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

FOURTH SEMI-ANNUAL REPORT

January, 1983 to June, 1983

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

FOURTH SEMI-ANNUAL REPORT

for the period 1 January 1983 to 30 June, 1983

submitted by

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July, 1983

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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

### Faculty Associates

Farrokh Mistree

Stanley J. Kleis

### Research Assistant

Gary Kwan (M.S.M.E. student) - 1 January, 1983 to 31 May, 1983

Halil M. Guven (Ph.D. student) - 1 January, 1983 to 30 June, 1983

S. Kumar (Ph.D. student) - 1 January, 1983 to 30 June, 1983

Y. Wu (M.S.M.E. Student) - 1 January, 1983 to 31 May, 1983

## PROGRESS ON OBJECTIVES

### OBJECTIVES FOR THE PERIOD 1 JANARY TO 30 JUNE 1983

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: No trips were taken during this reporting period. The extensive travel by Mr. Thomas and Dr. Mohan (see Second Semi-Annual Report) completed the objectives of most of the Indian travel planned in the U.S. It also exhausted the budget for this activity.

Dr. Bannerot has tentatively moved his planned December trip to India to August, 1983. This date will allow him to attend the International Solar Energy Society's "1983 Solar World Congress" in Perth Australia in August.

#### I. LINEAR FOCUSING

##### Short Term Review of Concentrators:

Previously completed.

##### Long Term Review of Concentrators:

Mr. Halil Guven is still maintaining the literature in this area.

##### Model Development:

Modeling of the optics of parabolic troughs is completed. The state-of-the-art optical model supplied by the Sandia National Laboratories has been modified and expanded to include the handling of several manufacture and operation errors. The Sandia model was originally developed for design studies for the U.S. design environment, and therefore it did not have provisions for analysis of gross errors that may be expected in developing countries. In its present form, the optical model can be used for design studies in both technically advanced and less advanced design environments. A report, documenting the optical model and discussing the optical design considerations of parabolic troughs for developing

country environments is near completion. An extensive review of the thermal design aspects of parabolic troughs has been completed. A technical report on this subject is planned.

Testing Facilities (Review):

Previously completed.

II. SELECTIVE COATING:

Technology Assessment

Previously completed.

III. NON-TRACKING OPTICS

Previously completed.

Collector Design:

No activity was performed in this time period.

IV. THERMAL SYSTEM DESIGN

Tracking

The hardware utilized in the U.S. was assessed by Mr. Thomas during his visit last spring. The main activity at the University will be in the procurement of some of this hardware for the project.

V. FLAT PLATE THERMO-SYPHON SYSTEM DESIGN

A laboratory experiment has been designed and is currently 80% complete which will be used in a study of storage tank design for use in solar thermo-syphon systems. In the laboratory set-up the solar input to the tank is simulated from a controlled hot water supply. Approximately 50 thermocouples will be used to determine the long term thermal stability of several tank designs for various charging and discharging cycles.

VI. MATERIALS EVALUATION AND DEGRADATION

No activity was performed for this time period.

VII. AIR HEATERS TECHNOLOGY ASSESSMENT

No activity was performed for this time period.

VIII. EQUIPMENT SPECIFICATION

Four purchase orders were issued during this reporting period:

International Technology Corp.	\$ 5,919.50
Glaverbel	9,011.00
Eppley Laboratory	7,776.00
Device and Services	<u>13,106.00</u>
	\$35,812.50

Three previous purchase orders:

MKS Instruments	\$ 1,754.00
Olympic Solar Corp.	4,903.76
Schott Optical Glass	<u>300.00</u>
	\$ 6,957.76

One additional request to purchase has been received and is being processed:

HYDRO-FLEX Corp.	\$6,999.60
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Total Expenditures plus encumbrance

LITERATURE SURVEYS

This activity continues. Periodic surveys are conducted throughout the project.

## 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

None are planned at this time.

### TRIPS TO INDIA

Dr. Bannerot will visit India in late August.

#### I. LINEAR FOCUSING

##### Short Term Review of Concentrators

Completed as discussed previously.

##### Long Term Review of Concentrators

Mr. Guven will be continuing this work at Houston.

##### Model Development

As the next phase of the work, a state-of-the-art optimization package is planned to be used to interface the optical and thermal aspects of the parabolic trough design with the environmental (local) design considerations, in order to obtain optimum collector designs for developing country environments. The aforementioned state-of-the-art optimization package is available on the University of Houston computing system. A major effort is underway to become familiar with and to make the best use of the package. It is believed that incorporation of this optimization package into the design methodology will facilitate the development of effective parabolic trough designs.

##### Testing Facilities (Review)

Completed as discussed previously.

#### II. SELECTIVE COATING

Completed as discussed previously.

III. NON-TRACKING

Optics

Completed as discussed previously.

Collector Design

Completed as discussed previously.

IV. THERMAL SYSTEM DESIGN

Tracking

This activity for the prototype system will take place mostly in India. Hardware procurement should be the main activity at the University of Houston.

Non-Tracking

No activity was planned for this period.

V. FLAT PLATE THERMO-SYPHON SYSTEM DESIGN

The experimental set up will be completed. Data will be obtained on the effect on tank thermal stratification of thermal charging and dischargings.

VI. MATERIAL EVALUATION AND DEGRADATION

Completed for the prototype development.

VII. AIR HEATERS TECHNOLOGY ASSESSMENT

No activity is planned at present.

VIII. EQUIPMENT SPECIFICATION

The University of Houston will continue the procurement process. The procedure will be that the IIS will prepare purchase requests which will start the importation clearance process in India. The purchase requests

will be sent to the University of Houston. The University will use them to prepare its own purchase request which will include shipment to India.

IX. LITERATURE SURVEYS

This will continue as described previously.

**APPENDIX A**

**PROGRAM DESCRIPTION OUTLINE AND TIMELINE**

## VARIANCES FROM THE PROPOSED PLAN AND PROBLEMS

Deviations from the original timeline will occur during the July 1 to December 31, 1983 reporting period. They have been mentioned in the previous section and involve Tasks III, V, VI and VII. There are delays in the work associated with Tasks III and V as previously reported. Also, as previously reported Task VI (Materials Evaluation) and Task VII (Air Heaters) have been dropped. These tasks had only a peripheral effect on the project. Task VI was to have taken place throughout the project (See Timeline in Appendix A) and involved the environmental degradation of solar materials. However, due to the reconstruction of a roof area previously used as a test bed at the UH and the subsequent ban on further use of the area, it now appears unlikely the task can be started. Air heating, directly from a solar input, is not considered to be one of the design alternatives considered at this point. Therefore, there is no need to study it at this point.

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		1982		1983		1984
		June	Dec	June	Dec	June	Dec	June
<u>TRIPS</u>								
	to USA	1	2	3	4	5		
	to INDIA	1			2		3	
<u>REPORTS</u>								
	to AID (UH)		1	2	3	4	5	6
	Voucher Submission (UH)	1	2	3	4	5	6	7
<u>I LINEAR FOCUSING</u>								
	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 <u>SELECTIVE COATING</u>							
Technology Assessment	←						
III <u>NON-TRACKING</u>							
Optics	←	→					
Collector Design			←	→			
IV <u>THERMAL SYSTEM DESIGN</u>							
Tracking			←	→			
Non-Tracking					←	→	
V <u>FLAT PLATE THERMO-SYPHON SYSTEM DESIGN</u>			←	→			
VI <u>MATERIALS EVALUATION &amp; DEGRADATION</u>	←						→
VII <u>AIR HEATERS TECHNOLOGY ASSESSMENT</u>		←	→				
VIII <u>EQUIPMENT SPECIFICATION</u>	←						
IX <u>LITERATURE SURVEYS (periodic reports)</u>	←						→