specific goals are to determine the performance characteristics of solar energy assisted heat pumps by evaluating an existing installation, using these results to develop and check a computer model for simulating system performance, develop and publish a system design and economic evaluation procedure for solar energy assisted heat pump systems for commercial buildings and conduct a workshop to train system designers in the use of the procedure.

IMPORTANT REPORTS OR PUBLICATIONS

- Proceedings of the Solar Assisted Heat Pump Workshop, Penn. State University, July 1977.
- "Field Study of a Solar Energy Assisted Heat Pump Heating System."
- "Evaluation of the Solar Building, Albuquerque, NM," Annual Progress Report March 31, 1976 - April 30, 1977.

PROJECT TITLE:

Evaluation of the Solar Building,
Albuquerque, NM

INSTITUTION:

Pennsylvania State University
University Park, PA 16802

PRINCIPAL INVESTIGATOR:

Stanley F. Gilman

CONTRACT NUMBER: EY-76-S-02-2704

STARTING DATE: 04/01/75

DURATION: 29 months

AMOUNT: \$512, 303

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Solar Engineering and Equipment Co. will manufacture and deliver two solar assisted heating systems, one residential and one commercial. Both systems use air heating flat-plate collectors. Methods of applying Tedlar glazings will be developed for these collectors.

The single family residential system is located in El Reno, OK, and the commercial system is in Lincoln, NE. System performance is monitored by Marshall Space Flight Center.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Single Family or Light Commercial Solar Assisted Heating System Using Air Collectors Made from Prefabricated Steel Building Materials

INSTITUTION:

Solar Engineering and Equipment Company
3506 Metairie Road
Metairie, LA 70001

PRINCIPAL INVESTIGATOR:

Jules Jordy

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32247

STARTING DATE: 10/15/76

DURATION: 18 months

AMOUNT: \$155,600

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Solar Engineering and Manufacturing Co. will manufacture and deliver a solar assisted hot water system for two residential sites. The hot water system uses flat-plate, liquid heating collectors with a variable speed collector loop pump. Improved tank insulation and variable pump speed techniques will be studied.

The site locations are Loxahatchee, FL, and Macon, GA. Marshall Space Flight Center will monitor equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Single Family Solar Hot Water System Using One Storage Tank with a Variable Speed Pump Control in the Collector Fluid Loop

INSTITUTION:

Solar Engineering and Manufacturing Company
1054 N.E. 43rd Street
Ft. Lauderdale, FL 33334

PRINCIPAL INVESTIGATOR:

David Aspinwall, Sr.

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32248

STARTING DATE: 10/15/76

DURATION: 15 months

AMOUNT: \$19,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The purpose of this project is to design and install an optimized pyramidal optic focusing solar system for 12 months of test, and to evaluate and compare its performance with that of an existing prototype focusing system that has identical flat plate collectors and mounting orientations. Performance of the focusing systems which are exposed to the elements in their collecting mode will be compared with one that has a protective glass covering. Also included is the design, installation and testing of two different control systems for automatic opening, closing and optimum positioning of a hinged movable reflective panel.

This project has been completed and the performance of the system has been evaluated for the period of March 76-March 77. In the month of December 1976 the combined solar and solar heat pump system supplied 70% of the space heating load.

IMPORTANT REPORTS OR PUBLICATIONS

- Solar House Heating System Using Reflective Pyramid Optical Condensing System - Final Report - Wormser Scientific Corp; Stamford Connecticut, July 1977.
- Evaluation of Solar Energy Heating and Cooling System Employing Pyramidal Optics Solar Collection System, Progress Report, June 1, 1976.

PROJECT TITLE:

Evaluation of Solar Energy Heating and Cooling System Employing Pyramidal Optics Solar Collection System

INSTITUTION:

Wormser Scientific Corporation
Stamford, CT 06903

PRINCIPAL INVESTIGATOR:

Eric Wormser

CONTRACT NUMBER: EY-76-C-02-2769

STARTING DATE: 06/01/75

DURATION: 26 months

AMOUNT: \$123,594

PROJECT DESCRIPTION

Worsmer Scientific Corporation will develop and deliver a solar assisted heating and hot water system that uses the reflective pyramidal optical focusing collector system. Water from flat-plate collectors will be used for potable water heating, air space heating and heat pump coils. Marshall Space Flight Center will monitor the equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of an Integrated Multi-Family Solar Heating and Hot Water System Using Liquid Collectors with a Pyramidal Optics Concentrator (Roof Lite Glazing, Reflective Panels on Roof Structure and Copper Rollbond Absorbers at Focal Plane in Attic)

INSTITUTION:

Worsmer Scientific Corp.
89 Foxwood Road
Stamford, CT 06903

PRINCIPAL INVESTIGATOR:

Eric Wormser

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-832250

STARTING DATE: 10/15/76

DURATION: 22 months

AMOUNT: \$230,000

NO PHOTOGRAPH AVAILABLE

7. SYSTEMS ANALYSIS

PROJECT DESCRIPTION

The construction of the National Security and Resources Study Center at Los Alamos offers a timely opportunity for a comprehensive research and development program in solar heating and cooling techniques as applied to a large building. The Study Center, completed in the spring of 1977, is a forerunner of new buildings using modern energy systems. The design of this 59,000-sq-ft meeting place and library uses an energy-conserving operation with a solar-based heating and cooling system and the availability of several alternate modes of operation. A particularly interesting feature of this building is that there will be two types of solar-driven cooling systems—a lithium bromide absorption refrigeration water chiller and a Rankine-cycle unit. This solar-cooling experiment is unique and provides an unusual opportunity to study many options in operating a complete solar heating and cooling system. In addition to solar heating and cooling, the Study Center utilizes heat recovery, night-time cold water storage and energy system shutdown during periods of low utilization of building.

The variability of the Los Alamos climate will necessitate the use of all modes of operation of the heating, ventilating and air conditioning system. The conditions encountered include extremely cold winter nights (-10°F), warm summer conditions (95°F), and spring and autumn periods of very warm days followed by relatively cold nights (80°F to 30°F).

An important objective of the program is to determine the feasibility of developing simplified mathematical models of complex solar energy systems which would be suitable for computer implementation and economical use by practicing consulting engineers.

This project is divided into the following tasks:

Task 1—Provide adequate instrumentation and data acquisition capability to evaluate the performance of the energy system of the building under various static and dynamic operational conditions.

Task 2—Develop a multizone mathematical model of the complete Study Center and its energy system, and predict the results of experiments on the system using this model.

Task 3—Provide a field validation of the model using the instrumented Study Center as the test facility.

Other system studies were also included in this project.

PROJECT TITLE:

Solar Energy System Optimization Study
for the Los Alamos National Security
and Resources Study Center

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

J. D. Balcomb
C. A. Bankston

CONTRACT NUMBER: W-7405-ENG-36, D501

STARTING DATE: 07/01/76

DURATION: 24 months

AMOUNT: \$99,000

PROJECT DESCRIPTION

The objective of this project is to develop a validated and documented solar heating and cooling system design tool for use by persons untrained in solar system design and thermal analysis. A version of this tool will also be developed for engineering consultants. It will be a generalized solar energy heating and cooling computer program and a simple form designed to define the building's thermal characteristics. It will provide for the input of data to a widely distributed time-sharing computer system, and define a solar system for a specific building in a specific location according to a minimum life cycle cost. With modification, if necessary, it can be applied to any computer network.

The water heating design procedure is currently available.

IMPORTANT REPORTS OR PUBLICATIONS

- "Solcost - Solar Hot Water Handbook," ERDA/DSE - 2531/2, April 1977.
- Proceedings - ISES Winnipeg Conference, 1976, Vol. 10, pp. 230-234.

PROJECT TITLE:

Solar Heating and Cooling Computer
Analysis - A Simplified Sizing Design
Method for Non-Engineers

INSTITUTION:

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

PRINCIPAL INVESTIGATOR:

R. T. Grellis

CONTRACT NUMBER: EY-76-C-02-2876

STARTING DATE: 03/08/76

DURATION: 18 months

AMOUNT: \$153,383

Solcost

Solar Hot Water
Handbook

A simplified design
method for sizing and
costing residential and
commercial solar
service hot water
systems

Energy Research and
Development Administration
Division of Solar Energy
Technology Transfer
Washington, D.C. 20545
April 1977

DSE-2531/2

PROJECT DESCRIPTION

Sandia Laboratory will perform system studies in the areas of solar heat pump systems and absorption cycles driven by tracking concentrating collectors. This project is divided into the following tasks:

Heat Pump

Task 1—Develop simulation models for unglazed collectors and transient heat pump performance.

Task 2—Validate models and perform system studies for one region, including utility/weather interaction.

Absorption Cycles

Task 1—Develop simulation models for steady state, and transient performance of 3- and 25-ton, 2-stage chillers with concentrating collectors.

Task 2—Perform system studies for single stage chillers with existing models (U. MD), and for 2-stage chillers with models to be developed.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

System Studies for Heating and Cooling

INSTITUTION:

Sandia Laboratories, Div. 5742
Albuquerque, NM 87115

PRINCIPAL INVESTIGATOR:

J. M. Alcone
W. J. Kennish

CONTRACT NUMBER: AT(29-1)-789

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$140,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This is a continuation of the 1976 project which is validating the Martin-Marietta simplified method (SOLCOST) solar heating and cooling of buildings system design for nonengineers, and is developing better procedures for model validation. This includes techniques for discriminating in the comparison of digital simulation models.

The SOLCOST method using limited CSU heating sensor data was validated and a validation methodology was prepared. In 1977 the project continued to validate TRNSYS, SOLCOST, FCHART for different types of solar heating and cooling systems as data became available.

IMPORTANT REPORTS OR PUBLICATIONS

- "Model Validation Studies of Solar Systems, Phase III," Monthly Report, April 1977.

PROJECT TITLE:

Model Validation Studies of Solar Systems

INSTITUTION:

Solar Environmental Engineering, Inc.
Ft. Collins, CO

PRINCIPAL INVESTIGATOR:

C. Byron Winn

CONTRACT NUMBER: EY-77-C-02-4229

STARTING DATE: 03/15/77

DURATION: 8 months

AMOUNT: \$98,838

PROJECT DESCRIPTION

The objective of this project is to further study the general problem of transient simulation, an important aspect of solar energy utilization. Previous support has resulted in the development of a general transient process simulation method, the development of component models for solar processes simulation and the application of the processes simulation method to evaluation of several solar heating and cooling systems.

This project will include: enlargement of the capability of TRNSYS to simulate additional kinds and combinations of solar heating and cooling facilities; investigation of the efficient use of actual meteorological data in solar processes; reduction of computing costs through programming methods and critical use of component models; development of design optimization methods; and use of these results in the design of an air heating system for a single family residence.

TRNSYS Vol. 9.1 was released in October 1977. FCHART Vol. 3.0 will be released on about March 1978. FCHART is a design procedure based on correlations of TRNSYS results for space or water heating systems.

The Arlington experiment solar house is in operation and is instrumented. This R&D project will obtain data on performance of the system and its components: evacuated tubular air collectors, pebble-bed storage, and use of off peak electric for auxiliary heating.

IMPORTANT REPORTS OR PUBLICATIONS

- Duffie, J.A., Beckman, W.A., and Klein, S.A., "TRNSYS - A Transient Simulation Program," ASHRAE Transactions, Vol. 82, Part 1, 1976.
- "TRNSYS: A Transient Simulation Program - Report 28," University of Wisconsin, October 1977.
- Beckman, Klein and Duffie, "Solar Heating Design," Wiley Interscience Publication, 1977.

PROJECT TITLE:

Computer Modeling and Simulation of
Solar Heating and Cooling Systems

INSTITUTION:

University of Wisconsin
1500 Johnson Drive
Madison, Wisconsin 53606

PRINCIPAL INVESTIGATOR:

John Duffie

CONTRACT NUMBER: EY-76-S-02-2588

STARTING DATE: 02/01/77

DURATION: 19 months

AMOUNT: \$403,780

8. CONTROLS

PROJECT DESCRIPTION

This project will implement an optimal control policy with a controller placed in one of the CSU Solar Village houses. The project will include the development of a microprocessor optimal control, development of a program for control, installation of control hardware in a solar house, obtaining data on the system's performance and examination of the energy savings that could be realized by widespread use of such controllers.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Optimal Temperature Control in
a Solar House

INSTITUTION:

Colorado State University
Solar Energy Applications Laboratory
Ft. Collins, CO 80523

PRINCIPAL INVESTIGATOR:

C. Byron Winn

CONTRACT NUMBER: EG-77-S-02-4519

STARTING DATE: 06/01/77

DURATION: 12 months

AMOUNT: \$18,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of the project is to evaluate the proportional flow control system employed in the RKL solar heating and cooling demonstration project.

There are two specific tasks:

1. Develop an accurate Proportional Flow Control simulation model (by modifying the TRNSYS program) for the RKL system and validate it against the actual performance of the RKL system.
2. Evaluate the proportional flow control system and the control device, i.e., the pinch valve.

The performance evaluation is based on three considerations:

1. Energy Consideration: Quantity, quality and time occurrence of usable solar energy and the amount of auxiliary energy displaced over 1 day, 1 week, 1 month and 1 year.
2. Technical Consideration: Operating and design problems associated with flow control strategies (such as flexibility of operation, complexity of control strategies, reliability of the control equipment, response time constants and any other difficulty in implementing the flow control).
3. Cost Consideration: Increase in capital and operating cost incurred when using continuous flow control relative to the savings of decreased use of auxiliary energy.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Evaluation of the Performance of a Proportional Flow Control System in a Building

INSTITUTION:

Drexel University
Philadelphia, PA 19104

PRINCIPAL INVESTIGATOR:

P.R. Herczfeld
R. Fischl

CONTRACT NUMBER: EG-77-S-02-4512

STARTING DATE: 07/01/77

DURATION: 12 months

AMOUNT: \$39,000

PROJECT DESCRIPTION

This project will develop and evaluate novel control systems for solar heating/cooling systems with electrical backup. These new systems will have control logic designed to reduce electric utility peak loads. It is believed that the active participation of an electric utility from the start of the project will ensure that the control algorithms designed will be practical and will be effective in reducing peak demands.

Initially, simple control logic will be selected, followed by various versions of anticipatory controls. Both utility-operated and locally-operated controls will be considered. Suitably selected control algorithms will then be simulated on individual buildings, followed by simulation of the PECO network (summer peaking) and the PP&L network (winter peaking). If successful, these simulations will then be performed for other selected utility networks.

Cost savings from peak shaving will be determined; they will be compared to the cost of installing the control system. Finally, hardware availability will be assessed, and marketing plans for implementing desirable control strategies will be formulated.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Novel Control Strategies for
Solar Assisted Systems to Reduce Utility Peak Loads

INSTITUTION:

The Franklin Institute Research
Laboratories
20th and Race Streets
Philadelphia, PA 19103

PRINCIPAL INVESTIGATOR:

H.G. Lorsch

CONTRACT NUMBER: EG-77-C-03-1594

STARTING DATE: 09/19/77

DURATION: 12 months

AMOUNT: \$125,509

PROJECT DESCRIPTION

This research effort will develop and evaluate load management strategies in conjunction with electrical backup demand in solar heating and cooling systems. The developmental effort involves control mechanisms and strategies that can offset unfavorable economic impacts on utility systems in terms of production and investment costs. The project will also consider requirements for consumer acceptance.

The program will commence with an assessment of current utility load management practices. Major U.S. utilities will be queried as to their plans in regard to load management. Concurrently, potential cost savings will be appraised using load management models in conjunction with an existent cost program.

Another phase of the research will involve the design and optimization of controllers for selected representative solar systems. For each of these control designs, sensitivity to design parameters and uncertainty in solar, weather and power demand forecasts will be determined. Promising candidates will then undergo performance evaluation conducted with the use of a detailed simulation program. An evaluation of the economic impacts of various system-controller scenarios on customer and utilities using the tools of production costing programs will conclude the study.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Management of Electrical Backup
Demand in Solar Heating and Cooling
Applications

INSTITUTION:

Georgia Institute of Technology
School of Electrical Engineering
Atlanta, GA 30332

PRINCIPAL INVESTIGATOR:

A.S. Debs

CONTRACT NUMBER: EG-77-C-03-1595

STARTING DATE: 09/19/77

DURATION: 12 months

AMOUNT: \$78,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this research is to design control systems for solar heating and cooling systems for optimum cost effectiveness. The optimization process will include tradeoff studies involving several aspects of controls, new sensor functions and strategies, more suitable actuators and smarter controllers.

The project will design and optimize control systems for nine representative solar systems. The systems will be designed for each application using components and strategies that appear to be cost effective. These systems will be cost evaluated, then modeled on a computer for performance evaluations in several geographical regions. Control systems will be ranked according to life cycle cost effectiveness, and optimized systems will be selected for each application and each region. Finally, a cost trade-off analysis will be made between some form of large scale integrated circuit conventional electromechanical control implementation.

The project will conclude with the submission of regional recommendations for advanced control hardware, functions, strategies and system design which provide optimum cost effectiveness within the constraints of reliability, minimum maintenance and effective thermal control. A recommendation as to the need or justification of using memory devices, such as microprocessors and minicomputers, in the controller design will also be forthcoming.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Cost Effective Control Systems
for Solar Heating and Cooling
Applications

INSTITUTION:

Honeywell, Inc.
Energy Resources Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

J.G. Rupert

CONTRACT NUMBER: EG-77-C-03-1592

STARTING DATE: 09/06/77

DURATION: 12 months

AMOUNT: \$94,060

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

In an effort to evaluate requirements for the second generation Solar Energy Management System (SEMS) super-chip controller, this project will endeavor to design and develop a first generation SEMS controller for solar heating and cooling applications. This first generation controller, based on micro-processor technology, will provide for implementation of a variety of energy management control strategies. This program will utilize off-the-shelf components in an effort to limit development risk.

Initially, a review will be made of a variety of solar heating/cooling configurations currently in use or being planned throughout the United States. The functional requirements for the SEMS system will also be established and hardware specifications will be prepared.

The project will refine the SEMS concept, assure all hardware and software specification items are met, and complete the control/annunciator panel and electronics module design. These two system components will then be fabricated and assembled. Following integration of the software and hardware, the system will undergo testing and evaluation. The project will culminate with delivery of the SEMS device along with detailed design drawings.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Energy Management System
(SEMS) Controller Design and
Development

INSTITUTION:

Honeywell, Inc.
Energy Resources Center
2600 Ridgeway Parkway
Minneapolis, MN 55413

PRINCIPAL INVESTIGATOR:

Richard D. Lane

CONTRACT NUMBER: EG-77-C-03-1598

STARTING DATE: 09/26/77

DURATION: 12 months

AMOUNT: \$118,763

PROJECT DESCRIPTION

A relatively inexpensive electronic controller has been developed that will be capable of operating a solar heating and cooling system in a near-optimized manner. An experimental solar heating and cooling system has been constructed and will be used to compare, experimentally, the value of alternative control algorithms, first using the LBL-developed controller, and then using other controllers that are commercially available.

The prototype controller has been fabricated, debugged and used to control initial operation of the heating and cooling system. This experimental solar heating and cooling system has been instrumented and calibrated; preliminary test runs are underway to achieve a small enough uncertainty (5%) in heat balance during system operation to determine the relative cost effectiveness of alternative control strategies.

An input solar energy simulator has been developed and an output load simulator is being synthesized; these will permit repeated experimental runs under the same input and output conditions.

IMPORTANT REPORTS OR PUBLICATIONS

- Lawrence Berkeley Laboratory Reports: LBL-4436 and LBL-5892.

PROJECT TITLE:

Development of Electronic Controller
and Evaluation of Control Algorithms
for Solar Heating and Cooling Systems

INSTITUTION:

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94723

PRINCIPAL INVESTIGATOR:

Michael Wahlig

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 10/01/76

DURATION: 12 months

AMOUNT: \$95,000

PROJECT DESCRIPTION

This project will apply adaptive control techniques to the problem of finding optimal energy conserving strategies for the operation of building and HVAC systems. Adaptive control will allow a substantial part of the analysis to be done in an automated fashion. It is a flexible technique with general applicability to any building and HVAC system. The NSRSC building will be used as a case study.

The specific tasks which will be completed in this program are:

1. Develop a heating simulation model,
2. Develop an air conditioning simulation model,
3. Develop conventional controllers for each simulation model,
4. Develop adaptive controllers for each simulation model,
5. Develop a system identification process, and
6. Assess the energy savings obtainable.

IMPORTANT REPORTS OR PUBLICATIONS

- Farris, Donald R., Melsa, James L., Murray, Hugh S., McDonald, Thomas E., and Springer, Thomas E., "Energy Conservation by Adaptive Control for a Solar Heated Building," September, 1977.
- Farris, Donald R. and Melsa, James L., "Energy Savings for a Solar Heated and Cooled Building Through Adaptive Optimal Control."
- Farris, Donald R., Murray, Hugh S., Springer, Thomas E., McDonald, Thomas E., Melsa, James L., and Monopoli, Richard V., "Adaptive Control for Energy Conservation."
- Farris, D.R., Murray, H.S., Springer, T.E., Melsa, J.L., Monopoli, R.V., "Adaptive Control for Energy Conservation," Status Report No. LA-6753-SR, March, 1977.

PROJECT TITLE:

Adaptive Control for Energy
Conservation

INSTITUTION:

Los Alamos Scientific Laboratory
P.O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

D.R. Farris

CONTRACT NUMBER: W-7405-ENG-36

STARTING DATE: 10/01/76

DURATION: 12 months

AMOUNT: \$60,000

PROJECT DESCRIPTION

This research effort is directed at establishing generic control functions needed in the future (near-term extended) solar heating and cooling systems.

A major portion of the activity in this research effort is the collection of data. This will involve the gathering of data from four sources: state-of-the-art literature, solar system manufacturers, A&E firms and installers and Rho Sigma engineering files. Approximately 2 weeks of investigation will be devoted to each source area. The results of the analysis portion of the project will be presented as conclusions and recommendations.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Assessment of Need for
New Controllers

INSTITUTION:

Rho Sigma, Inc.
11922 Valerio Street
North Hollywood, CA 91605

PRINCIPAL INVESTIGATOR:

Andrew D. Davis

CONTRACT NUMBER: EG-77-C-03-1597

STARTING DATE: 09/06/77

DURATION: 6 months

AMOUNT: \$47,036

PROJECT DESCRIPTION

Rho Sigma will develop and deliver a micro-processor controller that handles 16 analog and 16 digital inputting signals and provides 16 outputs. The outputs will use solid state relays (10 Amps), electromechanical relays (10 Amps) and analog signals for proportional speed control. Rho Sigma plans to market this product commercially.

Marshall Space Flight Center will monitor equipment progress.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of a Programmable Microprocessor for Solar Heating and Cooling Systems

INSTITUTION:

Rho Sigma, Inc.
11922 Valerio Street
North Hollywood, CA 91605

PRINCIPAL INVESTIGATOR:

Robert Schlesinger

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32256

STARTING DATE: 10/15/76

DURATION: 13 months

AMOUNT: \$45,196

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project will evaluate the cost effectiveness of sophisticated controllers for solar heating systems and offset their increased cost with the value of energy savings they produce.

The major constituent of this research will be a comparison of the relative performances of an un-complicated state-of-the-art controller and a micro-processor-implemented simplification of an optimally-designed controller. This comparison will be based on a 1-year study segmented into two stages: the first evaluates incremental benefits of proportional control and the second the benefits of intelligent processing of the many system variables used in formulating the control strategy.

For this study, two solar-assisted heating systems will be examined. Control optimization theory will be used to derive theoretical performance measures for sophisticated systems. The effects of complex decision-making and the value of proportional actuators will be considered both separately and in combination. Promising control strategies will be modeled using the TRNSYS computer simulation program to find detailed operating savings. These will be compared to the capital first cost of implementing the systems using a life-cycle cost analysis. Payback periods will be computed based on assumed fuel costs, cost of capital, and inflation rates.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Two-Stage Approach to Effective
Controllers via Adaptive Optimization

INSTITUTION:

The Singer Research and Development
Corporation
286 Eldridge Road
Fairfield, NJ 07006

PRINCIPAL INVESTIGATOR:

Thomas Taylor

CONTRACT NUMBER: EG-77-C-03-1593

STARTING DATE: 09/19/77

DURATION: 12 months

AMOUNT: \$100,461

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this program is to develop a high performance solar controller which offers novel, adaptive control for collection and distribution optimization, in addition to other more conventional controller features. This adaptive aspect reduces the flow rate as load demand is satisfied to increase COP. All other proportional speed controllers reduce COP by increasing the flow rate with temperature increases.

The technical objective of the program is to verify the improved performance of an adaptive-proportional controller. Accordingly, this project will analytically model candidate solar heating systems in representative types of buildings and climates using MITAS or TRNSYS. Here, criteria specifications will be developed. This procedure will be followed by the step-by-step design and development of a prototype. This will include the design of system interfaces and circuits and the evaluation of the microprocessor. The completed prototype will then undergo thorough laboratory testing to various performance limits. The test results, along with a description of controller operation and the performance predictions, will be delivered with the final report and the prototype controller.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Development of a Novel Controller

INSTITUTION:

Solar Control Corporation
5595 Arapahoe Road
Boulder, CO 80302

PRINCIPAL INVESTIGATOR:

Thomas B. Kent

CONTRACT NUMBER: EG-77-C-03-1599

STARTING DATE: 09/01/77

DURATION: 12 months

AMOUNT: \$91,476

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Solar Control Corporation will develop and deliver a modular controller that uses two analog input channels and multiple digital output channels. The modularity allows use with additional controllers as the system requires.

Marshall Space Flight Center is monitoring equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of Modular Electronic
Controller for Solar Heating Systems

INSTITUTION:

Solar Control Corporation
5595 Arapahoe Road
Boulder, CO 80302

PRINCIPAL INVESTIGATOR:

Martha McGavin

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32258

STARTING DATE: 10/26/76

DURATION: 12 months

AMOUNT: \$63,113

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Andover Control Corporation will develop and deliver a controller/hydronics package system. This system includes a programmable microprocessor controller with 32 analog and 32 digital input channels and 32 digital output channels. The hydronics portion of the system package includes pumps, valves, pipes, etc. Andover Control Corporation plans to market this package commercially.

Marshall Space Flight Center will monitor equipment performance.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Development of a Programmable Microprocessor/
Hydronics Package for Solar Heating and Cooling
Systems

INSTITUTION:

Andover Control Corporation
P. O. Box 34
Shawsheen Village Station
Andover, MA 01810

PRINCIPAL INVESTIGATOR:

Thomas D. Hazzard

CONTRACT NUMBER: NASA/MSFC Contract:
NAS8-32257

STARTING DATE: 10/18/76

DURATION: 12 months

AMOUNT: \$97,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This project will attempt to identify the kinds of controllers that are needed, determine how they fit into the solar system and recommend those controllers which should be developed.

The investigation will begin with a preliminary survey of the currently available controllers and their capabilities. The data provided here will serve as a basis for comparison with anticipated future needs. To complete this initial phase of the project, a state-of-the-art literature search and survey, by telephone and mail, of controller manufacturers will be conducted. The data from these two sources will provide a basis for comparison of requirements for new controllers.

Data for the determination of needed controllers will be obtained through surveys made of solar-system suppliers and installers, personal interviews with primary suppliers and installers, and mail surveys made of secondary suppliers and installers. This data will be used to depict the indicated types of controllers needed and their performance capabilities and cost considerations.

A detailed analysis will then compare the two primary sets of data and determine which controllers are presently needed but not available. From this comparison and analysis, recommendations for possible future R&D efforts can be made.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Assessment of Need for New
Controllers

INSTITUTION:

Solar Control/Zia Division
5590 Arapahoe Road
P.O. Box 1466
Boulder, CO 80306

PRINCIPAL INVESTIGATOR:

Thomas B. Kent

CONTRACT NUMBER: EG-77-C-03-1596

STARTING DATE: 09/19/77

DURATION: 6 months

AMOUNT: \$44,921

NO PHOTOGRAPH AVAILABLE

9. SUPPORT PROJECTS

PROJECT DESCRIPTION

A workshop on the Use of Solar Energy for the Cooling of Buildings was organized in the City of San Francisco.

The workshop includes a number of specific objectives, listed below not necessarily in order of importance:

- a) It should serve as a mechanism of accountability on the use of tax money, both for the sponsor, DOE, and for the individual DOE contractors. It should assist in reconfirming or reevaluating the validity of the overall program and the individual projects and approaches.
- b) It should provide a forum for those who have independently funded efforts and for those who have potentially useful ideas which are still in the planning stage.
- c) It should give capable technical people who have as yet been outsiders to the specific program involved, a good enough overview of the ongoing effort so that they can see what else needs to be done. It should open up the R&D program to those who are qualified.
- d) It should stimulate interchange between research groups, discussion and criticism. Hopefully this process can minimize the unnecessary duplication of effort, and particularly also the repetition of mistakes or of unrewarding approaches which have already been tried by others.
- e) The workshop proceedings should constitute a complete overview of the current state-of-the-art and should have a complete bibliography.

IMPORTANT REPORTS OR PUBLICATIONS

- Altas Corporation, "Extended Abstracts of the Third Workshop on the Use of Solar Energy for the Cooling of Buildings," Informal Report (B. Clarke, ed.), February 1978.

PROJECT TITLE:

Workshop on the Use of Solar Energy
for Cooling Buildings

INSTITUTION:

Altas Corporation
2060 Walsh Avenue
Santa Cruz, CA 95050

PRINCIPAL INVESTIGATOR:

Frances de Winter

CONTRACT NUMBER: EG-77-C-02-4576

STARTING DATE: 07/01/77

DURATION: 12 months

AMOUNT: \$39,780

Preliminary Announcement

Third Workshop On THE USE OF SOLAR ENERGY FOR THE COOLING OF BUILDINGS

**February 15, 16, 17,
1978**

Location
Sheraton Palace Hotel (415) 392-8800
San Francisco, California

Sponsored by
U.S. Department of Energy
Conservation and Solar Applications
Research and Development Branch

and by
Center for Management and Technical Programs
Division of Continuing Education
University of Colorado at Boulder

Workshop Coordinator
Frances de Winter (408) 425-1211
Altas Corporation
500 Chestnut Street
Santa Cruz, California 95060

Organized in Cooperation with
American Society of Heating, Refrigerating
and Airconditioning Engineers
Electric Power Research Institute
American Section of the International
Solar Energy Society

PROJECT DESCRIPTION

This program will provide support to the Department of Energy in projects relating to thermal energy storage. The specific tasks which will be completed in this program are:

- Task 1—Proposal Review: The Laboratory will, as required, organize and conduct a peer-review of unsolicited proposals received by the Research and Development Branch.
- Task 2—Project Evaluation: To provide technical evaluation of the assigned projects in the area of thermal energy storage. Appropriate reports on the activities in this task will be provided to Research and Development Branch.
- Task 3—Procurement Activities: To assist in the preparation of statements of work and the evaluation criteria for various forms of public solicitations (such as RFP's). The Laboratory will also participate in the evaluation of the responses to these solicitations.
- Task 4—Program Plan: Assist in the review and modification of the Solar Heating and Cooling R&D program, as required.
- Task 5—Coordination: Participate on an inter-laboratory coordination committee. This committee will be responsible for the coordination of the activities at the various support laboratories.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Program Support for the Research
and Development Branch - Thermal
Energy Storage

INSTITUTION:

Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439

PRINCIPAL INVESTIGATOR:

Allan Michaels

CONTRACT NUMBER: W-7409-ENG-38

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$100,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

A technical evaluation of the ERDA-DSE Research and Development Program for Fiscal Year 1977 will be performed.

An overall review with the following objectives in mind will be undertaken:

- A. To suggest changes for improvement to meet the needs of the Heating, Ventilating and Air Conditioning (HVAC) industry as Program Research and Development Announcements (PRDA's) result in contracts for research and development in the solar heating and cooling field.
- B. To suggest missing tasks that should be included in the program.
- C. To recommend changes in the R&D strategies for the 10 paths that are delineated, if such are deemed to increase their effectiveness.
- D. To recommend changes for improvement in tasks under each path.
- E. To suggest levels of priority for path and task.

IMPORTANT REPORTS OR PUBLICATIONS

- "A Review of ERDA 76-144," March 1, 1977.

PROJECT TITLE:

R&D Plan Review

INSTITUTION:

ASHRAE
345 E. 47th Street
New York, NY 10017

PRINCIPAL INVESTIGATOR:

L. R. Kimball

CONTRACT NUMBER: EX-76-C-01-2224

STARTING DATE: 12/14/76

DURATION: 4 months

AMOUNT: \$22,020

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

A conference on the control of solar energy systems for the heating and cooling of buildings will be held in Boston during May 1978. Conference proceedings will be published. Topics will include:

1. State-of-the-art in control technology.
2. Control optimization.
3. Control strategies for peak-load reduction.
4. Novel controllers - proportional and adaptive.
5. Cost effective controllers.
6. Working groups.

Effective controllers are crucial to the success of a solar heating and cooling system. This conference will focus attention and disseminate information on this important subject.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Conference on the Control of
Solar Energy Systems for the
Heating and Cooling of Buildings

INSTITUTION:

Boston University
College of Engineering
Boston, MA 02215

PRINCIPAL INVESTIGATOR:

Ming M. Chen

CONTRACT NUMBER: EG-77-C-02-4578

STARTING DATE: 06/30/77

DURATION: 12 months

AMOUNT: \$39,769

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

In this support project Brookhaven National Laboratory (BNL) will assist the United States Department of Energy (DOE) in the development of solar heat pump and solar cooling technologies. The support will consist of various project management tasks to identify and develop cost effective solar heat pump and solar cooling technologies. In addition, BNL proposes to assist DOE with the technical support of the "Demonstration" program in the solar cooling area. BNL will develop in-house solar heat pump and solar cooling research activities with tasks to be identified later.

This project is divided into the following tasks:

Task 1—Assist in the review of unsolicited proposals.

Task 2—Visit contractors sites.

Task 3—Review progress report.

Task 4—Conduct annual contractors meetings.

Task 5—Assist in the preparation/evaluation of Requests for Proposals.

Task 6—Develop a program plan.

Task 7—Assess current solar cooling technology "Demonstration" program.

IMPORTANT REPORTS OR PUBLICATIONS

- Andrews, J., and Wilhelm, W., "Low-Cost Site-Assembled Solar Collector Designs for Use with Heat Pumps," BNL 50671, May 1977.
- Auh, P. C., "A Survey of Absorption Cooling Technology in Solar Applications," BNL 5074, July 1977.

PROJECT TITLE:

Program Support for the Research
& Development Branch —
Solar Heat Pumps & Cooling

INSTITUTION:

Brookhaven National Laboratory
Uptown, NY 11923

PRINCIPAL INVESTIGATOR:

J. G. Cottingham
Paul C. Auh

CONTRACT NUMBER: E(30-1)-16

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$360,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objectives of this project are to organize a workshop on the use of solar energy systems for cooling buildings, disseminate information and simulate caution in the field in both technical and non-technical areas.

The project is divided into the following tasks.

Task 1—Organize a preliminary 2-day meeting in Washington, D.C. with researchers performing work for DOE and for other U.S. Government agencies.

Task 2—Arrange for session chairman and commentators.

Task 3—Send out all mailings.

Task 4—Arrange for all audio-visual equipment and personnel.

Task 5—Coordinate the workshop meeting.

Task 6—Edit the typed transcript of the meeting, publish and distribute the proceedings.

Task 7—Furnish DOE with a camera-ready copy of these proceedings for distribution through the U.S. Government Printing Office.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Workshop on the Use of Solar
Energy for Cooling Buildings

INSTITUTION:

University of Colorado
Center for Management and Technical
Programs
P. O. Box 3253
Boulder, CO 80307

PRINCIPAL INVESTIGATOR:

Ann F. Wohl

CONTRACT NUMBER: EG-77-C-02-4576

STARTING DATE: 07/01/77

DURATION: 12 months

AMOUNT: \$39,781

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this project is to conduct a series of solar energy seminars in Jamaica, in conjunction with the Jamaican Ministry of Mining and Natural Resources. Nine seminars will be held in a period of 4 weeks. The seminars will feature training in the design, assembly, installation and maintenance of solar water heating systems. A general background in the fundamentals of solar energy collection and use, and various types of solar technology and applications suitable for Jamaica will be provided.

Lecture notes for the seminars will be published in Jamaica. Lecture tapes will be developed by the University of Colorado.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Energy Training Seminars
for Jamaica, W.I.

INSTITUTION:

University of Colorado
Boulder, CO 80307

PRINCIPAL INVESTIGATOR:

Tom Stein

CONTRACT NUMBER: EG-77-C-02-4313

STARTING DATE: 04/01/77

DURATION: 4 months

AMOUNT: \$10,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The purpose of this project is to provide systems level retrofit program planning for solar heating and cooling of buildings in the United States. Such planning will address the program elements of R&D; development in support of demonstration; and demonstration for the various combination of hot water, heating and cooling obligations.

The specific tasks to be accomplished are as follows:

Task 1—Data aggregation including a planning outline, literature and solar project activities survey.

Task 2—Planning and analysis including a program functional flow diagram, definition and analysis of options, goals and key issues, identification of approaches and definition of program tasks and responsibilities for program implementation.

The results of Tasks 1 and 2 will be presented in task progress reports.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Retrofit Program Planning for
Solar Heating and Cooling of
Buildings

INSTITUTION:

Energy Systems International
P. O. Box 1604
Washington, D. C. 20013

PRINCIPAL INVESTIGATOR:

Herbert C. Yim

CONTRACT NUMBER: EG-77-X-01-3365

STARTING DATE: 07/14/77

DURATION: 4 months

AMOUNT: \$9,973

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The Florida Solar Energy Center organized and managed a conference on solar energy (thermal) flat-plate collectors. This was cosponsored by the U.S. Energy Research and Development Administration (ERDA) and was held in Orlando, Florida the week of February 28-March 2, 1977.

The conference objective was to provide a forum for presenting and discussing new concepts in collector design of flat plate collectors. State-of-the-art of collector design, new collector concepts, performance data on efficiency and reliability, standards and test procedures and manufacturers' considerations were included as conference topics. A manufacturers' products exhibit and experiences of collectors users were included as formal activities of the conference to provide an interface between theory and application.

Conference Proceedings contain formally delivered papers, topical evaluations and session summaries. These were distributed to attendees.

IMPORTANT REPORTS OR PUBLICATIONS

- *Proceedings*, 1977 Flat-Plate Solar Collector Conference, February 28-March 2, 1977, Orlando, Florida.

PROJECT TITLE:

Solar Energy Flat-Plate Collector
Conferences/Exhibit/Workshop

INSTITUTION:

Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920

PRINCIPAL INVESTIGATOR:

Delbert B. Ward

CONTRACT NUMBER: EY-76-S-05-5271

STARTING DATE: 09/15/76

DURATION: 12 months

AMOUNT: \$39,261

COSPONSORS:
U.S. ENERGY RESEARCH
AND DEVELOPMENT
ADMINISTRATION
WASHINGTON, D.C.
AND
FLORIDA SOLAR
ENERGY CENTER
CAPE CANAVERAL, FLORIDA

EDITED BY:
DELBERT B. WARD
FLORIDA SOLAR ENERGY CENTER
FSEC-77-8
SEPTEMBER 1977

PROCEEDINGS 1977 FLAT-PLATE SOLAR COLLECTOR CONFERENCE

FEBRUARY 28-MARCH 2, 1977
ORLANDO, FLORIDA

PROJECT DESCRIPTION

The Georgia Institute of Technology organized and conducted a 3-day workshop on Concentrating Solar Collectors at their facilities during the week of September 26-28, 1977. The conference was sponsored by the U.S. Energy Research and Development Administration (ERDA) in cooperation with the College of Engineering of the Georgia Institute of Technology, the Engineering Division of the American Section of the International Solar Energy Society and the Solar Energy Division of ASME.

The purposes of the proposed conference were to:

1. Bring together researchers, manufacturers and users of concentrating solar conference were to: the state of development of these collectors,
2. Examine new concepts in the design and fabrication of concentrating collectors,
3. Promote the exchange of detailed information on the latest collector developments and numerical models,
4. Provide recommendations as to the most promising avenues of future R&D efforts,
5. Examine techniques for testing concentrating collectors and develop suggestions for modifications and improvements,
6. Compare various numerical models of focusing collectors and recommend uniform criteria for such models, and
7. Present performance data for concentrating collectors developed to date.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Workshop on Concentrating Solar Collectors

INSTITUTION:

Georgia Institute of Technology
College of Engineering
Atlanta, GA 30332

PRINCIPAL INVESTIGATOR:

J. Richard Williams

CONTRACT NUMBER: EG-77-G-05-5488

STARTING DATE: 06/01/77

DURATION: 6 months

AMOUNT: \$39,325

Georgia Institute of Technology
Atlanta, Georgia
September 26-28, 1977

SPONSORED BY:
Division of Solar Energy, U.S. Energy Research and
Development Administration

COORDINATED BY:
Georgia Institute of Technology

IN COOPERATION WITH:
International Solar Energy Society, American Section
American Society of Mechanical Engineers, Solar Energy Division
Georgia Solar Energy Association

PROJECT DESCRIPTION

This project will research and analyze energy development commercialization issues to assist DOE in its formulation of an integrated, energy commercialization plan. The following three specific functions will be performed:

1. Devise specific product market plans for production incentive strategies and distribute selected solar heating and cooling technologies attractive to private industry.
2. Recommend a schedule by which selected technologies could move onto more advanced stages of development.
3. Integrate the findings of the above studies and develop alternative product plans to be submitted to DOE for consideration.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Product Planning Analysis for
Solar Heating and Cooling
Branch

INSTITUTION:

Institute of Public Administration
1717 Massachusetts Avenue
Washington, DC

PRINCIPAL INVESTIGATOR:

Sumner Myers

CONTRACT NUMBER: EG-77-S-01-4012

STARTING DATE: 02/01/77

DURATION: 12 months

AMOUNT: \$66,916

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This program will provide support to the Research and Development Branch, Division of Solar Energy in projects relating to controls for solar energy systems and the non-engineering aspects of solar heating and cooling of buildings. The specific tasks which will be completed in this program are:

- Task 1—Proposal Review: The Laboratory will, as required, organize and conduct a peer-review of unsolicited proposals received by the Research and Development Branch and the Barriers and Incentive Branch.
- Task 2—Project Evaluation: To provide technical evaluation of the assigned projects in the area of controls for solar energy systems and the non-engineering aspects of solar heating and cooling of buildings. Appropriate reports on the activities in this task will be provided to Research and Development Branch.
- Task 3—Procurement Activities: To assist in the preparation of statements of work and the evaluation criteria for various forms of public solicitations (such as RFP's). The Laboratory will also participate in the evaluation of the responses to these solicitations.
- Task 4—Program Plan: Assist in the review and modification of the Solar Heating and Cooling R&D Program, as required.
- Task 5—Coordination: Participate on an inter-Laboratory coordination committee. This committee will be responsible for the coordination of the activities at the various support laboratories.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Program Support for the Research and Development Branch—Controls and Non-Engineering Aspects

INSTITUTION:

Lawrence Berkeley Laboratory
Berkeley, CA 94720

PRINCIPAL INVESTIGATOR:

Michael Wahlig

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$40,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The objective of this work is to provide program support and contract monitoring for the Division of Solar Energy R&D Branch.

The following types of support will be provided to the R&D Branch program:

1. Assist in the review of unsolicited proposals within the general area in which LLL is providing program support and assist in the evaluation panels for RFP and PRDA proposals.
2. Provide technical monitoring and evaluation of various R&D contracts in the general area in which we are providing program support. This activity will include contractor site visits, contractor meetings, progress report reviews, assistance in contract renewals and other appropriate activities. For each assigned contract it is expected that one or two site visits will be made each year and one contractors meeting will be conducted. Appropriate reports on the activities in this task will be provided to the R&D Branch; the format and frequency will be determined by the R&D Branch.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Program Support Agricultural/
Industrial Systems

INSTITUTION:

Lawrence Livermore Laboratory
P. O. Box 808
Livermore, CA 94550

PRINCIPAL INVESTIGATOR:

W. C. Dickinson

CONTRACT NUMBER: W-7405-ENG-48

STARTING DATE: 07/01/76

DURATION: Continuing

AMOUNT: \$80,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

LASL assisted the Research and Development Branch, Division of Solar Energy by performing the following tasks:

Task 1—Reviewed available documents relevant to the Solar Heating and Cooling R&D Program.

Task 2—With the close cooperation and concurrence of the Chief, Research and Development Branch, organized and conducted the special 2-day meetings in the following areas to assess the state-of-the-art in each area:

- (1) Solar Collectors,
- (2) Solar Air Conditioning and Heat Pumps,
- (3) Systems and Controls,
- (4) Thermal Energy Storage, and
- (5) Non-Engineering Aspects.

Task 3—Recommended a program of the research, technology and engineering development required to develop solar heating and cooling systems capable of competitive large scale commercialization.

IMPORTANT REPORTS OR PUBLICATIONS

- Balcomb, J.D. and Perry, J.E., Jr., "Paths to Solar Heating and Cooling, A Proposed Plan for Research and Development in Solar Heating and Cooling," Fourth Draft, LA-6380-MS, June, 1976; Sixth Draft with Editorial Revisions by ERDA, Interim Report ERDA-76-144, Dec. 1976.
- Balcomb, J. D. and Perry, J. E., Jr., "Assessment of Solar Heating and Cooling Technology," Los Alamos Scientific Laboratory Informal Report, LA-6379-MS, Issued May 1977.

PROJECT TITLE:

Assistance in Developing Solar Heating and Cooling R&D Plan

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

J. D. Balcomb

CONTRACT NUMBER: W-7405-ENG-36,D497

STARTING DATE: 11/05/75

DURATION: Completed

AMOUNT: \$95,000

ERDA 76-144

Interim Report National Program Plan for Research and Development in Solar Heating and Cooling

Division of Solar Energy
Washington, D.C.

November 1976

PROJECT DESCRIPTION

This program will provide support to the Research and Development Branch, Division of Solar Energy in projects relating to solar collectors. The specific tasks which will be completed in this program are:

Task 1—Proposal Review: The Laboratory will, as required, organize and conduct a peer-review of unsolicited proposals received by the Research and Development Branch.

Task 2—Project Evaluation: To provide technical evaluation of the assigned projects in the area of solar collectors. Appropriate reports on the activities in this task will be provided to Research and Development Branch.

Task 3—Procurement Activities: To assist in the preparation of statements of work and the evaluation criteria for various forms of public solicitations (such as RFP's). The Laboratory will also participate in the evaluation of the responses to these solicitations.

Task 4—Program Plan: Assist in the review and modification of the Solar Heating and Cooling R&D program, as required.

Task 5—Coordination: Participate on an inter-laboratory coordination committee. This committee will be responsible for the coordination of the activities at the various support laboratories.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Program Support for the Research and Development Branch - Collectors

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

C. A. Bankston

CONTRACT NUMBER: W-7405-ENG-36,D506

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$250,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

LASL organized and conducted a workshop on Passive Solar Heating and Cooling of Buildings. The workshop was held on two successive days, May 18 and 19, 1976. An organizing committee layed out a meeting agenda and determined an initial list of invited papers and speakers. The travel expenses of invited participants were refunded with the usual limitations applicable to foreigners. The workshop was coordinated by the organizing committee co-chairmen, J. Douglas Balcomb (LASL) and William Mingenbach (The Architects Taos). The Architects Taos was reimbursed for expenses incurred in the course of workshop organization in accordance with ERDA regulations and policy. The proceedings of the workshop were tape recorded and video recorded. Following the workshop, written proceedings were edited by LASL and published as a report in the LA series.

IMPORTANT REPORTS OR PUBLICATIONS

- "The Passive Solar Heating and Cooling Conference and Workshop Proceedings," May 18-19, 1976, Albuquerque, New Mexico, LA-6637-C.

PROJECT TITLE:

Workshop on Passive Solar Heating and Cooling of Buildings

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

J. D. Balcomb

CONTRACT NUMBER: W-7405-ENG-36, D498

STARTING DATE: 04/05/76

DURATION: 8 months

AMOUNT: \$35,000

PASSIVE SOLAR HEATING AND COOLING

Conference and Workshop Proceedings
May 18-19, 1976, Albuquerque, New Mexico

sponsored by:
Energy Research & Development Administration,
Division of Solar Energy, Heating & Cooling Branch

coordinated by:
Los Alamos Scientific Laboratory, Solar Energy Group

in cooperation with:
The American Society of Heating, Refrigerating &
Air Conditioning Engineers

and
The New Mexico Solar Energy Association

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

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UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CONTRACT W-7405-ENG-36

PROJECT DESCRIPTION

This program provides support to the Research and Development Branch, Division of Solar Energy in projects relating to solar collectors. The specific tasks which will be completed in this program are:

- Task 1—Proposal Review: The Laboratory will, as required, organize and conduct a peer-review of unsolicited proposals received by the Research and Development Branch.
- Task 2—Project Evaluation: To provide technical evaluation of the assigned projects in the area of solar collectors. Appropriate reports on the activities in this task will be provided to Research and Development Branch.
- Task 3—Procurement Activities: To assist in the preparation of statements of work and the evaluation criteria for various forms of public solicitations (such as RFP's). The Laboratory will also participate in the evaluation of the responses to these solicitations.
- Task 4—Program Plan: Assist in the review and modification of the Solar Heating and Cooling R&D program, as required.
- Task 5—Coordination: Participate on an inter-Laboratory coordination committee. This committee will be responsible for the coordination of the activities at the various support laboratories.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Program Support for the Research and Development Branch - Passive Systems

INSTITUTION:

Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM 87545

PRINCIPAL INVESTIGATOR:

J. D. Balcomb

CONTRACT NUMBER: W-7405-ENG-36,D506

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$30,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The United States is the pilot country for the Solar Energy Pilot Study of the Committee on the Challenges of Modern Society (CCMS) of NATO. The objective of this pilot study is the exchange of information on solar heating and cooling programs and projects of each participating country so as to encourage the cost-effective and practical application of solar energy to heating and cooling in residential, commercial, agricultural and public buildings.

The key elements in this information exchange are the preparation and distribution of special reports, to be prepared in an agreed format, and general reports concerned with solar heating and cooling in buildings; and the participation in meetings for the review of research programs and exchange of information and ideas. The objective of this work is to provide program support to DOE in its role as the lead agency for this CCMS Pilot Study.

IMPORTANT REPORTS OR PUBLICATIONS

- "CCMS Solar Energy Pilot Study; Solar Heating and Cooling Systems in Buildings," Report of the Annual Meeting, Report No. UMD-4908-5, August 4-6, 1975.

PROJECT TITLE:

Assist the NATO Committee on the
Challenges of Modern Society
(CCMS) Solar Heating and Cooling
of Building Projects

INSTITUTION:

University of Maryland
Department of Mechanical Engineering
Solar Energy Projects
College Park, MD 20742

PRINCIPAL INVESTIGATOR:

Redfield Allen
Sheila Blum

CONTRACT NUMBER: EY-76-S-05-4908

STARTING DATE: 01/01/75

DURATION: 48 months

AMOUNT: \$152,406

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The NBS was designated to perform the following tasks for Research and Development Branch, Division of Solar Energy.

- Task 1—Develop solar heating, cooling and hot water supply systems.
- Task 2—Prepare four (4) hourly climatic data tapes for use on NBS computer by 5/15/76.
- Task 3—Calculate hourly thermal loads for each of four climatic conditions for "design" buildings using NBS low determination program and distribute low tapes to pertinent project participants by 5/31/76.
- Task 4—Collate comments on data requirement matrices and prepare summary for presentation at fall meeting in October 1976.
- Task 5—Perform testing of solar collectors.
- Task 6—Summarize U.S. experience and prepare comments and changes in NBSIR 74-635; mail to rapporteur by 8/31/76.
- Task 7—Investigate initiation of collector round robin test program and submit plan at the fall meeting in October 1976.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Assist Division of Solar Energy
in Planning for IEA Cooperative
Projects

INSTITUTION:

National Bureau of Standards
Gaithersburg, MD 20767

PRINCIPAL INVESTIGATOR:

Elmer Streed

CONTRACT NUMBER: E(49-1)-3800

STARTING DATE: 04/08/76

DURATION: Continuing

AMOUNT: \$0

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

PRC Energy Analysis Company will provide technical and management support to the Solar Heating and Cooling Division of Solar Applications. The tasks assigned vary depending on the immediate problem at hand. Significant tasks include:

- Updating the 76-145 to include all the projects underway during the Transitional Quarter and through FY 1977.
- Developing the plan for Passive Systems and Active Systems program elements.
- Studying various management options which can better accommodate an expanding R&D program.
- Developing and maintaining management tools.
- Organizing DOE Conferences and Workshops.
- Establishing advanced systems testing and test facilities requirements.
- Investigating and coordinating solar system simulation and economic analysis comparisons.
- Conducting surveys and evaluating current status of design techniques for solar domestic hot water systems.
- Supporting R&D Program Solicitation process.

IMPORTANT REPORTS OR PUBLICATIONS

- "Status of Solar Domestic Hot Water Systems Design Methods."
- "Solar Capability of Commercial Building HVAC Energy Analysis Computer Programs."
- "Plan for Testing Advanced Solar Heating and Cooling Systems - Preliminary Plan."
- "International Energy Agency Survey of Components for Solar Heating, Cooling and Hot Water Supply Systems."

PROJECT TITLE:

Solar System Engineering and
Management Support

INSTITUTION:

PRC Energy Analysis Company
7600 Old Springhouse Road
McLean, VA 22010

PRINCIPAL INVESTIGATOR:

Michael T. Panich

CONTRACT NUMBER: EG-77-C-01-2522

STARTING DATE: 05/20/77

DURATION: 12 months

AMOUNT: \$250,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

This program will provide support to the Research and Development Branch, Division of Solar Energy in projects relating to the solar energy systems. The specific tasks to be completed in this program are:

Task 1—Proposal Review: The Laboratory will, as required, organize and conduct a peer-review of unsolicited proposals received by the Research and Development Branch.

Task 2—Project Evaluation: To provide technical evaluation of the assigned projects in the area of solar energy systems. Appropriate reports on the activities in this task will be provided to Research and Development Branch.

Task 3—Procurement Activities: To assist in the preparation of statements of work and the evaluation criteria for various forms of public solicitations (such as RFP's). The Laboratory will also participate in the evaluation of the responses to these solicitations.

Task 4—Program Plan: Assist in the review and modification of the Solar Heating and Cooling Branch's R&D program, as required.

Task 5—Coordination: Participate on an inter-laboratory coordination committee. This committee will be responsible for the coordination of the activities at the various support laboratories.

IMPORTANT REPORTS OR PUBLICATIONS

- No report available

PROJECT TITLE:

Program Support for the Research and Development Branch - Systems

INSTITUTIONS:

Sandia Laboratories
System Analysis, Division 5742
Albuquerque, NM 87115

PRINCIPAL INVESTIGATOR:

Sam Varnado

CONTRACT NUMBER: AT(29-1)-789

STARTING DATE: 04/01/76

DURATION: Continuing

AMOUNT: \$170,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

SERI will perform research and development projects and monitor the technical progress of R&D work underway to provide the assessments necessary for guidance in program direction.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Solar Energy Research and
Program Support

INSTITUTION:

SERI
1536 Cole Boulevard
Golden, CO 80401

PRINCIPAL INVESTIGATOR:

P. Rappaport

CONTRACT NUMBER: EG-77-C-01-4042

STARTING DATE: 04/08/77

DURATION: Continuing

AMOUNT: \$4,878,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

Systems Consultants, Inc. will assist the Research and Development Branch of the Solar Heating and Cooling Division in preparing the final report of the program plan for R&D, ERDA 76-144. The following tasks shall be performed:

Task 1—Review and make evaluation comments on the draft document ERDA 76-144 from ASHRAE, ASME, SEIA and others for possible use in preparing the final report on the program plan.

Task 2—Coordinate with Lawrence Livermore Laboratory the development and status of the program plan for agricultural and industrial process heat. This plan will be included in the program plan for the Research and Development Branch.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Support of Solar Application of
the Project Management System

INSTITUTION:

Systems Consultants, Inc.
1055 Thomas Jefferson Street
Suite 202
Washington, D.C. 20007

PRINCIPAL INVESTIGATOR:

Pandit Patil

CONTRACT NUMBER: EG-77-C-01-4006

STARTING DATE: 01/18/77

DURATION: 9 months

AMOUNT: \$52,000

NO PHOTOGRAPH AVAILABLE

PROJECT DESCRIPTION

The past few years have seen considerable activity in the construction of solar heated and cooled structures. There have been various stimuli for this. A large one is the "Solar Heating and Cooling Demonstration Program" instituted 3 years ago by the U.S. Congress.

The purpose of this conference is to offer a forum on the current situation in the monitoring of solar heating and cooling systems. This will be accomplished through submitted papers, invited papers and panel discussions. Covered will be topics on data systems and handling, instrumentation, and analysis techniques. In addition to a printed summary to the papers presented, a comprehensive overview document will be prepared.

IMPORTANT REPORTS OR PUBLICATIONS

- New contract - No report available

PROJECT TITLE:

Conference on Monitoring and
Evaluation of Solar Heating and
Cooling Systems

INSTITUTION:

University of Utah
Department of Mechanical Engineering
Salt Lake City, UT 84112

PRINCIPAL INVESTIGATOR:

R. F. Boehm

CONTRACT NUMBER: EG-77-S-04-4094

STARTING DATE: 07/15/77

DURATION: 9 months

AMOUNT: \$21,137

ADVANCE MEETING ANNOUNCEMENT AND CALL FOR PAPERS

"Conference on Performance Monitoring Techniques for
Evaluation of Solar Heating
and Cooling Systems"

April 3 and 4, 1978
Shoreham Americana Hotel, Washington, D.C.
Sponsored by Solar Heating and Cooling Program
Conservation and Solar Energy Applications
U.S. Department of Energy
Organized by the University of Utah