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MEDIUM TEMPERATURE, HIGH EFFICIENCY TRACKING AND NON-TRACKING SOLAR ENERGY COLLECTORS FOR RURAL AND INDUSTRIAL APPLICATION

SEMI-ANNUAL REPORT

May, 1981 to Dec., 1981

MEDIUM TEMPERATURE, HIGH EFFICIENCY TRACKING AND NON-TRACKING SOLAR ENERGY COLLECTORS FOR RURAL AND INDUSTRIAL APPLICATION

SEMI-ANNUAL REPORT

for the period May 5, 1981 to December 31, 1981

submitted by

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February, 1982

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ABSTRACT

In a collaborate research program between the Department of Science and Technology, the Government of India and the Agency for International Development, of the U.S. State Department, it is proposed to develop cost-effective, tracking and non-tracking solar energy collectors and to use these collectors in demonstration systems such as agricultural pumping, industrial hot water and steam production, thermal power and/or space heating and cooling in rural India.

The collector and prototype system development is a three-year effort and constitutes the first phase of this five-year project. The second phase (also proposed for a three-year period but not yet funded) begins after the second year and is devoted to the commercialization of the collectors developed and to system development, demonstration and commercialization appropriate to rural India. The collector and system development will stress the use of appropriate technology, on-site labor and materials and cost-effectiveness relative to the site of intended use. It is intended that this project will lead to the development of a rural solar industry which will help to raise the standard of living in rural India by providing hot water, pumping and electricity as well as to establish an industrial base resulting in jobs and increased income.

The project is a collaborative effort between the Indian Institute of Science, Bangalore, on the Indian side and the University of Houston, Houston, Texas, on the U.S.A. side.

SUMMARY OF STAFF

Principal Investigator

Richard B. Bannerot

Research Assistant

Gary Kwan (M.S.M.E. student) - June 1 to December 31

Student Assistants

Mohamed Anwer (B.S.M.E. student) - June 1 to September 31

Ibrahim Khanmohamed (B.S.M.E. student) - December 1 to December 31

PROGRESS ON OBJECTIVES

OBJECTIVES FOR THE PERIOD MAY 5 TO DECEMBER 31, 1981

The program description outline and timeline taken from the revised proposal, is reproduced as Appendix A of this document. The progress on objectives is presented below in a format paralleling that utilized in the program description outline.

TRIPS: Completed as Planned

Dr. Bannerot visited India from May 20 to June 14. His itinerary included:

- New Delhi (USAID, IIT Delhi, the National Physics Laboratory)
- Bangalore (IIS, several industries either using or building solar equipment)
- Madras (IIT)
- Hyderabad (BHEL)
- Bombay (IIT)

Dr. Rao visited the USA from August 30 to October 24, 1981. His itinerary included:

- Washington, D.C.(USAID, National Bureau of Standards: Materials Division, Physics Division, and Building Technology Division (for the solar activity))
- Canton, Ohio (Olympic Plating Corp.)
- Pittsburg, Pennsylvania (a coating and an optics company)
- Boston, Massachusetts (MIT, MIT Energy Laboratory, Lincoln Laboratories)
- Edison, New Jersey (Berry Solar Products)

Atlanta, Georgia (Georgia Tech and Georgia Power & Light)

Houston, Texas (University of Houston)

Dallas, Texas (Solar Kinetics, Inc.)

Denver, Colorado (Solar Energy Research Institute)

Tucson, Arizona (Optical Science Center, University of Arizona)

Los Angeles, California (Gier-Dunkle, Inc., Jet Propulsion Laboratory, Telic Corp.)

San Jose, California (Acurex Corp.)

I. LINEAR FOCUSING

Short Term Review of Concentrators: This review was essentially completed by Dr. Rao's first-hand inspection of a demonstration site at Georgia Power & Light (Atlanta), visits to the two leading U. S. manufacturers of linear focusing collectors: Acurex (San Jose) and Solar Kinetics (Dallas), discussions at the Solar Energy Research Institute (Denver), Jet Propulsion Laboratory (Los Angeles), and the Optical Science Center, University of Arizona (Tucson), and various discussions with people in related industries (all sites).

Long Term Review of Concentrators: A considerable amount of literature has been assembled (and is still being added to) on the hardware development in the USA for linear focusing devices. Over 20 kilograms of papers and reports were mailed to Dr. Rao following his visit. (See plans for next six months for the continuing activity.)

Model Development: No activity was planned for this six-month period.

Testing Facilities (Review): No activity was planned for this six-month period.

II. SELECTIVE COATING

Technology Assessment: Dr. Rao performed this assessment as part of his travels in the USA. He visited academic researchers at the University of Arizona, University of Houston, MIT, Lincoln Laboratory, NBS, and SERI as well as industrial researchers and production engineers at Olympic Plating Corp., Berry Solar Products and Telic Corp. His discussions with "users" of the technology at Georgia Tech, Solar Kinetics, Acurex and SERI were also helpful in "getting both sides" of the industrial story.

III. NON-TRACKING

Optics: A computer simulation program has been completed which determines the detailed optical performance of a class of two-faceted grooves utilized as non-tracking concentrators. An initial design criterion for this class of concentrators has been developed.

Collector Design: No activity was planned for this six-month period.

IV. THERMAL SYSTEM DESIGN

No activity was planned for this six-month period.

V. FLAT PLATE THERMO-SYPHON SYSTEM DESIGN

Although no activity was planned for this time period related directly to this project, activity has been underway as part

of another project in this area. The current interest is in the modeling of liquid storage with thermal stratification. In previous work some experimentally developed information was obtained. We hope to establish an acceptable theory by using the experimental data to verify the model.

VI. MATERIALS EVALUATION AND DEGRADATION

Materials of interest were identified during Dr. Rao's visits to the various industries and research center in the USA. The development of a test facility at the University of Houston to investigate degradation has been temporarily delayed since the roof of the Engineering Building previously used in a similar study of flat plate collector materials, is scheduled to be resurfaced and will not be available for use until the late Spring.

VII. AIR HEATERS TECHNOLOGY ASSESSMENT

No activity was planned for this six-month period.

VII. EQUIPMENT SPECIFICATION

All major items of equipment were identified in the meetings at the IIS in June. Specifications were developed for much of the equipment during Dr. Rao's visit. Quotations have been received on some of the equipment.

IX. LITERATURE SURVEYS

As mentioned previously a large amount of related literature has been sent to the IIS. The process of gathering literature continues at the University of Houston. Periodic shipments are anticipated.

PLANS FOR THE NEXT SIX MONTHS

The same reporting format will be used here as was used in the previous section.

TRIPS TO THE USA

Visits are anticipated by Dr. Mohan and Mr. Thomas. The visits will begin in March and continue for approximately eleven weeks. Extensive travel is anticipated in the USA.

TRIPS TO INDIA

Negotiations are currently underway for the following trips of American scientists and solar experts:

Dr. Bernard Seraphin (from the Optical Sciences Center at the University of Arizona). He was to have visited Bangalore as part of a trip to Dacca for NSF. However, this possibility did not materialize. Dr. Seraphin has never been available when I called and has not returned my calls.

Mr. Bim Gupta (from the Solar Energy Research Institute). He is tentatively planning to visit Bangalore in the Spring.

Dr. Bannerot will probably not visit India until next winter, but this question is not yet decided.

I. LINEAR FOCUSING

Short Term Review of Concentrators

Completed as discussed previously.

Long Term Review of Concentrators

A new student has been added to the project. He will be responsible for this task. He will be visiting the Solar Division of Sandia

Laboratories in February for about a week to obtain a detailed update. Sandia has been the primary contributor to the development of linear focusing solar collectors. Documentation in the form of reports, papers and company literature will be collected.

Model Development

The model development is a direct outgrowth of the above task (Long Term Review of Concentrators). Sandia Laboratory has indicated that we will have access to all their performance simulation programs. The plan is to use the performance model developed in a design oriented algorithm to optimism the design of the hardware and the control strategy.

Testing Facilities (Review)

Mr. Thomas of the IIS will be coming to the USA in March. He will likely be responsible for the testing program in India. Therefore, I hope to include in his itinerary several solar test facilities. His first-hand exposure will be most beneficial. In addition, documentation will be gathered on the testing of collectors from all available sources.

II. SELECTIVE COATING

Arrangements will be made to accommodate Dr. Mohan's interests in selective coatings during his spring visit. He will visit the Optical Science Laboratory at the University of Arizona, SERI, the Physics Department at the University of Houston, as well as at least one industrial site.

III. NON-TRACKING

Optics

The activity described in the Progress on Objectives will be continued. The analysis of the Optics will probably continue through the summer.

Collector Design

The start of this task will probably be delayed until the next six-month period.

IV. THERMAL SYSTEM DESIGN

Tracking

A literature survey will begin to determine the availability of well-documented computer codes for this activity. It is expected that the interaction with Sandia Laboratories, mentioned previously will be very useful in this regard.

Non-Tracking

No activity was planned for this period.

V. FLAT PLATE THERMO-SYPHON SYSTEM DESIGN

The activity described previously in the Progress on Objectives section will be continued. Due to re-roofing of the Engineering Building, experimental work will be delayed until the summer.

VI. MATERIAL EVALUATION AND DEGRADATION

Mr. Thomas and Dr. Mohan will be exposed to the current U.S. activities related to materials development during their Spring visit. The Solar Energy Research Institute will probably be the best source of this type of information. In addition, they may individually visit selected material manufacturers and processors.

VII. AIR HEATERS TECHNOLOGY ASSESSMENT

The plan is to use a new student for this task. At present, however, none has been identified. Mr. Thomas has had some experience in this technology, and he may be visiting a few manufacturers during his visit.

VIII. EQUIPMENT SPECIFICATION

Contingent upon the approval of a change in the procurement responsibility, the University of Houston will begin the procurement process as soon as possible. Much of the equipment has been identified but additional work remains to be done.

IX. LITERATURE SURVEYS

This will continue as described previously.

VARIANCES FROM THE PROPOSED PLAN AND PROBLEMS

Minor deviations from the original time-line will likely occur during the January 1 to June 30 reporting period. These are detailed in the previous section and involve Tasks III, V and VII. The deviations will be minor delays in the start of work on the specific tasks due primarily to delays in staffing (a problem previously anticipated due to the fast "start-up" of the project).

No serious problems have developed nor are they anticipated. However, careful attention will have to be paid to the procurement and shipping of equipment to India. This task has just recently (and tentatively) been negotiated to the responsibility of the University of Houston.

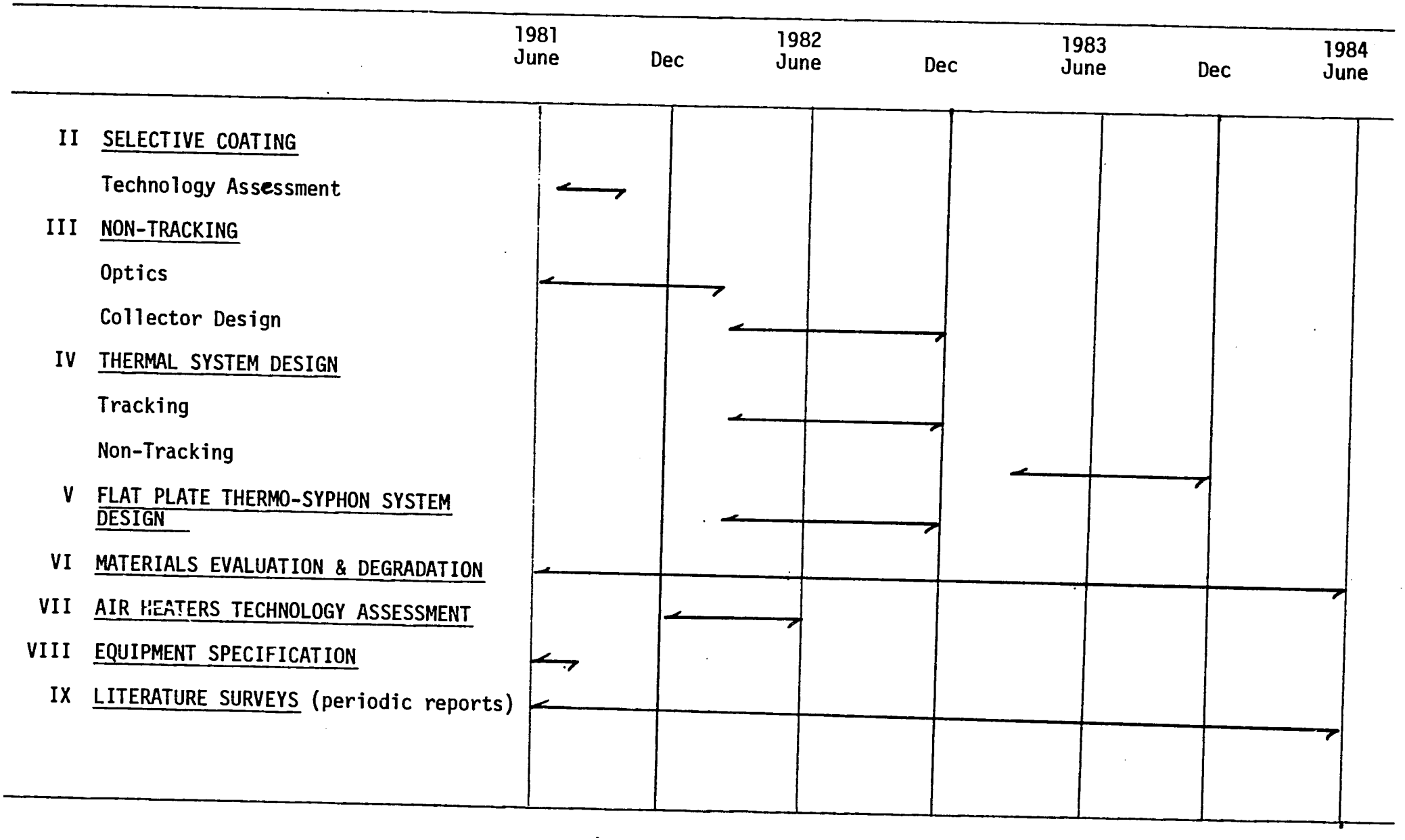
APPENDIX A

PROGRAM DESCRIPTION OUTLINE AND TIMELINE

INDO-US COLLABORATIVE PROJECT ON "MEDIUM TEMPERATURE, HIGH EFFICIENCY TRACKING AND NON-TRACKING SOLAR ENERGY COLLECTORS FOR RURAL AND INDUSTRIAL APPLICATION"

PROGRAM OF CENTRAL CAMPUS OF HOUSTON UNIVERSITY

	1981 June		Dec	1982 June		Dec	1983 June		Dec	1984 June
TRIPS										
to USA		1	2		3		4	5		
to INDIA	1					2			3	
REPORTS										
to AID (UH)			1	2		3	4		5	6
Voucher Submission (UH)	1	2	3	4	5	6	7	8	9 10	11 12 13
I LINEAR FOCUSING										
Short Term Review of Concentrators										
Long Term Review of Concentrators										
Model Development										
Testing Facilities (Review)										


1981 June
Dec
1982 June
Dec
1983 June
Dec
1984 June
II SELECTIVE COATING
Technology Assessment
III NON-TRACKING
Optics
Collector Design
IV THERMAL SYSTEM DESIGN
Tracking
Non-Tracking
V FLAT PLATE THERMO-SYPHON SYSTEM DESIGN
VI MATERIALS EVALUATION & DEGRADATION
VII AIR HEATERS TECHNOLOGY ASSESSMENT
VIII EQUIPMENT SPECIFICATION
IX LITERATURE SURVEYS (periodic reports)