DOE/NASA CONTRACTOR REPORT

DOE NASA CR-161570

SOLAR HOT WATER SYSTEM INSTALLED AT DAY'S INN MOTEL, DALLAS, TEXAS (VALLEY VIEW)

Prepared from documents furnished by

Day's Inn of America, Inc.
2751 Buford Highway, N. E.
Atlanta, Georgia 30324

Under Contract DOE EG-77-G-01-1632

Monitored by

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy

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U.S. Department of Energy

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This work was done under the technical supervision of Mr. Valmore Fogle, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

This final report describes the solar energy hot water system installed in the Days Inns of America, Inc., Days Inn Motel (120 rooms), I-35/2276 Valley View Lane, Dallas Texas. The solar system was designed by ILI Incorporated to provide 65 percent of the total domestic hot water (DHW) demand. The Solar Energy Products, model CU-30WW liquid (water) flat plate collector (1,000 square feet) system automatically drains into the 1,000 gallon steel storage tank when the solar pump is not running. This system is one of eleven systems planned under the EG-77-G-01-1632 grant. Heat is transferred from the DHW tanks through a shell and tube heat exchanger. A circulating pump between the DHW tanks and heat exchanger enables solar heated water to help make up standby losses. All pumps are controlled by differential temperature controllers. The operation of this system was begun March 11, 1980. The solar components were partly funded ($15,000 of 30,000 cost) by a Department of Energy grant. The technical management was done by NASA/George C. Marshall Space Flight Center, Huntsville, Alabama.

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SOLAR DOMESTIC HOT WATER SYSTEMS DESIGN REVIEW DATA PACKAGE

FOR

CECIL B. DAY COMPANIES, INC.

AT

DAYS INN MOTEL

2275 VALLEY VIEW LANE

DALLAS, TEXAS

by

ILI, Inc.
5965 Peachtree Corners East
Norcross, Georgia 30071
(404) 449-5900

ILI, Inc., will provide the material for and install the solar domestic hot water system described herein for Cecil B. Day Companies, Inc., on the motel located at:

2753 Forest Lane, Dallas, Texas

The system will be a retrofit and is expected to provide up to 64%[1] of the inn's domestic hot water for the rooms and the associated laundry. A copy of an "F Chart" printout by month is provided on page 2.

The system piping schematic is provided on page 3 and a list of equipment is provided on page 4.

Check valves are located in the collector lines to prevent hot moist air from rising through the pipe and being condensed in the collectors (which could result in collector transport system damage if water were to freeze in the collector).

Pressure gauges are installed across each pump so the system flow reates can be set and read periodically as a preventative maintenance check. Temperature measuring devices are also installed so temperature of the following points can be measured:

Input to collectors and bottom of thermal storage tank; (same as input to collectors); output of collectors and input to heat exchangers (same as top of thermal storage tank); output of heat exchanger; input from domestic hot water tanks, out put to domestic hot water tanks.

The combination of flow rates derived from the pressure meters and the temperatures can be used to assess system performance as well as diagnosis certain system failures.

(1) Based on "F-Chart Program", analysis using computer program developed by Scotch Programs Co.

PROJECTED SOLAR SYSTEM PERFORMANCE

2275 Valley View Lane, Dallas, Texas

SOLAR F-CH			
SCOTCH SE1			
DALLAS TX.			
		0.73	FR S
		35.39	MBTU
		25.95	MBTU
29.00	ANG		
0.74	F'TA		
1.09	F'UL	0.75	FR S
0.00	HTG	35.39	MBTU
35.39	WTR	26.70	MBTU
		0.74	FR S
		35.39	MBTU
LIQ SYST		26.21	MBTU
960.00	FT	0.67	FR S
0.36	FR S	35.39	MBTU
35.39	MBTU	23.63	MBTU
12.84	MBTU		
		0.58	FR S
0.45	FR S	35.39	MBTU
35.39	MBTU	20.48	MBTU
15.92	MBTU		
		0.44	FR S
0.57	FR S	35.39	MBTU
35.39	MBTU	15.55	MBTU
20.06	MBTU		
		0.36	FR S
0.61	FR S	35.39	MBTU
35.39	MBTU	12.62	MBTU
21.54	MBTU		
0.66	FR S	424.68	MBTU
35.39	MBTU	245.02	MBTU
23.52	MBTU	0.58	FR S

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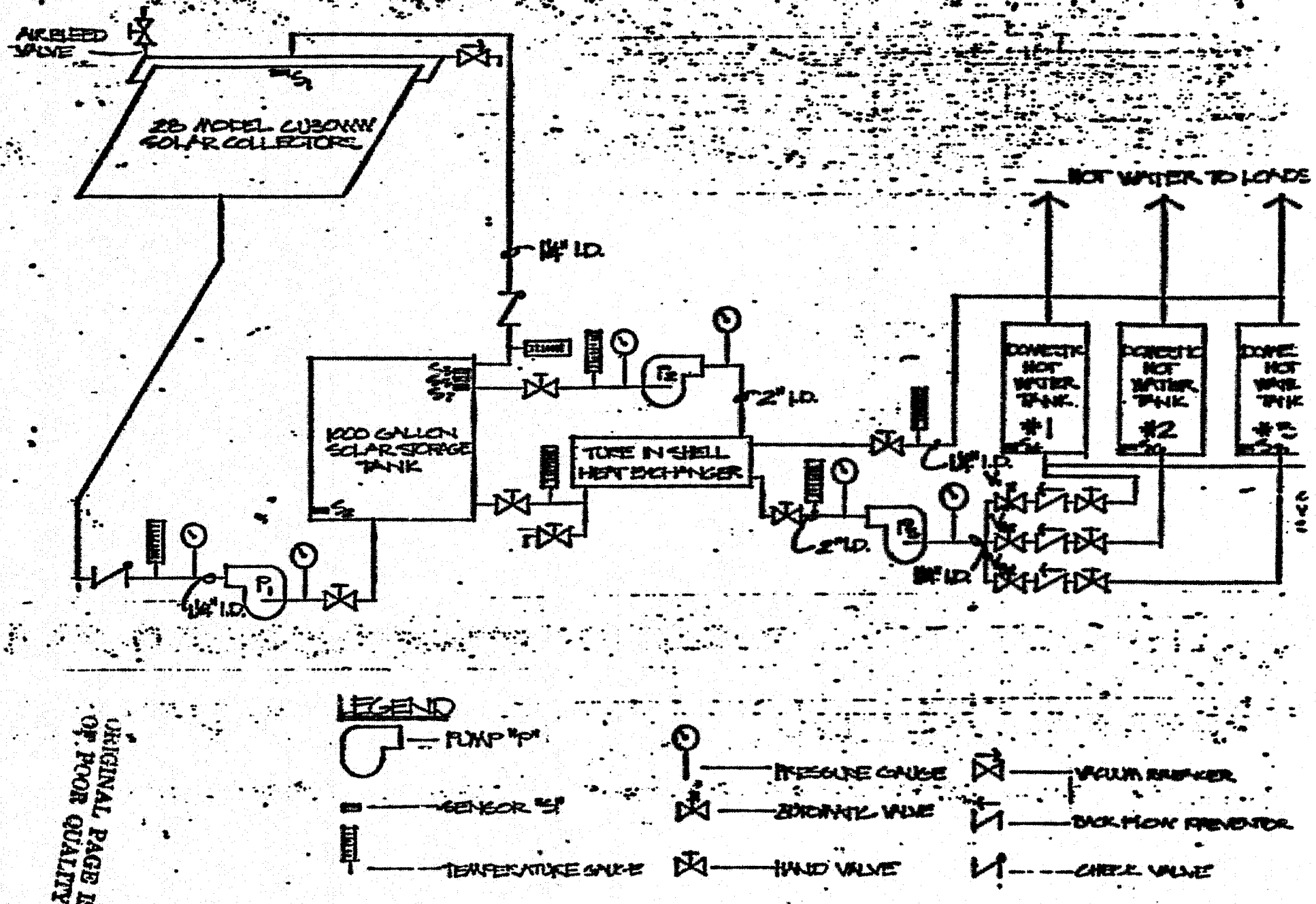
Notes: 1) Angle - Collector angle with horizon; 2) F" TA - Collector performance intercept; 3) F" UA - Collector performance slope; 4) WTR - Domestic hot water laod - million BTU/month; 5) F 2- Net area of collector absorberplate; 6) FRS - Fraction of total load provided by solar ; 7) MBTU - First entry - Total load million BTU; 8) MBTU - Second entry - Solar contribution million BTU; 9) First 12 sets of output data - monthly, starting in January; 10) Last set of output data, yearly totals.

SOLAR DOMESTIC HOT WATER SYSTEM FOR 150 UNIT MOTEL



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EQUIPMENT

PUMPS

1	- BELL & GOSSETT	1535-3515	115VAC
2	- BELL & GOSSETT	1525-3525	115VAC

VALVES

3(1)	- TACO	#557	24VAC

TANK

1	- ILI, Inc.	1000 Gallon - Steel

HEAT EXCHANGER

1	- ILI, Inc.	HX - 8048-4P-1C

CONTROL CARDS

4	- ILI, Inc.	SC111 Single Stage Differential Controller

SENSORS

8(1)	- HONEYWELL Sensors	C773A / C773C / C773D

COLLECTORS

30	- SOLAR ENERGY PRODUCTS Collectors(2)	CU30-WW

ILI, Inc.
5965 Peachtree Corners East
Norcross, Georgia 30071
(404) 449-5900

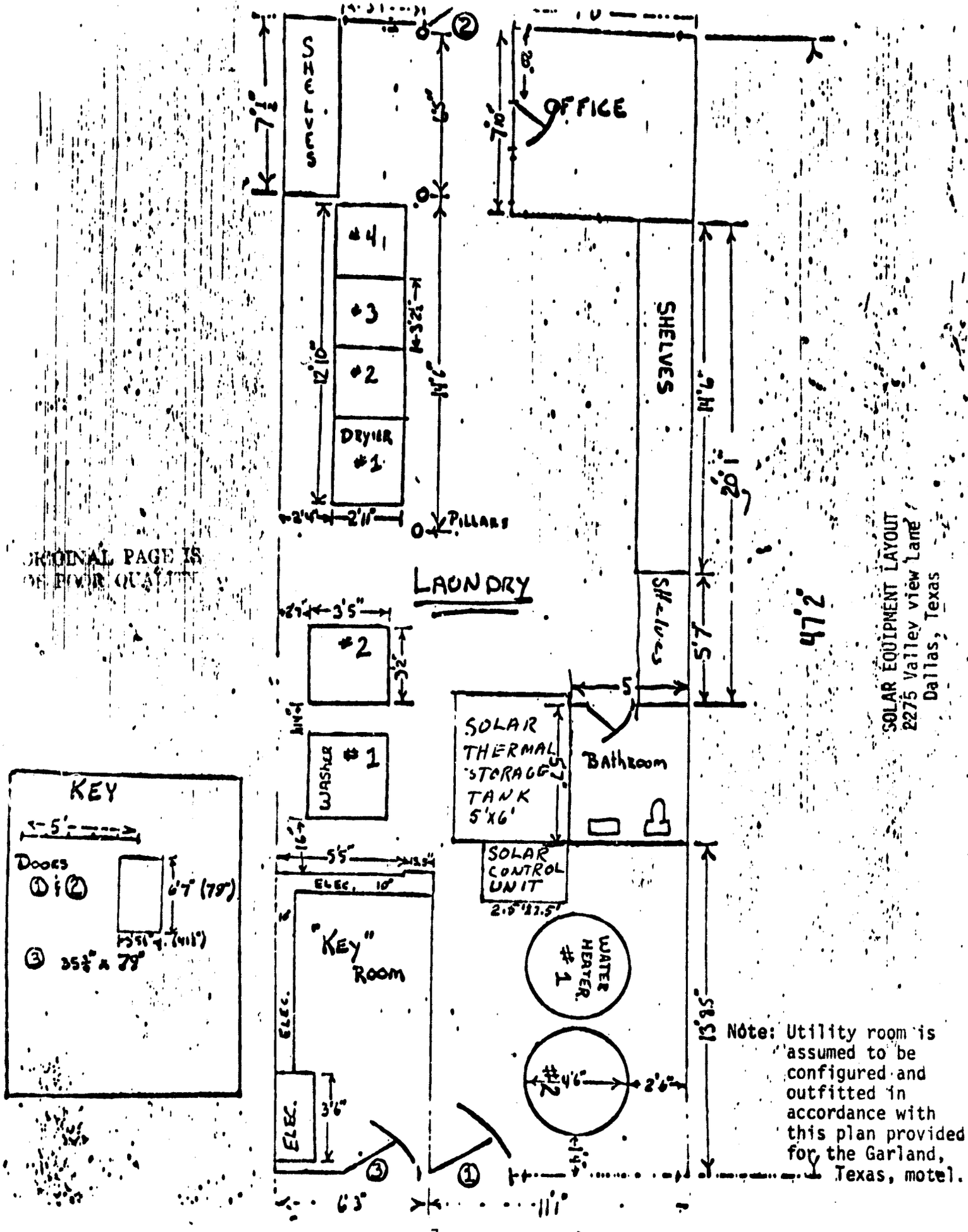
(1) Assumes a maximum of three domestic hot water tanks are tied into the system.
(2) DAYSTAR Model 1400 collectors are considered an acceptable alternative based on performance analysis.

A layout of the thermal storage tank and the solar control unit. The plan is thought to be best based on conservation of floor space and minimizing solar system piping. This plan can be adjusted provided Days Inn prefers some alternate layout.

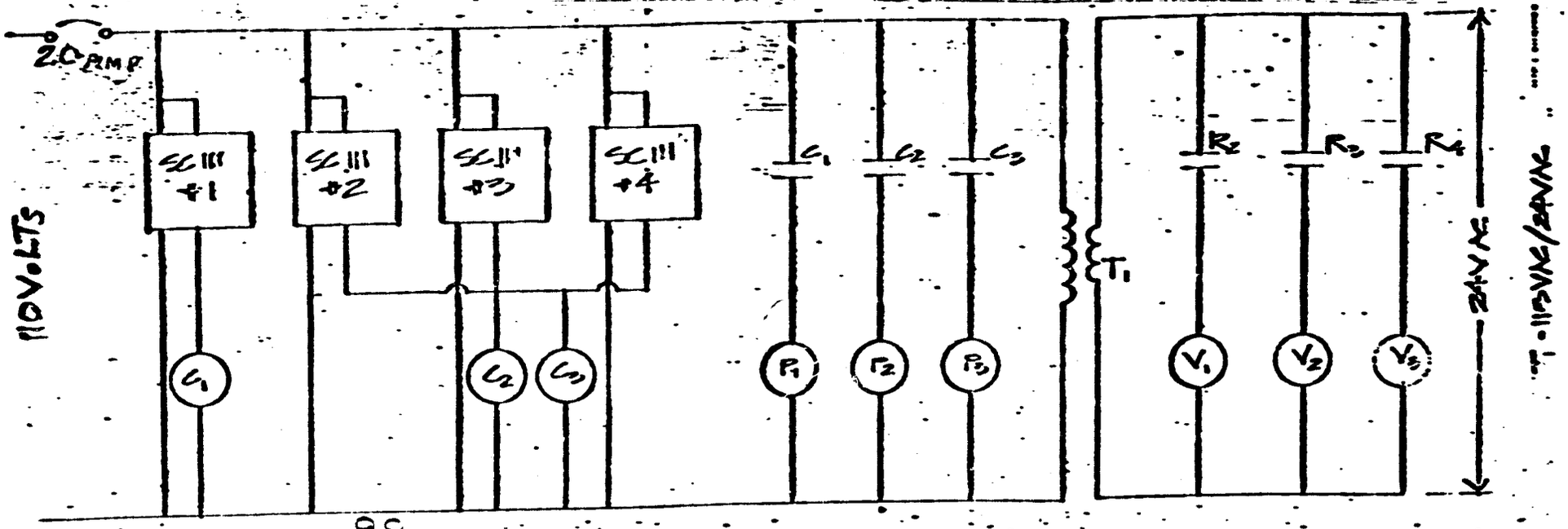
Controls for the system consist of four differential thermostats. One for the collector/storage differential which controls P_1. Three differentials are used to control the DHW (tank heating, one for each tank). Any one of these differential thermostats can turn on P_2 and the DHW circulation pump when the water in the bottom of its DHW tank is cooler than the water in the top of the 1,000 gallon solar storage tank. All differential controllers have variable turn on/turn off settings. For the collector loop a ΔT of $10^{o}F$ on and 3^{o} off is planned. For the three DHW ΔT's a $18^{o}F$ on and a $10^{o}F$ off is planned for the heat transfer through the heat exchanger. A simplified schematic is provided on page 7.

The solar equipment, including the storage tank, is to be located directly below the collector arrays which are shown in the Roof Plan, page 8. The collectors face South $\pm$ $5^{o}F$. A collector angle of 29^{o} provides maximum yearly energy. Spacing of 22' or greater will be maintained to prevent shading.

The array is further depicted in Collector Array Piping, Elevation and Plan drawings, page 9. Here the 10^{o} sun angle for 8 A.M. on December 21 is depicted, along with the planned piping arrangement. All external piping is covered with 1/2" expanded rubber insulation which is painted with latex. Internal piping will be either fiber jacket or expaned rubber. The solar thermal storage tank will be insulated to a R 19 or better. The tank is planned for a 4'X5'X5'4" height. This configuration provides for a minimum space requirement while making retrofit possible without enlarging 6' door openings.



Note: Utility room is assumed to be configured and outfitted in accordance with this plan provided for the Garland, Texas, motel.



SOLAR CONTROL UNIT
ELECTRICAL DIAGRAM
for
150 UNIT MOTEL

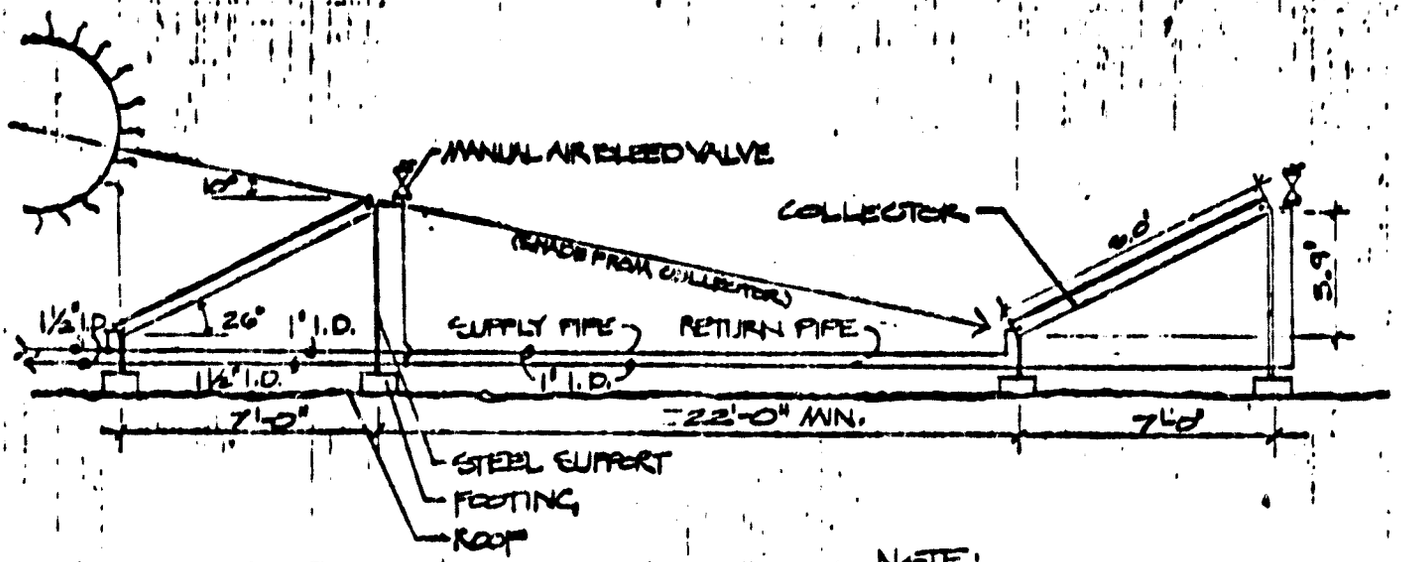
NOTES:

1. SC 111's - ILI, Differential Controllers
2. Pumps - Bell and Gossett #1535-351; 1/3 HP, 3500 RPM
3. Valve - TACO, #560 - 1" zone
4. Transformer - Johnson, 75 VA with overload and reset protection
5. Contactors - 8 amp @ 115 volt or higher rated relays

SOLAR ROOF PLAN

150 UNIT MOTEL

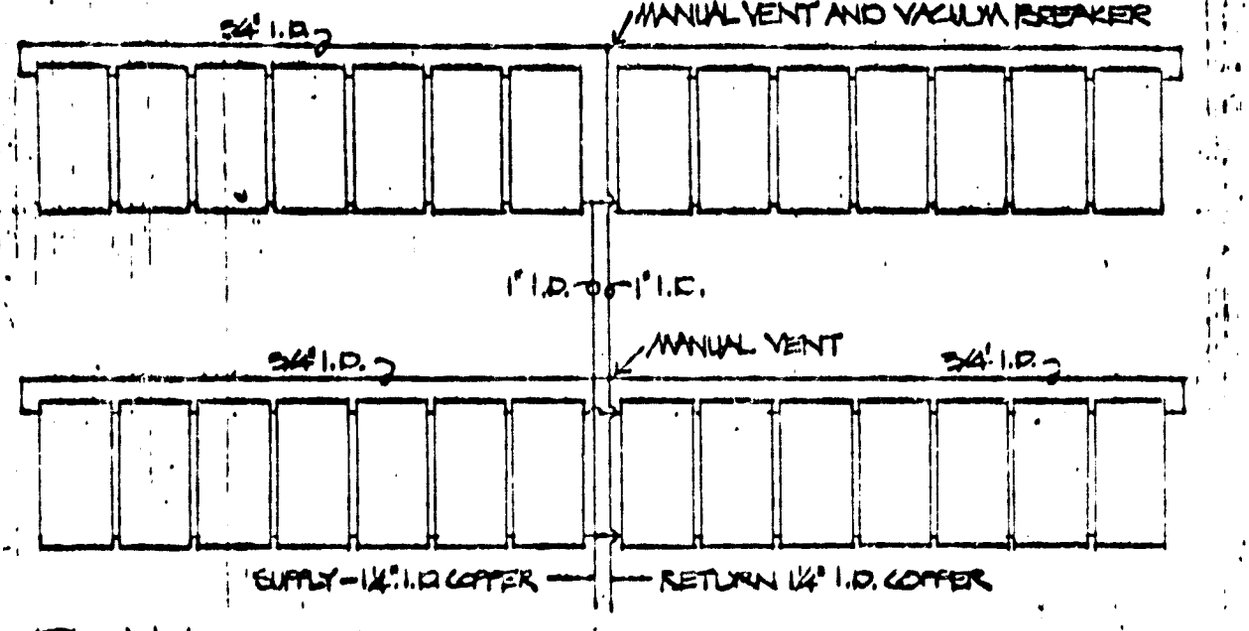
COLLECTOR ARRAY AND PIPING



ELEVATION

NOTE:
ALL PIPING TUBE COPPER W/ ½" EXP. RUBBER INSULATION PAINTED WITH LATEX FOR ULTRA-VIOLET RADIATION EXPOSURE. COLLECTOR INTERCONNECT PIPING IS ¾".

NOTE:
COLLECTOR ARRAY MADE UP OF 4 MODULES WITH 7-4'x8' COLLECTORS IN TWO MODULES AND 7-4'x8' COLLECTORS IN TWO MODULES



PLAN

SOLAR DOMESTIC
HOT WATER
SYSTEM MANUAL

for

DAYS INN

(Airport N.)
I-35E & 2275 Valley View Lane
Farmers Branch, Texas 75234

designed & installed by

ILI, Inc.

5965 Peachtree Corners East

Norcross, Georgia 30071

SECTION I

SYSTEM DESCRIPTION

The system is designed to provide solar heated domestic hot water to the motel for use in the rental units for shower and lavatory purposes as well as hot water for the laundry room. The system is an automatic draindown design employing an atmospheric vented storage tank for storing the hot water collected by the 1,000 square foot collector array. The collector array is mounted on the roof directly above the laundry room where the storage tank and control unit are located. The control unit houses all pumps, heat exchangers, differential thermostats, relays, valves (except one check valve in the collector return line), meters, gauges, and sensors (except for the collector, thermal storage and DHW tank sensors).

The collector array consist of four large modules containing a total of 20 collectors plumbed in series/parallel. The two end modules contain eight collectors each while the two center modules contain seven collectors each.

Figure 1 depicts the collector array and module relationship as well as the collector plumbing. The collector feed is at the bottom of the collectors and connects to the left and right ports of the collector internal headers.

The first and second module are fed through a 1-1/4" pipe while the third and fourth modules are fed from a 1 inch and 3/4" pipe respectively.

The collector return piping is identical to the feed except for the last outlet in module No. 4 which has a vacuum breaker. Since all internal headers (upper and lower) are connected in series, the single vacuum breaker can function for all collectors.

The solar collectors have copper absorber plates coated with a flat black finish. The glazing is water white tempered glass with a strippled pattern which reduces spectral reflectance. The collectors are south facing and at a pitch of 26^{0} for maximum year around collection.

COLLECTOR ARRAY - REVERSE RETURN PLUMBING FOR 4 MODULES CONSISTING OF 30 COLLECTORS

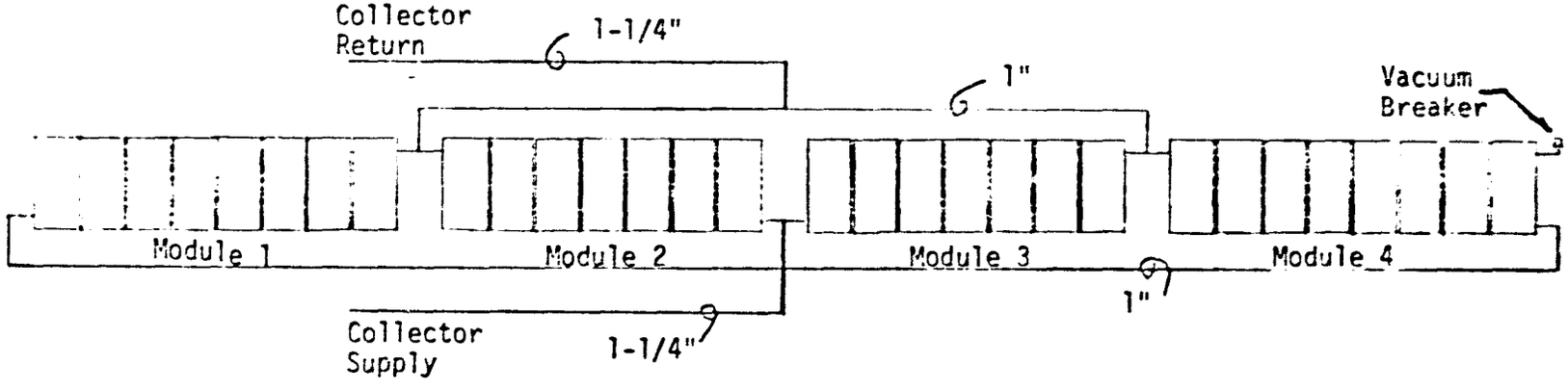


FIGURE 1

Notes:

Module 1 - 8 Collectors
Module 2 - 7 Collectors
Module 3 - 7 Collectors
Module 4 - 8 Collectors

PROJECTED SOLAR SYSTEM PERFORMANCE

Valley View Lane

SOLAR F-CH
SCOTCH SE1
DALLAS TX.

29.00	ANG
0.74	F'TA
1.09	F'UL
0.00	HTG
35.39	WTR

LIQ SYST

960.00	F²
0.36	FR S
35.39	MBTU
12.84	MBTU
0.45	FR S
35.39	MBTU
15.92	MBTU
0.57	FR S
35.39	MBTU
20.06	MBTU
0.61	FR S
35.39	MBTU
21.54	MBTU
0.66	FR S
35.39	MBTU
23.52	MBTU

0.73	FR
35.39	MBTU
25.95	MBTU
0.75	FR S
35.39	MBTU
26.70	MBTU
0.74	FR S
35.39	MBTU
26.21	MBTU
0.67	FR S
35.39	MBTU
23.63	MBTU
0.58	FR S
35.39	MBTU
20.48	MBTU
0.44	FR S
35.39	MBTU
15.55	MBTU
0.36	FR S
35.39	MBTU
12.62	MBTU
424.68	MBTU
245.02	MBTU
0.58	FR S

Forest Lane

SOLAR F-CH
SCOTCH SE1
DALLAS TX.

29.00	ANG
0.74	F'TA
1.09	F'UL
0.00	HTG
28.54	WTR

LIQ SYST

960.00	F²
0.43	FR S
28.54	MBTU
13.25	MBTU
0.53	FR S
28.54	MBTU
15.04	MBTU
0.66	FR S
28.54	MBTU
18.70	MBTU
0.70	FR S
28.54	MBTU
20.10	MBTU
0.77	FR S
28.54	MBTU
21.86	MBTU

0.84	FR S
28.54	MBTU
24.06	MBTU
0.87	FR S
28.54	MBTU
24.74	MBTU
0.85	FR S
28.54	MBTU
24.32	MBTU
0.77	FR S
28.54	MBTU
22.01	MBTU
0.67	FR S
28.54	MBTU
19.20	MBTU
0.52	FR S
28.54	MBTU
14.74	MBTU
0.42	FR S
28.54	MBTU
12.06	MBTU
342.48	MBTU
229.10	MBTU
0.67	FR S

Notes: 1) Angle - Collector angle with horizon; 2) F" TA - Collector performance intercept; 3) F" UA - Collector performance slope; 4) WTR - Domestic hot water load - million BTU/month; 5) F 2- Net area of collector absorberplate; 6) FRS - Fraction of total load provided by solar; 7) MBTU - First entry - Total load million BTU; 8) MBTU - Second entry - Solar contribution million BTU; 9) First 12 sets of output data - monthly, starting in January; 10) Last set of output data, yearly totals.

SECTION II

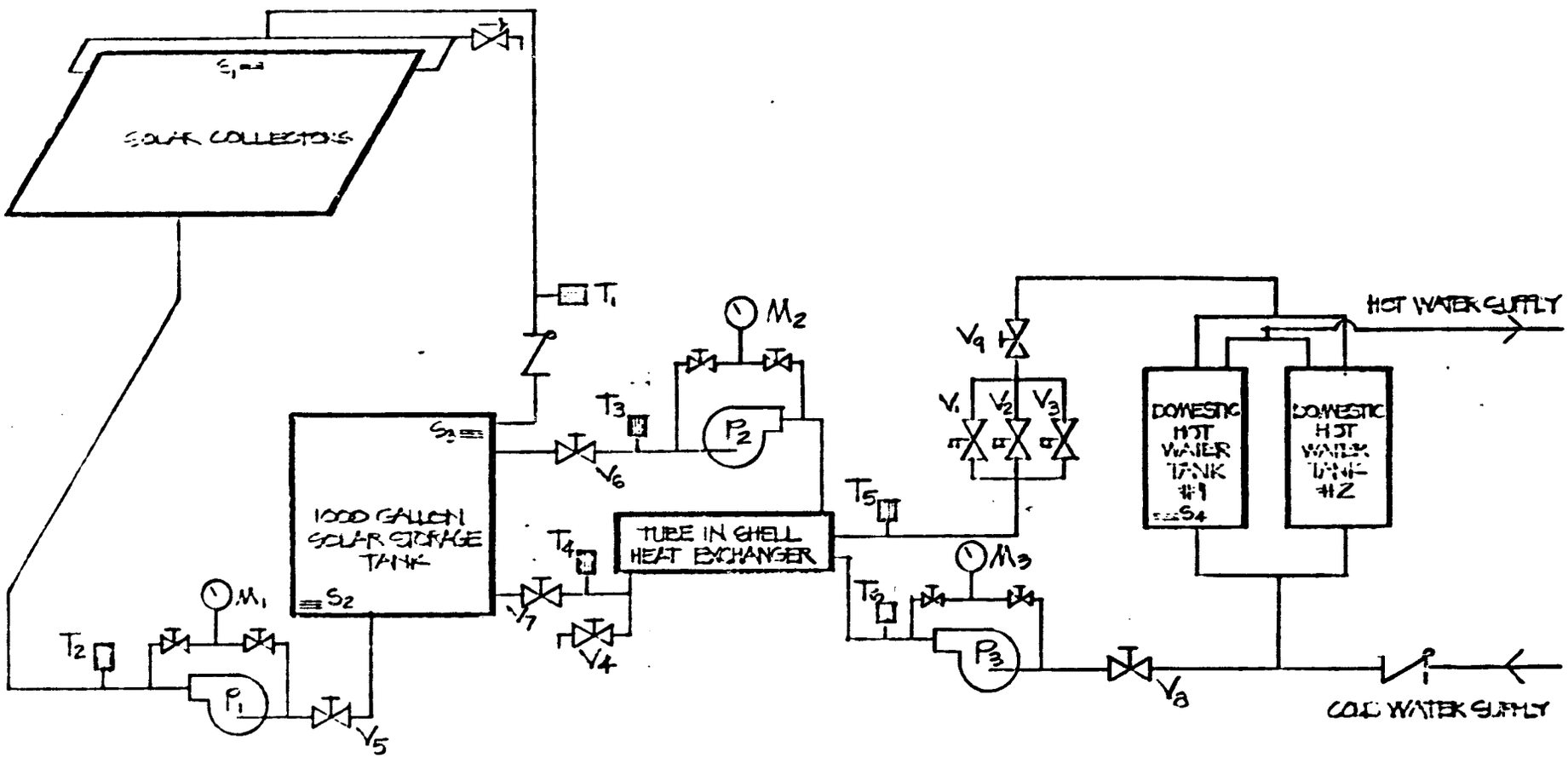
SYSTEM OPERATION

A schematic of the system is provided in Figure 2. The solar collection loop is from the bottom of the 1,000 gallon storage tank through P_1 and the collectors and return to the storage tank. The check valve in the return line is added to prevent moisture from rising in the pipe and condensing in the collectors. To heat domestic hot water, pumps P_2 and P_3 are activated. Pump P_2 circulates hot water from the top of the 1,000 gallon storage tank through the shell side of the heat exchanger and returns to the bottom of the domestic hot water tanks through the tube side of the heat exchanger and returns the heated water to the upper section of the domestic hot water tanks. Equal pipe lenghts are maintained from each tank to the common feed lines to ensure balanced flow from each tank. A back flow preventor is located between the cold water supply line and the solar water heating pump to prevent water from being pumped into the cold water supply line.

The pumps are controlled by differential temperature controllers, see Figures 2 and 3. Operation is based on the collector temperature(S_1) being hotter than the bottom of the storage tank (S_2) to collect and store energy. This control is via SC120-1. Pumps P_2 and P_3 are operated by the SC120-2 which uses sensors S_3 in the top of the storage tank and S_4 in the bottom of one of the domestic hot water tanks. When S_3 is hotter than S_4, SC120-2 energizes P_2 and P_3. SC120-2 also opeates R6 which energizes automatic valves V_1, V_2, and V_3.

The LCD tempeature meter obtains its 9v D. C. power from either of the SC120 controllers. Its' temperature sensors are designated T_1 through T_6 and are located as shown in Figure 2. System temperatures can be read from the panel meter by rotating the selector switch on the front panel of the control unit from T_1 through T_6. Meter calibration is performed in positions T_7 or T_8.

Pressure meters are mounted on the suction and discharge side of P_1, P_2 and P_3. System flow rates can be determined by reading these meters and using the curves provided in Figure 4.



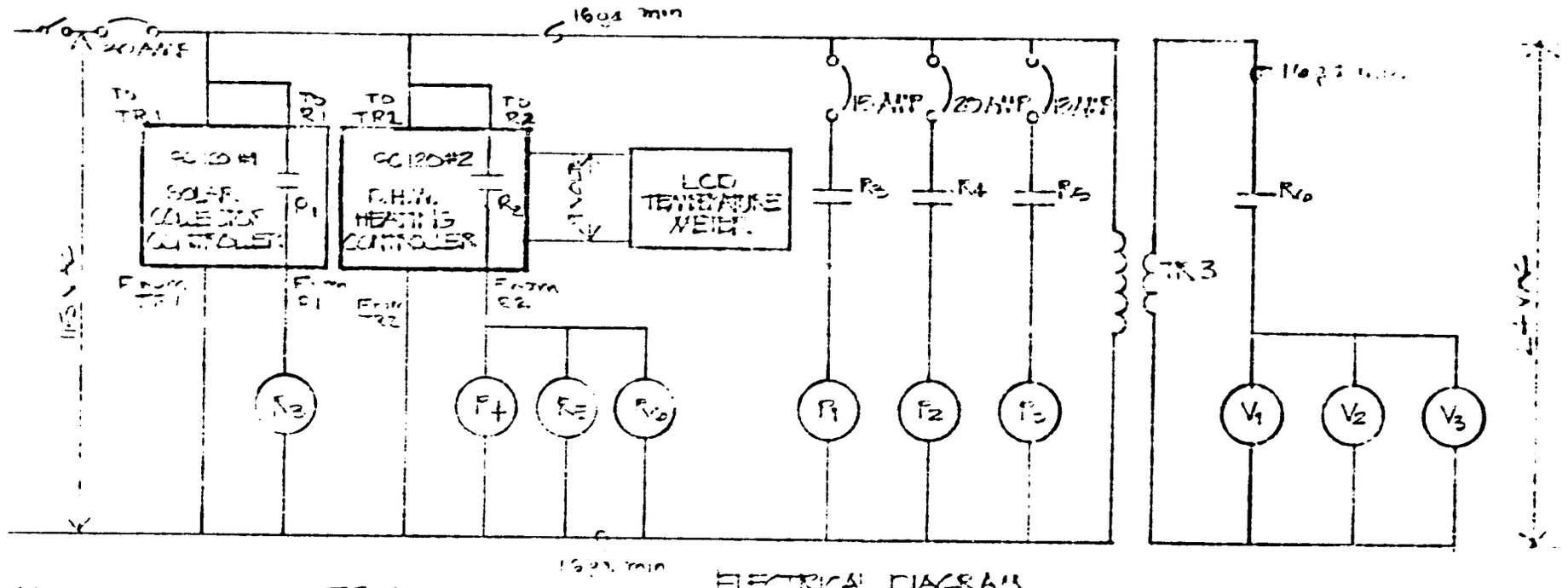
PUMP "P"
CONTROL SENSOR "S"
TEMPERATURE SENSOR "T"
PRESSURE METER "M"
AIR BLEED VALVE
HAND VALVE
AUTOMATIC VALVE
VACUUM BREAKER
CHECK VALVE

Note: Hydronic Schematic ONLY. Not intended to show physical component location nor orientation.

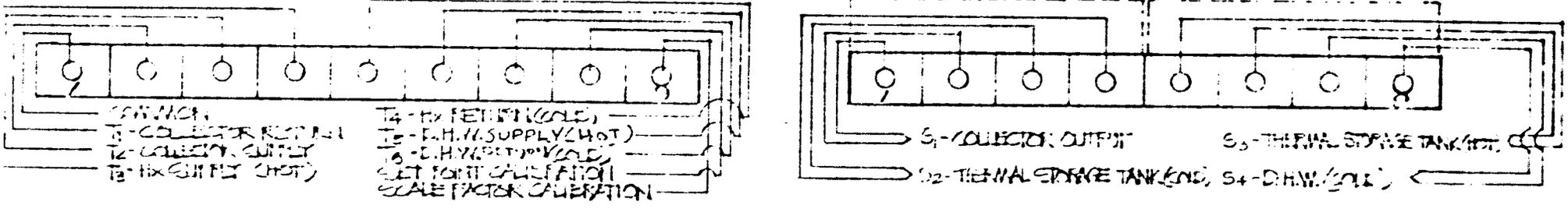
SOLAR DOMESTIC HOT WATER SYSTEM

FIGURE 2

INC



ELECTRICAL DIAGRAM



TERMINAL STRIPS

NOTES:

1. SC 120's - I.L.I. DIFFERENTIAL CONTROLLERS
2. PUMPS - P2 - BELL AND GOSSETT 1535-3515, P1 & P3 BELL AND GOSSETT 1535-3515
3. VALVE - TACO. #560 1" ZONE
4. TRANSFORMER - JOHNSON 75 VA W/OVERLOAD AND RELIEF PROTECTION
5. RELAYS - 5 AMP @ 115 VOLTS
6. TEMPERATURE METER - I.L.I. T-100's

SOLAR DOMESTIC HOT WATER SYSTEM

FIGURE 3

CALIBRATION STEPS FOR ILI'S

SOLAR DIFFERENTIAL CONTROLLER MODEL 120

USED FOR THE COLLECTOR PUMP

1. TURN POWER OFF TO THE DIFFERENTIAL CONTROLLER.
2. PUT DIFFERENTIAL CONTROL SWITCH IN THE AUTOMATIC POSITION.
3. TURN R_1 AND R_2 ON CONTROLLER FULLY CLOCK WISE (CW) (R_1 IS THE LOWER POT, R_2 IS THE UPPER POT OR MIDDLE POT IF THREE POTS ARE ON THE BOARD).
4. REMOVE OPERATIONAL SENSORS AND CONNECT CALIBRATION SENSOR BOX TO CONTROLLER. (HIGH TEMPERATURE SENSOR (HTS) ON INSIDE TWO TERMINALS REFERENCE SENSOR ON OUTSIDE TWO TERMINALS).
5. SET REFERENCE SENSOR TO 760.
6. SET HTS TO 775 ($15^0 \triangle$T ON).
7. TURN POWER TO CONTROLLER ON.
8. ADJUST R_2 COUNTER CLOCKWISE(CCW) UNTIL LED LIGHTS.
9. ADJUST R_1 FULLY CCW.
10. SET HTS TO 765 ($5^0 \triangle$T OFF).
11. ADJUST R_1 CW UNTIL LED GOES OUT.
12. SET HTS TO 775 - LED SHOULD COME ON, IF NOT, ADJUST R_2.
13. SET HTS TO 765 - LED SHOULD GO OFF, IF NOT, ADJUST R_1.

    (Repeat steps 8 and 9 until calibration is within desired range of accuracy).
14. TURN POWER OFF TO THE DIFFERENTIAL CONTROLLER.
15. REMOVE CALIBRATION SENSOR BOX AND RECONNECT OPERATIONAL SENSORS.
16. TURN POWER ON.

* LED (Light Emitting Diode-an indicator bulb)

Notes:

1) Calibration can be made at any desired tempeatures, however, it is recommended that they be made in the range of expected systems operation. See thermistor transfer characteristics table for resistance setting other than those given.

2) Linear pots can be used and set at desired resistance value according to thermistor transfer characteristics tables instead of using the calibration box.

CALIBRATION STEPS FOR ILI'S

SOLAR DIFFERENTIAL CONTROLLER MODEL 120

USED FOR THE D.H.W. PUMP

1. TURN POWER OFF TO THE DIFFERENTIAL CONTROLLER.
2. PUT DIFFERENTIAL CONTROL SWITCH IN THE AUTOMATIC POSITION.
3. TURN R_1 AND R_2 ON CONTROLLER FULLY CLOCK WISE (CW) (R_1 IS THE LOWER POT, R_2 IS THE UPPER POT OR MIDDLE POT IF THREE POTS ARE ON THE BOARD).
4. REMOVE OPERATIONAL SENSORS AND CONNECT CALIBRATION SENSOR BOX TO CONTROLLER. (HIGH TEMPERATURE SENSOR (HTS) ON INSIDE TWO TERMINALS REFERENCE SENSOR ON OUTSIDE TWO TERMINALS).
5. SET REFERENCE SENSOR TO 760.
6. SET HTS TO 780 (20^0 $\triangle$T ON).
7. TURN POWER TO CONTROLLER ON.
8. ADJUST R_2 COUNTER CLOCKWISE(CCW) UNTIL LED LIGHTS.
9. ADJUST R_1 FULLY CCW.
10. SET HTS TO 770 (10^0 $\triangle$T OFF).
11. ADJUST R_1 CW UNTIL LED GOES OUT.
12. SET HTS TO 780- LED SHOULD COME ON, IF NOT, ADJUST R_2.
13. SET HTS TO 770- LED SHOULD GO OFF, IF NOT, ADJUST R_1.

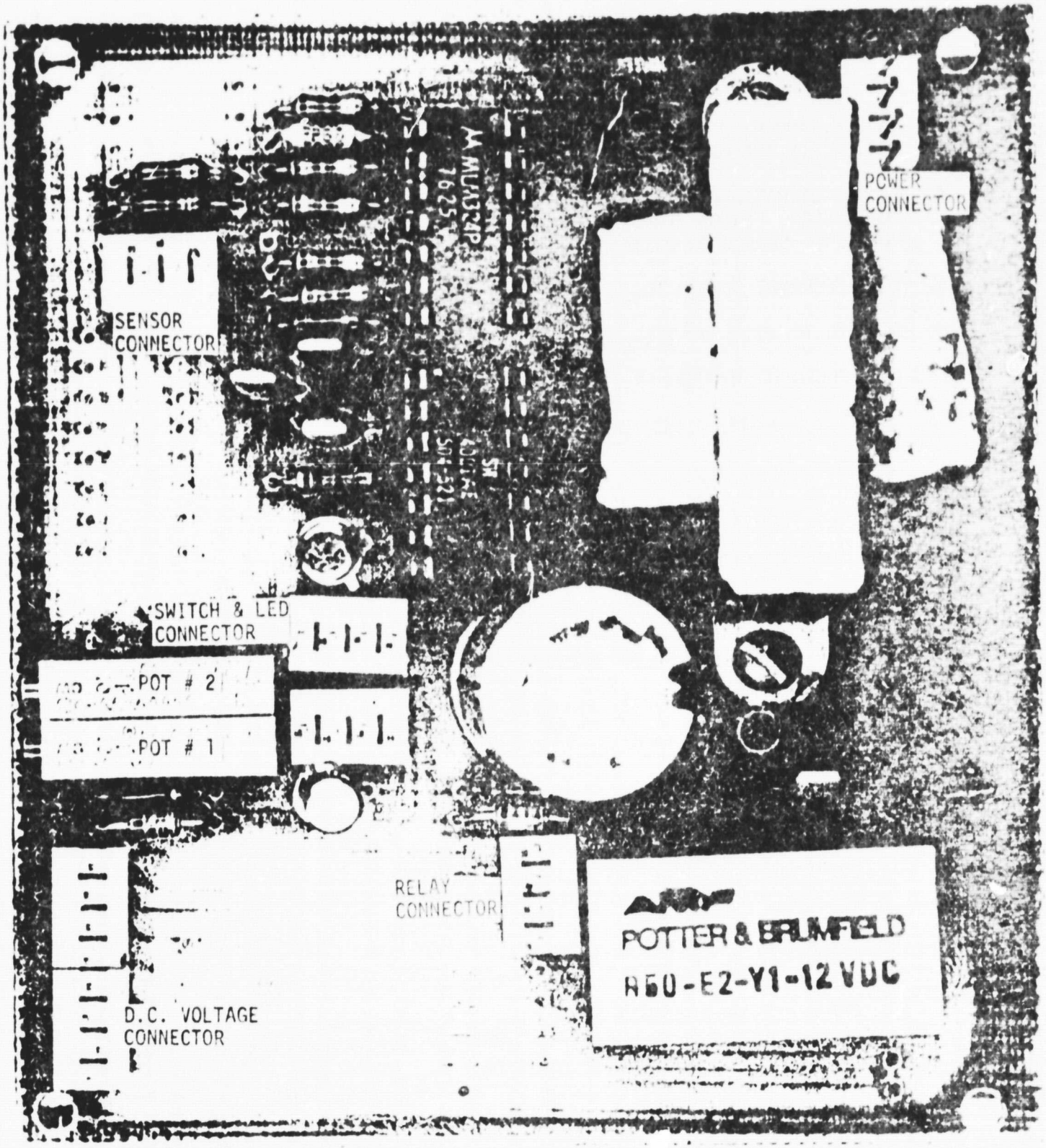
    (Repeat steps 8 and 9 until calibration is within desired range of accuracy).
14. TURN POWER OFF TO THE DIFFERENTIAL CONTROLLER.
15. REMOVE CALIBRATION SENSOR BOX AND RECONNECT OPERATIONAL SENSORS.
16. TURN POWER ON.

* LED (Light Emitting Diode-an indicator bulb)

Notes:

1) Calibration can be made at any desired tempeatures, however, it is recommended that they be made in the range of expected systems operation. See thermistor transfer characteristics table for resistance setting other than those given.

2) Linear pots can be used and set at desired resistance value according to thermistor transfer characteristics tables instead of using the calibration box.



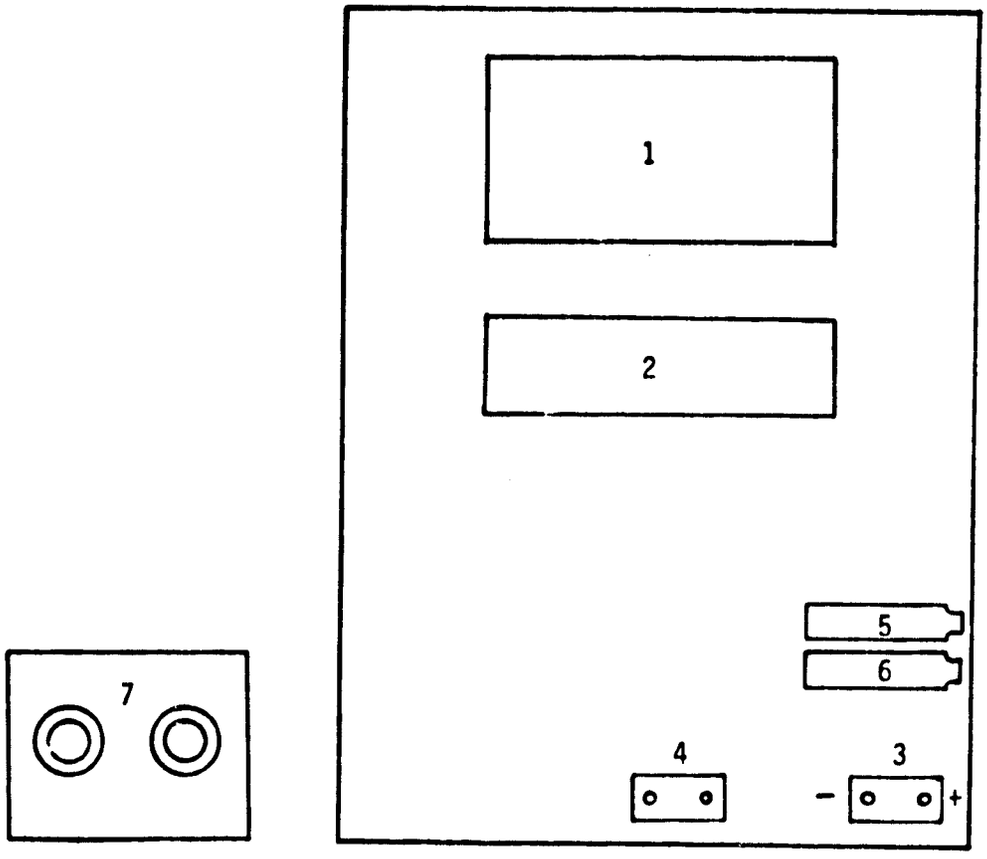
ILI'S DIFFERIENTAL CONTROLLER

ILI TEMPERATURE METER
CALIBRATION PROCEDURE

1. Set simulator setting at 650(A resistance equivalent to a sensor at 0° C).
2. Adjust OFFSET POT 6 until LCD reads 000.
3. Set simulator setting at 821 (A resistance equivalent to a sensor at 100° C).
4. Adjust SCALE POT until LCD reads 100.
5. Repeat steps 1 through 4 until the correct readings are obtained.

COMPONENT DESCRIPTION

1. 40 pin LCD (Liquid Crystal Display)
2. 40 pin IC chip
3. 9 volt DC input terminals
4. Sensor input terminals (and simulator input terminals)
5. Scale potentiometer
6. Offset potentiometer
7. Sensor simulator (If a simulator is not available, a resistance of 3250 ohms is the same as a setting at 650. A resistance of 4109 ohms is the same as a setting at 821.)



SECTION III

EMERGENCY SHUTDOWN

EMERGENCY SHUTDOWN - THE SWITCH AT THE BOTTOM LEFT of the control box will disconnect all power to solar unit (DOWN IS OFF).

IF LEAKAGE IS THE CAUSE FOR EMERGENCY SHUTDOWN, first close valves # 8 and # 9 . This isolates the solar system from the city water supply and building distribution. Next close valves # 5 , # 6 , and # 7. This isolates the 1,000 gallon tank from the piping system.

RETURN TO OPERATION - If the system was turned off during the day, for over 5 minutes, with the sun out, the system should not be turned on until sunset. The reason for this is with the sun out and the collector plate dry, the collector plate will get very hot. If water is pumped to the collectors while they are very hot, it would flash into steam and possibly damage a collector.

To return to a safe operation put all control switches (small switches) to OFF (middle position). Turn the power switch to ON. If the sun is not out or the system has been off for less than 5 minutes turn the collector switch to ON, the collector circulator pump should turn on. Now switch the collector switch to AUTO and leave there. Next, operate the D.H.W. switches ON. The two pumps should operate and the three Taco valves on the dischare side of the heat exchanger should opeate. Now put the switch in the AUTO position. The system is now in the fully automatic position.

Note: A lighted fuse holder indicates a blown fuse.

SECTION IV

MAINTENANCE

1. MONTHLY CHECK SIGHT GLASS. When the tank is hot and the collectors are drained (end of a bright day), the water level observed in the sight glass should be below but within 1" (one inch) of the top of the sight glass. If the level is greater than 1" (one inch) below the top of the sight glass water should be added. Add the water through the drain/fill valve at the bottom of the control unit. Connect a hose between this drain valve and a waterline. (Make sure the vaccum breaker is on the fill valve). Open the valves at both ends of the hose and leave both open until the water level observed in the sight glass is even with the top of the sight glass. Turn off both valves at the ends of the hose and remove the hose to prevent tampering or overfilling.

2. BI-MONTHLY CHECK AUTOMATIC VALVES. This test will determine if the valves are stuck open. Operate the D.H.W. switches on the control box to the middle position (OFF). Wait about 1 minute. On the side of each green valve operator is a black lever. Move the lever towards the pipe and then away from thepipe - resistance should be felt moving the lever towards the pipe (you are manually opening the valve). If the lever will move only about half-way then stop - the valve is frozen shut. If no resistance is felt moving the lever - the valve is frozen open. Repeat for all three valves. Now, switch the three bottom left switches to the ON position (push switch to the left). Wait about 2 minutes. Operating the same levers on the valves, no resistance should be felt. If resistance is felt pushing the lever towards the pipe the valve is not opening. If this condition exists see if 24VAC is being delivered to the actuator (green box on valve). If 24VAC is being delivered, replace the actuator. If 24VAC is not being delivered consult ILI, Inc. After completion of this test, return ALL the switches to the AUTO position.

3. CHECK CONTROL CARDS. If operation is questioned. Insure all switches are in AUTO position. To check, the sensor at the bottom of each tank (solar and D.H.W.) is put in ice water - the light corresponding to that sensor should turn on (if it is out); put it in boiling water - the light should turn off (if it is on).

4. PERIODICALLY RECORD TEMPERATURES. Record at least monthly. Pick a clear day and record every 2 or 3 hours. This is a operation record of the system and will help identify any problem that might otherwise go unnoticed.

5. PUMP MOTORS. The motors and pumps are permanently lubricated and require no oiling. A pump seal leaking will cause a wet spot on the floor. A burned out pump motor will illuminate one of the three lamps on the front of the control box when the pump is signaled to turn on. To turn the pumps on, first insure the breaker is on and the power switch is on. To manually turn on P-1, switch the collector

switch to the ON POSITION. The small red light above the switch should turn on along with the pump. Return the switch to the AUTO POSITION. Switching the D.H.W. switches to the ON POSITION will operate P-2 and P-3. Return the switch to the AUTO POSITION.

6. EMERGENCY TURN OFF. The switch at the bottom left of the control box will disconnect all power to the solar unit (DOWN IS OFF).

7. PUMP FUSE CHECK -
   A. Turn "POWER" switch to ON , If light in the power fuse turns on, the main power fuse is blown. Replace it with a 30 amp slow blow #4AG fuse.

   B. Power must be on. Operate "COLL" Switch to ON if the light labeled P-1 turns on then the fuse is blown; replace if required. If not, return the switch to AUTO. This tests P-1 circuit. (If fuse needs replacement use 220 amp, 4 AG fuse).

   C. Power operates "D.H.W." Switch to ON if the light's) labeled P-2 or P-3 turn on, then the fuse(s) are blown; replace if required. If not, return the switch to AUTO. This test P-2 and P-3. (If fuse needs replacement use 15 amp, 4 AG fuses.)

OPERATING RECORDS

The system temperature and flow rates are key information in determining how well the solar system is performing. Therefore, this information should be determined periodically and some judgement made as to system performance. To aide in detecting performance trends, the data should be recorded and information comparisons made with previous data taken under comparable conditions. If the conditions (outside temperature, sunshine, and temperature of the load) are not close then no judgement can be made as to system trends. A suggested data sheet format is provided on the following page.

Under normal or average conditions, one could expect the temperature rise across the collectors ($T_1 - T_2$) in the area of 6°C. This is also a reasonable temperature rise on the output of the HX tube ($T_5 - T_6$) if T_6 is in the 15°C range and T_3 is in the area of 25°C. As T_6 increases or T_3 decreases, ($T_5 - T_6$) will decrease. Observation of these temperatures over a period of time will assist in detecting the need for system maintenance.

The rate of flow through the pump circuits effect the temperature rise/fall of the circuits. The normal flow rate through the collectors (P_1) should be in the area of 30 gpm. ($\triangle$P of 22 PSI). The mean flow rate through the shell side of the heat exchanger P_2, is 23 gpm (P of 16 PSI) and the tube side P -3, is 34 gpm ($\triangle$P of 13 PSI). It is not necessary that these flow rates be exact. However significant departures from these rates indicate changes in system operating characteristics. It is therefore desirable to detect very early any changes that indicate a trend either up or down.

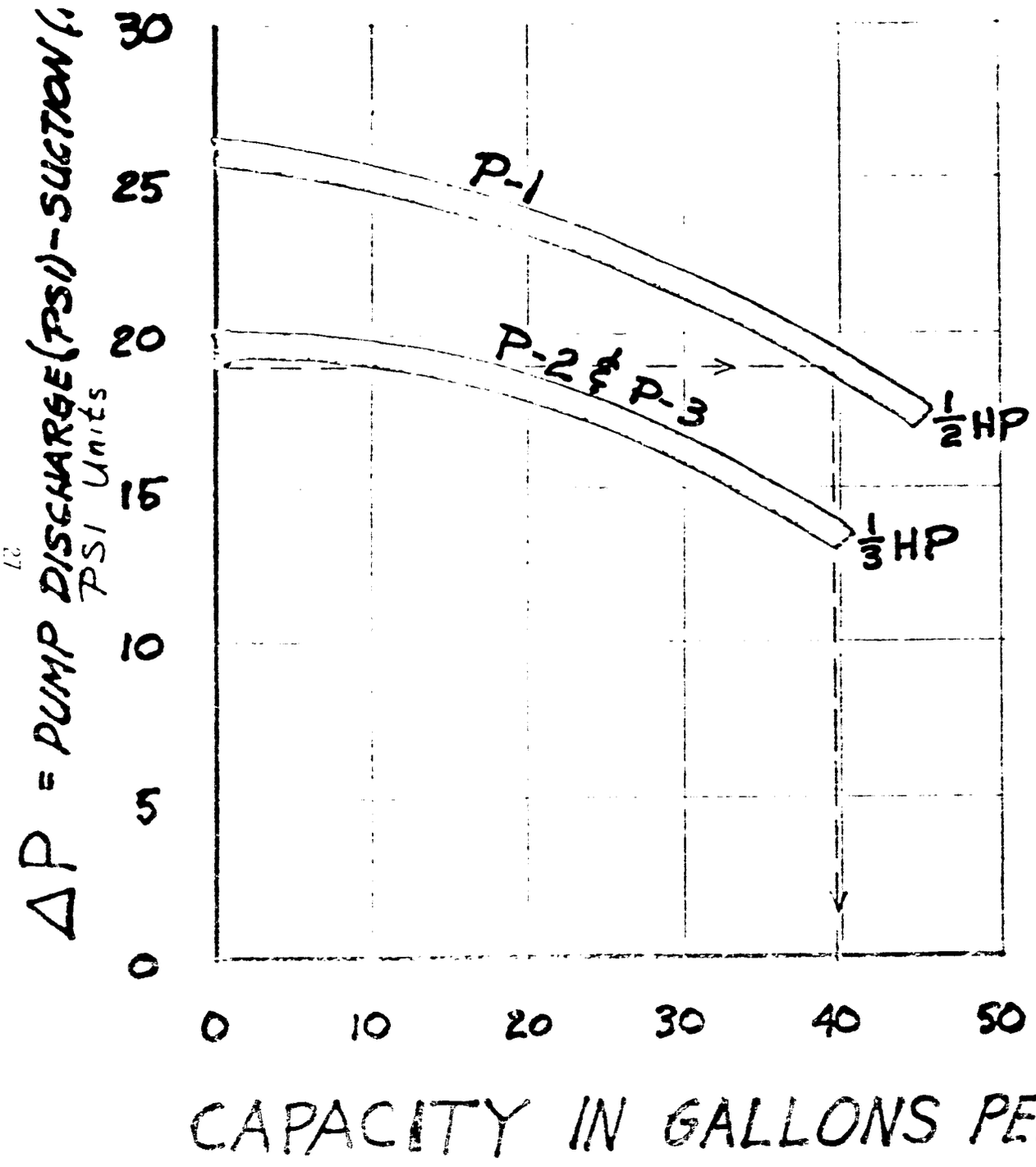
Figure 4 provides a curve for interperting pressure drop across the pumps in terms og gmp. By taking the pump discharge pressure and subtracting the pump suction pressure, we obtain a P which can be entered on the left axis of the graph. Reading across until the proper pump curve is intersected and then down to the horizontal axis, we can find the capacity flow in gallons per minute. An example is provided on Figure 4 to insure proper interpretation.

If conversion between degrees celsius and fahrenheit is desired, use the equations below:

$$^{o}C=\frac{5}{9}(^{o}F-32)$$

$$^{o}F=\frac{9}{5}\ ^{o}C+32$$

DATE	TIME	COLLECTOR TEMPERATURE		HEAT EXCHANGER TEMPERATURE		DOMESTIC HOT WATER		PRESSURE READING			
		SUPPLY-T1	RETURN-T2	SUPPLY-T3	RETURN-T4	SUPPLY-T5	RETURN-T5	P-1	P-2	P-3	



1. FIND PUMP AND CURVE
2. FIND ΔP BY SUBTRACTING PUMP SUCTION PSI
   * FROM DISCHARGE PSI
3. READ ΔP ACROSS TO PUMP LINE, THEN DOWN TO GPM

→ EXAMPLE: ½ HP, 19 PSI = ΔP ∴ 39 GPM

* NOTE IF VACUUM ON SUCTION IS INDICATED- ΔP = DISCHARGE PSI + ½ x (INCHES HG.)

FIGURE 4

SECTION V

SYSTEM EQUIPMENT

PUMPS

2	-	BELL & GOSSETT	1535-351S	115VAC
1	-	BELL & GOSSETT	1525-352S	115VAC

VALVES

3	-	TACO	#557	24VAC

TANK

1 - ILI, Inc. 1,000 Gallon - Steel, Non-pressure. Non-toxic epoxy paint inside. Temperature range (paint), -20°F to 220°F.

HEAT EXCHANGER

1 - ILI, Inc. HX - 8048-4P-1C
With 160°F inlet water @ 23 GPM (Shell side), and 130°F inlet water @ 34 GPM (Tube side) HX designed to give 145°F water (Shell side) and 140°F water (Tube side-to DHW Tank)

CONTROL CARDS

2 - ILI, Inc. SC120 Single Stage Differential Controller

TEMPERATURE METER

1 - ILI, Inc. M 15 LCD

SENSORS

10 - HONEYWELL Sensors C773A / C773C / C773D

COLLECTORS

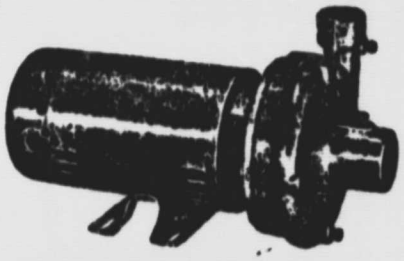
30 - SOLAR ENERGY PRODUCTS Collectors CU30-WW

ILI,Inc.
5965 Peachtree Corners East
Norcross, Georgia 30071
(404) 449-5900

BELL & GOSSETT

SUBMITTAL

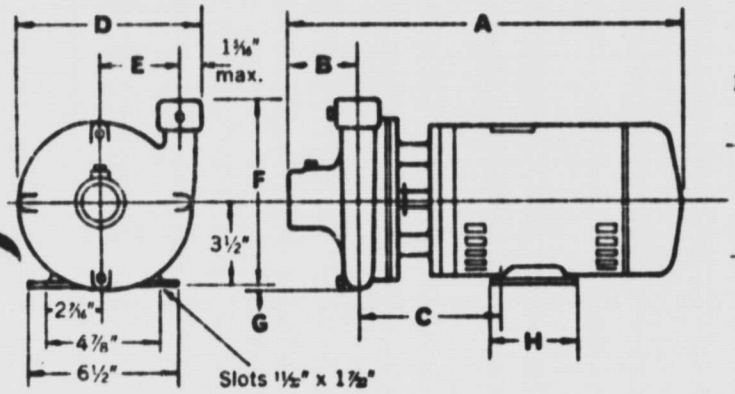
B-341
REVISION 3



Series 1535
Close-Coupled Centrifugal Pumps

JOB	B & G REPRESENTATIVE _____
UNIT TAG NO. _____	ORDER NO. _____ DATE _____
ENGINEER _____	SUBMITTED BY _____ DATE _____
CONTRACTOR _____	APPROVED BY _____ DATE _____

DIMENSIONS



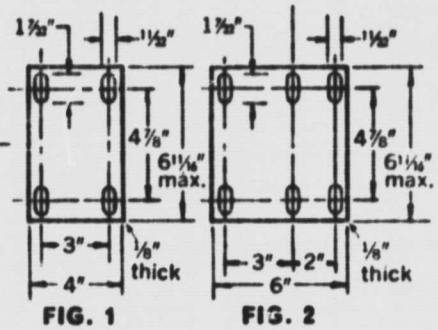


FIG. 1 FIG. 2

CONSTRUCTION FEATURES

CI Volute

Brass Impeller

SS Shaft

Mechanical Seal for temperatures ranging from −20°F. to +225°F.

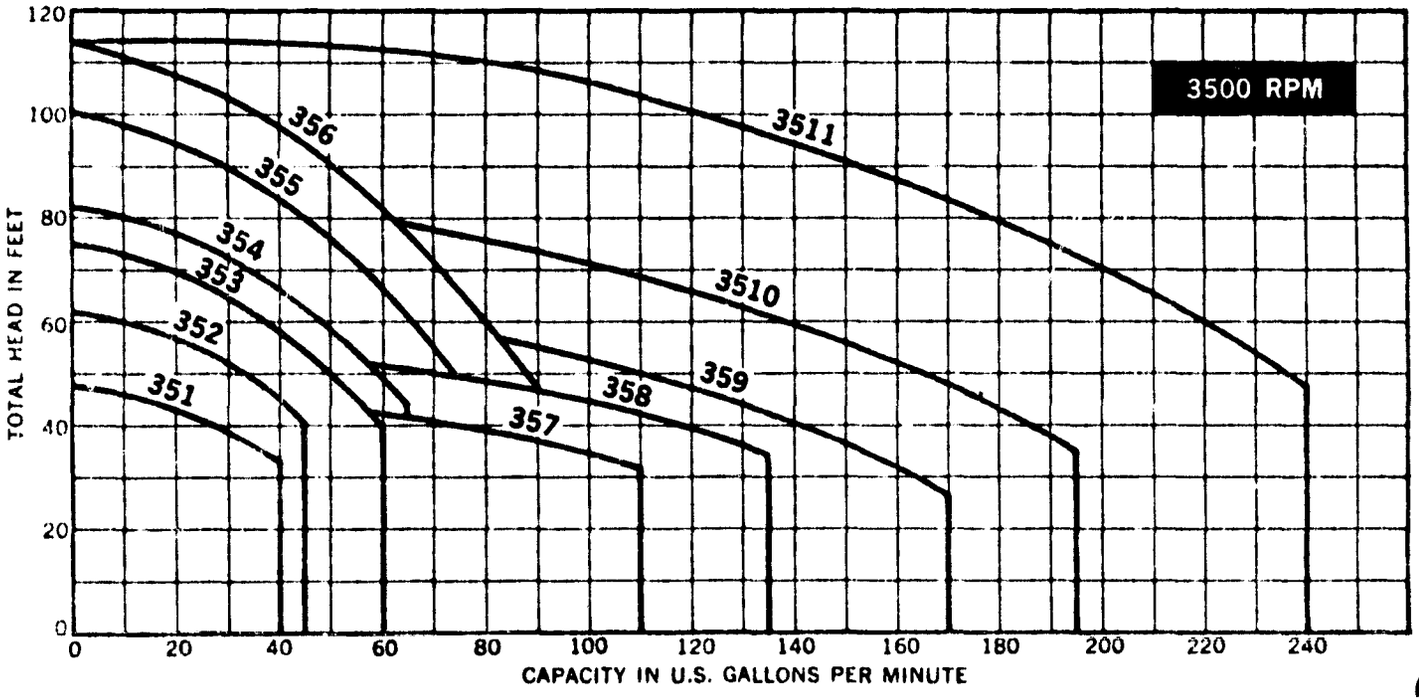
Bronze Fitted Construction. Motors—Open Dripproof. Single Phase—Unit Number ending in "S", 115/230 Volt, 60 Cycle, 1 Phase. Three Phase—Unit Number ending in "T", 200 Volt or 230/460, 60 Cycle, 3 Phase. (Please specify) All Single Phase Motors have built in overload protectors. 3500 RPM. 175 PSI Maximum Working Pressure.

MODEL NO.	H.P.	SUCTION SIZE (NPT)	DISCHARGE SIZE (NPT)	DIMENSIONS IN INCHES							
				A (MAX.)	B	C	D	E	F	G	H
351S	1/3	1 1/4	1	14 3/4	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
351T	1/3	1 1/4	1	15	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
352S	1/2	1 1/4	1	15	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
352T	1/2	1 1/4	1	15	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
353S	3/4	1 1/4	1	15 1/2	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
353T	3/4	1 1/4	1	15 1/2	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
354S	1	1 1/4	1	15 3/4	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
354T	1	1 1/4	1	16	2 1/16	5	8	3 3/8	8	1/4	FIG. 1
355S	1 1/2	1 1/4	1	16 1/16	2 1/16	5 5/16	8	3 3/8	8	1/4	FIG. 2
355T	1 1/2	1 1/4	1	16 7/16	2 1/16	5 5/16	8	3 3/8	8	1/4	FIG. 2
356T	2	1 1/4	1	16 7/16	2 1/16	5 5/16	8	3 3/8	8	1/4	FIG. 2
357S	1	2	1 1/2	16	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 1
357T	1	2	1 1/2	16 1/4	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 1
358S	1 1/2	2	1 1/2	17 3/16	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 2
358T	1 1/2	2	1 1/2	16 11/16	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 2
359T	2	2	1 1/2	16 11/16	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 2
3510T	3	2	1 1/2	17 3/16	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 2
3511T	5	2	1 1/2	18 11/16	2 1/16	5 5/16	8 3/8	3 3/8	8 3/4	1/2	FIG. 2

2 HP through 5 HP units are not available in single phase.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERIES 1535 PERFORMANCE CURVES



Add "S" to pump number when ordering single phase pumps. Add "T" to pump number when ordering three phase pumps.

PRINTED IN U.S.A. 6-75

BELL & GOSSETT
8200 N. AUSTIN AVE. - MORTON GROVE, ILL. 60053
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

taco

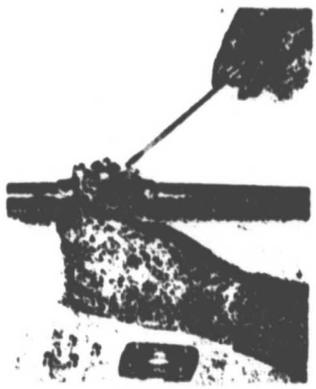
INSTRUCTION SHEET

Plant ID. No. 001-302

TO SERVICE

1 — Twist off Power Head

2 — Remove the 4 Screws from hold down plate



3 — Pry out seat assembly

TO RE-ASSEMBLE

Reverse above procedure pushing down on seat assembly and hold down plate against return spring.

NUMBER

IS-100-4-1

MODELS

555-½"	560-½"	571-¾"
556-¾"	561-¾"	572-1"
557-1"	562-1"	573-1¼"

ZONE VALVES

EFFECTIVE: May 15, 1971

Supersedes: IS-100-4-1, Dtd., 2/1/69

APPLICATION

The Taco-Zone Valve is an electrically operated valve used for zone control of Hydronic Heating and/or Cooling Systems. It controls the flow of water in a room or zone in response to the demands of the room or zone thermostat. This valve is a precisely made device and must be installed with care.

RATING

		555-½" 556-¾" 557-1"	560-½" 561-¾" 562-1"	571-¾" 572-1" 573-1¼"
Working Pressure (PSIG at Valve including Pump Head)	—	125 PSI	125 PSI	125 PSI
Maximum Differential Across Valve (Pump Head-Feet of water)	—	150 Ft.	65 Ft.	65 Ft.
Recommended Temperature Range — Max.	—	240 F	240 F	240 F
Min.	—	40 F	40 F	40 F
Electrical Rating ..... Amps.	—	1.0 Max.	1.0 Max	1.0 Max.
Volts	—	24	24	24

SIZE	FLOW RANGE — GPM				PRESS. DROP THRU VALVE FEET OF PIPE EQUIV.
	3 Ft./Sec.	4 Ft./Sec.	5 Ft./Sec.	6 Ft./Sec.	
½"	2	3	4	5	10
¾"	4	6	7	8	20
1"	8	10	13	15	70
1¼"	12	15	18	21	160

INSTALLATION

Valves should be installed vertically, to simplify replacement or cleaning of the seat, if ever required at some future date. The vertical installation permits drawing a vacuum in the system and replacing or cleaning the seat without draining the system.

Valve may be sweat into the line without taking apart, provided, care is taken to prevent overheating. Follow these simple instructions: —

1. Use a torch with sharp, pointed flame.
2. Clean surfaces thoroughly and use a good grade of flux.
3. Use 50-50 or 60-40 solder. If grades of solder requiring higher temperatures are used, such as silver solder, the valve must be dismantled.
4. Avoid excessive use of flux.

THERMOSTAT

Use a No. 568 Taco Thermostat (designed specifically for Taco-Zone Valves) with Heat Anticipator set at " **D** ". Other suitable two wire (SPST) Thermostats may also be used if Heat Anticipator can be set at 0.9 Amps to match valve rating.

TRANSFORMER

Use a No. 569 Taco Transformer or other make rated at 115/24V-40VA. One transformer can accommodate a maximum of 3 Taco-Zone Valves

MANUAL OPENING LEVER

For gravity circulation thru valve, push lever in Power Head all the way down. Push back up to restore to automatic operation. Lever moves easily when valve is open. Resistance is encountered when valve is closed.

CAUTION: Addition of certain chemical additives to systems utilizing Taco equipment, voids the warranty.

IMPORTANT NOTE

Never remove Power Head while thermostat is calling for heat. If necessary to remove Power Head, move thermostat to lowest setting, wait a minute, then proceed.

TACO, INC.

1160 Cranston Street
Cranston
Rhode Island 02920

Printed in U.S.A.

Taco Heaters of Canada, Ltd.
3090 Lenworth Drive
Cooksville, Ontario

2 WAY MODELS

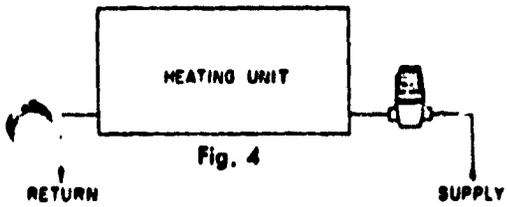


Fig. 4

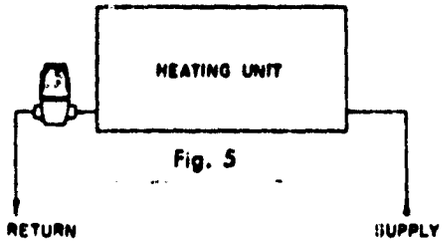


Fig. 5

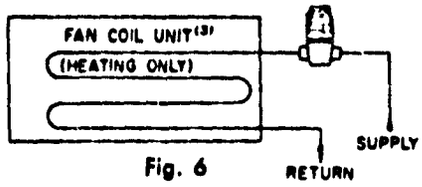


Fig. 6

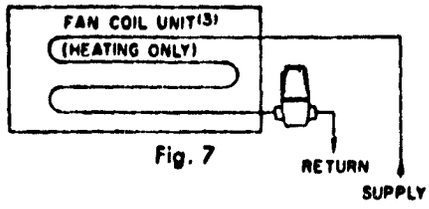


Fig. 7

lay also be used for cooling if by-pass is provided in piping to prevent chiller freeze-up.

3 WAY MODELS

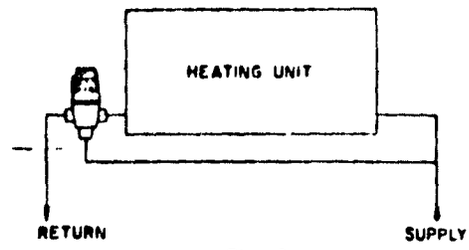


Fig. 8

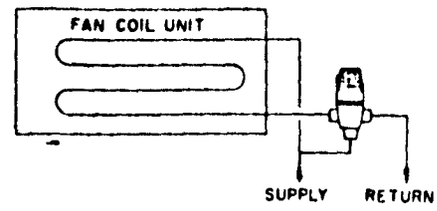
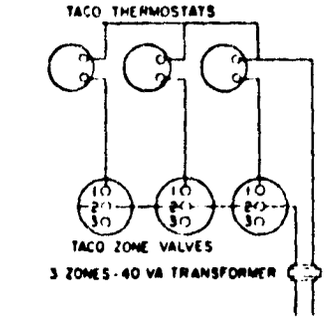
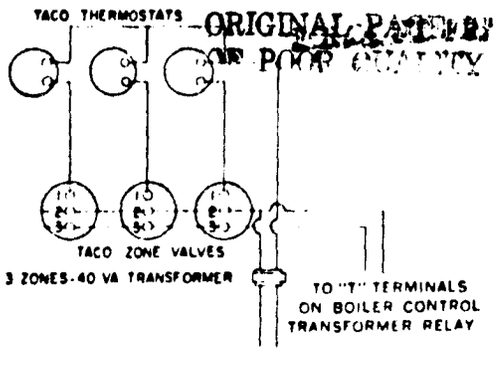


Fig. 9

TYPICAL WIRING DIAGRAMS

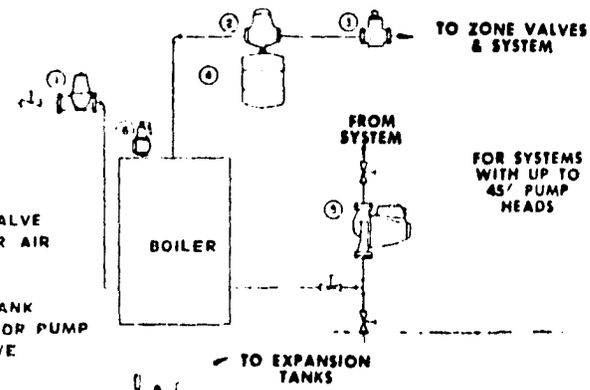


BASIC WIRING DIAGRAM
CONTINUOUSLY OPERATING PUMP

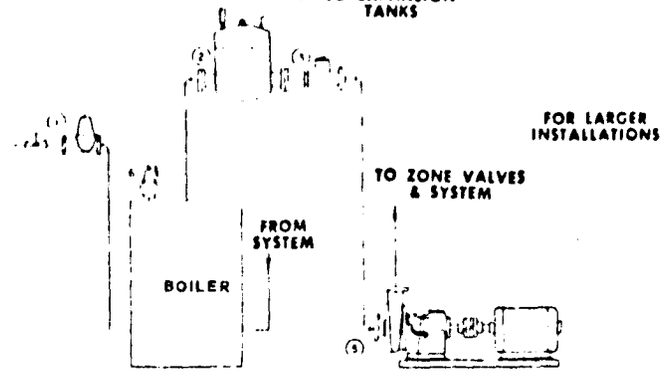


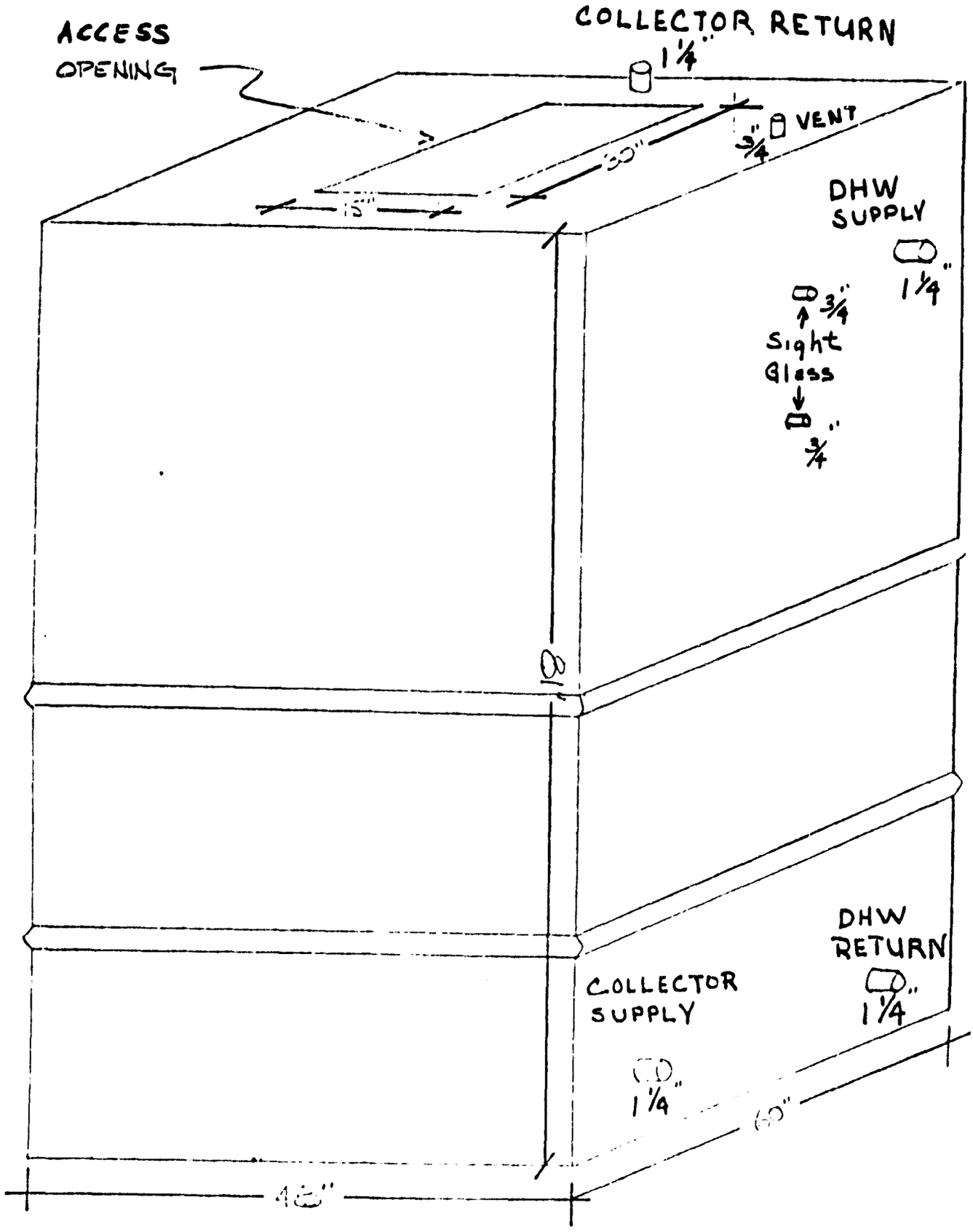
BASIC WIRING DIAGRAM
INTERMITTANT OPERATING PUMP

TYPICAL BOILER HOOK-UPS



1. REDUCING VALVE
2. AIR-SCOOP OR AIR CONTROL
3. FLO CHEK
4. TACO-TROL TANK
5. CIRCULATOR OR PUMP
6. RELIEF VALVE





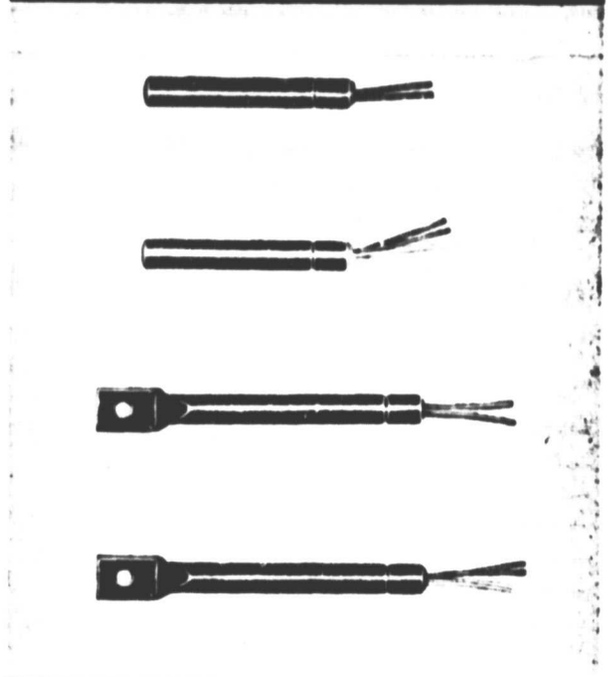
ILI 1000 GALLON TANK

Honeywell

ELECTRONIC TEMPERATURE SENSORS

THE C773 IS A PLATINUM FILM SENSOR WHICH HAS A POSITIVE TEMPERATURE COEFFICIENT. ON A RISE IN AMBIENT TEMPERATURE THE RESISTANCE OF THE SENSOR INCREASES.

- C773A contains a single sensor for storage tank or solar collector mounting.
- C773B contains a double sensor for storage tank or solar collector applications.
- C773C contains a single sensor with a flattened end and mounting hole for easy solar collector installation.
- C773D contains a double sensor with a flattened end and mounting hole for easy solar collector installation.
- Available with a medium or high ambient temperature range (specify when ordering).
- Immersion well and remote sensor wiring compartment available separately.



C773A-D

R.L.
10-77 (.03)

Form Number 60-2330-1

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

TRADELINE MODELS AVAILABLE:

C773A Temperature Sensor. Single sensor mounts in storage tank using immersion well or on collector with mounting clip.

C773B Temperature Sensor. Double sensor mounts in storage tank using immersion well or on collector with mounting clip.

C773C Temperature Sensor. Single sensor has flattened end with mounting hole for collector installation.

C773D Temperature Sensor. Double sensor has flattened end with mounting hole for collector installation.

LEADWIRE:

C773A,C–two black 18 inch [457.2 mm], No. 22, NEC Class 1.

C773B,D–two black, two white, 18 inch [457.2 mm], No. 22 stranded, NEC Class 1.

TEMPERATURE RANGE: Minus 50 to plus 450 F [minus 46 to plus 232 C].

DIMENSIONS: See Figs. 2 and 3.

ACCESSORIES:

Immersion Well–for mounting sensor in storage tank. See Table 1 and Fig. 1.

Remote Sensor Wiring Compartment–for wiring storage tank sensor, Part No 111892F.

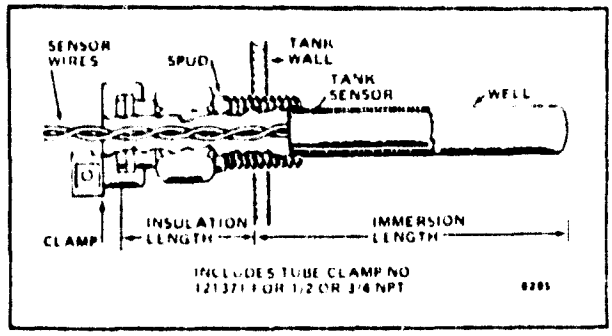


FIG. 1–TANK SENSOR INSERTED IN IMMERSION WELL.

TABLE 1–IMMERSION WELL TABLE

IMMERSION LENGTH		INSULATION LENGTH		SELECT WELL MATERIAL AND ORDER NUMBER BELOW			
				COPPER		STAINLESS STEEL	
in.	mm	in.	mm	1/2 NPT	3/4 NPT	1/2 NPT	3/4 NPT
3 3/8	85.7	1-1/2	38.1	121731A	121371B	121371E	121371F
3 3/8	85.7	1-1/2	38.1	–	121371K[a]	–	–
3 3/8	85.7	3	76.2	121371L	121371M	–	–
3 3/8	85.7	4	101.6	122554A[a]	122555A[a]	–	–
5 3/8	136.5	4	101.6	122554B[a]	122555B[a]	–	–
6	152.4	1-1/4	31.8	112620BB	–	–	–

[a]Has plastic sleeve on insertion well.

continued on page 3

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY–

1. Order number.
2. Accessories (immersion well remote sensor wiring compartment).

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. **YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY)**
2. **RESIDENTIAL DIVISION CUSTOMER SERVICE**
   HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

   (IN CANADA–HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

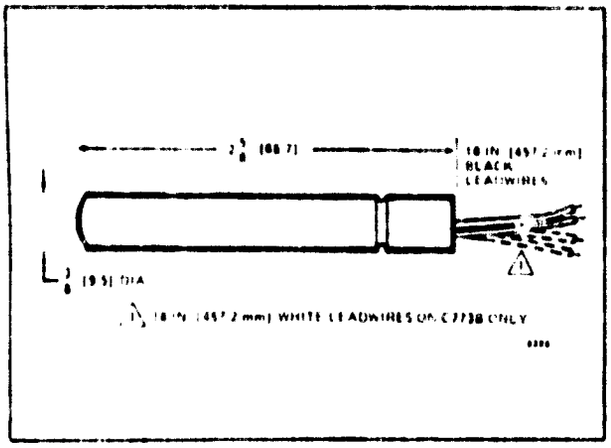


FIG. 2–C773A,B DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

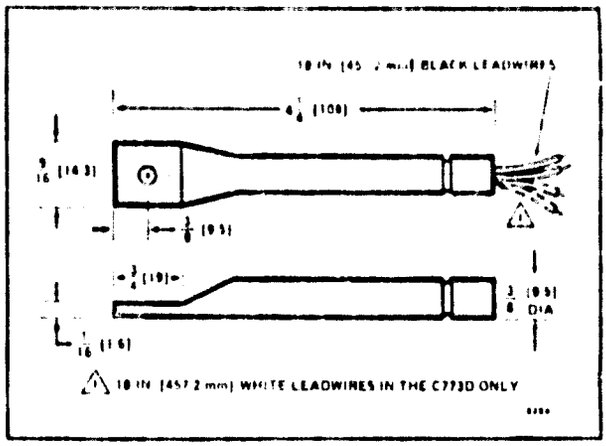


FIG. 3–C773C,D DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

INSTALLATION

CAUTION

1. Installer must be trained and experienced.
2. Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage.
3. Always conduct a thorough checkout as outlined in the instructions with the primary control when installation is complete.

LOCATION

Follow the system manufacturer's recommendations for the best location of the sensor. Each sensor should be located so that it experiences the most useful temperature for proper system operation.

MOUNTING SENSOR

Mount C773A,B as a storage tank sensor using an immersion well as follows:

1. Drain system fluid to a point below the sensor fitting.
2. Screw the well into the threaded fitting. Use an approved pipe dope or Teflon tape to seal the threads.
3. Refill system and check for leaks.
4. Insert the sensor probe into the immersion well until it bottoms. See Fig. 1.
5. Attach retainer clamp over groove on well spud. Fit wires in clamp groove and lightly tighten screw. Do not overtighten.

Install C773A,B as a collector sensor using the mounting clip provided and No. 8 screw. Mount C773C,D as a collector sensor using the flattened end with mounting hole and a No. 8 or 10 screw.

Temperatures in excess of 450 F [232 C] will damage the sensor. Shield the sensor against possible overtemperature conditions prior to system operation. *Do not mount collector sensor to collector fluid channels.*

WIRING

WARNING

1. **Shield the sensor against possible overtemperature conditions prior to system operation.**
2. **On unglazed collectors mount the sensor with leadwires down to keep sensor from accumulating water.**
3. **Wire additions to the leadwires must be capable of withstanding a temperature of 450 F [232 C].**

All wiring must comply with applicable codes and ordinances. The C773 can be used for numerous applications in solar energy systems. Fig. 4 shows the sensors wired to an R7412 Differential Temperature Controller.

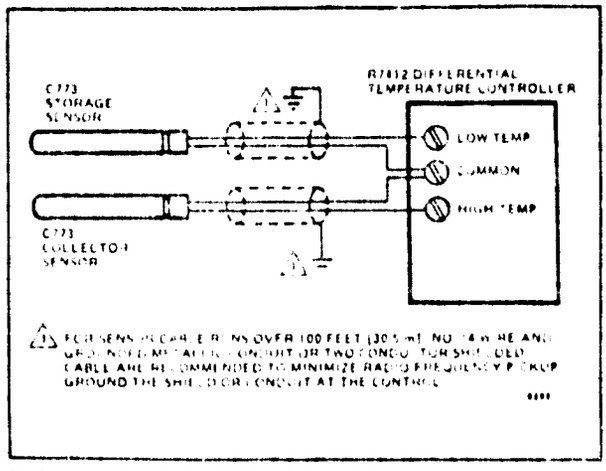


FIG. 4–WIRING C773 TO R7412 DIFFERENTIAL TEMPERATURE CONTROLLER

60-2330-1

For the C773B and C773D Temperature Sensors, the two black leadwires belong to one sensor and the two white leadwires belong to the other sensor.

If the amount of sensor cable used exceeds 100 feet [30.5 m], use No. 14 wire and grounded metallic conduit or two conductor shielded cable. Connect the shield or conduit to ground at the controller. Grounded metallic conduit or shielded cable (such as Belden 8762 or equivalent) minimizes possible radio frequency signal interference.

Remote Sensor Wiring Compartment (Part No 111892F) is available for tank sensor wiring (see Accessories).

OPERATION AND CHECKOUT

OPERATION

The C773 is a platinum film sensor packaged in a copper capsule. The sensor has a positive temperature coefficient; on a rise in ambient temperature the resistance of the sensor increases (Fig. 5).

CHECKOUT

Make certain that each sensor is securely mounted. When observing the system in operation, check that the sensors are correctly located. Each sensor should be located so that it experiences the most useful temperature for proper system operation.

To determine the temperature which the sensor is experiencing, use a high resistance ohmmeter (20,000 ohm/volt or greater) to measure the resistance of the sensor. This measurement may be converted to a temperature reading using Fig. 5. Check a variety of temperature locations to insure that the sensor reading is providing the most accurate temperature for proper system operation.

If the sensors are not providing correct temperature readings because of location, change the location and mount properly.

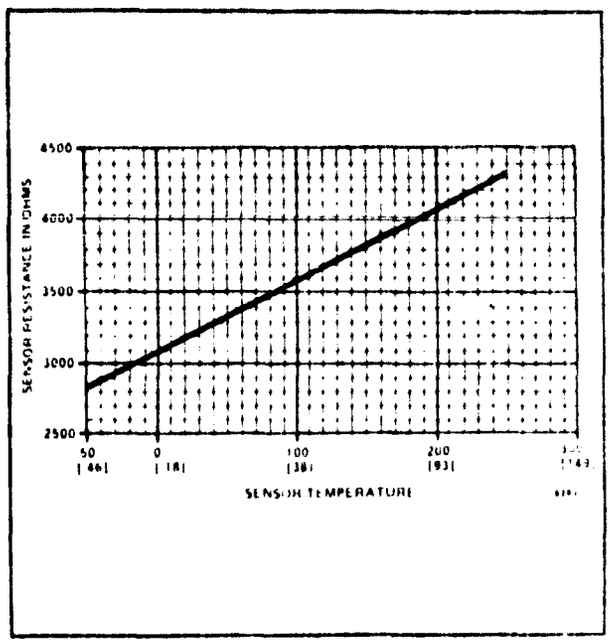


FIG. 5–CONVERTING SENSOR RESISTANCE INTO DEGREES F [C].

HONEYWELL MINNEAPOLIS MINN 55408 INTERNATIONAL Sales Offices in all principal cities of the world Manufacturing in ... Canada Great Britain France Germany Japan Mexico Netherlands Spain Taiwan United Kingdom U S A

PRINTED IN U S A

FEATURES : CU30 FLAT PLATE SOLAR COLLECTOR

FEATURE FOR FEATURE — The Gulf Thermal CU30 is carefully designed and constructed of the finest quality materials to provide dependable performance with a maximum service life expectancy.

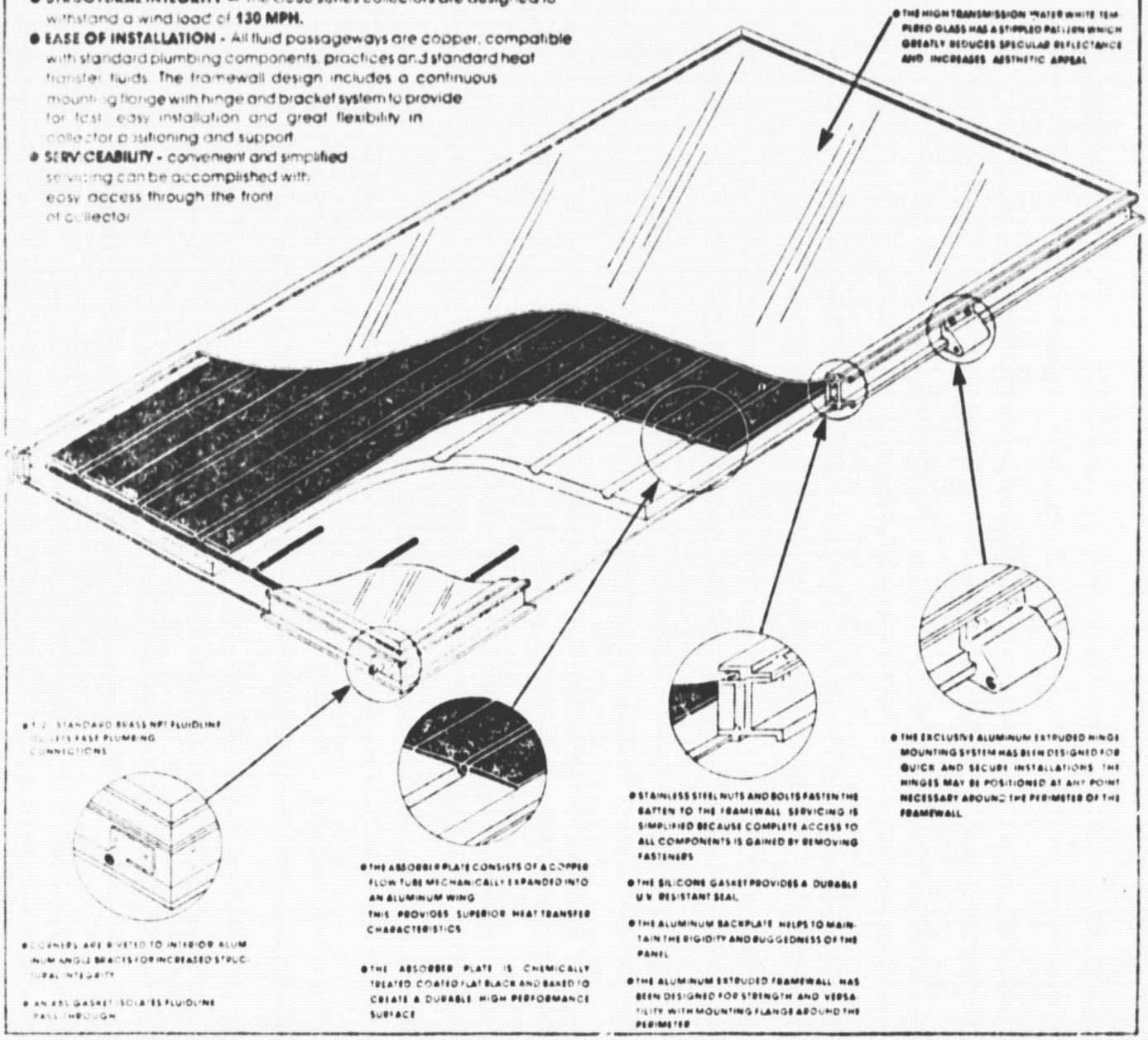
- **PERFORMANCE** — Our advanced design absorber plate combines copper flow tubes mechanically expanded into a highly conductive aluminum extruded wing, closed cell isocyanurate insulation, high transmissivity tempered glass cover plate, and a highly absorptive durable plate coating assuring outstanding thermal performance **(See Test Analysis page 5)**. The CU30 may be used in open or closed systems with **working pressures to 150 p.s.i.** and provides **thermal performance stability to 300°F.** An outstanding feature of the CU30 is the advanced design of the custom aluminum extruded framewall. The framewall has been designed for strength and versatility in mounting, in either saw-tooth or integrated roofing applications.
- **DURABILITY** — The anodized aluminum frame, non-degrading tempered glass cover plate, water-resistant closed cell insulation, silicone gaskets, and copper flow passageways all provide for design service life of **30 years,** when properly operated.
- **STRUCTURAL INTEGRITY** — The CU30 series collectors are designed to withstand a wind load of **130 MPH.**
- **EASE OF INSTALLATION** - All fluid passageways are copper, compatible with standard plumbing components, practices and standard heat transfer fluids. The framewall design includes a continuous mounting flange with hinge and bracket system to provide for fast, easy installation and great flexibility in collector positioning and support.
- **SERVICEABILITY** - convenient and simplified servicing can be accomplished with easy access through the front of collector.

SEP Systems have been designed and constructed to meet:

- **The Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems (NBSIR-76-1059)**
- **HUD Minimum Property Standards for Solar Heating and Domestic Hot Water Systems (4930.2).**
- **Independent Testing has been conducted by DESERT SUNSHINE EXPOSURE TESTS, INC., in accordance with The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE 93--77) guidelines.**

WARRANTY

The CU30 Modular Solar Collector is warranted against defects in materials and workmanship for five years from date of purchase (except for freeze damage, glass breakage and damage due to aggressive heat transfer fluid).



SPECIFICATIONS: CU30 FLAT PLATE SOLAR COLLECTOR

	CU30-SL	CU30-WW
OUTSIDE DIMENSIONS:	98.5" x 48.5" x 2.57"	Same
APERTURE AREA (sq. ft.):	29.3	30.05
PERIMETER AREA	33.17	33.17
DRY WEIGHT (lbs.):	156	190
COVER PLATE		
Material	Sheet Lime glass	Water White glass
Lights Per Panel	(3) 17 lbs. each	(1) 85.5 lbs.
Iron Oxide Content (%)	0.05	0.01
Thickness (inches)	1/8	3/16
Dimensions (inches/light)	46 x 31.5	46 x 96
Solar Transmission (%)	84	91
Tensile Strength (psi)	6400 (tempered)	6400 (tempered)
Elastic Modules (psi 10^6)	10.5	10.5

COVER PLATE GASKET: Silicone gasket seal bonded to framewall and cover plate batten; UV stable

BACK PLATE

Material: 0.032 mill finish aluminum sheet

Weight: 13.0 lbs.

FRAMEWALL, BATTEN, AND MULLION

Materials: aluminum alloy extrusion: Alloy no. 6063-T5

Weight: 35 lbs.

Finish: clear anodized

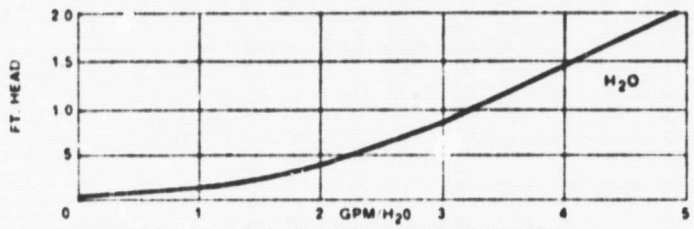
ABSORBER PLATE

Material: 0.5" I.D. - 0.026 wall copper flow tubes mechanically expanded into extruded aluminum wings for superior thermal conductivity. Flow tubes brazed to ¾ inch copper headers unless specified otherwise. All wetted surfaces are copper or brass.

Fluid Capacity: 0.84 gallons

Flow Characteristics: 0.05 ft. head at 0.75 gpm flow rate (water). Internal baffles direct flow for a uniform flow distribution. Absorber plate is designed to allow for fluid drainage when used in freeze-dump systems. Maximum design flow rate is 5 gpm.

Pressure Drop Curve



THE ABOVE CURVE ILLUSTRATES PRESSURE DROP ACROSS THE CU30 PANEL WITH WATER AS THE TRANSFER FLUID

Surface: Assembled plate is chemically treated and coated flat black unless specified otherwise.

Solar Absorptivity: 0.98

Emmissivity: 0.89

Weight: 49 lbs.

INSULATION

Material: 1-1/8 inch isocyanurate foam board, routed to receive flow tube pattern.

Thermal Conductivity: 0.09 Btu-in./ft.^{2}°F

Flame Spread Classification: 20

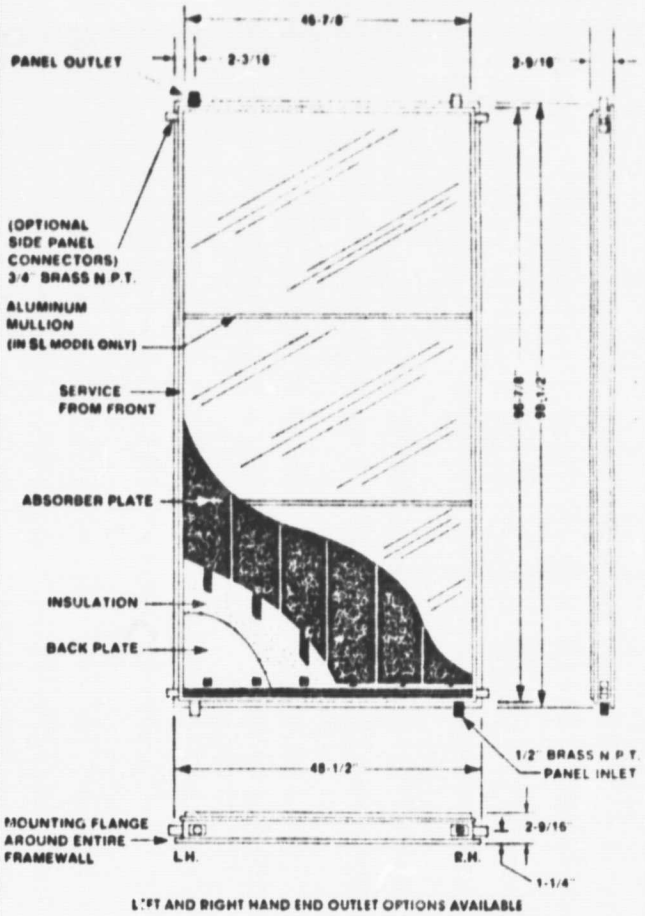
Weight: 7.0 lbs.

DESIGN LIFE: Material selection and design considerations allow an expected service life of thirty (30) years, when the panel is operated properly.

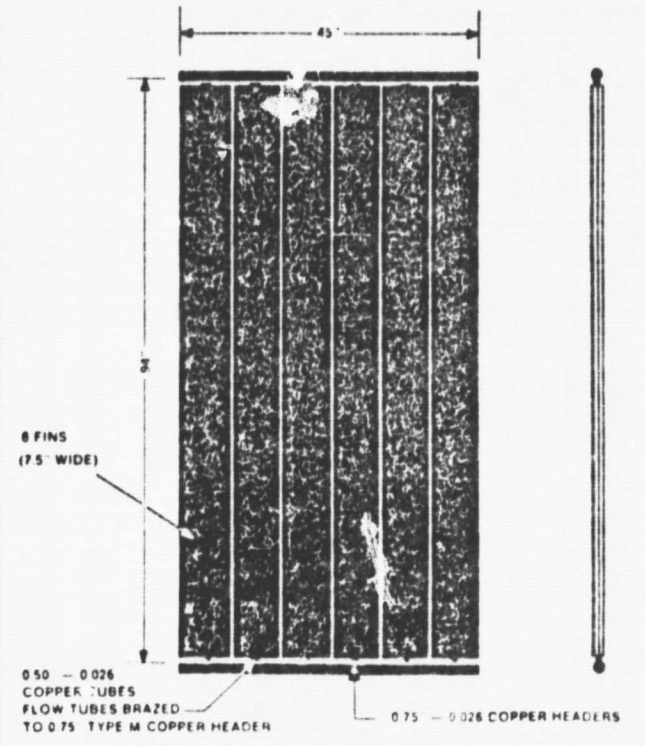
OPTIONS

- **CU30-HRM Mounting System:** Aluminum extruded mill finish hinges (4) designed to mate with any section of framewall. Aluminum standoffs (2) and mounting brackets (4) suitable for fixed position or adjustable mounting (from 0° to 90° +). Weight 9.0 lbs.
- **CU30-SO** ¾" brass threaded outlets with parallel internal 1" I.D. – 0.035 wall copper headers.
- Left hand and right hand ½" brass NPT end outlets.
- **CN30 –** ½" cupronickel flow tubes for aggressive heat transfer fluids.

CU30-SL



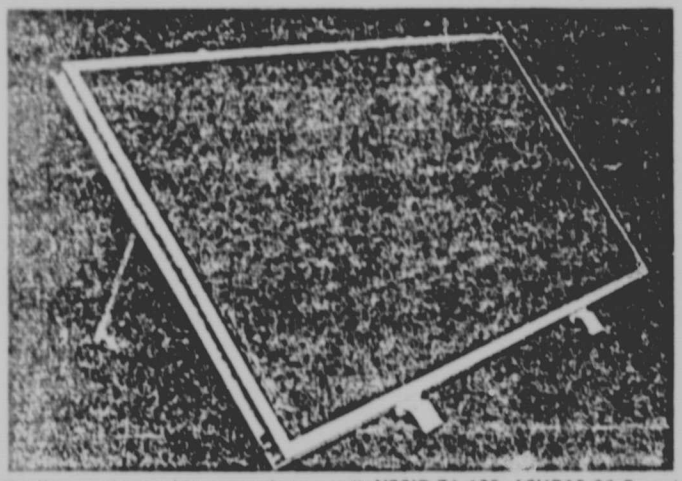
LEFT AND RIGHT HAND END OUTLET OPTIONS AVAILABLE



ABSORBER PLATE

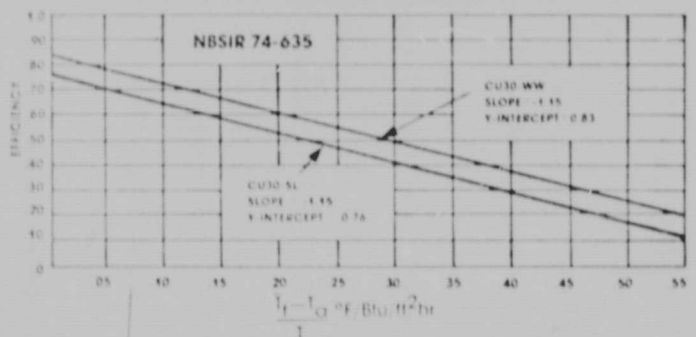
PERFORMANCE: CU30 FLAT PLATE SOLAR COLLECTOR

CU30-WW FLAT PLATE SOLAR COLLECTOR

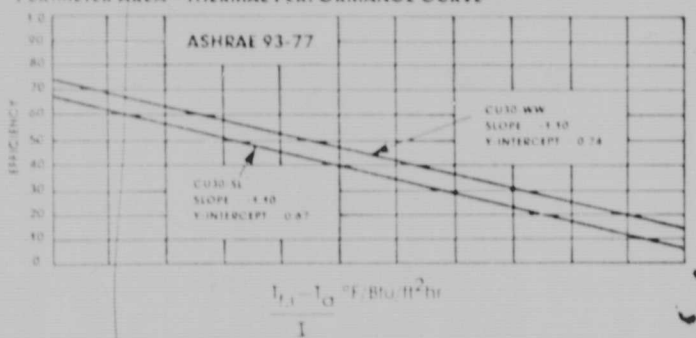


Testing performed in accordance with **NBSIR 74-635, ASHRAE 93-P** and **ASHRAE 93-77** by Desert Sunshine Exposure Tests, Inc., Phoenix, Arizona.

APERATURE AREA—THERMAL PERFORMANCE CURVE



PERIMETER AREA—THERMAL PERFORMANCE CURVE



T_a = ambient temperature $T_f = \frac{T_{in} + T_{out}}{2}$ of collector fluid

I = solar insolation

THERMAL PERFORMANCE CURVE EXPLANATION

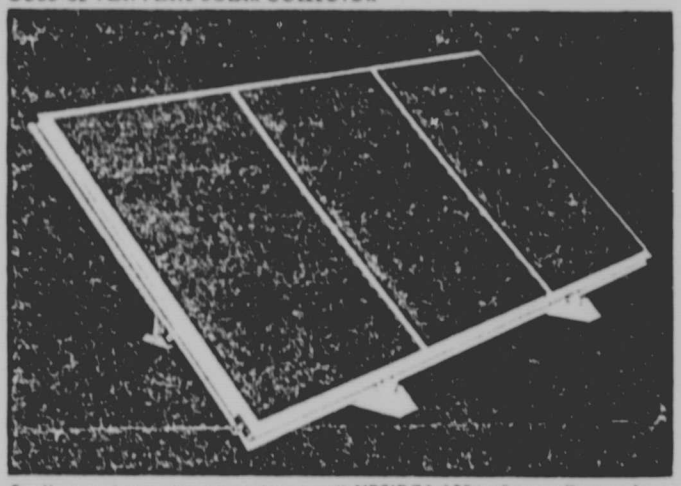
Test conducted by Desert Sunshine Exposure Tests, Inc., Phoenix, Arizona.
Test data available upon request.

Instantaneous solar collector efficiency of the CU30 solar collector is found by operating the panel under stable conditions and monitoring inlet and outlet temperatures and the mass flow rate. The panel inlet and outlet temperatures are averaged and the ambient air temperature is subtracted from the result. This number is then divided by the incident solar radiation (Btu/hr/ft²). The resulting value is plotted along the x-axis of the graph. The value to be plotted on the y-axis is the actual efficiency of the panel: output (outlet temperature minus inlet temperature °F multiplied by the flow rate lb./hr.) divided by input (insolation Btu/hr.). These values plotted at different inlet temperatures, provide an instantaneous performance curve.

THERMAL PERFORMANCE STABILITY

Thermal distortion of the solar collector during operation and periods of stagnation to temperatures of 300°F will not cause significant deterioration of panel's performance.

CU30-SL FLAT PLATE SOLAR COLLECTOR



Testing performed in accordance with **NBSIR 74-635** by Energy Design Associates, Inc., Gainesville, Florida.

SPECIFICATIONS SUMMARY: CU30 FLAT PLATE SOLAR COLLECTOR

The CU30 Flat Plate solar collector panels shall be capable of absorbing solar radiation and transferring the resulting heat into a heat transfer fluid circulating through the panel. The absorber plate shall consist of a grid pattern of aluminum "fin" extrusions with copper flow tubes mechanically expanded into the fins, providing positive thermal contact of minimum 67% of tube surface. The enclosure box shall be constructed of clear anodized aluminum with the mounting flange extending around the entire perimeter of the panel. Insulation shall be 1-1/8" closed cell isocyanurate rigid foam board. The cover plate shall be tempered sheet lime or water white glass with transmissivities of .84 and .91 respectively. The cover plate gasket shall be a dry extruded silicone bead. The panel fluid connections shall be thermally isolated 1/2" NPT brass nipple.

THERMAL PERFORMANCE

The panel's aperature shall be independently tested according to ASHRAE 93-77 test standards. The panels shall have a linear analysis thermal efficiency described by the equations:

$$EFF = 0.83 - 1.15\frac{(T_f - T_a)}{I} \quad \text{(NBSIR 74-635)}$$

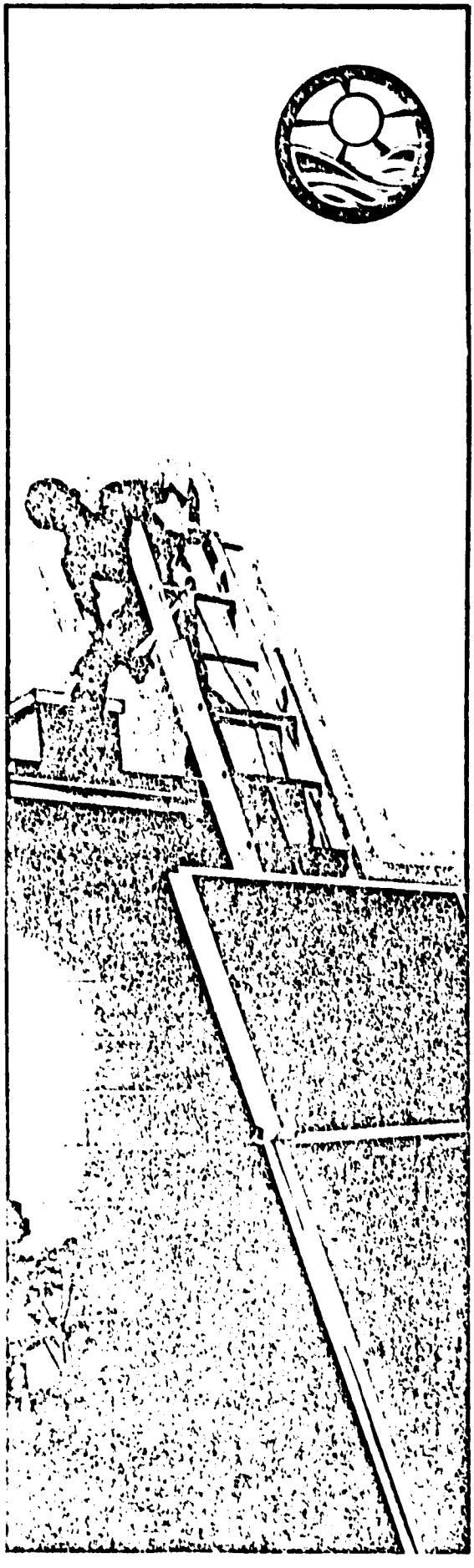
$$EFF = 0.74 - 1.10\frac{(T_f - T_a)}{I} \quad \text{(ASHRAE 93-77)}$$

DURABILITY

The panel shall be capable of withstanding stagnation temperatures of 300°F without significant degradation. The panel shall be designed to withstand wind loads to 130 mph, when properly mounted. The absorber plate shall be designed to allow fluid drainage for freeze protection and shall be capable of withstanding working pressures of 150 psi. The panels shall have a design service life of 30 years.

SERVICEABILITY

The glass cover plate shall be removable from the front of the panel with simple hand tools. The absorber plate and other components shall then be removable through the front of the panel.



Solar Energy Products, Inc.

Warranty

DOMESTIC HOT WATER SYSTEMS WARRANTY

I. SYSTEM WARRANTY

Solar Energy Products, Inc. warrants its Solar Domestic Hot Water Systems with the following conditions and limitations

A. Conditions of System Warranty

1. This warranty is extended to consumers who purchase Solar Domestic Hot Water Systems directly from **SEP** or from any of **SEP's** Authorized Dealerships and to all subsequent owners of these systems so long as the system remains in its original installation
2. This warranty covers **Authorized** installations only when they are installed, operated and maintained according to the procedures described in the SEP Installation, Operation and Maintenance Manual and the Authorized SEP Dealer Policy Manual
3. This warranty covers **Unauthorized** installations only when they are installed, operated and maintained according to the procedures described in the SEP Installation, Operation and Maintenance Manual
4. The **Warranty Registration Card** for Suntried™ Energy Systems must be signed and completed by the Purchaser and the Installer and returned by the Purchaser within (10) days of the completion of each of the required Warranty Validation Inspections
5. The **Warranty Validation Inspection** form must be completed by the Installer, approved by the Purchaser and returned within (10) days of completion of each of the Warranty Validation Inspections.

B. Coverage of System Warranty

1. **Authorized Installations**

   Warranty applies when the system is installed by an Authorized **SEP** Dealer properly licensed to install Solar Domestic Hot Water Systems

   a. One year full warranty from date of initial installation completion against failure of the Solar System, including any component or assembly, where such failure is caused by a defect in materials or manufacture, installation, or corrosion of the absorber plate or coolant passages. This warranty covers the full cost of parts, labor, shipping (to the site), handling (necessary to remedy the defect), replacement at the site (if necessary), and field inspection within a reasonable time of the complaint to verify and establish probable cause and determine corrective action (by an **Authorized SEP Dealer**.)

2. **Unauthorized Installations**

   Warranty applies when the system is installed by a properly licensed contractor but **not** by an **Authorized SEP Dealer.**

   a. **One year limited warranty** from date of initial installation against failure of the solar system, including any component or assembly where such failure is caused by a defect in materials, manufacture, or corrosion of the absorber plate or coolant passages. This warranty covers the full cost of parts and shipping (to the site).

3. **Unwarranted Installations**

   Systems installed by unlicensed personnel and/or those with no [illegible]

II. COMPONENTS WARRANTY

[illegible] following components, along with each component's warranty coverage, refer to the manufacturer's warranty cards.

A. Collector Limited Warranty

Solar Energy Products, Inc. warrants the **Solar Energy Products, Inc.** [illegible] any component or assembly for a period of **five years** from date of installation against failure of the collector caused by a defect in materials or manufacture, but not glass breakage. This warranty covers the full cost of all parts, labor, shipping (to the site), handling (necessary to remedy defect), replacement at the site (if necessary) and is unaffected by change of ownership as long as the collector remains in the original installation.

NOTE: Collector is not warranted against damage from exposure to freeze conditions.

B. Absorber Plate and Coolant Passages

Solar Energy Products, Inc. warrants the **Solar Energy Products, Inc.** Collector absorber plate and coolant passages for a period of five years from the date of installation against failure due to corrosion **ONLY** when, in Closed Systems original fluid and any makeup consists of 50/50 mixture of Prestone II® manufactured by Union Carbide Corp. (or any copper compatible heat exchange fluid as determined by the Copper Development Associations) and distilled water or water testing from 9.4 to 7.0 ph. In Open Systems water having a ph between 9.4 and 7.0 is acceptable. This warranty covers, for the first year only, the full cost of all parts (including the cost of furnishing a new absorber plate), labor, shipping (to the site), handling (necessary to remedy the defect), and replacement at the site (if necessary). This warranty covers for the **second through fifth years** the full cost of all parts (including the cost of furnishing a new absorber plate), labor and shipping to the site. The warranty goes with the collector and is unaffected by change of ownership so long as the collector remains in the original installation.

C. Differential Controls Limited Warranty

Solar Energy Products, Inc., and Hawthorne Industries warrant **Solar Energy Products, Inc.** differential controls for a period of **one year** from date of purchase against failure due to defect in materials or manufacture, providing that the product has not been repaired, serviced, altered, subjected to misuse, neglect, accident or improper installation (by anyone other than the manufacturer). This warranty covers the full cost of parts, labor and shipping, and is unaffected by change in ownership, so long as the controller remains in the original installation.

D. Pumps Limited Warranty

Solar Energy Products, Inc., and Grundfos Corp. warrant all Grundfos Pumps sold by **Solar Energy Products, Inc.** for a period of **eighteen months** from date of purchase against failure caused by defect in materials or manufacture, provided that they are properly installed and used with manufacturer's recommendations, and have not been repaired or altered outside the Grundfos Pumps Corporation factory. This warranty covers the full cost of all parts, labor and shipping and is unaffected by the change in ownership, so long as the pump remains in its original installation.

E. Storage Tanks and Storage Tanks With Built-In Heat Exchangers Limited Warranty

Solar Energy Products, Inc., Mor-Flo Industries, Inc., Ruud Manufacturing Co. and Rheem Manufacturing Co. warrant storage tanks and storage tanks with built-in heat exchangers sold by **Solar Energy Products, Inc.,** for a period of five years from date of completion of installation against failure caused by defect in material, manufacture, or natural corrosion provided that the heat exchanger solution is maintained per instructions. This warranty covers the full cost of parts, labor and shipping and is unaffected by change in ownership, so long as the storage tanks and storage tanks with built-in heat exchangers remain in their original installations.

III. AUTHORIZED SEP DEALER WARRANTY REQUIREMENTS

Authorized **SEP** Dealers are responsible and obligated to comply with all local, state and federal consumer warranty requirements.

Installations must be performed by properly licensed personnel in accordance with all known governing building ordinances.

Authorized **SEP** Dealer is responsible and obligated to be adequately insured for completed operations liability.

Authorized **SEP** Dealer is responsible and obligated to perform 30 day warranty inspection as well as inspection at the end of 365 days of system operations.

WARRANTY SCHEDULE FOR SOLAR ENERGY PRODUCTS, INC., DOMESTIC HOT WATER SYSTEMS

ITEM	System Including All Components and Assemblies		Collector	Absorber Plate Coolant Passages Collector		Differential Controls	Pumps	Storage Tank and Heat Exchanger
WARRANTOR	Authorized Dealer Installer		Mfg Vendor	Mfg Vendor		Mfg Vendor	Mfg Vendor	Mfg Vendor
WARRANTOR'S NAME			SEP	SEP		Hawthorne, SEP	Grundfos, SEP	Mfg Rep RHEEM SEP
INSTALLATION	Auth	Unauth						
WARRANTY PERIOD	1 yr	1 yr	5 yrs	1 yr	2 5 yrs	1 yr *	18 mos *	5 yrs *
WARRANTY COVERS FAILURE DUE TO:								
Defect Material	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manufacture, Installation,	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CORROSION:	Yes	No	No	No	No	No	No	No
Absorber & Passages	Yes	Yes	No	Yes*	Yes*	—	—	—
COSTS COVERED BY WARRANTY:								
Parts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Labor	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Shipping	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Handling	Yes	No	Yes	Yes	No	No	No	No
Inspection	Yes	No	No	No	No	No	No	No
Replace at Site	Yes	No	Yes	Yes	No	No	No	No
SUBSEQUENT OWNER COVERED	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* Not warranted when damage is caused by use of unacceptable transfer fluid.

WARRANTOR'S NAME	ADDRESS	PHONE
Solar Energy Products, Inc.	1208 N.W. 8th Avenue, Gainesville, FL 32601	(904) 377-6527
Grundfos Pumps Corporation	2555 Clovis Avenue, Clovis, CA 93612	(209) 299-9221
Metal Industries, Inc.	18450 South Miles Road, Cleveland, OH 44128	(216) 663-1400
RHEEM Water Heating Division, City Inv. Co.	7600 South Kedzig Avenue, Chicago, IL 60652	(312) 436-5400
Ruud Water Heating Division, City Inv. Co.	7600 South Kedzig Avenue, Chicago, IL 60652	(312) 436-5400

INDEPENDENT LIVING INCORPORATED (ILI)
SOLAR ENERGY SYSTEMS
CERTIFICATE OF LIMITED WARRANTY

A. A FIVE-YEAR WARRANTY

Each ILI Solar Energy System, which consists of the compressor, collectors, energy storage tank, control unit, domestic hot water tank, water coil and expansion device, is warranted by Independent Living, Inc. (ILI) to be free from defects in material and workmanship for five (5) years or for the time warranted by the original equipment manufacturer, whichever is shorter, from the date of shipment, and, if found upon inspection by ILI to be defective, will be repaired at ILI's expense, provided that the defective material is returned, all transportation charges prepaid, to the nearest ILI Authorized Repair Station. The location of said repair station can be obtained by telephoning (Area Code 404 – 455-0927).

B. TWELVE-MONTH COMPONENT WARRANTY

Each solar system component is warranted by ILI to be free from defects in material and workmanship for twelve (12) months from the date of shipment and, if found upon inspection by ILI to be defective, will be repaired or replaced at ILI's option and expense, provided that the defective part is returned, all transportation charges prepaid, to the nearest ILI Authorized Repair Station. The location of said repair station can be obtained by telephoning ILI (Area Code 404 – 455-0927).

C. TWELVE-MONTH INSTALLATION WARRANTY

If during the first year after installation the system fails due to defective workmanship by ILI, ILI will repair the system. This warranty is not valid if any modifications or repairs to the ILI installed solar energy system are made by anyone other than ILI or its designated representative.

D. GENERAL WARRANTY CONDITIONS AND LIMITATIONS

This warranty does not cover any field labor for replacement or repair of parts, or for inspection, removal, transportation to and from the ILI Authorized Repair Station or reinstallation of component or water-source heat pump. Replacement or repair under this warranty will not extend the above warranty periods.

This warranty is extended to protect the user from equipment defects only, and ILI assumes no liability under the terms of this warranty for parts which fail because of misapplication, improper installation, improper maintenance, abuse, corrosion, improper voltage, or acts of God or other causes beyond the control of ILI.

ILI neither assumes nor authorizes any person to assume for it any obligation or warranty other than those stated herein.

Any suggestion to the contrary notwithstanding, ILI shall not, in any event, have any liability under this warranty unless and until it has been paid in full for the product supplied. The warranty period shall begin to run as described above, however, whether or not payment has been made.

E. LIMITATION OF WARRANTIES

IT IS EXPRESSLY UNDERSTOOD THAT THIS WARRANTY IS MADE IN LIEU OF ANY AND ALL OTHER REPRESENTATIONS, CONDITIONS AND WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER ARISING FROM STATUTE, COMMON LAW, CUSTOM OR OTHERWISE, AND THAT THE PROCEDURE SET FORTH IN THIS LIMITED WARRANTY SHALL BE THE EXCLUSIVE REMEDY AVAILABLE TO ANY PERSON. NOTWITHSTANDING THE PRECEDING SENTENCE, IF THIS WARRANTY IS DEEMED TO BE FOR A CONSUMER PRODUCT AS DEFINED IN 15 U.S.C. 2301, et. seq., THEN, IN THAT EVENT, NO IMPLIED WARRANTY, INCLUDING BUT NOT LIMITED TO THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, SHALL EXTEND BEYOND THE PERIODS SPECIFIED ABOVE IN SECTION A AND B.

F. CONSEQUENTIAL DAMAGES

ILI SHALL NOT IN ANY EVENT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE OWNERSHIP, USE OR OPERATION OF THIS EQUIPMENT, WHETHER A CLAIM FOR SUCH DAMAGES IS BASED UPON WARRANTY, CONTRACT, TORT OR OTHERWISE.

G. GLASS

This warranty does not cover any glass damage at any time regardless of the cau[illegible]

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