

SOLAR SUPPLEMENT TO LAUNDRY DRYING

ANNUAL PROGRESS REPORT  
FOR PERIOD 31 OCTOBER 1977 TO 31 OCTOBER 1978

CHARLES C. SMITH

OCTOBER 1978

SOLAR ENERGY APPLICATIONS LABORATORY  
COLORADO STATE UNIVERSITY  
FORT COLLINS, COLORADO 80523

PREPARED FOR THE  
U.S. DEPARTMENT OF ENERGY  
OFFICE OF CONSERVATION AND SOLAR APPLICATIONS  
UNDER CONTRACT EG-77-S-02-4517

**NOTICE**  
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

## DISCLAIMER

**This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.**

## **DISCLAIMER**

**Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.**

## EXECUTIVE SUMMARY

A project was undertaken to develop and demonstrate solar energy used for commercial scale laundry drying. Air is heated in flat-plate solar collectors which is then supplied directly to the air intake of standard commercial laundry drying units.

The cost-effectiveness of solar energy for commercial/institutional laundry drying is high compared with space heating, cooling or service hot water heating. This is due to three factors:

1. The commercial laundry operates all year and consequently utilizes most of the solar energy available all year. The system (especially the collectors) represent greater value under these conditions because it is primarily an investment cost with very little operating cost.
2. The commercial/institutional laundry is operated during normal daytime working hours, i.e., 8:00 a.m. to 5:00 p.m., which is also the period of highest solar availability. Again, the value of the system is increased and the possibility of eliminating solar heat storage exists.
3. And, finally, the air for drying must be drawn in at outdoor ambient temperatures. This low temperature air is heated more effectively than it is for recirculated air for space heating.

The system in this project was installed on a hospital laundry facility. The facility is one year old with an excellent layout for solar collector location. The laundry dryers are next to the south wall and the south exposure is nearly totally unobscured from the sun.

The solar collection area is 43 square meters (440 square feet). This area is calculated to provide about one-half of the energy requirements of one dryer. There are three identical dryers so that direct comparison between solar and natural gas operation can be made. The operation of the laundry will not be altered in any way due to the solar system.

The study is aimed at determining cost of solar installation, fuel savings and operational characteristics. Background information about solar drying and solar systems in general indicate high potential for cost-effectiveness. The CSU laundry project will demonstrate this potential in quantitative terms.

TABLE OF CONTENTS

List of Figures . . . . . v

Abstract . . . . . vi

OBJECTIVES . . . . . 1

    Site Selection Procedure. . . . . 1

    Location of Solar Collectors. . . . . 2

SYSTEM OPERATION . . . . . 2

COLLECTOR SIZING . . . . . 6

COLLECTOR TYPE . . . . . 6

SYSTEM DESIGN . . . . . 7

PROBLEMS ENCOUNTERED . . . . . 8

PLANS FOR NEXT REPORTING PERIOD. . . . . 8

ASSESSMENT OF FUTURE PROGRESS ON OBJECTIVES. . . . . 8

APPENDIX A, Colorado State University-Poudre Valley  
    Memorial Hospital Agreement. . . . . 9

APPENDIX B, Collector Manufacturer Literature. . . . . 12

LIST OF FIGURES

Fig. 1 Solar Laundry Drying Collector Array . . . . . 3

Fig. 2 Schematic Diagram of Poudre Valley Memorial  
Hospital Solar Laundry Drying System . . . . . 4

Fig. 3 Hood on Laundry Dryer for Supply of Solar  
Heated Air . . . . . 5

Fig. B-1 Solar Collector Performance Information. . . . . 14

## ABSTRACT

A project is reported which utilizes solar energy to supplement the heating energy requirements of a large commercial type laundry dryer. Air is solar heated in flat-plate collectors and is introduced into the air intake of a dryer. The air is drawn directly from the outdoor ambient air. This system is designed for direct supply of solar heated air to the dryer with no solar heat storage. Solar heat storage could not be justified economically due to the close match in schedule between solar availability and laundry operation. The factors associated with selection of a hospital laundry facility for the project site are discussed. The design of the system for solar laundry drying is presented.

This work has been supported by the Solar Heating and Cooling Research and Development Branch, Office of Conservation and Solar Applications, U.S. Department of Energy.

## OBJECTIVES

The objectives of this project as they were stated in the Colorado State University programmatic grant proposal (June 1977, page A-51) are as follows:

- (1) Design a solar system to supplement the heat energy for clothes drying in an institutional laundry.
- (2) Install a system developed from this design in a laundry at Colorado State University or other public institution in the Fort Collins, Colorado area.
- (3) Document construction, operation, and performance data for reporting and presentation at technical and trade meetings.

The first two objectives have been met. The third has not been met due to a delay in the project of approximately five months. Objective (3) is planned and is expected to be completed by March of 1979.

## Site Selection Procedure

The initial task of this project was to locate a suitable laundry operation to which a solar system could be reasonably added (retrofitted) in the northern Colorado area. This search produced twelve prospective sites in Fort Collins, Denver, and surrounding communities. These sites included hospital laundries, the CSU Athletic Department laundry, commercial laundries, and coin operated public laundries. The choice from among these sites was overwhelmingly in favor of a laundry facility at the Fort Collins hospital. The advantages of selecting this facility were as follows:

- (1) It was a new facility with only one year of operation. This was ideal because the equipment is modern and in good condition. It was actually advantageous that it had operated one year, however, and was not completely new so that the equipment and operations were broken in.
- (2) The facility has three identical large commercial dryers which are operated under exactly the same conditions and receive the same amount of use. This made a comparison of solar versus non-solar very easy by solarizing one or two of the dryers and continuing the third on total fuel (natural gas) operation.
- (3) The dryers are located along the south wall of the building such that duct length and bends were at an absolute minimum.
- (4) The south side of the building is almost totally open to the sun in that it is a parking lot which has no plan of being changed.
- (5) Collector mounting was easily accommodated on the flat roof or on a paved ground area against the south wall.

Plans and design for the system proceeded on the assumption that approval of the hospital board and the Department of Energy for this site would be forthcoming. The approval was granted and an agreement between Colorado

State University and the Poudre Valley Memorial Hospital (PVMH) was entered into on 1 January 1978. The agreement is appended (Appendix A) to this report.

### Location of Solar Collectors

Initially the CSU staff and the PVMH staff preferred roof mounting of the collectors. This appeared practical because it would put the collectors out of the way and secure from most hazards. This, however, did not conform to the roof guarantee. Furthermore the roof was leaking from unidentified causes.

A second suggestion of hanging the collectors just over the roof on the south wall was pursued. This approach proved uneconomical structurally. The overhung collectors would exert a bending moment on the south wall which was unacceptable to the building's structural engineer. In addition, upward pressure from the high local winds demanded further structural support. The final structural design called for foundation piers with massive steel columns and beams. The structural steel cost under this scheme would cost far more than the collectors. Also the appearance would be objectionable due to steel cross bracing.

The final consideration, which proved to be most satisfactory, was to mount the collectors on the ground next to the south wall. Fig. 1 is a photograph of this installation. This location proved to be very satisfactory and at least cost. The collectors are skirted on the front and ends, which reduces heat loss and pressure from the wind. It also adds to the appearance and provides some storage space. A third advantage was the speed of collector installation near the ground. Three men, inexperienced at collector installation, installed all 22 collector panels in six hours without the use of a crane.

The framework of the collector support consists of 5 by 10 cm trusses at 0.6 meter spacing. The top surface and the sides are sheathed with one cm plywood for rigidity. The collectors finish off watertight so that untreated wood was used beneath them. The ends and front of the framework are covered with painted galvanized steel for appearance and weatherability.

### SYSTEM OPERATION

It was necessary to have the exact site determined before very much system design could be done. This was simply because there are different laundry drying operations with dryers requiring different temperatures and air flow rates. The most significant factor, however, was the daily schedule of demand since this determined the need for heat storage.

One reason the PVMH laundry was chosen was that it operated on an excellent time schedule with respect to solar availability. The laundry is operated from 7:00 a.m. to 4:30 p.m. for five days per week and usually for six days per week. Of course it is also operated throughout the year. As a result, there is only one day per week that solar energy is available and is not fully utilized directly. The use of solar heat storage to store one day's energy out of seven is not deemed practical. Furthermore, with

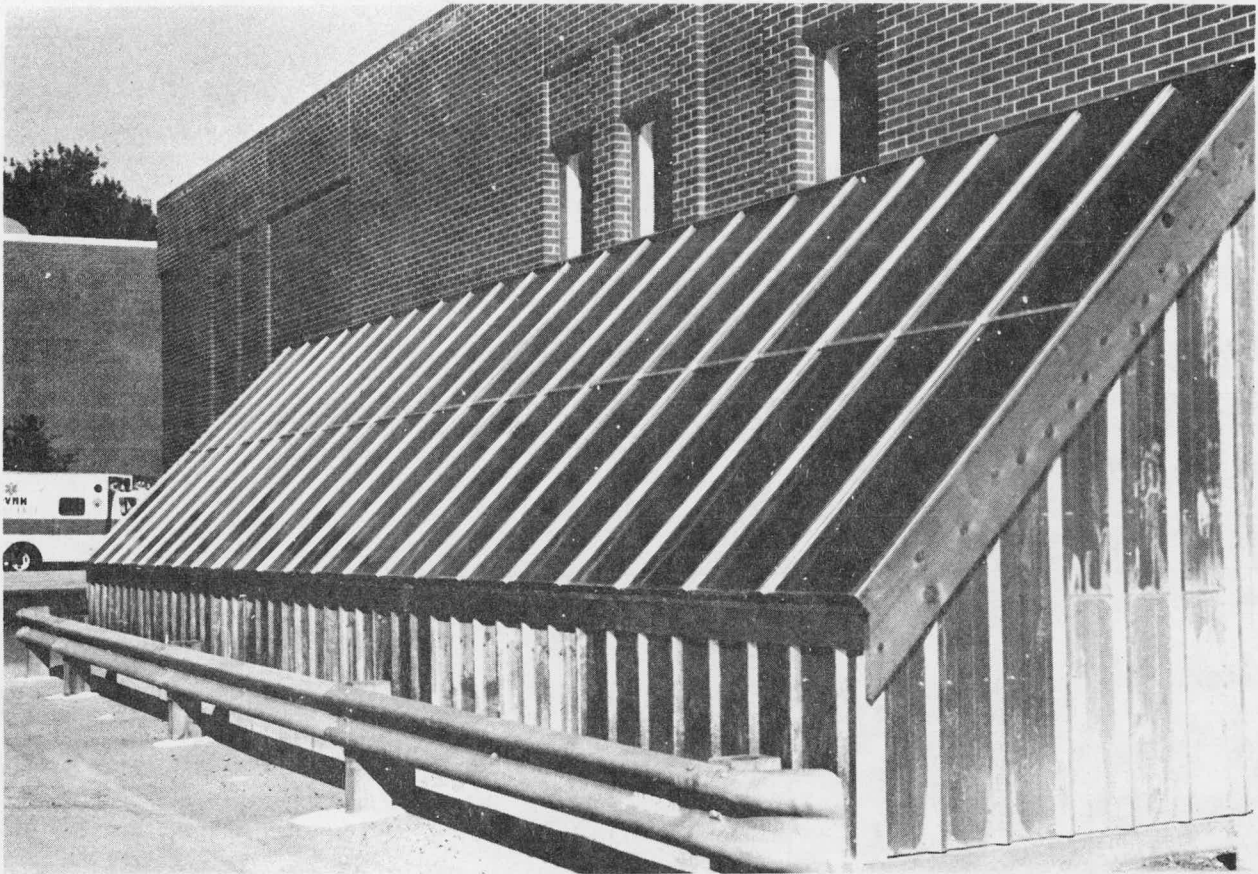


Fig. 1. Solar Laundry Drying Collector Array

increased demand on the laundry, a seven day per week schedule may likely be introduced in the future.

The elimination of solar heat storage greatly reduces the cost of the installation, not only for the storage unit itself but for ducts, dampers, and controls. Also, the cost of blower power to force air through the storage unit is saved over the useful life of the system. Fig. 2 is a schematic diagram of the system designed for the Poudre Valley Memorial Hospital dryers.

Under previous operating conditions air to the dryers was drawn directly from the building interior space. This air was drawn into the building through a roof hood and tempered with a steam coil heater. A natural gas burner atop each dryer heats the air to the temperature set for drying (typically 80 to 90°C). Consequently the air is heated from two sources, first by the tempering coil to room temperature (i.e., 20°C) and finally by the dryer itself by direct fired natural gas.

The solar system draws air directly from the outside and delivers it to the dryer intake first before crossing the gas burners. The reason for taking in outdoor air directly rather than taking in room air to the collectors is twofold. The outdoor air is usually at lower temperature than

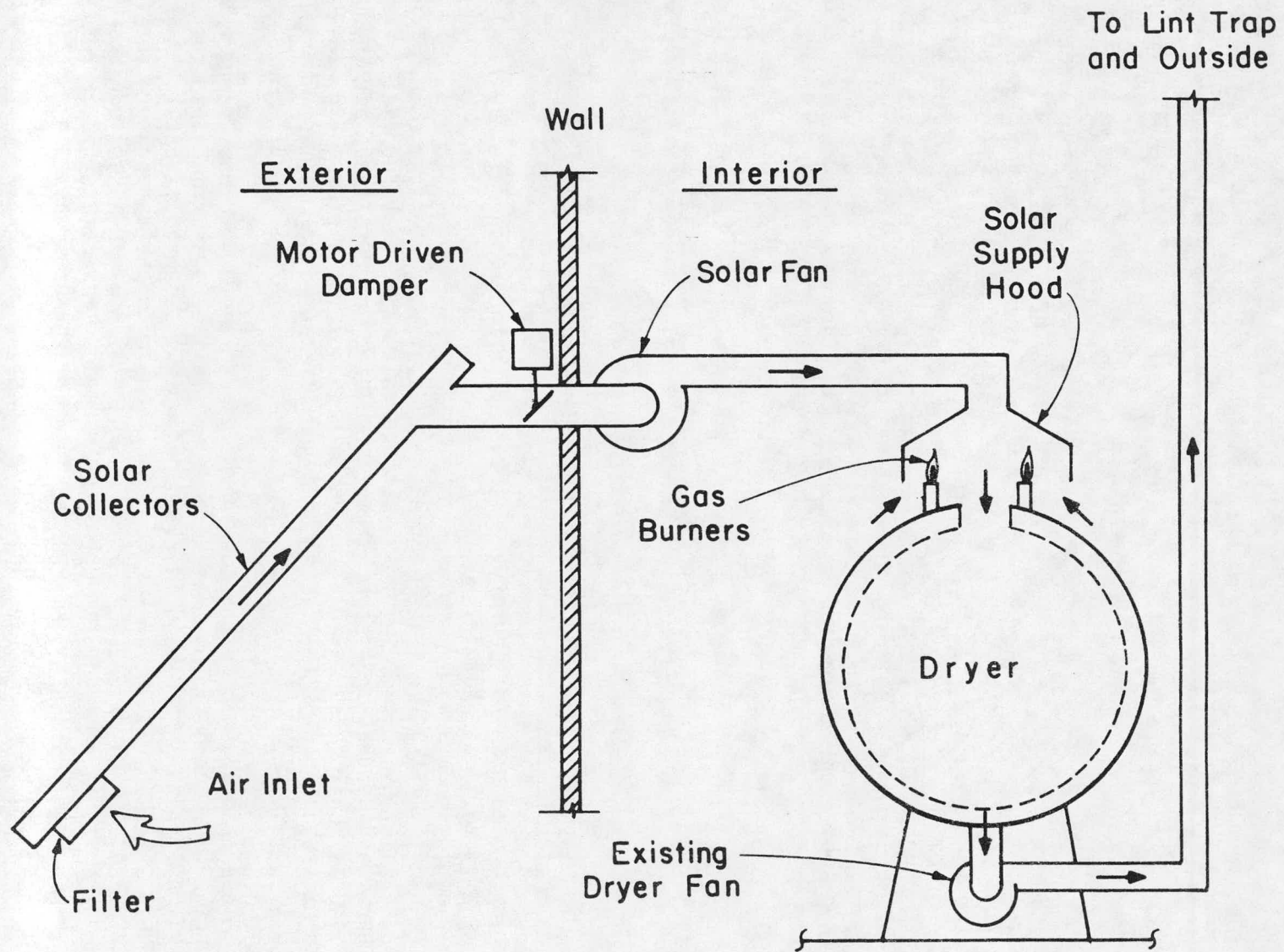


Fig. 2. Schematic Diagram of Poudre Valley Memorial Hospital Solar Laundry Drying System

indoor air and as a result the collector will operate more efficiently by heating the outdoor air. Secondly, there is no need for return air ducting to the collectors or another wall penetration into the building for a duct. This, of course, saves installation cost for the duct and also some fan power.

The air to the dryer may still come from the interior space if necessary. The reason this may be necessary is that the gas burners of the dryer are only capable of heating the air to an 80°C rise. For a 90°C drying temperature, the incoming air must be above 10°C. Therefore on a cold day with low solar input, it may be necessary to shut off solar and rely completely on fuel. That is, to draw inside air and operate as previously designed.

Fig. 3 is a photograph of the dryer intake hood. When solar is used, both the dryer fan and the solar fan are on and the damper is open. The air flow is carefully balanced so that solar heated air does not spill out into the room but also the inside air is not drawn into the dryer. Strips of ribbon hung from the lip of the hood show at a glance if the flow is out of balance and, if so, the solar fan speed may be adjusted. When air temperature from the collectors is too cold to meet the requirements as explained above, the solar fan is turned off and the damper is closed. The inside air is then drawn under the hood and into the dryer.

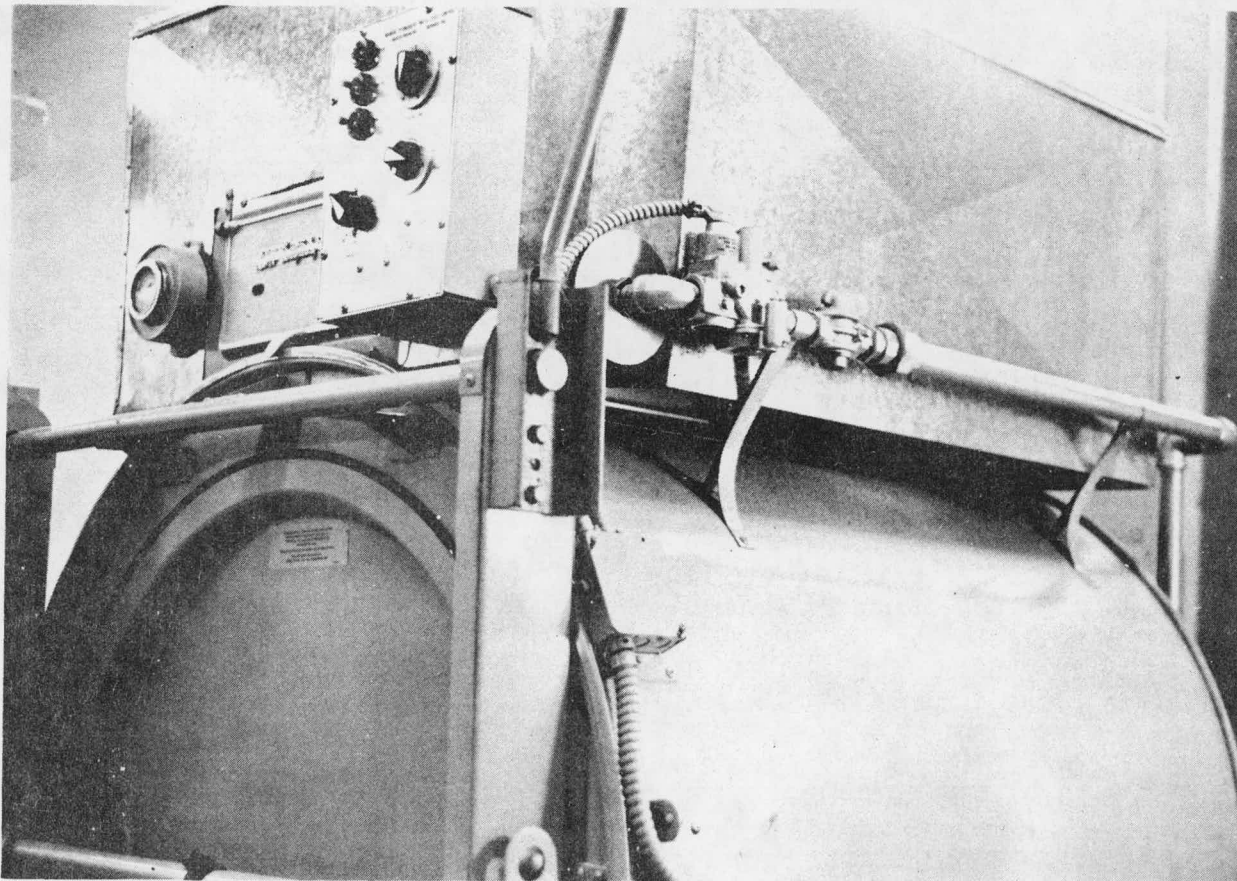


Fig. 3. Hood on Laundry Dryer for Supply of Solar Heated Air

An intermediate damper position will be experimented with to allow some "leakage" from the collectors under low solar conditions. This would allow for small contributions of solar heat when the full solar operating conditions just described are not met.

The clothes moisture and some variation in laundry loads in the dryer may result in small fluctuations of air flow drawn by the dryer fan. If it is established that such fluctuation is outside acceptable limits for air flow balance, solar air flow control will be provided. This can be accomplished easily by modulating damper control.

#### COLLECTOR SIZING

The PVMH laundry operates three industrial dryers, each rated at 53 kW fuel input. Under near ideal solar conditions, by heating ambient air a solar collector can deliver 700 watts per square meter. To meet the heating load of one dryer under the best solar conditions, the collection area would thus need to be 75 square meters. Half of the load (as selected as a goal in the proposal) would require 38 square meters.

The size is also established by collector panel size available and the space available. The width of the total array was limited by exit doors on each end of the building. The actual area selected was 41 square meters.

#### COLLECTOR TYPE

The collector array is made of 22 panels, 3.1 meters long by 0.61 meters wide, for a total gross area of 41 square meters. The net area of absorber surface is 38.4 square meters.

The collector is a commercially available unit manufactured in Denver, Colorado (see Appendix B). It was shipped preassembled. The installer bolts aluminum cap strips into place and connects ducts to duct collars provided on the collector back. Appendix B is the manufacturer's literature describing the solar collector construction with illustrated drawings. The collector is single glazed with a black chrome selective absorber surface on copper. Air is passed below the absorber sheet for heating.

Ambient air is brought in at the lower end of each collector through air filters. The air exits at the top of each collector through a 21 centimeter round duct connection provided by the collector manufacturer. The back of the collector is insulated with 5 cm thick polyurethane foam in addition to 2 to 6 cm of fiberglass insulation. The thermal resistance to back heat loss is  $3.52 \text{ m}^2 \cdot ^\circ\text{C}/\text{watt}$ .

Collector efficiency from the manufacturer's literature is shown in Fig. B-1 (p. 15). This efficiency is given for an air flow rate of 5 liters per minute per square meter of collector area, whereas the actual flow rate at the laundry will be 9 liters per minute per square meter. The higher flow results in higher velocity over the absorber plate and, consequently, a somewhat higher efficiency is expected.

## SYSTEM DESIGN

The system design objectives, consistent with cost, were as follows:

- (1) No alteration to present dryer operation
- (2) Maximum solar thermal efficiency
- (3) Maximum utilization of available solar energy
- (4) Minimum electric power for fan.

The first item pertains to the air flow rate and the control scheme. The same air flow rate which the dryer already uses was used for the solar collectors. This meant that the solar collector air passage had to be sized to provide the optimum velocity of air through the collector; high enough to provide good convection heat transfer from the absorber plate (item 2) but low enough to minimize fan power (item 4).

The collector air flow was established as being the same as used in the dryer at 700 liters per second at atmospheric pressure and 20°C. The velocity also depends upon the total collector area and the flow pattern within the collector array.

The flow pattern is simply parallel flow in each of the 22 collector panels. The area is again 41 square meters. This results in a velocity of 2 m/sec through the collector air passages. The flow rate yields a pressure drop of 63 mm water static pressure through the collector, which is a reasonable pressure drop in terms of fan power requirements.

The thermal performance related to air flow is obtained by first considering the development of turbulent flow, which greatly enhances the convection heat transfer coefficient. The Reynolds number based upon plate spacing is:  $Re = \rho VL/\mu = 2670$ . Turbulent flow exists for aspect ratios (collector length divided by plate spacing) over .0021  $Re$ . For this collector: .0021  $Re = 5.6$ . Since the actual aspect ratio is 120, the flow is well into the turbulent range.

The duct system was designed to produce no more than 100 mm water static pressure. The air filters account for half of this pressure allowance before replacement. The damper causes about 10 mm pressure allowance and thus 40 mm remain for duct runs, bends, and connections. To comply with this pressure drop, the duct cross-section areas are as follows:

Duct	No.	Flow L/S	Area m <sup>2</sup>	Velocity m/s
Primary duct	1	700	.588	1.25
Manifold ducts	2	350	.355	.98
Collector connections	22	32	.106	.30

It is important that the parallel pressure drop resulting from the individual collectors plus air filters be significantly higher than the manifold ducts. This is to minimize maldistribution of flow between collectors resulting from pressure variation along the manifold. Here the manifold pressure drop is less than ten percent of the parallel path pressure drop. Consequently flow distribution is expected to be quite uniform.

#### PROBLEMS ENCOUNTERED

Very few design or installation problems occurred. The problems were in delays due to material deliveries and lack of sufficient labor when needed. The retrofit nature of the installation resulted in some custom work but this was anticipated and proved no more difficult than expected.

#### PLANS FOR NEXT REPORTING PERIOD

The next reporting period will include two important tasks: (1) the start-up and initial operations and (2) performance data. The system is expected to be in full operation during October of 1978. This will allow a full year from 31 October 1978 to 31 October 1979 to monitor performance for the next annual report on the project.

#### ASSESSMENT OF FUTURE PROGRESS ON OBJECTIVES

The future objectives are twofold. The primary purpose is to collect and present accurate performance data. But secondly there is the objective of optimizing the operation and noting the operating characteristics of the system on a continuing basis. While the second objective is less quantitative in terms of reported results, it can be of equal importance to the practical consideration of implementing such solar applications nationally.

APPENDIX A

Colorado State University-Poudre Valley Memorial Hospital Agreement

## MEMORANDUM OF AGREEMENT

No. 1369-1

This Agreement is made and entered into this first day of January, 1978, between Colorado State University (hereinafter referred to as CSU) on behalf of its Solar Energy Applications Laboratory (hereinafter referred to as SEAL) and the Poudre Valley Hospital District doing business as Poudre Valley Memorial Hospital (hereinafter referred to as PVMH).

CSU-SEAL is conducting a research project entitled "Solar Supplement to Laundry Drying" under the sponsorship of the United States Department of Energy, and desires to set up a solar energy system as a supplement to the PVMH laundry facility as hereinafter set forth; and PVMH is willing to accept the installation and monitoring of the solar system under the terms and conditions hereinafter set forth.

Now therefore the parties do mutually agree as follows:

1. Description

CSU will install the solar system provided for in the project at the laundry drying facility at PVMH. CSU will provide all labor and materials from the project. CSU and the PVMH Administrator will make arrangements for access to do the modifications and installations with as little inconvenience to the operation of the laundry as possible.

II. Period

This Agreement shall be in effect from January 1, 1978 through May 31, 1979, with CSU having the option to extend access further if they and/or the Department of Energy wish to monitor further or make needed alterations.

III. Equipment and Materials

The equipment and materials installed by CSU at the laundry will remain there and will become the property of PVMH at the completion of all the research.

IV. Supervision

Mr. Charles C. Smith of CSU-SEAL will supervise this project.

V. Governing Law

This Agreement shall be governed and enforced in accordance with the laws of the State of Colorado. This Agreement sets forth the entire agreement and understanding between the parties hereto and merges or supersedes all prior discussions, proposals, offers and arguments, if any, with respect thereto.

VI. Changes in Agreement

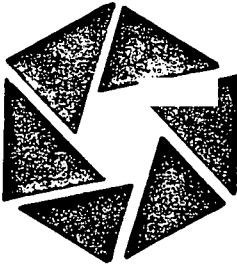
This Agreement may be changed, modified or terminated upon written mutual agreement of the parties hereto.

COLORADO STATE UNIVERSITY

POUDRE VALLEY HOSPITAL DISTRICT  
POUDRE VALLEY MEMORIAL HOSPITAL

\_\_\_\_\_  
Title \_\_\_\_\_

\_\_\_\_\_  
Title \_\_\_\_\_



## Air Division

R-M Products realizes the advantages and disadvantages to both air and water systems. However, the company also felt that both types of systems were desirable in particular situations.

As a result, R-M Products manufactures air collectors as well as hydronic. To date, R-M has manufactured about 15,000 sq ft of air solar panels.

## Construction

Air solar panel construction is intended to meet the same requirements of quality, efficiency, versatility, and durability that are built into R-M Products hydronic collectors.

The panels are built with the finest materials in order to assure quality construction. Basic construction allows for architectural versatility. The collector is manufactured in 6, 8, 10, 12, 15, 16, 18, 20, and 24 feet lengths. The common 2 foot width allows for mounting versatility for all types of designs. Collectors can be deck mounted, set between roof joists on two foot centers or mounted on steel racks. R-M Products has experience in horizontal panel configurations as well as vertical.

Standard collectors are single glazed with a tempered glass; however, other nonbreakable glazings are available. The glazing is secured to the collector box by means of a weather and temperature resistant caulking material. Because of varied lengths of collectors, mullion strips are included for glass support.

The absorber plate is copper. R-M Products utilizes copper because of its superior heat transfer characteristics and resistance to corrosion. Electroplated onto the copper is black chrome (on black nickel flash) selective surface. This selective surface has proven to be superior in its durability to solar degradation as well as in its high absorbance and low emittance. R-M Products stresses that no collector should be allowed to reach stagnation (no-flow condition) temperatures for extended periods, in order to maintain surface durability. However, the black chrome surface is durable at temperatures up to 600°F.

The absorber plate is constructed into a plenum with an inlet and outlet in each plate. The depth of each plenum is varied in order to maintain consistent pressure drops through the various length collectors. The inlet and outlet ducts are extended through the back of each absorber plate container. Each collector in a bank of collectors then feeds to a common supply and return duct.

The absorber plenum is mounted within the enclosure, and allowances are made for expansion and contraction of the plenum without creating edge heat loss.

The collector enclosure is constructed with galvanized steel sides and back. It is available in a standard mill finish; however, the box can be painted at extra cost.

Insulation behind the plate and on the edges allows for R values of 20 and 5 respectively. The insulation is designed and utilized to withstand thermal exposure.

Humidity, and subsequent condensation, is controlled by allowing the box to breathe through a self-regenerating silica gel bed. The silica gel absorbs condensate within the collector when it cools and allows it to be baked off during collector operation.

Provided with the collectors are aluminum cap strips and mullion covers. However, for architectural versatility, cap strips and mullions are available in copper and anodized aluminum. Mounting hardware, retainer strips, hold-down clips, and screws are provided as well. Provisions for flashing are manufactured into each collector; however, because of field measuring, flashing is not provided.

# Collector Performance

The air collector from R-M Products has been independently tested at the University of Arizona under the direction of Dr. Stanley Mumma. R-M Products is in the process of having a collector tested at Desert Sunshine Exposure Tests, Inc. As new performance statistics are received, this section will be updated

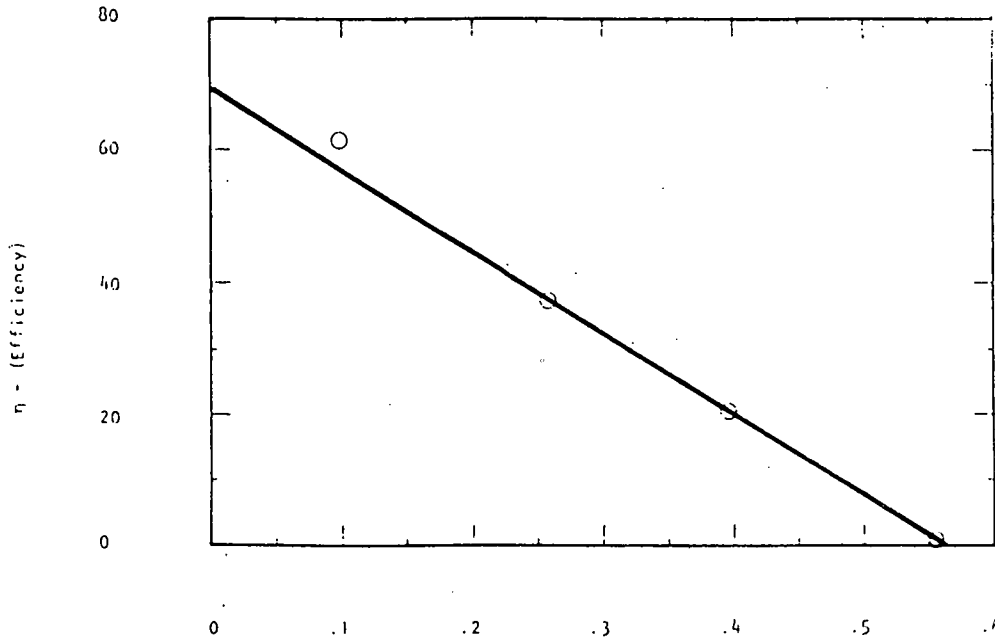


Figure B-1

$$\frac{t_{fi} - t_a}{t_{tu}} > \frac{F-hr-ft^2}{8tu}$$

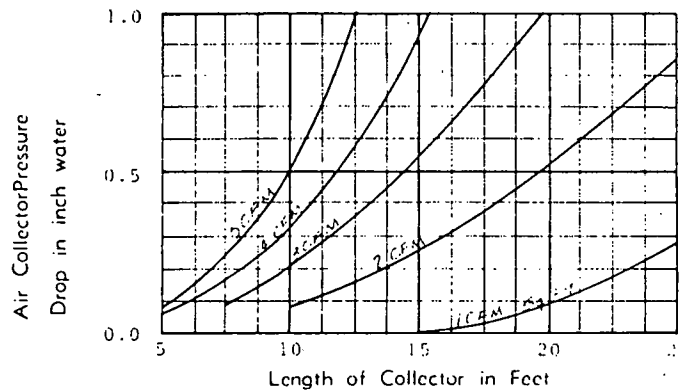


Figure B-2

LENGTH (FT)	GROSS AREA (FT. SQ.)	NET AREA (FT. SQ.)	% EFFECTIVE AREA	APPROX. WT. (1 GLASS COVER)	APPROX. WT. (2 GLASS COVER)	PAN DEPTHS FOR FLOWS OF 2 & 3	
						CFM/GROSS SQ. FT. 2	CFM/GROSS SQ. FT. 3
6	12	10.1	84.5	72#	87#	1/4	3/8
8	16	13.6	85.2	84	117	3/8	1/2
10	20	17.3	86.7	112	146	1/2	3/4
12	24	20.8	86.8	135	175	5/8	1
15	30	26.4	87.9	168	219	13/16	3/16
18	36	31.7	88.2	202	262	1	1 3/8
20	40	35.4	88.6	224	292	1	1 5/8
24	48	42.6	88.8	269	350	1 1/4	1 7/8

(Sized for 500 FPM face velocity)

## Air Collector Isometric & Specifications

**Flashing:** by others (attachment provisions included)

**Cover:** Single cover standard; 3/8 in. tempered glass; low iron-oxide content; 89.1 transmittance

Dimensions:

23 1/4 in x 47 1/2 in.  
x 59 1/2 in.  
x 71 1/2 in.

Combinations for various length collectors

**Mullion:** 22 3/4 in. x 1 1/2 in.; 22 ga galvanized for glass support in varied collector lengths

**Cover**

**Sealant:** Dow Corning 790 silicone base caulking (bronze color) --- applied to edges and mullion

**Distance from cover**

**to absorber spacing:** 1 - 1 1/2 in.

**Absorber**

**Plenum:** 22 1/2 x varied lengths 0.0162 in copper (12 oz)

surface: black chrome on bright nickel flash; selective surface absorbance 0.95; emissivity 0.08

formed into plenum with 22 ga galvanized steel depth; varied according to collector length plenum intake and outlet 8 in. diameter through back of container

common return and supply ducts (supplied by others) size according to CFM requirements

recommended 2-3 CFM/sq ft of collector ratio of absorber area to total (see enclosed chart)

**Desiccant:** Self-regenerating desiccant breather for condensate removal

**Insulation:** Rear of collectors—2 in. polyurethane foam 1/2 to 1 1/2 in. fiberglass

aluminum foil

R = 18 to 22

(°F) (hr) (sq ft)/BTU

Sides of collector—1 in. ductboard each edge

R = 5

(°F) (hr) (sq ft)/BTU

**Container:** (Patent pending)

22 ga galvanized steel (see dimension sheet) pop-riveted and brazed construction

**Mounting**

**Hardware:** (included)

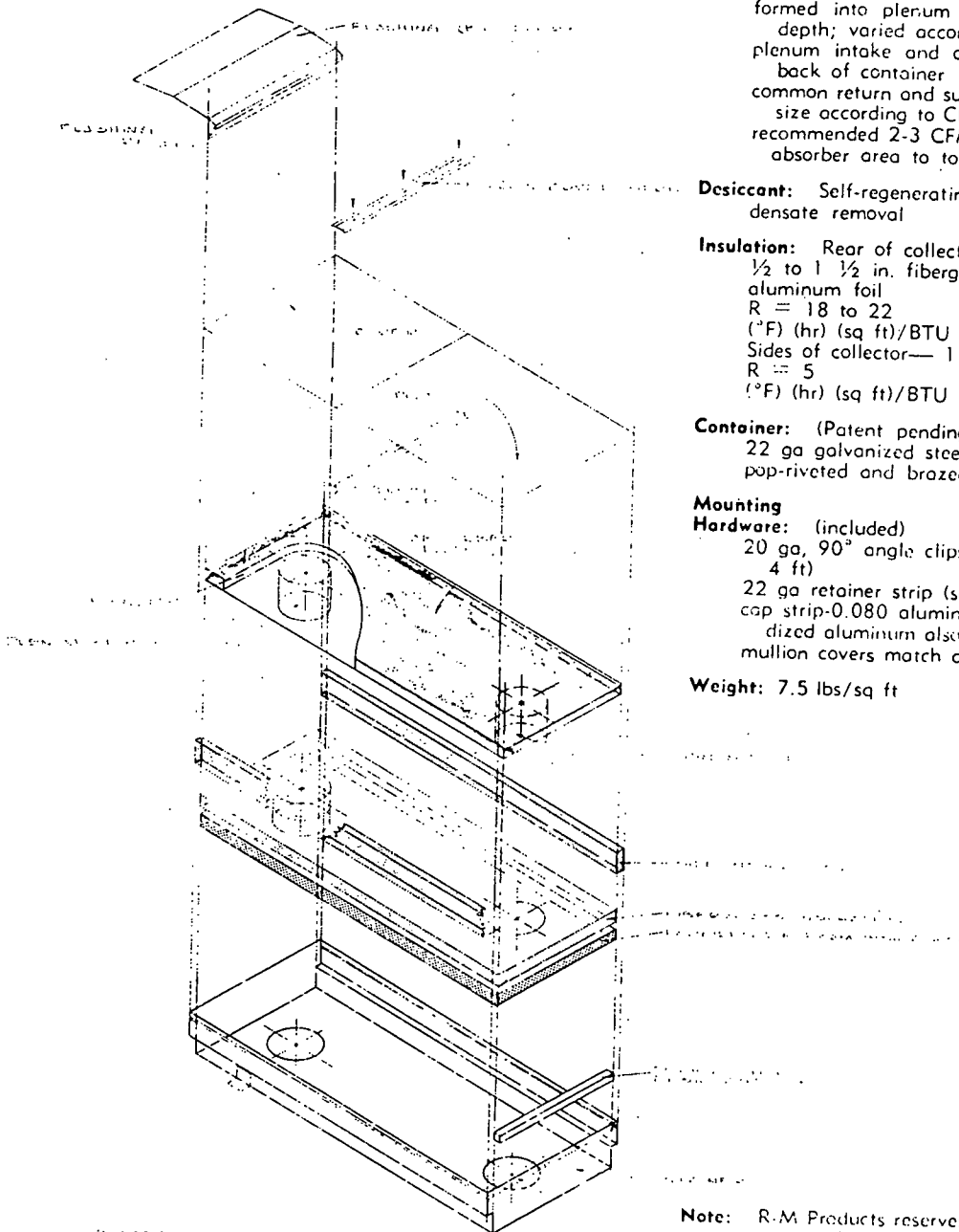
20 ga, 90° angle clips (recommendation, one every 4 ft)

22 ga retainer strip (see cap strip detail)

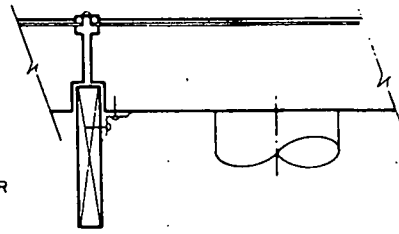
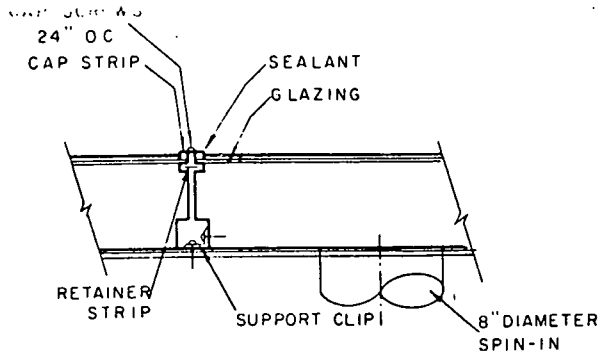
cap strip—0.080 aluminum standard, copper or anodized aluminum also available

mullion covers match cap strip material

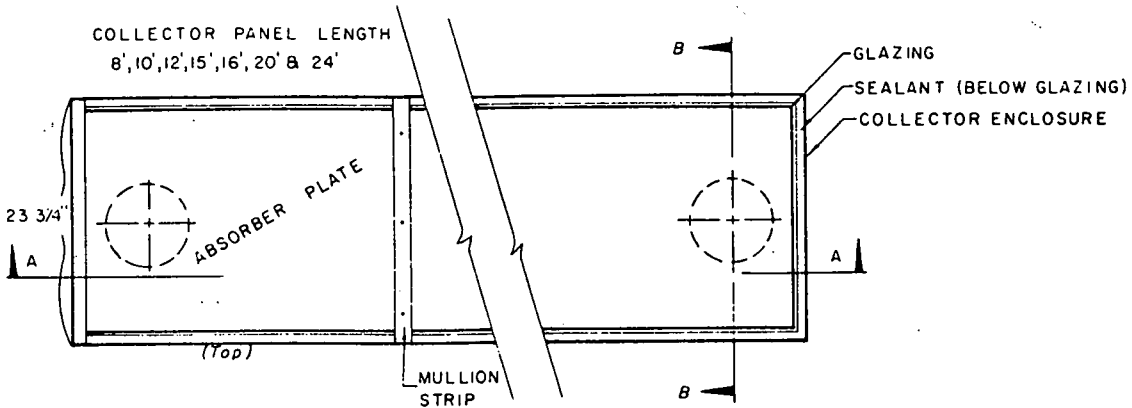
**Weight:** 7.5 lbs/sq ft



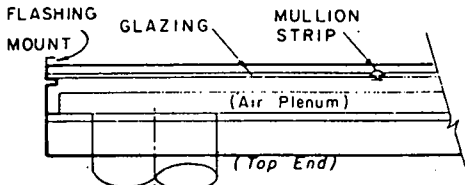
# 16 Air Collector Detail



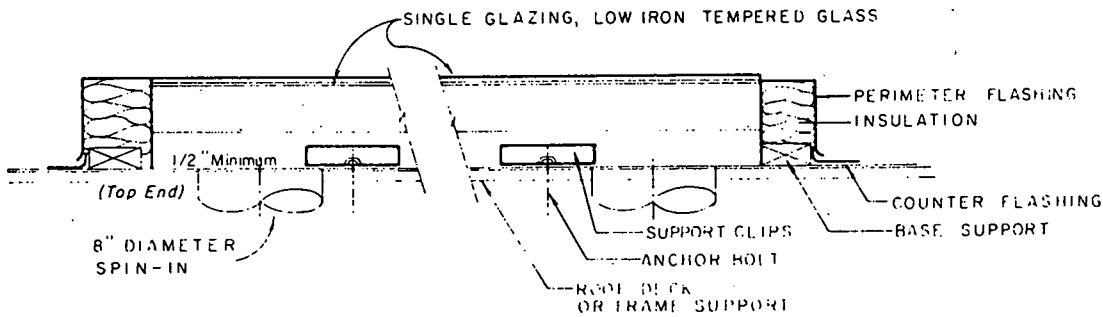
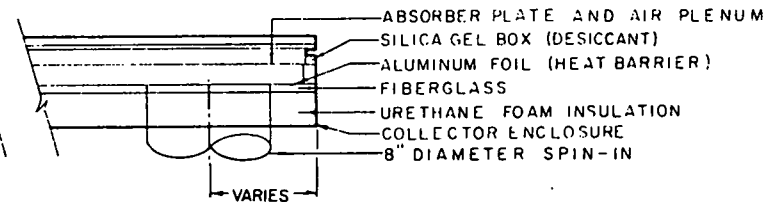
SECTION THROUGH SURFACE MOUNTED COLLECTORS



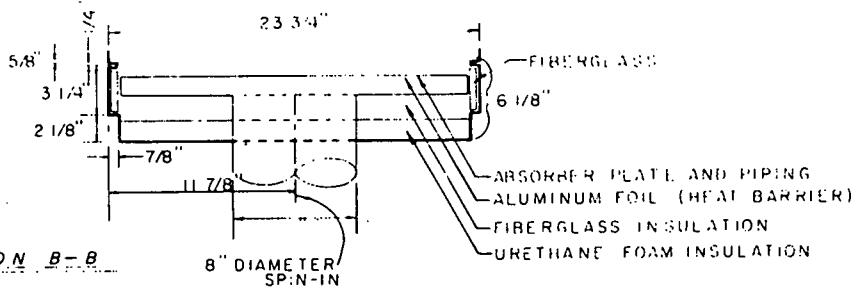
TOP VIEW SOLAR COLLECTOR PANEL



SECTION A-A



ANCHOR AND SUPPORT POINT WITH FLASHING



SECTION B-B