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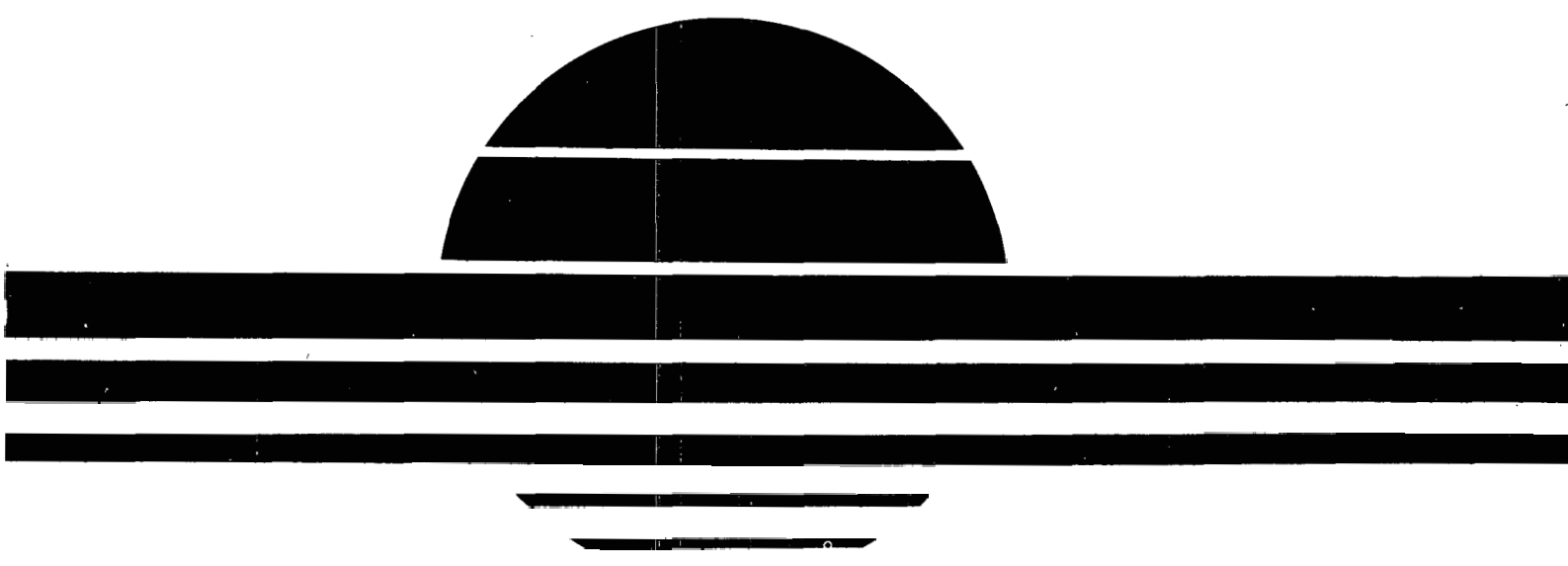
SOLAR HEATING AND COOLING COMMERCIALIZATION RESEARCH PROGRAM

By
David L. Christensen
William Tragert
Sue Weir

November 1979

Work Performed Under Contract No. EM-78-S-01-4218

The University of Alabama in Huntsville
The Kenneth E. Johnson Environmental and Energy Center
Huntsville, Alabama



U.S. Department of Energy

Solar Energy

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Huntsville, Alabama 35807

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Senior Research Associate
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DOE Contract EM-78-S-01-4218

DISCLAIMER

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PREFACE

The Solar Heating and Cooling Commercialization Research Program has addressed a recognized need to accelerate the commercialization of solar products. The development of communication techniques and materials for a target group of heating, ventilating and air-conditioning (HVAC) wholesalers and distributors has been the primary effort of this contract.

The following report presents a summary of the program, the approach to the development of the techniques and materials, the conclusions derived from seminar feedback, the development of additional research activities and reports and the recommendations for follow-on activities. The appendices offer detailed information on specific elements of the research effort.

EXECUTIVE SUMMARY

The growth and future of our nation is directly linked to the availability of clean, safe, and abundant energy resources. Solar energy has been shown to be a major potential candidate to fill the role as a renewable source to meet our energy needs.

The Residential and Commercial Solar Heating and Cooling Demonstration Programs, as well as numerous Federal and state tax-credit or incentive programs have helped to reveal solar energy to the public as an attractive and viable alternative to fossil fuels. These demonstration programs have heightened consumer interest and have stimulated manufacturers to initiate in-house research and development programs to develop or improve solar products. This effort to improve equipment quality provides the consumer with more efficient and reliable products and services. Also, the demonstration programs and private developments have provided needed experience for architects, engineers, and installers to apply solar energy to meet our energy needs for buildings. These experiences are vital for expanding future markets.

Despite these recent improvements, an organized, operational system of distribution from manufacturer to user is lacking. A need exists for concise technical and market information that can be used by heating, ventilating and air conditioning (HVAC) wholesalers and distributors, particularly at the local and regional levels. The University of Alabama in Huntsville (UAH) Solar Heating and Cooling Commercialization Research Program, under Department of Energy (DOE Contract EM-78-S-01-4218), has addressed this need of accelerating the normal process of new product introduction and acceptance, which can more rapidly stimulate the commercialization of solar-energy equipment. The development of informational materials and techniques to assist key personnel in the market-development process is a critical part of this pilot program.

Results of the pilot program need to be applied to regional locations for further development and refinement and to meet local needs. A "solar specialist" program to meet the needs of various wholesaler and distributor organizations should also be established on a regional basis. This expanded activity is in agreement with the overall objectives of the national solar energy program.

The existing national network of HVAC wholesalers and distributors offers the new and innovative solar technologies an established, compatible, and convenient way to "go to market." A conduit to and a valuable information resource for the installer and consumer, the wholesaler/distributor is the critical link between the manufacturer and the designer. This channel is a fully-organized structure which is vital to the process of introducing new products. Developing new networks will be very expensive and time-consuming; therefore the most efficient and effective delivery system is through the existing, historic route for HVAC products, namely the wholesaler/distributor.

Based on these premises, this study has endeavored to accelerate solar commercialization by bolstering the existing HVAC-wholesaler/distributor market sector. This strategy capitalizes on the readiness of the sector and uses the expertise of the industry's national associations.

As an experienced energy research and development organization, it has not been necessary for the UAH and its supporting team members to invest needless time to develop skills for assessing the needs of the marketplace. The basic objective of the program has been to develop the communication materials to stimulate the awareness and interests of the wholesaler/distributor. The materials have been developed, field-tested and evaluated by HVAC industry leaders. The program has been organized to:

- Analyze the existing HVAC-market infrastructure by identifying the individuals and firms involved and assessing their receptiveness to solar products. Market leaders of the major geographical areas have been identified and involved in development of the materials

- Identify the information needs of leading HVAC trade organizations as a means of establishing the generation and exchange of marketing aids and information

- Produce information and prepare materials designed to heighten HVAC-vendor awareness of solar-energy systems and products

- Design and conduct seminars to acquaint participating HVAC organizations and personnel with solar-energy products, and to gain their confidence

- Solicit opinions and feedback from the seminar participants to refine and improve the materials and programs for subsequent widespread use within local HVAC industries

Five seminars have been conducted at major cities throughout the nation. The locations have been chosen for their unique geographic and climatic conditions, and for their ability to provide the program with a representative cross section of HVAC wholesalers and distributors. Each location represents a major market with distinct requirements for solar-energy use.

The seminars have attempted to secure an accurate account of the present state of solar-energy commercialization within each locality; to identify the major obstacles confronting wholesalers and distributors; and to initiate the spread of solar product information. Participants have been key members in HVAC organizations whose feedback most effectively represents the impact of solar-energy products on HVAC markets.

Special presentation materials have been developed for the seminars, including an oral presentation, augmented by visual aids, to present important solar

fundamentals and concepts to participants. Literature on the application of solar-energy equipment has been carefully designed in a looseleaf manual or handbook format to simplify the selection and installation of solar hardware by the contractors. The HVAC contractor looks to the wholesaler/distributor for guidance, therefore, the familiar "counterbook" is normally used by wholesalers to make product information and background technology available. Unfamiliarity with solar-energy terms and concepts can be significantly reduced by putting a document of solar-energy fundamentals and hardware descriptions into the salesmen's hands. A solar-energy systems manual was developed under the contract to help increase customer receptiveness and which consequently could increase the sales of solar equipment.

Participating HVAC representatives have been encouraged to respond to the seminar and the supporting materials. At the completion of each pilot seminar, each individual has been asked to complete a questionnaire concerning the following topics:

- Current knowledge of existing solar-marketing activity within HVAC organizations
- Appropriateness of the form and content of the seminar
- Adequacy of the presentations and audio-visual materials

The responses have shown that HVAC wholesalers and distributors have a number of key concerns and needs, as well as opinions, on the marketing of solar products. These include:

- Active solar-energy systems should be marketed through the HVAC industry
- Development of the solar market can be accelerated by using more economic incentives, widespread use of local seminars, and "solar specialist" instruction
- Additional background and instructional materials need to be developed for air-heating and passive solar energy systems
- More information is needed on system sizing, performance, troubleshooting, and economics
- Solar-energy systems or components should be sold in the usual way by advertising and direct sales
- Component-performance information should be provided by manufacturers
- Solar-system financing should be handled through bank loans, construction loans, etc. Federally guaranteed, low-interest rates would be useful

- Solar-equipment guarantees should be comparable to those of conventional HVAC equipment

In evaluating the needs of wholesalers and distributors for state-of-the-art design and cost information, it was determined that a strong interest was apparent in the potential use of prepackaged and modular solar energy systems and subsystems. This interest was based on the need for improvements in overall reliability and reductions in installation costs. Consequently, a study effort was initiated to evaluate the status of that activity in the solar industry. The results of this study of industrial cost reduction techniques are given in Appendix H.

This study revealed that certain design techniques and installation practices, which are presently improving system performance and cost effectiveness, should be given broader impetus. Examples of techniques and practices are: component and subsystem standardization, prepackaging, modularization, metrication and use of Federal procurement leverage.

A subsequent program is now under way to provide more in-depth evaluations of the need and potential applications of various methods for reducing system costs and improving overall system performance and reliability.

INTRODUCTION

"There is nothing new under the sun" is a statement as old as solar technology itself. Utilizing what is "under the sun" in an effective and efficient manner is the "new" of the solar energy development program of today. With solar technology adequately developed, it becomes imperative that it be commercially applied as soon as possible.

There has been some general confusion at the marketing level of solar energy products because of the haphazard and sporadic growth in solar energy utilization. This confusion has revealed a need for concise information in terms that are understood by heating, ventilating and air-conditioning (HVAC), wholesalers and distributors.

The Johnson Environmental and Energy Center (JEEC) of The University of Alabama in Huntsville is supporting the National Solar Heating and Cooling Demonstration Program by providing assessment and development of technical information programs and audio-visual materials to aid in the commercialization of solar-energy.

Initiated in August, 1978, a study entitled "Solar Heating and Cooling Commercialization Research Program," has developed into an extensive research and supporting activity. Basic contractual efforts have included the identification of solar market channels, a survey of available promotional and orientation materials, analysis of the needs of wholesalers and distributors of HVAC equipment, and the development of specialized materials to meet those needs.

After careful analysis of available educational materials which have been used at seminars in five major cities, UAH has originated a display, systems manual, and slide presentation. Feedback from these seminars and others has been analyzed and has formed the basis of the specific conclusions and recommendations for follow-on activities.

The five basic tasks of this effort include:

- Support of the National Solar Heating and Cooling Demonstration Program by providing assessment and development of programs and materials to aid in the widespread commercialization of solar-energy heating and cooling technology
- Provision of basic information materials for selected solar-energy equipment wholesaler and dealer participants
- Sponsoring of seminars at various locations throughout the country to help evaluate the usefulness of the basic information packages
- Analysis of review comments from wholesaler and dealer participants to further meet their actual needs
- Preparation of additional planning for the follow-on activities based on Phase I program results

As an experienced solar-research team, UAH has drawn upon an extensive research base and has applied this understanding to these contractual efforts. Assumptions that have been based on this broad-research background are as follows:

- The existing national network of HVAC wholesalers and distributors offers the new solar technologies an established distribution channel
- The HVAC wholesaler/distributor is a conduit to and a valuable information source for the installer and the consumer
- The wholesaler/distributor is the critical link between manufacturer and installer
- The wholesaler/distributor channel is vital to introducing new products
- Developing new networks will be expensive and time-consuming
- The most efficient and effective delivery system for solar products is through the existing, historic route for HVAC products

Based on these assumptions, UAH has determined that the most effective method for accelerating commercialization is to capitalize on the readiness of the wholesaler/distributor sector and use the expertise of the industry's national associations.

UAH's basic role has been to develop the communication materials to stimulate the awareness and interests of the HVAC wholesalers and distributors. These materials have been field-tested and evaluated by HVAC industry leaders.

The importance and substance of the program can best be understood by the subjective responses to a questionnaire submitted by attendees of the seminar. These statements reveal the level of awareness and interest at the wholesaler and distributor level and indicate the areas in which the commercialization program should be focused.

Several outgrowths have also resulted from this project including "A List of Solar Energy Training Programs for Installation, Maintenance and Repair", a review of solar-energy short courses, a listing of solar-energy information sources and selected bibliography, an international marketing study, and a study of modular and prepackaged systems.

APPROACH

The basic approach to determining the needs of the wholesaler and distributor of solar-energy systems and products in promoting their commercialization has been to first survey the field and then to develop requisite materials.

Initially, it has been necessary to study the current market channels through which such products move. This effort necessitated interviews with representatives of selected companies and collation and assessment of their opinions on the most effective channels of distribution. For further details, see Appendix A. HVAC trade associations have been contacted for additional information and opinions. The input from these national associations has been instrumental in developing surveys, determining problems and developing strategies. These in-

puts helped in the identification of HVAC members' information needs and in the analysis of the HVAC-market infrastructure. Types of individuals and firms involved have been identified and their receptiveness to solar products has been assessed. The expertise of the identified market leaders has been utilized in the material development. A list of these organizations is given in Appendix B.

Research on available courses for the installation and maintenance of solar-energy systems and components has involved contacting numerous educational institutions, soliciting their course materials, and evaluating these materials as to their utility and applicability to the development of key materials for seminar presentation. For a list of these materials, see Appendix C.

The information produced and the prepared materials have been designed to heighten the wholesalers' and distributors' awareness of solar-energy systems and products. When working in the area of information dissemination, it becomes readily apparent that the quality of presentational materials is of utmost importance. A motivational program is indeed a marketing adventure; therefore, the marketing tools are decisively influential when promoting a new concept or idea. Although solar-energy is not new, solar-energy commercialization is relatively new in the HVAC industry; and it must be sold to the wholesaler and distributor as well as to the public or consumer.

The brochure, display, manual and slide presentation developed by UAH under this contract has brought and will continue to bring much attention to the solar commercialization program. In addition to the attention these materials draw, they are a useful means of presenting the basic fundamentals of solar-energy and promoting its application. They are also flexible and have broad application. Their utility will not lessen with time. Advancements in the state-of-the-art can be easily incorporated so that the materials do not become obsolete.

The "Getting Ready" Brochure is an eye-catching pamphlet promoting solar commercialization among HVAC wholesalers and distributors. It introduces the program with a vivid, graphic cover setting the "Getting Ready" theme. The text is bold, direct, and focuses on the purpose of the solar commercialization program. Stylistic caricatures of a typical HVAC wholesaler or distributor lead the reader through the "What, Who, How, When and Where" of the subject. "Future Goals and Objectives" summarizes the "Getting Ready" purpose, and additional pertinent articles are included to stimulate the reader's interest. A copy of the brochure is included as Appendix D.

The "Getting Ready" display is a visual presentation stressing the theme of the solar commercialization program. It conveys the message of the energy of the sun as an alternative resource. A rear projection screen shows a continuous slide presentation of pertinent solar projects and information. The 80-slide sequence includes an explanation of the commercialization program. Additionally, it can be modified to incorporate slides that are of special interest to a particular audience.

The display was used at the pilot seminars and other conventions and exhibitions including the national ASHRAE convention in Philadelphia in January, 1978. It is completely portable, consisting of a matrix of metal rods that frame fiberboard blocks. It is stored in fiberboard boxes that form the base for the display. A picture of the display is provided in Appendix E.

A slide package has been developed to enhance the effectiveness of the presentation. The "Getting Ready" theme once again is used to introduce the presentation and incorporates the objectives and purpose of the program. Each graphic illustration of the text is complimented with a corresponding slide. Technical data, such as system and subsystem schematics, is presented in a three-dimensional format. Each visual aid is clear and concise. More complex concepts such as sun angles, solar parameters, loss factors, collector efficiencies, etc. are more readily explained and understood through these innovative graphics. The professional quality of the slide package creates an interesting, as well as informative, presentation.

The Solar Energy Systems Manual developed by JEEC is a concise presentation of essential solar information needed by the wholesaler and distributor. It is presented in a loose-leaf binder that is easily identifiable among the many books and catalogs common among wholesalers and distributors. The "counterbook" is the normal method used by wholesalers/distributors for product and technological reference. This "solar-counterbook" can reduce unfamiliarity of terms and concepts by putting solar-energy fundamentals and hardware descriptions into the salesmen's hands.

The format and organization of the manual is designed to reduce the overwhelming volume of available information into precise, understandable, and usable terms. This should allow the wholesaler and distributor to transact solar sales more efficiently, especially among customers not familiar with the technology or its systems and products.

The manual emphasizes liquid solar energy systems and is divided into the following sections:

- Systems
- Subsystems
  - Collector
  - Storage
  - Transport
- Components
- Basic sizing concepts
- Component selection criteria
- Installation guidelines
- Regional performance

Color-coded tabs make reference to individual sections easy and quick. The text has been developed and presented in a manner that is compatible with existing HVAC technology and terminology. It describes generic (liquid) systems and subsystems without bias to a particular system or design.

The questionnaire for seminar attendees has been designed to obtain as much usable feedback as possible without unduly burdening the participant. The topics that have been covered are as follows:

- Current knowledge of existing solar-marketing activity within HVAC organizations
- Form and content of the seminars
- Adequacy of the presentations and audio-visual materials

Most questions require only a circled yes or no answer. Subjective questions are phrased to be answered with a minimum of words.

Time has been allotted at the end of seminars for completing the questionnaires and their collection. THe information has been analyzed both quantitatively and subjectively. The questionnaire has been fundamental in evaluating the materials and presentation and in obtaining information for refinement and further development of the seminar materials. A copy of the questionnaire is given in Appendix F.

Five pilot, solar-energy commercialization seminars have been held at selected locations. Each of the five cities have represented geographic areas with existing well-developed HVAC market channels, but each has distinct requirements for solar-energy product use, usually determined by type of climate, fuel and utility costs, and building-energy needs.

Each pilot seminar has assembled a representative cross-section of HVAC wholesalers and distributors. The seminars have attempted to secure an accurate account of the present state of solar-energy commercialization within each locality; to identify the major obstacles confronting wholesaler and distributor efforts to commercialize solar products in existing HVAC market channels; and to initiate the spread of solar product information compatible with the existing information and technology.

In choosing seminar participants, efforts have been made to select key members of HVAC organizations, preferably middle and upper-level management personnel with a degree of decision over new product introduction. In addition, participants have been chosen whose feedback most effectively represents the impact of solar-energy products on HVAC markets. Participants have also been chosen who would directly benefit from the seminar.

The seminars have been held at the following locations:

- 16 Jan 79 — Airport Marina Hotel
Dallas, Texas
- 17 Jan 79 — Wilshire Hyatt Hotel
Los Angeles, California
- 23 Jan 79 — Admiral Benbow Inn
Tampa, Florida
- 6 Feb 79 — Sheraton Oak-Brook
Chicago, Illinois
- 21 Feb 79 — 60 East Club
New York, New York

KTA-NPD Energy Systems, a subcontractor to JEEC, has been responsible for seminar coordination, meeting arrangements and participant accommodations. Each participant has been a local HVAC sales or marketing agent who has a knowledge of prominent organizations and individuals within his region.

Because participants have had varying experience with solar hardware, an introduction to basic solar principles has been presented to establish a common ground for discussion and feedback. Every attempt has been made to keep the presentation informal and to encourage maximum group participation, including spontaneous comments and questions.

The basic seminar agenda for each location is as follows:

8:30 A.M.	Refreshments
8:50 A.M.	Introductory remarks
9:00 A.M.	Principles of solar-energy
10:30 A.M.	Open break
10:40 A.M.	Manual and slide review of subsystem configurations
12:00 Noon	Luncheon and discussion
1:00 P.M.	Manual and slide review of systems, components, sizing, and selection criteria
2:30 P.M.	Open break
2:40 P.M.	Discussion of product warranty and liability
3:30 P.M.	Explanation of questionnaire and concluding comments

Appendix G provides a complete list of the pilot seminar attendees.

RESULTS

The following summary provides responses from the seminar discussions and related questionnaires. The dominant impression is that all participants strongly believe that active solar-energy systems should be marketed and distributed through normal HVAC channels and should be handled as other items of HVAC equipment. Comparisons are repeatedly made between refrigeration equipment and solar-energy equipment. The HVAC industry has over the years demonstrated that the specialized knowledge required for refrigeration is not a deterrent to successful marketing. The consensus is that three criteria govern the commercialization of solar energy:

- A ready market
- Availability of high quality reliable equipment
- Indoctrination of HVAC industry personnel in solar applications

The majority of respondees indicated that these criteria have not yet been met and that the role of government in solar-energy commercialization should be one of stimulation rather than concern for prescriptive standards. The general impression of the wholesalers' philosophy is that the HVAC industry is self-regulating and, if given government support in strategic areas, it will meet the market needs. Dealing with each of the criteria in turn, the major suggestions for government support are:

Ready market

- Provide realistic economic incentives for solar energy
- Foster a positive attitude toward solar energy
- Remove restrictive codes that mandate against solar energy
- Provide indoctrinational material and seminars for potential residential, commercial, and industrial customers

Availability of equipment

- Apart from government-development grants to manufacturers and government-sponsored demonstration projects, the government should not be heavily involved, as equipment quality and reliability will improve by natural selection as based upon market-place pressures

Indoctrination of HVAC personnel

- Provide informational material, guidelines, and seminars tailored to the various levels of the HVAC industry, i.e., manufacturers, representatives, wholesalers, and contractors

The need for indoctrination and orientation in all facets of solar-energy technology has been raised repeatedly. This activity is obviously a key factor in solar-energy commercialization, and it is evident that there is need for specialized information that is not being met.

A major concern of this sector is the economics of solar energy. Economic worth arises as a topic in most discussions. Simple or compound pay back is not favored as a means of defining solar economics. There is a clear need for an economic model that can be used both to compare systems for selection and to define the economic worth of a system. This model should be in the form of simple to use nomographs, but should account for all major variables. The output most desired is positive or negative cash flow.

A synopsis of the needs and concerns of the seminar participants is given below in order of priority. Priorities are allocated on the basis of the numerical incidence of topics and the degree of emphasis it is given.

- Active solar-energy systems should be marketed through the HVAC industry
- The solar market should be developed through available information resources and economic incentives
- A particular need exists for information on system sizing, system performance, trouble-shooting and overall system economics
- Solar-energy systems and components should be sold in the usual way through all forms of advertising and direct sales
- Component performance information should be provided by manufacturers
- Solar system financing should be supported through bank loans, construction loans, etc. Federally guaranteed low-interest rates would help
- Guarantees should equate with those for other accepted HVAC equipment

Other responses from wholesalers and distributors indicated that they:

- Do not have sufficient information about manufacturers of solar equipment
- Would like to receive information through seminars and trade publications
- Need system sizing charts, performance specifications, trouble-shooting guides, installation manuals, list of solar products and pricing of information
- Believe the best way to get information is from the manufacturers
- Think the best way to disseminate information to prospects is by wholesaler initiative, direct mailing, trade publications, direct sales calls, national solar programs and wholesale sponsored training programs
- Are aware of salable solar equipment and are unsure whether it is reliable and cost effective
- Believe solar energy equipment should be improved by meeting standards, and improving testing and quality.
- Have received requests for solar equipment
- Do not have sufficient climatic data to understand solar potential
- Vary in their use of the ASHRAE guide and related materials
- Are not aware of interference of building codes with solar equipment or of problems with permit requirements
- Think that components should be standardized to some degree
- Believe the domestic market is not ready for metric units

- Believe an informed public is most important in accelerating commercialization
- Believe the seminars are beneficial and successful
- Would like to have the presentation material one week before the seminar which also contained a detailed section on methods of cost analysis.

ADDITIONAL INFORMATION

In addition to the information derived from the seminar activities, the development of related materials, and the responses to the questionnaires, other useful data have been accrued as a result of the contract. These include a list of pertinent trade associations (Appendix B), a list of courses useful in solar energy indoctrination and orientation (Appendix C), and the development of many key contacts throughout the country with an interest in this program.

Studies were also made as a part of the overall commercialization research effort to investigate the development of standardized and prepackaged solar-energy subsystems and systems. This activity was performed to evaluate possible cost reduction methods needed to improve the domestic and international commercialization of solar-energy products. A report was prepared by the research team which incorporates design concepts, system cost comparisons, conceptual guidelines, and recommendations for expanding the use of modular and prepackaged solar-energy systems. This report is attached as Appendix H.

Other activities included the development of model code information packages, evaluation of solar export programs, and studies related to export of U.S. solar products to lesser developed countries.

RECOMMENDATIONS

Based on the information and data generated by the Solar Heating and Cooling Commercialization Research Program, and further study in related areas, the following recommendations are submitted:

- Assess in greater depth, the status and needs of the wholesale/distributor market channel to improve solar product sales
- Develop regional pilot programs to further test and develop the available materials within the four solar energy regions
- Expand the seminar programs to local levels, working closely with the regional solar energy centers and with technical and industrial organizations
- Expand the development of information materials to include a solar energy factbook, and materials to cover air heating, and passive heating and cooling systems.
- Incorporate solar-assisted heat pumps and other available solar technologies into the next phase of the program.

- Develop the "solar specialist" program including additional information and technical training activities to meet the needs of this market sector

- Consider the various recommendations to improve cost reduction techniques as described in Appendix H (Cost Reduction Recommendations for the Solar Energy Industry)

APPENDIX A

SOLAR MARKETING CHANNELS

The programmatic stimulus applied by the DOE to the relatively new solar industry in the years following 1976 has generated increasing interest and expectation among producers and potential users of solar equipment. The DOE commercialization demonstration program has provided participating architects, engineers, and major mechanical contractors with a degree of expertise to assist them in the selection and installation of available solar equipment.

However, the small mechanical contractor, the building tradesman, and the consumer have not gained such expertise. In fact, the normal channel of application information for this segment of the HVAC market has remained largely dormant during this period of market formation. The HVAC wholesaler and distributor generally have not accepted solar equipment as technically mature or economically feasible. This situation has been a negative factor in the development of the solar market.

The program of orientation that constitutes the major feature of the present program has been designed to remedy this weakness. By developing an awareness of solar hardware and its application among wholesalers and industrial leaders, this program has generated in the industry a receptive attitude that was previously absent.

The application literature, which is also a product of the program, has been designed to facilitate the selection and application of solar hardware at the installing contractor level. The use of counter-books has been a customary method of making product information and background technology available at the wholesaler's counter. By putting solar energy fundamentals and generic descriptions of solar hardware in the form of an indexed book at the counter salesman's fingertips, another barrier to market growth and unfamiliarity with solar energy terms and concepts has been significantly reduced.

The solar marketing channels are identified as:

1. Manufacturers usually deal with general contractors who are engaged in "plan and build" practice, through an independent agent or representative.

2. Manufacturers generally deal with larger general contractors on a factory-direct basis with selling service performed by in-house specialists or regional salesmen.

3. In some cases, a manufacturer deals with the wholesaler through a manufacturer's agent or representative.

4. The manufacturer often sells directly to a wholesaler who may or may not stock the product.

5. The larger general contractor often has the in-house capability of the mechanical contractor and thus directly interfaces with the ultimate purchaser.

6. The wholesaler supplies the smaller general contractor as well as the one who has no direct factory connection.

7. The over-the-counter sale by a wholesaler is usually made to a mechanical contractor.

8. The general contractor who does not have in-house mechanical capability usually subcontracts with a mechanical contractor for installation work.

9. The mechanical contractor is in most instances the ultimate conveyor of the equipment to the purchaser.

10. The retailer may or may not install the product for the purchaser.

11. The generic identification of Purchaser includes the homeowner, developer, builder, and commercial or industrial owner.

These interrelationships are shown graphically in Fig. 1.

Marketing channels for solar products are still in the process of being established. Manufacturers are searching for the best way to market and distribute their products. Companies of various sizes are experimenting with many different channels, but the channel most used is the independent wholesaler.

Members of the channel generally agree that solar commercialization is dependent on consumer "pull". They feel that this consumer pull can only be developed by mass education of the public with emphasis on the economics of solar. The successful commercialization of solar is very dependent on the physical location of the market and its environment, both physically and economically.

Following are sample reviews of the marketing strategies of selected companies.

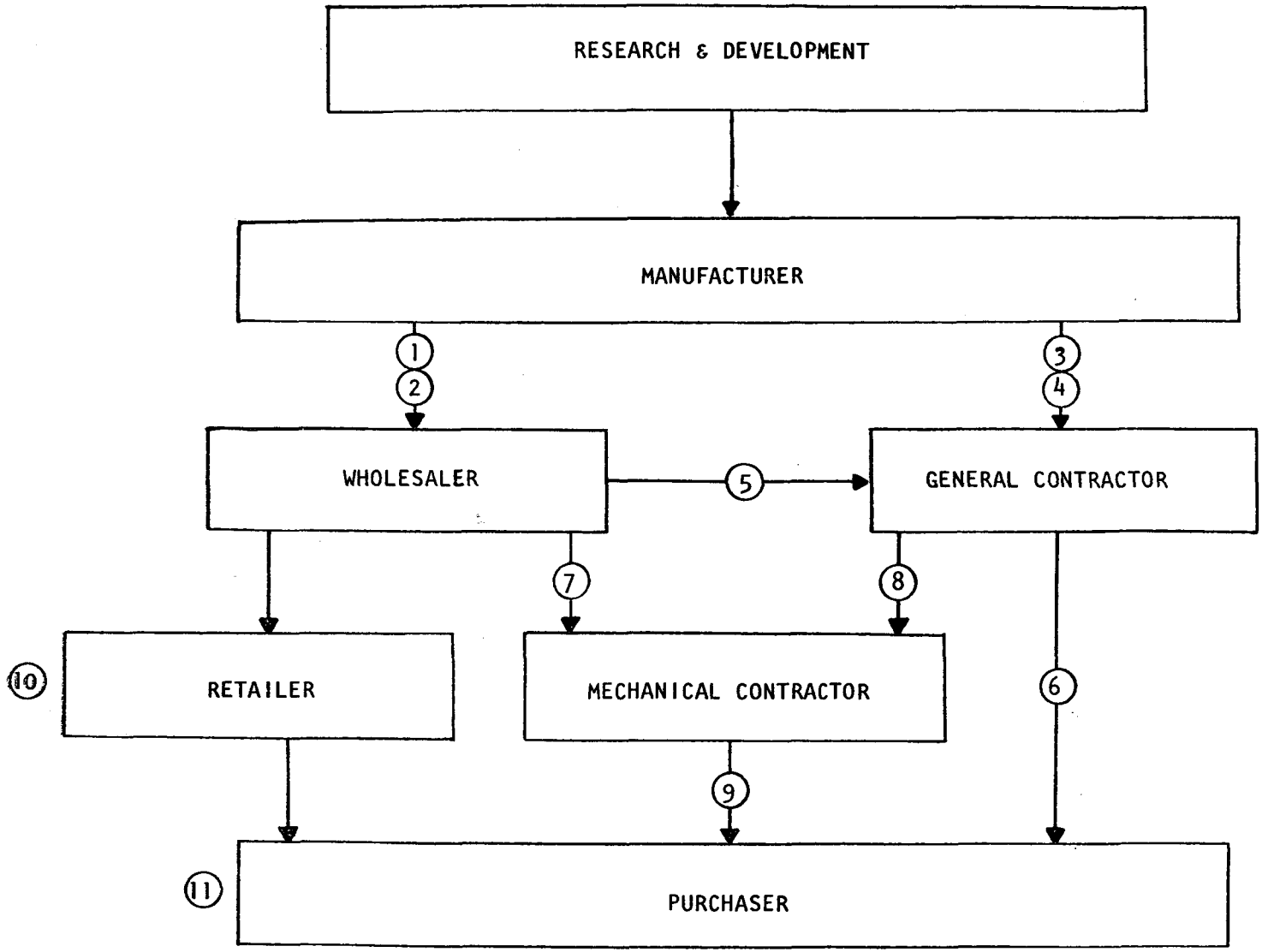


FIGURE 1 - MARKETING CHANNELS FOR SOLAR EQUIPMENT

State Industries
Ashland, Tennessee 37015
Contact: Frances Hooper
Janice Farmer

State Industries is a large manufacturer of water heaters and heating and air-conditioning equipment. It manufacturers the Solarcraft System for solar hot water. State uses the manufacturer-independent wholesaler/distributor consumer channel and manufactures under a private label for Sears. It conducts an extensive training program for the installation of the Solarcraft System.

All promotion and advertising is handled by the wholesaler/distributor although State provides advertising materials. The wholesaler normally advertises in trade journals and at trade shows. State maintains mobile displays (vans) with demonstration systems. The company promotes by contacting builders, plumbers, architects, designers and engineers. Jim Benton of Jim Benton and Associates states, "The independent wholesaler is the 'only' way to market solar. Only 25% of the plumbers are receptive to solar at this time, so solar must be 'pushed' through the channel by a wholesaler who can personally contact those people making the decision."

Sears is test marketing the private labeled State solar hot water heater in Tampa, Memphis, Columbus, Houston, Hawaii, and Washington, D.C. Sears has installed a demonstration system on the home of solar marketing representatives in these cities. The system is sold as a package including water heater, solar panels and installation/tilt kits. They are selling best in Hawaii.

Mr. Kirby, Marketing Manager of Sears in Memphis, states that the solar hot water heater is not selling in Memphis. He blames this on the low TVA utility rates and the amount of solar energy available in that area. "The payback period is running 20-24 years at this time and a customer will not invest in it at this rate. We are also 'batting heads' with TVA in their incentive program allowing the homeowner to borrow money for the installation of solar. They are selling the end product instead of us. We cannot compete." The demonstration unit is the only operational Sears unit in Memphis and is proving to be efficient, but the consumer still must ask "what am I going to save during this warranty period?" The warranty period varies for each component, but runs up to 10 years on the water heater.

The Memphis Sears is promoting only through the newspaper. The six test markets are strictly controlled by Sears headquarters and are told how to promote, price, etc. All test markets must adhere to their individual test guidelines.

"The market today is through the wholesaler/distributor, but in my opinion, the only successful commercialization of solar will be through the retailer," Mr. Kirby said. He explained, "The wholesaler is not 'pushing'solar. He does not talk to the homebuyer and the homebuyer is the final consumer. Wholesalers talk to builders. Solar must be "pulled" through the channel by the final consumer and the final consumer, the homebuyer, needs person to person contact in order to understand and desire solar. This is best done by the retailer!"

Sears is the only large retailer involved in solar and they are only test marketing. When all data from the test market is complete, Sears will decide pro or con on marketing solar. The retailer will push and promote for a profit, so solar must be profitable to be promoted. It must show a payback. Mr. Kirby's personal opinion is, "there is a future in solar, but it will depend on the cost of utilities and the availability of other energy sources. Sears would like to be in it full force, but only if it is profitable and it can't be profitable if government competes with the retailer in selling the end product. Utilities should sell energy; the retailer should sell the equipment."

Sears started test marketing in November 1978 and planned to run the test for one year. Mr. Kirby said that he will pull his solar display off the market at the end of six months if sales don't increase within the next two months.

It might be noted that wood-burning stoves are selling very well at the Memphis Sears and Mr. Kirby plans to continue with this profitable and popular product.

The following are the six test markets:

1. Tampa - Bob White
   (813)870-2400
2. Hawaii - Mack Asakura
   (808)487-4255
3. Houston - Bill Young
   (713)527-2435
4. Memphis - Robert Kirby
   (901)725-3405
5. Washington - Dick Demert
   (301)469-4513
6. Columbus - O.D. Riley
   (614)251-6005

State Industries uses the following marketing channels:

Wholesaler for Alabama for State Industries:

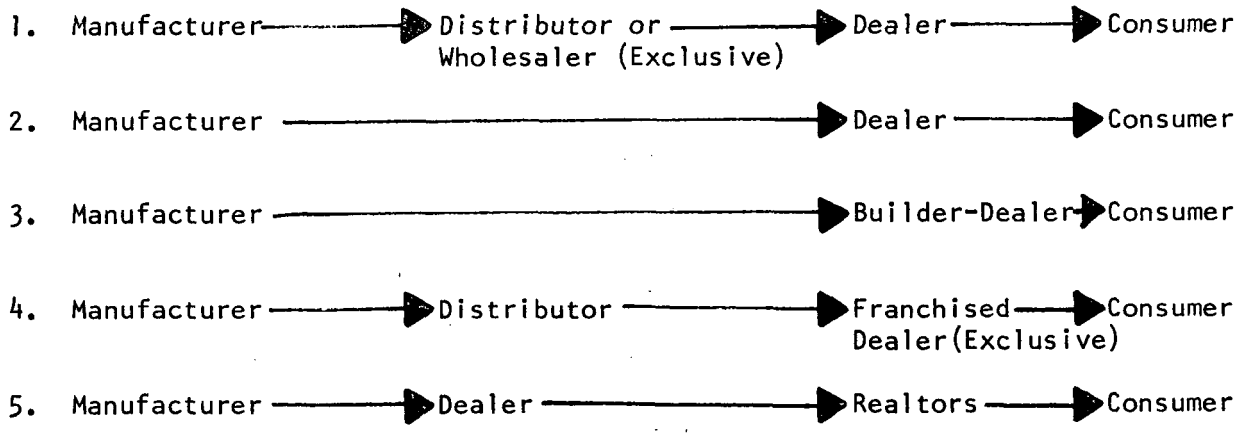
Jim Benton and Associates
1449 Panarama
Birmingham, Alabama
(205)942-1668

Solar Unlimited
Huntsville, Alabama
Contact: Don Bowden

Solar Unlimited is a small, new manufacturing company dealing only in solar products. It has tried various marketing methods to arrive at the most successful means of distribution and sales strategy. The manufacturer-to-dealer channel did not prove to be the most efficient, as the manufacturer's representative had too much territory to cover and did not have effective contacts throughout his territory.

The manufacturer-distributor-dealer channel has proven to be more successful. Distributors have protected territories. Dealers' territories are not protected unless contracted under a franchise. The dealers originate from differing occupations including plumbing, heating and air conditioning, and solar installation. Manufacturing is by "job order" only. Incentive plans include services provided by the manufacturer for a minimum investment in product. Most product is sold on a system basis.

The various channels being used are as follows:



Energy Systems
San Diego, California
Contact: Terry Caster

Energy Systems markets its solar products through the following channels:

1. Manufacturer → Distributor → Dealer → Consumer
   Manufacturer Rep.
   Wholesaler

2. Manufacturer → Dealers → Insulation Company → Builder → Consumer

3. Manufacturer → Insulation Company → Builder → Consumer

4. Manufacturer → Dealer → Contractor → Consumer

It uses the manufacturer-dealer channel in California, Arizona, Colorado and Hawaii and the manufacturer-distributor channel in the remaining parts of the country. The company has established a training course in Los Angeles.

Honeywell Inc.
Honeywell Plaza
Minneapolis, Minnesota 55408
Contact: Roger A. Hammer

Honeywell is a large manufacturing company. Its involvement in solar products is limited to controls. It manufactures all the controls which are used on conventional and solar systems plus one new control applicable to solar systems only, the differential temperature controls. Honeywell's customers number between 20,000 and 25,000.

Honeywell's largest customer for solar controls is Lennox. They have a technology agreement with Lennox whereby they supply the expertise for Lennox to manufacture their own controls.

Honeywell's other customers range from wholesaler/distributor to dealer and contractors. Honeywell maintains its own sales force. Its largest distribution channel lies in the wholesaler/distributor. Honeywell offers training programs in installation, design and management and offers its customers many means of support.

Roger A. Hammer of Honeywell feels the technology for solar is here, but the economics are not. Incentives will help and the surge may come with the increase in utility rates and the scarcity of energy. He says the manufacturer must not propose unrealistic savings to the customer.

"There are pros and cons to a new company," states Mr. Hammer. The small company may "leap frog" over existing companies by taking risks, but the trade off for slower more established methods is that the older company will still be here tomorrow. Honeywell establishes the image of responsibility through testing and quality reliability.

"The average consumer is unsure how to go," says Mr. Hammer. "Everyone has a different idea. We need efficiency ratings on solar as we now have on electric applicances; ratings that show a level of performance; a slide rule for each system. We need bottom lines and final figures. At this time, a customer doesn't know what to expect from a system and he wants to know what he's getting. People need education to do their own evaluation. In other words, we must educate the general public."

"In my opinion," says Mr. Hammer, "we should develop a community program with community receivers with a pro-rated cost to everyone. Individuals would not have to assume the entire expense. I'm talking about public solar energy."

"Solar must be 'pulled' by the consumer. People must be educated and motivated to invest in solar. Solar still has a 'space age' image. The savings must be more than energy - it must show up in the pocketbook. People only own their homes for five to seven years, but its taking 15 to 20 years for solar to pay back."

APPENDIX B

TRADE ASSOCIATIONS

The following list is comprised of active, established trade associations representing numerous professionals and tradesmen nationwide. The associations include members from the heating, plumbing, air conditioning, building, refrigeration, and electric industries, and represents designers, engineers, contractors, manufacturers, wholesaler/distributors, administrators, and planners from each respective industry.

Based on discussions with association leaders and members, each association demonstrated interest and responsiveness to current DOE efforts of solar energy product commercialization activity.

HVAC TRADE ASSOCIATIONS

NAME/ASSOCIATION	MEMBERSHIP PROFILE
ARW (AirConditioning Refrigeration Wholesalers)	An international group of wholesaler/distributing organizations including interests from the plumbing, air conditioning/refrigeration, heating, sheet metal, and electrical contracting professions. ARW members are located in 49 U.S. states and 461 cities, in 8 Canadian provinces and 37 cities, and in Britain, France, Mexico, and Puerto Rico. ARW headquarters are located in Deerfield Beach, Florida.
ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers)	A nationwide group of professionals representing the Heating, Refrigeration, and Air-Conditioning industries. ASHRAE members include engineers, designers, manufacturers and contractors dealing with the above product groups.
CEFP (Council of Educational Facility Planners)	A nationwide organization including corporations, educational staffs, editors and writers, architects, engineers, designers, and students who are professionally involved with specific phases of educational facility planning. CEFP has approximately 6000 members, and is headquartered in Columbus, Ohio.
NAHB (National Association of Home Builders)	A nationwide organization with members from all areas of home construction. Currently having an active membership of 111,000, NAHB headquarters are in Washington, D.C.
NAPHCC (National Association of Plumbing, Heating, and Cooling Contractors)	A growing organization of contractors involved with plumbing, heating, and cooling industries. Present membership is approximately 6300 nationwide, and is headquartered in Washington, D.C.

NECA (National Electrical Contractors Association)	A nationwide group of contractors involved with all aspects of electrical technology. Presently encompassing about 6000 commercial organizations, having 133 local chapters. NECA headquarters are in Washington, D.C.
SEIA (Solar Energy Industries Association)	A nationwide association of manufacturers, suppliers, and designers of solar energy systems and components. SEIA headquarters are in Washington, D.C.
SMACNA (Sheet Metal and Air Conditioning National Association)	A nationwide group consisting primarily of trade professionals involved in all aspects of the air conditioning and sheet metal/ ducting trade. SMACNA presently has about 2800 individuals, and is headquartered in Vienna, Virginia.

APPENDIX C

Johnson Environmental and Energy Center

The University Of Alabama In Huntsville

P.O. Box 1247
Huntsville, Alabama 35807

March 1979

SOLAR ENERGY TRAINING PROGRAMS FOR INSTALLATION, MAINTENANCE AND REPAIR

(prepared under DOE Contract EM-78-S-01-4218)

This listing provides the names and addresses of various organizations involved in solar energy training programs related to installation, maintenance and repair. The identified organizations and activities are those known to the Johnson Environmental and Energy Center at this time. This material is being compiled to aid in the commercialization of solar energy use in buildings as required under a contract with the U. S. Department of Energy.

DISCLAIMER

The University of Alabama in Huntsville (UAH) is not responsible for errors in or ommissions from this listing. It should also be noted that UAH accepts no liability for the representations contained herein. Neither UAH nor any other agency can assume any responsibility for the accuracy of any statement in these listings.

For further copies, or to provide comments, corrections or additions to this listing, please contact:

Mr. David L. Christensen, Senior Research Associate
The University of Alabama in Huntsville
Johnson Environmental and Energy Center
P. O. Box 1247
Huntsville, Alabama 35807

STATE-SPONSORED TRAINING PROGRAMS

ARIZONA	Many courses on training of solar installers
Glendale Community College Glendale, Arizona 85301	Solar Cooker/Overview
Maricopa Community College Phoenix, Arizona 85004	Heating/Cooling
Pima College Tucson, Arizona 85709	Overview/Build Collector
Scottsdale College Scottsdale, Arizona 85251	Overview
Yavapai College Prescott, Arizona 86301	How to Size and Build
ARKANSAS	
Various Institutions	Using Solar King and sheet metal workers course
CALIFORNIA	
California Office of Appropriate Technology(OAT) 1530 10th Street Sacramento, California 95814 (916) 322-8901 Contact: Mr. Jack Haley Director of Instruction	Two-year program leading to employment as mechanics, technicians or engineers in solar industry
California State Energy Commission San Bernadino West Side Community Development Corporation Contact: Mr. Bill Shaw Training Director, CETA	On-the-job training for installation of space and hot water heating systems on low income housing
California State University Sonoma Davis San Jose	Offers courses in solar installation training. Basically a technician training program with installation field experience
Chaffey Community College 5885 Hayen Avenue Alta Loma, California 91701	Offers "Solar Energy I", introduction to solar heating and cooling systems and "Solar Energy II", construction and installation of solar energy devices. Basic construction and installation skills

San Jose Center for Employment Training Energy Resources and Development CETA	Construction of solar water heaters, on-site. Skills in piping and soldering
San Jose City College 2100 Moor Park Avenue San Jose, California 95128	Courses offered for technicians including training in installation, maintenance and repair
University of California San Diego Contact: Mr. Jon Hamrin or Mr. Dean Anson	Energy Extension Service
The Habitat Center 573 Mission Street San Francisco, California 94105 (415) 534-1294	Hands on experience on design and construction of low-cost systems such as greenhouses, adobe houses and breadbox water heaters($15-$28)

COLORADO

Community College of Denver, North Campus 1001 East 62nd Avenue Denver, Colorado 80202	One course in solar energy do-it-yourself techniques (build collectors, solar ovens and some theory); will offer technical courses on operation and maintenance and repair of solar heating systems in the future
Community College of Denver, Red Rocks Campus 12600 West 6th Avenue Golden, Colorado 80401 Contact: Mr. Craig Hilton	Solar energy installation and maintenance
Solar Energy Applications Laboratory Colorado State University Fort Collins, Colorado 80521	"Solar Heating & Cooling of Buildings, Design of Systems" and "SHACOB: Sizing, Installation and Operation of Systems": Five day programs covering fundamentals of solar hydronic and air systems for space heating and cooling and domestic hot water heating

CONNECTICUT

Connecticut Somers Correctional Institute 340 Capital Avenue Hartford, Connecticut 06120 Contact: Edmond Gobbins, Director of Education (203) 641-5517	Hands-on instruction for prisoners using DOE and Homestudy materials
Hartford Graduate Center 275 Winsor Street Hartford, Connecticut 06120 Contact: Mr. Peter Holmquist (203) 549-3600 X 253 or 252	Environmental Science and Technology Program offers degree and non-degree courses in solar for professionals (architects, engineers, consultants, etc.) who want technical training and or graduate students planning on working

Hartford Graduate Center (continued)	in solar. Courses offered include "Solar Energy", "Solar Energy for Buildings", "Advanced Solar Energy Systems Design". Solar studies included in some other courses as well. "Solar Energy Systems Component Selection, Installation, and Maintenance" is directed toward professionals but includes installation and maintenance for technicians
University of Connecticut Office of Extension/Solar Evaluation Center Box U-56K Storrs, Connecticut 06268	Television course offering detailed review of various solar technologies including maintenance
University of New Haven Division of Special Studies 300 Orange Avenue West Haven, Connecticut 06516	Offers a course entitled, "Solar Heating and Cooling: An Applications Course", designed to provide contractors, realtors, engineers, and architects with the capabilities to design and install solar energy systems
DELAWARE	
Energy Conservation and Applications Training Center 1417 Newport Road Wilmington, Delaware 19804	Offers two courses designed to develop the capability of practitioners in the construction industry to size, install, and operate solar heating systems for buildings
FLORIDA	
Florida Solar Energy Center 300 State Road 401 Cape Canaveral, Florida 32920 Contact: Roy Massena (305) 783-0300	"Solar Water and Pool Heating: Installation and Operation" includes basic solar energy facts, water heating, swimming pool heating, installation, economics and insolation
Pinellas Vocational-Technical Institute 61000 154th Avenue Clearwater, Florida 33520	Offers two training programs (two nights per week; registration every nine weeks): 1) "Solar Energy" (heating and cooling) mechanics and theory of building solar hot water heaters, also design and construction of solar air conditioning units. 2) "Household Energy Conservation/Solar Energy", to assist homeowners in learning how to conserve energy, learn economics of solar hot water heating for own home, and learn key parts of working system
GEORGIA	
De Kalb Community College 495 North Indian Creek Drive Clarkston, Georgia 30021	In process of developing short term course in Solar Equipment and Maintenance. Long range plans to include solar as part of the Heating, Air Conditioning and Refrigeration Program

North Georgia Vocational-Technical School Lake Burton Road, Georgia 197 Clarksville, Georgia 30523	Curriculum to train technicians to install and service solar systems

ILLINOIS

Southern Illinois University Carbondale, Illinois 62901	Solar Energy for the Homeowner: six week evening extension course for homeowners and technicians
Trenton College Trenton, Illinois 62293	Solar energy seminars oriented toward technicians
University of Illinois Urbana-Champaign Cooperative Extension Service and Small Homes Council Urbana, Illinois 61801	Workshops for contractors, builders and suppliers

IOWA

Scott Community College Belmont Road Bettendorf, Iowa 52722	Offers an Associate Degree in Solar Energetics Technology (two years). Prepares students for employment as technicians in research labs, solar energy systems installation, assistants to designers and architects, systems maintenance, and other energy related occupations. Graduate will also be proficient in heating and air conditioning, sheet metal work and all installation of domestic and industrial units

LOUISIANA

Louisiana Department of Natural Resources P. O. Box 44156 Baton Rouge, Louisiana 70804 (504) 342-4594	Developing a design course with portions applicable to installers. Available February 1979

MASSACHUSETTS

Blue Hills Regional Technical Institute 100 Randolph Street Canton, Massachusetts 02021	Offers a solar heating system design and laboratory course which covers techniques for determining size, performance, cost of systems and field installation, and "trouble shooting" problems

Cape Cod Community College Engineering, Science, and Industrial Related Technologies Department West Barnstable, Massachusetts 02668	"Solar Energy I - Design and Installation Techniques for Residential Building", system design, sizing and installation of solar heating units; "Solar Energy II - Design and Installation Techniques for Residential Building", installation and operation of solar heating systems (including retrofit); and "Survey of Alternative Energy Sources", discussion of various energy sources
Springfield Technical Community College Armory Square Springfield, Massachusetts 01105	A.S. Degree in Solar Energy. Graduates are qualified to install complete liquid or air heating systems, size systems, and evaluate cost effectiveness

MINNESOTA

Red Wing Area Vocational Technical Institute Pioneer Road at Highway 58 Red Wing, Minnesota 55066 (612) 388-8271	Currently offers three courses: "Air Conditioning, Heating, Refrigeration and Related Solar Energy Technology", "Energy Conservation and Management for Buildings", and "Solar Energy System Technology"

NEBRASKA

Carlton Technical Community College Fort Omaha Campus Department of Continuous Education P. O. Box 37210 Omaha, Nebraska 68137 (402) 457-5100	Offers an installation training course

NEVADA

Clark County Community College 3200 East Cheyenne Avenue North Las Vegas, Nevada 89030 (702) 643-6060	Presently implementing a "Solar Technician Training Program", a thirty-credit curriculum will be offered, leading to a "Certificate of Achievement in Solar Energy Technology"

NEW HAMPSHIRE

Governor's Council on Energy Concord, New Hampshire 03301	Has developed a "Solar Hot Water Systems Installation Guidelines" to support the HUD Hot Water Initiative Program
New Hampshire Vocational and Technical College 1066 Front Street Manchester, New Hampshire 03102	Certificate in solar systems installation, maintenance, and repair

NEW JERSEY

Essex County Technical Careers Center Heating, Ventilating, and Air Conditioning 91 West Market Street Newark, New Jersey 07103	Adult education, day and evening; installation and service of domestic hot water heating, and residential and commercial space heating systems.
Ocean County Vocational/Technical Schools Route 571 Jackson, New Jersey 08527	1) "Solar Energy Theory for Heating, Ventilating and Air Conditioning Technicians", certificate, fifteen week course for HVAC specialists covering design considerations for solar hot water and space heating; 2) "Solar Energy Workshop", twenty-one hour program to assist homeowner in designing and installing a solar hot water system, covers the theory of operation, life cycle costing and installation; and 3) "Climate Control", high school students only, two-year high school certificate, training in plumbing, heating, air conditioning and refrigeration; learn to design, repair and install systems; course includes new unit in design and installation of solar heating equipment

NEW YORK

Mohawk Valley Community College 1101 Sherman Drive Utica, New York 13501 Contact: Dr. Francis Dunning	Offers "Solar Energy for the Heating and Air Conditioning Technician", development of skills for the installation, maintenance, and repair of solar and cooling systems; includes information on climatology, contractor licensing laws, codes, marketing, etc.
Opportunities for Broome, Inc. Box 1492 Binghamton, New York 13902 Contact: Mr. Norm Abess (607) 723-6493	Course for economically disadvantaged youths with hands-on work and actual installation experience

NORTH CAROLINA

North Carolina State University Division of Continuous Education Industrial Extension Service Box 5506 Raleigh, North Carolina 27650 (919) 737-2356	Offered a three-day training course in the practical aspects of "Design of Active Solar Heating Systems for Residential Buildings", August 21-23, 1978

OREGON

Clackamas Community College Oregon City, Oregon 97045	Offers "Solar Heating for Northwest Oregon" course which covers design, how systems work, Northwest solar installations, etc.

Eastern Oregon Community Development Council	Solar technician course, two-day workshop on how to install simple solar systems and make homes more energy efficient
Mid-Willamette Valley Community Training Corporation Salen, Oregon 97308	Solar technician course, instruction for installing solar hot water heaters

SOUTH CAROLINA

Florence-Darlington Technical College P. O. Drawer 8000 Florence, South Carolina 29501	Two-year program in air conditioning, refrigeration, and heating which leads to a diploma. A course on solar energy covers theory and practical application, solar design, installation, and service
York Technical College U. S. 21 Bypass Rock Hill, South Carolina 29730	Two-year program which contains one course titled "Solar Energy Applications". Emphasis is placed on hands-on work with solar system installation, service, and controls

TEXAS

Central Texas College Highway 190 West Killeen, Texas 76541	Proposed: Training program to prepare individual's needs for equipment, installation, operation, and maintenance
Galveston College 4015 Avenue G Galveston, Texas 76470	Proposed two-year program for installation, repair and maintenance
Navarro College Highway 31 West Corsicana, Texas	Solar Engineering Technician Curriculum Development Program: Two-year Associate degree curriculum. One-year certificate degree program for installers
Odessa College P. O. Box 3752 Odessa, Texas 79760	Proposed program: A systematic approach for training job entry-level solar power technicians
Texas State Technical Institute James Connally Campus Waco, Texas 76705	Training curriculum program in SH/SC at the technician level - 6 technology curricula, 6 quarter program design, training, materials, equipment, facility and faculty requirements
Texas State Technical Institute Rolling Plains Campus Sweetwater, Texas 79556	Proposed program for training installers of solar energy equipment

VIRGINIA

Lord Fairfax Community College
P. O. Drawer E
Middletown, Virginia 22645
Attn: Electronic Technology Dept.

Covers sizing, installation, and maintenance with emphasis on economics

INDUSTRIAL/MANUFACTURERS PROGRAMS

American Solar King Corp. 6801 New McGregor Highway Waco, TX 76710 (817) 776-3860	Five day dealer and distributor training in applied technology of American Solar King products. No charge.
California State Energy Commission (League of California Cities)	"Solar Installation," train local zoning and building code enforcement agents to reduce barriers to solar installation.
David Alternative Technology Associates Box 503 Davis, California 95616 (916) 756-9300 Contact: Bruce Maeda Dean Anson	Conduct: Seminars
Daystar Corporation 90 Cambridge Street Burlington, Massachusetts 01803 (617) 272-8460	Manual: DAYSTAR dealer manual, two-binder set, which DAYSTAR uses to train dealer-installers. For further information, contact Mr. Marvin Goldberg, Exxon Enterprises, Inc., Solar Commercialization Venture, Box 192, Florham Park, New Jersey 07932, (201) 267-4440 X 247
Energy Systems, Inc. 4570 Alvarado Canyon Road San Diego, California 92120	Solar energy training course; source: HUD solar status, "Installing Solar: Training Expands to Meet the Need," HUD-PDR-189-11, September, 1978.
General Electric Company Advance Energy Programs P.O. Box 13601 Philadelphia, PA 19101	Conducts Solar Systems Design and Applications Seminars with emphasis on commercial and industrial applications of their evacuated tube collectors. (215) 962-2112
The Habitat Center 573 Mission Street San Francisco, California 94105 (415) 543-1294	Weekend workshops; hands-on experience in design and construction of low-cost systems such as greenhouses, adobe houses, and bread-box water heaters.
Lennox Industries, Inc. P.O. Box 250 200 South 12th Avenue Marshalltown, Iowa 50158 (515) 754-4011	Lennox, a Major Manufacturer of heating and air conditioning products is now in the market with solar products. To market these products, a complete training program including a solar text, slides, video tapes, and training hardware has been developed for a total solar heating curriculum.

Lennox Industries, Inc. (cont.)	This training is in addition to basic heating and air conditioning courses which are available through local vocational and technical schools. Manuals: "Heating-Air Conditioning Technology...Keeping Pace With An Energy Conscious World," 20 pages, and "Something New Under the Sun...A Solar Training Course by Lennox," 9 pages.
Midwestern Solar and Insulation 2235 Irvin Cobb Drive P.O. Box 2384 Paducah, Kentucky 42001	Three-day course on solar sales, installation and repair. The cost for the training manual is fifty dollars.
Science Applications, Inc. 274 Madison Avenue, Suite 1504 New York, New York 10016 (212) 679-3244	Manual on state-of-the-art-retrofit methods for house and commercial building installation.
Solar Energy Products, Inc. 1208 NW 8th Avenue Gainesville, Florida 32601 (904) 377-6527	Authorized dealer training seminar for prospective authorized dealers. This course insures proper representation and maintenance of SEP's solar systems. Fee is $100.
Solar-Energy Research Corporation 7018 South Main Street Longmont, Colorado 80501 (303) 772-8406	Manual: "Installation, Operation, and Maintenance Manual: DHW 801 Solar Domestic Hot Water System," includes installation, operation, and maintenance guidelines for their domestic hot water system equipment, 43 pages.
Solar-Eye Products, Inc. 1300 NW McNab Road, Building G & H Fort Lauderdale, Florida 33309	This company does not have a written course of study but does offer a formal "hands on" training program at their plant.
Solar Unlimited 4310 Governors Drive West Huntsville, Alabama 35805 (205) 837-7340 Contact: Mr. Don Bowden, Pres.	Offers a three-day course for dealers and distributors which is very extensive and covers system requirements, designs, installation, marketing, and financial management. Manual is very complete and covers the intricacies of solar commercialization in infinite detail. Slide presentation and tours of installations is an integral part of the workshop.
Solaron Corporation 300 Galleria Tower 720 S. Colorado Blvd. Denver, Colorado 80222 (303) 759-0101	Systems applications, installation, theory, etc. Applications Engineering Manual.

SUNEARTH Solar Products
Corporation
Progress Drive
Montgomeryville, Pennsylvania
18936
(215) 699-7892

This manual serves as a guide only and is intended to help the installer, with a mechanical background, complete a solar hot water system using a SUNEARTH system.

State Industries, Inc.
Ashland City, Tennessee 37015
1-800-251-8170

Complete installation training course held at the State Industries Training Center, Solar Water Heating Institute. This is a very extensive, highly organized, three-day training program to reach each student's final goal: installation of a functioning solar water heater. A $200 deposit for tuition is required including hotel room and meals. Ten dollars is refunded when the students arrive at the training facility.

CORRESPONDENCE AND HOME STUDY COURSES

Home Study Institute 1661 W. Anderson Road Columbus, Ohio 43220	Offers a solar collector installation course.
North American Heating & Air Conditioning Wholesalers Association 1661 West Henderson Road Columbus, Ohio 43220 (614) 459-2100	Accredited home study course for HVAC contractors on installation, operation, and maintenance of solar heating and cooling systems. Developed by SMACNA and NHAW. Successful completion of course certifies individual as qualified solar system installer. (Available September/October 1977) NHAW offers other home study courses in basic heating and cooling also.
NRI Air Conditioning, Refrigeration, and Heating School McGraw-Hill Continuing Education Center 3939 Wisconsin Avenue Washington, D.C. 20016	Correspondence courses in air conditioning, heating, and refrigeration, including solar energy applications.
Sheet Metal and Air Conditioning Contractors National Association 8224 Old Court House Road Vienna, Virginia 22180	"Fundamentals of Solar Heating" is a correspondnece course. More information available from: National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22161 The cost of a printed copy is nine dollars.
Solar Energy Applications Laboratory Colorado State University Ft. Collins, Colorado 80521	Fundamentals of Solar Heating

LABOR UNION SPONSORED PROGRAMS

Association of Energy Engineers 464 Armour Circle N.E. Atlanta, Georgia 30324 contracted to Attaviano Technical Services Inc. 150 Broad Hollow Road Melville, New York 11746 (516) 271-1911	Solar Energy: Seminar for HVAC contractors covers the "nuts and bolts" specifics and technical. Covers basics, hardware and its application, installation characteristics, maintenance requirements, and sub-components. Special attention to computer programs available for hand-held calculators and how they can be used from basic sizing to return on investment analysis. Conducted by Rye Loope, one of the foremost experts in solar energy. Dates: Feb.-April, 1979, Chicago, San Francisco, Washington, Dallas. Cost: $360.
Denver Solar Course	Solar installation with particular attention to sizing, duct work, piping and storage.
International Association of Plumbing and Mechanical Officials 5032 Alhambra Avenue Los Angeles, California 90032	Presently developing a solar energy course that will be made available to vocational, community, and four-year schools.
National Association of Solar Contractors Box 197 Sudbury, Massachusetts 01776	Offers an installation training course.
National Training Fund 1900 "L" Street NW Suite 405 Washington, D.C. 20036	Offers a course for those who wish to become sheel metal workers--solar installation is part of the course.
Plumbing Institute Training Center 531 East Seven Mile Road Detroit, Michigan 48203	Offers an installation training course.
San Diego County Construction Laborers Benefit Fund 4161 Home Avenue Suite 260 San Diego, California 92105 Attn: Mr. E. Thurman	Offers a six-week training program for those who want to become construction laborers--one week on installation and maintenance of solar equipment.
Sheet Metal and Air Conditioning Contractors 8224 Old Court House Road Vienna, Virinia 22180	Developed a correspondence course "Fundamentals of Solar Heating" under a DOE Contract. The course includes lesson plans, examinations and progress reviews. Documents are available from NTIS (HCP/M 4038-10 and -01CREV) concerning this program.

DOE SPONSORED PROGRAMS

Cape Fear Technical Institute (Host.) Warren O. Stiles, P.E. Consulting Engineer P.O. Box 466 Rightsville Beach North Carolina 28480	Sponsored by North Carolina State University. ORNL, and DOE, a short course entitled "Solar Water Heater Installation" was held August 14-15, 1978. Other courses on active and passive system design were also sponsored by the North Carolina State University in Charlotte and Raleigh.
Florida Solar Energy Center 300 State Road 401 Cape Canaveral, Florida 32920	Offered a short course September 20-22, 1978, entitled, "Solar Installation Short Course," sponsored by the Florida Solar Energy Center- with major funding by the Solar Technology Transfer Program, ORNL.
Johnson Environmental and Energy Center The University of Alabama in Huntsville P.O. Box 1247 Huntsville, Alabama 35807 (205) 895-6262	Offered a DOE and ORNL sponsored short course to Alabama Home Builders during September, 1978. Developed extensive supporting material for this pilot program which are available for widespread applications.
Louisiana Department of Natural Resources P.O. Box 44156 Baton Rouge, Louisiana 70804	The Louisiana Department of Natural Resources is developing a solar system design course targeted to the home builder, architects, and engineers. While this course is not aimed at installers, portions of it may be of use. The material will be available in February, 1979.
New England Electric Systems 20 Turnpike Road Westboro, Massachusetts 10581	Offers a solar collector installation course.
New England Fuel Institute 390 Commonwealth Avenue Cambridge, Massachusetts 02215 (Solar Educational Division Technical Training Center Suite 500, 390 Commonwealth Ave. Boston, Massachusetts 02215)	Offer solar heating course to train installers and maintenance workers for solar equipment. Covers all pertinent technical and maintenance aspects of solar heating equipment installations and maintenance, including basic technical concepts, installation procedures, testing and maintenance, and field developments in solar heating industry.
Northeast Solar Energy Center 70 Memorial Drive Cambridge, Massachusetts 02142 (617) 661-3500	Has offered several short courses, primarily for designers and builders.

Department of Energy Solar Technology Transfer Branch 20 Washington St. Washington, D.C. 20545	Has developed materials and procedures for the training of instructors in the teaching of solar equipment installation.
Texas Solar Energy Society 1007 South Congress Suite 348 Austin, Texas 78704 (512) 443-2528	A series of two-day, limited-attendance "nuts and bolts: workshops for Texas builders. Practical "how-to" instruction by experienced solar contractors and designers, with informal discussion of legal and financial aspects of solar installations. September 1978.
University of Connecticut Storrs, Connecticut 06268 (203) 486-3832	Offered three separate five-day sessions of a course entitled, "Solar Design of Active Systems,"--June 11-June 16; July 9-July 14; July 30-August 4,1978. Sponsored by US Dept. of Commerce, US Economic Development Administration and the Solar Applications Laboratory of Colorado State University in cooperation with the National Association of Home Builders.

MISCELLANEOUS

Ectotope Group
747 16th East
Seattle, Washington 98112

Manual, "Solar Workshop Manual" on how to install solar systems, aimed at homeowner

REVIEW OF SOLAR SHORT COURSES

I. INTRODUCTION

An attempt has been made to assess the availability of courses which provide adequate information for an employee of an equipment wholesaler who desires to become skilled in solar energy systems. This employee can then help retailers and installers with their problems. The course would cover the fundamentals of solar energy, component selection criteria, and installation techniques.

A number of solar energy related courses have been identified and the corresponding course notes have been obtained. The material provided has been reviewed for its applicability to the HVAC wholesaler's employee.

Section II is an analysis of each course. Each course has been reviewed in three areas. The first area is the fundamentals of solar energy systems. The employee should know the availability of solar energy, how to orient collectors to collect the most energy, what the penalties are for shading or misorientation, how collectors work and how they are rated, what the typical system configurations are and their advantages and disadvantages, etc.

The second area is the coverage of design criteria for solar components. The emphasis in this area is to provide the wholesaler's employee with enough information so that he can identify solar products that are well made and that will perform adequately. Coverage in this area includes: life and performance of various collector parts (glazing, absorber plate, absorber coating, insulation, etc.), methods of allowing for thermal expansion, sealing methods, insulation properties, and methods of corrosion protection.

The final area is the treatment of installation problems that are more or less unique to solar systems. Installation considerations include: methods of attaching solar collectors to the roof (both flat and tilted), good piping run practice, required fittings and locations for safety, required fittings (and location) for good performance, etc.

None of the courses reviewed seem to address the target audience. The courses that emphasize fundamentals usually provide information that is of interest to an engineer. The courses that emphasize installation are generally associated with a particular product and therefore are limited in their scope. Several of the courses do provide information which will allow the student to identify good products, but this information is generally disorganized.

In summary the following points can be made:

- Several solar energy related courses are available.
- Informantion as to exact course content is difficult to obtain.
- None of the courses reviewed appears to be aimed at training a wholesaler's representative to be a practical "expert" in solar energy systems.

2. REVIEW OF COURSES

NORTH CAROLINA STATE UNIVERSITY (Raleigh, N.C.)

"Passive Solar Design for Residential and Commercial Applications"
September 11-12, 1978

Presented by
Charles Michal, Vice-President for Design Group
and
Dan Scully, Director of Design
of
Total Environmental Action, Inc.
Church Hill
Harrisville, New Hampshire 03450

Material Reviewed: Course Notes (173 pp.)

Course Outline:
Section 1 - Introduction to Passive Solar Heating (12 pp.)
Section 2 - Basic Principles (31 pp.)
Section 3 - Practical System Designs (54 pp.)
Section 4 - Engineering Techniques (49 pp.)
Section 5 - Economics 23 pp.)
Section 6 - Case Studies (5 pp.)

Course Description:

The course is a fairly complete description of the operation and application of passive solar energy concepts. Included are fundamentals of sizing and construction of passive systems. Both "rule-of-thumb" methods and analytical design techniques are presented. Construction details and installation considerations are presented along with brand names of suitable construction materials.

The course notes are probably more comprehensive than would interest most wholesalers/retailers of solar components.

Topic Coverage:

Fundamentals - Good technical coverage of heat losses and insolation. Good presentation of basic passive techniques.

Component Design - Good coverage of requirements for components. Some brand names suggested as typical.

Installation - Good consideration of practical details. Shows cutaway views of typical passive designs and discusses contractors' problems such as scheduling.

STATE INDUSTRIES, INC. (Tennessee)

"Water Heating School Manual - Solar and Commercial"

Material Reviewed: Workbook

Course Outline:

A. What is solar heating? - a quick history and introduction
B. Different types of solar water heating systems - an overview
C. Advantages/disadvantages of various solar water heating systems
D. Introducing Solarcraft - the sun-powered water heater by state
E. Comparing Solarcraft to other systems - a look at the competition
F. Solarcraft - general installation considerations and sizing
G. Government involvement - things to consider
H. Legal considerations - know your local codes
I. Installing Solarcraft - pre-planning, materials, tools and on-site preparation
J. Installing the collectors
K. Installing the collector piping and Solarcraft Storage tank
L. Connecting the panels to the storage tank
M. Making all the electrical connections and adjustments
N. Special installations and troubleshooting the system

Course Description:

The course is designed to describe and sell one particular type of solar collector system. The course material is meant to be completed during the lectures (i.e., fill in the blanks, etc.) so the workbook cannot be used by itself. This interaction should keep the students alert and facilitate learning.

A manual for the solar water heater was included which covers installation, operation and maintenance of the Solarcraft system. This manual is complete and well-organized for easy use by the installer. All procedures are described step-by-step and many drawings and pictures are included. Most of the course information is covered in this manual.

Topic Coverage:

Fundamentals - Not much coverage; it does indicate how the collector should be oriented.

Component Design - The course indicates why the Solarcraft system is better than the competitors.

Installation - Very good detail and procedure on this in the manual accompanying the course. Installation is only for the Solarcraft System

TEXAS SOLAR ENERGY SOCIETY & OAK RIDGE NATIONAL LABORATORY (Texas)

"Solar Building Technologies Workshops" (2 day)
Midland-Odesson/Wace/Beaumont
sponsored by a grant from the DOE

Material Reviewed: Workbook

Workshop Outline:

A. Passive Systems
   1. The Case for Passive Solar Design
   2. Design Decisions in Passive Solar Design
   3. Explanation and Application of Passive Systems
B. Rock-Air Solar Heating Systems
   1. Glossary of Terms
   2. Components of a Flat-Plate Solar Heating System
   3. Design Considerations
   4. Comparing Systems
C. Domestic Solar Water Heating
D. Liquid Solar Collector Systems and Applications (Outline and illustrations included)
E. The Collection & Utilization of Solar Energy
F. Institutional Factors Bearing on Solar Energy Development in Texas
   1. Building Codes (by city)
   2. Developing Solar Building Codes
   3. Sample City Codes

Course Description:

The course is designed for solar applications in Texas, especially in the presentations of solar projects and legal aspects. It covers a broad area of solar design including passive, air systems and liquid systems. The notes are primarily in outline form and therefore list highlights of topics covered but not necessarily the details and reasons.

Topic Coverage:

Fundamentals - Complete coverage of many aspects. Solar insolation, collector orientation, system configurations, and performance are among the topics covered.

Component Design - Gives some considerations of performance and life in terms of component construction.

Installation - Includes some installation consideration but not very much. Local codes in Texas are presented.

MARICOPA COMMUNITY COLLEGE (Arizona)

Material Reviewed: Course Notes (90 pp.)

Course Outline:

Chapter I - Natural Sources of Energy (12 pp.)
Chapter II - Solar Angles and Energy Collection (32 pp.)
Chapter III - Collector Systems (29 pp.)
Chapter IV - Heat Storage Methods (16 pp.)
Chapter V - Solar Water Heating (30 pp.)

Course Description:

The course is designed to give a good fundamental background in the application of solar energy to space and water heating. It covers all of the fundamentals of solar energy in a clear non-technical way. Emphasis is given to the decision making aspects of solar energy use: is the location suitable?, how should the collectors be oriented?, which basic type of collector is best in this application?, what kind of storage and how much?, what kind of system configuration?

The topics (see outline) are covered in an unbiased manner. Advantages and disadvantages of each type are fairly presented. Basic design data is given for approximate sizing of systems.

Topic Coverage:

Fundamentals - Good coverage, not overly-technical, good graphics.

Component Design - Basic information is given on materials used in various components but no specific recommendations are given. No information on good construction details.

Installation - No information on installation techniques.

CAPE FEAR TECHNICAL INSTITUTE (North Carolina)

"Solar Water Heater Installation" - Two-day Short Course

Presented by
Warren O. Stiles, P.E.
Consulting Engineer

Material Reviewed: Syllabus

Course Outline:

A. Service Hot Water Systems
   (Module 7 - copied from "Sizing Installation & Operation of Systems" prepared by Colorado State University, Solar Energy Applications Laboratory, U.S. G.P.O. Stock #003-011-00085-2)
B. Summary Report - B.C. Hedgepeth Solar Water Heater
C. Miscellaneous Information
   A. Insulation Tables
   B. Solar Energy Magazine
   C. Owens Corning "The Arkansas Story", Vol. 1, 2, & 3

Course Description:

The portion on Service Hot Water Systems came from CSU's training course in the practical aspects of sizing, installation, and operation of solar heating and cooling systems. Various basic types of hot water heating methods are described along with methods of system sizing and quantitive performance.

The section on the solar hot water heater at Wrightsville Beach, North Carolina, gives an overview of a typical application. It gives some system description and performance data. A section entitled "What Went Wrong" tells of typical installation and design errors and what to do to avoid them.

Topic Coverage:

Fundamentals - Good description of various types of solar hot water heating systems. Not much to help size systems correctly.

Component Design - Indicates some of the options available for consideration (such as types of heat transfer fluid) but generally not much to help with identification of good component design.

Installation - Not much on installation except for what not to do in the case study.

SOLAR UNLIMITED (Alabama)

"Dealer Training Manual"

Material Reviewed: Training Manual

Manual Outline:

A. Introduction
B. System Requirements Overview
C. System Designs
D. System Installation
E. Repair and Testing
F. Solar Economics
G. Sales and Promotions
H. Ordering
I. Financial Management

Manual Description:

This manual was not prepared for the general public; it was prepared for dealers associated with Solar Unlimited. Therefore, the manual is directed at providing information to sell, size, and install one particular line of products.

The manual gives detailed information on system sizing and system installation, complete sets of drawings are included.

Topic Coverage:

Fundamentals - Very little. Some basics are included but primarily for sales purposes.

Component Selection - Various collector types are compared but primarily to show the superiority of the silicon fluid based system.

Installation - Good, but is restricted only to the products distributed by Solar Unlimited, Inc.

SMACNA AND NHAW CORRESPONDENCE COURSE

"Fundamentals of Solar Heating"

Correspondence Course Prepared by the U. S. Department of Energy by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and the North American Heating and Air-Conditioning Wholesalers Association (NHAW)

Material Reviewed: Correspondence Text

Course OUtline:

A. Solar Heating and Cooling (Overview)
B. Solar Radiation
C. Solar Collectors
D. Heat Storage
E. Control Devices and Specialty Items
F. Sizing Solar Components
G. Operation of Solar Heating Systems
I. Heating System Installation
J. Servicing
K. Legal Responsibility

Course Description:

The course text is approximately 180 pages long and therefore may be a little long for a "short course". It was written to provide the on-the-job air conditioning industry employee the opportunity to learn about solar technology. The coverage is fairly complete and well presented. Many pictures and graphs are included and they present the concepts quite well.

The section on installation contains practical information on scheduling, component selection, and system configuration. Details are presented for such things as roof penetrations, connecting collector to header and collector sensor installation.

In general, the text is well designed and presented for its target audience.

Topic Coverage:

Fundamentals - Good. Includes methods of sizing systems and "rule of thumb".

Component Design - Good. Gives background on component requirements and the alternatives available. Also discusses some design differences.

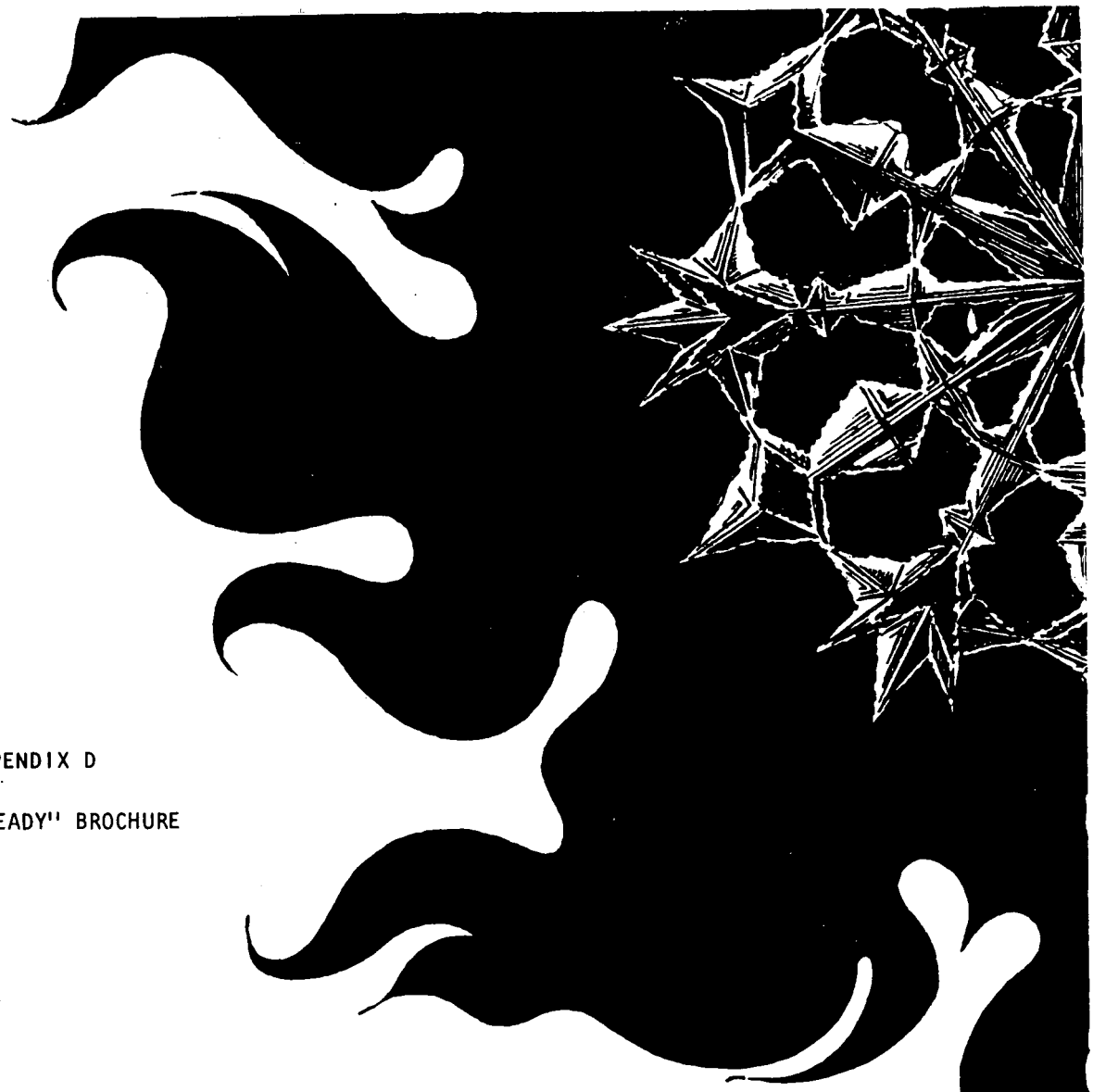
Installation - Good. Includes scheduling information as well as discussing good installation practice.

APPENDIX D

"GETTING READY" BROCHURE

APPENDIX D

"GETTING READY" BROCHURE



GETTING READY

The solar industry is on the verge of a tremendous expansion . . . a "solar boom" is in the making. As a national commitment to a **solar plan** is put into action, the rising demand for solar energy equipment will put the solar industry on the brink of a boom.

Manufacturers will be looking for experienced and capable wholesalers to distribute and market their solar products. "Getting Ready" for this solar expansion will require wholesalers to be knowledgeable about solar energy. . .

This is your opportunity for **"Getting Ready"**. . .

ENERGY FROM THE SUN

Residential & Commercial, Heating & Air Conditioning, Greenhouses, Pool and Water Heating

What

The University of Alabama in Huntsville is attempting to improve the commercialization of solar heating and cooling under a contract with the U.S. Department of Energy. As a part of this effort, materials are now being developed to familiarize the traditional heating, ventilation and air conditioning (HVAC) market channels with solar technologies, and with information needed to help assure proper performance of installed systems. Pilot seminars are being conducted on a national scale with HVAC wholesalers and distributors to obtain critical reviews of the developed materials and to improve their effectiveness.

This program is designed to determine:

- Solar information needs of the wholesale sector
- Problems in marketing and applications of solar equipment from the wholesaler/distributor point-of-view

Why

Our combined interest is to:

- Determine how commercialization of solar energy through wholesalers/distributors can be accelerated
- Assess the possible involvement of wholesalers/distributors in the solar energy equipment market
- Identify potential problem areas in the marketing of solar energy equipment

Who

The Johnson Environmental and Energy Center at The University of Alabama in Huntsville (UAH) is a research and educational organization with broad background and experience in solar energy program evaluation, management and utilization. The center has developed and makes available extensive data resources and materials. This new program is supported by consultants from the solar industrial community.

Numerous organizations in the wholesaler/distributor market represent firms with mutual business and economic interests in the HVAC field. They also stock products and conduct various meetings and programs to advance the state-of-the-art.

Who will be interested in this program?

Inventory Point	Wholesaler Distributor Dealer
Applicator	Heating Contractor Plumbing Contractor Builder Developer

How

Program goals may be accomplished through:

- Questionnaires to obtain input directly from meeting participants
- Area seminars with interested wholesalers to help identify and meet their solar information needs
- Personal/individual contacts to obtain "real world" assessments of solar energy potentials

How can participants help?

- Provide information on successes and resistance being encountered in solar energy applications.
- Recommend ideas which might aid in the increased utilization of solar energy

When & Where

Early 1979 seminars in major market areas

January 16 - Dallas
January 17 - Los Angeles
January 23 - Tampa
February 6 - Chicago
February 8 - New York

Future Goals & Objectives

- Inform wholesalers/distributors/ dealers of solar energy products and their advantages and disadvantages for incorporating solar energy into existing sales channels.
- Prepare general solar energy information packages as determined by seminar participants:
  - General solar energy information catalog (dealer/wholesaler-oriented)
  - Manuals for installation of solar energy equipment
  - Brochures for homebuilders and contractors
- Provide information concerning codes, standards, modular concepts and international market potential for solar energy equipment.

The original "Getting Ready" brochure contained pages 88-102 reprinted from the October 9, 1978 Business Week entitled "The Coming Boom in Solar Energy."

For additional information concerning the solar commercialization program for wholesalers/distributors, contact:

Mr. David L. Christensen
Senior Research Associate
The Johnson Environmental and Energy Center/UAH
P.O. Box 1247
Huntsville, AL 35807
(205) 895-6257

Sponsored by:

U.S. Department of Energy
Assistant Secretary for
Conservation and Solar Applications
Office of Solar Applications

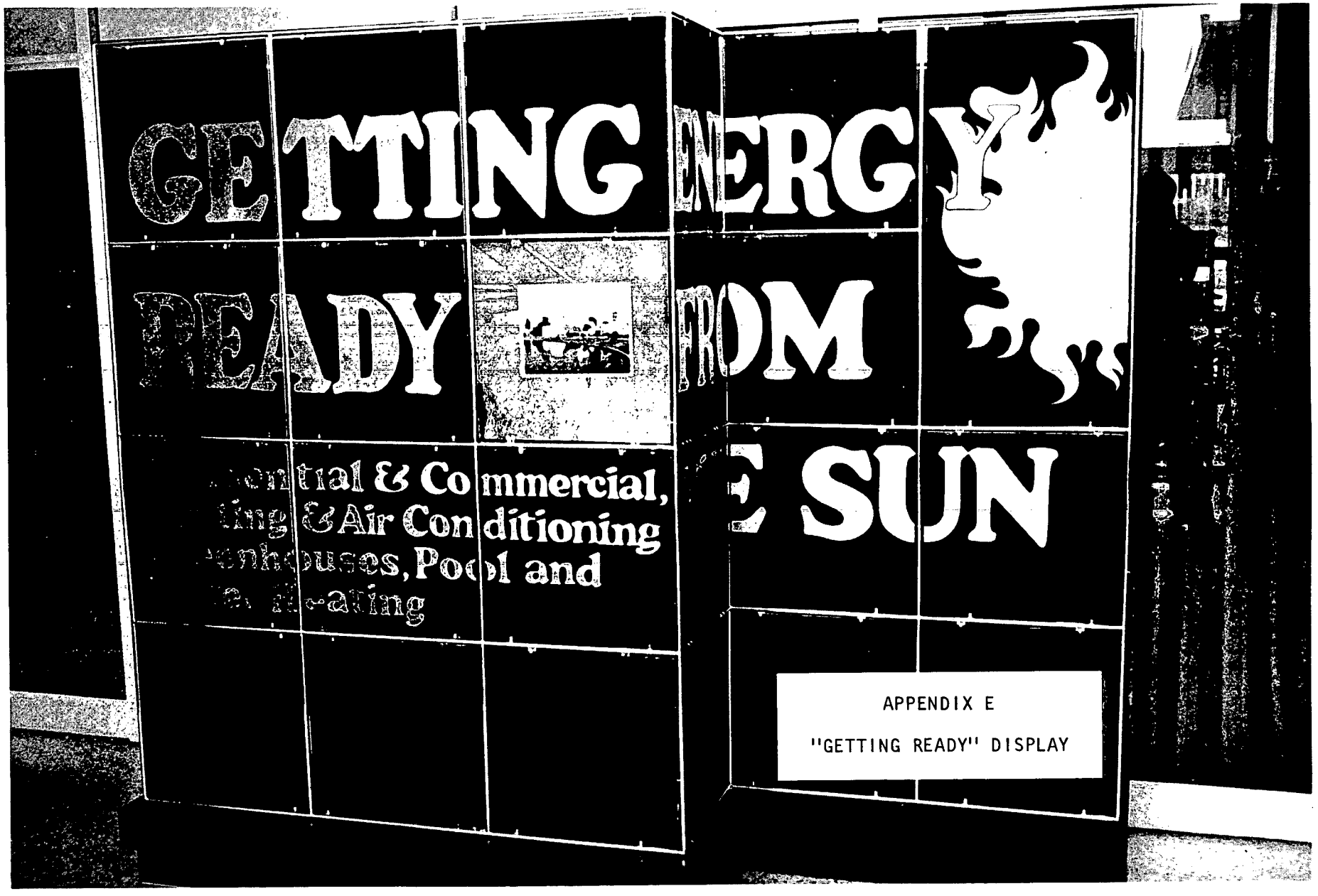
Prepared Under Contract
EM-78-S-01-4218
October 1978

Prepared by:

The University Of Alabama In Huntsville

Johnson Environmental and Energy Center

P. O. Box 1247
Huntsville, Alabama 35807



APPENDIX E

"GETTING READY" DISPLAY

APPENDIX F

QUESTIONNAIRE

NAME _____

QUESTIONNAIRE FOR PROSPECTIVE WHOLESALERS
AND DISTRIBUTORS OF SOLAR HEATING EQUIPMENT

Circle

1. Do you have sufficient information about manufacturers of solar equipment? . . . . . YES NO

   a. Names and addresses of manufacturers? . . . . . YES NO
   b. Types of equipment? . . . . . YES NO

      1. Flat-plate air collectors? . . . . . YES NO
      2. Flat-plate liquid collectors? . . . . . YES NO
      3. High temperature collectors (concentrators)? . . YES NO
      4. Storage? . . . . . YES NO
      5. Components? . . . . . YES NO
      6. Systems and/or kits? . . . . . YES NO

   c. How would you like to get additional information?

      1. Seminars? . . . . . YES NO
      2. Trade publications? . . . . . YES NO

         Which ones? _____

         _____

      3. Other _____

2. What information and materials do you need to help installers?

   _____

   _____

   a. How is the best way for you to get this information?

   _____

   _____

   b. How is the best way to get information to your prospects to help sell solar energy equipment?

   _____

   _____

3. Are you aware of any solar equipment for sale? If yes, please answer the following: YES NO

   a. Is most of the equipment of which you are aware satisfactory and saleable? YES NO

3. Continued

   b. How should the equipment be improved?

   _____

   _____

   c. How should it be marketed?

   _____

   _____

4. Have you received any requests or inquiries for solar equipment? . . . . . YES NO

5. Do you have sufficient climatic data to understand the solar potential in your sales area? . . . . . YES NO

6. Do you use the ASHRAE Guide for solar enrgy design and application? . . . . . YES NO

7. Are you aware of any building codes that interfere with the application of solar energy equipment? . . . . . YES NO

8. Are you aware of any local permit requirements that interferes with the application of solar energy equipment? . . YES NO

9. How can the potential for the use of solar energy be better understood and developed?

   _____

   _____

   _____

10. Do you have any suggestions concerning warranties?

    _____

    _____

    _____

11. Do you have any suggestions concerning financing?

    _____

    _____

    _____

12. Would standardized components benefit your sales?. . . . . YES NO

13. Which components or sub-systems would you suggest be standardized?

_____

_____

14. In your opinion, is the market ready for metric units? . . YES NO

15. Please provide any additional thoughts concerning the commercialization of solar energy. Include any ideas that could be applied to help realize a more rapid rate of commercialization.

_____

_____

_____

_____

16. Please comment on how this seminar could be improved.

_____

_____

_____

17. Would you be willing to review materials developed to enhance the solar energy equipment market? . . . . . YES NO
If yes, please include your:

Name: _____

Address: _____

Phone Number: _____

Return the completed questionnaire at the seminar or mail it to:

David L. Christensen
Senior Research Associate
The University of Alabama in Huntsville
Johnson Environmental and Energy Center
P. O. Box 1247
Huntsville, AL 35807

APPENDIX G

LIST OF ATTENDEES

ARKANSAS

Charles Davis
7708 Alanbrook East
North Little Rock, Arkansas 72116

CALIFORNIA

Phillip Brustein
1641 South Pomona D-35
Fullerton, California 92632
(714) 992-1637

R. J. Carlisle
2300 E. 28th Street
Long Beach, California
(213) 595-5301

Robert Chambers
16924 Marquardt Avenue
Cerritos, California 90701
(213) 926-6611

Bill Crawford
Burke Engineering Company
9700 Factorial Way South
El Monte, California
(213) 579-6763

Mike Hagerman
1327 South Atlantic Boulevard
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(213) 268-3211

Louis A. Harper
P. O. Box 972
Santa Barbara, California 93102
(805) 965-4918

Kenneth H. Kerr
700 Duboque Avenue South
San Francisco, California 94080
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Henry G. Martin
Refrigeration Supplies Distributor
1201 Monterey Pass Road
Monterey Park, California 91754
(213) 264-2800

John R. Mathes
P. O. Box 1407
Oakland, California 94604

John Murray
c/o Jack Ray, Inc.
1060 East Macy
Los Angeles, California 90033
(213) 225-5685

Harry D. Schneider
c/o Authorized Supply Company
1514 Maple Avenue
Los Angeles, California 90015
(213) 747-5121

Walter Tis
Himshaw Supply Company
145 11th Street
San Francisco, California 94103
(415) 431-2376

FLORIDA

Mac Hill
c/o Baker Brothers, Inc.
3935 West Cypress
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(813) 879-6460

Jim Kirkpatrick
Graves Brothers Refrigeration Supplies, Inc.
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Tampa, Florida 33605
(813) 247-4521

Dan Mason
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Tampa, Florida 33605
(813) 247-4521

Frank C. Pate
933 South Himes Avenue
Tampa, Florida 33609
(813) 256-6451 (Residence)
(813) 223-5527 (Office)

FLORIDA (Continued)

John V. Roberts
4120 Adamo Drive
Tampa, Florida
(813) 248-5061

Ron Rupek
5332 West Crenshaw
Tampa, Florida
(813) 885-6534

TEXAS

R. G. Broeckelmann
P. O. Box 1636
Houston, Texas 77001
(713) 224-1060

Dick Hillard
10940 Shady Trail
Dallas, Texas 75220
(214) 350-6631

Ken Jones
10940 Shady Trail
Dallas, Texas 75220
(214) 350-6631

ILLINOIS

Paul Clausen
Thermal Co., Inc.
3680 North Milwaukee Avenue
Chicago, Illinois 60641

Ron Gottfred, Vice-President
G & O Thermal Supply Company
5435 Northwest Highway
Chicago, Illinois 60630

Richard Haberle
4547 Sunderman Road
Rockford, Illionois 61111
(815) 877-2158

Norton Jensen
c/o Southside Conrol
488 North Milwaukee
Chicago, Illinois 60610

Robert F. Miaskowski
5959 West Howard
Chicago, Illinois 60648
(312) 647-8900

William Oberheide
5435 Northwest Highway
Chicago, Illinois 60630
(312) 763-1300

Ted Otterbacker
Marketing Manager
Mid-Way Supply, Inc.
2502 Deborah Avenue
Zion, Illinois 60099
(312) 872-5481

William W. Sauter
9600 William Street
Rosemont, Illinois 60068
(312) 671-3450

James Shanel
299 Roosevelt Road
Glen Ellyn, Illinois 60137
(312) 469-7300

Joseph M. Teskoski
c/o TESCO, Inc.
456 West Frontage Road
Northfield, Illinois 60093
(312) 446-1662

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Jamaica, New York 11435

Kenneth Foote
149-17 41st Avenue
Flushing, New York 11355
(212) 961-2667

Harold C. Kaplan
ABCO Refrigeration Supply
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Staten Island, New York 10304
(212) 273-0200

Michael Nissman
448 Connecticut Avenue, South
Norwalk, Connecticut 06856
(203) 838-8483

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Richard T. Shaw
c/o Thermodynamic Consultants, Inc.
381 Park Avenue, South
New York, New York 10016
(212) 889-4200

Ted Ujazdowski
730 Grand Avenue
Ridgefield, New Jersey 07657
(201) 943-5900

APPENDIX H

COST REDUCTION RECOMMENDATIONS FOR THE SOLAR ENERGY INDUSTRY

by

David Doyle, William Tragert, David L. Christensen

Prepared for:

The U.S. Department of Energy

under

Contract EM-78-S-01-4218

TABLE OF CONTENTS

FOREWORD

The U.S. solar industry is faced with the need for greater demand for their products and a greater public understanding of the performance and cost effectiveness factors that can influence their broader use. Particularly needed are reductions in front end costs and further developments in design to improve performance and durability.

This paper recommends that certain design and installation techniques already being successfully used by some U.S. solar energy companies, be given broader impetus by means of Federal specifications leverage.

The information contained herein represents an informal survey of the state-of-the-art and the cost reductions already being realized through certain industrial techniques. As a result of informal discussions with industrail leaders, there is no doubt that the entire solar energy industry is interested in responding to Federal procurement incentives that could accelerate the commercialization of solar energy. Barriers to more rapid application of industrail techniques include lack of investment capital, lack of an assured market, and lack of requisite knowledge as to the potential benefits of modularization and standardization.

SUMMARY AND CONCLUSIONS

One of the factors currently inhibiting faster market acceptance of solar energy systems, is their high front end cost compared to their pay-back time. Federal involvement can help hasten the lowering of costs through several avenues. One of these paths is to assist in the process of adoption by the solar industry, of selected industrialized techniques including pre-assembly, modularization, and standardization.

The opportunities for cost reductions in the U.S. solar industry, especially for reduction of on-site labor and associated costs, have been examined. The conclusion is that there are several areas where costs can be reduced by using component and sub-system standardization techniques, pre-packaging and modularization. There has been some work in all of these areas, by solar design, manufacturing and installation firms. Examples of this work, with cost reduction figures where they are known and can be relied upon, are given in this report. Some specific cost reduction techniques are identified. Many of them are similar to the techniques used to reduce on-site time and difficulties in the building industry.

However, the U.S. solar industry is not yet using these techniques sufficiently to reduce costs cumulatively and on a significant scale. A mature, sophisticated approach is needed which many solar firms are too new and inexperienced to exercise. In addition, an overall stimulation program is needed to create the demand and other conditions which will speed up the process.

There is a clear need for further examination of these techniques and their promise for cost reductions and energy savings. The most valid of them must be identified and encouraged. This report proposes a program to identify the most promising techniques, classify and categorize them, and then to stimulate their use.

Presumably the U.S. solar industry will, with the passage of time, reduce front end equipment and installation costs. However, the process may be slow and with it not only will many more small and medium companies go under, but the domestic market will not grow as fast as is needed to nourish the infant industry. Major opportunities to reduce costs, overcome consumer wariness,

and prepare for export opportunities are being lost. Consequently, severe demand restraints are being imposed on the industry.

The problem is how to stimulate the U.S. solar industry to move rapidly toward the practical steps which can be taken and to correct this situation while it is still early enough for corrective measures not to be too costly.

Solutions to some of the problems raised above are addressed herein. All these solutions have precedents, either in the U.S. or abroad. They are practical, and there is no reason to believe that they can not be put into effect. They can lower costs, hence prices, provide better quality systems, and permit a deeper domestic and overseas market penetration.

Should the U.S. solar industry perceive that these solutions have merit and will benefit the industry, the next step will be to decide what changes are the most effective and practical, in what time frame, and with what support from the U.S. Government.

Possible solutions which should be studied in depth by industry and government together, fall into three main groups:

- Pre-assembly or pre-packaging of sub-systems and systems
- Standardization of certain components or sub-systems
- Metrication of solar components (not just dimension equivalents, but actual size changes)

It is assumed that U.S. Government support will be required to help effect changes that may be perceived as valid, including use of the government procurement process to ensure demand continuity and strength during the initial stages.

Federal procurement leverage can be used in order to stimulate the solar industry to increase the use of these cost reduction techniques.

The techniques mentioned for possible inclusion in the proposed program, are not new to the solar industry. Some of them (already used with success in the building industry) are now in use by solar companies and have brought

about cost reductions and other benefits. But these techniques are not in systematic or widespread use in the U.S. solar industry.

It should be clear from the outset, however, that the steps proposed are not seen as a panacea. There is no single cure for high front end costs. A combination of factors is needed to reduce costs. Those proposed for this program are measures which have already worked and which should be given more Federal support on a sound and logical basis.

Work already underway in the solar industry has proven that significant cost reductions can be achieved by:

- Decreasing installation costs using pre-packaging or pre-assembly methods which reduce on-site time and associated programs
- Decreasing engineering design and installation costs through the use of certain standardization techniques

Some U.S. solar firms which are pioneering in these techniques have claimed up to 70% reductions of on-site labor time. Total installed system costs have reportedly been reduced by as much as 25% to 30%.

This is the appropriate time to stimulate wider use of these techniques. Their effectiveness has been demonstrated in the solar industry (as it was earlier in the building industry). A concerted program is needed, to stimulate widespread use of these means to reduce on-site problems caused by lack of skills, improperly prepared materials, weather interruptions, etc. Thus costs would be reduced by significant amounts, using proven methods, on a broader basis than now.

Before the use of industrialized techniques in the building industry was widely accepted, that industry required an assured market. As an example, in post-World War II Europe damaged buildings had to be replaced quickly and inexpensively. The U.S. solar industry needs a similar type of assured market. Then it could afford to incorporate those techniques and innovations in the production and assembly of components and sub-systems which require more investment than simple hand-crafting, and more inventory.

A program is needed which introduces pre-assembly, modularization and some degree of standardization, through use of Federal procurement specifications. They can provide an opportunity to introduce the proposed innovations with few changes in the applicable Federal rules required in order to realize the goals of the program. The initial phase would require development of procurement specifications based upon cooperative efforts with industry to identify the various options most appropriate to the program's success. Working with solar components and systems designers, manufacturers and installers on the one hand, and with architects and builders on the other hand, the specific tasks will include:

- Identification and rationalization of manufactured components and systems
- Differentiation of potential building types suitable for the program.

This will permit efficient and logical coupling of selected industrialized solar techniques with their most appropriate and related building types and technologies.

Those elements of industrialized solar techniques will thus be identified and specified, which will most practically and effectively:

- Reduce costs - both on-site and engineering costs,
- Improve performance - with more problems solved before installation
- Increase durability - with better engineering and use of materials.

This effort will also tend to:

- Enlarge U.S. domestic market acceptance of solar systems
- Improve the overseas competitive status of U.S. solar goods and services,

However, it should not inhibit the industry's creativity, flexibility or competitive nature.

The procurement specifications to be prepared during this program will emphasize the best of the state-of-the-art in solar systems standardization techniques, and the basic requirements of the building industry. They would

be tested in federal procurements and the overall program should be carefully tracked to permit detailed evaluation of its success and its problem areas.

This paper briefly looks at some of the techniques, first used in the building industries of Europe and the U.S., which have reduced costs and produced other rewards. Some successful cost reduction techniques in the solar industry are described and initial cost reduction figures and summarized. Benefits in other areas, such as better quality and performance resulting from in-factory testing and check out, are described. Methods to adjust U.S. solar energy goods and services for future foreign markets are suggested.

The conclusions are that pre-packaging and selective standardization will greatly enhance the economic potential of the U.S. solar industry. Movement into these techniques now, will save much greater effort and expense later. But U.S. Government support is needed to help speed the fragmented industry's movement along this path. Only the U.S. Government has the ability to ensure the large and sustained demand needed to give the industry the incentive it needs to broaden the use of standardization techniques. One single set of procurement specifications (that of the Federal Buildings Program) could be used to establish the initial conditions most conducive to nudge the industry along.

The end result would be to help break the chicken-and-egg problem: the Federal procurement provides industry with the demand it needs to introduce the innovations which the procurement specifications call for. Industry introduces these techniques, tries them out on a much wider basis than it now can. Costs are reduced, hence consumers pay less and sales increase.

It is early to pre-judge what specific measures might be taken to help reduce costs and improve quality by the standardization and modularization suggested, but there will probably be agreement on an approach that includes:

- More than one level of industrialization. Specifications could be met by a range of suppliers, some with large plants and some with small assembly shops, depending on the job being done
- Standarized components and sub-systems in various ranges of dimensions, thus giving designers considerable flexibility

- Commencing in a relatively modest way, and only moving to full standardization and modularization when the industry has indicated its acceptance of all aspects

The proposed program would test the extent to which the Federal mechanism can be used to stimulate these changes and then rapidly phase out of the picture. A concurrent objective is to examine how the Federal mechanism might be used cost effectively to help the industry prepare for export market requirements.

INTRODUCTION

The U.S. solar industry is still in its infancy and consists of a large number of predominantly small, disparate design, manufacturing and installation companies. This fragmented industry faces a market that is generally smaller than anticipated.[1] Demand is constrained by several factors, including high front end prices. Even where solar systems are clearly going to have a short pay-back period, many consumers are wary of making the relatively substantial investment required. Other problems have contributed to slow growth of the market for solar energy systems, including a large number of poor quality components and systems; installation difficulties; dubious performance reports; simple lack of public understanding; and Federal and state incentives that are perceived by the industry to be inadequate. However, by far the greatest cause of slow demand growth is the high price consumers have to pay up front.

In this period of random expansion, the U.S. solar industry has paid little attention to modern industrialized techniques and the requirements of the commercial building industry. Much time is lost during installation of systems because components are usually (and often unnecessarily) assembled on site. Installation labor is frequently not sufficiently trained (or if highly skilled, is extremely expensive).

Actually, the U.S. solar industry currently has its market in sight. Potential demand is significant if prices are right. Skilled labor and capital offer no barriers, assuming that prices are competitive enough to make a market. Raw materials and supplies can be found in relative abundance, as can innovative management. The main barrier is the lack of a sustained market. Thus we have the chicken-and-egg situation; prices are too high, yet can be decreased only on the basis of greater demand, which in turn awaits lower prices.

Costs of raw materials are relatively immutable in the context of one industry, especially the small solar industry. However, the labor quotient in solar energy equipment and system prices is large. To design, manufacture, and

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1 - Per private and public statements by many industry leaders and "watchers" including SEIA President Sheldon Butt, solar investment experts A. Adler and J.D. Bell. Also, personal experiences of the authors as solar specialists and businessmen.

install collectors, costs range between 1.2 and 2.2 person hours per square foot of collector.[1] This does not include labor in such related tasks as designing, manufacturing and installing piping and insulation, pumps, valves, controls, tanks and so on. It being essentially still a hand-crafted industry the labor quotient is high and may be as much as 75% of the dollar cost of a system. Costs for installation of the average U.S. solar system constitutes about 40-50% of the total in-place system costs.[2] The total percentage will inevitably decrease as more components and sub-assemblies are made in series (which will occur as demand grows). But it will not decrease inevitably unless a rational approach is made to consider pre-assembly, careful advance engineering, and specific installation tasks. That is one of the main purposes of the proposed program.

Both the residential and the commercial building industries face problems similar to those of the solar industry. Work done on-site is expensive (especially on roofs), subject to weather conditions, and is generally not as effective as the same work done under factory or warehouse conditions. In the residential field, pre-fabricated houses are built in the U.S. in increasingly large numbers.[3] Cost reductions and quality improvements can be passed along to the consumer. The work of carpenters, plumbers, electricians, roofers and so on, traditionally performed on site, is done under controlled conditions in factories. The owner can specify changes and customer modifications. Materials are not as subject to moisture damage, freezing, or being trampled, run over, or stolen. Finally, the finished house is delivered to a pre-built foundation on an agreed date, and can be installed in hours.

In the commercial building field substantial cost reductions have been achieved in Europe and the Middle East where war damage and lack of capital caused new

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1 - P. Spewak, Mitre Corp., in a personal communication. See Appendix A (Fossil Fuel Cost of Solar Heating by Payne and Doyle) which quotes Spewak and others.

2 - National Solar Heating and Cooling Demonstration Handbook, Project Experience Handbook (DOE/CS-0045/D); also from sales data provided by States Industries, Grumman Corp., Natural Energy Corp. and from the authors' experience as solar manufacturer/installers.

3 - From National Association of Home Manufacturers and the 1978 Red Book of Housing Manufacturers. See Appendix B. During 1972-78 while U.S. housing starts declined 31%, sales of major production and manufactured homes rose 48%.

trends in building to spring up in the past four decades. These cost reductions include pre-assembled wall sections and roof segments, pre-fabricated modular bathrooms and kitchens, pre-fabricated apartments and even entire floors of office and apartment buildings and areas of factories. See the Appendix for examples of this technology.

Industrialized building techniques for commercial buildings are also used in the U.S. and have allowed equally substantial cost reductions. The Appendix contains additional data on the residential and commercial building techniques summarized above.

SOLAR ENERGY SYSTEM COST REDUCTIONS

Success in the building industry's use of industrialized techniques has already been emulated in the U.S. solar industry. Significant cost reductions have been achieved by pioneer companies using pre-assembly, modularization, and selective standardization techniques. Using concepts already proven in the building industry, not only have costs been reduced but performance and durability improved. Basically the thrust of most of this pioneer work has been in reducing on-site time as pre-assembled and pre-tested modules can be installed on-site by experienced company technicians in a minimum of time.

The solar energy systems market is ready for lower cost systems. Reduction of cost to the consumer by as much as 30% are claimed by the proponents of industrialized techniques. However, progress proving the point on a broad scale has been slow due to lack of a strong market. Federal help and encouragement could help provide a steady demand via which increases in sales and cash flow could enable further cost reduction techniques to be achieved.

The next few pages briefly examine:

- The state-of-the-art in solar systems and sub-systems pre-assembly, modularization and standardization
- Benefits derived from using these techniques
- Use of Federal procurement programs and similar Federal projects to strengthen markets and allow continuity for applications which use these techniques

The goal is to identify systematically the most valid and cost-beneficial of these techniques, working with the solar industry. Then, using the U.S. Government's procurement leverage, assist the industry to put the best of these techniques into widespread use. An ancillary goal is to identify and also bring into use measures to adjust pertinent U.S. solar products and services for better acceptance in overseas markets.

SOLAR INDUSTRY STATE-OF-THE-ART

Pre-packaging, pre-assembly, modularization and some degree of standardization are not only feasible but are necessary for the degree of cost reductions which will direct the solar industry into the market which awaits it.

By introducing careful system and sub-system design engineering, by pre-assembly and modularization, and by using selective standardization to meet requirements of the building industry, some U.S. solar companies have already reduced on-site time and skills requirements, and installation problems, enough to cut on-site installation labor by as much as 30%. System cost reductions of 25 to 30% have already been projected. Yet the surface has only just been scratched. As costs fall, sales will rise; cash flow and profits will enable further cost reduction advances based on industrialized techniques.

The most compelling argument in favor of a complete study of the benefits and pitfalls of industrialized solar systems manufacture; lies in the fact that some U.S. solar designer/manufacturers have already designed and built, shipped and installed, systems of this nature. Results have been described as excellent both as to system performance and cost reductions.

This report brings together data on the work in this field by some of these U.S. solar industry pioneers. The state-of-the-art survey proposed in the recommendations would compile more detailed data in this field from around the U.S. It would also compile the advanced concepts of known and respected leaders in the building and solar industries so that the most advanced thinking could be brought together and used for planning purposes.

The Appendix provides additional details and representative information about several of these firms and their products.

Independent Living, Inc., Norcross, Georgia

Independent Living, Inc. (ILI) has developed solar sub-system and system pre-packaging and installation techniques which have reduced installation costs by an average of 65% through greatly reduced on-site time and skills. At the same time, controlled pre-installation testing procedures have improved

performance and reduced on-site checkout problems. The company uses modern building techniques to install solar collectors which have been pre-assembled into modular units, and also pre-packaged control units. ILI is currently moving toward further improvements in pre-packaging and pre-testing, and at DOE request is analyzing its cost reductions in order to derive some hard figures on savings which have resulted from its work.

Taco Inc., Providence, Rhode Island

Taco has developed a family of pre-assembled "Taco Boards" which include expansion tanks, heat exchangers, pumps, controls and valves on an externally mounted board, ready for rapid hook-up by installers. Cost reduction to the installers comes from reduced on-site time and factory quality control. Some installers and wholesalers prefer to assemble these items themselves in order to reduce costs.

Lennox Industries Inc., Dallas, Texas

Lennox is doing considerable development work in the area of cost reduction concepts, especially in factory engineered, pre-packaged equipment. They offer a system which consists of collectors, tank, and solar transport subsystem (pump, heat exchanger, controls) for space heating as well as domestic hot water. The installer makes only six connections on-site, and the space heating system is pre-sized for arrays of 15 to 30 collectors.[1] Lennox has no cost reduction figures yet but estimates they will be around 20% to 25% of total installed system costs (they were surprised when they analyzed costs, to find that labor costs were much higher than they had thought they would be).

Piper Hydro Inc., Anaheim, California

Piper, a general contractor as well as solar systems installer and components manufacturer, has developed a set of solar components which are sized to integrate into standard building dimensions. Piper makes nominal 2' x 8' solar collectors, sized to fit between the standard California 25" on center

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1 - Lennox inventories equipment at Lennox expense, thereby relieving its distributors of what might otherwise be a serious burden attributable to modularization.

roof rafters, and 14 1/4" blower housings to fit the floor joist bay standard sizes (16" OC). Substantial cost reductions have been achieved in this manner, and by careful planning as well as pre-packaging. Piper recently designed and built hot water/heating systems for a 254 unit apartment building at Ventura del Sol, with pre-assembled sub-assemblies which were rapidly and simply fitted into place. The result was an integrated system, totally pre-planned and engineered, with no increase in front end costs over a conventional system. Piper asserts it is now facing a demand so strong that its only constraint is lack of growth capital. They are now at maximum capacity, filling orders for professionals only in the building business, with pre-assembled hybrid systems that give no codes, unions, architectural or supply problems to builders.

Suntec Systems Inc., St. Paul, Minnesota

Suntec Systems make semi-concontrating collectors which consist of ten "slat" mirrors each 1 x 20 feet, slightly concave, which focus on a target preset in an "A" frame. The slats track the sun, driven together by a cable-pulley drive system. Suntec's first design was such that much field installation work was required, with consequent extremely high installation costs. Suntec has reduced on-site installation time by as much as 70%, and has improved performance and durability, by extensive re-design to include as much in-factory pre-assembly as possible.

Each collector is pre-assembled into an "erector set" concept frame, 10 by 20 feet. Only the rear leg is attached on-site by the installer, who cuts it to the required latitude tilt angle. The mirrors drop into place, pre-focussed (99% accurate), and set with a locking key; a veneer adjustment is all that is necessary at the site. The mirror drive is pre-assembled in a non-exposed casing, and the installer merely has to mount the motor. Due to the rigid framing, one motor can drive six collector frames from a center position between two groups of 3 collectors. There is less "slop" in the mirrors, so the tracking photocells are not overworked and the micro-processors perform better.

In addition to the 70% less time spent on site, the factory costs have been reduced by some 15% by improved inventory control and associated savings

from one-time assembly procedures. The system owner saves on maintenance because there are fewer parts; parts are pre-set, pre-cut, pre-fixed; sections are of tougher design and pre-sealing has also contributed to better durability. Each collector now tracks and focusses better, further contributing to more cost-effectiveness of the system.

Wallace Sheet Metal Works, Gainesville, Georgia

Wallace Sheet Metal designs and manufactures liquid solar collectors, pre-assembles them into modules on angle-iron frames in groups of four and six collectors. Wallace owns a truck crane for on-site module handling, and has developed its own rapid mounting system for industrial building roofs. The company uses Taco Boards, finds them not cheap but hand; Taco is re-designing a larger board for the requirements of Wallace Sheet Metal.

The company has developed a standardized domestic hot water kit, 72 square feet of collector with a 120 gallon tank for a family of 4 to 5 people in the northern Georgia area. Wallace built a Holiday Inn domestic hot water system, without U.S. Government assistance, which will pay off in 3 years (2 years if the new Investment Credit is applied). The system was pre-assembled, and consists of 324 square feet with reflectors, producing 80,000 Btu/hour annual average (3,000 gpd with a DT of 20°F. from 42°F. make-up water. Installed cost was $10,500, and the system was sold to Holiday Inns for $14,000. Wallace finds that its pre-assembly and use of modules saves considerable on-site time (hours instead of days) and enables them to use labor that is paid one-half of the normal skilled labor rates. Total cost reductions are being calculated, but are estimated as 20-25% of the total system costs.

Wallace Sheet Metal is now working with the University of Georgia to design and manufacture a dairy heat recovery system, and with the Coca Cola company of Atlanta which also wants to use pre-assembled modules. Wallace is also working with Mayhill (tract) Homes, which built 1,500 houses in the area in 1978 and plans more in 1979; they will use pre-assembled, standardized Wallace ground-mounted hot water systems. Wallace President, Joe Pendergrass, believes that a standardized module size or series of sizes is practical and useful for the solar industry, but not standard sizes of individual collectors, which could require excessively rigid specifications for local conditions.

It is of some interest that Wallace Sheet Metal, a 30 year old HVAC and metal bending firm, is selling solar energy systems on a commercial basis without any U.S. Government assistance for funding.

Solar Unlimited, Inc., Huntsville, Alabama

Solar Unlimited pre-assembles solar hot water, space heating and air-conditioning systems, using components (collectors, heat exchangers, controls, tanks, etc.) purchased from manufacturers. The company has designed and built a major heating and cooling system for a commercial building, and is now supplying several hundred hot water kits to a government client. No precise figures are yet available on cost reductions from the company's pre-packaging and modularization, but they are estimated to be substantial in terms of on-site labor, breakages in shipment, and quality control of modules.

The University of Alabama in Huntsville (UAH), Huntsville, Alabama

The University of Alabama in Huntsville has developed a free-standing pre-packaged module intended to be built under controlled conditions in a factory. The module is designed for new or retrofit applications. It could be brought to the site as a ready-to-plug-in module, a utility shed with solar space heating and domestic hot water production--hence multiple functions. The module reduces costs substantially, because it is pre-fabricated as a unit and lends itself readily to mass-production. The University designed and built a prototype of this module under funding by NASA, and the design is freely available to industry. NASA is using it as an example in its technology utilization program. (See NASA Technical Support Package Brief No. MSF 23925). Cost reductions and mass production potential are being evaluated along with two other allied concepts: A Plenum Wall/Roof heat transport system and an Integrated Core Module pre-fabricated control, storage and air handling system designed by two architectural and engineering firms under subcontracts to UAH.

Other cost reduction concepts using modular construction, multiple function systems (e.g., collector arrays doubling as snow fences, or storage systems doubling as building foundations) are also being investigated by the UAH team in an effort to reduce system costs.

KTA Corp., Rockville, Maryland

KTA Corp. produces a tubular concentrating solar collector, a flat plate collector, and air handling equipment. The tubular concentrator is supplied in four, eight or twelve by five foot modules (18, 36 and 54 square foot net collector area). Cost reductions result from pre-assembly which leaves only two plumbing connections to be made on-site (the company's experience is that the most expensive on-site trade is the pipe-fitter). The air handling equipment is completely pre-assembled in-factory, so that only one connection is required on-site--the AC power connection. On-site costs have thus been reduced by about 35%, depending on the application.

Motorola Corp., Phoenix, Arizona

Motorola is currently manufacturing its photovoltaic panels at one central U.S. plant. However, for the future, it is looking toward central manufacture of solar cells only, with local encapsulation and assembly of modules. This is particularly for their overseas operations, where customs duties can be drastically reduced through in-country assembly.

At present, modularization in-factory consists only of pre-assembling of their standard solar panels, and some assembly of small standard packages such as battery chargers complete with battery and mounting structure. These small packages are over-sized for most climates, merely for user and sales convenience.[1]

Company plans include near-term central manufacture of a standard set of appliances - pumps, refrigeration kits, lighting systems, and larger battery chargers. That is the trend, and they will keep up with it. (Solarex of Rockville, Maryland is already producing a complete photovoltaic water pump using a French pump, and plans other pre-packaged assemblies).

Panel sizes which are standard to the photovoltaic industry will probably be the norm in the future. Most likely the industry will follow the Jet Propulsion Laboratories' (JPL) latest size specification (Block 4) which calls for 1.2 meters (4 feet) as the standard panel size. It is Motorola's opinion

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1 - For larger systems, variations of climate and other factors for each specific site require custom sizing and pre-packaging is therefore not yet undertaken.

that appearance of large Government procurements that specify metric dimensions, would be accepted without question by the industry because their primary market is the Government.

Motorola was not able to provide cost reduction figures resulting from modularization and pre-packaging. The dominant cost in the photovoltaic industry is that of solar cells, which are very sensitive to quantity orders.

Exxon Enterprises (new name: Solar Thermal Systems Division), Burlington, Massachusetts

Exxon believes the future calls for pre-assembly and modularization. They now manufacture 2-collector domestic hot water systems, which can include a modular roof assembly kit or "basement" kit which contains the tank with integral heat exchanger, pump, controls and valving.

The process of selecting and designing other modular, pre-assembled systems is proceeding. However, the main purpose is to reduce on-site installation costs for the user of installer, thus making the products more attractive to the market. For this reason, no cost reduction figures are yet available.

Exxon is aware of the probable eventual need for metrication in some form or another, but has no plans for metrication until the market demands it.

Owens-Illinois, Toledo, Ohio

Owens-Illinois is an industrial giant in packaging products. They are presently marketing evacuated tube collectors in 4' x 8' assemblies with plans for introducing a 4' x 4' version to be used exclusively in Domestic Hot Water applications. The SUNPACK^{TM} collector is made up of a series of parallel evacuated sleeves, with the basic collector design being determined by realistic limits to vacuum product dimensions. Cost reductions are planned where on-site labor and technical supervision can be minimized. Capital investments in installation equipment and inventory will also attribute to significant cost reductions.

Westinghouse, Falls Church, Virginia

Westinghouse is now designing and marketing solar products on a whole-system basis. By offering both liquid and air solar energy systems, Westinghouse is actively incorporating new concepts which will minimize on-site

labor and installation costs. For example, the air collectors eliminate the need for intra-panel headering, rather, they have designed a unit which is internally headered and statically balanced. Westinghouse supplies collectors which measure 4' x 8', the size of many conventional building materials.

Libbey-Owens-Ford, Toledo, Ohio

Libbey-Owens-Ford (LOF) is a recognized leader in glass products. They currently manufacture a 3' x 7' flat plate collector covered by an 1/8" piece of tempered glass. LOF supplies collectors through several established sales channels within the corporation, and have had considerable experience in large collector array installations. Cost reductions have not been precisely determined yet, but substantial savings to be realized through lower on-site labor, pre-engineered mounting systems, and experience in product shipment.

DISCUSSION

The work just summarized clearly tells the planner that considerable cost reduction and other benefits can come to the solar industry via the industrialized systems approach. Potential benefits for each segment of activity needs to be determined by acquiring even more detailed and complete data than has been made available to date. At what level of continuity of production, and market size, can these benefits be realized? What impact will there be on the market, at various levels of pre-assembly, modularization and standardization? And how might these innovations impact on overseas sales? What other adjustments, such as metrication of dimensions, might make U.S. solar products and engineering most competitive overseas? What problems will be encountered in relation to acceptance by professionals and trade unions, designers, financiers, and so on?

These and other questions need to be answered through more pre-assembly, modularization and standardization techniques now used or planned by the solar energy industry.

Definitions

Advances in the field of industrialized system building techniques, particularly in those countries of Europe and the Middle East which were badly damaged during wartime or (like Sweden) have reacted skillfully to pressures to reduce costs, have given us the basis for defining how solar energy system production and installation can interface with and complement such advanced techniques.

Industrialized solar systems would include:

- Scientifically engineered, total, organized integration of all components and sub-systems into an overall system or process
- Fully industrialized systems design, production, pre-assembly and testing, transportation and installation techniques
- Modularized and standardized components and sub-systems, pre-packaged to maximize controlled production techniques and minimize on-site time.

- Fully interfaced with advanced, industrialized systems building techniques and materials.
- All components with hard conversion or rationalized metric sizes
- Inexpensive maintainability features, with maximum maintenance cost reductions through minimizing on-site skills and time required. (Such maintainability features include factory-sealed weather proofing, and using modular or pre-packaged parts with few on-site attachment points.)

The foregoing definition is ideal, and could only be put into effect nation-wide after gaining compliance from all sectors of the solar and building industries. What we are trying to identify and work toward, is the most practical middle ground which yields the most benefits with the least harmful short term disruptions.

Benefits from Pre-Assembly

The benefits to be expected from pre-assembly, pre-packaging, pre-fabrication and/or modularization of solar sub-systems and systems are numerous and have already been tested by a number of U.S. and foreign solar firms. They include cost reduction such as:

- Faster design and engineering time, as a result of the in-house use of (standardized) modules
- Decreased on-site time, with less losses due to weather, travel, materials delivery failures, on-roof work, etc.
- Less risk of production and installation cost overruns
- Reduced production costs, due to controlled climatic and other conditions, 2 and 3 shift possibilities, etc.
- Bulk materials orders, of standard sizes
- Quicker, cheaper replacement procedures
- More rational shipping, insurance, damage safeguards and procedures Use of containers; wider sales radius
- Readier acceptance in the export market

- Less expensive interface with building industry
- Less costly, lengthy test and adjustment procedures
- In-factory use of specialized skills
- Improved maintainability; reduced skills of on-site maintenance persons
- Improved installation and maintenance documentation
- Easier maintenance training

Other advantages include:

- Reduced on-site problems which normally result from leakages, malfunctioning equipment and ill-fitting components
- Increased sales as a result of lower prices; hence more jobs created for the building trades and professions
- Improved public, trades and professional understanding of solar energy systems and benefits
- Improved architectural and engineering (technical and aesthetic) support, and better distribution channels, resulting from using the systems approach

Standardization and Modularization

Standardization and modularization are, of course, two different concepts although they can readily complement each other. For ease of explanation, modularization is discussed twice although not as the same subject.

Incidentally, this paper often refers to the building professions and trades. This is done for several reasons, including the fact that industrialized techniques have already been applied to buildings, and solar energy is particularly suited to hot water, heating and eventually air conditioning of buildings. Also, the very many potential uses of solar energy in other fields, such as industrial processes, lighting and communications, and agricultural functions and processes should not be overlooked. One benefit of the study recommended in this paper, could also be to define those non-building applications of solar energy systems which also lend themselves to

pre-assembly, standardization and metrication. However, the program this paper proposes is limited to the use of solar energy in or related to buildings.

In the building business, a considerable amount of standardization and modularization have already taken place in the U.S. Plywood, wall board, insulation, nails, lumber, windows, doors, can all be ordered in standard size ranges and, in fact, cost more if not so ordered. The list should also include such things as gutters and downspouts, roof shingles, plumbing pipe and fixtures, kitchen appliances, electrical switch and junction boxes.

Modular sub-systems for buildings are also in increasingly wide use. They include pre-hung doors (often standard size), modular kitchens and bathrooms or sections thereof, wall sections, plumbing assemblies, and on through the range of modules until we get to the pre-fabrication of entire buildings. It is worth noting that several Middle Eastern buyers have purchased pre-fabricated housing from the U.S., where prices have been attractive due to a combination of currency factors and quality products built in series under controlled (factory) conditions.

The U.S., while still behind Europe in industrialized techniques for the building and furnishing of commercial/industrial buildings, uses such techniques where local codes and economic or labor factors permit.

The U.S. solar energy industry, to its great advantage, already uses some standard components: Plumbing and electrical fittings, insulation, tanks, screws, nuts, bolts and so forth. Modular sub-systems are used, including pump/heat exchanger/control boards, fan-coil units, stone lined storage tanks with resistance back-ups, etc. Some designers and manufacturers make collectors and other components (such as blower housings) to fit between rafters or in floor joist bays, for easier (hence cheaper) integration into regional building practices. But so far very few solar manufacturers turn out pre-packaged systems, and those who do are usually not making them to any standard size ranges. Even the pre-packaged solar hot water heaters

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which are on the market, vary considerably in component and system sizes.

It is probably quite impractical, and indeed not even valid, to seek total and rigid standardization on the grounds that it would lower costs nationwide. No purpose would be served, and many problems would be raised, if the Federal Government were to attempt to make all solar components or systems fit into the same mold. However, enough work has already been done in the fields of standardization of certain components and modularization of sub-systems, that we can assume that the net benefits derived from such initiatives could be very large for the solar industry. Thus, they merit close study, inspection and definition.

The approach we recommend is flexible, and is geared to creating a demand which will pull the solar industry toward that degree of pre-assembly, standardization and metrication which industry and government agree upon, in a practical time frame and without inhibiting small business, innovation, aesthetics or customizing.

Benefits of Standardization

The benefits of standardization and modularization are much the same as those of pre-assembly (which, of course, also includes the use of modules). They also include such additional benefits as:

- Lower engineering costs resulting from the use of well-known, standard sizes, shapes and modular sub-systems.
- Less qualified, lower paid skills are needed in design of systems, of bid packages, and in responding to calls for bids and proposals
- Less on-site time is needed, and less skilled labor, for installation of familiar items

Other Export Considerations

Many solar experts believe that, in addition to the U.S. domestic market, the largest near-term market for U.S. solar products and services (especially high technology products) will be overseas. Some claim that the LDCs (Less Developed Countries) represent a truly huge potential market because

of their great need and their strategic location in the Sun Belt.

The figures projected by PRC (Planning Research Corporation) and SRI (Stanford Research Institute) in 1978 are very encouraging. PRC's compilation of data from a large number of sources for the DPR (Domestic Policy Review) can be summarized as follows:

Global Solar Investments (1978 $)[1]	Year
$500,000,000 to $3,000,000,000	1985
$1,800,000,000 to $7,600,000,000	2000

SRI's figures for cumulative capital expenditures associated with the level of solar energy use which they assumed, were:

Global Solar Investments (1978 $)[2]	Year
$12,000,000,000 to $18,000,000,000	1978 through 1985
$420,000,000,000 to $580,000,000,000	1978 through 2000

The foregoing figures are based upon a large number of variables and should be seen only as a rough indication of the international solar market potential. Without benefit of market surveys, many large European solar energy firms are already investing heavily in stimulating and capturing a large share, of the LDC markets.[3] Their optimism is justified so far, especially in the photovoltaic field where international funding has provided a stronger demand than exists in Europe. Some U.S. firms have already been successful overseas; Revere Copper made its largest single sale of solar collectors (50,000 square feet) to Saudi Arabia in 1978.[4]

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1 - DPR International Panel, Market Report (PRC), October 1978, Table 3, page 22.

2 - "Potential International Solar Energy Markets," SRI for the DPR, September 1978, pages 3 and 4.

3 - DOE/CS/ISCWG "Solar Energy Commercialization for European Countries," Volume 1, page 7. December 1978 (Payne Inc.).

4 - William J. Heidrich, Revere Solar and Architectural Projects, in a personal communication, January 1979.

The primary overseas market for U.S. solar products will most probably be in specialized components such as solar cells and photovoltaic packaged systems, other high technology pre-packaged systems, high quality design engineering, and the licensing of U.S. products for manufacture abroad. Joint ventures, partial ownership, and overseas assembly operations will also contribute to this market. In almost all cases, U.S. goods and services will be more acceptable if they are easily adaptable to metric components. Design of systems, repair of damaged parts, replacements, and hooking up to metric piping or 240 volt AC 50 cycle power, are easier if the U.S. product is prepared for this adaptation. The U.S. designs and hardware which will best compete in what promises to be a stiff international competition, will be, inevitably, those which are deliberately geared to export market requirements.

Metrication (not just dimensional equivalents but actual size changes) may be mandatory in the future, to successfully compete overseas. Pre-packaging is already considered important to those U.S. firms wishing to find sustained overseas markets.[1]

Apart from metrication, there are other export considerations which may be attractive options or even mandatory for successful U.S. competition overseas. These certainly include pre-packaging, modularization and such things as export labeling and packing care. This paper does not discuss such considerations, because they are not as obviously useful or as clearly cost effective as metrication. However, this program should also include examination of these options because they are closely related to the investigation that must precede any decisions on metrication. It will cost less to examine these issues concurrently rather than at a different time. Therefore, the proposed program would include provisions for identifying and weighing the value of such issues.

Problem Areas

There are some significant problem areas which must be explored before the proposed program is presented in the Recommendations. However, none of the

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1 - From personal communications with Robert McGuiness of Motorola Corporation, Patrick Scalli of Daystar (Exxon Enterprises) and others, March 1979.

arguments against elements of the program (arguments summarized below) appears to outweigh the program's potential benefits.

The large scale purchase of solar energy equipment for use in Federal buildings is being eyed by the U.S. solar industry as the next big opportunity to make significant sales. All of the contacted sources have observed that most objections to pre-assembly, pre-packaging, modularization, standardization or metrication, would evaporate were the specifications requiring them written into a major U.S. Government procurement program.

One effective means to influence the U.S. solar industry in the directions set forth above, would be to write all or some of these potential cost saving initiatives into the specifications for government-funded buildings. New and (if practical) retrofit[1] applications, especially as they pertain to military and federally owned civil buildings, would make a good test program. But regardless of the incentives which such Federal leverage gives to industry to overcome resistance to innovations and changes, some of the counter-arguments are real and must be dealt with. These include:

- Pre-assembly and modularization will tend to drive marginal firms out of business and keep small firms from entering the industry. Increased costs of capital equipment and inventory and the need for more sophisticated skills will result in this squeeze of small companies, and may also cause a surge in prices to cover front end costs. The response to this is that the increased costs and skills are not substantial, provided the program's requirements are not initially too stringent. Many of the solar firms that already use pre-assembly and modular techniques, are small business with limited resources. In some cases (such as Lennox) a large supplier provides inventories for its distributors. Various financial mechanisms (SBA, front-end and progress payments, guaranteed loans) are available to cover reasonable capital improvements and inventory increases when the market is assured. The key is to have an assured market--which is what this proposed program is all about.

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1 - Another effective means to achieve these objectives might be through AID-funded programs overseas, also using bid specifications as the means.

- Damage in transit (for example to solar collectors) is already at a high level. Greater (than acceptable) damage can be expected when shipments include modular arrays.

  In fact, several firms are already successfully shipping modular arrays. Some use special vehicle bodies, while others use special packing methods. Attention to the packing and shipment methods of glass manufacturers and others who are familiar with large bulk shipments, is the solution to this problem.

- Standardization will tend to restrict design flexibility, to stifle creativity and to favor large ("sausage") manufacturers.

  Use of standardized components has not done this to the building industry, where some of the most innovative designs are built with standard size doors, windows, 2 x 4's, etc. In any event, this proposed program calls for only limited standardization, on a practical level, acceptable to the solar industry as a whole; and then only for certain Federal procurement specifications on a test basis. Furthermore, the program (in the case of solar collectors) forsees the use of various sizes of individual collectors, provided they fit into standard sized modules.

- The cost of metrication would be far too high for the U.S. solar industry to absorb without significantly increasing prices.

  The whole purpose of this proposed program is to help the industry cross over such front end costs, by assuring a sustained and reasonable market for those who participate. It is certain that, if metrication is inevitable for the U.S., Federal help will be necessary. Also, in the case of a young industry just beginning to design and fabricate its own special components (instead of borrowing parts from other industries as the solar industry has often done so far), the sooner it converts to metric the cheaper it will be. However, the program recognizes the difficulties of a metricized solar industry interfacing with a solidly non-metric building industry, and so metrication may have to proceed very slowly.

RECOMMENDATIONS

The recommendations made below have, for the most part, already appeared in--or are implicit in--the Summary and Conclusions or the Discussion sections above.

Program Outline

The program which is recommended, would have the following general outline:

1. A state-of-the-art survey, to up-date and add to the data already acquired by the authors. This survey should include all U.S. and selected foreign solar design, manufacturing and installation companies which are leaders in one or more of the major thrusts of the program.

2. Close coordination between this program and the National Certification and Codes initiatives.

3. In close coordination with industry, development of options for initial inclusion in a brochure on:

    - Pre-assembly and pre-fabrication
    - Modularization
    - Standardization
    - Metrication and other Export Considerations (in coordination with DOE/International Solar Commercialization Working Group)

4. Development of draft design guidelines and procurement specifications, for review and comment within DOE.

5. Re-draft of the brochure, and review by a selected industrial audience.

6. Development of interim design guidelines and procurement specifications; review within DOE, U.S. Government, and selected industry audience.

7. Final brochure for industry-wide comment.

8. Publication of Procurement Specifications.

Acquiring Industry Input

The Program Outline indicates that industry input will be obtained in steps 3, 5, 6 and 7. In fact, industry input is of critical importance to the proposed program, and is recommended that it be obtained on an informal basis throughout the various stages of the program. The state-of-the-art survey, step 1 of the proposed Program Outline, would be the first mechanism for getting industry input--at the same time as data on the various company activities is being collected.

Industry input sources will include as many individual solar companies as practical, queries to foreign companies and institutions, academic sources in the U.S., selected architects, builders/developers, exporters and financiers, and the pertinent trade and professional associations such as SEIA, ASHRAE, ANSI, ISES and so on.

At all stages, industry input would be reviewed for its relevance, cost benefits, and practicality by the most appropriate persons in DOE, NBS, DOD and other interested government agencies. Such reviews would be conducted informally for the most part, except where the Program Outline calls for formal review.

Use of the Federal Buildings Program

As noted, all industry sources contacted to date have been unanimous in their statements that a large Federal procurement which specifies the techniques proposed for this program, would overcome financial or other reservations against their use. The most suitable vehicle for near-term testing of this program, is the Federal Buildings Program. It is, therefore, recommended that the Federal Buildings Program be used as the test vehicle for this program.

Brochure for Industry Review

A brochure for review in draft stages and for final publication, is recommended as the most practical method of explaining the goals, criteria and methodology of the program, for describing the suggested design guidelines

and procurement specifications, and for obtaining industry-wide comments and a consensus of views.

The Program Outline indicates the steps by which this brochure would be put together, and the various reviews it would receive. The key, of course, is that industry be satisfied generally that the brochure meets its requirements as well as those of DOE and DOD.

GSA has no standard buildings. Although many are of similar design, there is no country-wide standard specification to which the solar industry can address itself. However, there are groups of building types which can be identified, although even here variations occur within each group. Therefore, flexible procurement specifications will be necessary.

It is recommended that the work done in putting together the brochure with design guidelines and procurement specifications, would classify solar collectors by mechanical and thermal criteria. Potential sites (buildings and grounds) would be rationalized into category envelopes. Then the appropriate mix between the two would be defined through the specifications which are developed for the program.

It is recommended that, in the interests of starting out on a test basis which does not take on more than can be handled, the first round of procurement specifications will concentrate on:

- Solar collector modules, pre-assembled
- Support structures, pre-assembled
- Insulated piping or ducting, pre-assembled
- Combination control, valve, pump and heat exchanger sub-systems, pre-packaged
- Combination solar collector arrays which form (or are integrated into) finished roof or wall structural members, pre-fabricated with insulation

Once the foregoing have been successfully tested in the program, specifications could be developed to stimulate other pre-assembly and modularization

techniques which will suggest themselves as the program progresses. This could include overall system specifications which consider overall cost effectiveness and performance factors.

The brochure would explain all these factors, and would concurrently provide a complete statement of the program:

- Philosophy and goals
- State-of-the-art
- Known and projected cost reductions
- Return on investment estimates, for government and industry
- Design guidelines and criteria
- Options and selection of initial choices
- Tasks and milestones of the program
- The procurement specifications
- Impact evaluation

Evaluation of Impact

Evaluation of the program's impact and the details of how it has reduced costs, would be of great importance to the industry. To obtain a full picture of precisely what has been accomplished in respect to each option that is selected for the program, provisions for follow-on reporting should be established.

APPENDIX - ILLUSTRATIONS

Solar State-of-the-Art Illustrations

The first three illustrations are from the work of Independent Living, Inc. (ILI) of Norcross, Georgia. They show a pre-assembled control unit for a 25-ton solar chiller, a pre-packaged modular storage tank undergoing tests, and a module of four solar collectors being lifted into place. The ILI solar collector module--consisting of four collectors in a frame of predetermined dimensions and specifications--is of particular interest because it illustrates how one form of standardizations might be accomplished. Various sizes of individual solar collectors can be fitted into standard size frames. This reduces on-site engineering and bid-package preparation time, yet does not necessitate limiting manufacturing to one standard collector size. (See pages A-2, A-3 and A-4.)

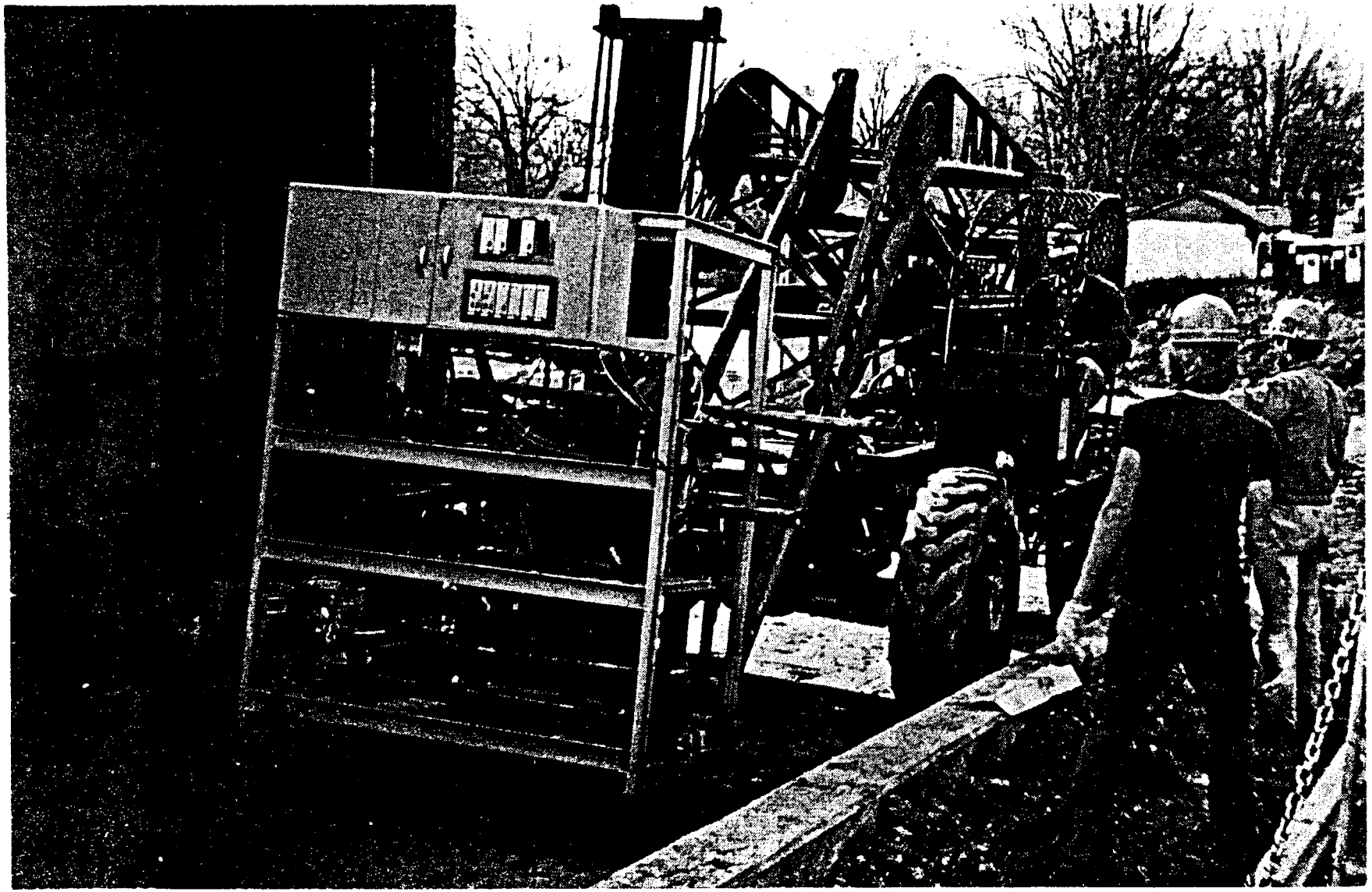
The next illustration is a Taco brochure showing a family of pre-assembled modular combinations of controls, pumps, valves, heat exchangers and expansion tanks. (See pages A-5 and A-6.)

The assembly of a Suntec Systems, Inc. module is shown next. Note the prefocussing position of the slats. Each slat contains ten 24"-long mirrors. The target is pre-assembled, and the entire drive and tracking sub-system are prepackaged. (See page A-7.) The next illustration shows the Suntec collector. Most of the assembly of this collector has been completed on-site. (See page A-8.)

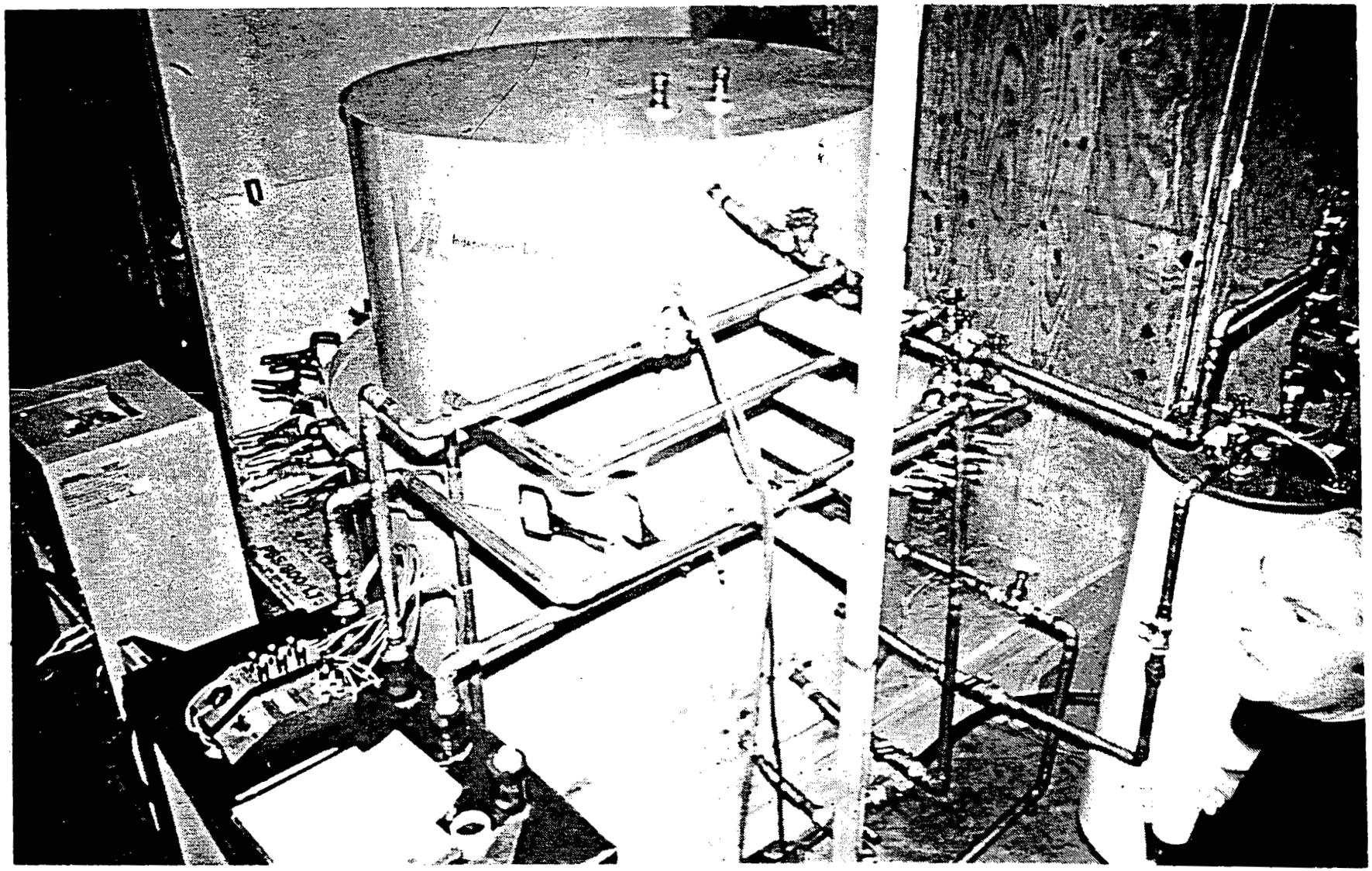
The next four illustrations show various pre-cast and prefabricated building components being lifted and installed in a building. (See pages A-9, A-10, A-11 and A-12.)

The Suncatcher Solar System produced by Solar Unlimited, Inc. is shown in the next illustration. This system is designed to use a non-toxic silicone fluid and potable water. All components are designed for long life and no scheduled maintenance is necessary. (See page A-13.) The assembly line for production of the Suncatcher System is shown on page A-14.

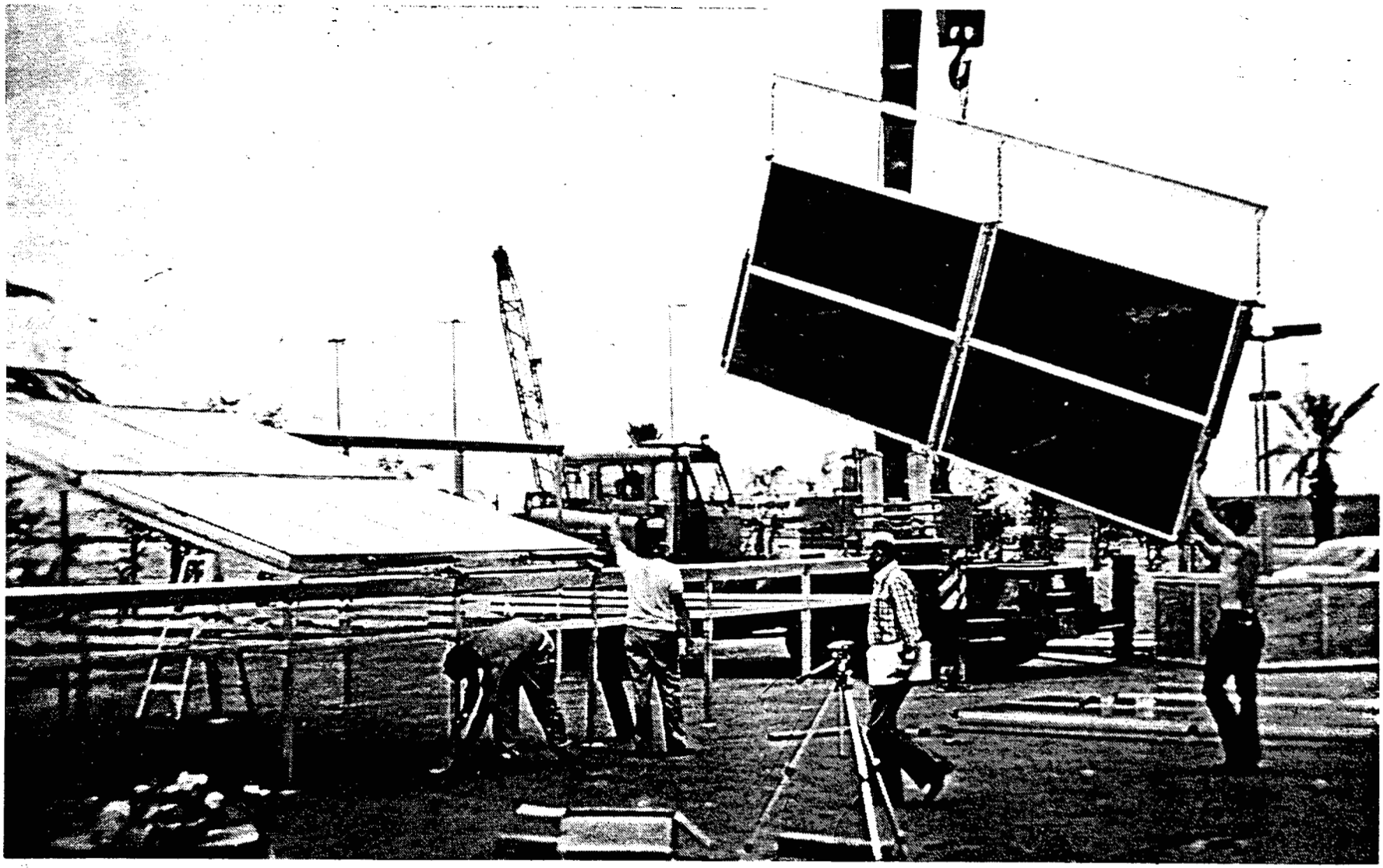
Pages A-15 through A-22 describes a solar energy heating modular system which was designed by the University of Alabama in Huntsville under a contract with NASA. The illustrations show how standard, free-standing, modular designs can be used for a number of applications. Thus, potential cost savings can be realized from mass production of similar systems.



An ILI pre-assembled solar control unit for 25-ton air-conditioning unit



An ILI 1,000-gallon, modular, solar thermal storage tank undergoing tests in a solar system



An ILI four-collector module being lifted into place by a crane

The solar age is here...

for the commercial and industrial markets

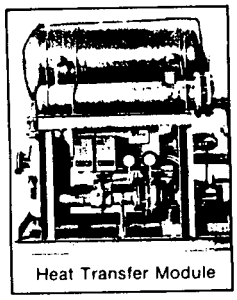
Taco

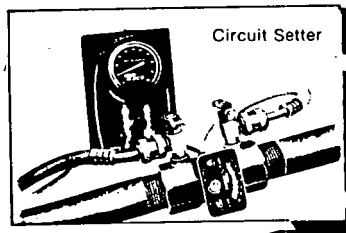
— a leader in Hydronic heating since 1920 turns its technology to the sun.

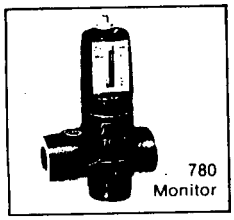
Today Taco leads the way with a complete quality line of energy saving products and Solar pumping, heat transfer, air separation, pressure control, flow metering, and electrical control equipment.

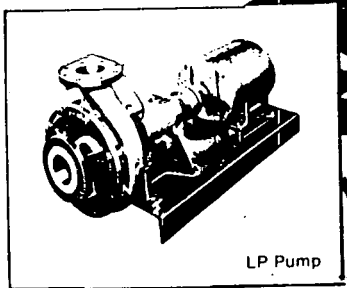
Taco makes it all . . . from small domestic hot water systems through heating and air conditioning applications using water source heat pumps. Taco Solar equipment is available as individual products or as prepackaged control modules.

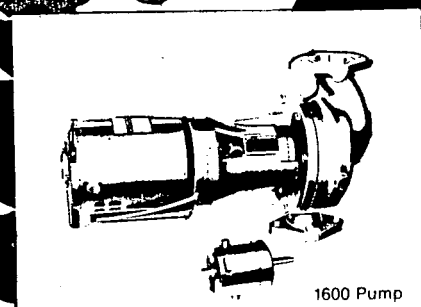
Taco Solar products are backed by a national distribution system of factory trained representatives, advanced design ideas, and proven "on the job" performance since 1920.

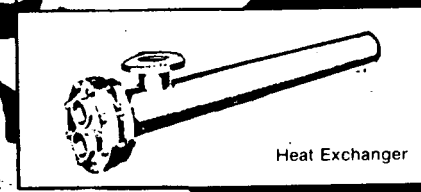

Heat Transfer Module

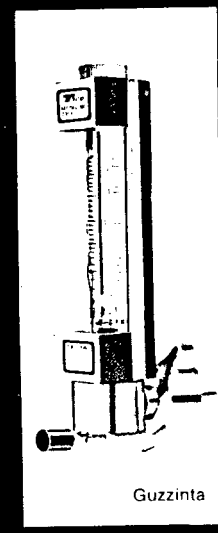

Circuit Setter


780 Monitor


LP Pump

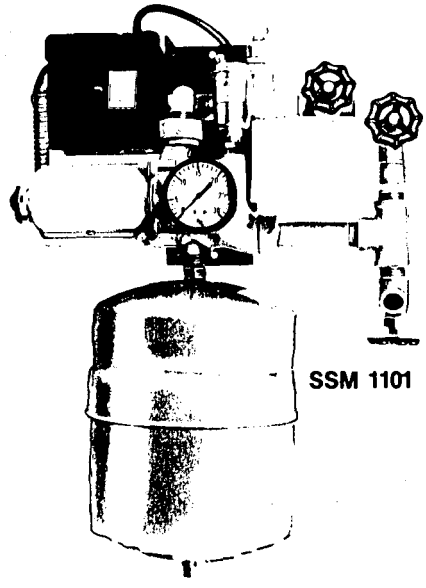

1600 Pump


Heat Exchanger


Guzzinta

1. SSM 1101 Solar Systemizer

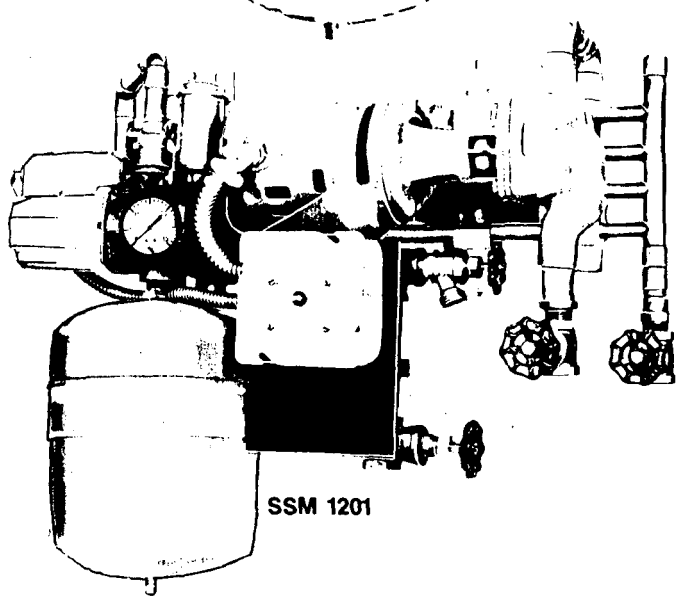
The SSM 1101 is designed for Solar systems which have a storage tank with an integral heat exchanger. The SSM 1101 contains a 008V Solar Cartridge Circulator, differential temperature controller, air vent, Flochek, pressure gauge, expansion tank, fill and drain valve, and isolation valves all in one compact, easy-to-mount unit.



SSM 1101

2. SSM 1201 Solar Systemizer

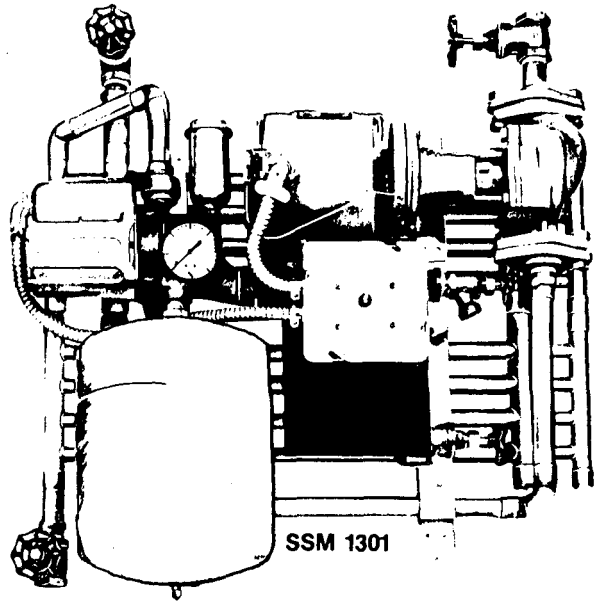
The SSM 1201 is designed for systems which have a storage tank that requires an external heat exchanger. Features include all the components of the 1101 plus a heat exchanger and bronze circulator. The 1201 delivers heat transfer capacity up to 200 square feet of collector area in domestic hot water applications. Maximum heat transfer is assured due to the exclusive counter flow design of the Taco heat exchanger, This results in maximum collector efficiency.



SSM 1201

3. SSM 1301 Solar Systemizer

The SSM 1301 features more heat exchanger capacity than the SSM 1201 . . . up to 400 square feet of collector area. Secondary pumps are available in bronze for domestic hot water applications and cast iron for heating applications. Suitable for small heating and light commercial domestic hot water applications.



SSM 1301

4. SSM 1401 Solar Systemizer

Now a Solar control module that does it all —heating, air conditioning, and domestic hot water. Only Taco has it!

The SSM 1401 is a sophisticated pre-packaged module that provides all the pumping, heat transfer, and control functions necessary in a Solar/water source heat pump designed to provide heating, air-conditioning, and domestic hot water.

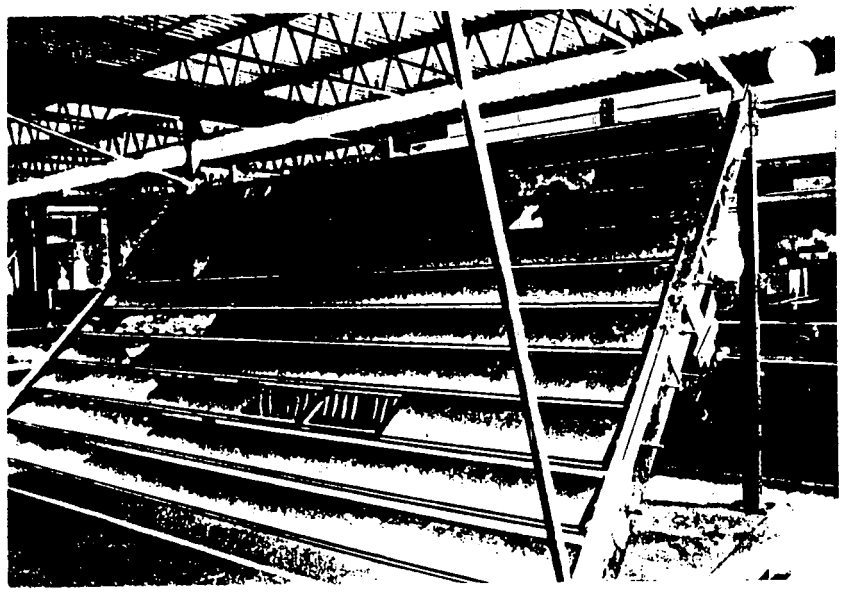
The unit features a micro-processor control which provides up to 72 different modes of operation automatically. Duplex heat exchanger, pumps, control valves and auxiliary heat source respond to the commands of the micro-processor to provide domestic hot water, heating with a duct-coil, heating with the heat pump, air conditioning with the heat pump, and heating with the auxiliary heat source.

Provision is also made to provide swimming pool heating as well as using the pool for heat rejection when air conditioning is required. In lieu of a pool, a cooling tower is used.

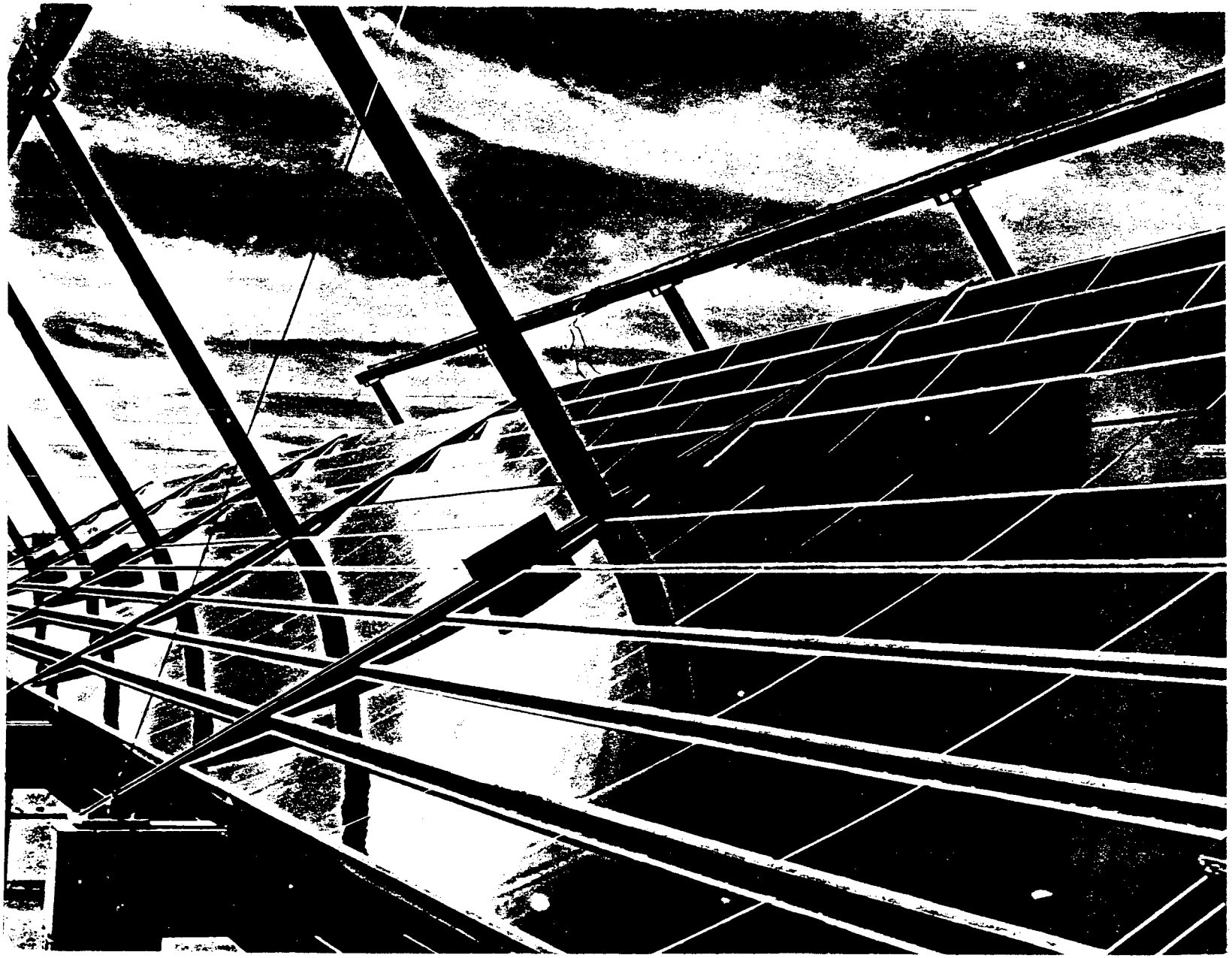
Taco

Solar Circulators

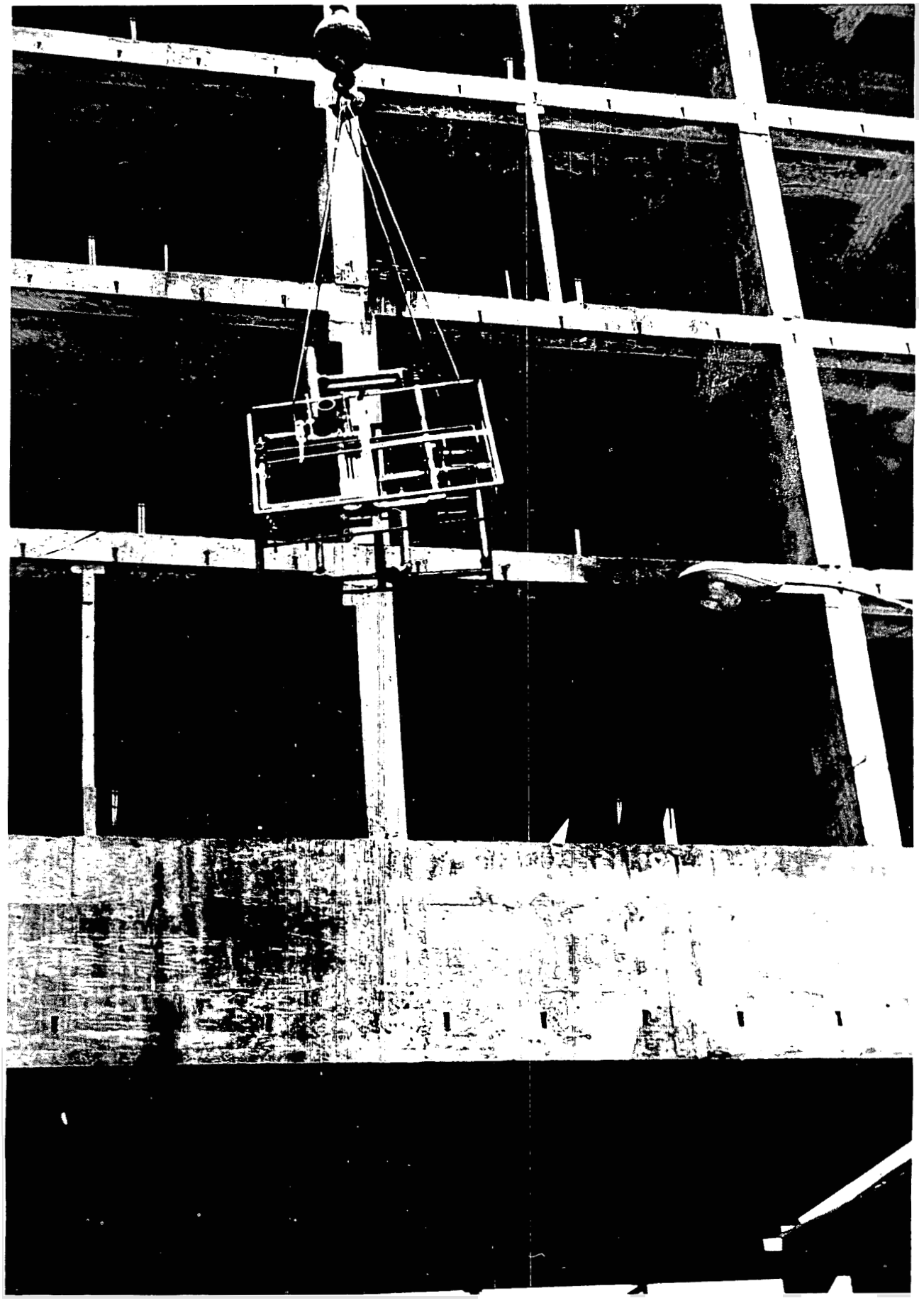
Taco Solar circulators cover a broad range of performance and applications. They are self-lubricated, UL listed, and are equipped with an energy efficient 1/25 HP, 3250 RPM motor. These permanent split capacitor motors are inherently overload protected.



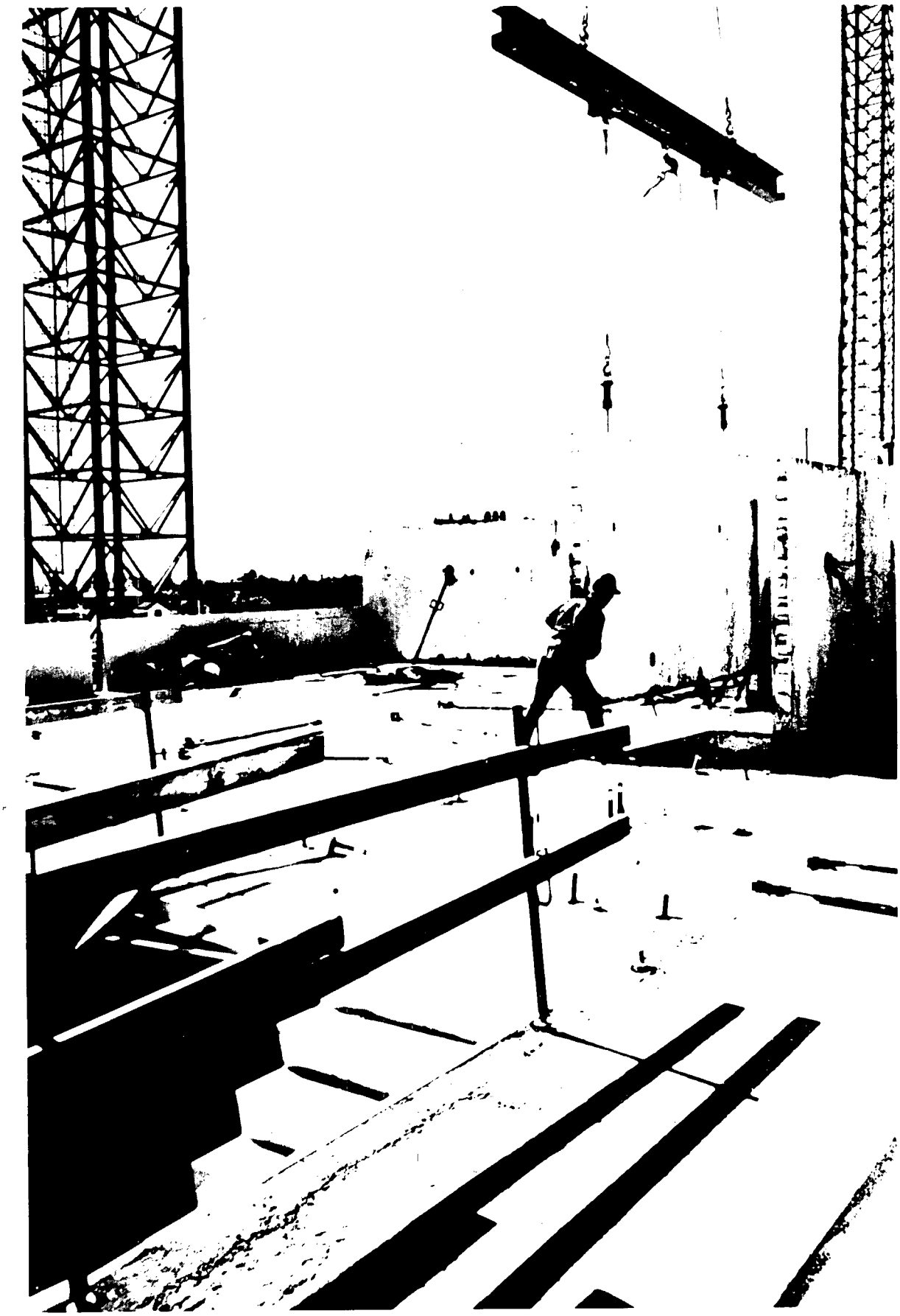
A Suntec Systems, Inc., module being assembled in the factory



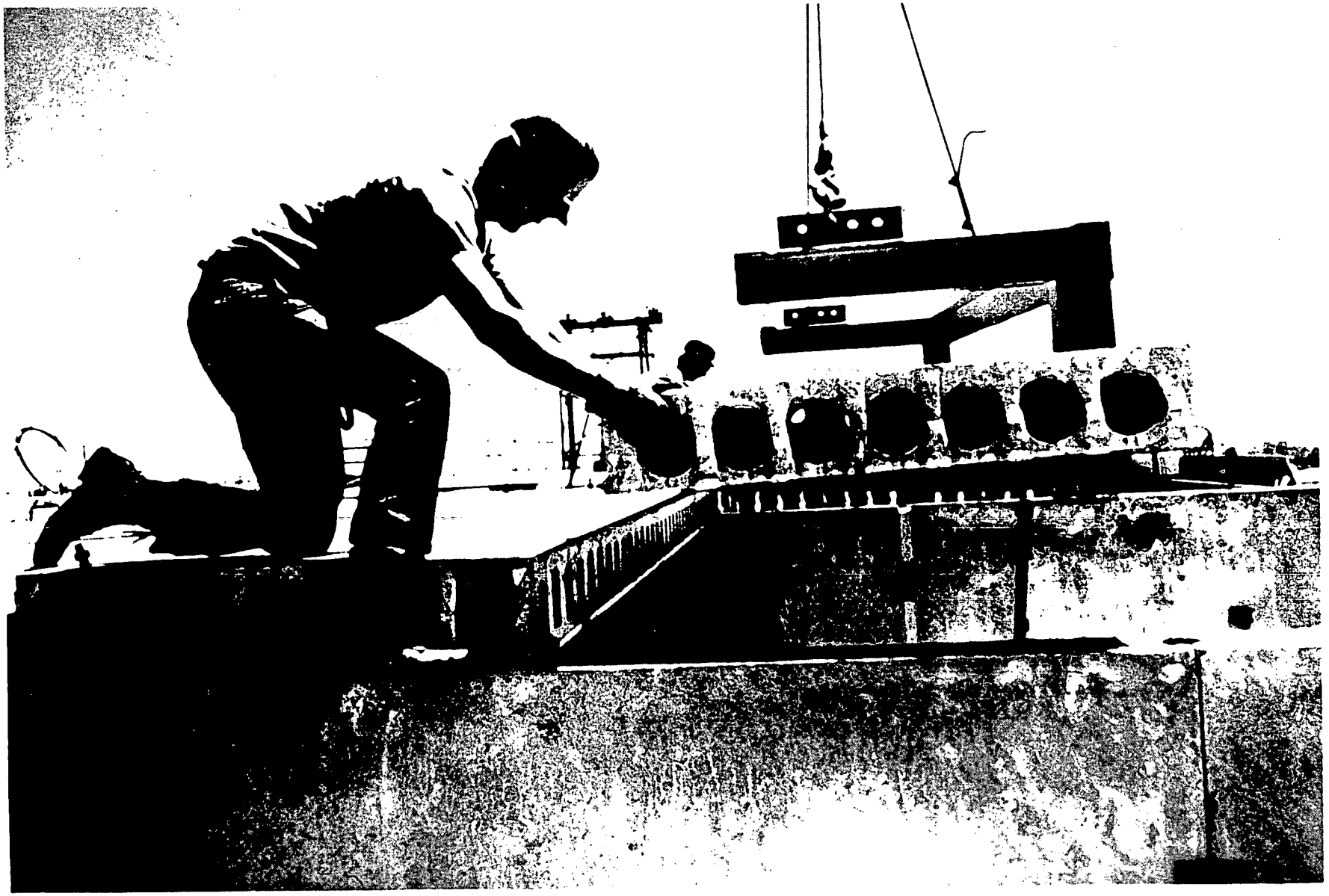
Suntech collector



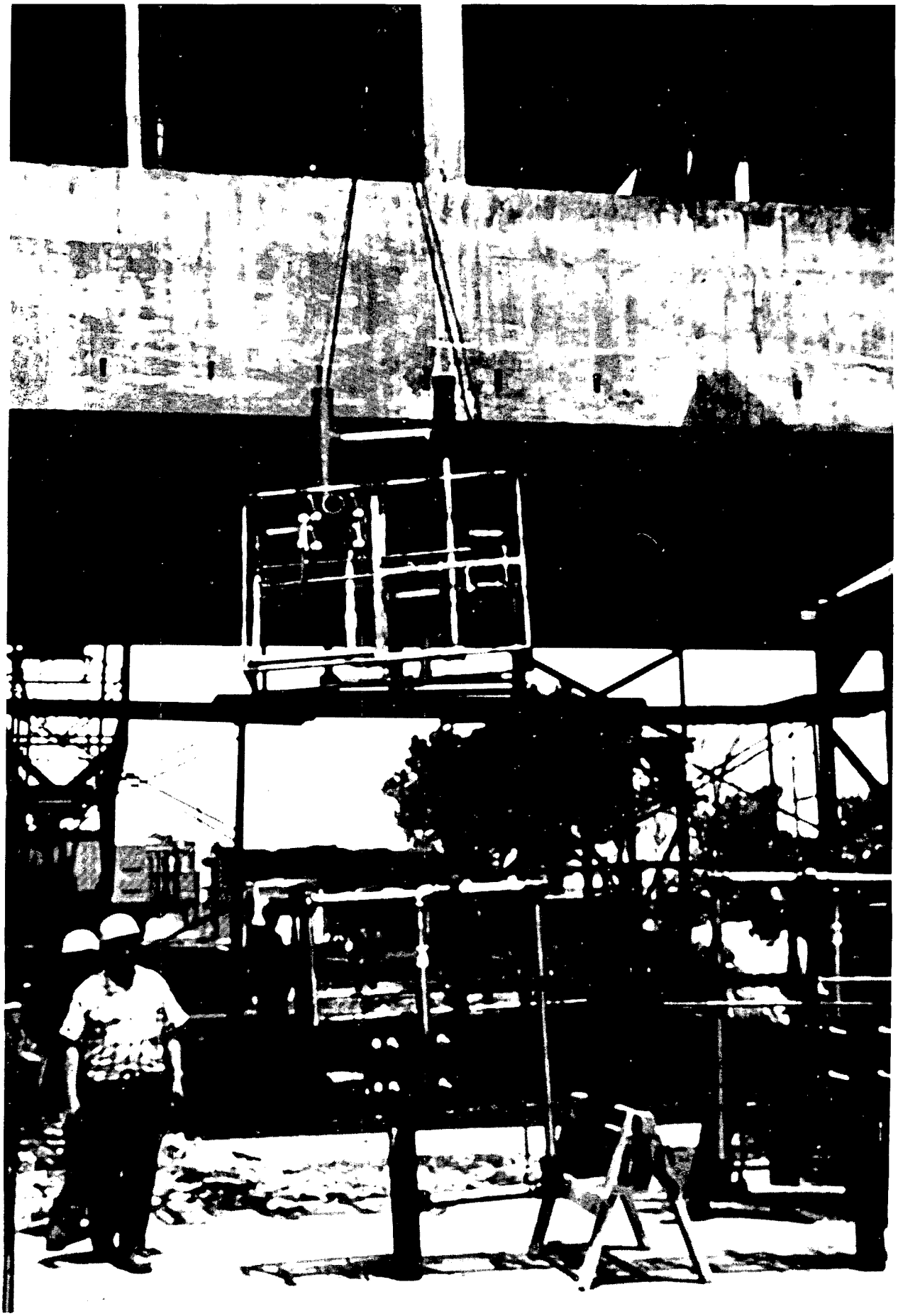
A prefabricated plumbing wall is lifted for installation



A pre-cast wall panel is lowered into place



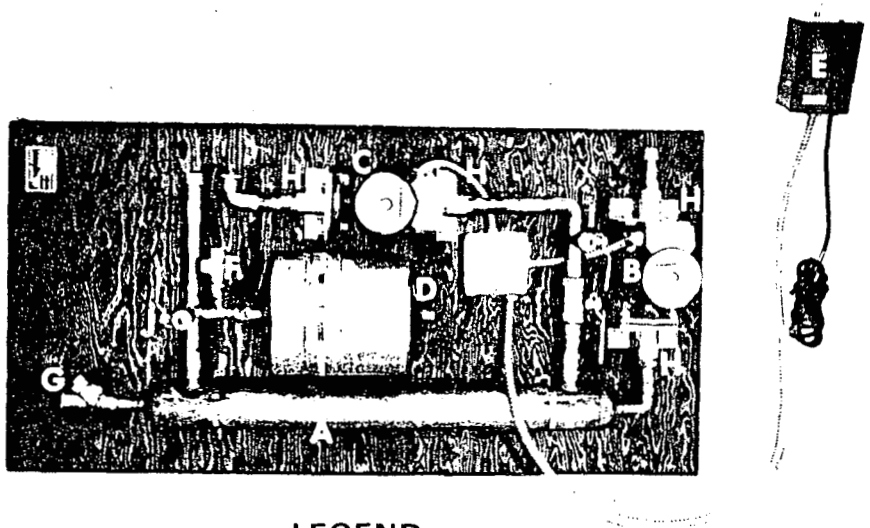
A pre-cast floor panel is lowered into place



A prefabricated plumbing wall being lifted for installation

SUNCATCHER ® SOLAR SYSTEMS

HEAT EXCHANGER ASSEMBLY—MODEL HEA-01



LEGEND

A. Heat Exchanger	E. Differential Temperature Controller	H. Isolation Valve
B. Stainless Steel Pump	F. Pressure Relief Valve	I. Inlet Fill Valve
C. Iron Pump	G. Check Valve	J. Outlet Fill Valve
D. Expansion Tank		

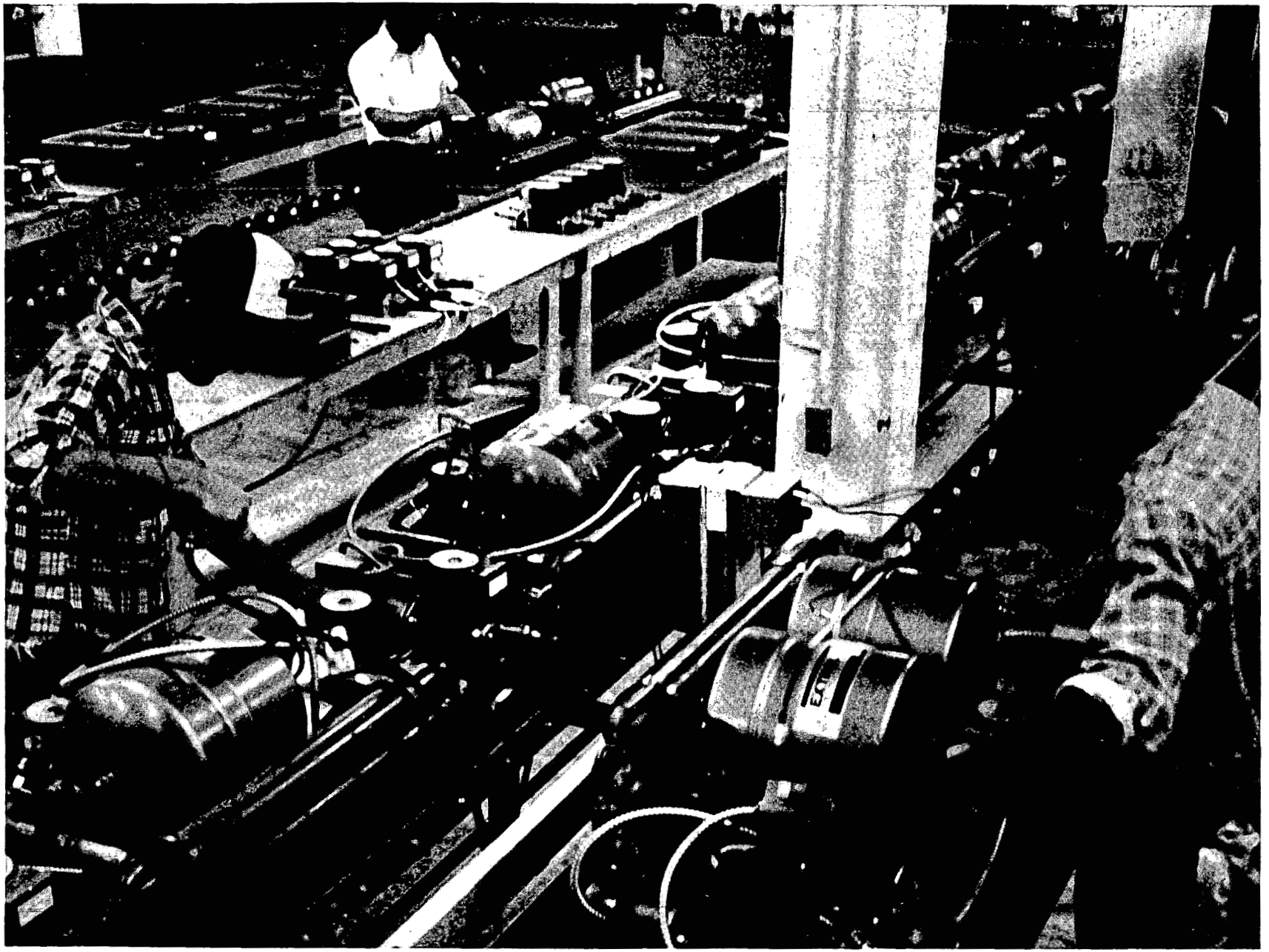
DESCRIPTION — The HEA-01 heat exchanger assembly contains all components necessary for the circulation of heat transfer fluid and water in a solar energy collection and storage circuit and for transferring the heat from the heat transfer fluid to water. It is specifically designed to use Dow-Corning Syltherm 444-an inert, non-toxic silicone fluid-and potable water. The controller allows automatic operation of the system and control set points may be adjusted if necessary. The pumps are arranged to prevent cavitation and thermal overload. The pumps are also provided with isolation valves so that the pumps may be easily removed in the event of a failure. All fill, check, and pressure relief valves are mounted in the assembly. All components are designed for long life and no scheduled maintenance is necessary.

COMPONENTS

Pumps: 1/12 horsepower Grundfos; 1 iron (UP 26 64F) in heat transfer fluid line, 1 stainless steel (UP 25-64SF) in water line. Canned, self-lubricating type with maximum current draw of 1.65 amps per iron pump and 1.75 amps per stainless steel pump in normal operation with 60 cycle 115 VAC. Warranted for 18 months continuous operation.

Expansion Tank: Amtrol Model #15 Extrol. Flexible butyl diaphragm, steel construction, 12 psig precharge, 75 psig working pressure. Acceptance volume of 1 gallon.

solar unlimited incorporated
204 Oakwood Ave., NE • Huntsville, Alabama 35811 • (205) 534-0661



Suncatcher System assembly line

The University Of Alabama In Huntsville

Kenneth E. Johnson
Environmental and
Energy Center

P. O. Box 1247
Huntsville, Alabama 35807

August 1979

SOLAR ENERGY HEATING MODULE PROGRAM

The Kenneth E. Johnson Environmental and Energy Center (JEEC) of The University of Alabama in Huntsville (UAH) has designed and developed a solar heating system using a modular design concept which could expand the market potential for solar heated water and air applications through both retrofit and new building installations. This design and development program was funded by a contract between the UAH and the NASA Marshall Space Flight Center, Huntsville, Alabama. The prototype design unit is now installed and operating at the Alabama Space and Rocket Center in Huntsville and is being used to heat the "Space Odyssey," a simulated space ride at the Center, the largest such space museum and information center in the world.

The modular solar heating system is designed to accommodate solar collectors of various sizes and types and can be used for residential and commercial applications. The unit can provide utility, workshop, or storage space, as well as providing hot water and/or hot air for various uses. Extensive insulation minimizes heat losses in the structure, the storage and the fluid handling subsystems based on testing the thermal characteristics with infrared scanning techniques.

The solar collector array of 240 square feet now uses five of the Ying Manufacturing Corporation solar collectors which were furnished by the Marshall Space Flight Center as subsystems from the inventory of solar collectors now being used in the systems development program for the National Solar Heating and Cooling Demonstration Program. All other components, materials and subsystems were acquired by the UAH Task Team and installation and checkout were accomplished as a joint effort by the UAH team, local contractors, and personnel of the Alabama Space and Rocket Center.

Some 500 gallons of hot water storage can be used to provide a year-around source of wash water for tour busses and mobile exhibit vans stationed at the Alabama Space and Rocket Center, in addition to meeting the primary space heating requirements for the space ride.

The unit is designed to demonstrate the functions and capabilities of the various subsystems, including the solar collectors, manifolds, pumps, controls, storage, heat transfer fluids and heat exchangers through the use of a descriptive layout and schematic of the various system elements.

A complete set of engineering drawings have been prepared which can be provided along with descriptive brochures, performance data, and various application layouts for do-it-yourself projects by individuals or for production or prefabrication of standard modules by utility shed manufacturers, mobile and manufactured home industries, solar collector companies and other organizations. Reduced installation costs were a prime objective of the design approach.

The following illustrations show the current installation details of the module and other possible applications now under consideration.

For further information concerning the Solar Energy Heating Module please contact:

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Johnson Environmental and Energy Center
The University of Alabama in Huntsville
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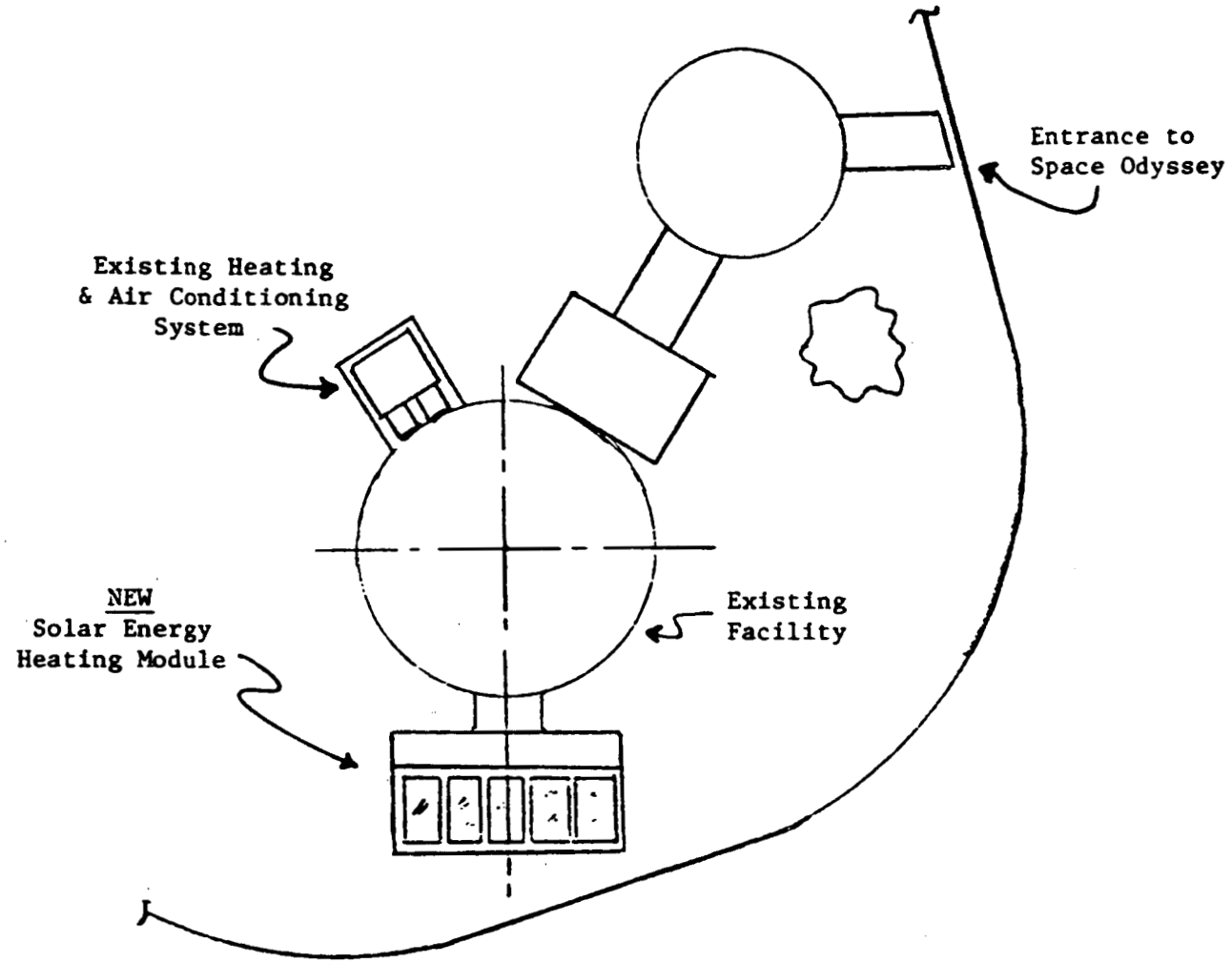
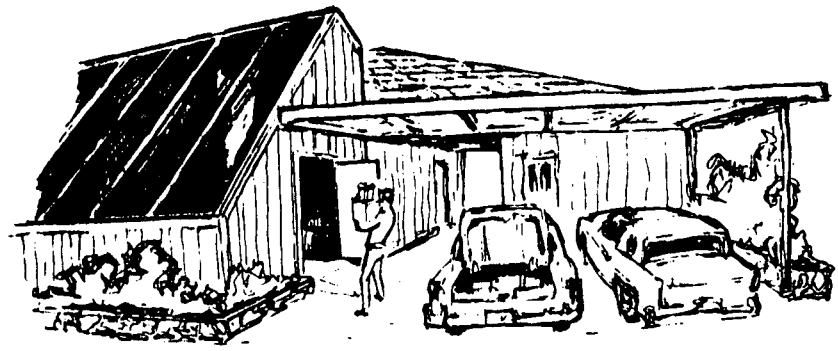
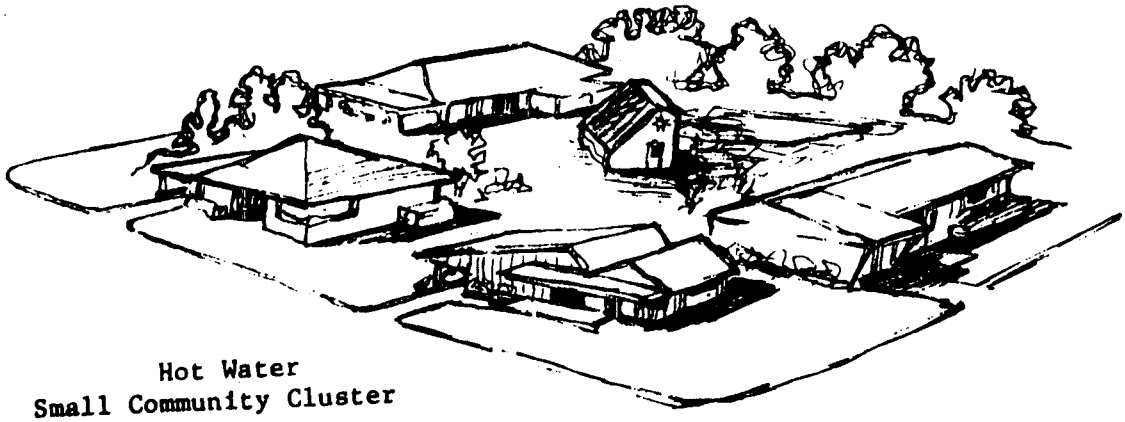


LAYOUT PLAN OF SOLAR ENERGY HEATING MODULE



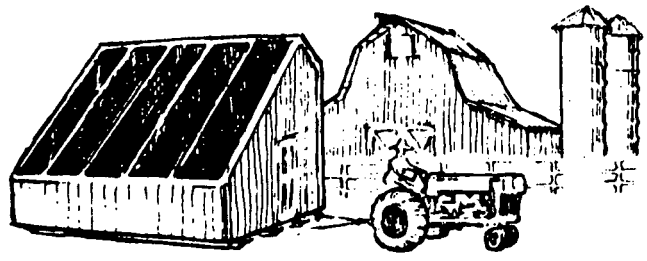
Heating and Hot Water
Single Family Residence



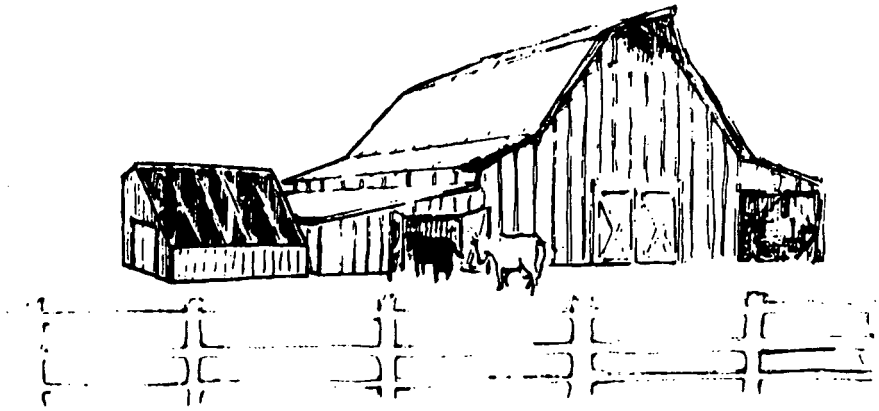
Hot Water
Small Community Cluster

Hot Water
Mobile Home Park Laundry

Space Heating
Chicken Brooders

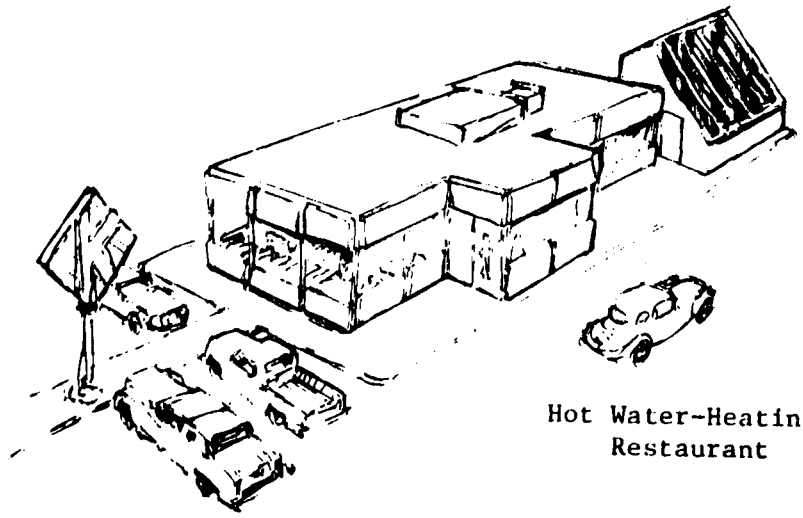


Portable Heater
Crop Drying

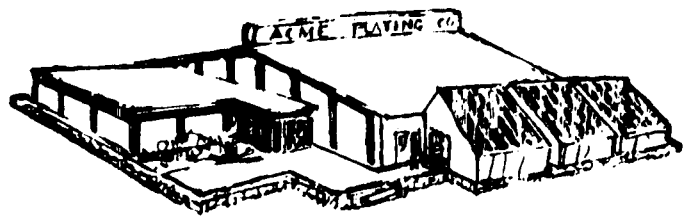


Hot Water
Dairy Operations

Hot Water
Canning Operations

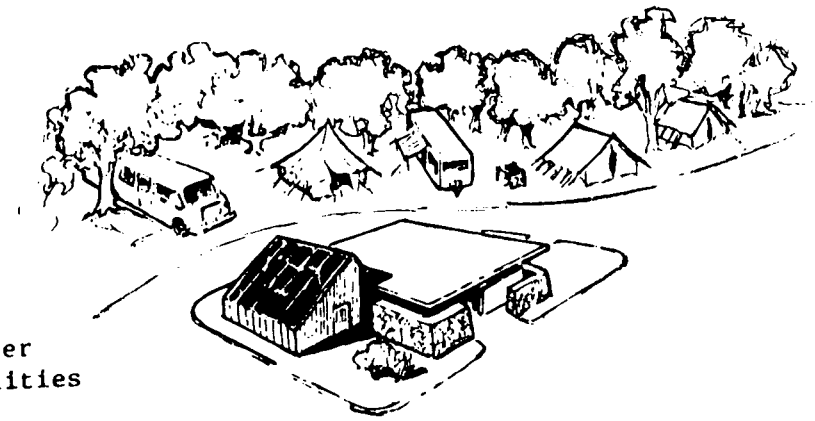


Hot Water-Heating
Restaurant

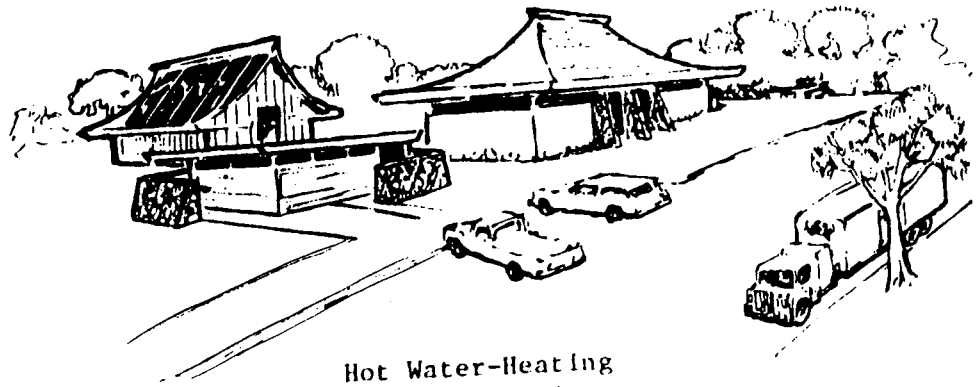


Hot Water
Plating-Film Processing

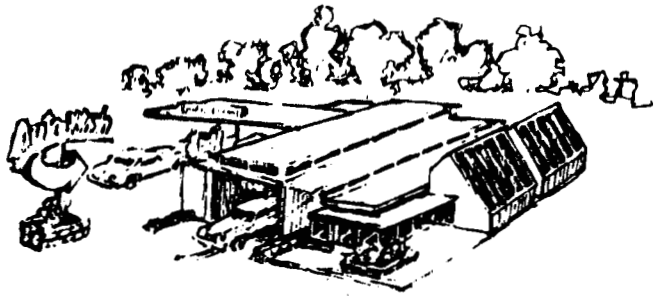
Hot Water-Pool Heating
Motel-Hotel



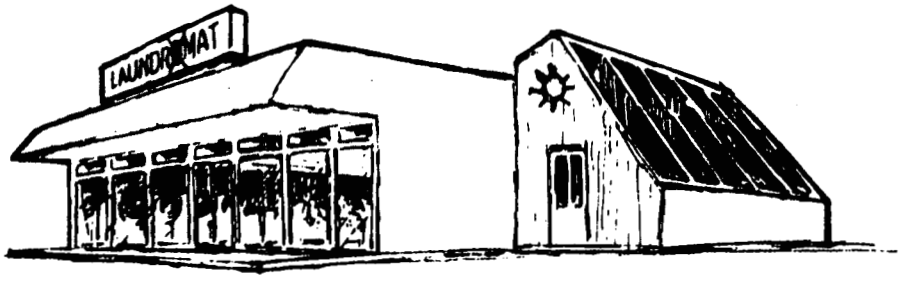
Hot Water
Camper Facilities



Hot Water-Heating
Highway Rest Areas



Hot Water
Automobile Washing Facility



Hot Water-Heating-Drying
Automatic Laundry Facility